Vintage Radio

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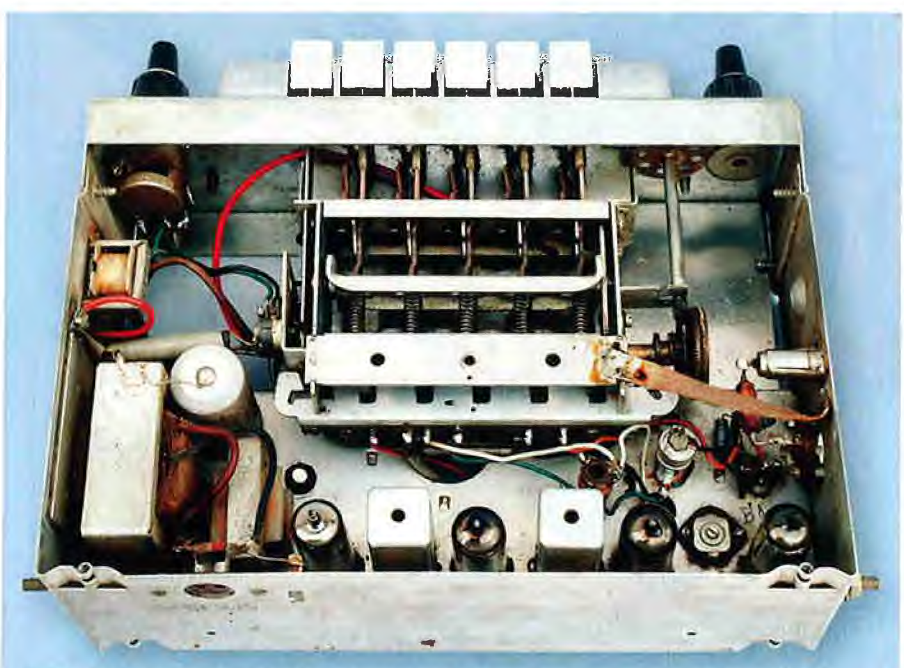
The AWA 976A Hybrid Car Radio

Developed during the 1960s, hybrid car radios combined a valve front-end with an audio output stage based on germanium transistors. They quickly replaced valve-based designs with vibrator power supplies but were themselves made obsolete within a few years.

In the beginning, the radios used in cars were nothing more than small domestic valve receivers. They were powered by an assembly of filament (A), high tension (B) and bias (C) batteries, which was rather unwieldy.

In most cases, these radios would have been used only while the vehicle was stationary (and with the engine off), as the ignition noise from vehicles such as the Model-T Ford would have been horrendous. In short, they were hardly a practical proposition and their use would have been restricted to a small percentage enthusiasts.

It soon became obvious to the manufacturers that there was a market for dedicated car radios and suitable sets began to appear during the early 1930s. In fact, it was this development that prompted valve manufacturers to produce valves with 6.3V heaters, to suit the 6V electrical systems used in cars at the time.



This is the view inside the chassis with the top cover removed. Note the pushbutton tuning mechanism.

The ubiquitous vibrator also made its appearance during the early 1930s and this meant that car radios could now be completely powered from the vehicle's electrical system. These vibrators were initially half-wave devices but were swiftly replaced by the full-wave types which are familiar to vintage radio enthusiasts.

Hybrid radios

Vibrator power supplies and 6.3V and 12.6V heater valves were almost universally used in car radios up until the early 1960s, until the introduction of hybrid car radios. These hybrid sets used a mix of valves and germanium transistors and no longer required a vibrator to supply the high-tension (HT) voltage. Instead, a special range of valves was developed that could operate satisfactorily on either 6V or 12V of HT. In fact, the upper plate voltage rating of many of these valves was around 33V.

However, while these valves worked quite satisfactorily in the radio frequency (RF), converter, intermediate frequency (IF) and low-level audio stages, they could not draw enough current (due to the low plate voltage) for the audio output stage. On the other hand, early transistors were rather poor performers at the frequencies used in RF, converter and IF stages but were quite satisfactory at audio frequencies.

As a result, these transistors were used in the audio output stages and they provided enough output power to drive a loudspeaker.

This combination of low-HT valves and germanium transistors proved to be quite successful. However, this arrangement was to be short-lived. Within a couple of years, transistors had been improved sufficiently to make valves redundant and the hybrid sets were replaced by full-transistor designs.

