Vintage Radio

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The Raycophone Broadcast-Band "Pee-Wee" Midget

Manufactured by Raycophone around 1933, the Pee-Wee Midget is an early superhet receiver with a regenerative IF stage. It's an interesting set but is does have a few design problems that limit its performance.

IN THE 1920s and into the early 1930s, tuned radio frequency (TRF) receivers were the norm. Experimenters and manufacturers were still feeling their way with radio receiver design and felt comfortable with TRF circuits despite their increasingly obvious limitations.

By then, however, the more adventuresome were experimenting with superheterodyne receivers. In fact, a few superhets such as the RCA 26 (see SILICON CHIP, August 2008) were already being sold in Australia and overseas. Despite this, superhets were very thin on the ground, as very few people understood this "tricky" new technology.

The Raycophone company

One interesting Australian company at that time was Raycophone Pty Ltd. This company was run by Raymond Allsop who was both the director and

The Raycophone "Pee-Wee" is a compact unit that's housed in an attractive wooden cabinet. The lack of a dial and indistinct markings around the tuning knob makes it difficult to tune to a wanted station.

The chassis is easy to remove but care must be taken to avoid damaging the under-chassis components.The parts mounted on the top of the chassis are all easily accessible.

the chief engineer. Radio was just one aspect of his involvement with electronics, his main interest being with sound movie equipment in the pre-WW2 era.

At that time, Raycophone was still relatively unknown as far as radio was concerned. And despite some considerable research, I have been unable to discover when they commenced operation and when they closed. The only reference to the production of radio receivers is in the "Radio Trade Annual and Service Manual" for 1939, which contains circuits and rudimentary technical information on several receivers produced by Raycophone in 1933.

However, I have been unable to find any circuits in the "Australian Official Radio Service Manuals".

Raycophone Pty Ltd was located at Booth and Trafalgar Streets, Annandale, NSW. During WW2, they produced Fortress amplifiers, signalling lamps, anti-submarine equipment, movie (sound) projectors and cathode-ray oscillographs.

As an aside, Raycophone projectors are still in use at a cinema in Swanpool (a small township south of Benalla in Victoria), even though they were built in 1948.

The Raycophone "Pee-Wee"

I first saw a circuit of this 1933 receiver several years ago and wondered whether I would ever see one. Recently, however, I found out that one of our local vintage radio club members had a working unit and he readily agreed to lend it to me.

As shown in the photos, the set is installed in a fairly small cabinet which is made of quite heavy timber. The cabinet is quite attractive when viewed as a mantel receiver, although the underside of the cabinet is untreated bare timber. It would have been better if some small buffers had been fastened to the bottom of the cabinet, so that it could be made to look like the rest of the cabinet.

The front of the receiver is quite attractive, with the speaker in the centre and two controls (tuning and volume) either side of it. In this set, the tuning control is on the left and the volume control on the right, which is the opposite to that used on other sets (the right hand is normally used for tuning). Both controls have some indistinct lettering near them.

Strangely enough, the volume control is wired to increase in volume as it is turned anti-clockwise, which is somewhat annoying. The tuning control is fitted with a medium sized knob. This is connected directly to the shaft of the tuning gang, which makes tuning rather critical.

There are no markings on the knob and this, coupled with the indistinct markings on the surround, further complicates tuning. Basically, it's impossible to know what station or part of the band the set is tuned too.

A glance inside the cabinet shows that there is little spare space, with the components squeezed quite close together. It's easy to remove the chassis from the cabinet, however. All you have to do is remove the two knobs and four bolts on the underside of the cabinet. The chassis then slides out.

