Vintage Radio

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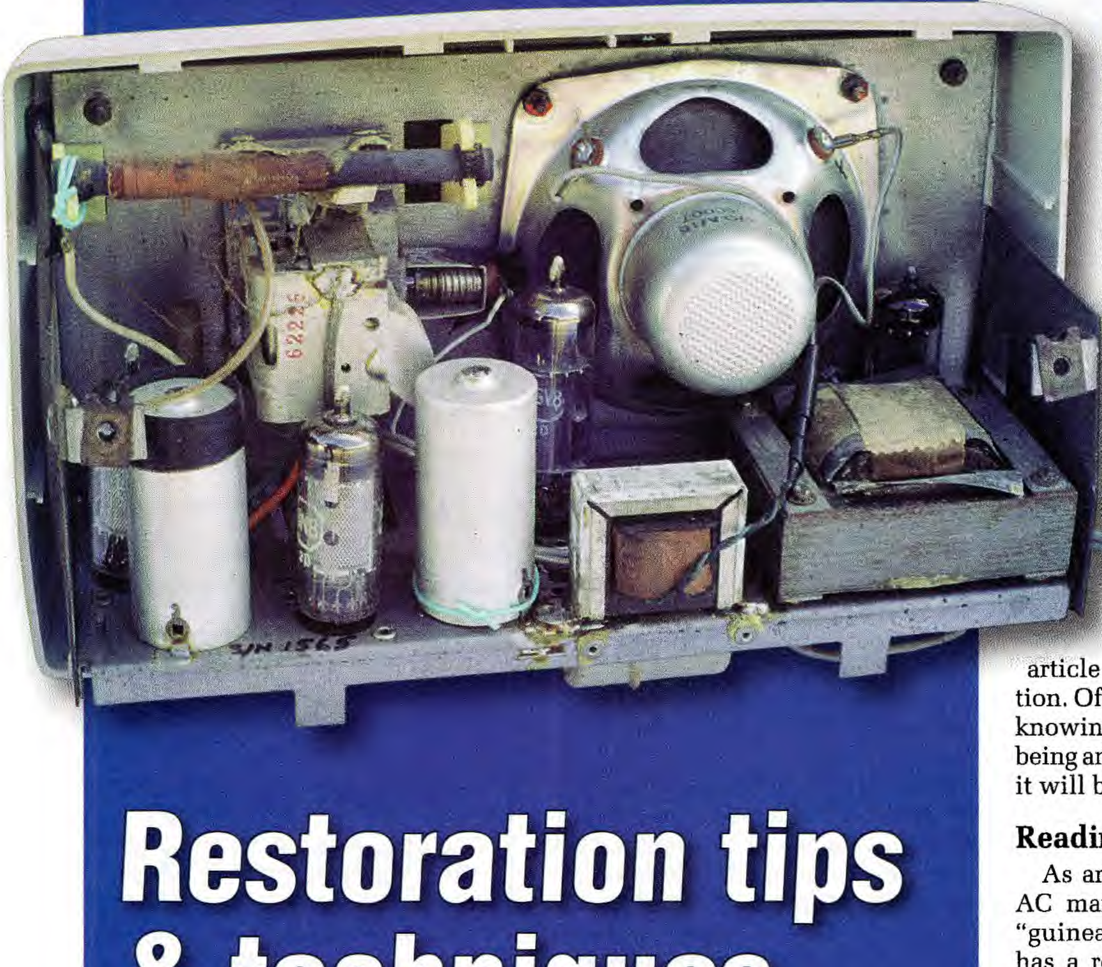


Restoration tips & techniques

It's not surprising that many vintage radio enthusiasts don't come from an electronics background. In fact, prior to taking up the hobby, most never got closer to the subject than using the external controls on various pieces of electronic equipment.

SOONER OR LATER, a vintage radio enthusiast must decide which technical areas to become competent in so that they can at least carry out some restoration work. Some will simply do the cabinet work and clean the chassis but leave the electronics restoration to someone else. By contrast, others will want to do the lot. The problem is, electronic circuitry is a complete mystery to many newcomers.

