Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The American Philco 52-545 5-Valve AC/DC Mantel Receiver

Manufactured in the US in the early 1950s, the Philco 52-545 is a 5-valve broadcast-band superhet. It's a transformerless AC/DC that runs directly off 115V AC and so a care must be exercised when working on it.

IN BOTH AUSTRALIA and New Zealand during the valve radio era, it was standard practice to use a mains transformer to convert the 240V AC mains to other AC voltages, as required. By using a transformer, the lethal mains voltage was isolated from the receiver's metal chassis and this made it safer for both users and servicemen.

However, there were some exceptions to this convention as there were areas with DC mains and areas that relied on 32V DC house lighting plants. Many AC/DC sets were made for use in country areas and these often had one side of the mains directly connected to the chassis!

This meant that, depending on which way around the mains was wired, the chassis could operate at 240V AC with respect to earth. For the unwary, they could be a real death trap and were always dangerous to work on.

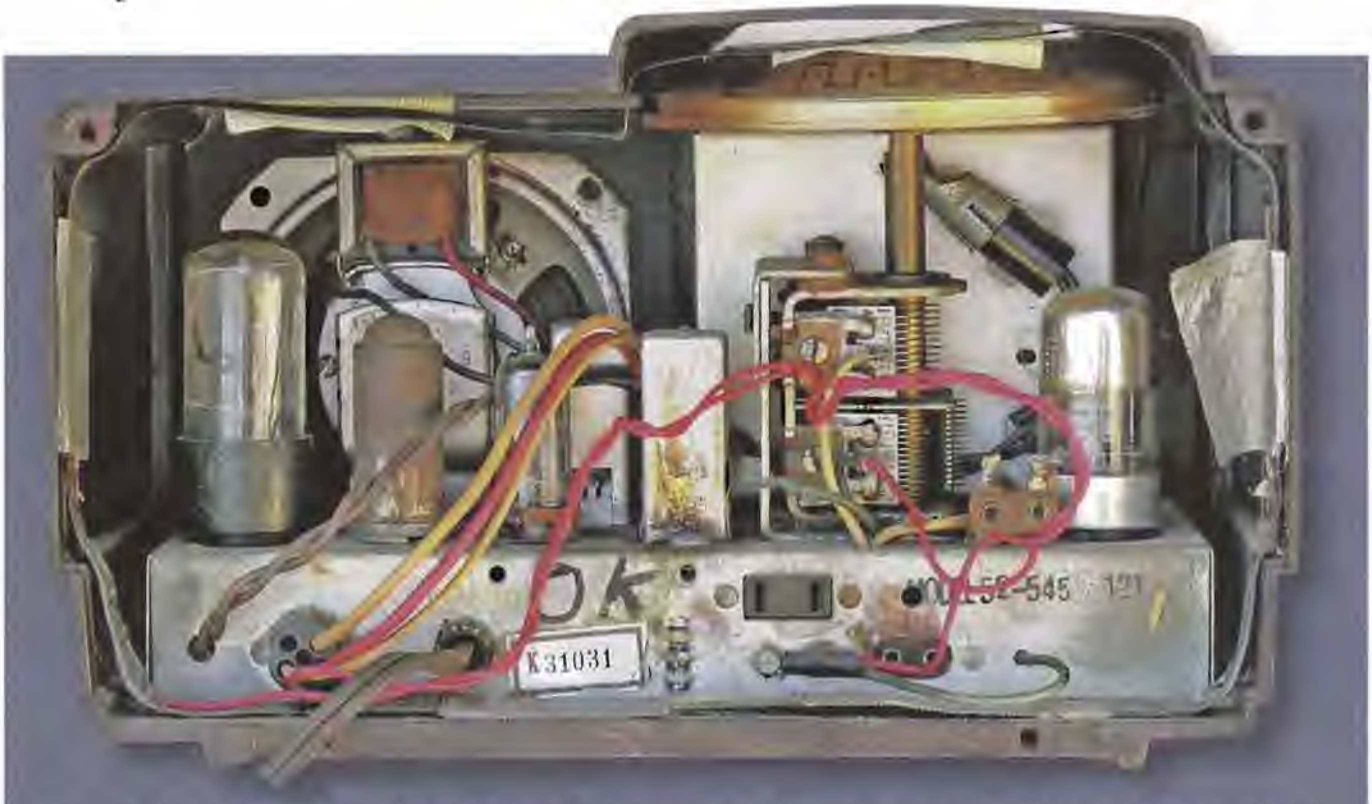
Because of this, AC/DC receivers were always totally fully enclosed in a cabinet (ie, with closed backs) and the controls were often fully insulated from the chassis. That wasn't always the case though. Many AC/DC sets had metal-shafted controls which were attached to the chassis and if a knob came off, users could get a nasty if not fatal shock from the bare control shaft!

