Vintage Radio

By Maurie Findlay, MIE Aust, VK2PW

The Hotpoint Bandmaster J35DE console radio

Over the next few months, veteran radio designer Maurie Findlay will go through the process of restoring a good "1940s wireless" to its original performance – and for those who are interested, he describes how to make it perform even better than new. The radio to be restored is a Hotpoint Bandmaster which was made in console (J35DE) and table (T55DE) models. Maurie takes up the story . . .

The Hotpoint Bandmaster J35DE was a 1940s console radio that offered quite good performance in its day. This example is still in good condition, although the grille cloth needs replacing and the cabinet requires work.

WHILE THERE were many run-of-the-mill radios produced during the valve era, those with better performance were considerably more expensive and are now hard to come by. And while the sets made by AWA were highly regarded, those branded Hotpoint would these days hardly rate a second glance by vintage radio collectors. However, they would be missing out.

Hotpoint-branded radios were made by AWA Pty Ltd (Amalgamated Wireless Australasia), Australia's biggest electronics company in the 1940s. Which just goes to show that "badge engineering" was not confined to the automotive industry.

The Hotpoint Bandmaster T55DE/J35DE is a 5-valve radio offering AM broadcast band and shortwave reception, with provision for a pick-up to play records. The chassis may also have been the basis for radiograms made by AWA at the time.

The Hotpoint J35DE/T55DE chassis was virtually identical to that in the AWA 721-C console radio and the 618-T mantle (or table) radio. A set of this general type, in good order, will have a reserve of performance for local broadcast stations and will receive the stronger shortwave stations.

With care and patience, the valves and other components can be tested, replaced if necessary and the set re-aligned for best performance using no more than a multimeter. That said, the meter needs to be a modern digital multimeter.

Multi-range meters available at the time the Hotpoint was designed mostly used a moving coil meter which required a current of 1mA for full-scale deflection (FSD). Such a meter would give readings very much in error in many radio circuits because of the high resistances involved.

For example, take a look at the circuit diagram of the radio featured in this article. At valve V3's plate, it would read about one third of the actual voltage on the 100V scale. That's because the relatively low impedance of a moving coil multimeter loads down the voltage when attempting to measure such a circuit.

By contrast, a modern digital multimeter has an input resistance of 10MΩ (100 times greater) and would have very little effect on the voltage.

Apart from a good digital multimeter (DMM), you will need spare parts, small hand tools and most important of all, some skill with a soldering iron. Still, if you have assembled a typical PCB, you should have no trouble soldering parts in an old radio chassis. However, you will need a bigger soldering iron to do some of the work.

The Hotpoint T55DE is typical of 5-valve sets made in the valve era. It used good quality components which were operated conservatively and offered what most owners wanted: reliable reception of the local broadcast stations.

More elaborate receivers, for use in remote areas, would have had an extra stage of amplification between the aerial and the mixer stage. For those needing high volume, a more elaborate audio system, perhaps using push-pull valves, would be prescribed. In addition, shortwave reception could be improved by incorporating a bandspread system so that particular frequencies can be tuned more easily, while an extra RF amplifier stage is also a big advantage at the higher frequencies. And so it goes on.

The aim of this article and the one that follows is to give enthusiasts, with only a basic knowledge of radio, a systematic means of restoring vintage receivers to full performance. A particular set has been chosen in order to avoid a string of generalities which could easily have been confusing. I have redrawn the manufacturer's circuit diagram, with component values marked, to avoid the need to refer to the parts list when studying the diagram.

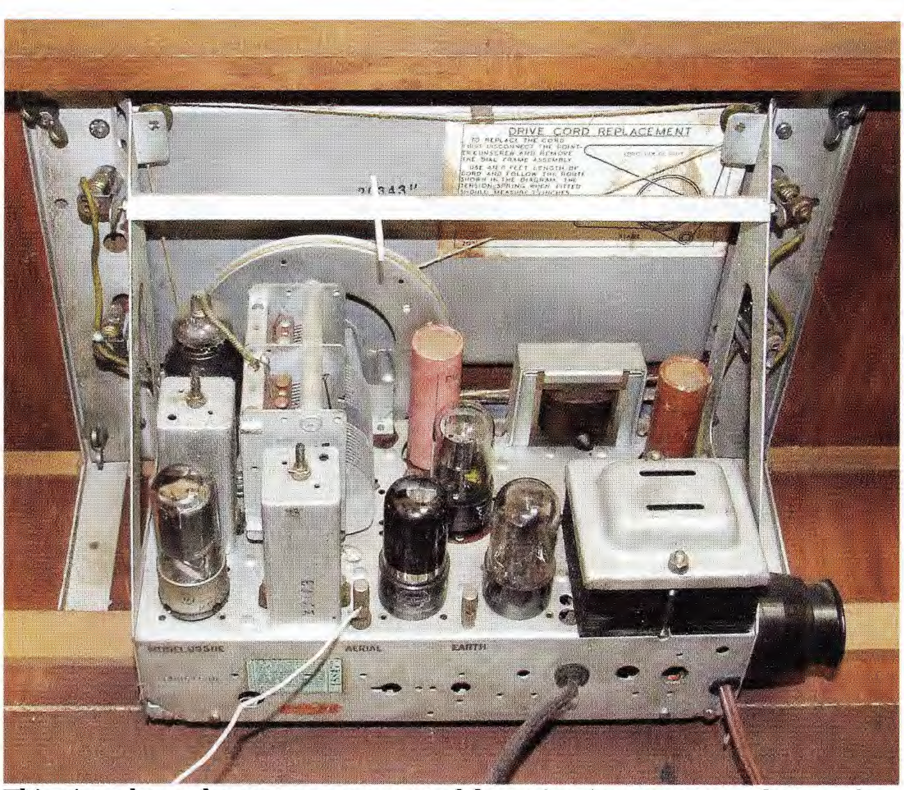
Circuit details

Let's start by going through the various stages of the Hotpoint T55DE. Fig.1 shows the circuit details.

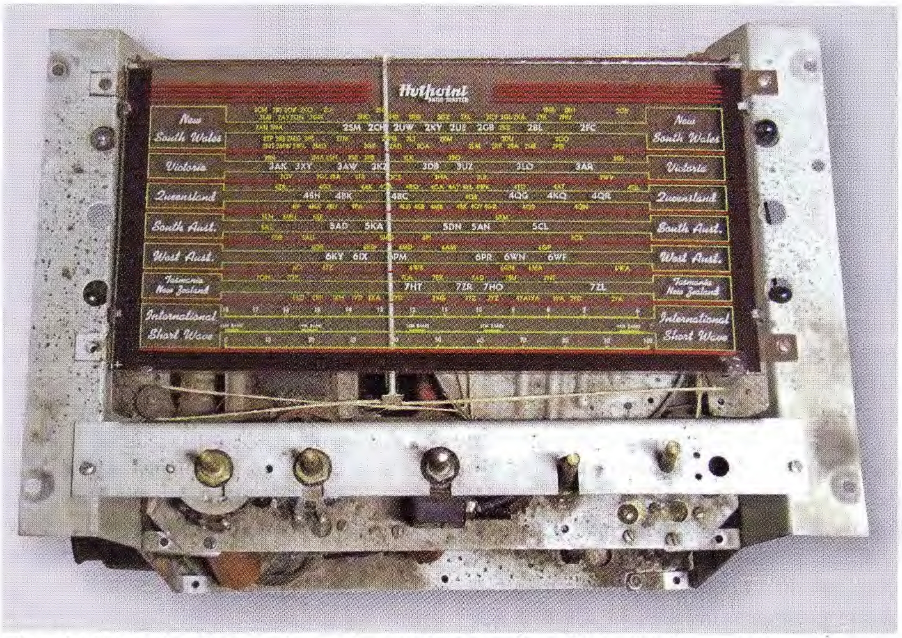
Valve V1 is the mixer, sometimes called the 1st detector, and is a 6J8-G. It takes the signal from the aerial (antenna) and converts it to an intermediate frequency which makes it easier to obtain the amplification and selectivity required.