So how can a novice learn how to check and restore electronic circuits? Well, we all have to start somewhere and that's the aim of this article – to provide a basic introduction. Of course, it won't take you from knowing nothing about electronics to being an electronics wizard but at least it will be a start.

Reading a circuit diagram

As an example, the Kriesler 11-90 AC mantel receiver is used as the "guinea pig" for this article, as it has a relatively simple circuit. It is a broadcast-band receiver with four valves, one of which (the 6GV8) is a dual valve – ie, it has a triode and a pentode in the one glass "envelope". As a result, the Kriesler 11-90 is functionally equivalent to a conventional 5-valve receiver.

The circuit diagram is shown in Fig.1. As can be seen, it is well labelled, which makes checking things within the circuit relatively easy.

A schematic circuit diagram is a "shorthand" method of showing how the parts are connected in a piece of equipment. For this reason, it's essential that you become familiar with what the various symbols mean, in order to understand how the circuit works (if only at a basic level).

Let's start with valves. These are usually drawn with a heavy oval shape which contains the various elements. We will use the 6N8 as an example – see Fig.1.

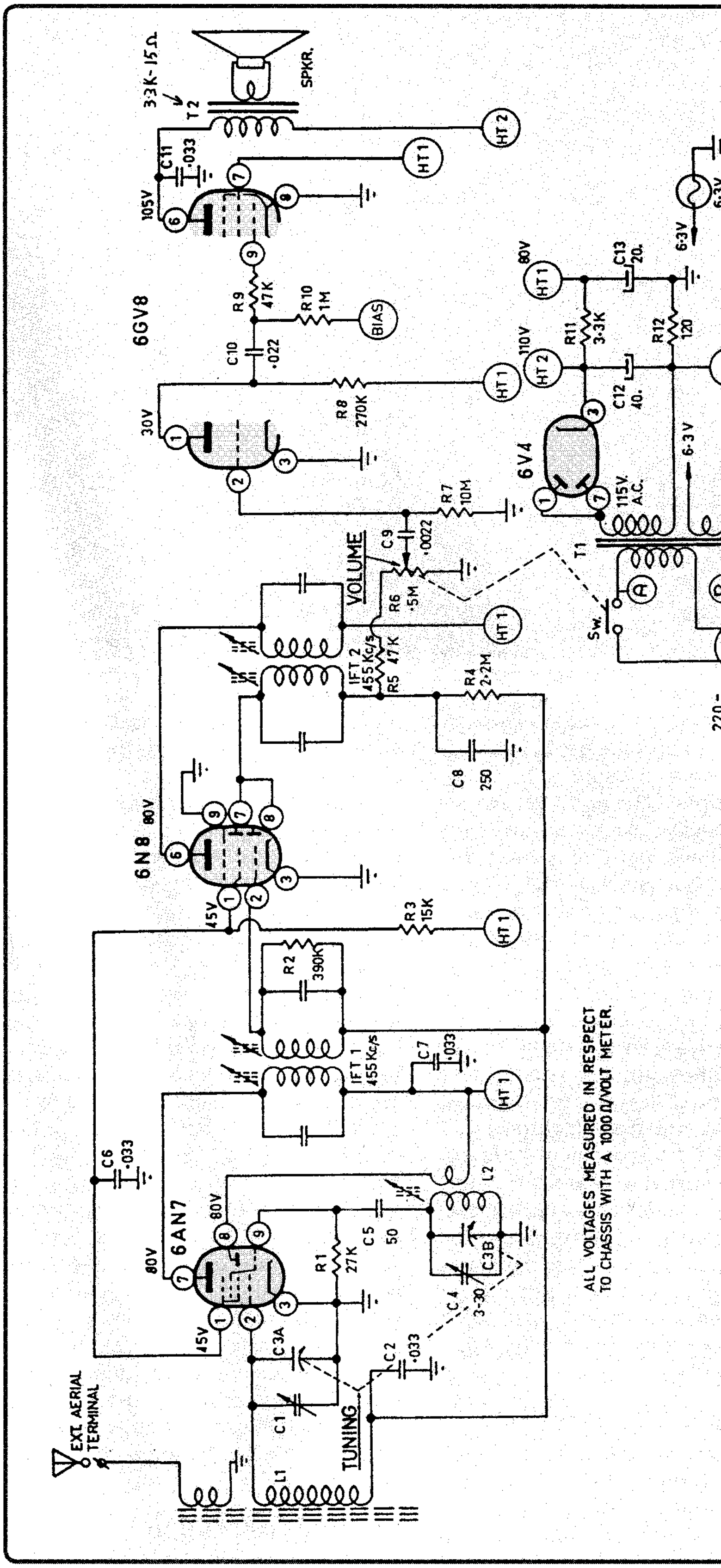


Fig.1: the circuit diagram for the Kriesler 11-90 AC mantel receiver. It uses four valves and covers the broadcast band.

Pin 3 is attached to the "cathode" of the valve and this element emits electrons when it is heated. Pin 2 is the control grid and is shown as a dashed line – it's simply a grid of wires. The electrons from the cathode pass through the grid and are attracted towards the positively-charged "plate" which is attached to pin 6.