To overcome this problem, some sets did not earth one side of the mains so that the chassis itself could be earthed. In these sets, all items that would normally have been earthed to the chassis were instead connected to a bus bar (often a thick solid-core tinned copper wire). This bus was then earthed as far as RF was concerned using a large high-voltage paper or mica capacitor wired between it and the chassis.

In addition, the antenna coil primary winding was often completely isolated from the mains, with one end going directly to the antenna and the other going directly to an outside earth.

No standards

The techniques used by the manufacturers to isolate both users and servicemen from electric shock from AC/DC sets were generally quite satisfactory – at least, for normal use. However, it seems that there was little uniformity in the methods used to ensure that the unwary (or careless) were protected against electric shock



This view from the back shows the unit prior to restoration. Note the antenna loop around the inside of the cabinet and the unusual mounting arrangement for the tuning gang.

or worse, electrocution. In those days, if a fault developed, people often took the backs off sets to see which valves lit up and would wriggle various components, etc, with the set turned on. And if the chassis was at 240V AC, a severe shock or even electrocution was likely.

Some servicemen were also rather "gung-ho" in their attitude to these potentially dangerous sets and suffered the same consequences. The use of a 1:1 mains isolation transformer made servicing these sets much safer but many servicemen lacked such a basic device.

In my time as an impoverished serviceman, I always checked before I started servicing an AC/DC set to see which side of the mains was attached to the chassis before I plugged the set into the power point. I often altered the mains plug wiring so that the Neutral (which is virtually at earth potential) was attached to the chassis instead of the Active (Neutral and Earth are connected together at the switchboard).

Of course, even this will not be safe if Active and Neutral have been transposed at the mains outlet, so you always had to be extremely careful. **The moral of the story with AC/DC sets is if you don't know what you're doing then don't! Leave them strictly alone and you'll live to see another day.**

US & European sets

In the US, AC/DC sets were extremely common as they tended in later years to be the "cheap and cheerful sets". However, this was not always the case. Many valves were designed to have heater voltages much higher than 6.3V and this meant that a number of such valves could be connected in series string across the mains (115-120V in the US). The heater current was usually 0.15A but some valves had heater currents as low as 50mA.

Of course, if a person touched the 115V mains in the US, he or she was less likely to be electrocuted than a person who touched our more lethal 240V mains in similar circumstances. However, that should not be taken as a suggestion that touching 115V mains can not result in death. It's still all too easy to receive a fatal shock.

In Europe, 230V AC/DC receivers were common. If you look carefully at many European receivers with mains transformers, it will be apparent that the mains wiring is often not that well protected against accidental contact when the chassis is being handled, as can happen at times when it is being serviced. This means that such sets should always be switched off at the power point before moving them to gain access to a particular section during servicing.

By contrast, Australian AC-operated receivers are generally much better laid out to protect users and servicemen against shock but never take that for granted.

In short, when servicing AC/DC sets or even imported sets with a transformer, it's a good idea to always use a 1:1 isolation transformer. If that's not possible, make sure that the chassis or the common bus bar is connected to the Neutral side of the mains. In addition, after applying power, always use your multimeter to confirm that there is no voltage between the chassis and mains earth.

Finally, use an Earth Leakage Detector (ELD) on the mains just to be doubly sure that all is safe. I always use an ELD as standard practice and in some cases an isolation transformer as well.

The Philco 52-545

One such transformerless set is the US Philco 52-545. The unit featured here is owned by a friend and is a typical 115V AC/DC receiver from the

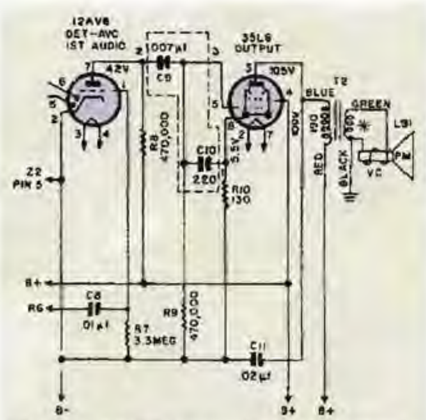


Fig.1: a 12AV6 is used as a detector and first audio stage, while a 35L6-GT is used as the audio output stage.

early 1950s. It is a standard 5-valve superhet.

