

VINTAGE RADIO

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The AWA FS6 army transceiver

A significant number of vintage radio buffs collect and restore amateur, military and commercial radio equipment. Along with the more familiar domestic radio gear, this equipment is also a part of our radio heritage and an interesting part of it at that.

The front panel layouts of military radios are purely utilitarian and they don't look a million dollars in matt khaki or some other unexciting colour. Aesthetics was not one of the design principles and there are no elegant timber consoles here. However, it is interesting to compare them in many ways with the domestic radios of the same era.

During WWII and on the military surplus market in the late 1940s and early 1950s, the FS6 high frequency (HF) portable army transceiver was common. Many amateur radio operators modified them for use on amateur radio bands and they were also used by bushfire brigades, the Flying Doctor Service (WA), fishermen and other organisations.

However, the FS6 is not the sort of gear that the majority of vintage radio buffs collect. There are various reasons for this, the most common being that there are now very few such units around.

General description

The 1943 provisional training manual on the FS6 gives us a few pertinent facts about the equipment, which I have paraphrased. It is quoted as a medium range, portable combination sender-receiver, suitable for point-to-point communication. It has a frequency range of 4.2-6.8MHz and will operate on both W/T (CW telegraphy, Morse) or R/T (radio telephony).

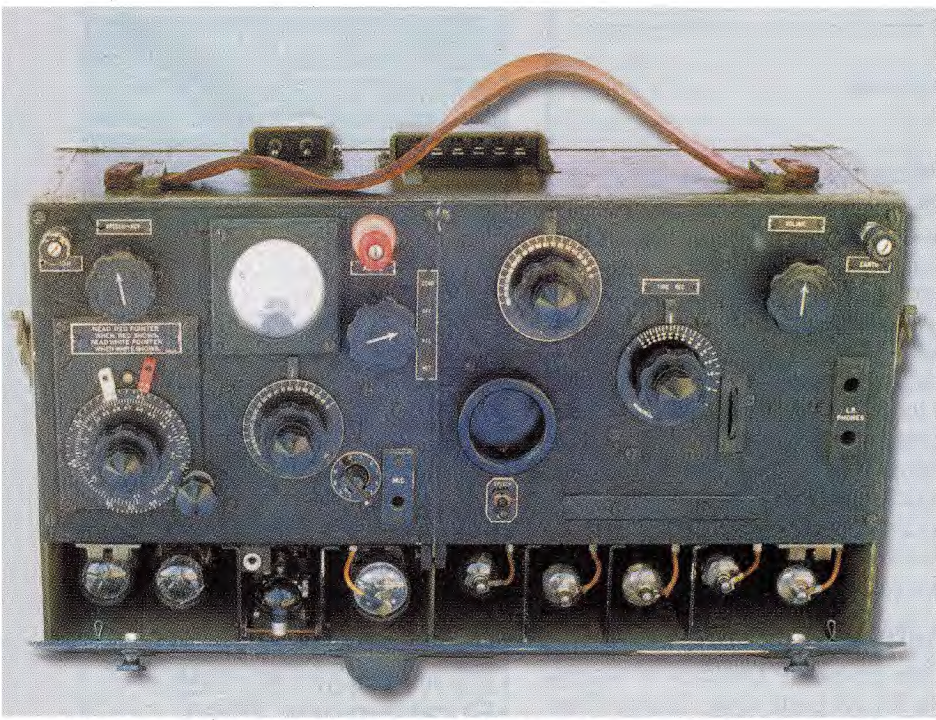
For transporting over short distances, the set can be classed as a 2-man pack. The weight of the station is listed at 157lb, or about 71.4kg (I'm glad they said "short distances") and it can be used as a ground station or as a mobile truck station.

The receiver has two headphone outlets so that two operators can operate the set at the same time. The receiver is a 5-valve superheterodyne with AVC, while the sender (transmitter) has three valves consisting of a master oscillator, a modulator and an RF power amplifier.

