Vintage Radio

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The 1930s Palmavox 5-valve superhet; Pt.1

This is how radio receivers looked in the 1930s

Housed in a console-style cabinet, the Palmavox is an interesting Australian-made 5-valve superhet AM radio from the early 1930s. However, this particular set had been extensively modified by someone who thought they "knew better" than the original designers.

IT'S NOT OFTEN that you come across a made-in-the-1930s radio in good condition. But that's just what we have here – this Palmavox receiver looks almost new in its polished wooden cabinet, although it's no longer original and has had quite a lot of work done on it.

The first clue we have to the age of the set is a sticker attached to the base of a type 58 valve. It's marked "Palmers, Park Street, Sydney. Valve is guaranteed until 14.8.34". If we presume that the valve was tested some time after the radio was originally purchased, the set is nearly 80 years old.

While everything outside and inside the set looked original, a close inspection revealed some modifications. Instead of the expected five valves, there were only four valves and two coil cans on the chassis. I also found two hand-drawn schematic diagrams, one for a 5-valve superhet and another for a 4-valve TRF. Someone had modified and simplified the original design!

But why would anyone do this? To understand their motivation, we need to delve into the circuit.

The original design used an "autodyne" frequency converter with a type 57 valve. This arrangement was used at a time when radio valves were very expensive and in the case of domestic sets, allowed a superhet circuit to be designed with one less valve than used in costly professional models.

Marginal operation

There was one potential problem though – the oscillator function of the autodyne was sometimes marginal, being dependent on the quality of the coils and the amplifying ability of the valve. As a result, it's possible that the original owner just wasn't able to get the oscillator to work and so decided to convert the set to a simpler TRF (tuned radio frequency) arrangement. He may not have fully realised just how poor the performance of the set would be with one less valve and no IF (intermediate frequency) amplifier stage with its superior selectivity.

Both the original hand-scribbled circuits have been redrawn and are reproduced here. Bearing in mind their origins, neither of them may be completely accurate. My immediate aim was to check out the power supply, the audio amplifier and loudspeaker. Then, a little further down the track, my aim is to convert it into a much better-performing radio with a frequency converter and IF amplifier stage, much like the original circuit.

Not surprisingly, it's no longer possible to obtain original spare parts and that includes the oscillator coil and one of the IF transformers. That

The chassis is bolted to a shelf inside the timber cabinet, while the electrodynamic loudspeaker is mounted on a heavy wooden baffle immediately below. The baffle isn't original though – it's made of chipboard, a material that didn't exist in the 1930s. The grille cloth has been changed as well.

means that suitable substitutes will have to be found.

The previous owner did a beautiful job of restoring the metal chassis by filling in the holes left by the valve socket and the two coil cans he removed. Metal pieces have been soldered into the holes, the gaps filled and the outside of the chassis repainted. Only by close inspection can these mechanical repairs be seen.

It would be a pity to undo this workmanship, so when restoring the receiver to the original circuit my plan is to mount the converter valve and other components underneath the chassis, where they won't be seen. Hence the Palmavox will end up as a questionable mixture of 80-year-old and more recent technologies but to anyone looking into the rear of the cabinet, it will look original . . . almost!

1920s-1940s radios

To understand the Palmavox better, let's take a look at the way radios were made in the 20 years from 1920-1940. During that period, valve technology reigned supreme and the semiconductor technology we now take for granted hadn't even been dreamed about.

Although the idea of the "supersonic heterodyne" (or superhet) receiver was by then well-known, most domestic radio receivers made in the 1920s relied on front-end amplifiers and circuits that were tuned to the frequency of the incoming signal. These sets were referred to as tuned radio frequency (or TRF) receivers. They used less valves and so were cheaper to build than supherhet receivers, although their performance was somewhat inferior.

During that period, experimenters often assembled radios from kits. These often used a feedback system (known as regeneration) which allowed the user to adjust the front-end so that it was on the verge of oscillation, thus gaining a big increase in both amplification and selectivity. This meant that users had to be technically inclined to get the best out of such sets. And if a set was allowed to go into oscillation, it could radiate

The Terms Explained

TRF: Tuned Radio Frequency – a radio receiver with all the selective circuits tuned to the incoming signal frequency.

Superhet: short for "supersonic heterodyne" – a radio circuit that converts the incoming signal to another frequency (ie, the intermediate frequency), with advantages in gain and selectivity. The intermediate frequency (or IF) is usually lower than the signal frequency and, during the 1920s, could be as low as 30kHz. Modern AM medium-wave receivers have an IF of 455kHz or 450kHz, while 10.7MHz is used for FM.