The 6J8-G has a special "heptode" construction which consists of a fine helix grid close to the cathode, a screen grid surrounding that and yet another screen grid followed by the suppressor grid and then the plate. In between the two screen grids is another grid which is connected to the grid of a separate triode element.

This sounds complicated but this construction allows the local oscil-



This view shows the neat arrangement of the major components on the top of the chassis. A label on the dial backing plate shows the drive cord arrangement.



The old Hotpoint featured a rather elaborate glass dial which carried markings for the Australian states, New Zealand and the international shortwave band.

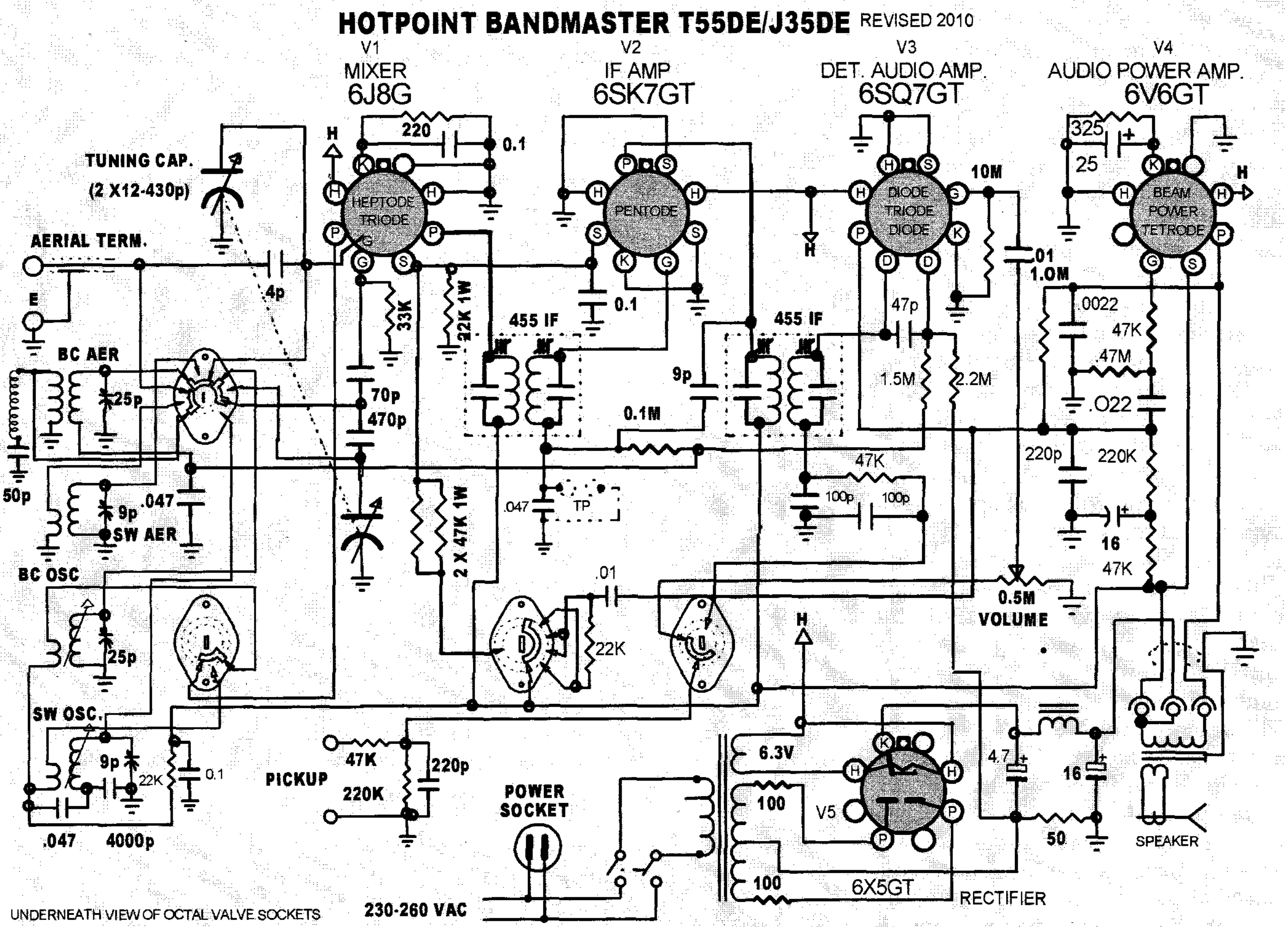


Fig.1: the redrawn circuit for the Hotpoint Bandmaster J35DE radio. It's a fairly conventional 5-valve superhet configuration with AGC and a 455kHz IF. The set can tune both broadcast and shortwave bands.

lator, using the triode section, to function with full efficiency, while mixing of the two signals takes place in the electron stream from cathode to plate. Several frequencies appear at the plate but the one we want, the difference between the signal and the higher oscillator frequency, is selected by the 455kHz tuned circuit.

6J8-Gs cost more to manufacture than other valves designed to do the same job but this valve worked better than most, particularly on the shortwave bands. It was often used in quality receivers manufactured at the time.

The next stage, V2, uses a 6SK7-GT pentode. The internal shielding between the control grid and the plate is provided by the usual screen and suppressor and the valve is able to amplify in a stable fashion. Other valves, such as the 6U7-G, available at the time, could have done the job equally well.

An important requirement for this stage is that the valve has a "variable mu" characteristic; the gain reduces as the negative bias on the grid increases, which allows for automatic gain control (AGC).

An interesting point about the design of the Hotpoint circuit is that AGC control is applied to both the 6J8-G and the 6SK7-GT on the broadcast band but only to the 6SK7-GT on shortwave. This allows greater amplification for the weaker shortwave signals.

Another special design point is the filter in the broadcast band aerial circuit. A 50pF capacitor in series with a high-Q inductor forms a series tuned circuit at 455kHz, effectively shorting out the receiver input at that frequency. Not many designers would have considered this necessary, because 455kHz is kept clear of high-power transmitters.

As was conventional at the time, this set has four circuits tuned to the intermediate frequency of 455kHz, two before and two after the amplifier. Coupling between the circuits was loose enough for the circuits to be tuned individually without affecting each other. The resultant selectivity caused attenuation of the higher sidebands and hence a reduction in the higher frequency audio. At the time, few designers would have incorporated a bandpass arrangement. People seemed to think that radios should have a "mellow" tone.

Detection & AGC

The next valve, V3, a 6SQ7-GT, incorporates two diodes and a triode. It recovers the audio from the intermediate (IF) signal, provides the automatic gain control and amplifies the recovered audio signal.