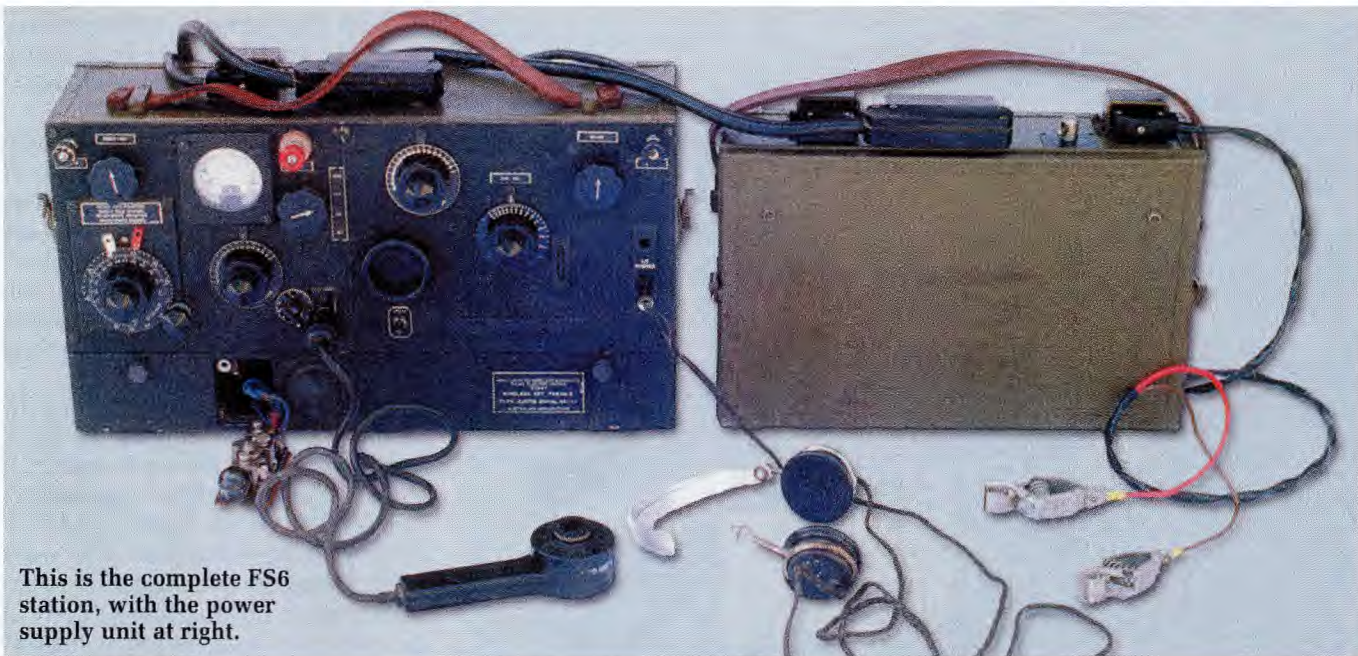
The power source is a 6V, 75Ah battery. A 6V vibrator power supply provides all of the HT and bias voltages and the set draws 3.2A on receive and 6.0A on transmit W/T. If a pedal generator is used, only a 25Ah battery is needed to power the set.

Background to the FS6

Prior to WWII, the military had a variety of specifications that had to be met when supplying equipment for their particular needs. One particular specification for radio equipment specified that the valves should all be



This view shows the FS6 transceiver with the valve access panel open. Military equipment was designed so that all valves were accessible via a single panel.



This is the complete FS6 station, with the power supply unit at right.

accessible through a hatch in the front of the case. This is clearly shown in one of the photographs of the transceiver – here, the hatch (or cover) has been left open and all the valves are clearly visible.

This made valve replacement an easy task. However, there was a real disadvantage in that the valves could not be placed in their optimum positions for stable operation, maximum gain or highest frequency operation. I suspect that this requirement came into being around the end of WWI when valves were very unreliable and hadn't been rescinded by the outbreak of WWII.

