VINTAGE RADIO

By JOHN HILL & RODNEY CHAMPNESS

The basics of reflex receivers

The reflex circuit gave many early valve radio receivers a substantial performance lift without the expense of an extra valve. Here, we take a look at the reflex circuit & explain how it works.

Anyone who reads this column regularly will know that I am only a hobbyist with a keen interest in vintage radio. I have had no formal training in electronics and there are no letters after my name. But such a situation has been to my advantage.

Because I lack a lifetime of servicing experience and a deep theoretical knowledge of radio, most of my stories are, at best, only semi-technical in content. However, this seems to be about the right mix to hold the interest of novice vintage radio repairers, of which there are many.

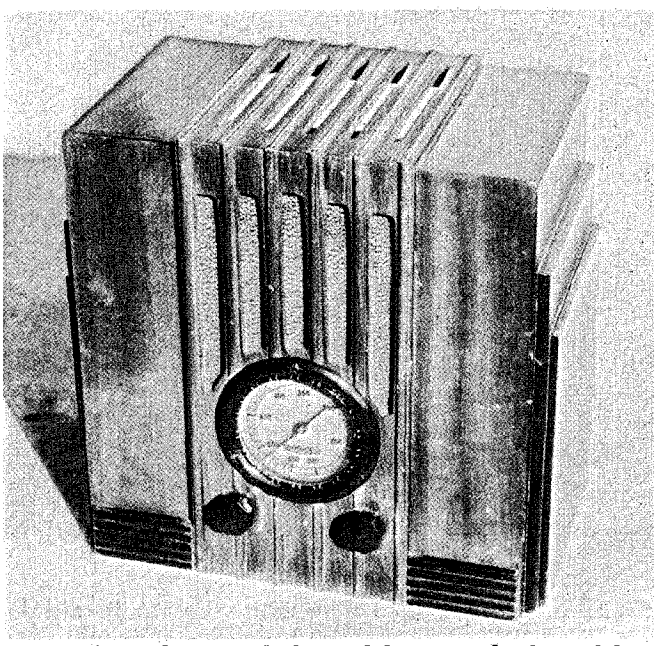
When a collector friend, Rodney Champness, suggested that I write something on reflexing, my eyes glazed over a little and I mumbled incoherently in reply. Although I know the basic function of reflexing (using the one valve to amplify both radio and audio frequency signals simultaneously), writing a detailed account on the subject is quite another matter.

This month, I would like to introduce Rodney to Vintage Radio readers and allow him to explain the function of reflexing. If he is well received (excuse the pun), we may call on him again for an in-depth study of another subject.

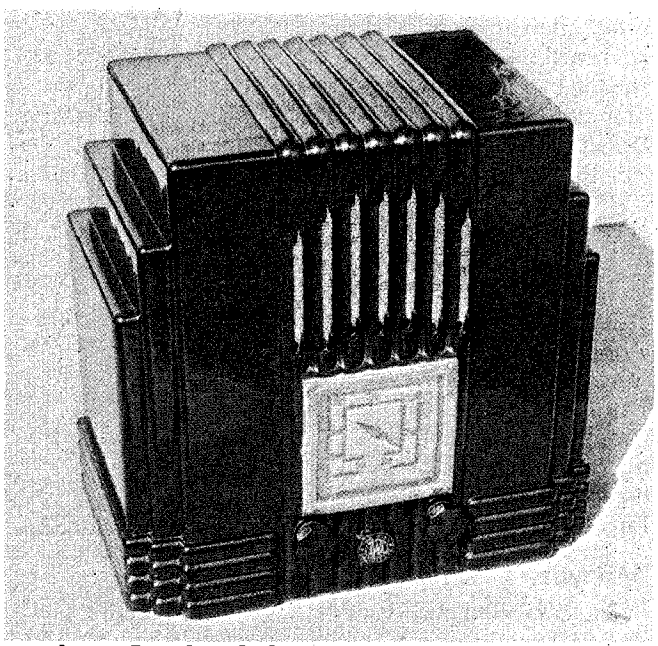
Reflexing of domestic valve radio receiver circuitry was more common in Australia than in other countries and was usually done to keep manufacturing costs down – particularly the economy sets. One of the most expensive components in early receivers was the valve and if the price of a valve could be saved while still retaining good performance, then it was well worth the effort.