An interesting innovation

Many vintage radio buffs will be unaware of hybrid car radios, due mainly to the relatively short period of time that they were made. However, they were quite an interesting innovation and demonstrated how two different technologies could be successfully married together.

In my case, I had been bemoaning the fact that I had been unable to obtain a hybrid car radio for some time – both for my collection and to prepare a column in Vintage Radio. However, when I mentioned this on one of the amateur bands recently, an amateur I'd not heard from for many years came on and said that he did have such a set – an AWA 976A, in fact. He also offered to lend it to me, along with a service manual, and I quickly took him up on his offer.

This version of the AWA 976A was made to fit Ford Falcon cars made during that era. The chassis is rather large for a car radio.

Circuit details

During this transitional time when transistors were finding their way into car radios, vehicles could be either positive or negative to chassis. European vehicles tended to be positive earth and American vehicles were negative earth.

Most vibrator-powered car radios were not polarity sensitive, so it didn't matter whether the active line from the vehicle battery was positive or negative. However, some car radios were polarity sensitive and had to be designed to operate with either earthing situation. This was achieved by fully floating the circuit inside the cabinet, which made life more difficult for both designers and servicemen alike.

By contrast, the AWA 976A was designed to be used only with negative-earth vehicles. The valve section of the set follows the normal valve line-up, with an RF stage (12BL6), a converter stage (12AD6), a single 455kHz intermediate frequency (IF) amplifier and finally a duo-diode-triode (12FK6) as a detector, AGC detector and low-level audio amplifier.

Fig.1 shows the circuit details. The antenna input is typical of most car radios from the early 1950s until the end of the valve era. The tuning is not done with a variable ganged tuning capacitor but with a variable-inductance (permeability) tuning mechanism. What is different about the input circuit is that the antenna and its cable form part of the tuned circuit at the input. Final tuning of the antenna circuit is required when the receiver is installed in the vehicle.

As usual, a telescopic antenna is used and the signal is fed to the receiver's input via a coaxial cable. In effect, the coaxial cable is in parallel with trimmer capacitor C1 and forms part of the tuned circuit. Their combined capacitance is intended to tune the antenna circuit to a peak at around 1500kHz.

During installation, C1 is adjusted to compensate for variations in the coaxial cable capacitance. The coaxial cable is not just any old coaxial cable, being usually around 110Ω in impedance and with air spacing to keep the capacitance between the centre conductor and the shield to a minimum.

Note that coaxial cable is necessary for the antenna lead, otherwise electrical noise from the vehicle would drown out all but the nearest and strongest radio stations. The coaxial cable provides shielding which prevents noise pick-up and externally mounting the antenna also significantly reduces noise.

The 12BL6 is coupled to the 12AD6 (V2) via tuned circuit L4, C5 & C6 and coupling capacitor C7. V2 is a pentagrid converter and works much the same as a 6BE6.

IF stages

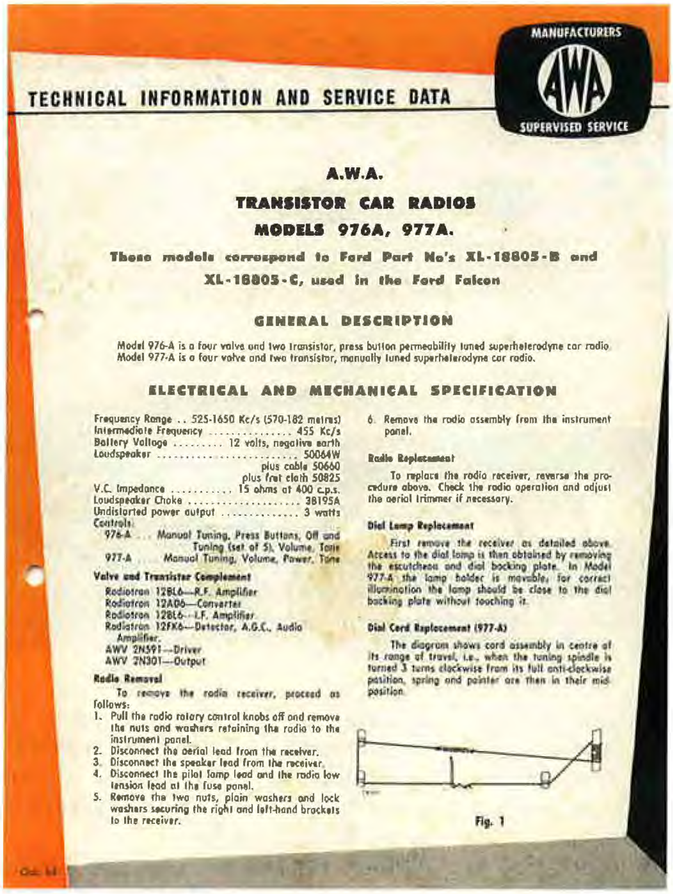
The output of the 12AD6 is at 455kHz and this signal is fed to IF transformer TR1. From there, it goes to IF amplifier stage V3 (another 12BL6) and is then fed via IF transformer (TR2) to the diode detector.