Other valve types capable of doing the same job were available at the time. For example, a pentode double-diode could have been chosen for higher gain. But the triode provides a reserve of gain anyway, with a very simple circuit. The small amount of negative bias required is obtained from a high-value resistor in the grid circuit (10MΩ).

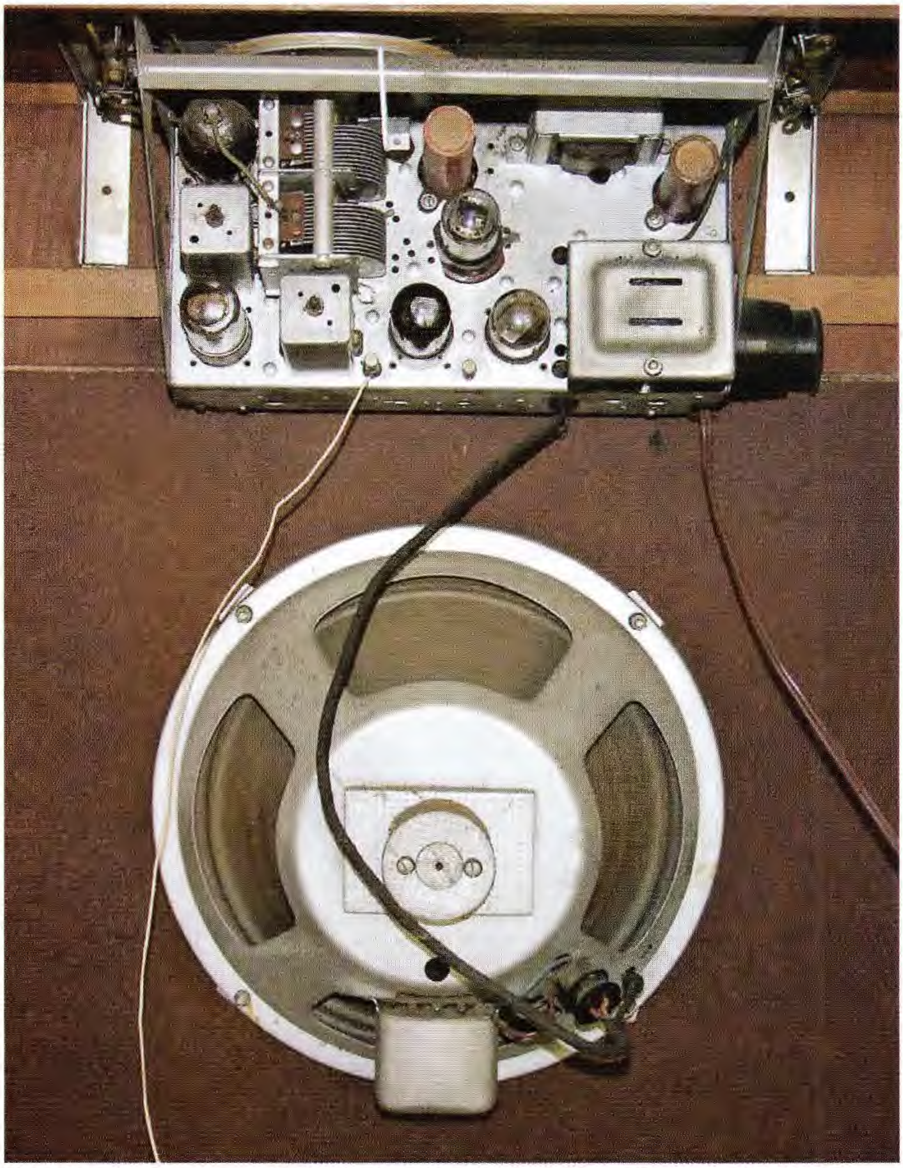
The diode connected to pin 5 of V3 rectifies the 455kHz signal from the IF transformer and the recovered audio signal appears at the lower end of that transformer. At this point, the audio is mixed with the 455kHz IF signal and a filter, consisting of a 47kΩ resistor and two 100pF capacitors, removes this 455kHz component. With the function switch in the "radio" position, the recovered audio appears across the 500kΩ (0.5MΩ) volume control potentiometer.

AGC is developed by the diode connected to pin 4 of V3. However, pin 4 is returned to a voltage that's negative with respect to the cathode via a 2.2MΩ resistor and therefore does not start developing an AGC voltage until a certain signal level is reached. This is "delayed AGC" and ensures that maximum gain is available for very weak signals.

Output stage

V4, the audio output valve, amplifies the signal further and provides power to drive the loudspeaker. It is a 6V6-GT and was the best choice for the job at the time this set was designed.

In this set, it is operated with a cathode bias resistor that's slightly larger in value than usual. This reduces the power dissipation and audio output of the valve but would make for longer life. The optimum load resistance with the higher bias resistor would be higher than the usual 5kΩ and is probably somewhere around 7kΩ.



The chassis mounts vertically inside the cabinet, so that the glass dial and control shafts face upwards. Note that the output transformer is mounted on the speaker frame. This means that the 6V6-GT output valve could be destroyed if the speaker cable is disconnected from the chassis while power is applied.

Design fault

This circuit has a serious design fault concerning the arrangement for connecting the speaker. The output transformer is mounted on the back of the speaker and is connected to the output valve via a plug and socket arrangement on the chassis. As a result, if the set were to be accidentally switched on without speaker connected, the 6V6-GT screen current would be very high and this would probably ruin the valve.

A better arrangement would be to have the speaker transformer permanently mounted on the chassis and the voice-coil leads extended. Alternatively, a solution such as that described on page 91 of the August 2010 issue of Silicon Chip, for an Airzone 612 console radio, could be adopted. This is what we eventually did with this Hotpoint set.

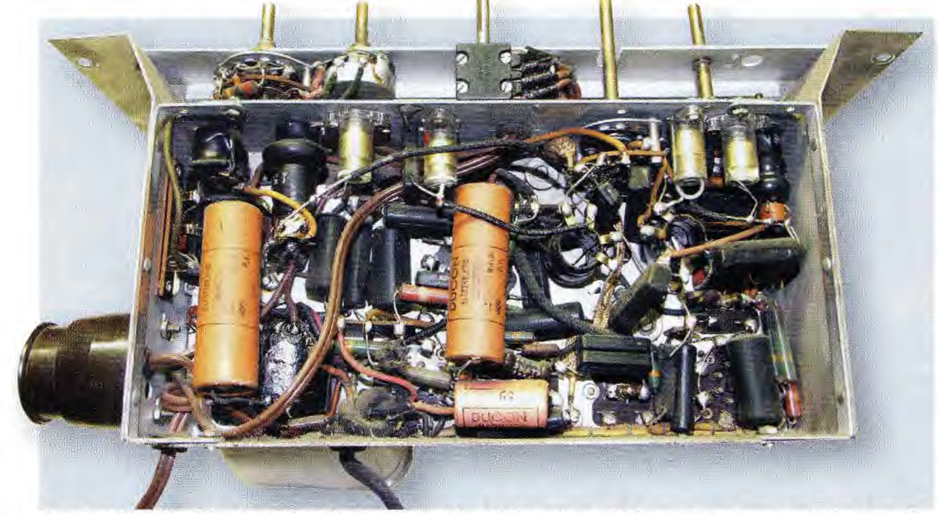
Power supply

A power transformer and rectifier valve, V5, are used to derive the 240V DC high-tension supply for the amplifying valves. However, the usual approach has not been taken. V5 is a 6X5-GT and this valve has special insulation, designed to withstand the high voltage between the cathode and the 6.3V filament. The 6.3V heater winding on the transformer also supplies the other valve filaments and is effectively at chassis potential.

