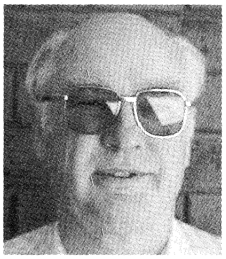
VINTAGE RADIO



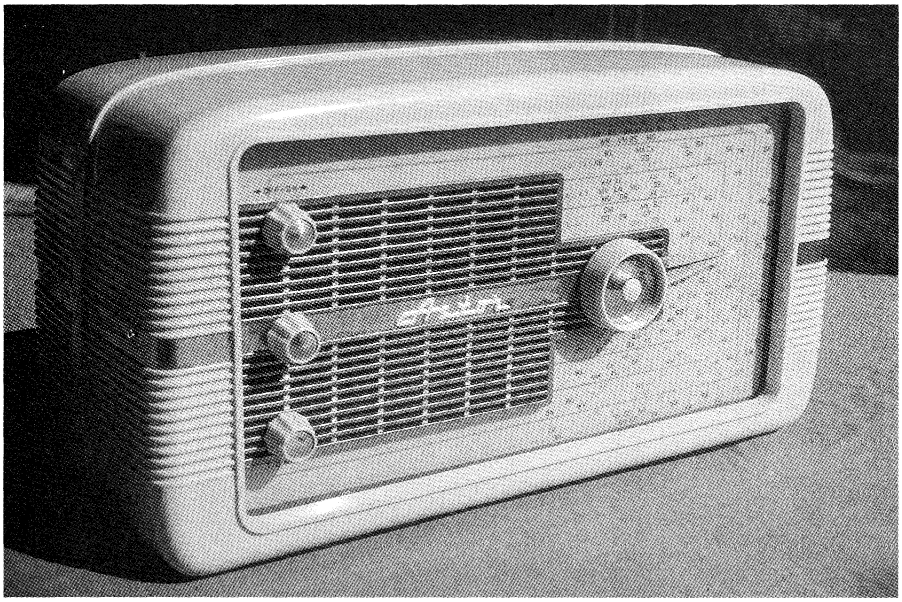
By JOHN HILL

Look Ma, no tuning gang!

Generally, vintage radios have tuning gangs but that doesn't apply to all sets. Coming across a set without a tuning gang often throws the restorer into a bit of a tizz. That such sets work quite well is acknowledged but understanding how the circuits work is something else.

In the early days of radio, variable inductance tuning was common until good single gang variable capacitors became available. Subsequently, the introduction of multi-ganged variable capacitors almost spelt the death knell of variable inductance tuning. It never died completely, however, being used extensively in transmitters and a few special purpose receivers. It was also often used to tune aerials to resonance.

Gradually, iron dust and ferrite cores for radio frequency (RF) coils, aerial coils, oscillator coils and intermediate frequency (IF) transformers became more common for fine adjustment of tuned circuits for best performance. It was found that a considerable variation in the inductance of a coil could be achieved by sliding an iron dust or ferrite core in and out of a coil. In fact, a tuned circuit consisting of a variable inductor with a fixed capacitor across it could be easily made to tune the broadcast band – and other bands as well.



The Astor GPM receiver was housed in a pink plastic cabinet and featured a large tuning dial. This unit had been knocked around somewhat during its history and someone had carried out some rough and ready service work on it.

The Astor GPM and BNQ

In the early 1950s, Radio Corporation started to bring out inductance tuned radios under the brandnames of Astor, Airchief and several other labels. The inductance tuning system really suited car radios as dust tended to block the ganged tuning capacitors previously used.

On the domestic front, the Astor GPM and BNQ mains-powered models were produced in 1955 and 1956 respectively. The circuit shown is for the GPM (Fig.1) and I have a BNQ – but no circuit for it. However, the circuits are almost identical, the differences being that the BNQ used a 6X4 rectifier in lieu of the 6V4 and the cathode resistor on the 6BH5 is 47Ω. The BNQ model also has a tone control.

One of the unusual features of these sets is the variable inductance tuning. Radio Corporation was one of very few manufacturers that used inductance tuning in 240V domestic receivers. A number of manufacturers used it in their car radio ranges, however.

The circuitry around the 6BE6 in the schematic diagram can be seen to be unusual compared to what is considered to be the norm. Instead of two windings on each coil or a tapping, both coils consist of a single winding.