Note that the plate of the 12BL6 goes to a tapping on the IF transformer primary. This is not common practice and was probably done to match the output impedance of the valve with the dynamic impedance of the tuned circuit, to ensure maximum gain and minimum loading.

Next, the IF signal is applied to the detector diode (pin 6) of the 12FK6 (V4), where it is detected. The recovered audio is then applied to the grid of the valve, with C16, C17 & R8 filtering out the IF signal. In addition, a tone control (RV2) and a tuning mute switch (SW1) are included in the grid input to this valve.

V4 provides a modest degree of amplification, after which the audio signal is fed to the transistor output stage.

The AGC diode (pin 5) of the 12FK6 is supplied with signal from the top of the plate winding of the IF amplifier. This means that the AGC voltage is greater than it otherwise would be if derived from the signal that's fed to the detector. The selectivity of the IF amplifier is lower here too, which means that as the set is tuned, the AGC starts reducing the gain of the receiver before it is right on station. This reduces any blasting as the tuning approaches the optimum position.


TECHNICAL INFORMATION AND SERVICE DATA

MANUFACTURERS AWA SUPERVISED SERVICE

A.W.A.

TRANSISTOR CAR RADIOS

MODELS 976A, 977A.

These models correspond to Ford Part No's XL-18805-B and XL-18805-C, used in the Ford Falcon

GENERAL DESCRIPTION

Model 976-A is a four valve and two transistor, press button permeability tuned superheterodyne car radio
Model 977-A is a four valve and two transistor, manually tuned superheterodyne car radio.

ELECTRICAL AND MECHANICAL SPECIFICATION

Frequency Range .. 525-1650 Kc/s (570-182 metres)
Intermediate Frequency .... 455 Kc/s
Battery Voltage .... 12 volts, negative earth
Loudspeaker 50064W
plus cable 50660
plus fret cloth 50825
V.C. Impedance .... 15 ohms at 400 c.p.s.
Loudspeaker Choke 38195A
Undistorted power output .... 3 watts
Controls:
976-A ... Manual Tuning, Press Buttons, Off and Tuning (set of 5), Volume, Tone
977-A ... Manual Tuning, Volume, Power, Tone

Valve and Transistor Complement

Radiotron 12BL6—R.F. Amplifier
Radiotron 12AD6—Converter
Radiotron 12BL6—I.F. Amplifier
Radiotron 12FX6—Detector, A.G.C., Audio Amplifier.
AWV 2N591—Driver
AWV 2N301—Output

Radio Removal

To remove the radio receiver, proceed as follows:

1. Pull the radio rotary control knobs off and remove the nuts and washers retaining the radio to the instrument panel.
2. Disconnect the aerial lead from the receiver.
3. Disconnect the speaker lead from the receiver.
4. Disconnect the pilot lamp lead and the radio low tension lead at the fuse panel.
5. Remove the two nuts, plain washers and lock washers securing the right and left-hand brackets to the receiver.
6. Remove the radio assembly from the instrument panel.

Radio Replacement

To replace the radio receiver, reverse the procedure above. Check the radio operation and adjust the aerial trimmer if necessary.