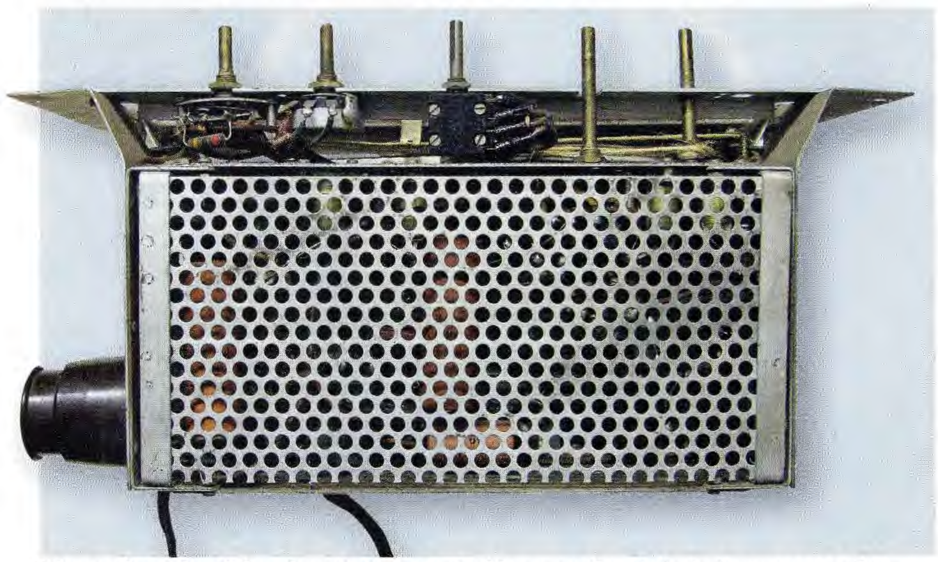
The alternative approach, and the one mostly used in sets at this time, was to use a 5Y3-GT rectifier which has directly-heated cathode supplied from a separate 5V heater winding. This could then "float" at the HT voltage which could be anywhere from 100-300V or more, depending on the circuit requirements.

The 100Ω resistors in each plate circuit of V5 are provided to limit the peak current. The 8μF capacitor connected to V5's cathode also affects the peak current and hence the life of the valve. It should not be replaced with a higher value.

To complete the circuit description, note the function switch which allows the set to be switched for radio or record pick-up operation. There are



By contrast with the top, the underside of the chassis is quite crowded due to the bulky old-style components used. Note the primitive technique used to anchor the power and speaker cables, ie, by tying knots in them.



The underside of the chassis is protected by a perforated steel cover, a rather unusual feature for radios of that time.

tone control positions for both radio and pick-up. In the pick-up position, the screen supply to V1 and V2 is disconnected so that "play-through" from the radio stage, due to stray coupling, is eliminated.

The pick-up input was designed to accept the high-output signals from the crystal (piezoelectric) pick-up cartridges used in the 1940s with 78 RPM records. Not every restorer will want to bring this back to life! In addition, the treble cut applied for radio listening is probably too severe for modern ears and could be reduced by choosing a smaller value for the associated .01µF capacitor.

A power socket for a turntable motor is mounted on the chassis and is alive even with the radio switched off. When replacing the power cord, we used the socket as a convenient termination. However, there is a safety issue here in that the metal terminations in the socket are close to the metal surface on which the socket is mounted. If the bare wires are not pushed right into terminations, there is the possibility of them touching the metal chassis with disastrous results.

Such a socket would definitely not meet approval today.

Preferred value components

In the original service manual for the Hotpoint Bandmaster J35DE, all the passive components, ie, resistors and capacitors, are in "non-preferred" values. For example, one resistor is specified as 2.5MΩ while others are marked 1.6MΩ, 50kΩ, 32kΩ, 25kΩ and 20kΩ. In the capacitor list, there is a 50pF unit, a 70pF (actually µµF) unit, some .05µF units and so on.

This is because this set was made before the introduction of the "preferred value" system, which is now universally used for small components.

With preferred value numbering, a designer can adjust a circuit value to a desired order of accuracy while stocking the minimum number of components. The numbers in the ratios 10, 15, 22, 33, 47, 68 and 100 would be stocked by a design laboratory over most of the range, except for very small and very large values.

On the other hand, for very critical circuitry, a designer may need to stock values in finer increments such as 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91 and 100. However, extended over the decades, this could involve a huge number of components.

So what do we do about, say, replacing the 50kΩ resistor in the grid circuit of the 6V6-GT output valve? You cannot buy a 50kΩ resistor at your usual supply store. The answer is that the exact value is not critical and a 47kΩ resistor will do the job perfectly well.

This also applies to most of the other components in the radio. The 2.5MΩ resistor could be replaced with 2.2MΩ, the 1.6MΩ with 1.5MΩ and so on. In addition, the .0025µF capacitor from the plate of V4 to ground can be replaced with a .0022µF capacitor with negligible effect on the way the radio works.

With this in mind, the circuit presented in this article has been redrawn with "preferred values" for most of the passive components. There are, however, some components where accuracy must be maintained.

The 4000pF (4nF) capacitor in the shortwave oscillator circuit is an example. It modifies the tracking of the oscillator frequency to give the desired tuning range. The same applies to the capacitors in the 455kHz IF coils (unmarked).

Next month

Next month's article will describe the practical side of getting the Hotpoint Bandmaster into operation. It is now 60 or more years since the set was manufactured and that meant that a great deal more than defective valves had to be considered. Many capacitors, resistors and even the wiring had deteriorated badly. SC

Vintage Radio

By Maurie Findlay, MIE Aust, VK2PW

Restoring The Hotpoint Bandmaster J35DE console radio; Pt.2

Last month, we discussed the Hotpoint Bandmaster J35DE in general terms. This month, we describe how it was restored to its original performance. The only instrument required was an inexpensive digital multimeter and the same general ideas can be applied to most vintage sets.

MANY OF THE ARTICLES on vintage radios in these columns give some of the details of restoration but rarely would a set which looks potentially good on initial inspection turn out to require so much work to restore it to its original standard of operation. And while some people might simply turn the set on and hope for the best, that is not likely to be successful in many cases.

The starting point with this set was the power cord. It was originally fitted with a twin-lead conductor power flex which is not deemed safe these days, especially when a 60-year old power transformer is being used. It might be OK for the present but that cannot be guaranteed.

Accordingly, a 3-conductor flex was fitted, with the chassis correctly connected to mains earth for safety. The power cord was securely anchored with an IP68 cable gland and the green earth wire terminated to the chassis with crimped lug, screw, nut and lockwasher. This works well although using a cable gland may not be an approved method when it comes to anchoring mains cords.

