VINTAGE RADIO

By JOHN HILL

All about regenerative receivers

A few weeks ago, I bought what I consider to be a rare receiver - a 4-valve Howard. This is a 240V mains-operated regenerative set of early 1932 vintage and was actually in working order.

My newly acquired Howard receiver is a stately console model standing on turned legs. Unfortunately, someone has had a half-hearted attempt at restoring the cabinet but I guess it will respond OK to treatment later on.

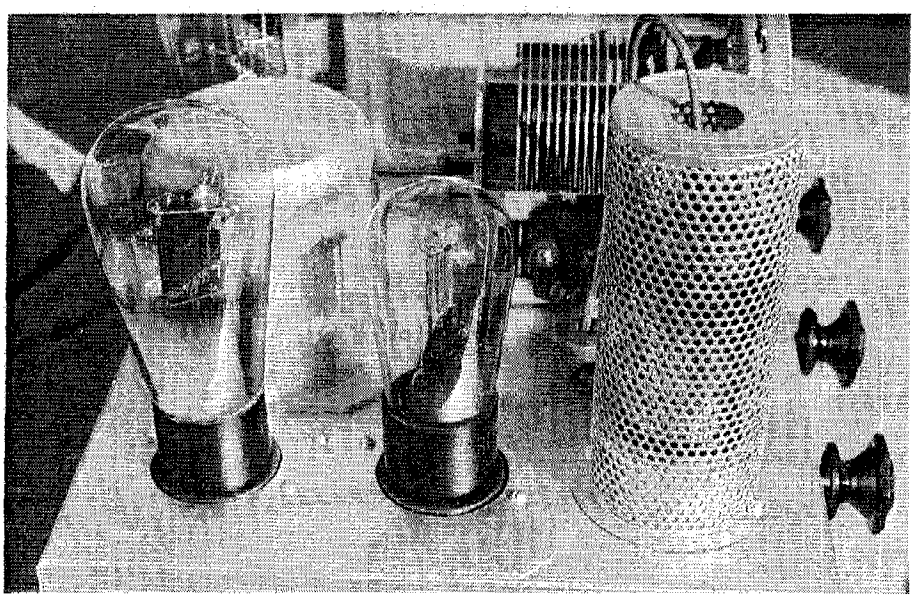
Console models with turned legs are indeed scarce and while I probably paid more than the set was worth (from an antique dealer), I am quite pleased to have it as part of my collection. When something really collectable comes along I don't mind paying the price, especially when the receiver is complete, in reasonable condition and working.

Most of the receivers in my collection are superhets, many of which date back to the early 1930s. While some superhets were made in the late 1920s, they were few and far between. The majority of late 1920s receivers were of the TRF (tuned radio frequency) type, either with or without regeneration. There were other, simpler, regenerative sets consisting of a detector with reaction plus one or two stages of audio amplification. This type of receiver was often described as having a "leaky grid regenerative detector".

In this month's Vintage Radio column, I would like to discuss "regeneration", because it played such an important role in early radio. Regeneration is one of those rare examples where we apparently get something for nothing. (But we don't really. Ed.)

Radio receivers before the valve era had only crude amplification systems. During reception, coherers and external battery-powered relays operated so that Morse signals could be recorded or heard. Later, crystal detectors and headphones increased the sensitivity of these early receivers by a considerable margin. But transmission distances were still relatively short, because the receiver operated only on the strength of the signal received by its aerial.

When receiving valves came into general use, it was a giant step forward for the triode valve not only rectified or detected the radio frequency signal, but amplified it as well.