Pin 1 is the "screen" grid (it screens the grid from the plate), while pin 9 is the "suppressor" grid. The latter "captures" electrons which bounce off the plate and takes them to earth (chassis). Pins 7 & 8 are the cathodes of the two detector diodes, which are located close to the main cathode at pin 3.

Note that the heater connections for the valves are not shown in Fig.1. In practice, these are connected between pins 4 and 5 for most 9-pin miniature valves (it is assumed in most diagrams that you know this).

So basically, the shorthand drawing of the valve is relatively close to what the internals of the valve are really like. Of course, the description here is a simplistic version of what really happens inside a valve.

Identifying valve pins

How do you identify which pin is which? Simple, the valve socket as viewed from below has a wider gap between two of its pins. This is the reference point and the pin numbers start from the left as number 1 and progress clockwise to number 9.

Other valve sockets are similar in concept. For example, small 7-pin sockets are read in the same way, while octal sockets are read clockwise from the keyway pin on the spigot. The valve base diagrams usually make this clear.

Other older valve socket types have different layouts. Checking through a valve data book will assist in identifying which pin numbers relate to which pins on their bases.

Resistors & capacitors

Resistors are the items with the "zig-zag" lines. For example, R10 is a 1MΩ (one megohm) resistor. The zig-zag symbol always reminds me of a tortuous path which restricts current flow and in some ways, resistors can be thought of as doing just that.

Capacitors, on the other hand, are represented by two parallel lines – eg, C8. The lines can be thought of as being equivalent to the two parallel plates that make up the capacitor. However, this really is symbolic as