The next step was a resistance measurement of the primary of the power transformer. Measured via the power plug pins it was about 50Ω and from the plug pins to the chassis it was a large number of megohms. So that was OK but the set has a double-pole rotary power switch operated by one of the front-panel knobs and it seemed very tired. Turning the switch backwards and forwards produced an occasional flicker on the meter but not the original 50Ω reading. So it had to be replaced but obtaining the same switch was impossible.

A used switch potentiometer with a double-pole switch rated at 240VAC 2A was found and fitted as a replacement but its shaft was too short. This was extended using a short section of shaft from another pot. They were joined using a threaded bush from yet another pot, the whole lot being glued together with JB Weld epoxy adhesive.

Terminating wires to the switch was yet another hurdle. The solder tags on the switch pot are of thin sheet metal and not designed to take the strain of stiff wires with mains insulation. For this reason, the mains wires were extended with flexible hook-up wire which was in turn covered with thick plastic tubing.

Fortunately, the original volume control, which is separate from the power switch, was quite usable.

Then we come to the valves. A natural tendency among these new to radio restoration is to pull out the valves and wipe away the dust and grime but this can be a real trap since it is so easy to clean off the label marking. Then how do you identify them? Four of the valves in this set are of similar size and have no connection to a top cap, so it would be easy to mix them up.

So before pulling any valves out of the chassis, do a quick diagram showing the location of each valve and its type. Then put a sticker on the base of each valve and label it as well.

Turning the chassis upside down is another hazard because it needs a rear support to stop it from resting on one of the IF transformers. A length of angle bracket bolted to the back of the chassis provided the necessary support.

Then we could have a detailed look at the components underneath. One manufacturer produced paper capacitors in a black plastic which melted at soldering temperature. Servicemen in the 1950s referred to them as the "black death". It was expected that most of these would be leaky. Surprisingly though, most of the capacitors were OK, both with regard to leakage and capacitance, except for a couple where the ends broke off when the multimeter was connected!

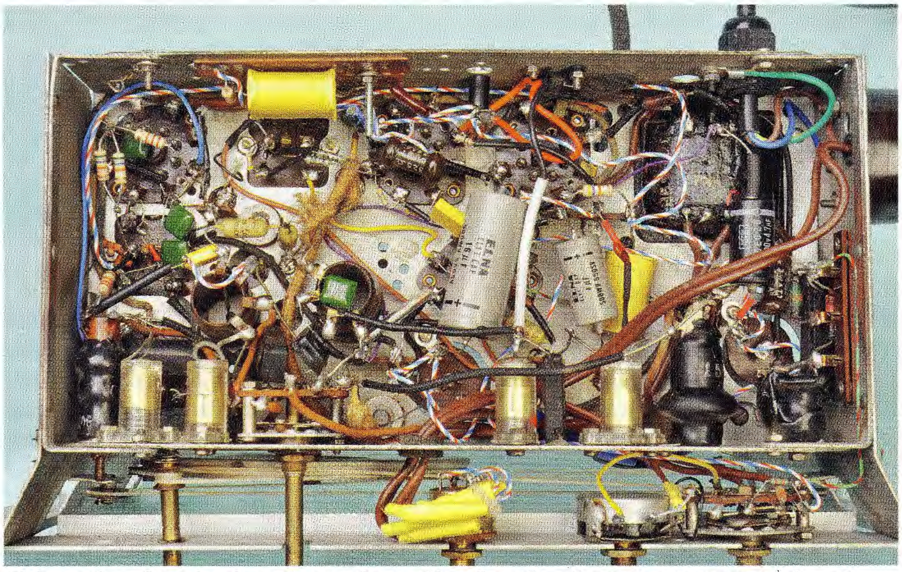
Ultimately though, most of the paper capacitors were replaced with modern metallised polyester types (greencaps etc) as the leads of the originals were so fragile.

The resistors were carbon composition, most about 35mm long and 6mm diameter, and were probably rated at 1W dissipation. Measurements showed that most of the resistors were high in value, some by a factor of two to one but the 325Ω V4 cathode resistor and the 50Ω resistor for the back bias circuit measured both very close to their marked values. They appeared to be wirewound types.

Electrolytic capacitors

Electrolytic capacitors in old valve radios usually have a high leakage or if not, they have dried out and have low capacitance. Still, replacements are available from a number of suppliers.

These faulty parts all had to be replaced in the old Hotpoint Bandmaster radio. Most are capacitors but there are also quite a few resistors, a couple of dial lamps and the 6J8G mixer valve.



This under-chassis view shows the radio after the above parts were replaced. It's normally fitted with a perforated steel cover.

In this particular case, the 4.7μF and 16μF capacitors were salvaged from a junk box and reformed using the electrolytic capacitor tester described in the August and September 2010 issues of SILICON CHIP.

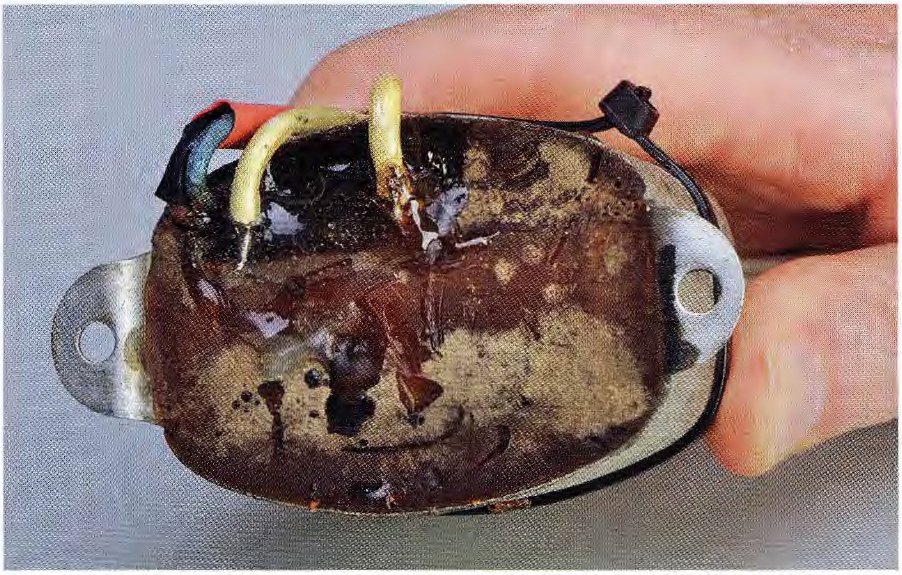
Resistance checks of the power transformer high-tension secondary and heater windings and the two windings in each of the two IF transformers gave the expected readings, being 400Ω for the HT, a low value for the heater winding (since the valve heaters are all in parallel) and about 10Ω for the IFs.

The broadcast-band (BC) aerial coil primary checked out at about 30Ω and the secondary (tuned winding) at about 4Ω. The BC oscillator primary and secondary both measured about the same as the latter. Initially, the shortwave coils were not checked.

Disintegrating wiring

A wire was removed from the 16μF filter capacitor just to check for shorts and its insulation disintegrated just as the wire was moved. Quite a number of other wires in the chassis looked as though they would do the same.

So, the big decision had to be made. Was it worth refurbishing the set to the point where it would be reliable and perform as it did originally? Having



Some of the leads of the speaker transformer had broken off at the base. It was repaired by digging away some of the pitch-like sealant, joining new leads to the exposed wire ends and then resealing the unit.

proceeded this far, there could still be other faults. For example, the tuning slugs in the IF transformers might not work, the rotary switch for BC/SW selection could be intermittent and so it goes on.