One unusual feature of this set is the way the dial-drive is arranged. As shown in the photos, the tuning gang is mounted on its back with its control shaft pointing upwards. A large knob is mounted onto this extended shaft and it is calibrated in much the same way as many handspan dials are. The tuning is smooth and effective, so it works well despite the rather unusual arrangement.

The chassis itself is housed in a brown bakelite cabinet which also has a clock built into it. Unfortunately though, the clock is of little use in Australia as it is designed for 60Hz mains operation and quickly loses time when used on our 50Hz mains.

This model has no external antenna connections, although investigations show that earlier models did have such a feature in the past. Instead, this unit uses a tuned-loop antenna winding around the rear edge of the cabinet. A twisted pair of wires to the tuning gang connects the loop to the set.

Valve line-up

The relatively rare 7A8 octode is used as the converter valve. Its oscillator coil is unusual in that it has no adjustable core. I suspect that adjustment at the low-frequency end of the tuning range was deemed unnecessary, as the dial calibrations are rather vague anyway.

The 455kHz signal from the converter is applied through a double-tuned IF transformer to a 12BA6 IF amplifier stage, the output of which is then fed to a second IF transformer. The resulting 455kHz signal is then detected using the diode section of a 12AV6 (see Fig.1) to derive the audio plus simple AGC. The triode section of the 12AV6 then amplifies this audio before feeding it to a 35L6GT audio output stage.

Finally, the 35L6GT drives the speaker via a speaker transformer (T2).

Power supply

Because it is an AC/DC mains receiver, the Philco's power supply is quite different to that used in sets using a mains transformer. Fig.2 shows the circuit.

In AC/DC receivers, the heaters are wired in series across the mains. However, because the total voltage drop across the filaments is less than the mains voltage, several methods are employed to drop the excess voltage and regulate the current flowing in the heater string. Note also that the heater currents must all be the same unless equalising resistors are used across those valves which have lower heater current requirements.

As mentioned above, valves with 0.15A heaters were commonly used in AC/DC sets. In this receiver, there is a 35Z5 rectifier, a 35L6GT, a 12BA6, a 12AV6 and a 7A8. This line-up gives heater voltage drops of 32 + 35 + 12.6 + 12.6 + 6.3 = 98.5V, respectively.

Applying 115V AC to a string of valves with a total heater voltage rating of 98.5V would not be conducive to them having a long life. As a result, in this set, a thermistor is used in series with the heaters to reduce the applied voltage.

Philco called this thermistor a "tube saver". When the receiver is first turned on, nearly 100V is dropped across the thermistor, which has a cold resistance of around 800Ω. As it warms up, this resistance gradually drops so that progressively more voltage is applied across the valve heaters.

In all, it takes about 40 seconds for the set to warm up and start operating.

Note that the warm-up characteristics of valves wired in series are not uniform. This means that in the absence of a component such as the "Tube Saver", some valves may have perhaps 30V across their heaters for a short time instead of their rated 12.6V. And that's hardly conducive to a long valve life.

Note also that although a thermistor has been used here, other components are also be used by different manufacturers, eg, a resistor, a barretor or, more rarely, a capacitor.

As Fig.2 shows, in the Philco 52-545, one side of the mains is connected to the negative bus (not to the chassis as is common) via a switch in the clock. The other side of the mains is connected to the rectifier's heater, while the rectifier's plate is connected to a tap on its heater.

The high-tension DC output from pin 8 of the rectifier goes to a filter network consisting of several electrolytic capacitors and resistors. From there, around 108V DC is fed to the plate of the 35L6GT audio output valve.

