By RODNEY CHAMPNESS, VK3UG

Restoring an AWA 948C car radio

First introduced back in the 1930s, car radios have been popular with motorists ever since. Here's a brief look at how they evolved, along with the restoration details for an AWA 948C dual-polarity car radio.

BACK IN THE 1930s, it wasn't too difficult to produce radios that ran from the mains supply and provided reasonable sound quality. By contrast, car radios provided quite a challenge for the radio design engineers.

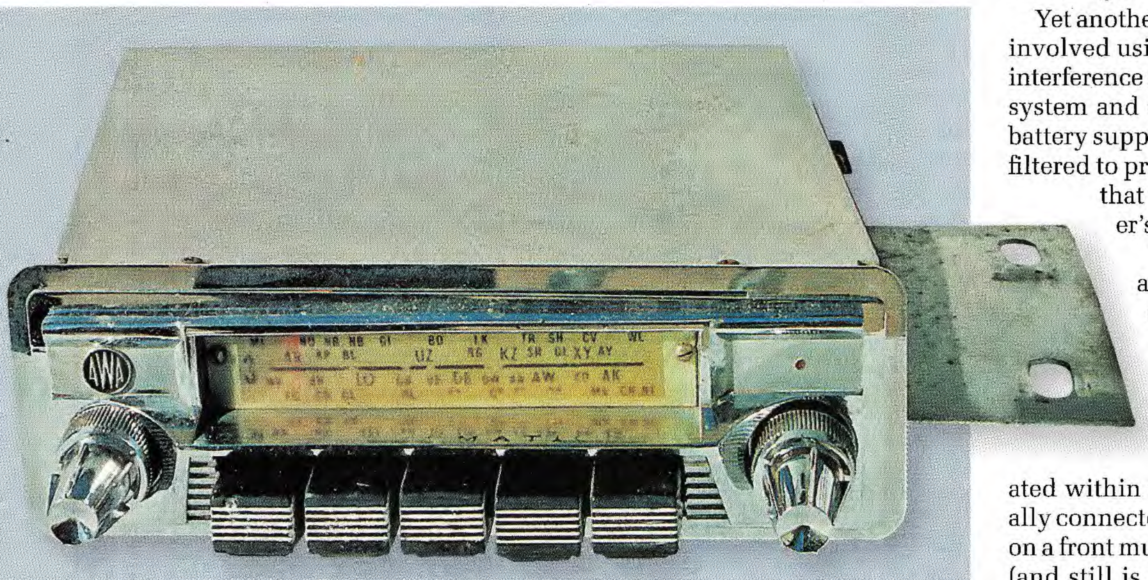
Initially, this challenge was met by using modified home-style receivers, complete with dry batteries and a wet-cell filament battery. These sets were mainly used when the vehicle was parked. However, the public wanted to hear music while on the move and that meant that specialised radios were needed.

There were quite a few problems to overcome to produce suitable radios, however. First, battery valves have relatively fragile filaments and bumping along the roads of the 1930s would have meant greatly reduced valve life. Second, the audio output of such valves was hardly enough to overcome the vehicle noise.

These problems gave birth to the 6.3V heater valves which suited the 6V car batteries widely used at that time. However, the high-tension (HT) supply was still a problem and some receivers had a small "genemotor" to supply a high-tension voltage of around 250V to mains-type valves. This device enabled audio valves such as the venerable 6V6GT to produce enough audio output to overcome the noise of a moving vehicle.

It wasn't long, however, before designers came up with the vibrator. This mechanical device converted 6V DC into 6V AC which could then be fed to a step-up transformer and rectified to provide the necessary 250V DC for the valve plates.

The first vibrators were half-wave devices and their design may well have been based on the concept used in the Ford Model-T ignition coil. The half-wave unit wasn't all that successful however, so after a short time the full-wave vibrator was developed. This subsequently became an integral part of car radio power supplies and survived right up until the early 1960s when hybrid and transistorised car radios took over from the vibrator-powered sets.