In all these cases the answer is as follows: if you are prepared to spend the money on components and hours of fairly skilled work with a soldering iron, a multimeter and long-nose pliers, and you regard the project as a hobby, then it is worthwhile.

Components improved greatly in the 1950s and many of the younger radios that come up for refurbishment would not have as many faults as this Hotpoint. Hopefully, your set would not require as much work.

A general tip: when working on a radio that requires many hours of concentration, don't continue for more than one or two hours without a rest. It is very easy to make a mistake which could be hard to find later.

In this set, many of the components were soldered directly to the chassis during manufacture. A large soldering iron would be required to undo the original connections. The way around this is to cut the wire close to the component after which a new component can be connected to the stub with a normal soldering iron.

Modern components are almost always smaller than vintage parts of the same voltage rating (in the case of capacitors) and power dissipation rating (in the case of resistors). So there is a temptation to terminate the leads in places different to the original. Don't do this. There are often cases where, for example, a different earth termination point could lead to instability. The original designer of the radio would no doubt have spent a lot of time determining the best component connecting points.

The damaged wiring loom presented real problems. There were cases where a wire with damaged insulation was bound up with other wires which appeared OK. In those cases, it was decided to leave the bad wire in place and just cut off the ends. Binding the new wire into the loom risked further disturbing the crumbling insulation so we tried to disturb it as little as possible.

Keeping it original

Many restorers want to keep the radio looking as original as possible. In this case, we left the original electrolytic filter capacitors in place so that the top the chassis looked the same. However, it was just not practical to make the inside of the chassis look original since most of the components have to be replaced in a relatively small space.

No doubt the purists would be aghast but taking the purist approach would be far more time-consuming and all for a result that no-one will see. In particular, as shown on page 96 of last month's issue, the Hotpoint chassis has a screening panel underneath which prevents you seeing inside unless it is removed.

With the passage of 60 years, there are changes to the circuitry of the Hotpoint which could be made to improve performance. However, we have resisted these temptations for the moment and adhered to the original circuit except for some modifications to the output transformer connection (the original circuit allowed the high-tension to remain on the screen of the 6V6GT output valve when the speaker cable was unplugged – see last month's article).

Incidentally, one reader emailed to say that there wasn't any design fault since the circuit shown on page 94 clearly showed a plug with inbuilt HT link. What he hadn't realised was that I had redrawn the circuit (also mentioned in last month's article) to incorporate this modification. Perhaps I should have emphasised that point.

Having replaced all the doubtful parts there comes the critical time to apply mains power. Measure from the high-tension line to ground to make sure that there is high resistance and also from pin 3 to pin 4 of the 6V6GT, to make sure that the primary of the speaker transformer is intact. The latter should measure a few hundred ohms. Of, course the abovementioned speaker plug should be in place.

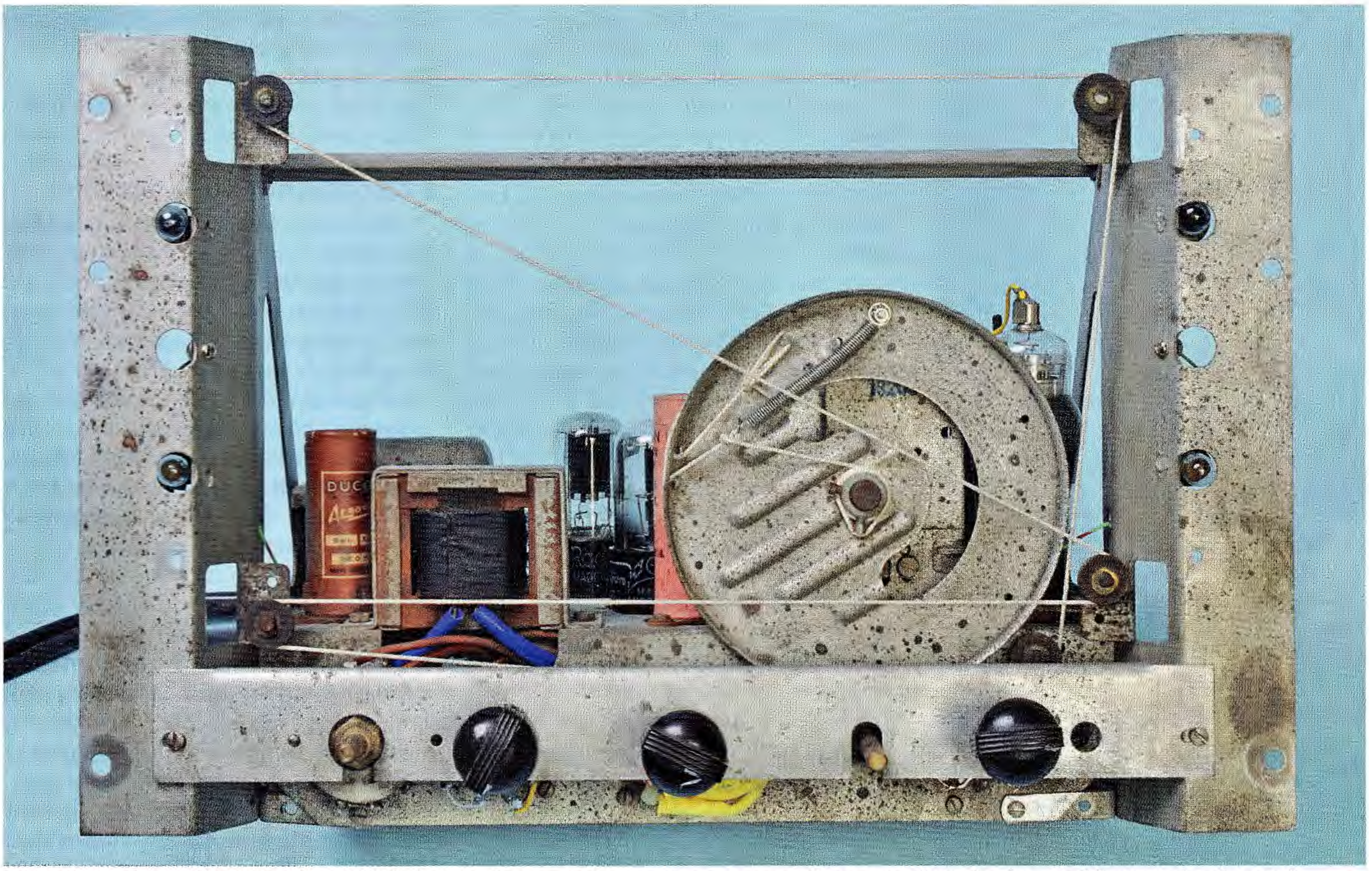
Place the chassis on the bench so that the valves can be viewed. Switch the power on but have your hand on the mains outlet switch in case anything shows distress. Check the valves. With most types the cathode will glow a dull red.

With the Hotpoint, there were no fireworks and the cathodes were all as expected. The heater element of the 6X6GT protruded out of the cylindrical cathode by about 8mm which isn't normal but the cathode was a normal dull red, so the valve still did its job.

With luck, there will be a gentle hiss from the set with the volume control fully advanced. And with an insulated wire connected to the aerial terminal, you should be able to hear some stations, even if weakly, as the tuning knob is rotated.

