Vintage Radio

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The STC 504: a 5-valve table radio from 1939

Manufactured just before World War 2, the STC 504 is a 5-valve table receiver housed in a very attractive timber cabinet. It's an interesting circuit that performs well, especially after a few minor tweaks to its AGC system.

THE VERY FIRST radios used breadboard construction, then came the coffin style before the large consoles of the 1930s and 1940s became dominant.

During the 1930s, compact sets that could be placed on table tops were also developed, although they were still usually too large for a mantelpiece. Many of these sets used a tuning dial located on a sloping panel on the top of the cabinet, which meant that they had to sit on a table or low cupboard.

These days, it's hard to envisage such sets sitting on a lounge-room table away from the wall where power, antenna and earth were available. However, many were positioned that way and became the focus of the family's entertainment.

There is no doubt these table sets were much more attractive than the average mantel set. For a start, they were usually housed in good-quality veneered timber cabinets. And although their sound quality would have been inferior to the consoles with their well-baffled 300mm (12-inch) loudspeakers, they were considerably better than the mantel receivers.

This month, we take a look at a typical table radio from the era, the 1939 STC 504. It is a mains-powered 5-valve superhet design that covers the broadcast band only (ie, no shortwave).

The STC 504 5-valve receiver

The unit featured here is one that I have on loan and is quite an interesting set. It's housed in a nicely-finished timber cabinet which measures 460mm long, 255mm high and 270mm deep. The complete set weighs 10kg, so it's no lightweight.

Unfortunately, the set is no longer completely original. The chassis had been overhauled several years ago, while the cabinet had only recently been restored. This restoration work has not been completely successful though, as explained later.

An unusual feature of the set is the mounting arrangement used for its 200mm (8-inch) speaker. This is attached to a fairly thick baffle which is mounted at an angle across the front lefthand corner of the cabinet. This baffle is quite effective for such a "compact" cabinet and contributes to the set's sound quality.

The dial-scale is rather elaborate in appearance and is mounted on the righthand side. As with many other dials of the era, it looks quite impressive when lit up at night.

The three controls are mounted underneath the dial escutcheon. From left to right, they are: Tone, Tuning and Volume.

A glance inside the back shows just how tightly packed the cabinet is, with the chassis occupying the remaining space next to the loudspeaker. Apparently, the cabinet didn't have a back which was not uncommon in those days.

Circuit details

Let's now take a look at the circuit details – see Fig.1. It's a typical 5-valve superhet design for the era, although there are a couple of quirks.