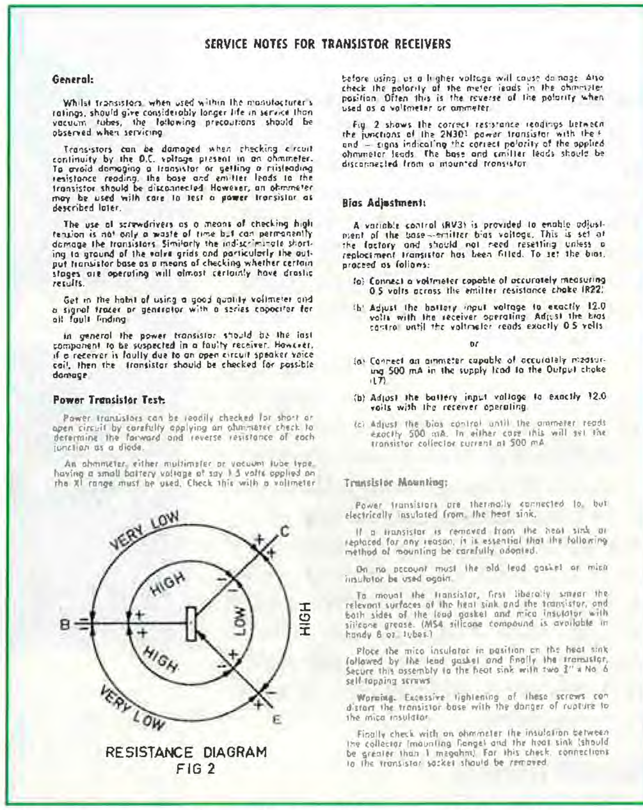
Dial Lamp Replacement

First remove the receiver as detailed above. Access to the dial lamp is then obtained by removing the escutcheon and dial backing plate. In Model 977-A the lamp holder is movable, for correct illumination the lamp should be close to the dial backing plate without touching it.

Dial Cord Replacement (977-A)

The diagram shows cord assembly in centre of its range of travel, i.e., when the tuning spindle is turned 3 turns clockwise from its full anti-clockwise position, spring and pointer are then in their mid-position.

Fig. 1


SERVICE NOTES FOR TRANSISTOR RECEIVERS

General:

Whilst transistors, when used within the manufacturer's ratings, should give considerably longer life in service than vacuum tubes, the following precautions should be observed when servicing.

Transistors can be damaged when checking circuit continuity by the D.C. voltage present in an ohmmeter. To avoid damaging a transistor or getting a misleading resistance reading, the base and emitter leads to the transistor should be disconnected. However, an ohmmeter may be used with care to test a power transistor as described later.

The use of screwdrivers as a means of checking high tension is not only a waste of time but can permanently damage the transistors. Similarly the indiscriminate shorting to ground of the valve grids and particularly the output transistor base as a means of checking whether certain stages are operating will almost certainly have drastic results.

Get in the habit of using a good quality voltmeter and a signal tracer or generator with a series capacitor for all fault finding.

In general the power transistor should be the last component to be suspected in a faulty receiver. However, if a receiver is faulty due to an open circuit speaker voice coil, then the transistor should be checked for possible damage.

Power Transistor Test:

Power transistors can be readily checked for short or open circuit by carefully applying an ohmmeter check to determine the forward and reverse resistance of each junction as a diode.

An ohmmeter, either multimeter or vacuum tube type, having a small battery voltage of say 1.5 volts applied on the X1 range must be used. Check this with a voltmeter before using, as a higher voltage will cause damage. Also check the polarity of the meter leads in the ohmmeter position. Often this is the reverse of the polarity when used as a voltmeter or ammeter.

Fig. 2 shows the correct resistance readings between the junctions of the 2N301 power transistor with the + and − signs indicating the correct polarity of the applied ohmmeter leads. The base and emitter leads should be disconnected from a mounted transistor.

RESISTANCE DIAGRAM
FIG 2

Bias Adjustment:

A variable control (RV3) is provided to enable adjustment of the base—emitter bias voltage. This is set at the factory and should not need resetting unless a replacement transistor has been fitted. To set the bias, proceed as follows:

(a) Connect a voltmeter capable of accurately measuring 0.5 volts across the emitter resistance choke (R22).
(b) Adjust the battery input voltage to exactly 12.0 volts with the receiver operating. Adjust the bias control until the voltmeter reads exactly 0.5 volts.

or

(a) Connect an ammeter capable of accurately measuring 500 mA in the supply lead to the Output choke (L7).
(b) Adjust the battery input voltage to exactly 12.0 volts with the receiver operating.
(c) Adjust the bias control until the ammeter reads exactly 500 mA. In either case this will set the transistor collector current at 500 mA.

Transistor Mounting:

Power transistors are thermally connected to, but electrically insulated from, the heat sink.

If a transistor is removed from the heat sink or replaced for any reason, it is essential that the following method of mounting be carefully adopted.

On no account must the old lead gasket or mica insulator be used again.