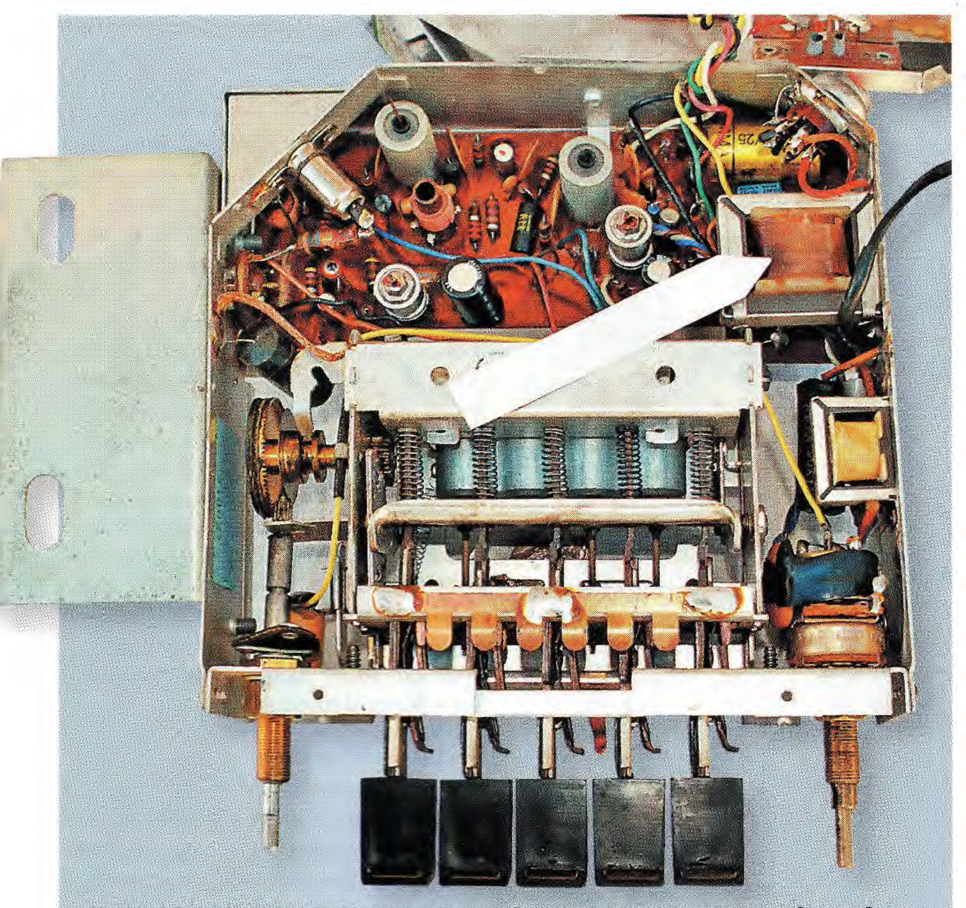


The AWA 948 car radio is a pushbutton unit with five tuning presets. This is the fully restored unit, complete with its mounting bracket.

Beating the interference

Yet another important development involved using a metal case to reduce interference from the vehicle's ignition system and other electrical gear. The battery supply to the receiver was also filtered to prevent any interference on that line affecting the receiver's performance.

The antenna lead was another important development, the designers coming up with a high-impedance coaxial cable. This shielded the central antenna lead from interference generated within the vehicle and was usually connected to an antenna mounted on a front mudguard. The antenna was (and still is today) a short whip-type mounted in a (relatively) interference-free area.



The audio output transformer arrowed prevents easy access to the audio amplifier components on the PC board. Note the size of the preset tuning mechanism which takes up about one third of the room inside the case.

Suppression of the ignition system usually took the form of a 400nF capacitor attached between the supply side of the ignition coil and earth. In addition, a 15kΩ resistor was included in series with the high-tension lead to the distributor. This resistor was specially designed for the job and its ends were simply screwed into each end of the severed high-tension lead.