But the chances are that you may not be so lucky. In that case, a systematic search through the circuitry will be necessary. This is a good idea anyway because it will pick up any more faulty components, including valves.

Place the chassis so that you can get at the underneath connections and measure the high-tension (HT)



This view shows the complicated dial stringing arrangement, necessary to ensure that the top and bottom horizontal sections both travel in the same direction to carry the long vertical pointer. About 2.4 metres of dial cord is required to complete the job.

voltage across the 16µF filter capacitor. It should be about 250V DC. Then measure the voltage across the 325Ω resistor from the 6V6GT cathode to earth. It should be about 13V which means that the cathode current of the valve is 40mA. If it is much less, it is probable that the valve is low in emission and due for replacement.

To check that the valve is amplifying, switch the meter to the ohms scale, connect the red (normally positive) lead to earth and touch the black lead to the junction of the 47kΩ and 0.47MΩ (470kΩ) resistors. There should be a thump from the speaker. If not, there is most likely a problem in the speaker transformer, the speaker or the connections.

All OK with the output stage? Measure the voltage at the plate (pin 6) of the 6SQ7GT. It should measure about 90V and touching the probe on the pin should result in a click from the speaker. If the voltage is much higher than 90V, the valve is probably low in emission and should be replaced. (Note: this is a case where the cathode current is only about 0.5mA and a usable valve would be failed by an emission tester.) Again, use the ohms setting of the meter from grid (pin 2) to ground to confirm that the stage is amplifying.

Also, the volume control can be checked by using the meter on the ohms scale. Start with the knob turned fully clockwise and note that the sound in the speaker is reduced as the knob is turned anticlockwise.

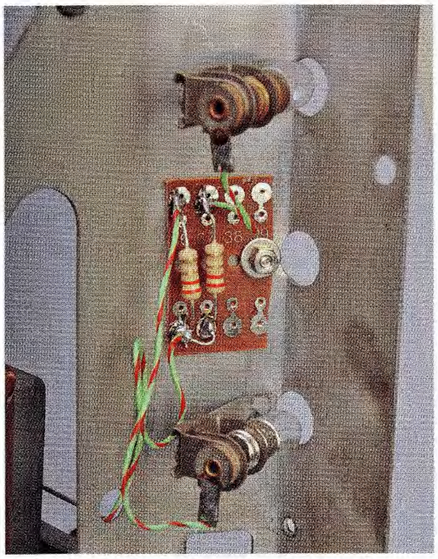
The lefthand knob is marked "PHONO – RADIO" and has positions marked "TREB", "MED" and "BASS" for both the phono and radio functions – six positions altogether. The frequency response of the Hotpoint shown in Fig.1 is for the "TREB" position. The other two positions impose very severe high-frequency audio attenuation.

The plate current of the 6SK7GT can't easily be checked because its cathode is grounded. Measure the resistance of the IF transformer primary with the set switched off. Then, after making sure the screen voltage is about 80V, the plate voltage about 250V and the grid -3V, measure the voltage drop across the IF transformer winding. This voltage divided by the resistance and multiplied by 1000 will give the plate current (in milliamps). With a good valve, it should be about 5mA.

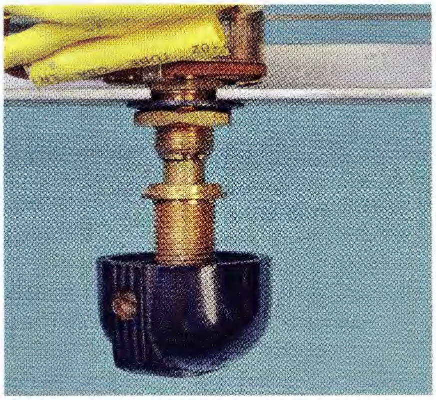
Now with the DMM on the ohms range, briefly touch the probe to the grid (pin 4) of the 6SK7GT. This should result in a slight click in the speaker if the valve is amplifying but not nearly as loud as with the audio stages,

Testing the 6J8G is a special problem in the Hotpoint chassis. The socket for the valve is hidden by the broadcast-band oscillator coil and the accompanying trimmer capacitor. It is just not practical to make contact with the two connections which are needed to determine if the valve is OK, ie, the cathode and the grid of the oscillator section.

As a result, the trimmer was removed and a 1MΩ resistor soldered to the oscillator grid connection on the valve socket (pin 5). The other end of the resistor was left to protrude between the two trimmers so that the meter connection could be made. The voltage reading will be only slightly reduced by the presence of the resistor (the capacitance of the meter leads would affect the oscillator frequency if



A 2.2Ω resistor was wired in series with each dial lamp to improve its reliability. This gives only a slight reduction in brightness.



The shaft of the replacement switch pot was extended using a short section of shaft from another pot. The two were joined using a threaded bush from another pot, the lot held together with JB Weld epoxy adhesive.

a direct connection were made).

In order to get at the 6J8G valve socket cathode connection, the side of the chassis which carries the support for the dial glass and dial lamps had to be removed. A length of hook-up wire was soldered to pin 8 of the socket. This pin is already bypassed to chassis so that the wire can be extended without affecting the performance. Altogether, this was a time-consuming job.

The cathode resistor and the oscillator grid-return resistor were both within 20% of their marked values and because of the difficulty of replacing them, they were left as is. The capacitors were difficult to undo and measure but their effect is easy to determine. If the 70pF capacitor is not about the correct value, the oscillator will not perform correctly across the band.

In addition, the gain of the valve will be low if the bypass capacitor across the 200Ω resistor is low in value. We checked this by connecting a 0.1μF capacitor from the extended wire to earth.

Ohm's law can be applied after measuring the voltage across the cathode resistor. The calculation should indicate about 6mA. It was much less than this with our set and so a new 6J8G was fitted. This fixed the problem of the set not receiving stations at the high-frequency end of the band.

The operating conditions for the 6J8G in the Hotpoint circuit are really not optimum for performance. The grid bias should be lower, giving a higher cathode current and thus increasing the gain and oscillator amplitude.

We did, however, decide to retain the original design where reasonable. Shorting out the 220Ω cathode resistor on the broadcast band is an easy way of proving the point. It improves the sensitivity on the broadcast band by about 6dB. However, to make the grounded cathode legitimate, negative bias has to be restored on shortwave.

The socket for the 6J8G in the Hotpoint chassis is shock-mounted from the chassis. We can only assume that early production versions of the valve tended to be microphonic and that this was done to prevent acoustic feedback from the 12-inch (30cm) speaker which was positioned close to the chassis.

Stringing the dial cord

The dial cord had at some time been re-strung with ordinary string and it just wasn't working as it should. Ordinary string doesn't work as it is too slippery to provide enough friction around the pulley for the tuning knob. And it has to be tensioned properly.

In the case of the Hotpoint, the dial cord arrangement is quite complicated since it supports the long pointer at both the top and bottom of the dial. Cord sections going in the same direction at top and bottom are provided by the special stringing arrangement. In fact, it requires about 2.4m of dial cord.

You have several choices if you cannot obtain dial cord. One approach is to use the cord from slimline venetian blinds and another is to use the thin line used by bricklayers. A third possibility is to use dental floss. Fortunately, the Hotpoint chassis has a diagram for the dial stringing on the back of the dial-plate.