In the case of the negative bus, a parallel network consisting of a 0.27μF

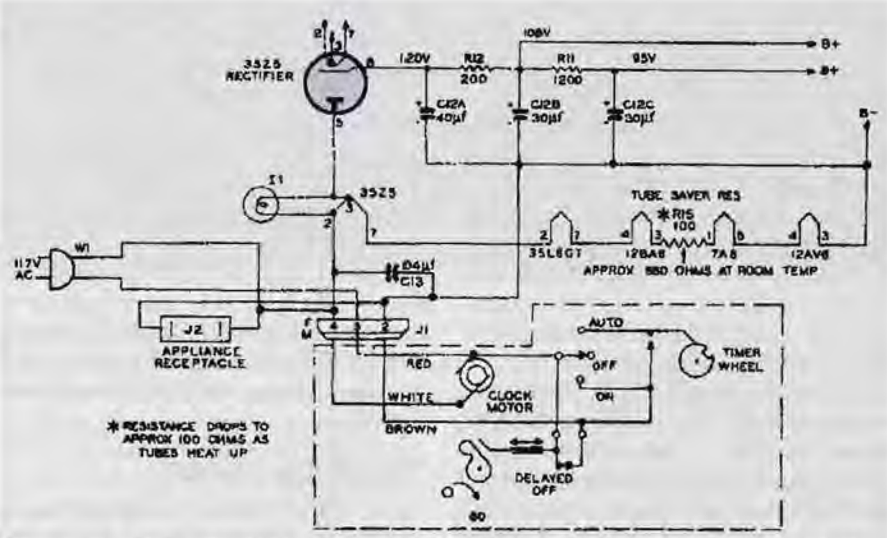
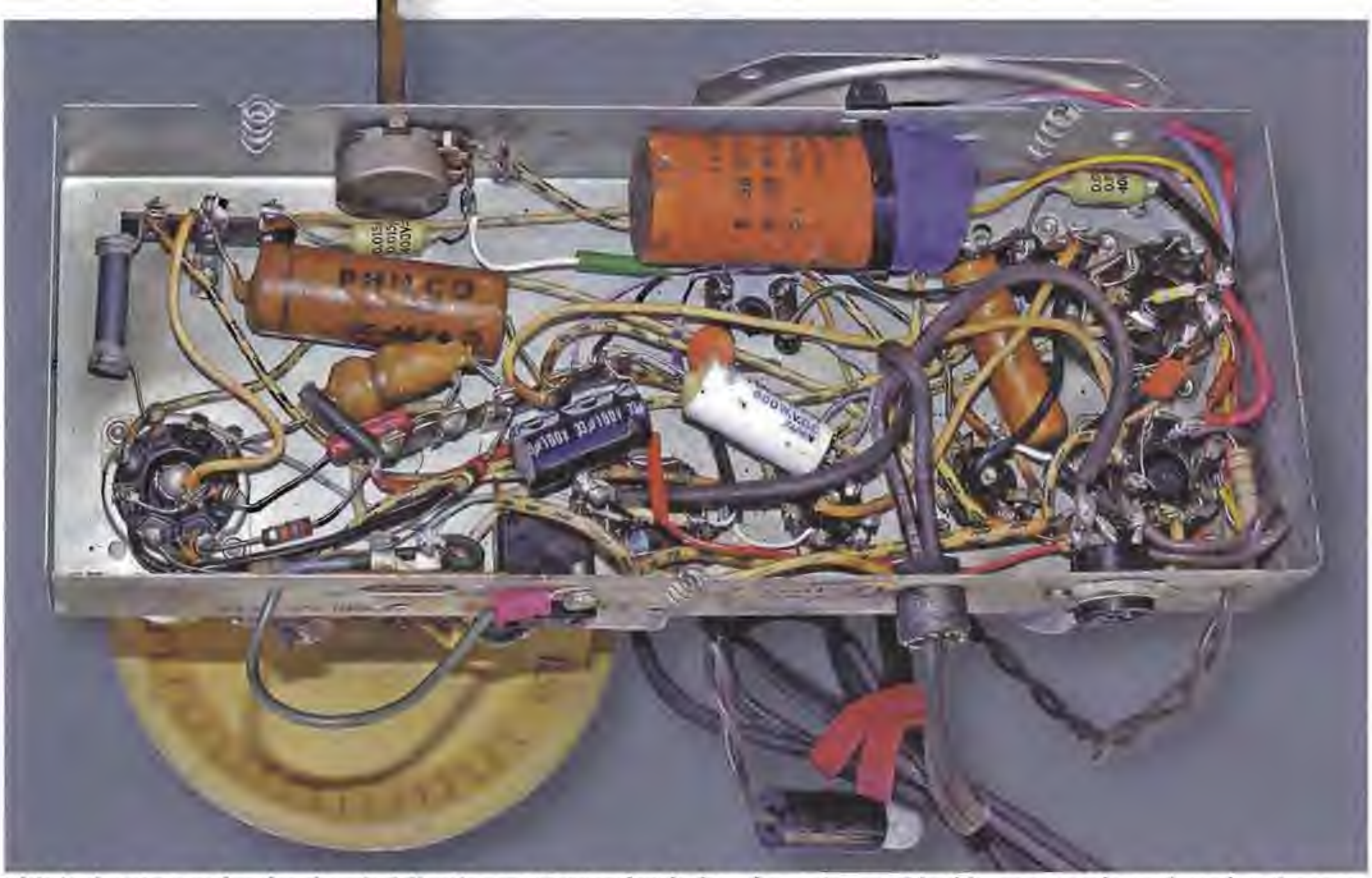