Early vibrator sets

Early vibrator-powered car radio receivers were quite large. Sets such as the Astor "Square Box", for example, included a 200mm (8-inch) speaker inside the case, the set itself measuring 230mm square by 140mm deep. It was connected to the control head by Bowden cables.

Later sets were much smaller and used an external speaker that could be mounted in a location that favoured better sound reproduction.

In those days, car radios were produced as either "universal" units that could be fitted into almost any vehicle or they could be made specifically for particular vehicles. However, some of the latter were simply universal models supplied with different mounting kits and escutcheons.

I once received tuition on fitting car radios, back in the late 1950s in Adelaide. The time taken to completely fit a set (including its speaker and antenna) to an FE Holden and do the antenna tuning and ignition suppression was just 20 minutes!

Positive or negative earth?

The advent of hybrid and (later) fully transistorised receivers presented a new problem that had to be resolved. Most vehicles from the 1960s era had the negative terminal of the battery connected to earth (chassis) but there were also quite a few models that used a positive earth. This usually didn't matter with vibrator-powered car radios, as the valve rectifier fitted to most sets always gave the correct polarity for the high-tension line.

By contrast, both hybrid and transistor car radios had to be designed to accept either positive or negative earth

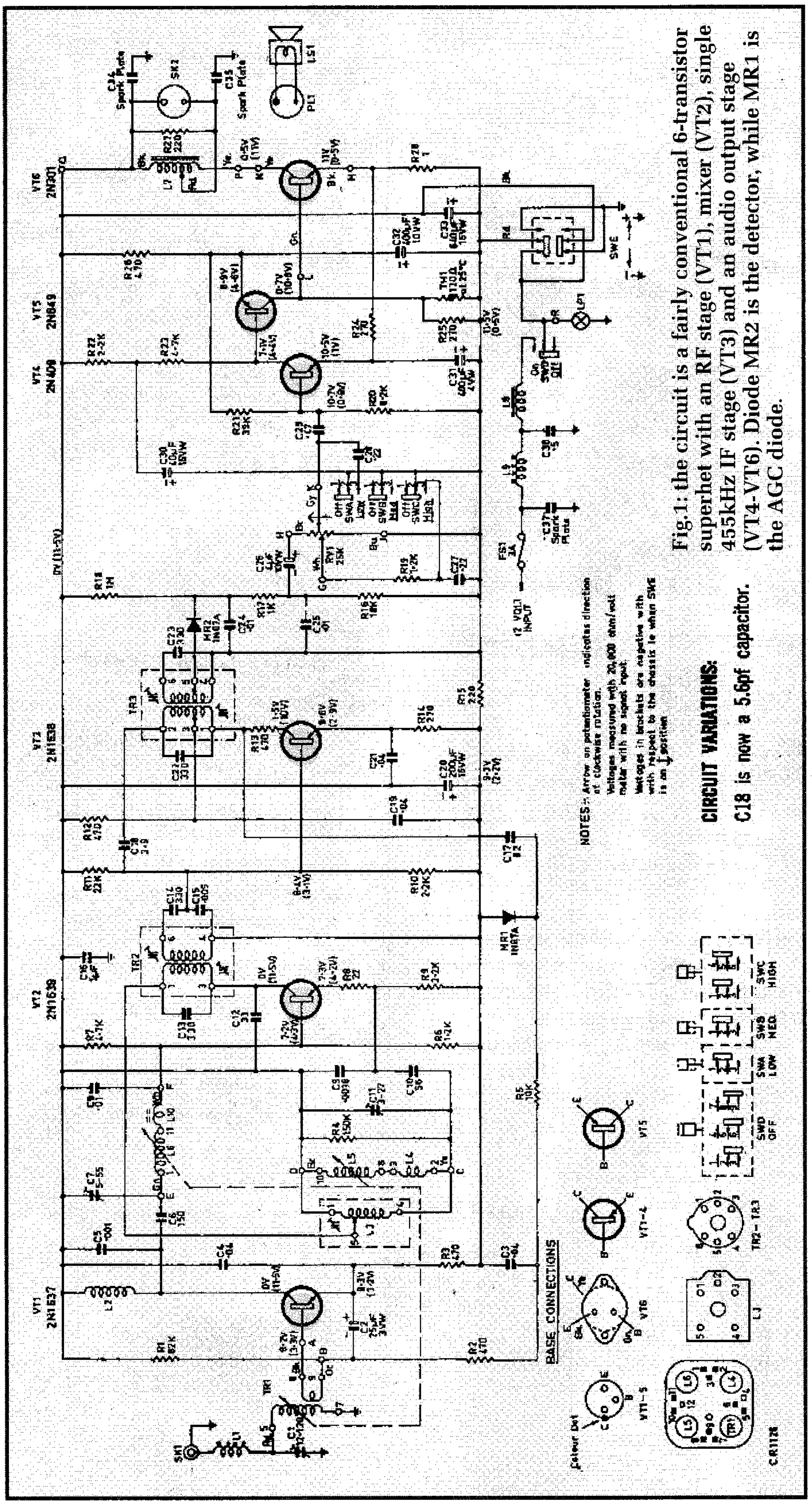


Fig.1: the circuit is a fairly conventional 6-transistor superhet with an RF stage (VT1), mixer (VT2), single 455kHz IF stage (VT3) and an audio output stage (VT4-VT6). Diode MR2 is the detector, while MR1 is the AGC diode.

(or both). You could not connect a set designed solely for a negative earth to a vehicle with a positive chassis earth or vice versa without doing considerable damage to the set.

The AWA hybrid set described in the December 2006 issue was designed for negative chassis operation. However, the AWA 948C unit described here is a fully transistorised set that can be used in both negative and positive earth vehicles.

The AWA 948C car radio

My first encounter with the AWA 948C came when a vintage car enthusiast handed me the radio from his Humber. It didn't work and he wanted me to overhaul it at my leisure.