As shown in the photos, the an-

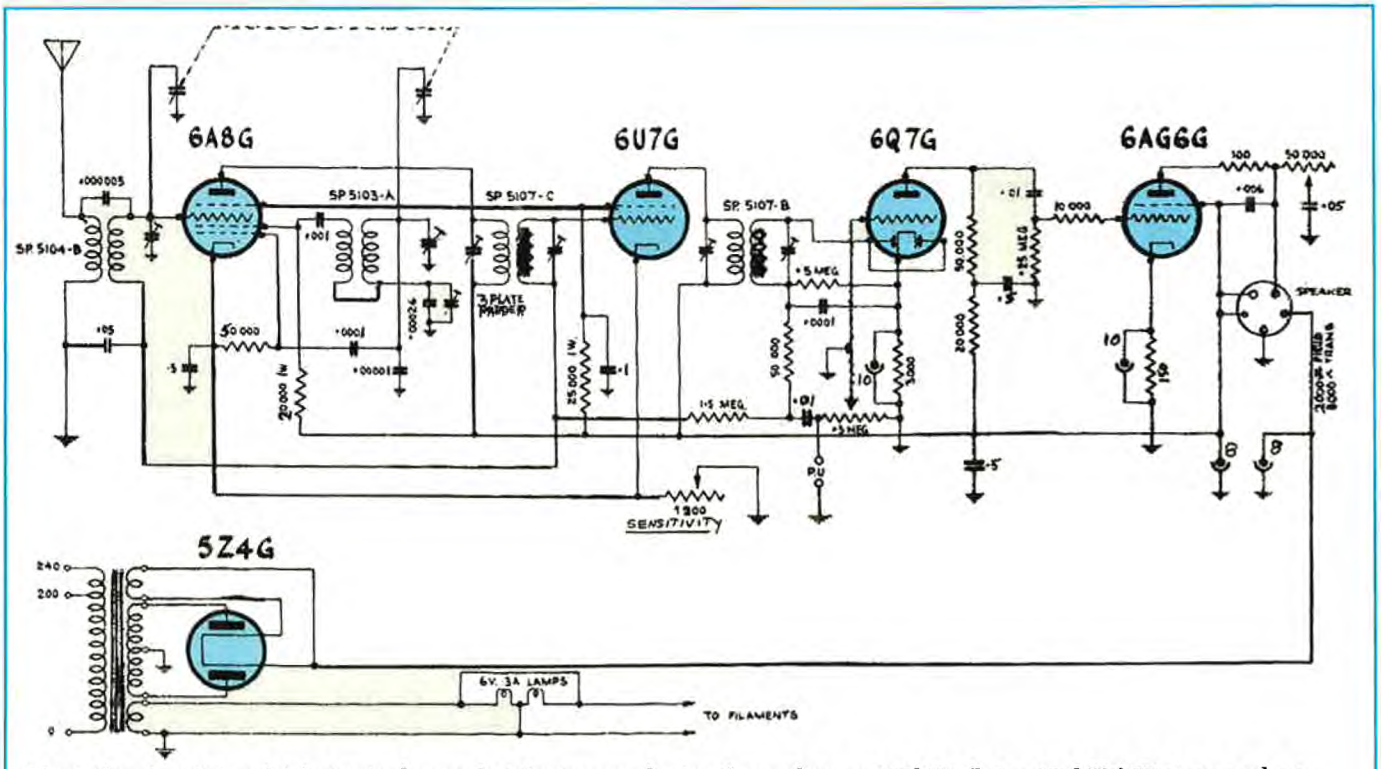


Fig.1: the circuit is a fairly typical superhet design employing five valves, a 450kHz (later 455kHz) IF stage and an electrodynamic loudspeaker. The sensitivity control is unusual and was difficult for the average user to master.

tenna terminal is at the far left on the back of the chassis. From there, the antenna lead goes through a hole in the lefthand end of the chassis and travels along this external edge until it re-enters the chassis near the front. This arrangement was used in many valve receivers and was done to keep the antenna lead away from the IF (intermediate frequency) amplifier. This reduced any chance of strong marine radio signals (which were close to the IF) breaking through into the IF stages.

The following antenna-tuned circuit is quite conventional, with the resulting signal applied to the grid of a 6A8G converter valve. The oscillator is a little unusual in that padder feedback was used to ensure more reliable oscillation than a conventional circuit often gave.

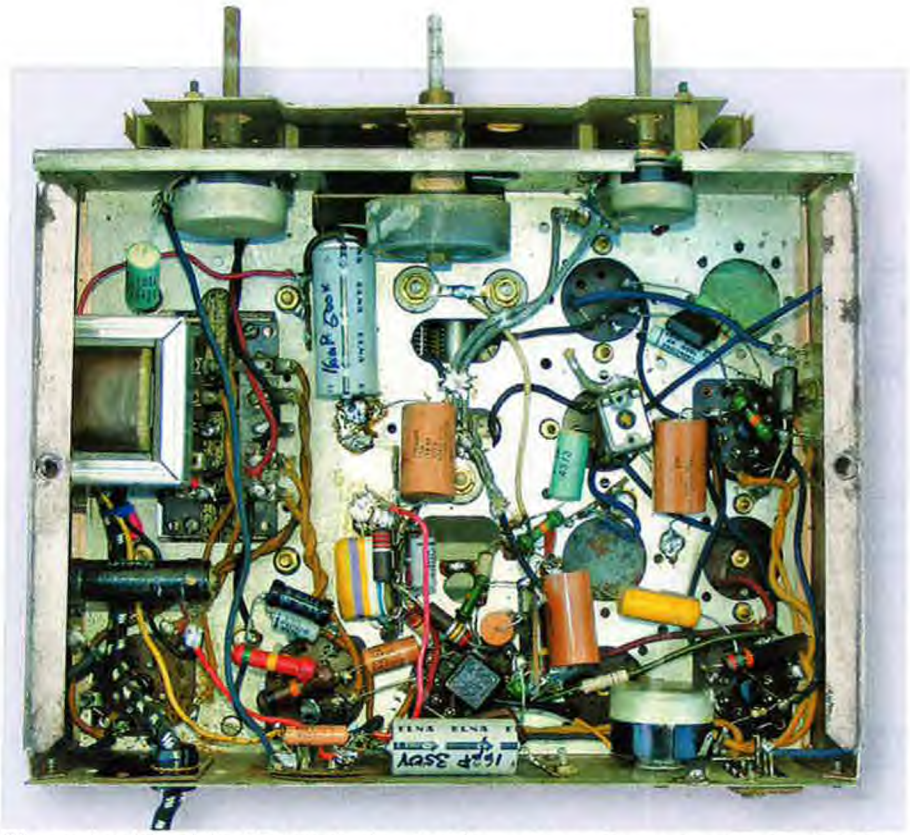
The coils for the antenna and oscillator tuned circuits are both aircored. As a result, adjustment of the frequency range and tracking must be done using the oscillator trimmer across the tuning capacitor and the padder capacitor. The antenna-tuned circuit can only be peaked at the high-frequency end of the dial.