Fig.2 shows the aerial input circuit redrawn to make it a little easier to understand. Amateur radio operators will be quite familiar with this circuit as it is called a pi-coupler. It is commonly used to match the impedance of the transmitter output valve to the aerial circuit and to tune the stage.

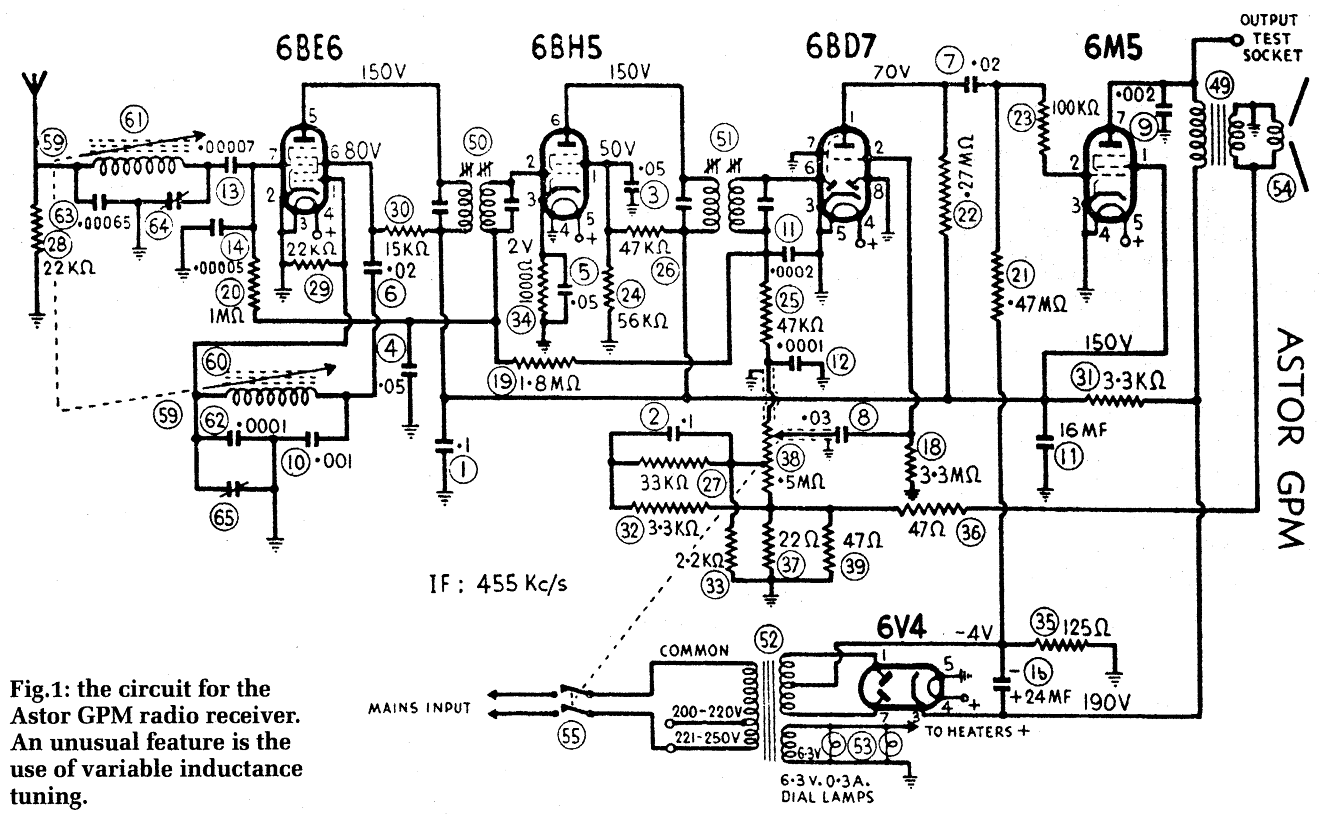


Fig.1: the circuit for the Astor GPM radio receiver. An unusual feature is the use of variable inductance tuning.

In the average set, the aerial connects to a coupling coil of about 400Ω impedance and wound on the same former as the tuned winding. This impedance is the RF "resistance" of the "average" aerial within the broadcast band. The coil is inductively coupled to the tuned winding. The signal voltage in the tuned winding is increased due to transformer action and the Q of the tuned circuit.

