Vintage Radio

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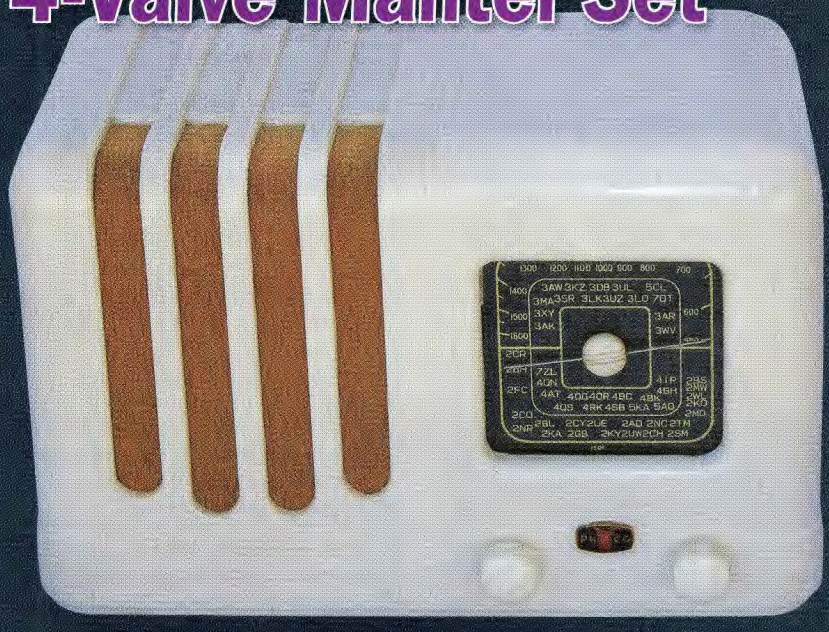
The Philco 40-40 4-Valve Mantel Set



Designed as a "wartime special", the Philco 40-40 is simple 4-valve receiver that was manufactured in Sydney in 1940/41. It's a compact reflexed design with some interesting features.

RADIO RECEIVER design has gone through many phases, both in regard to circuit design and cabinet styling. The very first designs were basically crystal sets but there were also sets that used other forms of solid-state detectors. Valves were only just being developed at that time and in any case, the early types were much too expensive for experimenters to buy.

The next phase saw the development of coffin-style radios based on one or more valves. These were often built by experimenters, with the parts laid out on a breadboard. This was then housed in a coffin-style cabinet to protect the wiring.

Coffin-style receivers were superseded in the late 1920s by commercial receivers built on metal chassis. The period leading up to WWII was a time of rapid development in both component and circuit design and many excellent receivers were produced.

The Great Depression hit hard during the early 1930s and manufacturers responded by producing simple receivers at low prices. As the depression receded, more elaborate designs were again produced towards the end of the 1930s. Then along came WWII and the emphasis changed again.

Because of military demands, component supplies were restricted during the war years and manufacturers had to use whatever they could obtain. As in the Great Depression, the emphasis was on austerity. However, radio design had progressed considerably over this decade and the WWII austerity models are considerably better than those of the depression years.

One local manufacturer from that era was Philco Radio and Television Corporation (Aust.) Pty Ltd. Based in Auburn, NSW, they produced radio receivers from the 1930s through to at least the mid-1950s. These covered the complete range, from simple receivers up to complex multiband sets.

The Philco set described here is an austerity WWII model, circa 1940-41. It was designated the "40-40" and is a 4-valve set with a reflexed IF/audio amplifier stage.

General details

The Philco 40-40 is basically a compact mantel receiver. It's housed in a Bakelite cabinet but despite its compact size, it still weighs in at 4.5kg. This particular set has a cream cabinet although it's fairly certain that brown cabinets would also have been available and there may have been other colours as well.

As shown in the photos, the dial scale on the Philco 40-40 is square-shaped. The pointer, however, is attached to the tuning gang shaft and sweeps through a 180° arc to cover a nominal frequency range of 550-1600kHz. A simple dial-cord drive couples the tuning control to the dial drive drum and the dial cord will be easy to replace when the time comes.

