

Vintage Radio

By Rodney Champness, VK3UG



The AWA 157P 7-transistor portable radio



Built in Australia more than 50 years ago, this AWA 157P 7-transistor radio is still in good condition and required only a few minor repairs to restore it to working order. It's built like a valve receiver, with point-to-point wiring and no printed circuit board.

TRANSISTOR RADIOS were well-established as a consumer item by about 1960, the year the AWA 157P was first manufactured. In fact, electronics hobbyists had been introduced to transistors as components as far back as 1954. "Radio & Hobbies" often carried ads for the Philips OC44, OC45, OC70, OC71 and OC72 series germanium transistors. These usually sold for around a pound to thirty shillings (\$2 to \$3).

By 1958, quite a few transistor receivers were coming into the country from Japan and Australia was also starting to produce sets at that time. These sets were quite a practical proposition if you lived in a city where one or more reasonably powerful radio stations were located.

Some of the early Japanese-manufactured receivers used a phenolic board that had holes punched through it, with the pigtailed of the components

wired to each other as required by the circuit. These sets were quickly followed by designs using true printed circuit boards (PCBs). However, it was necessary to be quite careful when installing or replacing parts in such early sets, as too much heat easily lifted the tracks off the board.

Australian manufacturers were slower off the mark when it came to using PCBs and the AWA 157P 7-transistor set featured here retained the point-to-point wiring techniques of the valve era, despite being circa 1960. And although the transistors were not mounted in sockets (as some manufacturers did), several are mounted through rubber grommets that are in turn fitted to the chassis.

These transistor mounting grommets are roughly located where valve sockets would be otherwise be fitted in an "equivalent" valve set. So the 157P was very conventional for its time. Compared to Japanese sets of the same era, they would have been more costly to produce.

Main features

As shown in the photos, the AWA 157P portable is built into a good-quality black leatherette and thick card case. The case front features an attractive perforated aluminium mesh, behind which is mounted a 5 x 7-inch (125 x 175mm) loudspeaker.

A hand-span direct-drive system is used for the tuning dial. This simple but reliable method was used by many manufacturers to keep prices down and is quite adequate for broadcast-band portables and other low-priced receivers.

The case itself is reasonably large. As a result, the parts are quite well spread out and access to the components is quite reasonable, which makes restoration easier. However, like most portables of the era, this set had a few problems with its case. In some places, the leatherette had become detached from the thick cardboard sections and

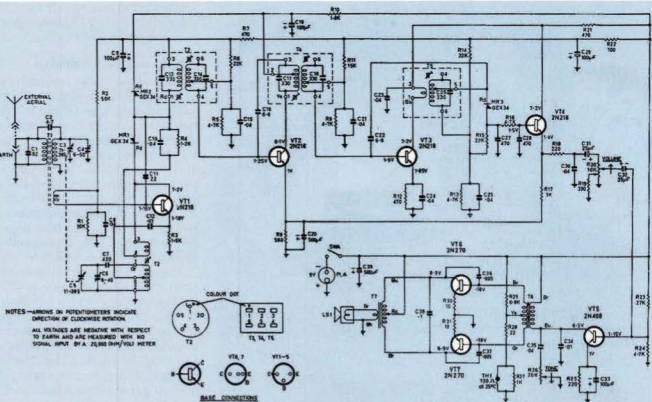


Fig.1: the circuit uses seven transistors in a fairly conventional superhet arrangement. VT1 is the converter, VT2 & VT3 are IF amplifier stages, VT4 is a preamp stage and VT5-VT7 form the audio amplifier. Output pair VT6 & VT7 are wired in push-pull configuration and are driven by VT5 via centre-tapped transformer T6.

some of the stitching around the edges had worn through.

By contrast, the set is very clean internally for its age with no evidence of corrosion. It weighs in at 3.1kg complete with battery, so it's no lightweight.

Circuit details

Take a look now at Fig.1 for the circuit details. It's fairly typical of the era, with an autodyne converter stage (VT1), a 2-stage IF amplifier (VT2 & VT3), a diode detector (MR3) and three audio stages (VT4-VT7). The output stage uses a pair of transistors (VT6 & VT7) wired in push-pull configuration.

Power is supplied from a type 276P 9V battery. The current drain with the volume turned down is 18mA, which is slightly more than the current drain from the 90V battery of a valve portable. However, because the supply to this transistor set is only 9V it is around six times more efficient and that's before we even consider the filament current in a valve set.