When I finally got around to looking at it, the first thing I attempted to do was to track down a circuit. Unfortunately, I couldn't find one for this particular set but I did find one that appeared to be quite similar – the AWA MF3 series car radio circuit.

The AWA 948C used a simple colour-coded plug to change the polarity (the Humber was positive earth). This plugged into the back of the set to make it either positive earth (red plug) or negative earth (black plug). The red plug can be seen in a photograph of the overhauled receiver.

Circuit details

The PC board used in this set was used in several different models, so the circuit description will also apply to other AWA car radios of the era. Fig.1 shows the circuit details. As shown, it uses six transistors – three in the radio frequency (RF) sections and three in the audio section. The transistors are all PNP germanium types except for VT5, which is an NPN germanium.

Temperature compensation was necessary with germanium transistors as they are prone to thermal runaway if they get a bit too hot. As a result, thermistor TH1 and resistor R25 (lower right of the circuit) provide thermal compensation in the audio output stage, to prevent thermal runaway.

The antenna input is conventional for a transistorised car radio and is coupled to transistor VT1 via the aerial coil (TR1). Note that the cold end of the variable inductance tuned circuit is earthed directly to the chassis of the set, whereas the other sections of the set are only physically earthed at the polarity changeover socket and plug combination. The only other exceptions are the dial lamp and the capacitors in the interference-suppression filters in the supply line.

Following VT1, a second inductance-tuned circuit feeds VT2, the autodyne mixer stage. The signal is then fed to an intermediate frequency (IF) stage based on VT3 & TR3, which is tuned to 455kHz. Diode MR2 then detects the signal and this then drives the audio amplifier stage (VT4, VT5 & VT6). Potentiometer RV1 is the volume control.

The AGC (automatic gain control) voltage is developed by feeding part of the signal from VT3's collector to diode MR1. The resulting control voltage is then filtered and applied to the base of the RF stage transistor (VT1).