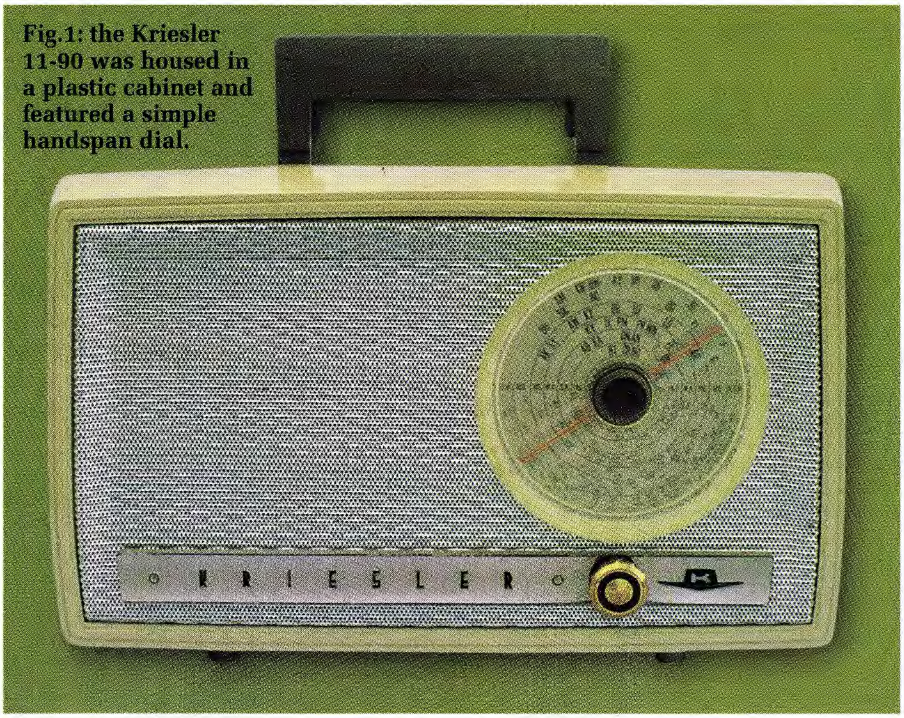


Fig.1: the Kriesler 11-90 was housed in a plastic cabinet and featured a simple handspan dial.

they may have many parallel plates, with insulation (dielectric) of various sorts between each plate.

For example, C3A and C3B are the tuning capacitor sections and they definitely have parallel plates that you can see. The symbol for C3A and C3B means that one series of plates moves while the others remain stationary (this is done to vary the tuning capacitance, so that the set can be tuned to different stations).

Similarly, C4 is an adjustable (or variable) capacitor which is used during the alignment of the local oscillator (ie, when the set was manufactured).

C12 and C13 are electrolytic capacitors and are different again. They have fixed values (40μF & 20μF respectively) and are also polarised – ie, the positive terminal of each capacitor must go to the positive supply rail (or more precisely, to a voltage rail that's more positive than that for the negative terminal).

Inductors & transformers

Inductors and transformers such as L1 appear to look like coils, which of course they are. The three parallel series of dashed lines indicate that it is wound on a ferrite or iron dust core (a ferrite loopstick in this case). Similarly, intermediate frequency transformers IFT1 and IFT2 have adjustable ferrite cores, again used during the alignment of the set.

Note that in both cases, the IFT windings are coupled together in close proximity.

Audio and power transformers have the same coil-like symbol but they differ by having two (sometimes three) solid lines alongside each winding. This indicates that they have an iron core. Consider the power transformer (T1), for example. This is a 240V transformer with a primary winding (on the lefthand side of the lines) and two secondary windings (on the righthand side). These secondary windings provide nominal output voltages of 115V AC (for the high-tension or HT supply) and 6.3V AC (for the valve heaters).

Note that many parts of the circuit are connected to earth (also called "common" or "chassis"). The most common symbol for this is the one used on the end of the line from pin 3 of all the valves except for the 6V4. This symbol consist of three parallel lines of progressively diminishing length. In this set, all points with this symbol are directly connected to the chassis.

Starting restoration

The first step in any restoration job is to give the set a thorough clean-up. This involves not only cleaning the cabinet but the chassis and the valves as well.

In most cases, the set will come up quite well unless it has really been abused in some way or another. Cleaning the set not only improves its appearance but makes it much easier and more pleasant to work on.

Static tests

As stated before in this column, I never (or rarely ever) turn a set on before carrying out a number of static tests. It's not nice having to repair a set that sends up smoke signals as soon as it is turned on. In fact, it really pays to be over-cautious here, to circumvent disasters before they happen.