To mount the transistor, first liberally smear the relevant surfaces of the heat sink and the transistor, and both sides of the lead gasket and mica insulator with silicone grease. (MS4 silicone compound is available in handy 8 oz. tubes.)

Place the mica insulator in position on the heat sink followed by the lead gasket and finally the transistor. Secure this assembly to the heat sink with two ⅜" x No. 6 self-tapping screws.

Warning. Excessive tightening of these screws can distort the transistor base with the danger of rupture to the mica insulator.

Finally check with an ohmmeter the insulation between the collector (mounting flange) and the heat sink (should be greater than 1 megohm). For this check, connections to the transistor socket should be removed.

These two pages from the service manual give the general specifications (left) and provide useful service data, including a test procedure for the transistors.

Note that the resistors in the AGC lines have very high values, which means that any leakage in C4 or C8 cannot be tolerated. The full AGC voltage is applied to both the signal and suppressor grids of V1, while V2 and V3 both have about a quarter of the AGC voltage applied to them compared to the RF stage.

Transistor stages

Let's now take a look at the transistor stages in the audio amplifier.

As shown in Fig.1, the triode audio amplifier's plate is directly connected to the base of VT1 (2N591), the first transistor audio stage. The amplified output from VT1 is then fed via audio transformer TR3 to the base of audio output transistor VT2 (2N301).

In this circuit, the 2N301 is used as a class-A audio amplifier. Its forward bias is set to give a standing current of 0.5A and this is achieved by adjusting RV3. Note that there is very little collector current flowing through the speaker when it is connected via socket SK2. This is because inductor L7's DC resistance is extremely low, so most current flows through this inductor.

The audio output from the 2N301 output stage is around 3W, which is sufficient to drive the speaker to good volume.

The receiver's total current drain is around 1.4A which was less than half that drawn by a comparable vibrator-powered receiver operating from a 12V supply. In practice, the hybrid valve and transistor combination worked quite well and these receivers were good performers.

Cleaning up

The AWA 976A and its manually tuned brother – the 977A – were designed for use in the Ford Falcons of the era. The case is quite large and that makes it a relatively easy set to service. With no pushbutton tuning mechanism, the manual model was even easier.

As with any set, its appearance some 40 years later depends on the quality of the material used; ie, the metal plating, the timber and veneers, and plastics and bakelite. It also depends on how well the set has been looked after and where it has been stored.

The top and bottom covers are easily removed, with just three self-tapping screws holding each cover in place. The heatsink and the 2N301 transistor can then be removed by undoing three screws along the front edge of the receiver case. The transistor and heatsink are then left "swinging" but still attached by the three transistor leads – well not quite, as the collector lead broke off in this particular set. The lead was single conductor and had fatigued and broken, so I replaced it with a multi-strand lead.

However, that was a minor fault. The most obvious problem was that someone in the distant past had applied lots of heavy oil to the pushbutton tuning mechanism. Over the years, with dust, heat and vibration, this oil had worked its way into many other areas of the receiver. The oil/dust combination had then congealed and much of the set had become a black "mucky" mess.

I attacked this muck using a small paintbrush dipped in kerosene, after which most of it could be removed using a rag wrapped around the end of a screwdriver. However, it was so bad in some places that I had to scrape it off. This isn't easy when there is little spare room, despite the good access for service.

In the end, the clean-up was reasonably successful but there is still some muck there. They only way to completely get rid of this would be to strip the whole set down but I'm not quite that keen. Unfortunately, the hardened oil gunk had also upset the inductance tuning mechanism and one slug has broken free.

The case itself is all metal, as is usual with car radios. This effectively shields the circuitry from the electrical interference generated by the car's electrical and ignition systems.

In this instance, the quality of the plating left something to be desired but then the manufacturer would not have expected the set to still be around some 45 years after it was made! The plating is quite pitted but it cleaned up quite well using a kerosene-soaked kitchen-scouring pad.

The control knobs on the set are not the originals according the photographs in the service data. Instead, they appear to from an AWA mantel set of around the same vintage.

Circuit checks

As usual, I began by checking the most critical capacitors for electrical leakage and found that they were all faulty. As a result, I replaced AGC bypass capacitors C4 & C8 with 50V disc ceramics, as well as audio coupling capacitor C22.