It's interesting to note that some time in 1939, STC changed the intermediate frequency used for their sets from 450kHz to 455kHz. However, although STC changed the IF centre frequency, there was no need to change the IF transformers themselves. That's because most IF transformers centred on 450kHz will tune easily from around 430kHz to 480kHz without any modification.

The resulting signal from the first IF stage is applied to a 6U7G IF amplifier, before being fed to the second IF transformer. The signal is then fed to a 6Q7G (a triode duo-diode valve) where it is detected. AGC is also obtained from the detector.

From there, the detected audio signal is fed to a 0.5MΩ volume control, after which it is amplified by the triode section of the 6Q7G. The amplified signal is then fed to a 6AG6G audio

This view shows the back of the set before restoration. The original electrodynamic loudspeaker had already been replaced with a permanent magnet speaker at some time in the past.



The underside of the STC 504's chassis (shown here after restoration) is tightly packed with components, although most parts are easy to access. The sensitivity control on the rear panel (bottom right) has been made redundant, to make the set easier to adjust (see text).

output valve which in turn drives the electrodynamic speaker.

Power supply details

The power supply is quite conventional. The primary of the transformer is tapped at 200V and 240V, which covered all the likely voltages used in Australia at that time. Its high-voltage CT (centre-tapped) secondary drives a 5Z4G rectifier and its output is fed through the field coil of the electrodynamic speaker to derive the HT line. Two 8µF electrolytic capacitors (one either side of the field coil) provide additional filtering.

Like most receivers that use electrodynamic speakers, the power consumption is relatively high at 52W. One real advantage of using a 5Z4G rectifier is that it has an indirectly-heated cathode which warms up and commences conduction at about the same time as the rest of the valves. As a result, the peak voltage across the filter capacitors is much lower than it would be if a directly-heated 5Y3G rectifier had been used.

Cabinet restoration

As stated, the cabinet has only recently been restored but only after someone else had "had a go" at it. Unfortunately, the outside of the cabinet had been rubbed down to get rid of imperfections but whoever did it was unaware of just how thin the veneer is and had sanded it down too far. This has exposed the lower-quality timber beneath the veneer.

This sanding down had been done with relatively coarse sandpaper across the grain. As a result, the most recent cabinet restorer had to be very cautious as to how he approached the job. In the end, he used some fine French polishing-grade steel wool to restore the surface to a good, but not perfect, condition (some of the sanding marks are still visible but only if you are looking for them).

The cabinet was then given a coat of "Golden Oak" stain after which it was finished with a pressure pack of 30% nitro-cellulose lacquer. Six coats were applied to the top to fill the grain of the wood, while three coats were applied to the sides and front. The inside of the cabinet was spray painted matt black, as was commonly done with timber cabinets of that era.