A 5-inch (125mm) electrodynamic speaker is mounted on the lefthand front of the chassis and the unit fitted to this particular set was still in surprisingly good condition. There are

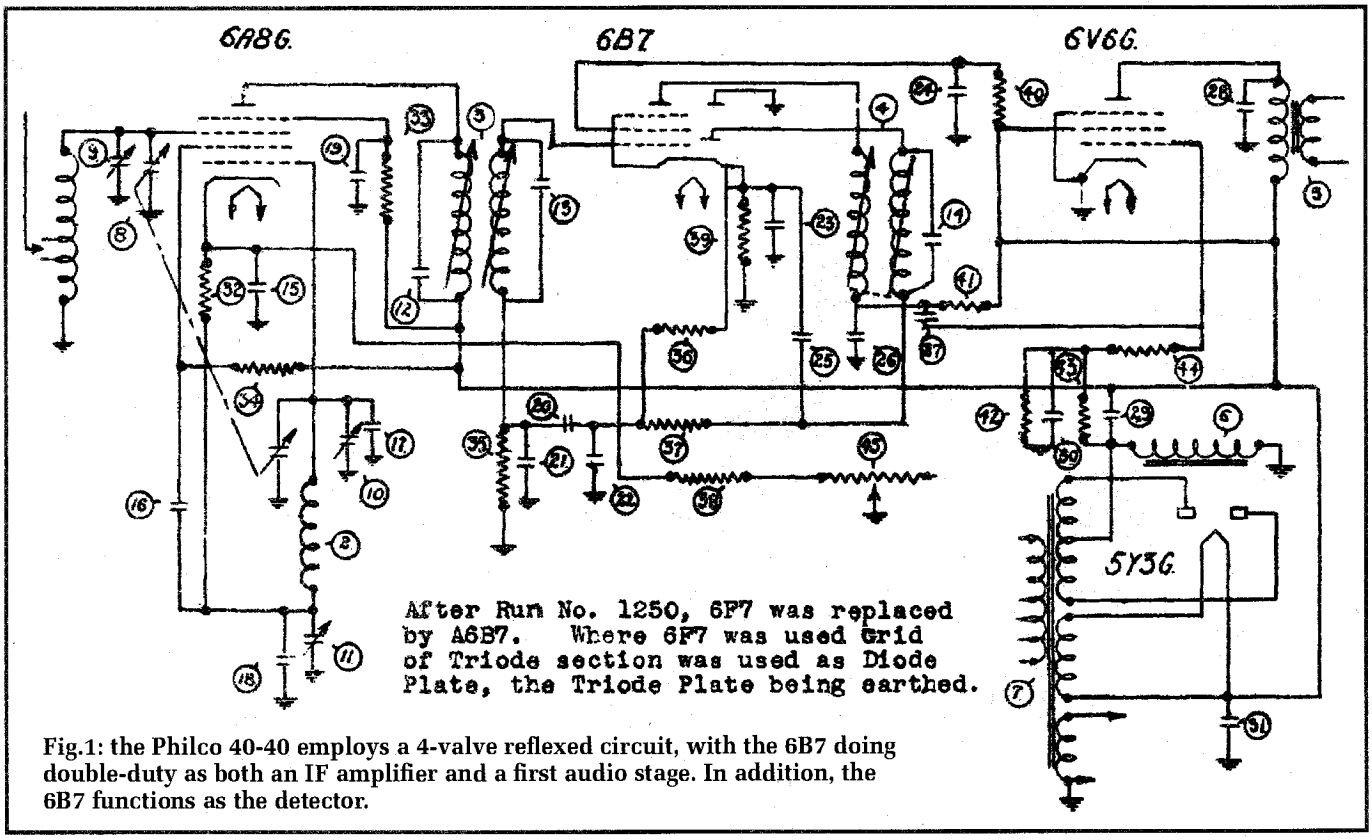


Fig.1: the Philco 40-40 employs a 4-valve reflexed circuit, with the 6B7 doing double-duty as both an IF amplifier and a first audio stage. In addition, the 6B7 functions as the detector.

just two controls, located beneath the dial scale: the volume control at left and the tuning control at right. There is no on/off switch – after all, this was a WWII austerity model.

Crowded house

From the rear of the receiver, it can be seen that things are quite crowded above the chassis. In fact, there is only about 5mm between the tops of some valves and the inside top of the cabinet. The same applies to one of the IF transformers. This chassis was really shoe-horned into the cabinet!

Despite this, the chassis is easy to remove from the cabinet. It's just a matter of removing the two knobs at the front and the three screws that go through the bottom of the cabinet into the chassis. The assembly then slides out.

I initially didn't notice that the cabinet had been repaired during a restoration several years ago. The repair job was expertly done and only close inspection reveals the colour-matched fibreglass matting covering some extensive cracks.

Circuit details

Now let's take a look at the circuit – see Fig.1. This is a 4-valve reflexed receiver and for those unfamiliar with the concept, take a look at Vintage radio for July 2010.