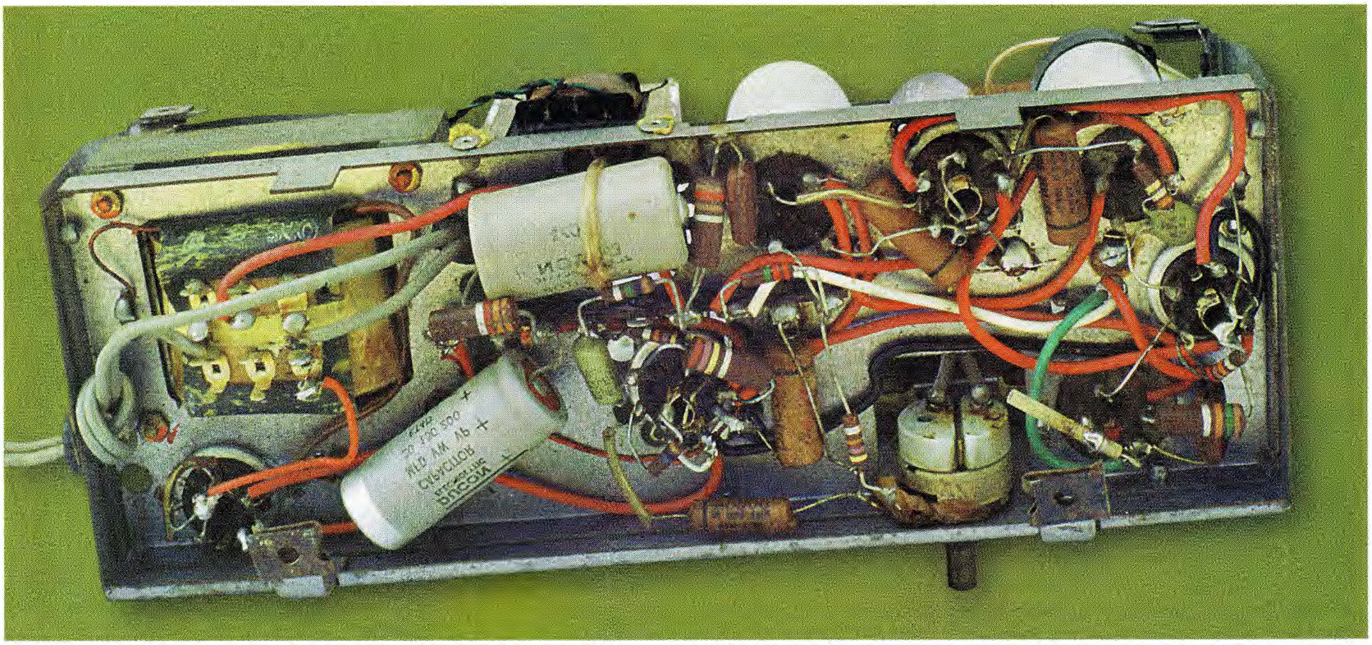
A digital multimeter is all you require for these initial tests, although an analog multimeter is also quite OK provided it has a rating of at least 20kΩ/V (20,000 ohms per volt). In fact, most common receiver faults can be found using just a multimeter. Make sure that the set is disconnected from the power point before starting the test procedure!

The first thing to do is to carefully inspect the chassis, the components and all the interconnecting wires. Look for shorts and broken wires, particularly if someone has been there before you. It's also a good idea to test the soldered joints by moving the wires attached to them where possible, as some may be what are called "dry joints". These are soldered joints where the solder no longer properly adheres to the leads and/or terminals it is joining. If you do find any bad solder joints, the wires (or terminals) should be cleaned, re-tinned with solder and resoldered together.

Next, make sure there are no shorting plates in the tuning capacitors. Shorts can be detected by first disconnecting the leads to the fixed plates. That done, you then connect a multimeter between the fixed and moveable plates and vary the tuning capacitor across its full range.

There should be almost infinite resistance between the moving and fixed plates. If the plates are shorting, it should be possible to bend the moveable plates slightly to eliminate the problem. This can be a delicate job but it's usually not too difficult provided the tuning gang hasn't been seriously damaged.

The next test is to make sure that the power transformer (marked T1 on Fig.1) has no short or partial short from the mains active and neutral wires (ie, the primary side) to chassis. An ohm-



This under-chassis view shows that all parts are readily accessible. Note that using a knot to restrain the power cord is no longer legal.

meter on its highest range should not show a reading of less than 10MΩ between points A and B on Fig.1. Most transformers test quite OK but it's imperative to find the fault (or replace a faulty transformer) if a short is found.

A much better test for the power transformer is to use a 1000V high-voltage tester across points A and B. If the high-voltage test is successful, with no apparent leakage, then the transformer is OK (at least as far as leakage to chassis is concerned).

If the set only has a 2-wire power lead (and has a transformer), consider fitting a 3-core lead to earth the chassis, as this is a safer option. Of course, this work must only be carried out be someone who knows exactly what they are doing – a mistake here could prove deadly. Make sure too that the new cord is properly anchored – tying a knot in the cord to restrain it (as was commonly done many years ago) is no longer legal!