The knobs were a little grubby and were given a wash in soapy water. Once dry, they were polished using automotive cut and polish compound, which brings bakelite up looking almost like new. One knob is obviously a replacement though and doesn't match the other two. The other two are originals, so it would be quite practical to get one of the members of the HRSA who specialises in making replica knobs to make another.

Chassis restoration

Before applying power to the set, I went through my usual routine of checking the power transformer and the HT line. This involves checking for shorts and excessive leakage in the transformer using a high-voltage insulation tester, especially between the primary and high-voltage secondary windings and the chassis.

Similarly, the isolation between the HT line to the chassis was also tested. These tests all indicated that the set would be safe to turn on after I'd checked all the other work that had been carried out.

In fact, this particular receiver seems to have had a rather chequered history of restoration, with bits and pieces carried out by several people. And although most of the work had been done to a reasonable standard, a few things did strike me as being a little careless. A little extra effort and the set would have been safer and a easier to service.

First, all of the electrolytic and paper capacitors had been replaced. However, a couple of UCC paper capacitors had been used and these have been known to become intermittent and/or leaky over time. I replaced them to avoid future problems.

In addition, the automatic gain control (AGC) system is not at all like the circuit and I'm not sure if this is a factory modification or if it was done by the restorer. It has been altered so that the AGC is now a delayed AGC system. After some deliberation, I modified it even further to make it a little more effective.

In fact, the AGC circuit is now very much like that shown in Fig.4 on page 92 of the June 2010 issue.

Sensitivity control

A slightly unusual feature is the inclusion of a "sensitivity" control, which is the potentiometer located in the centre-bottom of Fig.1. As the wiper is moved from its extreme righthand position to the left, the sensitivity of

the receiver will increase. Eventually, a position will be found somewhere along it travel where the sensitivity is at a maximum.

Note, however, that this occurs before the minimum resistance point (0Ω) is reached. That's because, at 0Ω, the converter and IF amplifier valves will have no cathode bias, as the cathodes will effectively be at chassis earth.

In addition, the return for the detector and AGC diodes is at a positive voltage, as set by the voltage across the 6Q7G's 3kΩ cathode resistor. As a result, this voltage is applied down the AGC line to the front-end valves.

In my opinion, the Sensitivity control was not a particularly smart design feature by STC, as most people would not understand how to set this control correctly (it's a screwdriver adjustment on the back panel).

The AGC circuit in this particular set has been modified to overcome the "positive voltage" problem with the AGC line. In addition, a previous restorer had fitted a 330Ω resistor in series with the wiper of the sensitivity control, so that the valves still have cathode bias at the minimum setting.

It was quite a good idea but that resistor value was too high to obtain maximum gain from the front-end. As a result, I substituted a 150Ω resistor and the bias is now correct for maximum gain with the control fully rotated to the lefthand end. This effectively makes the Sensitivity control redundant.

Obscured values

One of my pet peeves is components that have been installed so that their values are obscured. Unfortunately, the previous restorer had done just that, which is annoying.

It takes so little effort to orientate components so that their values can be seen that I cannot understand why it's not done – it makes life so much easier when troubleshooting or checking a circuit.

Speaker replacement

At some time in the past, the electrodynamic speaker had been replaced with a permanent magnet unit. This replacement and the associated modifications to the HT filter circuit had been quite well done and under normal operating conditions, was quite satisfactory.

A compact chassis fitted with an elaborate dial scale is used for the STC-504 5-valve receiver. The three controls beneath the dial scale are (from left to right): Tone, Tuning & Volume.

In place of the field coil, the previous restorer had installed a 14 Henry choke and a series wirewound resistor, giving a total of 2kΩ in series in the HT supply line. This matches the resistance of the original speaker's field coil.

However, if the speaker plug had been removed when the set was operating, the plate of the 6AG6G would have had no voltage on it. Conversely, voltage would have still been present on the screen and so the valve would have been destroyed quite quickly due to excessive screen current being drawn.

To eliminate this problem, I rewired the socket and plug so that removal of the plug removes HT from all sections of the receiver except for the first HT filter capacitor.

The power cord was also a problem, being retained only by a knot in the lead just inside the chassis. That may have been acceptable back in 1939 but it's certainly not acceptable today. This primitive anchoring scheme has now been replaced with an approved cable clamping system.