Unfortunately, the way that the circuit has been drafted leaves quite a lot to be desired. As an example, resistor 38 and potentiometer 45 on the cathode of the 6A8G could easily have been positioned to the left of the valve and arranged vertically. That way, their function would have been much more obvious at first glance.

The antenna coil is a flat basket-weave type of the style commonly fitted to portable receivers. It's located at the righthand end of the chassis and has two tappings so that the most appropriate one can be selected to suit the antenna being used.

As shown on Fig.1, the output of the tuned circuit is fed to the signal grid of the 6A8G which functions as a converter. In this particular set, a 6J8G has been fitted although a 6A6G is the correct type to use. The oscillator section uses a single coil winding (2), with the "earthy" end going to the relevant valve grid to give the necessary feedback to induce oscillation.

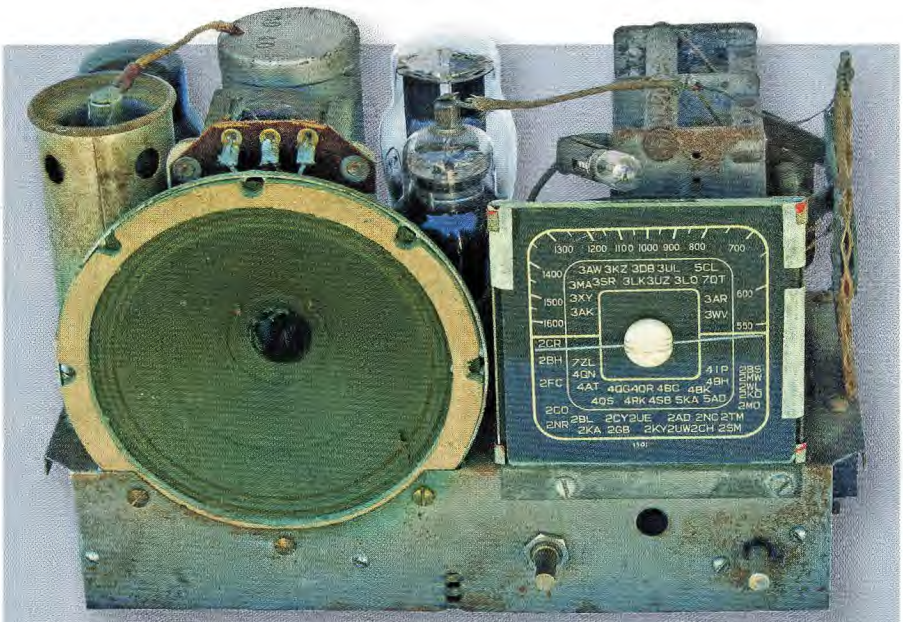
This receiver does not have AGC so the cathode circuit is connected to earth via a 300Ω resistor (38) and a series 7.5kΩ potentiometer (45). The setting on the pot determines the bias on the signal grid of the 6A8G and hence its gain. This in turn controls the volume of the receiver.

IF stage

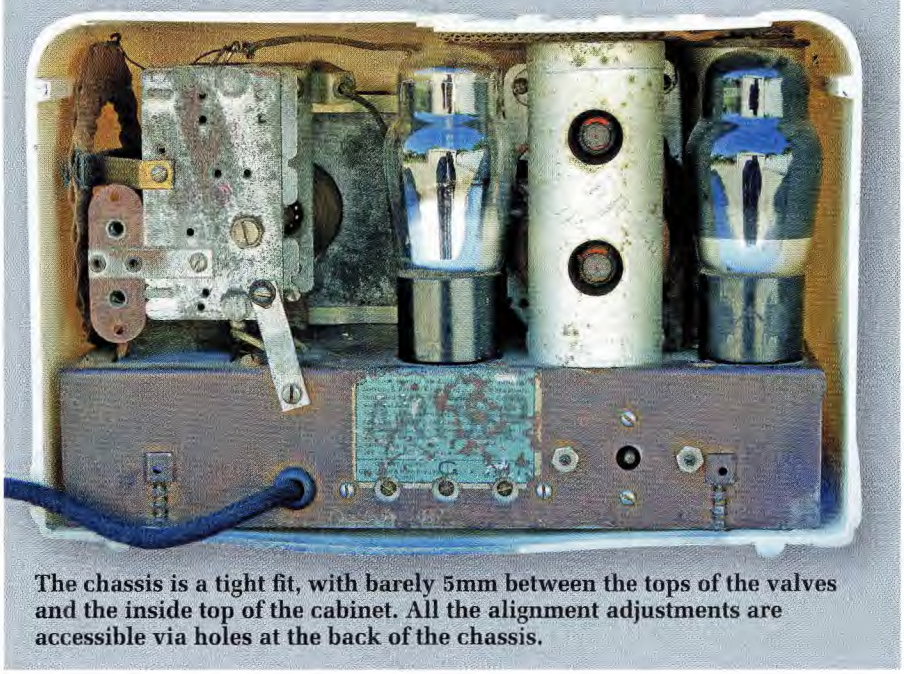
The intermediate frequency (IF) signal appears at the plate of the 6A8G and is fed through two tuned circuits in the first IF transformer to the grid of a 6B7. This functions as the IF and first audio valve. Here, the signal is amplified and then fed via a single-tuned IF transformer to one of the detector diodes in the 6B7.