The audio stages (VT4-VT6) are direct coupled, which makes life more difficult for anyone servicing this section when something goes wrong (as it did in this set). The audio output stage is a 2N301, a common PNP germanium "power" transistor. It drives a 15-ohm speaker via a step down audio output auto-transformer.

Finally, note that there are three "spark plates" in this receiver – one on the power input and two on the leads to the speaker. These devices are designed to assist in filtering out any interference that may be on these particular lines.

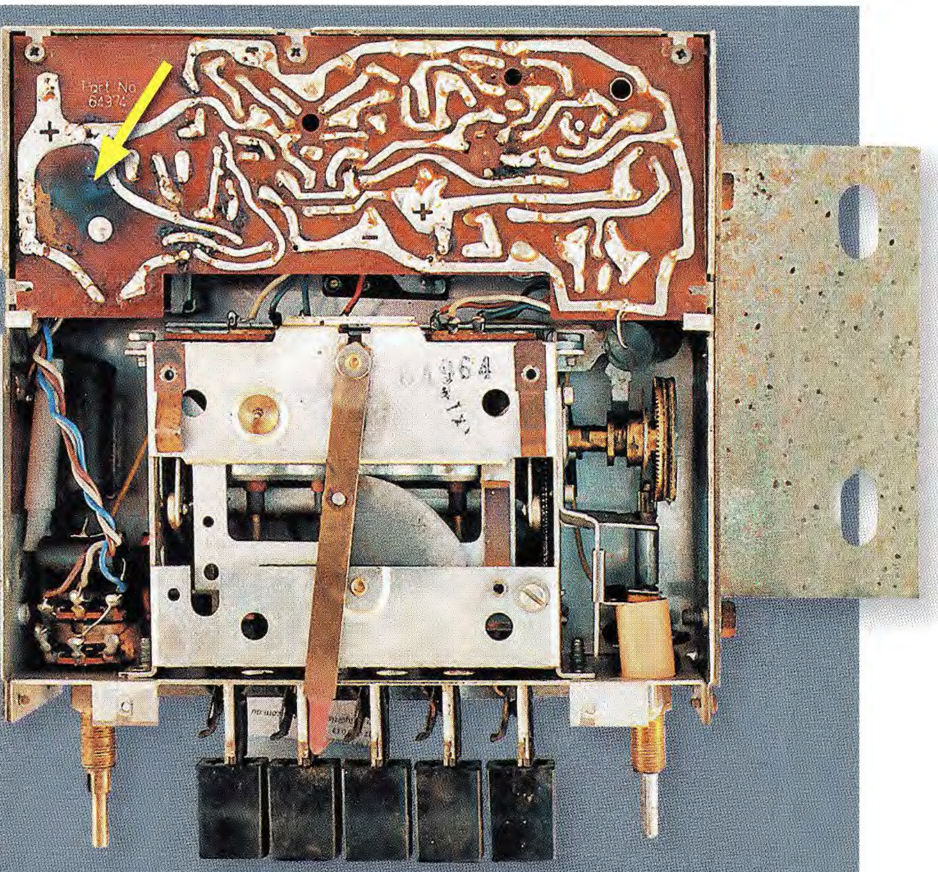
Overhauling the mechanism

Initially, I removed the top and bottom covers from the set and had a good look inside. This immediately revealed one obvious problem – wax had melted and leaked from the speaker auto transformer, indicating that it was getting too hot.