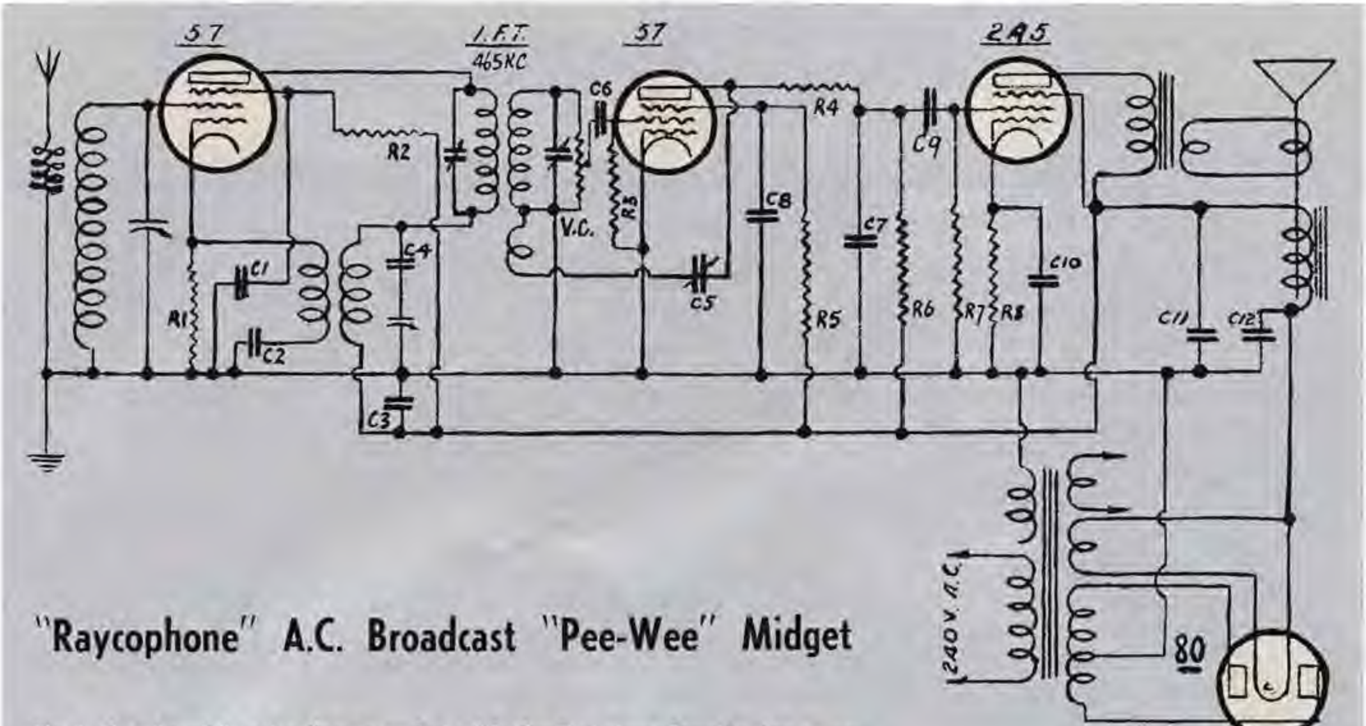


Fig.1: the circuit is a 4-valve superhet with the first stage functioning as an autodyne converter (ie, it functions as both a local oscillator and a mixer).

The components used in the early 1930s were quite large by today's standards. As a result, the large components mounted on top of the chassis nearly fill all the available space.

Most of the components on the underside of the chassis are mounted on a large component board. This is neatly done but it does make it difficult to access the valve pins underneath it without first disconnecting quite a few leads.

The aerial and oscillator coils and the regenerative intermediate frequency (IF) transformer are all located under the chassis. None of them are shielded in any way and care must be taken to ensure that none of their leads are broken when working on the set.

Circuit details

Fig.1 shows the circuit details of the receiver. Basically, the Pee-Wee was an "austerity-model" 4-valve receiver built towards the end of the depression of the 1930s. The set's basic circuit design was commonly called a "Super-Gainer" in amateur radio circles.

As shown in Fig.1, the signal from the tuned antenna circuit is presented to the grid of a 57 pentode. This functions as an autodyne converter stage – ie, it functions as both a local oscillator and a mixer.

Note that because the valve is being used as an autodyne converter, its cathode resistor (R1) is considerably higher than it would be if the valve was simply configured for RF amplification.

The IF output from this stage is at 465kHz and this is fed to an IF transformer. It is then fed via a potentiometer to a second 57 valve which functions as a fixed tuned regenerative detector. The potentiometer functions as the volume control (V.C.).