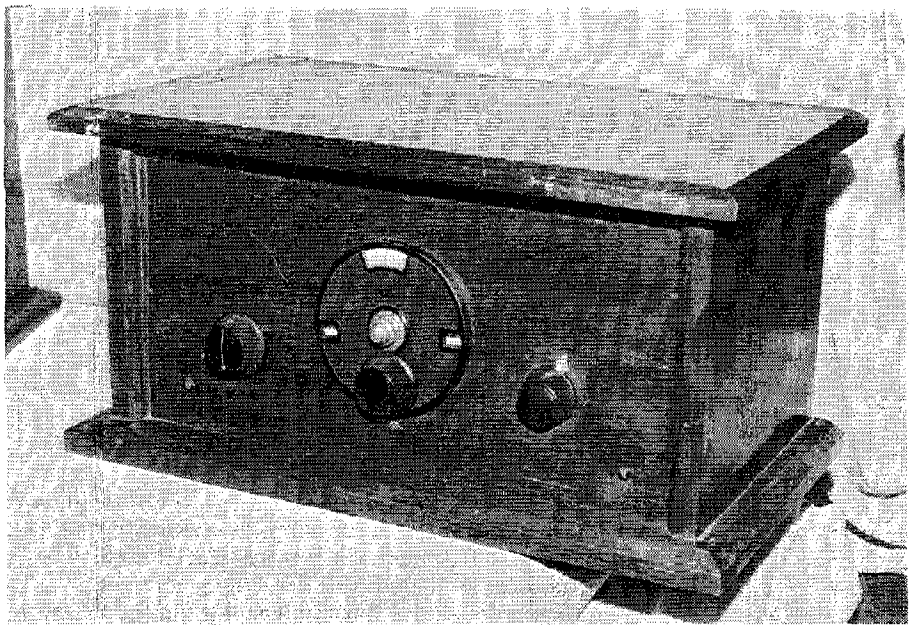


Regenerative type receivers usually have bulbous-shaped valves that were a characteristic of that era. This set is an early 1932 model and is mains operated. It has been fully restored to "as-new" condition.

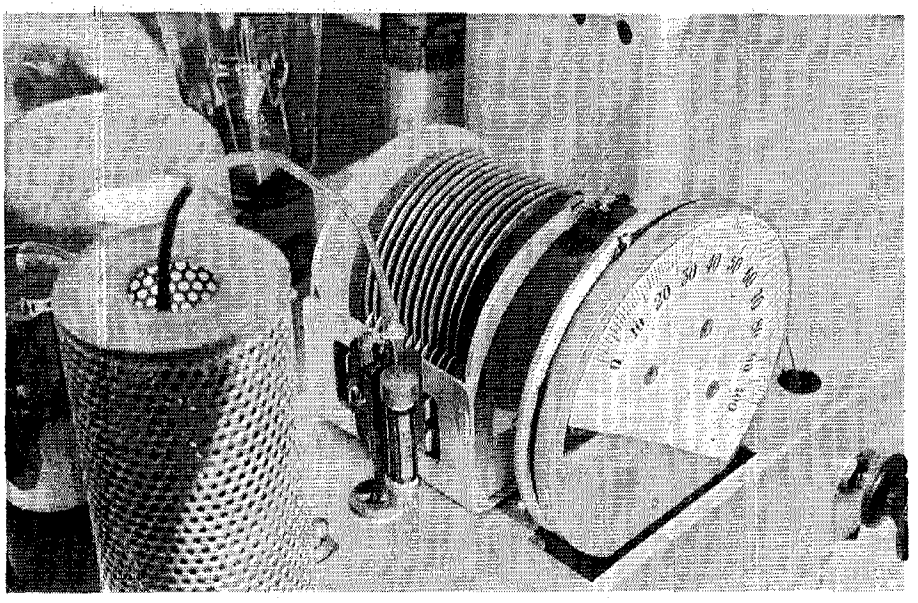
Regeneration

Shortly after, some clever person discovered (possibly by accident) that some receivers broke into oscillation (squeals) under certain conditions and that this effect could be controlled and used to great advantage. This was the beginning of an era when the regenerative receiver became quite popular.

What happens in a simple regenerative circuit is this. Some of the radio frequency energy in the anode circuit of the detector valve is diverted through a coil (regeneration coil) situated close to the tuning coil of that same valve. This induces a stronger



This 3-valve regenerative receiver from the mid 1920s was one of the many kit types available at the time. It consists of a detector followed by two stages of transformer coupled audio.



Simple regenerative receivers are easily identified by their single gang tuning capacitor. Note the grid leak resistor and capacitor immediately to the left.

signal on the grid of the valve and the amplification factor of the detector stage is increased many times - perhaps many hundreds of times.