Note that the circuit indicates that this second IF transformer is double tuned, as both windings appear to have tuning slugs. However, the secondary has no fixed capacitor across it, so it is not tuned and there is no adjustment for that winding (AWA also often used this same style of IF transformer to feed the diode detector). Once again, the draughtsman has been careless in drawing the circuit.

The detected audio is fed to the grid of the 6B7 via resistor 37, capacitor 20 and the secondary winding of the first IF transformer. The resulting amplified audio signal appears across a 100kΩ resistor (41) and is applied via capacitor 37 (10nF) to the grid of a 6V6



This front view shows the compact nature of the chassis. Despite this, it still manages to include a 5-inch (125mm) electrodynamic loudspeaker.



The chassis is a tight fit, with barely 5mm between the tops of the valves and the inside top of the cabinet. All the alignment adjustments are accessible via holes at the back of the chassis.

audio output valve. This then drives the electrodynamic loudspeaker via a speaker transformer.

Note that the cathode of the 6V6G is earthed and its bias is supplied via a back bias network from the power supply.

Power supply

The power supply is a little unusual in that the field coil/filter choke (6) is wired into the negative lead to earth. The more conventional method is to connect it in series with the positive HT lead from the rectifier filament.

The back bias for the 6V6G audio output valve is developed across the field coil. This bias is applied to the 6V6 via a resistive divider consisting of a 250kΩ resistor (43) and a 100kΩ resistor (42). This divider reduces the back bias voltage to around -12V, which is optimum for a 6V6G. A 100nF capacitor (30) filters any hum on the back bias line.

Note that the earth at the junction of (42) and (30) is poorly shown in the circuit diagram (it really is a confused circuit schematic). The labelling of the various power transformer input taps is missing too. This makes it necessary to measure the voltages on the filament lines in order to be sure that the correct terminals have been used.

My tests revealed that the transformer has three primary winding taps to suit voltages centred on 200V, 240V and 260V AC. I also discovered that the person who originally restored this set had wired the mains Neutral to a tap and the Active to the common transformer terminal. That's certainly not the recommended way to do it.

On the circuit diagram, it states that a 6F7 was originally used in the IF/audio preamplifier stage but this was changed to a 6B7 after run 1250. All the valves in this set are octal except this one valve but they may have had lots of 6B7s in stock and wanted to use them (the 6G8G is the octal equivalent). It's also possible that some valves types were unavailable during the war years and they had to make do with what was available.

Chassis layout

The components used in this compact mantel set are all full-sized. As a result, the designers had quite a job on their hands when it came to shoehorning everything into the available space. As mentioned earlier, the space between the valves and the inside top of the cabinet is just 5mm.

Both the front-end parts and the power supply components are adjacent to the power transformer which is mounted under the chassis, directly below the tuning gang. The oscillator coil is right alongside the power transformer, while the converter valve is at the front of the chassis, near the loudspeaker and the tuning gang.

The 5Y3G rectifier is located at the back of the chassis next to the tuning gang, while the 6B7 is at the lefthand end of the chassis (viewed from the front) alongside the speaker transformer. The (shiny) second IF transformer is underneath the chassis, while the 6V6G sits on top of the chassis in the back lefthand corner.

Because of its layout, this isn't an easy set to work on and it can be difficult to identify particular leads, especially when they disappear under other parts. The wiring colours have also faded and this adds to the difficulty of tracing individual leads.

One quite interesting aspect of the layout is that all the antenna, oscillator and IF adjustments are accessible from the back of the set, without removing the chassis from the cabinet. In par-

ticular, the trimmers for the antenna and oscillator circuits are accessed via three holes along the bottom edge of the back skirt of the chassis.