In operation, variable capacitor C5 feeds back a portion of the amplified RF signal (ie, from the plate), which is then re-amplified. This capacitor is adjusted so that the receiver does not go into oscillation due to excessive feedback when the volume control is fully anti-clockwise.

In addition, the audio signal on the plate of the second 57 is fed out via R4 and C9 to the 2A5 audio output valve. Note that R4 and C7 act as an RF attenuator to prevent IF signals getting into the audio output stage.

The 2A5 is connected as a conventional cathode-biased audio output stage. It drives a 5-inch (127mm) electrodynamic loudspeaker via a speaker transformer.

The power supply is quite conventional with two filament windings, one at 2.5V and the other at 5V. The high-voltage secondary drives either an 80 or a 280 rectifier valve. This functions as a full-wave rectifier with two 8μF electrolytic capacitors and the speaker's field coil filtering the rectifier's output.

Restoration

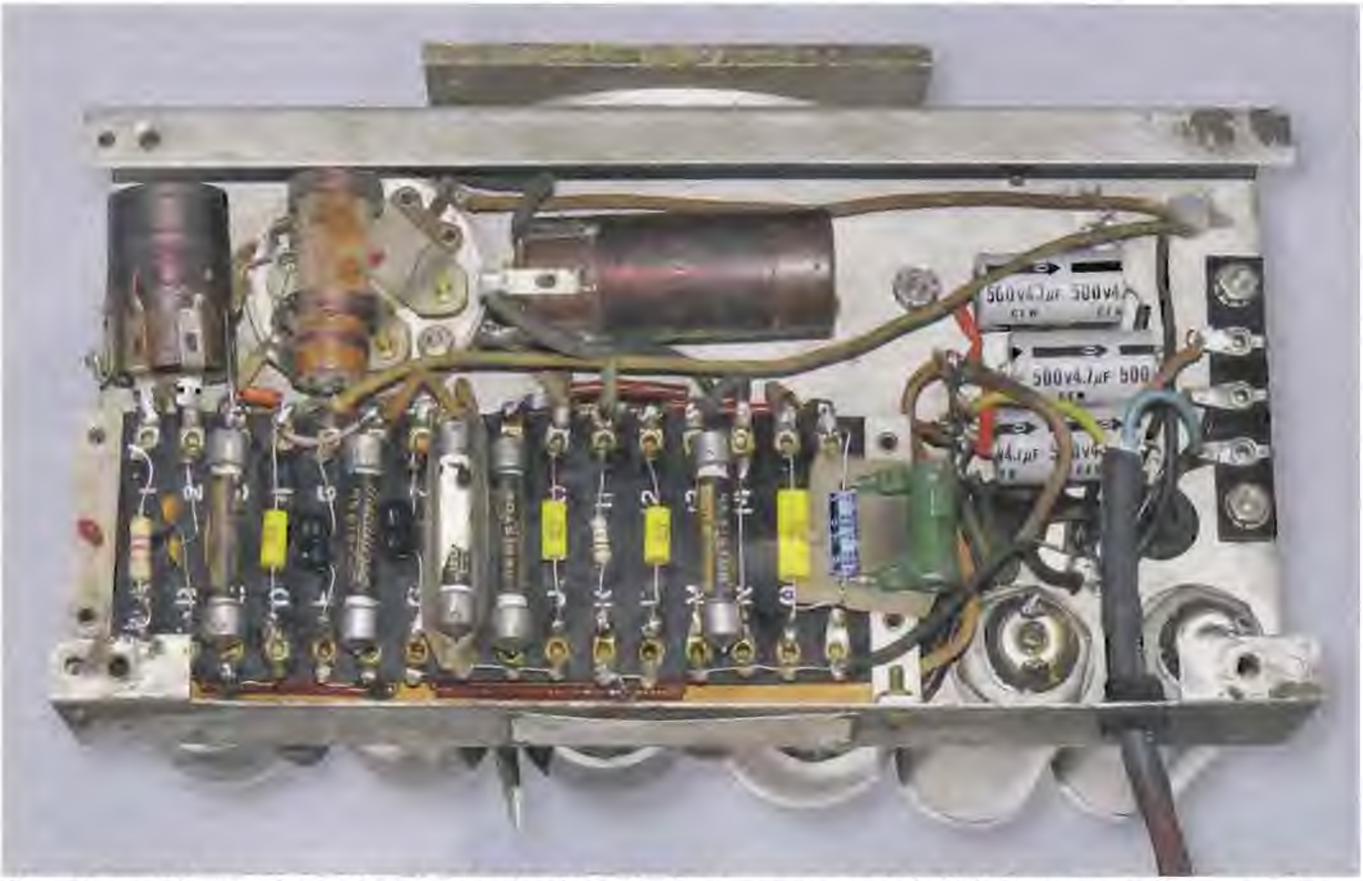
As supplied to me, the receiver had only quite recently been restored to working order. The cabinet had also had work done it and looked to be in good order.