Autodyne: a circuit arrangement, usually based on a pentode, which combines the functions of frequency changer and local oscillator into one valve. It was commonly used in superhet receivers before special converter valves were developed.

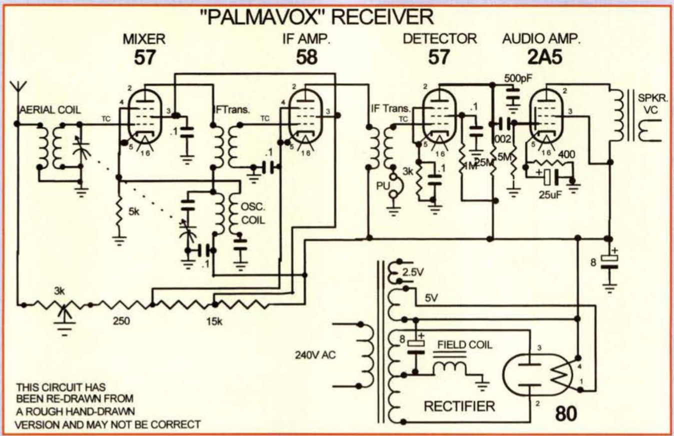

Fig.1 (above): the original circuit of the Palmavox receiver. It's a good example of early superhet design, with an autodyne mixer and an anode-bend detector but no AGC. Note the volume pot across the aerial coil primary winding.

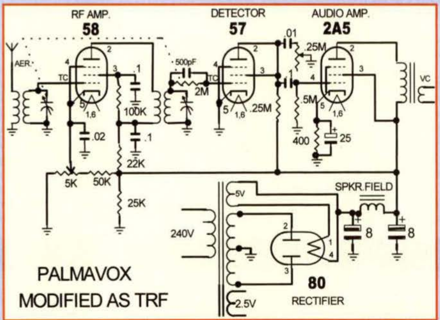

Fig.2: the previous owner's modified TRF circuit uses one less valve and one less IF transformer. It has some serious design flaws.

signals which would interfere with other radios nearby.

Valve manufacture

Amalgamated Wireless Valve Co (AWV) began manufacturing valves in Australia in 1933, with Philips following in early 1936. This quickly brought down the cost of valves and so superheterodyne circuits became the standard for domestic radios produced from the mid-1930s onwards.

Although some indirectly-heated valves with 2.5V filaments were produced locally, the introduction of car radios quickly established 6.3V as the standard (ie, the voltage of a fully charged 3-cell lead-acid accumulator). The late 1940s also saw the development of miniature directly-heated 7-pin valves, some with filaments designed to operate from 1.5V dry cells. The latter made battery-operated portable radios a practical proposition for the first time.

As shown in Fig.1, the original Palmavox circuit used several different valve types. These included two 57s (mixer and detector), a 58 for the IF amplifier, a 2A5 audio output stage and an 80 rectifier.

The type 57 has a screen grid and a 2.5V heater and is suitable for both radio and audio frequency amplification. The inner control grid (connected to a cap on the top of the glass envelope) is wound as a continuous fine wire helix, giving the valve a "sharp cut-off" characteristic. It was replaced in the 1930s by the 6.3V 6C6 and 6J7 types and later by the octal-based 6J7G, all with similar characteristics.

The 58 also featured a 2.5V heater and was similar to the 57 except that the inner control grid helix was wound with a varying pitch. This gives the valve a "remote cut-off" characteristic. As the negative bias on the grid increases, the valve's amplification decreases, thus providing a simple way of controlling gain. The 58 was later replaced with the 6.3V 6D6 and 6U7G types.

The 7-pin miniature valve series developed in the late 1940s featured much higher gain, thanks mainly to improved manufacturing techniques. In particular, the 6AU6 is a sharp cut-off type and the 6BA6 a remote cut-off version, these valves doing similar jobs to the original 57 and 58 respectively.


The chassis in good condition but some of the parts, including a 57 valve and an IF transformer, are missing due to its conversion to a simpler TRF circuit.

Palmavox circuit

The original autodyne circuit used in the Palmavox receiver has a few puzzling design features – see Fig.1.

First, the 5kΩ resistor in the cathode circuit of the 57 mixer valve would result in a low plate current and so the gain of this stage would be quite low. In addition, this 5kΩ resistor is in parallel with the feedback winding of the oscillator coil assembly and so it would provide a high degree of damping.