In the late 1930s, AWA produced a predecessor for the FS6 designated the 101. I don't know exactly when it was produced but I suspect that, at the time, it was the most modern set of its type, using the recently produced octal battery valves. It was a very low-powered set, mounted in the same cabinet as the FS6 and supplied with power from a slightly smaller power supply.

The 101 struggled to provide an RF output of 0.4W on voice and 0.8W on CW, whereas its successor, the FS6, put out 4W and 8W respectively – a big improvement. However, to the untrained eye, the 101 looks the same as the FS6.

I suspect that AWA was asked to provide an updated, more powerful version of the 101, that looked virtu-

ally the same and could be used in the same way as the 101 (although I have no firm evidence for this). For example, the microphone, headphones, connectors and the like would have to be interchangeable between the two types.

The receiver remained the same in each set (101 or FS6) as it had proved to be quite satisfactory. The transmitter though was a complete redesign but was still be capable of fitting into the original space allocated for it in the 101.

Valve lineup

The 101 used all battery valves. A 1K5G acted as a master oscillator with two parallel 1K5Gs in the RF output stage. Voice modulation of the 1K5G output stage was achieved by impressing the voice signal onto its grid. Carbon microphones are high output units and there was sufficient audio energy put out to modulate the transmitter output stage when fed through a microphone transformer.

The transmitter was redesigned to use a 1L5G as the master oscillator and the ubiquitous 807 small transmitting valve as the output stage. However, it was more difficult to modulate the grid of the 807. As a result, another 1L5G was added after the microphone transformer to boost the audio to a sufficient level to modulate the transmitter effectively.

Another of the photographs shows

the equipment assembled and almost ready to operate, needing only a battery and an antenna and earth to complete the installation. The microphone rubber mouth piece had perished, so it is no longer fitted. Normally the

bottom left is a toggle switch which changes the operation of the receiver from voice (radio-telephone) to Morse code (wireless-telegraphy) – ie, this is the mode switch.

Above the mode switch is a “mystery” circular black bakelite holder of some sort. These devices were a mystery to me for some time and are mounted on many military radio transceivers. They are a holder for a fob watch. It was necessary to have a watch in a secure spot so that radio schedule (skeds) times could be kept.

The transmitter front panel is a little more crowded than the receiver. At the top left is the earth terminal, with the mode switch (speech-key) alongside it. In the centre top is the aerial current meter which is used when tuning the transmitter for maximum output power. Alongside it to the right is the aerial terminal and just below that is the “send/off/receive/net” switch which controls the switching between the transmitter and the receiver.

On the bottom left are the variable frequency oscillator controls. There is a locking knob in the centre of the frequency control knob and a rubber drive vernier onto the edge of the main control knob. The two controls at bottom right are used together to tune and match the transmitter to the aerial. Alongside these controls is the microphone jack.