The circuit details indicate that all but one of the low-value fixed capacitors are mica types but they are, in fact, mostly paper types. As usual, they were all quite leaky and had been replaced, some with polyester types and others with silver mica capacitors.

The electrolytic capacitors had also been replaced. However, the high-voltage chassis-mount units had been left in-situ to maintain the above-chassis appearance. Instead, they had simply been disconnected and replaced with much smaller modern pigtail types mounted under the chassis.

A couple of out-of-tolerance resistors had been replaced as well. Finally, a new 3-core power cord had been fitted and anchored into position.

At this stage, I decided to apply



The parts are laid out quite neatly under the chassis but the long component strip is difficult to remove. This means that the parts under it can only be accessed for service after a lot of work.

power and see how well the set performed. Well, it worked but not as well as expected. Even local stations were quite weak and the set oscillated in many places across the broadcast band.

Troubleshooting

It was time for some troubleshooting. First, I checked the "start-up" voltage at the output of the rectifier and got a rather unpleasant surprise. During warm-up, the voltage on the electrolytic capacitors rose to just over 500V. However, one of the electrolytics fitted was rated at 350V, while the other had a 450V rating (the person who originally drew up the circuit diagram had neglected to note any of the voltages expected within the receiver).

I certainly could not leave those capacitors in circuit or a rather dramatic failure would occur within a short period of time. Unfortunately, I didn't have any 8μF 500V capacitors but I did have some 4.7μF 500V capacitors. I placed one 4.7μF capacitor on the output of the 80 rectifier and connected another two in parallel across the HT line after the field coil.

Note that the voltage ratings of the capacitors that had been fitted were quite adequate once the set had commenced operating. Directly heated rectifiers like the 80, 5Y3GT, etc are operational within a couple of seconds of switch on.

By contrast, indirectly heated valves take up to around 15 seconds to start to draw current and during this time there is no voltage drop to speak of

There's not much room left inside the cabinet when the chassis is slid into place, although the valves can still be replaced. Note the thickness of the timber used to make the cabinet.

across the rectifier or across components such as the field coil.

This means that the peak voltage that the supply can deliver on no-load is substantially more than the loaded voltage. It is therefore necessary to allow for the very high start-up voltage which occurs at switch-on.

Curing the instability

The instability (oscillation) problems in the RF sections of the receiver proved difficult to fix. And although I have made major improvements, I have not been 100% successful.

First, resistor R1 had previously been replaced with a wirewound unit which would be inductive. As a result, I replaced it with a carbon resistor and this reduced the instability somewhat with the set no longer oscillating at all times in certain locations.

This view shows the unshielded 465kHz IF transformer windings. The leads are easily damaged when the chassis is removed.

Next, I tried adding extra filter capacitors to the HT line for both 57 valves and this gave a further slight improvement in one of the locations (ie, to the first 57). I then tried swapping the two 57 valves but this made no difference.

My next step was to examine the set's earthing arrangement. This revealed that all stages are earthed via an insulated lead that runs from one end of the chassis to the other. That meant that the RF section was earthed at the furthest end of the chassis and I felt that this could be contributing to instability problems.

As a result, I separated the earth wire part way along the component strip board. The front-end was then directly earthed to chassis near the converter stage, using a much shorter lead.

This simple modification again improved the stability but it still wasn't the complete answer.

Alignment checks

Next, I took a look at the alignment and this proved to be a bit of a mess, probably due to the age of the set.