The reflex concept

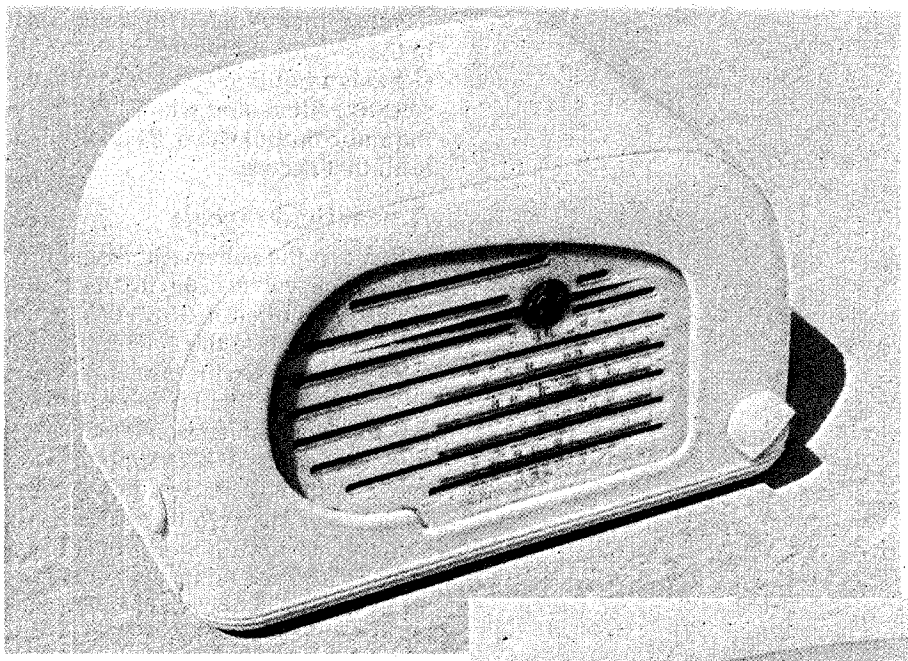
A reflex circuit has both audio and RF signals amplified in the one valve at the same time. Reflexing will only work where the two bands of frequen-



This timber cabinet Radiola Model 27 was the first of the Radiolette series to use a reflex circuit. Reflex receivers were common throughout the 1920s, 1930s and 1940s and were particularly popular in Australia.

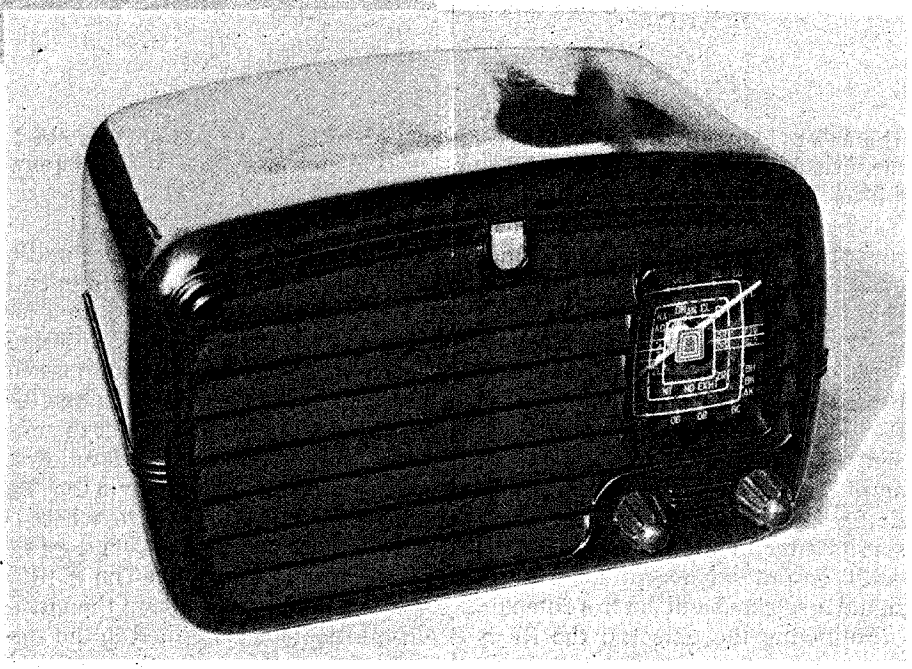


Another reflexed Radiolette receiver. Reflexing gave a receiver a substantial performance lift without the expense of adding another valve but the circuit had to be carefully designed.



Left: this little Peter Pan 4-valve radio is reflexed and its performance is quite outstanding. It also has excellent tonal quality for such a small receiver.

Below: the diminutive 4-valve Philips Philette is a typical reflex receiver. It may have been small but it gave big performance for its size.



cies are significantly different from each other.

In some early sets, it was possible to find an RF valve acting also as the first audio amplifier. In later superhet reflex receivers, the IF valve would amplify both the IF signal and do the job of the first audio amplifier. In addition to this, the same valve could also be supplying the AGC and detection functions using its two inbuilt diodes – quite a busy little valve!

Reflexing not only saved the cost of a valve but in battery receivers it saved LT (low tension) and HT (high tension) current as well. However, a reflex circuit can be quite a fickle beast if the operating conditions are not carefully selected.