In the pi-coupler tuned circuit, the low impedance input from the aerial is matched by the 650pF capacitor (C63), while the high-impedance input to the grid of the 6BE6 is matched by the combination of C64, C13 and C14. This tuned circuit also increases the signal voltage applied to the grid of the 6BE6 by the action of the circuit's Q and by the ratio of the values of the capacitors at each end of the coil.

So it does exactly the same job as a circuit with a fixed inductance (or fixed inductances) and a variable capacitor. The advantage is that only one winding is used.

In addition, the circuit in Fig.2 also acts as a low-pass filter. This means that it lets all frequencies below the design frequency through but progressively blocks higher frequencies. This is a handy feature for broadcast receivers, as it helps to reduce the image response without the need for an RF stage.

For example, if the set is tuned to 693kHz, the image for this set (which has a 455kHz IF) is 1603kHz. In this set, I measured the image response as being 35dB down on the wanted signal. This means that a 2mV 1603kHz signal would be required at the aerial to have the same effect in the set as a 30μV signal at 693kHz.

Oscillator circuit

The oscillator circuit is also configured as a pi-coupler but is really being used as a Colpitts oscillator. The 6BE6 is normally used as a Hartley oscillator, whereby the tuning coil is tapped and the cathode goes to that tap. However, in this case there is no physical tap, as can be seen on the circuit diagram. Instead, it is capacitively tapped by capacitors C10, C62 and C65, with the tapping point towards the end going to pin 6 of the 6BE6. The oscillator feedback ratio is controlled by the ratio of the values of C10:(C62 + C65) and remains constant across the broadcast band. As a result, this type of oscillator is more reliable than some others used in vintage radios.

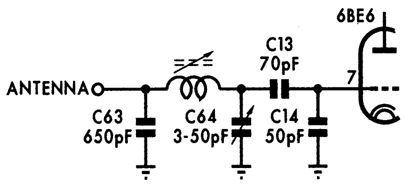


Fig.2: this diagram shows the aerial input circuit of the GPM receiver, redrawn to make it easier to understand.

As an aside, some sets which use 6A7 converter valves and the like are rather unreliable and may drop out of oscillation on the lower frequencies. This is often due to the actual circuit used for the oscillator, where the actual amount of feedback varies significantly across the band. I'll talk about this in a later article and describe how it can be largely overcome.

The circuit shown in Fig.1 uses no padder. So how did the manufacturer obtain good tracking across the broadcast band, with the resonant frequencies of the aerial and oscillator coils remaining 455kHz apart at all times? Elementary my dear Watson!

The oscillator coil is wound as a solenoid, with each turn right alongside the other. The aerial coil, on the other hand, has its turns wound side-by-side to begin with and then they are variably spaced over the rest of the winding. This can be seen on the photograph of the rear of the unit, which clearly shows the tuning mechanism (the aerial coil is the smaller diameter coil).

This is a simple way to do it but no doubt it initially took some experimentation to get the tracking right. A specially made cam would then have been fitted to the winding equipment so that it could easily wind this coil. There were no computers then to make the job easier.

Philips on occasions made inductance tuning mechanisms too and two views of a typical Philips unit can be seen in the photographs. It is much smaller than the Astor unit and is shielded, being built into one of their small IF can-sized assemblies. The Philips unit is also gear-driven compared to the metal belt drive on the Astor. A quite compact set could be made with a Philips variable inductance tuner.

Restoring the BNQ receiver

I got my BNQ at an auction for a nominal price of $3. The cabinet, like many plastic-cased sets, had faded from its original pink where it had been exposed to sunlight, so that it now looks a bit mottled. It was a bit knocked around and someone had carried some rough and ready service work on it at some stage during its history.

Care is needed when removing this set from its case. The front of the case consists of three plastic sections which are held together by plastic spigots. These go through holes in the mating section and are then melted into one another to hold the sections together. However, this is a very weak system and the front plastic escutcheon plate will break away from the main front section of the case with very little pressure.

To make matters worse, the dial lamps are attached to the escutcheon plate with short wires and it is very easy to withdraw the chassis and rip the escutcheon out at the same time. I extended the leads going to the dial lamps to overcome this problem.

Another problem occurs if the chassis-mounting clamps are not tightened correctly when the set is reinstalled in the cabinet. Unfortunately, it isn't easy to tighten these clamps as it's not possible to bear straight down on the screws which are slightly in from the back edge of the cabinet front. If the clamps are loose and you push the knobs on, the chassis slides back and again causes the escutcheon to break away from the front section of the cabinet. It's great fun having to repair the cabinet for the second time. In this case, it was broken before I even worked on the set, so others had had problems too.