Warning: if you are a novice, stay well away from hot-chassis (transformerless) sets, which have one side of the mains directly wired to chassis. They really are potential death traps for the unwary. If in doubt, ask someone who's qualified to give advice.

Next, check resistor R12 to make sure it is about 120Ω. It should be replaced if it has drifted in value but note that an allowance of ±20% in any resistor or capacitor value is generally OK. However, this doesn't include electrolytic capacitors, which can have very wide tolerances; eg, +100% and -50% for the very old types.

Similarly, check resistor R11 by measuring the resistance between points HT1 and HT2 on Fig.1 – you should get a reading of 3.3kΩ. If it is high, the resistor has drifted high in value and should be replaced if it is beyond the accepted tolerance range. Conversely, if it is low, it's possible that either or both C12 and C13 are leaky and need replacing. However, before doing this, you could try "reforming" the two capacitors, as described later.

The next step is to check the resistance between the HT2 and BIAS points. Initially, the meter should read up the scale then gradually increase in value to in excess of 50kΩ.

Also, check the resistance between HT1 and chassis. You should get a similar value to the previous measurement. If either of these reads low – ie, below 50kΩ – it indicates that there is a partial short on the high-tension line. Either C12 and/or C13 could be leaky or there could be a problem elsewhere. This can be diagnosed as follows.

First, removing all the valves will quickly indicate whether one or more of them has a problem. Valves rarely develop shorts, although some rectifiers do; eg, the 6X5GT. Next, measure all the resistors with an ohmmeter and if all is well, they will all be within 10% of their marked value. The only exception is R2, which shunts a low resistance winding in IFT1 – it will have to be checked with one lead disconnected from circuit.

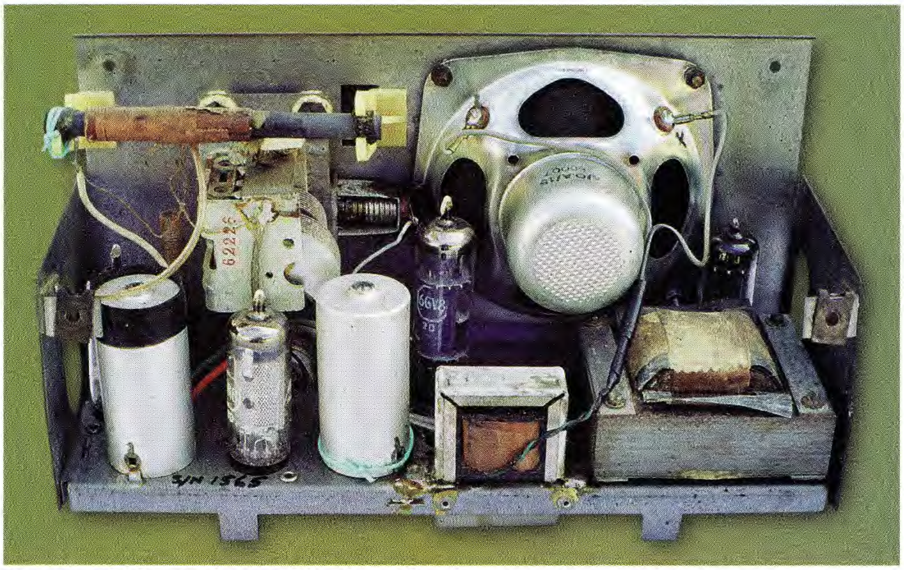
Similarly, disconnect one lead of each electrolytic capacitor (C12 & C13) and check them using an ohmmeter. Replace them if you get readings of less than 50kΩ.

Now measure between pin 6 of the 6GV8 and the chassis and if this shows a short circuit, it is likely that C11 has short-circuited. You should also check capacitors C6 & C7, which are on the HT line near IFT1. If there is no indication of a short but the HT line measures just a few ohms to earth (chassis), then it is necessary to disconnect sections of the circuit until the shorting part is found.

Output transformer

The audio output (or speaker) transformer is a component that often gives trouble, as the primary winding has a habit of going open-circuit. To check it, measure between HT2 and pin 6 of the 6GV8 – you should get a reading of about 150-200Ω. However, depending on the impedance of the transformer, the resistance can be around 500Ω in some sets.