Quite often, reflexed stages did not use AGC as it would have upset the audio gain, caused distortion or accentuated the minimum volume effect. In reflex sets, the volume usually could not be reduced to zero (minimum volume effect) due to the compromise operating conditions.

Reflexed stage valves also usually had to be replaced more often than valves in other stages, due to the operating conditions not being optimum in some designs. However, these things aside, the reflex circuit is fascinating, effective and not deserving of the bad PR that it seems to suffer. A well-designed reflexed set works well and is no more critical of a valve's condition than a set not using reflex circuitry.

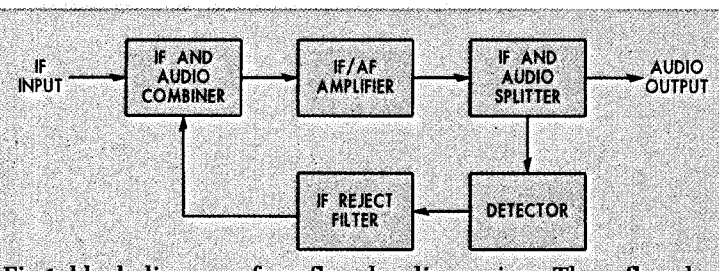


Fig.1: block diagram of a reflexed radio receiver. The reflexed valve has a signal combiner at its input which combines the IF and audio signals, the combined signal then being fed to the valve for amplification.

I have a couple of reflex sets, have worked on many others and find them no more tricky than conventional sets. Don't be afraid of them – they are just another variation in design that sets have had over the years.

To make things easier for those who have had little experience with reflex sets and find them hard to comprehend, the following may help to make

The Astor "Football" was a 3-valve reflexed TRF receiver. The 6B8-G valve in the little Astor provided RF and AF amplification plus detection, so it was quite a busy little valve.

reflexing a little more understandable.

Refer now to Fig.1 which is a block diagram of a reflexed radio receiver. The reflexed valve has a signal combiner at its input. This combines the IF and audio signals, the combined signal then being fed to the valve for amplification. From there, the amplified signal is fed to a circuit which selects and directs the audio to the audio output valve. Similarly, the IF signal is selected and fed to a detector.

Following the detector, the RF is filtered out and virtually pure audio is applied to the signal combiner and thus to the valve. The circuit that selects and directs signals of differing frequencies in different directions can be called a diplexer or a selective filter. However, it may be easier to understand if it is explained as follows.

The IF signal is applied via the signal combiner to the IF valve, where it is amplified and applied via a selective filter to the detector. The IF (RF) signal is then removed and the virtually pure audio is applied to the signal combiner which in turn applies it to the IF/audio valve. Here, the audio signal is amplified and then fed to the selective filter, after which it is fed to the audio output valve. Basically, that is all that occurs.

A practical circuit

Refer to the schematic diagram of Fig.2. The valve used in the reflex circuit was often a 6AR7-GT in the octal days, while the 6N8 and 6AD8 were used more in the miniature valve days. These particular examples are duo diode variable mu pentodes.

In most cases, AGC is applied to the valve, although generally at a lower level than if it were to be used as a straight IF amplifier. There are two reasons for this. First, the valve may be taken into an operating area where its distortion is increased. And second, with AGC applied to what is the first audio valve, the volume may *decrease* with an increase of signal level due to the AGC action.

The IF signal is applied to the grid in the normal way, although it will be noticed that C1 is much smaller than normal. It acts as a bypass for the IF signal but has little effect on the audio signal.

After amplification by the valve, the IF signal is fed to the IF transformer primary as usual and by mutual inductance into the secondary and thence to a conventional diode detector. On the primary side, C8 is again smaller than usual but still bypasses the IF signal at the end of the transformer to earth.