The designers must be applauded for this unique idea, which makes alignment much easier than otherwise.

Restoration

This receiver had been restored several years ago, prior to my friend buying it. This meant that it required only minor work to get it back to peak performance.

As can be seen in the photos, the chassis has surface rust but the set itself is quite clean. Unfortunately, stripping it down to remove the rust would be a huge amount of work. As a result, it was decided to leave it as it was and simply restore the circuit to proper working order.

The mains cord Earth lead had originally been soldered to the chassis, which was considered satisfactory in years gone by. This had subsequently been changed by terminating the Earth lead with a crimp connector and fastening this to one of the transformer mounting bolts (see photo).

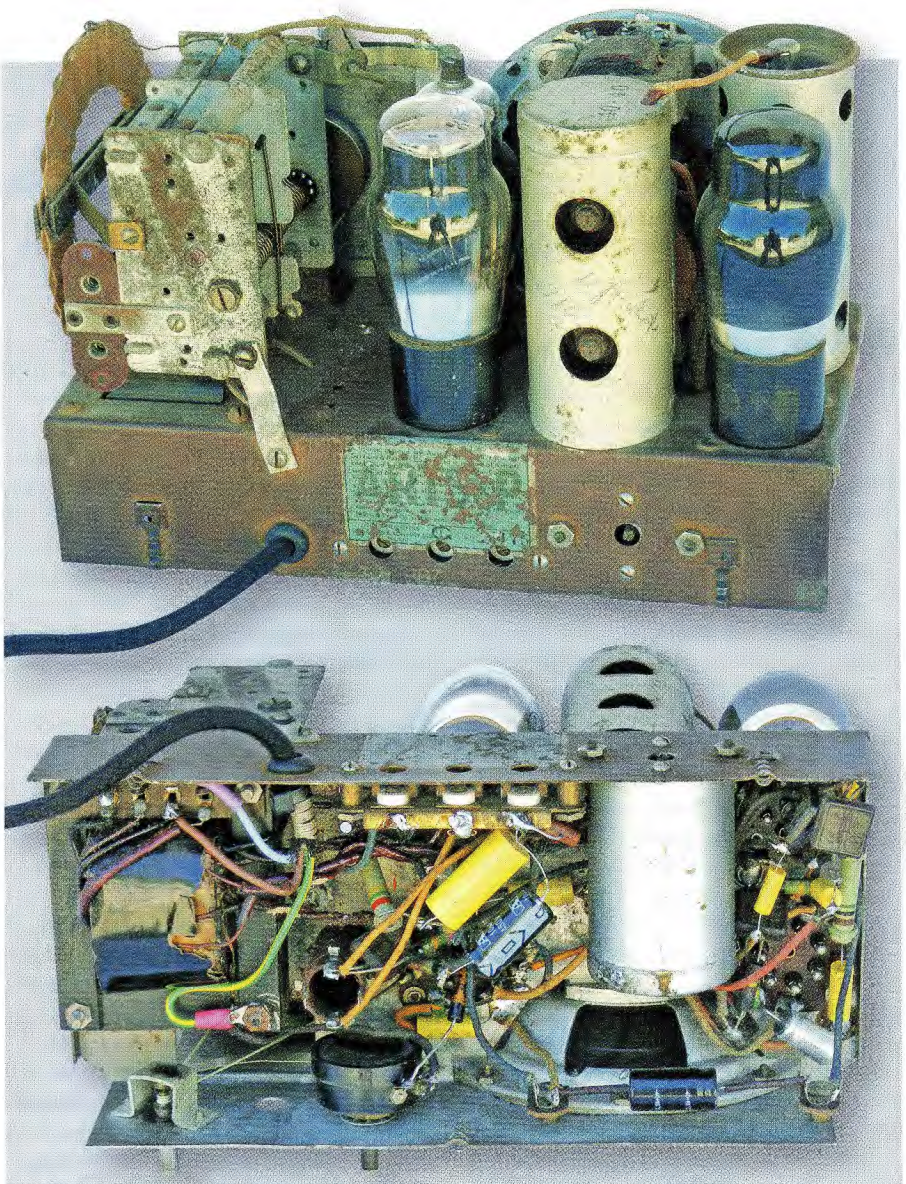
I wasn't happy with this and bolted the earth lead crimp connector to the chassis instead. A separate earth lead was then run from one of the transformer mounting bolts to a second chassis earth point. In addition, the Active and Neutral leads were transposed on the power transformer by resoldering them to the correct terminals.