Finally, close inspection of the wiring around the 6Q7G revealed a lump of solder between a couple of the valve pins. It was removed and fortunately hadn't caused any problems.

Test & alignment

With everything under the chassis now looking shipshape, it was time to check the set's performance and do an alignment.

The first thing to do was to see if the set actually worked and carry out some voltage checks, so I connected an antenna and earth and switched on. The dial lamps immediately came on and shortly after the valves started to glow and noise could be heard from the speaker. The various voltages around the receiver were all within expectation, ie, around 220-250V on the plate circuits and around 100V on the screens. The voltages across the cathode resistors were around 2.5V on the RF valves and 4V across the 6AG6G's cathode bias resistor.

Next, I tuned across the broadcast band and a number of stations were heard, so the set appeared to be working. As a result, I disconnected the antenna and attached my RF signal generator to the antenna input. With

The top of the chassis is tightly packed with the major parts. Metal shields are fitted to the converter, IF and detector/triode valves, while the mains cord is now firmly anchored with a cordgrip grommet in place of the original knot.

the tuning gang vanes closed, I applied a strong modulated 455kHz signal to the set and was rewarded with audio from the speaker. I then slowly reduced the signal generator's output, at the same time carefully adjusting each of the four IF trimmers for best audio output.

Note that one trimmer in each IF transformer is at the full HT voltage and therefore considerable care is needed to make sure the screwdriver doesn't slip and short the HT to the chassis (or that you don't get a shock). All four adjustments peaked easily and the performance noticeably improved.

The front-end tuned circuits were next and these are first adjusted at the low-frequency end. This initially involves setting the signal generator to 600kHz, then tuning the receiver to 600kHz on the dial. The padder capacitor is then adjusted until the signal generator's signal is heard at this dial location and then carefully adjusted for peak output.

That done, the generator is set to 1400kHz and the receiver tuned to 1400kHz at the high-frequency end of the dial. The oscillator trimmer on the top of the tuning gang is then adjusted for peak output, after which the

The parts around the detector/first audio amplifier socket are somewhat crowded together.

procedure at both the low-frequency and high-frequency ends of the dial is repeated several times, until there is no need for further adjustment.

Finally, the signal generator is removed, an antenna connected and the set tuned to a distant station close to 1400kHz. The antenna trimmer under the chassis is then peaked. There is no corresponding adjustment at the low-frequency end of the dial but the sensitivity of the receiver is reasonably consistent across the band.

Once these alignment adjustments had been completed, the set performed quite well although its worth noting that both the selectivity and gain of the IF amplifier stage is inferior to slightly later sets with iron-dust cored coils.

Gremlins

Having completed the alignment, a couple of gremlins suddenly reared their heads. The first fault was an occasional loud crackling sound from the speaker. It remained with the antenna removed but disappeared when the volume control was turned down.

This indicated that the problem was in the front-end and replacing the 6A8G fixed the problem.

The second fault occurred during final testing. I had the set upside-down to allow access to the wiring when suddenly the HT (high tension) rose to quite a high level, indicating no current was being drawn. At the same time, the dial lamps went out and there was a burning smell.

I hastily switched the set off, turned it over and checked the power transformer. The section where the filament winding was wound was quite hot and some of the wax had melted.

In the end, this fault was tracked down to one of the dial lamp sockets, which was intermittently shorting to earth. Replacing it fixed the problem but it's a good thing that I was on the spot when this fault occurred, otherwise it could have destroyed the power transformer. Having fixed these two faults, there were no further problems and the set worked well.

Summary

This is a good-looking set with better than average audio, due to good speaker baffling and a relatively broad IF bandwidth. However, the AGC and sensitivity control really weren't quite as well-designed as they could have been. As stated above, the sensitivity control is now superfluous following a few modifications to the AGC system.

The chassis also looks like it has been designed to suit several different receiver layouts. For example, there is provision for an additional tuning gang section, which suggests that a different receiver with an RF stage used the same chassis. There are also two holes in the chassis which have been covered over and these probably accepted additional components.

In summary, this is an excellent example of the state of the art just prior to World War Two. It performs well and is certainly worth having in a collection. SC