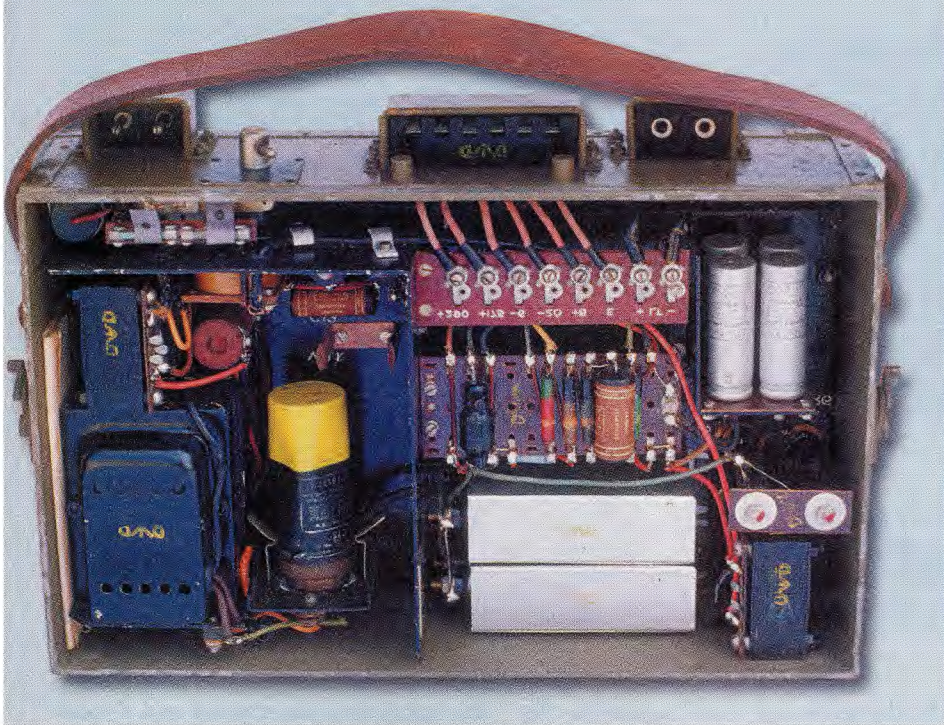
The Morse key is set into the valve access cover and is slid out when it is to be used. Alongside it is a jack which is used for remote control of the set. However, remote control of sets like these is rather limited in scope compared with what is expected from modern remote controls.

The power supply is in the separate case at left and has only one control which is the on-off switch. It also has three plug/socket connections to go to the transceiver and the battery.

The receiver

The receiver has a conventional superhet circuit typical of the era. The converter uses a 1C7G, followed by a 1K5G first IF amplifier on 460kHz, then a 1K7G as a second IF amplifier, detector, AGC detector and reflexed first audio. Following the 1K7G, audio is applied to another 1K7G which feeds a pair of low-impedance headphones via a transformer.

The basic circuit is similar in many



This view shows the FS6 power supply with the access cover removed. The vibrator is at bottom left.

power supply is stood to the left of the set and the headphones should be low impedance. The cabling between the power supply and the transceiver is made in such a way that it is impossible to interconnect them incorrectly.

The receiver is located in the righthand section of the cabinet while the transmitter is on the left. The receiver has relatively few controls and they don't follow the general layout used on domestic receivers.

Starting at the top left, the control here is the aerial tuning control, which is used to peak the performance of the receiver on different aerials. Once set, it can be locked in position by its central knob. At the far right is the volume control, with the earth terminal nearby.

The tuning control is in the centre, with the vernier tuning control just to the right of it. On the far right are the parallel headphone sockets. At the

Photo Gallery: Tasma Model 22

TASMA MODEL 22: manufactured by Thom & Smith, Sydney in 1931, the Tasma Model 22 is a 3-valve TRF receiver with the following valves: 224 detector, 247 output and a 280 rectifier. (Photo and information courtesy of Historical Radio Society of Australia).