It's no wonder that transistor receivers became so popular when both battery cost and weight were so

dramatically reduced. Of course, the current drain did rise considerably when the volume control was turned up and could reach 45mA on peaks.

A large ferrite rod (200mm-long x 13mm-diameter) is used for the signal pick-up. In addition, the AWA 157P has provision for an external antenna and earth to boost the performance on distant stations and this scheme works very effectively.

Transistor VT1, a 2N219, is wired as an autodyne frequency converter. Its 455kHz output is fed to the base of VT2 (2N218), the first IF amplifier, via double-tuned IF (intermediate frequency) transformer T3.

From there, the signal is applied via another double-tuned IF transformer (T4) to transistor VT3, the second IF amplifier. VT3's output is then fed to single-tuned IF transformer T5 and then to detector diode MR3.

As an aside, triode valves have considerable capacitance between their grid and plate elements and will often oscillate in RF and IF circuits if they are not neutralised. Similarly, transistors have considerable capacitance between the base and the collector and may also oscillate if not neutral-

ised. As a result, the two IF amplifier stages are both neutralised using 6.8pF capacitors C16 & C22 to make sure this doesn't occur.

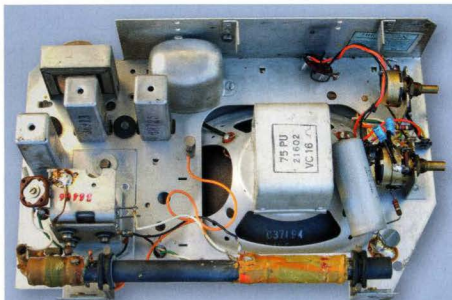
The detected audio signal is fed to the base of VT4 (another 2N218) which serves as a preamp stage. Its output is taken from the emitter and fed via a 10kΩ volume control pot to the second audio amplifier VT5 (2N408). The signal on the collector of this transistor is then fed to audio transformer T6 which in turn drives output pair VT6 & VT7 (2N270) which operate in push-pull configuration.

PNP transistors

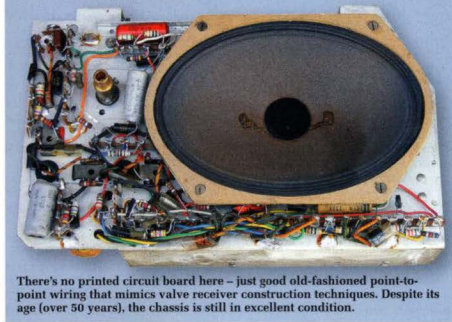
As is typical of the era, the transistors used in the AWA 157P are all PNP germanium types. As a result, the positive terminal of the battery is connected to the chassis and all voltages are negative with respect to the chassis (ie, the supply rail is at -9V). This "positive earth" is the opposite to what we normally expect in a set and must be kept in mind when servicing some early transistor radios.

Complex AGC

As with many other transistor re-



The circuit is built on a metal chassis, similar to a valve receiver. Note that several of the transistors are mounted in rubber grommets which are in turn mounted on the chassis.



There's no printed circuit board here – just good old-fashioned point-to-point wiring that mimics valve receiver construction techniques. Despite its age (over 50 years), the chassis is still in excellent condition.

ceivers, the AGC system in the AWA 157P is more complex than is usually the case with valve receivers. The output from the detector not only has an audio component but also a DC component which increases (ie, becomes more negative) as the signal strength increases. This DC voltage (along with the audio signal) is applied to VT4 and as a result, the emitter voltage increases with stronger signals.

VT4 acts as a low-impedance DC amplifier for the AGC system as well as an audio preamplifier. A third of the DC voltage at VT4's emitter is

applied to the emitter of VT2 (via a voltage divider). As a result, VT2's emitter voltage increases (from around 1V) with increasing signal strength and this in turn reduces the gain of this stage (note: VT2's base voltage is biased to 1.25V by the voltage divider consisting of R5 & R6).

In addition, the supply rail to VT2 is decoupled using R10 and C19. With no signal input to the set, the voltage across C19 is around -5.5V but this increases to around -8.2V with a strong signal as VT2 draws less current. If the incoming signal is extremely strong,

diode MR2 conducts and shunts the signal that's fed to VT2, thereby further reducing the receiver's gain.

Audio amplifier design

The audio amplifier is bound to look quite foreign to an audio enthusiast today. It has only two stages and three transistors, to give sufficient audio and gain from the signal at the collector of VT4, a germanium 2N218. This was devised long before the days of complementary transistors, direct-coupled amplifiers, high negative feedback and so on. Indeed, look at the circuit and you will find that there is no negative feedback around the audio amplifier. None. So how does it work?