Following the detector, the audio

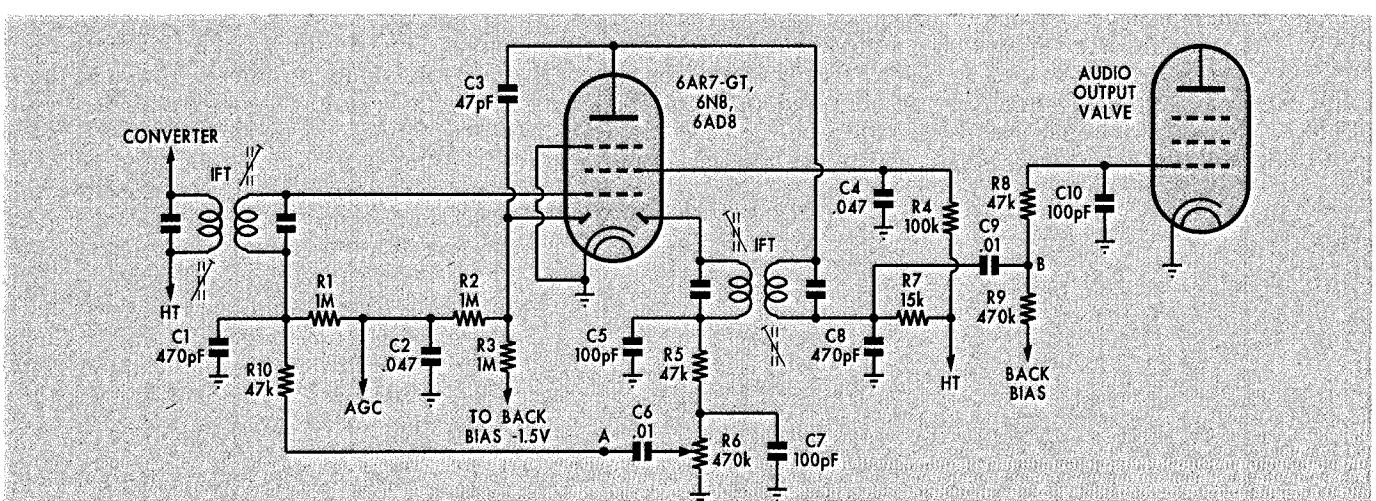


Fig.2: a practical reflex circuit. The valve used was often a 6AR7-GT in the octal days, while the 6N8 and 6AD8 were used more in the miniature days

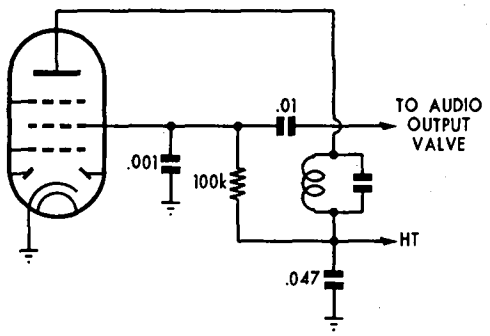


Fig.3: in some reflex sets, the audio is taken from the screen of the audio valve instead of from the plate. This circuit shows the basic scheme.

signal with some IF signal imposed on it is fed to the volume control via an IF rejection filter. This stage consists of a resistor-capacitor network and is also used in non-reflexed sets.

Now the interesting things occur! The audio level is picked off by the moving arm of the volume control and applied via C6 and R10 to the grid of the IF valve as an audio signal. C1 has little effect on the audio signal and the secondary of the IF transformer has even less effect.

The audio signal is now amplified through the IF-cum-audio valve and the amplified signal impressed across plate load resistor R7. This gives an alternating voltage which is applied to C9 and thence through the network to the grid of the audio output valve. The audio signal is unaffected by the primary of the IF transformer in the plate circuit and capacitor C8 also has little effect on this signal.

Note that many sets just apply the signal from C9 direct to the grid of the audio output valve. This is not a good move although some manufacturers did this and got away with it. In this circuit, R8 and C10 act as an IF filter to remove about 90% of the IF signal left after the filtering by C8. It is important that the IF signal be reduced to a low level as the audio output valve will amplify IF signals as well and these could easily feed back into an earlier stage.

In addition, the output valve is driven harder than most other valves. If it is amplifying unwanted IF as well as audio signals, distortion/overload may occur well before expected.

You will notice that R7 is much smaller than normal for an audio amplifier such as this (the values used are commonly 15kΩ, 22kΩ, 47kΩ and 68kΩ). This is because the valve must be run with a reasonably high voltage on the plate for efficient IF amplification. The audio amplification is lower than normal at around 12-15 times but is sufficient for the output valve to be driven quite hard, even on weak stations. The screen resistor value is within the normal range for a valve used as an IF amplifier.

Not all reflex sets take the audio from the plate circuit of the IF valve. Some take it from the screen of this valve instead. In this case, the RF bypass capacitor is reduced to about .001μF and the normal bypass capacitor is swung across to feed the grid circuit of the audio output valve.

Fig.3 shows a skeleton circuit of this. The plate circuit is as used in a non-reflexed IF stage. The audio gain remains much the same as for a reflexed amplifier using the plate circuit to supply audio.

In Fig.2, there are two circuit points marked "A" and "B". If the "A" end of capacitor C6 is lifted and attached to "B" and C9 removed from that point, the set will revert to non-reflexed operation. Of course, the audio gain will be down as there will now be one less audio stage in the receiver.

Parts count

If you look carefully at the parts used in a reflexed set and a set with two normal audio stages, you will find that there is very little difference in the number of passive components. The valve is really the only extra part.

As pointed out earlier in the article, valves were much more expensive than capacitors and resistors, so reflex sets had a small following right throughout the valve era. However, with the advent of the transistor, the need to use reflex circuitry became unnecessary. Semiconductors are cheap and using an extra transistor or so is no hardship. **SC**