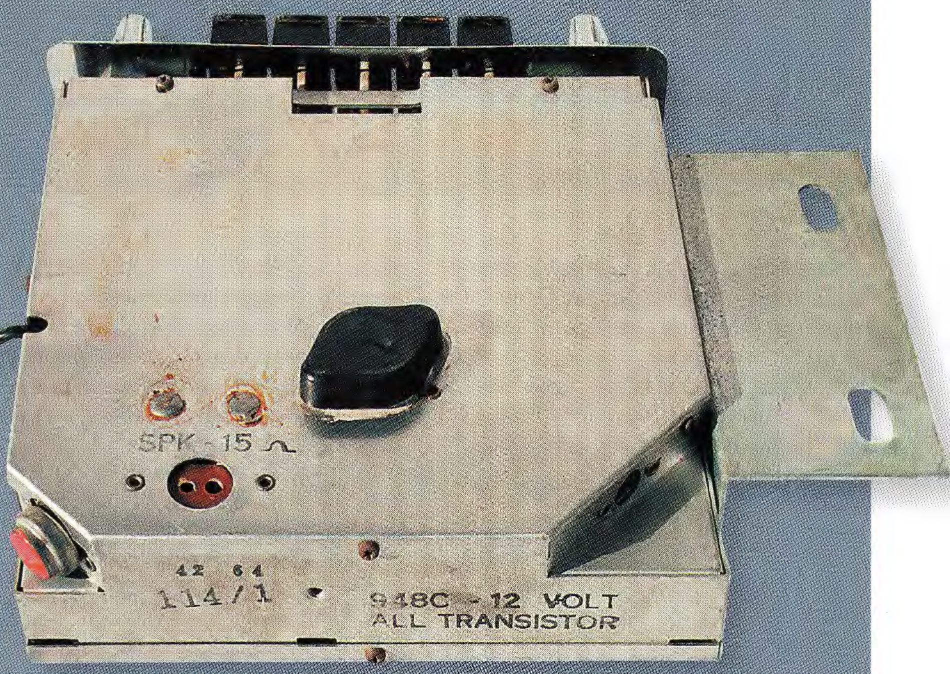
Further inspection revealed a problem with the dual-drive friction clutch and I decided to work on that first. The cork friction pad had come away from its metal drive disc and I reasoned that contact adhesive would do a good job of gluing it back into place.

Keeping the two sections of the clutch apart, I first smeared contact adhesive on to the side of the cork that would be in contact with the drive disc. That done, I made sure that the disc and the cork pad were lined up correctly before releasing the clutch. The clutch plate pressure was then sufficient to hold the two parts together while the adhesive dried.

Next, I lubricated the rest of the mechanism using my modified (blunt) hypodermic needle/syringe assembly. I then fitted a new terminal onto the active 12V line and installed a new 3A 3AG fuse. It was now time for some real troubleshooting.