FS6: RECEIVER UNIT

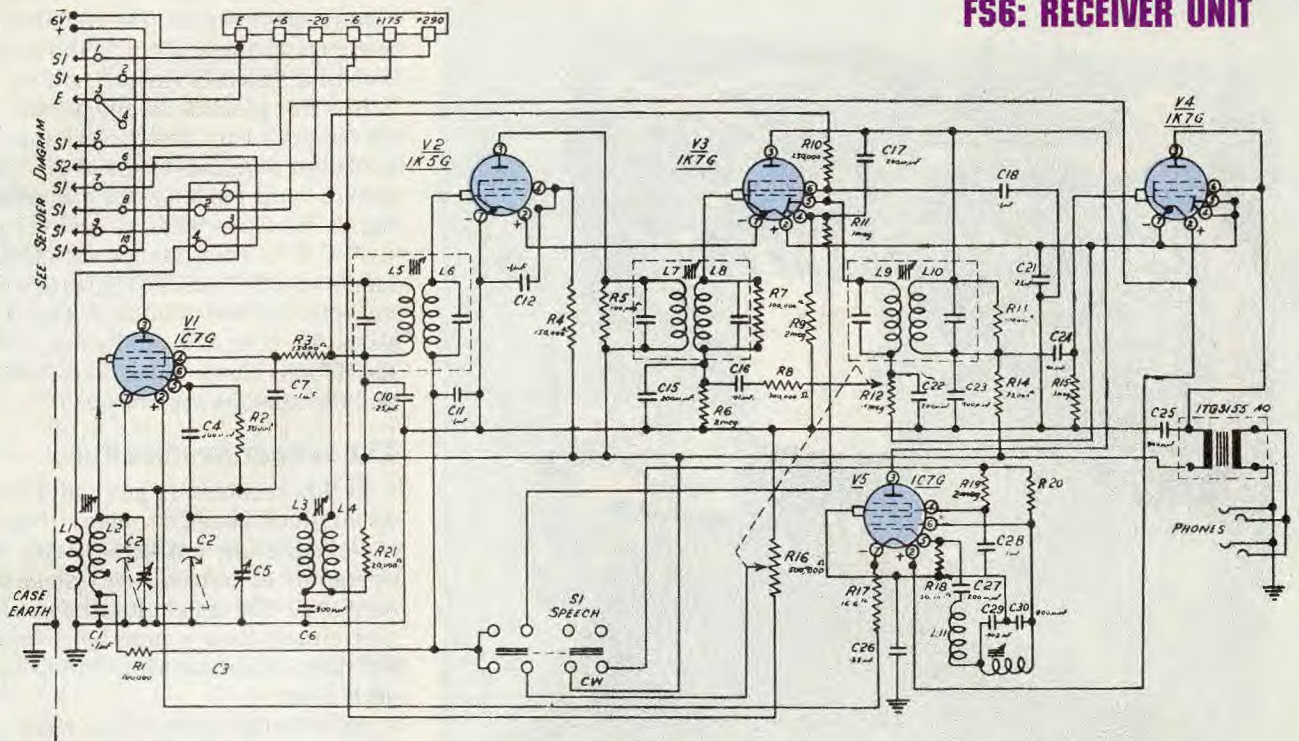


Fig.1: the FS6 receiver unit employed a conventional superheterodyne circuit with five valves.

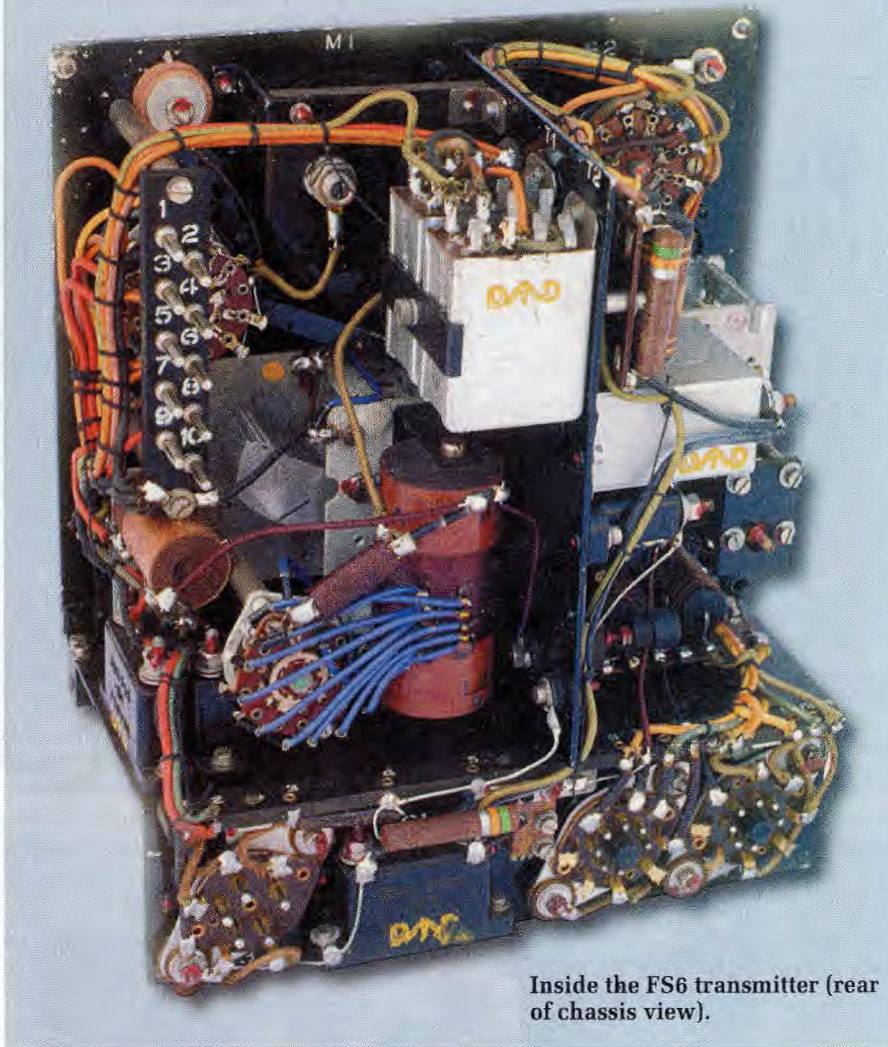
ways to sets such as the Fisk Radiola 184 of 1939.