The problem here is that none of the coils can be adjusted, as iron-dust adjustments slugs were still to become popular when this set was made. The receiver tuned from around 550-1500kHz and I extended this to around 1550kHz to cater for a local station.

In practice, the set will tune to above 1700kHz if the oscillator trimmer capacitor is reduced almost to its minimum value. However, the aerial stage cannot be peaked for best performance if this is done.

This led me to suspect that the aerial coil had too much inductance. The wire used to wind this coil is quite fine and its location makes it difficult work on without risking damage, so I decided to leave it alone.

In the past, I've noticed that coil inductance can increase in some very old sets, perhaps due to moisture ingress into the coil former. As a result, the alignment of the aerial and oscillator coils in this set are a bit of a compromise.

The secondary winding of the IF transformer also gave quite a broad response, with only a slight peak. However, the owner had fitted a 50kΩ volume control potentiometer across the winding in place of the 500kΩ unit that had originally been fitted.

Initially, I reasoned (incorrectly) that the lower resistance would damp out any tendency for the stage to oscillate, as I couldn't turn C5 to reduce the regeneration feedback. I was wrong and after fitting a 500kΩ potentiometer, the IF winding peaked nicely and the set's tendency to oscillate dropped dramatically.

However, it would still oscillate on some stations and it turned out that there were further problems, which came to light later.

Special potentiometer

The original potentiometer was apparently a special unit and was possibly an anti-log type. However, I didn't have a direct replacement. With some of the potentiometers I tried, earthing the frame (ie, when the pot was mounted) reduced the performance of the set. Apparently, the tuning of the IF transformer's secondary was being affected by the capacitance between the potentiometer's elements and its frame (which is earthed).

In addition, only a very small portion of the pot's travel was having any effect on the volume.

In the end, I decided to go back to the 50kΩ potentiometer and install a 390kΩ resistor in series with its "earthy end. This arrangement gave 440kΩ of resistance across the winding and allowed the pot to vary the volume over almost all of its travel.

As before, I found that earthing the frame of the potentiometer had the undesired effect of reducing the volume. As a result, I insulated the pot's frame from the chassis using insulated washers and an O-ring. I then retuned the secondary winding of the IF transformer and this fixed the problem.

It's worth noting that conventional potentiometers are not rated for RF work so it was not surprising that I struck this problem.

Following these modifications, the set is now probably performing as well as it did when new. However, it is very much an "austerity receiver" and its performance is only reasonable. It has no AGC so the volume control has to be manually adjusted to reset the level when tuning between weak and strong stations.

In practice, weak stations are not worth listening to, although the set would probably work better if the aerial coil had the right inductance. What's more, it still shows signs of instability when tuned to some stations.

Photo Gallery: Philips Model 112E Receiver

Made in the Philips' South Australian factory in 1949, the Model 112E was a 4-valve mantel set housed in a pale-blue bakelite cabinet. An unusual feature was the dial glass which protruded from the top of the set. The valve line-up was as follows: 6X5GT rectifier, ECH35 converter, EBF35 IF amplifier and EL33a audio output valve. This radio was restored by Tony Lightfoot of the HRSA. Photo by Kevin Poulter.

Summary

The Raycophone "Pee Wee" is an interesting little set but like most "austerity receivers", its performance is nothing remarkable. I have always been interested in superhets that use a regenerative IF stage and they can perform quite well if properly designed and constructed.

In this set, direct access to parts under the component strip is almost impossible (unless the strip is removed). This can make servicing it difficult. In addition, the clearance between the bottom of the chassis lip and many of the parts mounted under the chassis is only a millimetre or so. The coils in particular are quite vulnerable to damage when sliding the chassis in and out of the cabinet.

Another problem is that some sections of the set that are working at RF have quite long leads. This is bad design practice and can cause instability. The tuning is also quite touchy due to the direct-drive coupling and the relatively small control knob. This is made worse by the lack of a tuning indicator.

With more thought given to its design and component layout, this little set could have been much better than it is, both in terms of stability and overall performance. It could have been made easier to service as well.

In summary, the Raycophone Pee Wee has a number of design inadequacies that compromise its performance and make it difficult to use and service. **SC**