A further quick check of the output transformer can be done using an analog meter. Select a low ohms range and connect the leads between HT2 and pin 6 of the 6GV8 – a click should be heard in the speaker. This indicates that all is probably well with the transformer and loudspeaker. Note: digital



It's a good idea to thoroughly clean the chassis before checking the parts and starting restoration. Be sure to make a note of the valve positions before removing them from their sockets.

multimeters usually don't have much current flowing through their test leads, so a click may not be heard.

All of the wound components (coils and transformers) should have continuity with reasonably low resistance. For example, the aerial, oscillator and IF transformers should not have more than a maximum of 100Ω across any winding and quite often are less than 10Ω.

Paper capacitors

Now let's look at those components that often give trouble but are not easily detected using a multimeter.

First, Ducon and UCC paper capacitors (from the 1960s) became renowned for problems. The Ducons became leaky and the UCCs often became intermittent and sometimes leaky. By "leaky", I mean that they had relatively low resistance across them compared to a good capacitor – eg, a few megohms for a faulty one compared to 200-1000MΩ or more for a good one.

Unfortunately, a "normal" multimeter will not normally detect this leakage, as it usually does not become apparent until a considerable voltage is applied across the capacitor in question.

Note that some leakage can be tolerated in some capacitors but C2, C9 & C10 should all be replaced with modern polyester or similar capacitors of the same ratings. In fact, this should be done without question, unless you have a high-voltage tester. These capacitors are all located in parts of the circuit where leakage cannot be tolerated.

Capacitors C6, C7 & C11 can be mildly leaky without this being a trouble in the set. However, C11 occasionally shorts in this position and it is a good idea to replace it anyway. If any capacitor gets warm after the set has been running for a few minutes (switch the set off and pull the power plug from the wall socket before testing), it is too leaky and should be replaced.

Dynamic tests

OK, now for the smoke test! First, remove all the valves, then plug the set into the wall socket and turn it on. The dial lamp is still in circuit so it should light up unless it has blown. Try a new one in its place if it has failed.

Now keep an eye on the set while you run it for about 30 minutes. After this time, the power transformer should only be slightly warmer than the chassis. If it gets hot, then you have a faulty transformer. Fortunately, this is rare.

If the transformer appears to be OK, the voltages on the two secondary windings can be measured. These will be about 10% higher than the voltages measured when the set is fully operating. Take care when measuring the high-voltage secondary – it's capable of delivering a fatal shock!

The next step is to install the 6V4 rectifier but switch the set off first. Now turn the set on again – the voltage on pin 3 of the 6V4 will probably rise to somewhere near 140-150V, as there's no load on the power supply.

Now turn the set off and monitor the voltage at pin 3. It should decrease slowly, unless the electrolytics require "reforming". To do this, turn the set on, let the rectifier (6V4) warm up, wait a few seconds until the voltage on pin 3 appears to have stabilised, then turn the set off again and let the capacitors discharge. Repeat this several times with a gap of a minute or so between cycles, until the capacitors discharge quite slowly.

If the rectifier plates glow red during this procedure, then either the electrolytics are faulty or some other component is breaking down when the voltage is applied. In that case, the set should immediately be turned off. Disconnecting various sections of the set will then help to isolate the defective component.

If the HT voltage still "disappears" within 10-15 seconds, it means that one or both capacitors have excess leakage and cannot be "reformed". By disconnecting one capacitor at a time from the rectifier output, it is possible to determine which capacitor is faulty (ie, the faulty unit will discharge quickly compared to the good one when the power is removed). Note, however, that most modern electrolytic capacitors require little if any "reforming".

Installing all the valves

Once the power supply is working correctly, it is time to fit the rest of the valves. That done, turn the radio on, tune it off-station and measure the voltages at all the various points shown on the circuit. If everything is working correctly, these should all be within about 20% of the indicated values. Note that all voltages are measured with respect to earth, so it's a good idea to use a clip lead to attach the earth lead of the multimeter to the chassis.

If the voltage at HT 2 is much lower than 110V and the BIAS voltage is also low, it indicates that the 6V4 is low in emission and should be replaced. Conversely, if the HT 2 voltage is appreciably higher than 110V and the BIAS is noticeably less than -5V, this may indicate that the pentode section of the 6GV8 has lost emission and should be replaced.