The method used by a previous restorer to secure the mains cord was quite primitive and is completely unsatisfactory. It should be properly secured using an approved chassis clamp and the owner will attend to this when he takes the set home.

The paper capacitors had all previously been replaced, as had the electrolytic capacitors. I wonder how the old ones fitted in, as they would have taken up quite a lot of the space under the chassis and space really is at a premium.

Unfortunately, some of the replacement parts have been fitted with their values obscured. Wherever possible, I always fit resistors and capacitors so that their values can be easily read. This makes it much easier to service a set should it later require attention.

For some reason, the previous restorer had installed a 700pF mica capacitor in the padder circuit of the oscillator instead of a 475pF capacitor as specified. This error was discovered when I later switched the receiver on (see below).



The parts are tightly packed together on both the top and bottom of the chassis, although access is still reasonable. Note the primitive method used by a previous repairer to secure the mains lead. It should be secured using an approved chassis clamp, while the Earth lead should be bolted directly to the chassis, rather than secured to a transformer mounting screw.

Initial tests

It was now time to test the receiver. I began by checking the leakage between the windings of the power transformer using my high-voltage tester and this showed that it was in good order. In addition, there were no shorts or near shorts on the HT (high tension) line.

Having completed these checks, I connected a meter to the HT line and applied power. The HT shot up to over 400V initially, which is normal in a receiver with a loudspeaker field-coil filter. It then settled down to about 250V as the valves began drawing current.

Alignment

The next step was to attach an antenna to one of the antenna coil taps. When I did this, the set immediately began working. What's more, it seemed quite sensitive, with lots of stations coming in.

Because the Philco 40-40 has no AGC (automatic gain control), I had to constantly adjust the volume control as I tuned across the broadcast band. AGC certainly has its advantages and

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in this set, could easily have been applied to the converter stage.

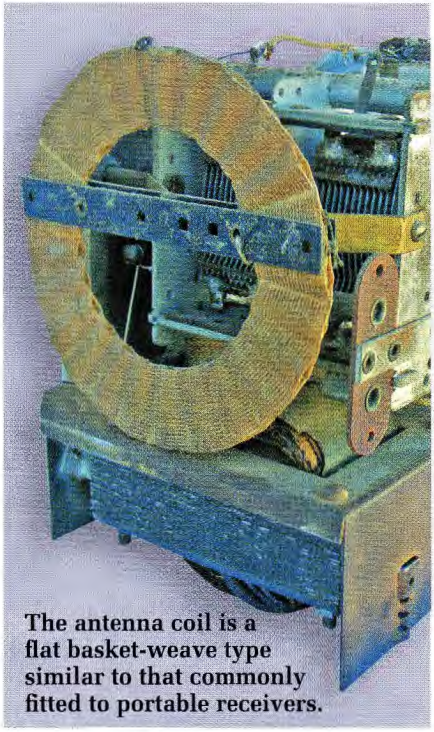
One thing I noticed was that the stations weren't quite where they should be on the dial. As a result, I decided to start the alignment procedure with the local oscillator.

Testing revealed that the receiver was tuning even lower in frequency than the IF (460kHz), which was decidedly odd. It was then that I found the 700pF fixed padder capacitor that had been fitted by the previous restorer, instead of the 475pF capacitor specified.

I replaced the padder with the specified value and was then able to correctly align the oscillator stage. Once that had been done, the stations came in at their correct locations on the dial.

Finally, the loop antenna was adjusted for optimum performance at around 1500kHz by peaking the associated trimmer capacitor (9). This was done with a long-wire antenna connected first to one antenna tap and then the other.

The old Philco receiver was now really hitting its straps and it really does perform well for a 4-valve austerity model set. In fact, on the strongest local stations, the volume could only be reduced down to a comfortable listening level, although it could be adjusted for zero output on weaker stations. There's a good reason to prefer sets with good AGC systems and audio stage volume controls.



The antenna coil is a flat basket-weave type similar to that commonly fitted to portable receivers.

Summary

This is an interesting little receiver that's well worthwhile having in a collection. Despite being a "wartime special", it's quite a good performer although it would have benefited by having AGC.

As mentioned above, all the alignment adjustments are accessible without removing the chassis from the cabinet. This feature is unique to this set as far as I know and it's certainly very convenient.

Finally, because the parts are so tightly packed into the chassis, this would not have been easy to service when using full-sized components. The designers certainly did a good job getting so much into such a small cabinet. SC