Also, since the signal being fed back is at the same frequency as the incoming signal, the increased gain occurs at that frequency only, resulting in much improved selectivity. So we score twice - increased gain and improved selectivity.

There are numerous ways of controlling the amount of feedback to the regeneration coil. It can be controlled by swinging coils (ie, by physically altering the distance between the regeneration coil and the tuning coil), by a variable capacitor in series with the feedback coil, by a potentiometer to control the anode voltage to the valve and, in some instances, by a rheostat in the filament circuit. There were other variations and some systems worked better than others.

Many exaggerated claims were made regarding various reaction circuits, but time seems to have proven that the "Reinartz" circuit was the most extensively used.

Fifty to sixty years ago, a single-valve regenerative receiver operating a pair of headphones was a standard project for any lad graduating from his first home-built crystal set. A receiver of this type could almost be built from scrap parts plus a few other bits and pieces, and was always a good activity for any young radio enthusiast to embark on.

The amazing aspect of such a simple radio set was the fact that, with so few components, it could pull in any station that a larger 4 or 5-valve receiver could. However, the listener was always restricted to headphones. Such performance would not have been possible from one valve without regeneration.

Basic limitations

Regeneration has its limitations. Although the feedback control can often bring an inaudible station up to quite listenable volume, when it goes beyond its practical limit the set will break into oscillation and squeal loudly - and often most uncomfortably - in the headphones.

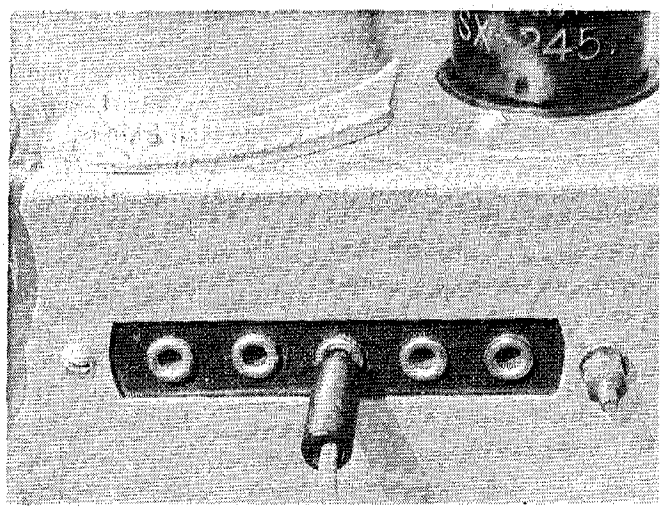
When a regenerative receiver oscillates, it has the annoying habit of transmitting a signal from the set's aerial. Therefore, if the receiver is oscillating on a particular station, other receivers in the neighbourhood, tuned to the same station, will receive the signal radiated from the regenerative set. For this reason, there was plenty of radio interference from regenerative sets in the 1920s and 30s.

TRF receivers

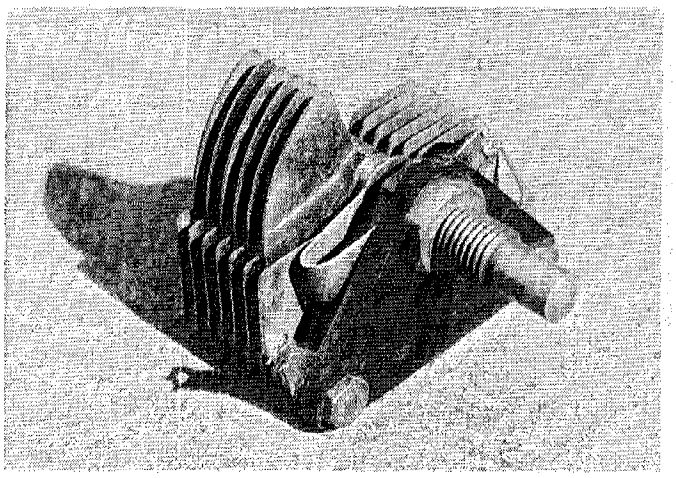
Mention was made earlier to TRF receivers with regeneration. A typical TRF receiver may have two stages of radio frequency amplification prior to a detector with reaction. This would then be followed by one or two stages of audio frequency amplification ahead of the loudspeaker.