Perhaps if the previous owner had simply removed this 5kΩ resistor and installed a lower-value resistor in parallel with the series capacitor in the feedback winding, the 57 would have worked fine as an autodyne converter. It would then have been completely unnecessary to downgrade the set to a TRF receiver.

An IF transformer is used to couple the 57's output to the following 58 IF amplifier stage. The hand-drawn circuit doesn't show tuning capacitors but they would certainly have been present, along with trimmers so that the circuit could be tuned exactly to the IF. The screen of the 58 is operated at about 100V in parallel with the screen of the mixer and the gain is controlled by a 3kΩ potentiometer in the cathode circuit.

A second IF transformer couples the IF amplifier's output into the grid of the 57 detector/amplifier valve. Here I would have expected the 57's cathode resistor to be higher than 3kΩ in order to provide linear detection. However, provision is also made for connecting a pick-up into the grid via the IF transformer so it's possible that the 3kΩ resistor was chosen as a compromise between radio performance and phonograph performance. After all, why worry about a little distortion!

A type 2A5 pentode is used as the audio amplifier and this drives a loudspeaker via an output transformer. This circuit is quite conventional except that the 400Ω cathode resistor is a little higher than usual. The 2A5 was later replaced by the octal-based 6F6G (6.3V) and following that by the 6V6G beam tetrode.

Power supply

The AC secondary from the power transformer is fed to a type 80 rectifier. This valve has a directly-heated 5V filament which is supplied by a separate winding on the transformer. This valve was superseded by the

There is plenty of room under the chassis. Two holes at top left have been filled in by the previous owner, while the two large holes at bottom right originally accommodated the HT filter capacitors. Note the knot used to "anchor" the mains cord – a technique that's unsafe and completely unacceptable today.

octal-based 5Y3G which has exactly the same electrical characteristics.

The power supply circuit also shows the loudspeaker's "field-coil". Basically, loudspeakers in the 1930s used a field coil as an electromagnet instead of employing a permanent magnet as used in modern speakers. This usually had a resistance of 1-2kΩ and also served as a filter choke for the HT line.

As a result, the power transformer's secondary voltage had to be higher to make up for the voltage drop across the field coil. A common value was 385V either side of the centre tap.

Because the 80 rectifier heats up faster than the other valves, there is a short period when the HT (high-tension) voltage is higher than normal. This must be taken into account when replacing the electrolytic filter capacitors. A rating of around 550V is desirable and such capacitors are difficult to obtain these days.

However, it is possible to buy filter capacitors with a value up to about 47μF and rated at 400V working. Two of these can be placed in series to exceed the voltage requirement but resistors should also be placed in parallel with each capacitor in case they have different leakage currents.

In the case of the Palmavox, two 10μF capacitors in series from the filament of the 80 rectifier to the transformer centre-tap and two 47μF capacitors in series across HT supply could be substituted for the original 8μF capacitors. These would reduce the 100Hz hum to a reasonably low level. A 100kΩ 1W resistor should be placed in parallel with each of these capacitors.

Note that in this circuit, the field coil is in the negative return of the HT line (ie, between the transformer's centre tap and ground). That's a little unconventional – in most circuits, the field coil is in series with the positive line, with the filter capacitors on either side.

Modified circuit

Fig.2 shows the modified TRF circuit. Unfortunately, the person who carried out these modifications made a number of serious errors, the worst of which was to abandon the original design in the first place!

In the modified circuit, the 58 has been used as a tuned RF amplifier. Its plate is coupled to the 57 detector via the original second IF transformer. The tuning capacitors had been removed from both IF windings and the second section of the tuning-gang connected across the secondary winding. As it happens, the inductance of the secondary is less than that of the aerial coil, so the circuit is tuned to a higher frequency.

The 57 valve is wired as a "leaky grid" detector which is effectively a diode directly coupled to a triode. The original plate detector would have provided greater amplification.

The end result is a receiver which is so insensitive that it needs a very long antenna to receive anything at all. It also lacks selectivity which means that two stations may be heard at the same time.

The power supply has also been modified, with the speaker field coil now in series with the positive line of the HT supply. This works OK but the original circuit has an advantage in that the voltage between the speaker frame and field coil is lower.

Proceed with caution

The changes made to this circuit were both unnecessary and badly executed. My advice to people restoring historical radio equipment is not to make any major changes unless you are fully confident about the undertaking. Unfortunately, the previous owner of the Palmavox had enough knowledge to trace out circuit diagrams but no real understanding of how they worked.

The old saying "a little knowledge is a dangerous thing" certainly applies here.

My next job is to restore the set to a fully-functional version, while retaining the original circuit ideas and appearance as far as possible. **SC**