Nothing else appeared to be defective other than that the oscillator coil slug had come adrift from the tuning mechanism. The slug adjustment shaft had a bright area on it, which indicated that it had been shielded from corrosion in the tuning adjustment mechanism. As a result, I slid the adjustment shaft into the mechanism so that the bright area disappeared and then glued it into position using contact adhesive. Once dry, it appeared to work well and the slug moved freely in and out of the coil when the tuning mechanism was operated.

Sticky mechanism

This check also revealed that the tuning mechanism was rather "sticky" and wouldn't tune across the whole broadcast band. This problem was fixed by judiciously cleaning the sliding mechanism and lubricating it (sparingly) with Inox. It's quite possible that the original owner had trouble with the tuning mechanism sticking and consequently oiled it quite heav-

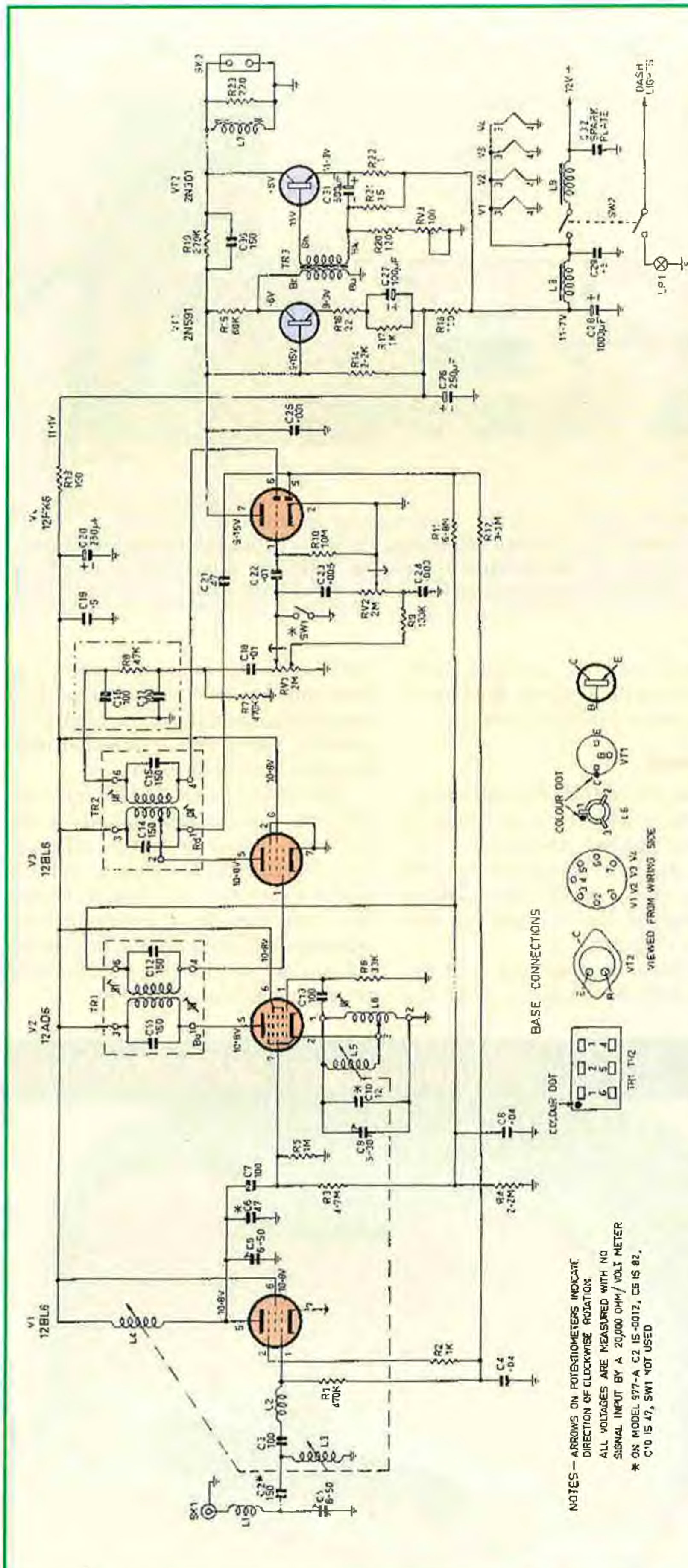


Fig.1: the AWA 976A hybrid car radio used four valves in the RF and IF stages, plus two PNP germanium transistors to form the audio output stage. Note that the output transistor (VT2) operates as a class-A amplifier.