This set had a different job to do compared to the domestic receivers of the era and so there are noticeable differences in some areas of design. Portable military radios very rarely had loudspeaker output, for several reasons: (1) it was much easier to hear clearly what was being sent to you if headphones were used and this avoided mistakes; (2) quite a bit of radio traffic was for the officer in command only and no-one else (operator excluded); and (3) when the sets were used on the front line, you didn't want the enemy hearing what was going on or being able to pinpoint where you were.

The other major difference is in the use of a beat frequency oscillator, which is V5 (1C7G) in the circuit. When receiving Morse code messages, this oscillator - which operates at around 460 kHz in the FS6 - beats with the incoming Morse signal to give an audio tone. AGC systems of the era didn't work well with Morse code signals, so the AGC system is disabled and a variable bias is applied to the AGC line via a ganged volume control (R12 and R16 are ganged via a belt).



Inside the FS6 receiver (rear of chassis view).



Inside the FS6 transmitter (rear of chassis view).

By increasing the volume control, the volume setting is increased and the bias applied to the AGC line (via R16) is decreased, thus increasing the gain of the RF section of the set.

In operation, the receiver works quite well and is reasonably sensitive. The dual-speed tuning is easy to operate and, using the vernier dial drive, shortwave stations are tuned as easily as broadcast band stations on typical domestic radios.

This particular receiver needed no replacement components when it was refurbished back in 1973, although that situation may have changed by now of course. The receiver circuitry is removed by undoing four screws at the front of the set and pulling it out of the case.

Most military sets aren't particularly easy to service and the FS6 receiver appears to be no different. That said, a close inspection of the chassis

reveals that much thought has gone into making the components relatively easy to access, despite the compact nature of the radio.

For example, the bottom adjustments for the IF transformers are easily accessed at the back of the set. On the other hand, the top adjustments are close to the front panel and at first sight, appear to be inaccessible. However, although not obvious in the photographs, there is a small panel on the front of the set that is removed to gain access to the IF transformer adjustments.

Should an IF transformer become defective, it is surprisingly easy to remove. Conventional wisdom has it that IF transformers are removed through the top of the chassis (plate) but this clearly impossible with the FS6, as the transformer top is hard up against the front panel. In this case, the transformer connections are un-

soldered and then the mounting screws are removed. The transformer is then withdrawn through the underside of the chassis (plate) – nifty.

It is not possible to operate the receiver out of its case unless jumper leads are attached to the 4-pin plug shown in the top left of the circuit (see Fig.1). The connections are: (1) HT +175V @ 27mA (maximum); (2) filaments +6V @ 240mA; (3) bias -6V @ < 1mA; and (4) aerial/antenna. The chassis is the common return circuit for the HT and filament negative, the bias and the antenna system earth.