Mr Radio Corporation certainly didn't get this part of the receiver's design right!

Circuit problems

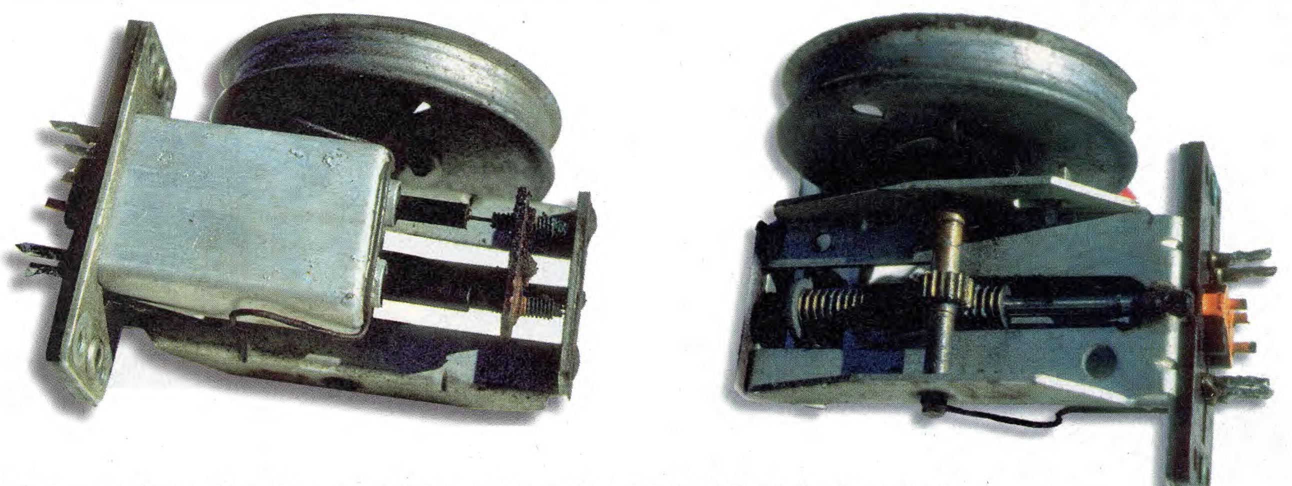
Now onto the electronic restoration. There were quite a few minor problems with the set which stopped it from working.

First, I discovered that a chassis-mounted electrolytic capacitor had lost its capacitance and someone had simply connected another capacitor across it. This is not really a good move as the faulty unit may have gone short circuit later on. In this case, both capacitors had lost almost all their capacitance, as indicated on a capacitance meter.

Further investigations revealed that several resistors had either gone high or open circuit and so these were replaced. I usually check the resistors in circuit with a multimeter and make allowance for any parallel resistances in my assessment. If there is any doubt, one end of the resistor is unsoldered so that it can be checked by itself, with any effect from other parallel components.

Paper capacitors in old receivers are quite often leaky, sometimes with a leakage resistance as low as a megohm. I use a high voltage tester across the paper capacitors to see how much leakage there is. Murphy has a great time with paper capacitors! The leakiest ones always seem to be in positions where no discernible leakage can be tolerated, such as the audio coupler between the plate of the first audio stage and the grid of the audio output, or the AGC/AVC bypass.

These nominated capacitors were replaced because they were quite leaky, along with several others. The cathode bypass on the 6BH5 was left



These two photos show the top and bottom views of a typical Philips inductance tuning mechanism. This unit is much smaller than the unit fitted to the Astor receiver.

in position, as it would have to be very leaky to cause a problem. As a general rule, it's a good idea to replace all paper capacitors with polyester or similar types where leakages under about 100MΩ can cause a noticeable alteration in the operating conditions of the valves in the set. Paper capacitors become more leaky as the temperature of the set rises.

I "rescued" a bagful of paper capacitors from defunct TVs many years ago and decided to test them at about 50°C in the kitchen oven. Before going into the oven, they tested OK on a multimeter but after heating, the multimeter showed almost all of them to be leaky. As a result, they were all consigned to the rubbish bin. 50°C is not an unreasonable temperature, as sets that are running can easily develop a temperature this high or higher inside them. On the other hand, polyester and polystyrene capacitors came out of this test smelling of roses.