Fig.2: the Philco 52-545's power supply circuit. This is an AC/DC set with the valve heaters wired in series with a thermistor directly across the mains.



This is the view under the chassis following restoration but before the mains cord had been properly anchored to the rear panel. The untidy nature of the original wiring makes it difficult to access some of the parts.

(270nF) capacitor and a 150kΩ resistor connects to the chassis. This network acts as an RF bypass and means that the chassis can give you a "tickle" under some circumstances but not enough to electrocute you.

However, always be careful servicing these transformerless receivers – a fault can render them lethal and they are inherently dangerous in any case.

Restoration

Usually, I am fortunate enough to have access to the relevant circuit diagram of each set that I restore. In this case, I wasn't quite so lucky.

I trawlled the internet but found only part of the circuit on one site. This was then used in conjunction with an older circuit I had in a book of Beitman's, so that I was eventually able to work out all the important parts of the circuit.

This was necessary to determine whether or not any drastic modifications had been done to the set. Fortunately, there did not appear to be any major changes but as the restoration progressed, I became aware of several silly modifications that had drastically reduced the set's performance.

During restoration, one of the first things I do is to visually check both sides of the chassis. This allows me to assess the quality of the workmanship, both at manufacture and during any subsequent servicing or restoration.

In this case, it was obvious that the set had been serviced. As a result, quite a bit of tidying up was necessary as someone in the past had used some quite heavy wire to replace older wiring. This new wiring had been run point-to-point, without much thought about access to the components underneath it.

The solder joints were also rather questionable, with large blobs on many connections and several pigtail ends nearly shorting to nearby terminals.

Next, I tested the electrolytic capacitors and found them all to be slightly low in value but not low enough to warrant replacement. During these tests, however, I noticed that the low level audio leads were unshielded and ran close to the heater line. As a result, hum was being induced from the heater line into the low-level audio circuit.

This problem was later cured by using shielded leads and by rerouting them away from the heater line.

Next, I set about replacing the heavy non-original wiring with something more appropriate. The original wiring that remained was mostly fabric-covered and was in good order. I then checked the resistors and replaced several that were well out of tolerance. Unfortunately, this wasn't an easy job as the component leads were all wound around the tie points to make them easy to solder during manufacture.

The paper capacitors were next on the list. Most were quite leaky electrically and so were replaced but some were in quite good condition and were left in circuit.

That done, I checked the wiring as best I could without an original circuit and found a couple of anomalies. First, the "cold" end of the loop antenna was connected to the chassis instead of to the AGC line. This meant that AGC could not be applied to the converter and under some conditions, quite high AC voltages were applied to its input grid.

The 7A8 also proved to be down in performance (I wonder why). I correct-

The parts on the top of the chassis are all easy to access once the large circular dial has been removed. The IF transformers and the loudspeaker required replacement, while the tuning gang was shorting out over part of its rotation.

ed this wiring but it's not easy finding your way around this chassis due to the untidy layout of the wiring.

Getting it going

To test the set, I connected it to 115VAC via an isolating transformer and switched on. I then carefully monitored the voltages as the set warmed up and they were normal. However, the only thing I got out of the set was a loud crackle that varied as the volume control was adjusted.

Because the volume control is located prior to the 12AV6 audio amplifier stage, it was obvious that the fault was located in an earlier stage of the receiver.

To diagnose the problem, I first removed the 12BA6 IF amplifier valve but the crackling remained. I then quickly replaced the 12BA6 in its socket, since removing a valve also interrupts power to all the remaining valve heaters.

My next suspect was the second IF transformer which couples the signal from the 12BA6 through to the detector. As a result, I disconnected the plate and HT leads from the transformer and earthed the screen of the 12BA6 to the negative bus with a clip lead so that the valve would not draw current. When power was reapplied, the crackle had gone and the audio stage was functioning normally.