The sender (transmitter)

In this section I've gone into more detail than usual, as many vintage radio buffs are unfamiliar with the operation of transmitters. Generally an AM or CW transmitter has a simpler circuit than a superhet receiver but they are noticeably different from each other.

As with the receiver, the transmitter is removed from the case by undoing four screws and pulling it out. A rear view of the chassis is shown in one of the photos.

This is a reasonably simple transmitter, having just two stages in the RF section and one in the audio section. A 1L5G (V2) acts as the variable frequency oscillator (master oscillator or VFO) and determines the actual transmission frequency. It has temperature compensating capacitors (top left in circuit) to ensure that the transmitter's output frequency does not drift unduly when operating.

The VFO is similar to the local oscillator in a superhet receiver but works at a higher power level. The signal from the VFO is applied to the 807 where it is amplified. The output signal is then applied to the tuning and matching circuits consisting of C14, L2 and S3 which ensure efficient transfer of power to the antenna system.

The output circuit of the transmitter is not unlike the circuitry of crystal sets, where the antenna and diode detector are matched to the tuned circuit for best performance. It is necessary to have a transmitter working at optimum efficiency for several reasons: (1) to provide the maximum output power transfer possible (for maximum efficiency); (2) to keep the valve dissipation down; and (3) to economise on the use of electrical power

(important when using batteries).

In the Morse code mode (CW), the transmitter has grid block keying. This involves placing a bias of -20V onto the grids of the 1L5G (V2) and the 807 (V3), which effectively prevents the 1L5G from conducting and in the case of the 807, reduces the current drain to a safe level when the key is up. When the key is down, the bias is removed and the transmitter operates.

When the transmitter is switched to voice operation, the VFO (V2) runs continuously with no blocking bias. The 807 power amplifier operates using both fixed bias (-20V) and self-bias, the latter derived from half-wave rectifying the signal from the VFO at its grid. The voice signal from the carbon microphone is amplified by V1 (1L5G) and fed to the grid of the 807 via T2, the modulation transformer.

The voice signal is impressed onto the grid of the 807 in series with the -20V bias. The resulting variation in the bias causes the 807 circuit to act as a high-power mixer. Mixers have several signals in their outputs and, in this case, we have the VFO frequency, the audio frequency and the products VFO + audio frequency and VFO - audio frequency.

The circuit only passes the RF signals. The VFO signal is the carrier and the + and - audio signals form the upper and lower sidebands. These three components form the composite AM signal we are all familiar with.

The power supply

The power supply is quite large for the amount of power it provides to the transmitter and receiver.

As shown in one of the photos, there isn't a lot of spare space inside the case. The front cover is just clipped on by two catches, one on each end. But despite this being an imperfect fit around the edges, there is very little interference to reception from the supply.

This is also quite a reliable power supply. The vibrator had a long life and rarely required replacement. This was probably due to the design of the vibrator transformer (T1) and the buffer arrangement (C6, C7, R7 & R8). In addition, the vibrator was sealed and filled with nitrogen gas.