Radio Corporation had a habit of using a combination of single conductor rubber-insulated hookup wire as well as plastic-covered wire in their sets. I don't know why they did that as the rubber-covered wiring often has to be replaced – the rubber goes hard and cracks off or goes gooey and behaves a bit like a resistor rather than an insulator. Perhaps plastic-covered wire was more expensive than rubber-covered wire in the early 1950s.

Anyway quite a bit of the wiring in critical areas had to be replaced. If there are any doubts about the safety of perished rubber wiring, it should always be replaced.

Switching on

Before applying power to the set, the insulation of the power transformer to the set chassis was checked with the high voltage tester. I also checked to make sure no shorts existed from high tension to chassis and tested the speaker transformer to make sure its primary winding was OK. In this case, the speaker transformer was OK although this component had obviously been replaced at some stage in the past, probably because the primary had gone open circuit.

Once these checks had been completed, the set was plugged in, power applied and the high tension (HT) voltage checked using a multimeter. This looked OK and so voltages elsewhere in the set were measured to see if they were as expected. Most were but one wasn't, so a bit more sleuthing was needed.

At this stage, the set was actually working but seemed very low on output and was not very sensitive. I checked the voltages around the set and found that the 6BH5 wasn't drawing any current. The reason for this was that there was no screen voltage, due in turn to the fact that one end of the resistor from the HT to the screen had become detached. I resoldered it and that fixed the problem.