So it appeared that the IF transformer was at fault. To test it, I turned the set off and checked its windings with a multimeter. The secondary was OK but the resistance of the primary constantly varied.

I removed and dismantled the transformer and found several dry joints inside, on its terminals. I resoldered these and then refitted the unit, fully expecting this to put an end to the crackling.

Well, it didn't and I was forced to the conclusion that there was leakage between the primary and secondary windings of the transformer. Fortunately, I had a similar-sized IF transformer out of an old AWA receiver in my junkbox, so I fitted that in place of the original. It ended up fitting well (after a little hole filing) and I wired it up in the conventional manner (the original circuit was peculiar to say the least).

That done, I turned the set on again and all was quiet except for a slight amount of hiss from the speaker.

Next, I connected my signal generator to the front end of the set – ie, earth lead to the negative bus and the active signal lead via a mica capacitor to the grid of the 7A8. By setting the generator to give a high output on around 455kHz, I was able to force a signal through the set and after adjusting the replacement IF transformer, the set was starting to look like it might be a "goer".

No oscillator

However, something was still not quite right, as the oscillator in the 7A8 was refusing to operate. This is fairly easy to check. First, you place another receiver (preferably a portable) alongside the set under test and tune it to around 1200kHz. You then tune the set under test from the low-frequency end of the dial towards the high-frequency end.

When this is done, a "swish" should be heard as the set under test is tuned to through 745kHz. If nothing is heard, then it is likely that the oscillator is faulty, as in this set.

Having established that the oscillator wasn't working, I first checked the oscillator coil and found that the two windings had continuity. The coil is unusual in that, as mentioned previously, it has no adjustment core (near enough is good enough, as the dial calibrations are rather vague).

At this stage, I thought that the valve must have succumbed to the drastic abuse it had suffered due to a previous owner's incorrect wiring of the loop antenna. However, a new valve didn't solve the problem so I looked more closely at the tuning gang and found that the oscillator section was shorting over part of its rotation.

Because it was an outside leaf that was shorting it was easily bent out a little and that solved the problem. The oscillator then worked with both 7A8 valves, although the new valve worked better. Even so, the set's performance was still woeful, due to it being badly out of alignment.

Unfortunately, I couldn't adjust the tuning of the first IF transformer as one core had had its slug mangled. In the end, I decided to remove it as well and fit the other AWA miniature IF transformer that I had.

Here's what the chassis look like with the dial in place. This dial protrudes through a slot in the top of the cabinet when the chassis is slid into place.

When I pulled the original out and dismantled it, I found that there was no hope of adjusting the mangled core. By contrast, the second core could be adjusted but a previous owner had wound it right out. It probably could have been made to work with a lot of mucking about but it looked like too much work so I just fitted the AWA transformer.

That did the trick. When I turned the set back on again, I found that it was now working reasonably well. After a final touch up of the tuning cores, the IF stage was again working like new.

Still below par

Despite my work on the IF section, the set's performance was still below par. The trimmer on the antenna loop had been adjusted for minimum capacitance but it still needed to be less at the high-frequency end of the dial. This indicated that the twisted pair of wires from the loop to the tuning gang had too much capacitance between them and this was preventing the antenna loop from tuning properly.

My first attempt at fixing this problem involved replacing this twisted pair with some air-spaced 300-ohm TV ribbon cable. My reasoning was that this would reduce the capacitance across the tuned circuit sufficiently to deliver a peak at the high-frequency end of the dial. However, while this did reduce the capacitance, the trimmer still could not be adjusted correctly.

It was beginning to look as though there were too many turns on the antenna loop, so I decided to check it. I unwound all the tape around the two points where the wires emerged from the loop and this revealed that there were in fact two windings wired in series. One was the tuned winding while the other was a link winding for an external antenna and earth, so someone had obviously been fiddling.

I disconnected the two windings and connected the winding with the highest resistance (about 2.5Ω) to the tuned circuit. The set was now starting to perform like it should. There were more stations evident at the low-frequency end of the dial and the antenna trimmer could now be peaked at the high-frequency end.

There was just one final problem with the set – the speaker has been damaged at some time in the past. It had been repaired but still sounded terrible and so it was replaced.

Summary

Although this restoration took some time, the result is a set that is quite a reasonable performer. As an AC/DC receiver, it is much safer than many and would make a worthwhile addition to any vintage radio collection. **SC**