A regenerative set with a stage of radio frequency amplification will not interfere with other radios if the set oscillates. An RF stage ahead of the detector effectively isolates the regeneration circuit from the receiver's aerial. Therefore, regenerative receivers of this type were considered better than the simple types without an RF stage.

Simple regenerative detector type receivers with a stage or two of transformer coupled audio can be easily recognised by the fact that they have



The aerial taps on a regenerative receiver are used to control the receiver's selectivity. While this scheme works, it's a nuisance having to fiddle with the connections as they are at the back of the set.



The most common method of controlling regeneration is by using a 100pF variable capacitor in series with the feedback coil. Other methods involved variable coil coupling using "swinging coils" and using a potentiometer to control the anode voltage to the valve.

only a single gang tuning capacitor. If a set has an RF stage, it will require a 2-gang capacitor. An upmarket TRF set could have as many as four tuning capacitors, while superhets have a minimum of two.

In spite of the improved selectivity provided by regeneration, regenerative receivers with only one tuned circuit were not as good as the larger TRF or superhet receivers. This limitation became increasingly evident as more and more stations crowded into the broadcast band.

Aerial taps

Most reaction sets had several aerial taps and using these to advantage would make the set more selective. However, the looser the aerial coupling, the weaker the signal becomes, particularly if it is only a 2 or 3-valve receiver. Thus, in practice, a compromise must be struck between selectivity and volume level.

As already noted, regeneration noticeably improves selectivity, particularly if it is brought up to a level where the set is just short of breaking into oscillation. On the debit side, however, when operating at the point of oscillation, a certain amount of distortion is present and thus sound fidelity is compromised when the control is used in this manner.

Another oddity with a regenerative receiver is that the amount of regeneration required varies depending on the dial position. More is needed at the low frequency end of the dial than at the high frequency end. This means that the control cannot be left at a particular setting. Instead, it must be constantly manipulated in accordance with the strength of the station and its position on the dial.

Still another disadvantage with a simple set is that the regeneration control is not always capable of controlling the volume of strong local stations and often the control cannot be backed off enough to permit comfortable volume levels when receiving powerful signals. This can be remedied by selecting another aerial tap, disconnecting the earth or fitting a shorter aerial. All things considered, these "remedies" are really rather tedious.

A variation of this problem involved selectivity. If the regeneration control was advanced to maximum to eliminate an interfering station, it could happen that the signal was then too loud. As before, fiddling with the aerial taps could solve the problem.

The better types of regenerative receivers had two controls: a regeneration control and a potentiometer controlling the input to the grid of the first audio valve. Sets of this type were much more manageable and strong signals could be controlled without having to fiddle with the aerial coil tappings at the back of the receiver.

Although regeneration was used originally with triode valves (the only types in use at the time), it is also compatible with other valve types. Many regenerative sets employing pentode valves were designed during the 1930s and 1940s and these simple receivers worked very well indeed. These valves offered higher amplification factors than the old triodes.

So far I have not painted a very good picture regarding regenerative type receivers. Compared to the superhets that followed during the 1930s, the old regenerative sets left much to be desired but that doesn't mean they are not worth collecting. On the contrary - they are very collectable!

Any TRF receiver with a reaction circuit is well worth having. If it is restored to good working order and is