Summary

Commercially made HF radio trans-

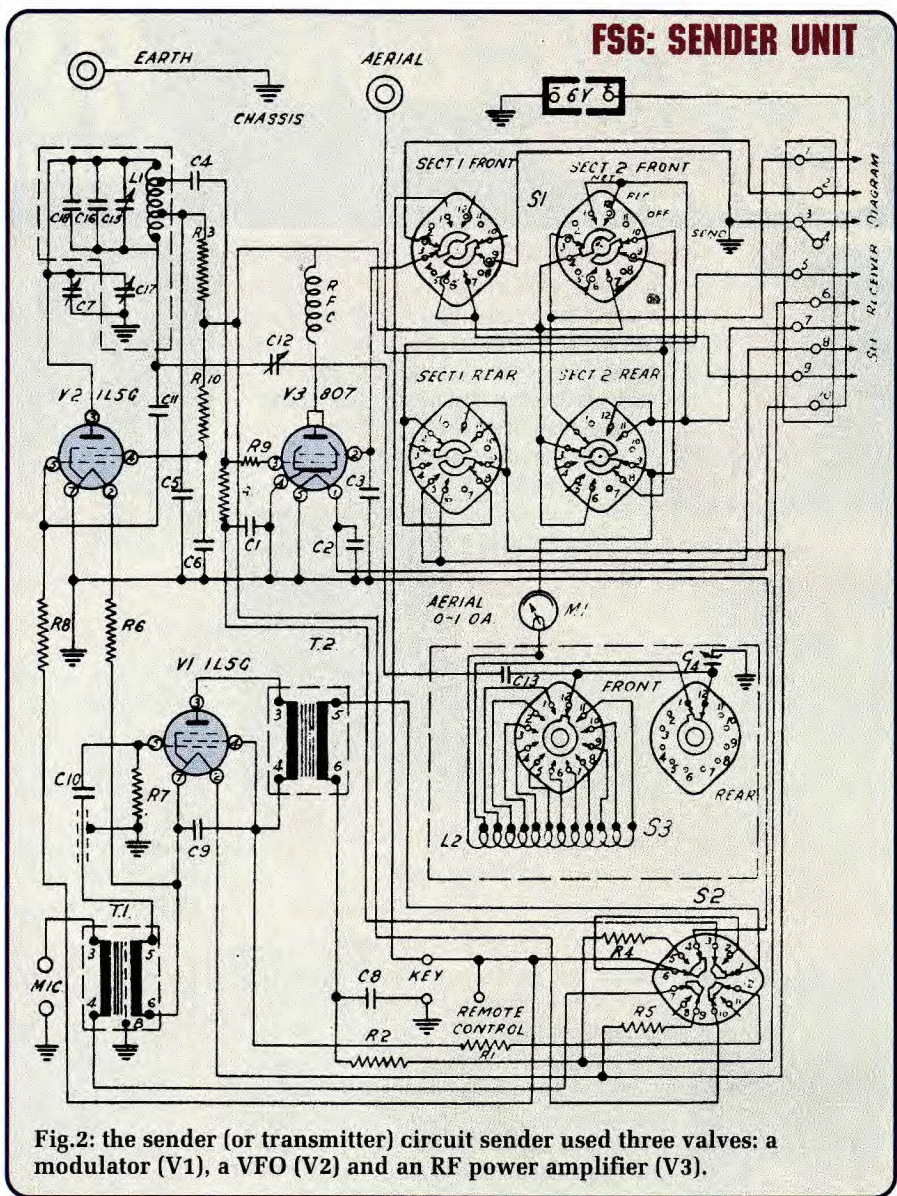


Fig.2: the sender (or transmitter) circuit sender used three valves: a modulator (V1), a VFO (V2) and an RF power amplifier (V3).

ceivers were rare and expensive after WWII. However, many of these WWII transceivers came onto the surplus market at a relatively low price.

They were often extensively modified to provide crystal control of the transmitter and to provide different and extended frequency ranges. Loudspeaker output was also sometimes added. For example, amateur radio operators modified them extensively to operate on the 3.5MHz and 7.0MHz bands.

Unfortunately, the FS6 wasn't very suitable for use where mud, water, humidity and dust were common – and that included many areas where the set was expected to be used. The set had no sealing gaskets around the cabinet edges, along control shafts or

over sockets to prevent the ingress of water, mud and the like. Additionally, it did not have "tropic proofing" or desiccator crystals to keep the moisture out of the set.

It also drew more current from the battery than later sets and its tuning range was quite restrictive – 4.2-6.8MHz, whereas later sets intended for the same job tuned 2-8MHz.

However, despite its many faults I believe that in the right environment, it would have proved an easy set to operate and keep in working order. As an aside, the later 122 portable transceiver cost around 1000 pounds during WWII – about the same as a Holden car soon after the war.

Military equipment wasn't cheap to produce!