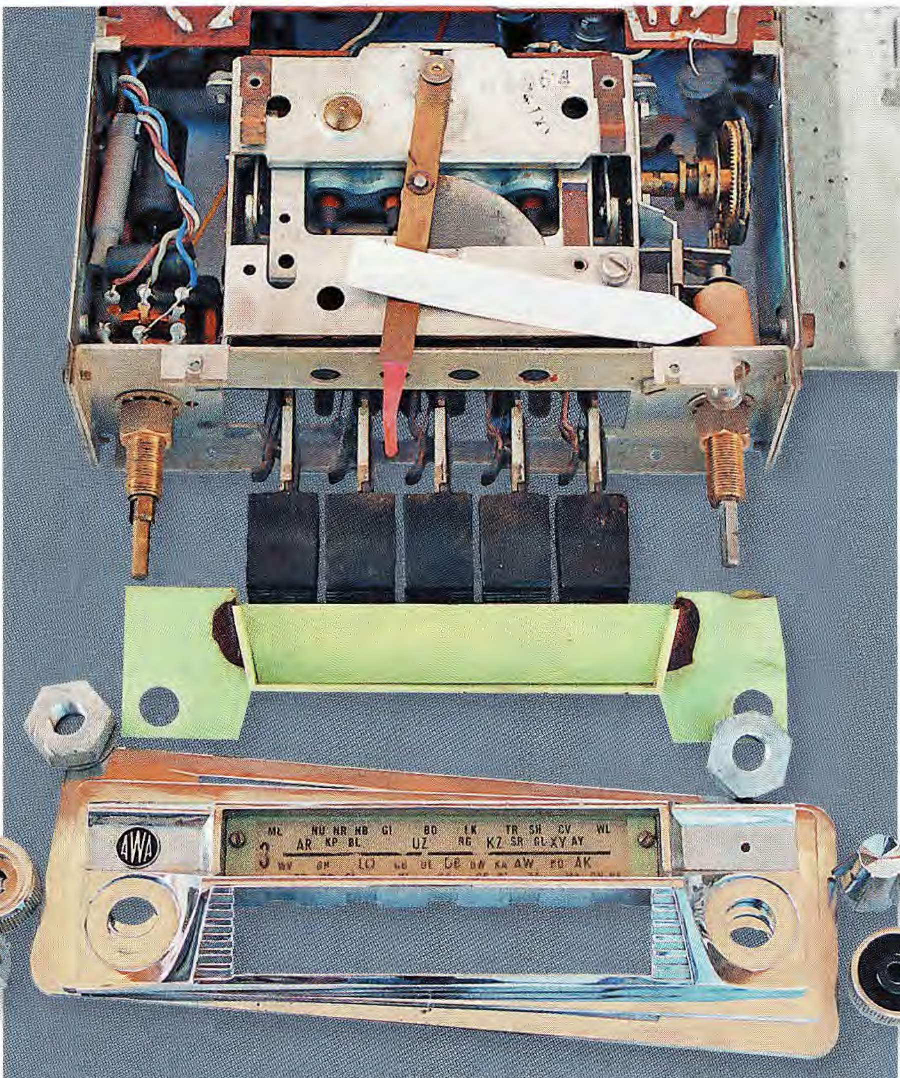
This is the underside view of the chassis with the cover removed. Note the charred area on the PC board (arrowed), around the audio output stage.



The audio output transistor is attached to the underside of the chassis (for heatsinking) and fitted with a plastic cover. Note the polarity plug at bottom left (positive earth in this case).

Overhauling the electronics

Because the speaker transformer had been overheated, I decided to remove the output transistor (2N301, VT6) from its socket This is done by simply undoing two screws and pulling the transistor out. I then tested it using the diode test facility on my digital multimeter (DMM).



You have to remove a lot of parts, including the knobs and the front panel escutcheon, just to replace the dial lamp (arrowed).

Basically, if you connect the test leads between base and emitter, the readings for a germanium transistor should be over-range in one direction and around 0.25V in the other direction. Similar readings should then be obtained if you connect the test leads between base and collector.

Well, I didn't get those readings! The 2N301 measured short circuit, so it was consigned to the bin.

My next job was to search for a suitable replacement, as germanium transistors are not all that common today (probably even less common than valves, in fact). Eventually, I did find one in my spare parts bin and it tested OK. This new transistor was then fitted into place after first smearing its mica insulating washer with heatsink compound.

I decided to leave the cover off the set at this stage, so that I could first check for any shorts and later take voltage measurements. The set proved to be clear of any obvious shorts, so I then connected it to my variable power supply with an ammeter in series with the negative lead.

Initially, I set the supply output to 1.25V and then gradually wound it up to 12V. The set drew just a few milliamps which indicated that there were still problems with the audio stages, as it should have been drawing around 0.5A or more.

Next, I checked the voltages on the 2N301 and they were haywire. I had suspected from the beginning that quite a bit of damage had been done in the audio section and I now thought that transistor VT5 (a 2N649) might be faulty too.

It was now time to really get serious about fixing the fault in the set. That meant being able to get at the audio section of the receiver but that's easier said than done.

First, I removed the screws that held the PC board in place. However, I was then able to move it only about a centimetre which gave me no more access to the audio section hidden beneath the audio output auto-transformer. Furthermore, I couldn't remove the transformer as this part was mounted with lugs through the side of the receiver case. These lugs are bent over flush with the case and soldered (it's obviously designed to be fitted once only).