The voltage on pin 1 of the 6GV8 should be around 30V when checked

Photo Gallery: 1937 Healing 447M

Manufactured by Healing in Melbourne in 1937, the Model 447M was housed in a stylish timber cabinet and tuned both the medium-wave broadcast band and the 6-18MHz shortwave band. The valve line-up was as follows: 6A8-G frequency changer, 6D6 IF amplifier, 75 audio amplifier/detector/AVC rectifier, 42 audio output and 80 rectifier. Photo: Historical Radio Society of Australia, Inc.

with a digital multimeter. If it is lower and resistor R8 is the correct value, the valve may be drawing too much current. If it is higher, the valve may be low in emission. Once again, try replacing the valve.

By the way, the circuit indicates that this voltage is measured with a 1000Ω/V analog meter. However, this is probably a mistake as 20kΩ/V analog meters were common in 1962.

On my set, I measured 22V with a 1000Ω/V meter and 26V with a digital multimeter. Resistor R8 is within tolerance and as both readings are below the indicated voltage, it would appear that the valve in my receiver is drawing more current than others of the same type. However, the receiver's performance is quite satisfactory so replacement of the 6GV8 is not warranted.

Both the 6AN7 and the 6N8 should have plate voltages of about 80V, while the screen grids should be at approximately 45V when the set is tuned "off-station".

What if it doesn't work?

By now, it is quite likely that the receiver is showing signs of life and you may even be able to tune stations in. In fact, at this stage it's not unusual to find that the receiver is performing quite well. But what if it isn't? Here are a few tests that can be conducted now that normal voltages are appearing around the circuit.

First, turn the volume control fully up and put your finger on the top terminal of the volume control **(but DO NOT do this with a live-chassis set). Be careful here, as the back of the volume control in this set carries terminals which are connected to the 240V AC mains (the pot functions as a combined volume control/on-off switch).** If the audio output stage (based on the 6GV8) is functioning correctly, a healthy "blurt" will be heard from the loudspeaker. If not, you've got a problem in the audio stages.

If you've carried out all the tests suggested previously, then it is likely that the valve is defective and another should be tried in its place.

If there are still no stations to be heard after getting the audio section working, the next thing to check is the local oscillator. This can be done by lifting the "earthy" end of R1 and connecting a multimeter (set to milliamps) between it and earth. When the set is turned on, the meter should show a reading of about 0.2mA and this reading should change slightly as you tune the set across the band.

If this happens, it indicates that the local oscillator is working. Conversely, if there is no reading, it is likely that the 6AN7 is defective or there are shorted turns in the oscillator coil(s). If necessary, a 6AN7A valve may be substituted for a 6AN7 with no circuit changes. Don't forget to resolder resistor R1's lead to earth after removing the multimeter.

If the local oscillator is working but the set still refuses to operate, try changing the 6N8.

It's worth noting that I find very few faulty valves and I probably average less than one replacement per set. Note too that some valves can become microphonic and you can quickly track down the culprit(s) by gently tapping each valve in turn with a pencil or the plastic handle of a screwdriver. If a valve is microphonic, it will produce a noise (possibly a "ringing" noise) when tapped.

Valve sockets can also cause problems, For example, the contacts may be dirty or they may be loose and not making proper contact with the valve pins. In addition, the sockets and switches may need to be lubricated and cleaned with a proprietary contact cleaner.

Other problems

If someone before you has twiddled with the cores of the various coils, it may be necessary to re-align the set using a signal generator before it will operate. Other possible problems include faults inside the RF, oscillator and IF coils that cannot be determined by pure resistance measurements.

Another trap to be aware of is that someone else may have replaced parts with incorrect values, or even installed parts in the wrong locations. As a result, simply checking the components may not show where the problem is. The way around this is to carefully check the receiver against the circuit diagram.

Finally, more complex receivers can also be tested using the same techniques described here – it will just take longer. However, it's best to start with the simpler broadcast-band radios first and then work your way up to more complicated units as you gain experience. **SC**