Most of the under-chassis components are wired point-to-point between the valve sockets, IF transformers and several tag strips. A large flat piece of metal provides heatsinking for the audio output transistor.

ily to overcome the problem. This may have had the desired effect but it certainly caused trouble later on.

Alignment

With all those initial repairs completed, the set worked as soon as power was applied. However, it was obvious that the alignment needed tweaking and this involves making adjustments in the RF, antenna and oscillator circuits.

First, the unit was tuned to the extreme high-frequency end of the dial. My LSG11 signal generator was then tuned to 1650kHz with a 1kHz modulation tone and connected to the antenna. C9 was then adjusted until the signal could be heard.

That done, the set was tuned to the extreme low-frequency end of the dial, the signal generator adjusted for 525kHz and L6 adjusted until the signal generator was heard. During this time, the signal generator level was kept relatively low to ensure the set was not overloaded, as this could result in spurious responses.

These two adjustments were done a couple of times, as they interact with each other to some extent. The actual adjustments required were small, as I had obviously managed to get the oscillator slug into the right position on the tuning mechanism when I glued it into place.

The antenna and RF slugs had not been interfered with, so I simply peaked C5 at around 1500kHz. The antenna circuit is tuned up with the set in the car. First, the set is tuned to around 1500kHz with the antenna fully extended and then C1 is adjusted for best performance. This adjustment is accessible from the outside of the case.

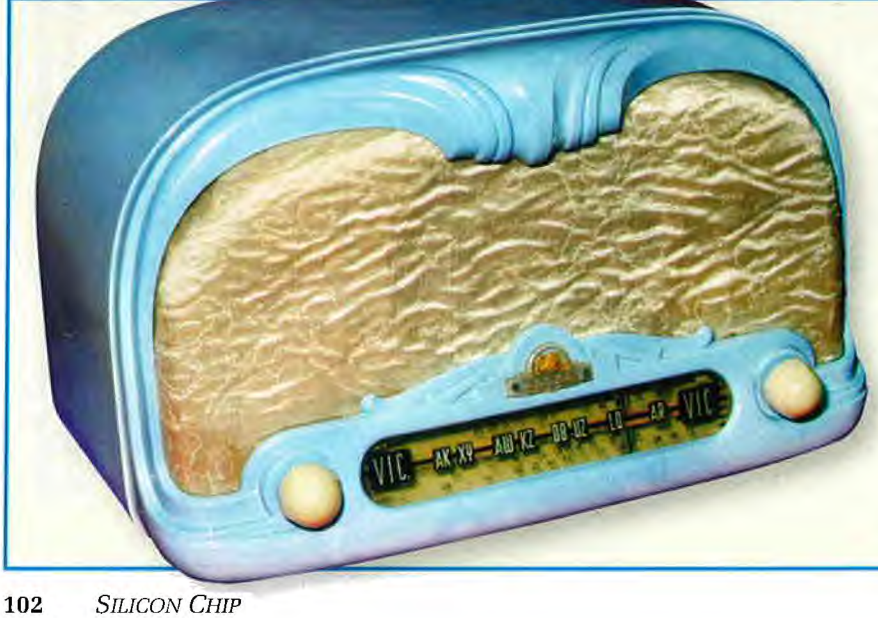
The IF amplifier stages seemed to be correctly tuned and the set was now performing normally, so no attempt was made to peak the IF stages. In fact, it is rare for the IF stages in car radios to drift in alignment due to the sticky core-locking compound used.

In summary, there wasn't a lot wrong with this set – a few leaky capacitors, a very gunky chassis, one tuning slug not operating and 40 years of corrosion just about complete the list.

Summary

This is the only hybrid car radio I've seen in recent years, as they are now quite rare. If you come across one, grab it. I would be more than happy to have one in my own collection, as they were an interesting type of radio that was quite popular, if only for a short time. **SC**

Photo Gallery: Astor Model GS (1949)



MANUFACTURED BY Radio Corporation, Melbourne, in 1949, the Astor Model GS was housed in a stylish bakelite cabinet and was available in a range of colours. This blue example was rare and is now very collectable.

This set used the same basic reflex circuitry that was common to a number of 4-valve Astor models. The valve line-up was as follows: 6A8-G frequency changer; 6B8-G reflexed IF amplifier/1st audio amplifier/detector/AVC rectifier; 6V6-GT audio output; and 5Y3-GT rectifier.

Photo: Historical Radio Society of Australia, Inc.