Over-bright dial lamps

Dial lamps in typical vintage radios present a reliability problem if operated at the full heater voltage of 6.3V. They get very hot and they can even lead to cabinet discolouration in those with Bakelite cases.

In the case of the Hotpoint, I decided to wire a 2.2Ω resistor in series with each of the four lamps. This results in a slight reduction in brilliance but also reduces the amount of heat they produce.

IF alignment

The next job was to align the tuned circuits and correct the dial station calibration positions. Bear in mind that the dial was originally designed when the stations were 10kHz apart in frequency; now AM broadcast frequencies have 9kHz spacing. Having said that, most of the major city stations are still close to their original frequencies.

Alignment of the 455kHz intermediate transformers can be undertaken using a local radio station and your digital multimeter (DMM). With care, the job can be done virtually as well as with a signal generator.

The positive lead of the DMM can be connected to chassis and the negative lead to a point on the AGC (automatic gain control) line which is bypassed. In the case of the Hotpoint, this could be across the .047μF capacitor at the bottom of the 1st IF transformer secondary. You may use the chosen point for the whole of the alignment procedure and it could be worthwhile arranging a "hands free" connection to the meter.

You will probably stand the chassis on end so that you can access all the adjustments. Tools such as small screwdrivers should be on hand and plastic alignment tools may be needed if some of the adjustments involve internal slugs.

An aerial wire, say five metres long, should be connected and when you tune accurately to a strong station the meter should indicate a positive value of a few volts. Carefully adjust the tuning capacitor for maximum reading. If there is a choice, use a station at the low-frequency end of the broadcast band.

Then, one by one, adjust the IF transformers for best meter reading. In most cases, the increase in reading will be small and accounted for by the aging of components. If one adjustment does not result in a peak meter reading then the IF transformer is faulty may need to be replaced. This doesn't happen with many sets.

Another possibility is that an adjustment screw or slug has jammed and can't be moved. A decision then has to be made. If, eventually, the set is sensitive enough to receive the stations needed, it could well be a reasonable decision to leave the component in place rather than face a difficult replacement.

The next job is to make the dial pointer agree with the station positions.

Tune to a known station at the high-frequency end of the band and then adjust the trimmer capacitor for the oscillator coil (25pF) so that the pointer indicates the station position correctly. That done, tune to a station at the low-frequency end of the band and adjust the core of the oscillator coil for the dial position.

When the set is tuned back to the high-frequency station, the dial position may have shifted slightly. Correct this again with the trimmer capacitor. It may be necessary to go backwards and forwards two or three times to complete the oscillator line up.

Signal frequency circuits are lined up for maximum sensitivity using the same general idea: adjusting trimmer capacitors towards the high-frequency end and inductors towards the low-frequency end. The tuning capacitor rotates through 180°. Try to make the adjustments near the 20° and 160° points.

Note: the shape of the tuning capacitor plates is the same for both the oscillator and signal-frequency tuned circuits, so tracking can only be perfect at three points on the dial: near the ends and towards the centre. The loss in sensitivity is not too serious, however. Some manufacturers in the late 1950s overcame this problem with tuning capacitors by having differently-shaped plates for the oscillator section.

If your radio has an RF amplifier stage, there will probably be two tuned circuits to adjust but the principle is the same: inductors towards the low-frequency end and trimmer capacitors towards the high-frequency end.

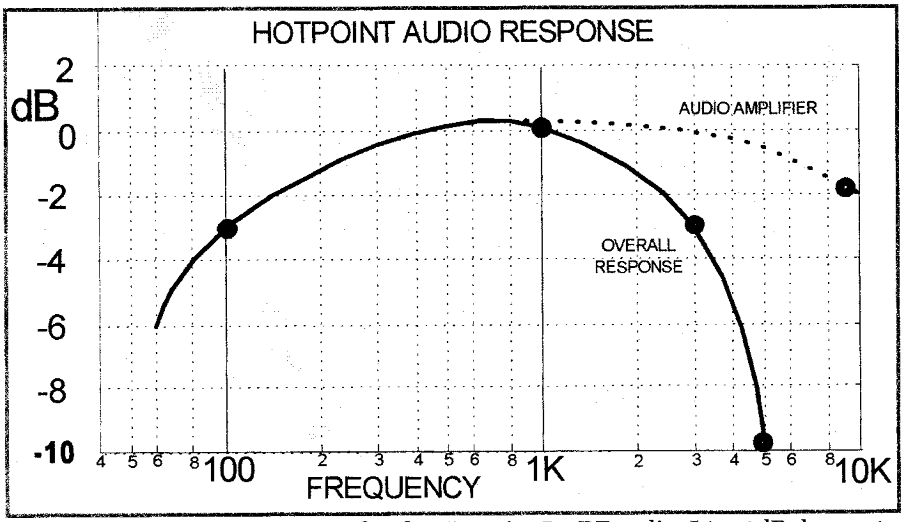


Fig.1: the audio response curve for the Hotpoint J35DE radio. It's 10dB down at 5kHz but most people were happy with a "mellow" tone in the 1950s.

Measured Performance

Audio Output .... Max. 3W; undistorted 1W.

Frequency Response .... -3dB @ 100Hz & 3kHz, -10dB @ 5kHz.

Receiver Sensitivity .... 12µV @ 600kHz; 8µV @ 1500kHz; 20µV @ 10MHz

(Signal level at receiver aerial terminal: AM signal 30% modulated @ 1 kHz for 50mW output)

Our Hotpoint presented another design problem: there is no means of adjusting the inductance of the aerial tuned circuits on either the broadcast or shortwave band. All we can do is adjust the trimmer capacitors.

Shortwave alignment without a signal generator does present a problem. The Hotpoint could never be considered as a set for the serious shortwave listener but something should be done so that strong stations can be heard. Simply turn the dial to the middle of the range and with the aerial connected, adjust the trimmer capacitor for maximum noise. This may be sufficient for some.

For those who wish to go further, use can be made of the American station WWV which transmits accurate frequency and time signals from both Hawaii and Colorado. The 10MHz signals can usually be heard at good strength in Australia in the early evening and are identified by a one-second pulse on the audio.

Simply adjust the shortwave oscillator trimmer so that WWV appears at the calibration point on the dial and then adjust the aerial trimmer for maximum volume

Once the dial calibration is correct at 10MHz, it will be easy to find the 25-metre (11.6-12.1MHz) and 31-metre (9.4-9.99MHz) bands. A long outside aerial will be desirable with sets like the Hotpoint because of limited sensitivity.

Shortwave propagation conditions around the world at the present time and probably for the next few years, tend to favour stations between about 4MHz and 12MHz so that it would be reasonable to adjust the aerial trimmer somewhere in the middle of that range.

How accurate is the alignment using the above methods?

We checked the Hotpoint with a laboratory signal generator, output test set and oscilloscope. The centre frequency of the intermediate stage was a few kHz away from the normal 455kHz but this really doesn't matter. We were unable to improve on any other adjustments.

The performance of the receiver is listed in the accompanying panel. The poor audio response is due to the narrow selectivity of the 455kHz IF stage attenuating the sidebands and is typical of AM receivers manufactured in the 1940s and 1950s, when people were happy with a "mellow" tone. The sensitivity, although not outstanding, is adequate for receiving local stations given about 5m of aerial wire extended away from shielding objects. SC