Eventually, I decided to disconnect one of the short leads to the coil tuning assembly but I still had problems. The three leads from the output transformer and the two leads feeding the DC into the set from the polarity socket were much too short to allow the board to be moved. In fact, another 50mm of insulated wire on these five leads would have made all the difference.

In the end, I lengthened the two going to the polarity socket, leaving the others as they were. That done, I was then able to access the parts beneath the transformer.

I removed transistor VT5 (2N649) and tested it. It checked OK but the 2N301's 1Ω emitter resistor was a charred mess and the PC board had also been blackened due to heat – see photos. A nearby electrolytic capacitor had also suffered heat damage.

I replaced the 1Ω resistor and the two electrolytic capacitors, as I believed they might have been damaged. I then reconnected all leads and tested the set again, starting with a low supply voltage and slowly increasing it while monitoring the current.

As I increased the supply voltage, the voltage across the 1Ω resistor rose to around 0.6V. This indicated that the output stage was drawing around 0.6A, which is roughly what it should draw when working properly.

It was now time to connect an antenna. The set immediately burst into life, so I let it run for some considerable time and the 2N301 became only slightly warm. The sensitivity appeared satisfactory and the alignment of the antenna, RF and oscillator coils appeared to be accurate. In fact, I rarely see car radio tuned circuits that are out of alignment.

Dial lamp

The dial lamp had blown and replacing it proved quite a chore. In fact, the entire front escutcheon had to be removed to gain access to it – see photograph. This is another example of poor design.

Furthermore, the original lamp was a 12V 150mA unit but I could only find one rated at 300mA. That problem was solved by installing a 10Ω 1W resistor in series with it to reduce the current drawn, which means that it should have a long life.

As a bonus, this also reduced the heating effect on the plastic dial sections, which appeared to have been overheated in the past.

Pushbutton tuning

Finally, it was time to take a look at the pushbutton tuning mechanism (I had been tuning the set manually up until this point).

For those unfamiliar with these units, it is necessary to tune manually to a station before setting the mechanism. This is done by pulling the press button out and then pressing it in hard. The mechanism is then set to select that particular station when its button is pressed.

This procedure is then repeated for the other four pushbutton.

The mechanism was still working correctly but the pushbuttons needed some restoration. First, I polished the tops of the pushbuttons with automotive cut and polish to improve their appearance. In addition, each button has five white recessed lines across it. These were looking rather shabby, so I "painted" the front of each button using typing correction fluid and allowed them to dry. Then, using fine wet and dry paper I carefully sanded away the correction fluid on the fronts of the knobs, leaving just the recessed lines.

The end result is not quite as good as I would have liked but the markings certainly look a lot better than they did.

Reverse polarity

So what caused all the damage to the output stage of this set? My suspicions are that it had been connected to a power supply with reversed polarity – probably not long before it was given to me to overhaul. This is a mistake that can easily occur with a dual-polarity set such as this.

The set is a good performer but the designer gets the thumbs down for the location of the speaker auto-transformer, as it obscures much of the audio amplifier. Additionally, the leads to it and other sections of the PC board are too short to allow access to the board without disconnecting several wires. Five of them could easily have been longer without any compromise in performance.

Access to the dial lamp is also poor and this could have easily been improved with just a little more thought. Still, it's a nice set to have in your vintage car. **SC**

Aeolian 5-Valve Autodyne Superhet (1933)

THE ORCHESTRAL COMPANY OF MELBOURNE was a well-known supplier of music and musical Instruments and the company also marketed radios under the "Aeolian" brand name during the early 1930s. The unit shown here is a 5-valve autodyne superhet from 1933. The valve line-up was as follows: 57 autodyne mixer, 58 IF amplifier, 57 anode bend detector, 59 audio output and 80 rectifier. Photo: Historical Radio Society of Australia, Inc.

These are the parts that were replaced. Note the corrosion on the transistor and the charring on the resistor and one of the electrolytic capacitors. The damage was probably caused by reversed supply polarity.