The signal from the volume control is AC-coupled to the base of VT5, a 2N408 transistor which is operating in class-A. It drives an interstage transformer, T6. Why would you need an interstage transformer in an audio amplifier? At the time, designers had not figured out a simpler way to generate two out-of-phase signals to drive a push-pull class-B output stage. In a valve amplifier, they would have used a "phase splitter" but trying to couple such out-of-phase signals had yet to be worked out.

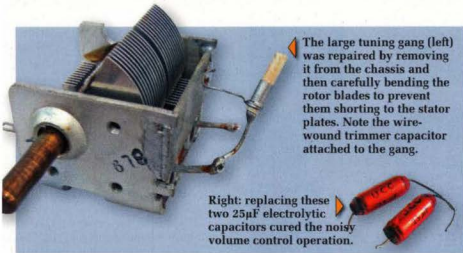
Ultimately, when NPN and PNP power transistors became available, the solution was easy but this was more than 10 years away (with complementary germanium power transistors).

The secondary of the interstage transformer is split into two halves, with each half driving the base of a PNP output transistor (VT6 & VT7). The centre tap of the secondary is connected to a resistive divider and this provides the base bias to the two output transistors which operate in class B, albeit with a small quiescent current to minimise crossover distortion.

Note that each output transistor drives only one half of the primary of the associated output transformer, T7, with DC flowing into the centre-tap and out into the respective collectors of the output transistors.

The operating conditions of the output transistors were stabilised against thermal runaway (yes, they had it in those days – they discovered it!) by the negative temperature coefficient (NTC) thermistor, TH1. It worked quite well and again, was the solution long before such circuit techniques as "Vbe multipliers" were devised.

And as far as negative feedback was



The large tuning gang (left) was repaired by removing it from the chassis and then carefully bending the rotor blades to prevent them shorting to the stator plates. Note the wire-wound trimmer capacitor attached to the gang.

Right: replacing these two 25 μ F electrolytic capacitors cured the noisy volume control operation.

concerned, it was more trouble than it was worth. With transformers in the circuit, the resultant phase shifts meant that only a small amount of negative feedback could be applied before instability became a problem; better to do without!

Cabinet restoration

Removing the chassis from the case is quite straightforward. The first step is to remove the two control knobs by pulling them off their shafts, followed by the hand-span dial. The latter is removed in similar fashion and was quite tight in this set but eventually came loose without damage.

The chassis itself is held in the case by three screws, one at either end of the handle and one through the bottom of the case. Once these were removed, the chassis could then be slid out through the back (after unclipping the rear flap).

That done, the case was wiped clean

with a moist cloth. The next step was to repair the case where the leatherette had come away from the bottom of the rear flap. The leatherette was simply glued back onto the cardboard using contact adhesive and held in position using a couple of clamps and scrap timber until the glue dried.

The leatherette had also come away from the top edges of the case and this was repaired in similar fashion. Once these repairs had been completed, the case looked quite good. It wasn't practical to repair the worn stitching along the edges but this particular problem is not particularly obvious.

Next, the plastic hand-span dial wheel was given a polish to reduce the scratch marks that were on it. The red station indicator line had also worn away in places over the years and this was repaired by dipping a steel nibbed-pen in red paint and running it carefully along the old line. This method worked well and the indicator

line now looks like new.

The dial-scale itself was also lifting along the edges so this was glued back into place using Tarzans Grip[®]. All that remained then was to remove the years of grime from the flutes of the knobs and this was done by scrubbing them with a nail brush and soapy water.

Circuit repairs

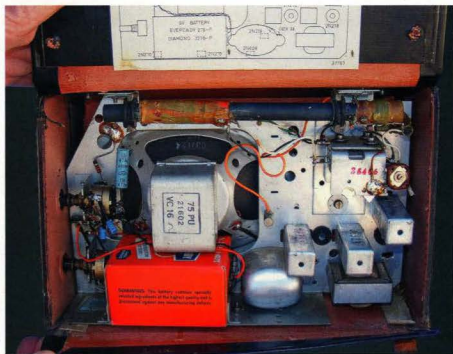
Leaky capacitors are far less critical in transistor sets than in valve receivers and it is usually safe to turn transistor sets on before doing any component replacement. The exceptions are when there is a short across the battery socket or where badly overheated (burnt) components are obvious.