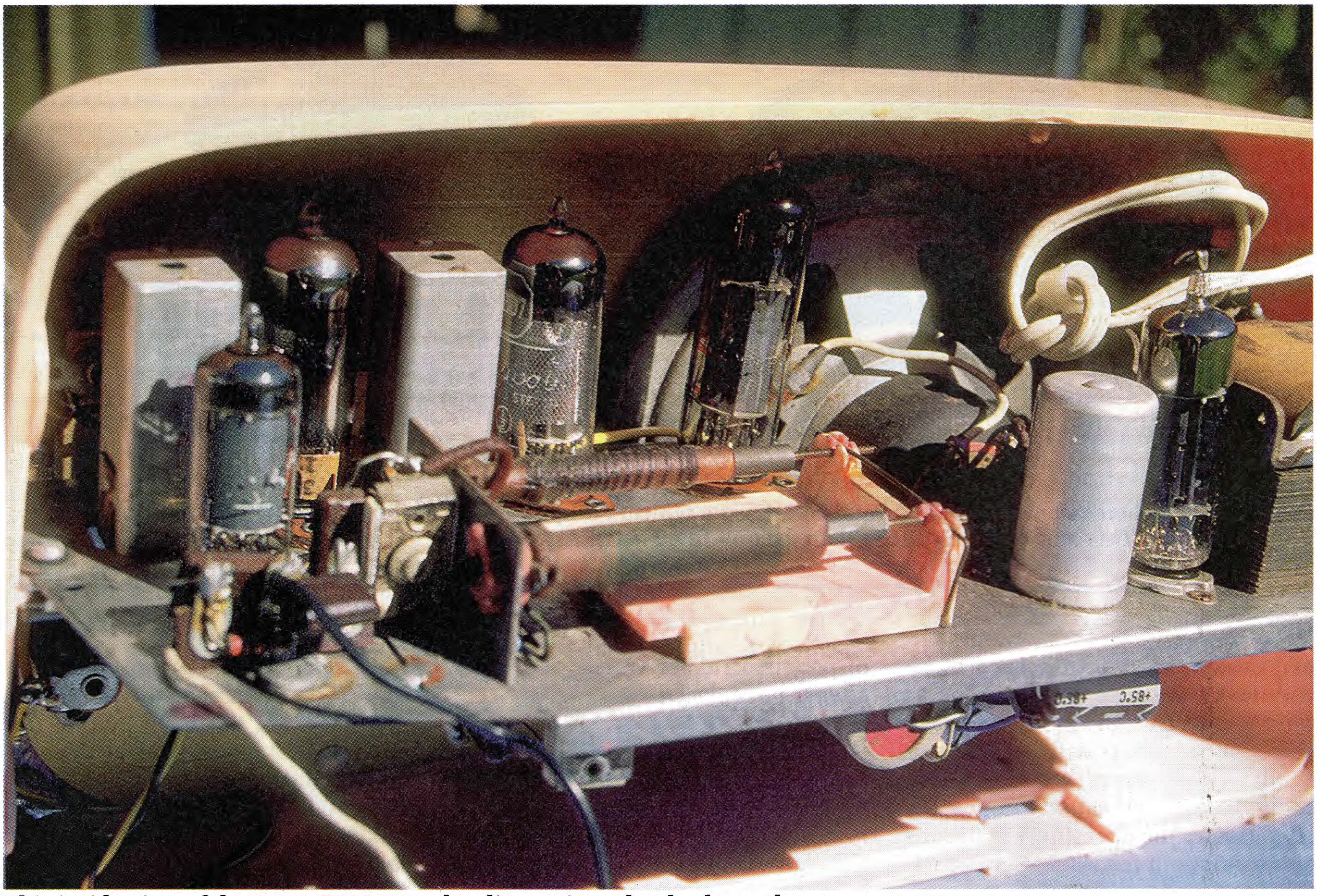
Alignment

The next job was alignment. The IF slugs seemed to be jammed so I couldn't do anything with the IF. However, checking the IF by tuning the signal generator between 400kHz and 500kHz confirmed that there was only one response peak and that was at 455kHz. As the sensitivity of the set was good, it was assumed the IF was correctly aligned. I had no option anyway!

Because it has an inductance-tuned front end, you may wonder how the alignment technique compares to a normal variable-capacity version. Well, the circuit is certainly different but in fact the alignment procedure is just the same as with the more familiar variable-capacitor tuned receiver front ends.

The first thing was to check that the oscillator tuning range was correct. It tuned from 530-1700kHz and the station calibrations were quite close to what they should have been so all was OK here. If the range had not been correct, it may have been necessary to adjust the oscillator iron-dust slug (the one in the larger diameter coil; see photograph) so that the set tuned down to 530kHz. Conversely, at the top end of the dial, the oscillator trimmer may have required adjustment so that the signal generator could be heard on 1700kHz.

A check at both ends of the dial will show whether the stations appear where they should on the dial. If they don't line up, the procedure is to first tune to a station at the bottom end of the band; eg, where 3AR is marked



This inside view of the Astor GPM mantel radio receiver clearly shows the variable inductance tuning mechanism. The aerial coil is the smaller coil (towards the rear of the unit) with the variably spaced winding.

(this was on 620kHz but is now on 621kHz and renamed 3RN). You then feed in a 620kHz signal from the signal generator and adjust the oscillator slug so that the signal generator is heard.

This done, you go to the other end of the dial and tune to the 3AK mark which corresponds to 1500kHz. The signal generator is then set to 1500kHz and the oscillator trimmer adjusted for maximum signal through the set.

Having got the oscillator tuning correct, all that remains is to tune to a station at about 600-700kHz and adjust the aerial coil iron-dust slug for best performance. You can either monitor the output by ear on a weak station using a typical aerial or using instruments on a medium to strong station. This done, you then adjust the aerial trimmer for best performance on a frequency between 1400kHz and 1500kHz.

Note that it may be necessary to repeat these adjustments as they do interact. Finally, seal the adjustments with some nail polish or beeswax. I have found that the inductance tuners hold their initial adjustment quite well and only rarely require more than a minor tweak to get the best out of them, as in this case.

Performance

So what is the set like to work on and what about its build quality and overall performance? The set is a good performer, although there is a tendency for some RF instability at the low-frequency end of the dial. I get the impression that the set was intended for the lower end of the market – the case certainly attests to that.

The works are built on a flat sheet of metal with brackets to mount the controls and the speaker, so it could almost be said to have no chassis. The chassis plate is situated half way up the inside of the case, so there is a lot of vacant space under the chassis, although this may not be obvious from the photograph of the back of the set.

The photograph of the front of the set shows that it has a large semicircular dial scale, marked with virtually all the stations that were available at the time. On the other hand, a rather small knob is used for tuning which makes the job a little fiddly.

Summary

The cabinet is poorly designed as previously mentioned and in my set, it has also warped. As a result, the plastic lugs at the top of the cabinet don't grip and the two sections can easily come apart. The use of rubber-insulated wire when they were also using good plastic-insulated wire in the same set is a backward step and the small direct-action tuning knob doesn't say much for the designer.

On the plus side, the performance of the set is quite good and in general the access is quite reasonable. I'm hard to please in this area but so many sets are spoilt just for a little more thought in operational ease (ergonomics), layout and accessibility.

I believe that Radio Corporation built many superb sets but seemed to lose the plot in some areas from time to time. However, I am happy to have this radio in my collection. **SC**