In this case, it was immediately obvious why this set had been taken out of service – the stators and the rotors on both sections of the tuning gang were shorting at the low-frequency end of the dial. In addition, the volume control was extremely noisy, with many dead spots on the track.

In short, it was a bit of a basket case! However, it seemed that if I could cure both of these problems, the receiver would probably work.

The twin-gang tuning capacitor was hard to get at in-situ, so I removed all the wires soldered to it and carefully labelled them. I then removed the extension on the tuning shaft, after which I removed the tuning gang and its small adaptor plate which was mounted to the chassis. I then removed the three screws that held the tuning gang to the mounting plate.

Once the tuning gang was free, I inserted a one-sided razor blade between



The chassis is secured inside the case using three screws – two at the top and one at the bottom. The battery is no longer authentic, the case now housing six 1.5V cells connected in series in a 6-way battery holder.

the shorting plates to lever them apart. This was only partially successful and in the end I found that I had to fully open the gang and drag a finger across the rotors to bend them slightly. Finally, after some further adjustments using the razor blade, I was able to get the rotor vanes to mesh with the stators without any shorts occurring.

Having done that, I reinstalled the tuning capacitor and wired it back into circuit. As can be imagined, the entire procedure was quite time consuming but it needed to be done with care, otherwise the tuning capacitor would have been ruined.

Faulty electros

At this point, the set was tested again and many stations could now be heard but the volume control was certainly very noisy. Sometimes, spraying a volume control with contact cleaner will fix this problem but in this case it didn't work.

As many will know, volume controls in valve radios that have DC flowing through them can be quite noisy. In some sets, the volume control is part of the detector load and this was done to reduce the component count. In other cases, the control becomes noisy because of leaking capacitors.

Electrolytic capacitors are used to couple between the audio stages in

most transistor receivers and although they do have some leakage, this is not usually a problem. In this receiver though, they were the problem and replacing C31 and C32 (both 25 μ F electrolytics) completely eliminated the noise.

In fact, these two capacitors were so leaky that I decided that it would be a good idea to replace all the electrolytic capacitors where leakage might cause a problem. These included capacitors C9, C19 and C29 (all 100 μ F).

Alignment

The IF transformers in the AWA 157P provide better selectivity than those in many other transistor receivers. The first two IF transformers (T3 & T4) are double-tuned, while the final IF transformer (T5) has one tuned circuit (and one tuning slug).

To align the set, I first tuned to a weak station and endeavoured to adjust all five IF transformer cores for best performance. One core, however, was jammed and couldn't be adjusted, so I had to adjust the other four around the frequency that it was set at. Fortunately, it was very close to 455kHz and the remaining tuned circuits were also very close to this frequency, so not much adjustment was needed.

The oscillator tuned circuit was next on the list. As it stood, the sta-

tions were quite close to the locations marked on the dial-scale and it was only necessary to remove a couple of turns from the wire trimmer used in the oscillator circuit to get them spot on. Unfortunately, I was unable to free the tuned winding on the loopstick antenna to adjust it at the low frequency end of the dial, as the locking "gunk" used on it had penetrated between the inside of the coil former and the ferrite rod itself. However, it does appear to be quite close to optimum.

Finally, the trimmer was adjusted at the high-frequency end of the dial and once again little adjustment was required. So it looked like AWA had used good-quality components in the tuned circuits.

Making up a battery

All of my testing was done using a small regulated supply to power the receiver. However, in order to use it as a portable, it was necessary to make up a battery pack since the original 276P 9V battery style is no longer available. This was done by fitting six 1.5V AA cells to a 6-way battery holder and inserting it inside an old 276P battery casing to keep it looking original.

By the way, while testing the receiver on the regulated supply, I found that it would perform quite satisfactorily down to 6V. So the battery life should be quite good at moderate volume.

Summary

This is a good-performing portable transistor radio. The only thing it doesn't do well is handle very strong signals. Certainly, an external antenna and earth could only be considered in more remote areas, away from stations.

It would appear that some modifications were done to the AGC system between production runs as my set has a slightly different circuit to that shown in Fig.1. This may have been an attempt to improve the set's performance on strong signals.

Finally, at the time it was made, manufacturers were still experimenting with construction techniques for transistor radios. The Japanese had begun using PCBs by 1960 but this technology had not yet been fully adopted by AWA. As a result, this particular set was built like a valve portable, with point-to-point wiring.

That said, it's still a well-built set that has lasted well and is worth having in a collection. **SC**