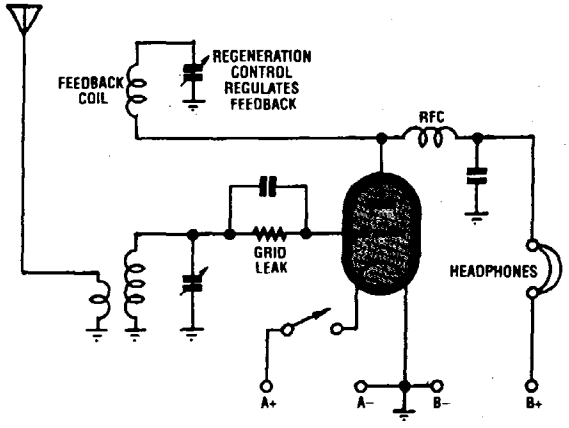
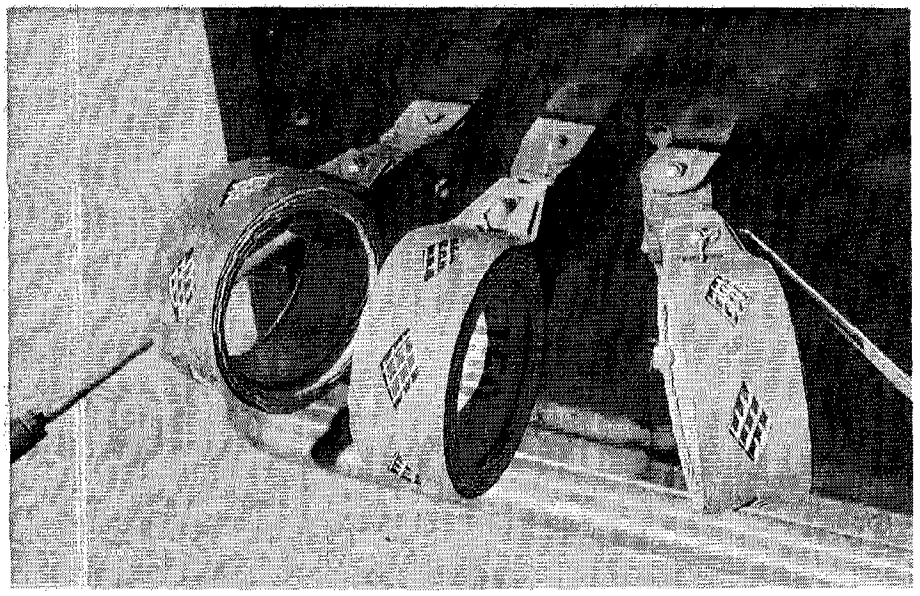
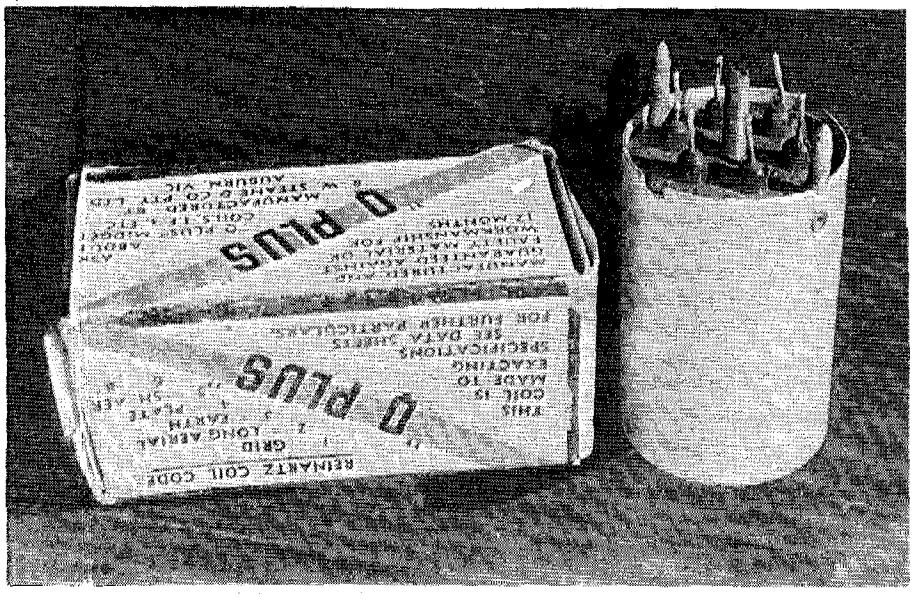


Fig.1: basic circuit for a "leaky grid" regenerative receiver. Note the variable capacitor which is used to control the amount of feedback.



Early regenerative type receivers used "swinging coils" for regeneration control (ie, the physical distance between the coils was altered to vary the coupling).



Even during the early post war period, "Reinartz" coils could still be bought for simple regenerative type receivers. However, most experimenters were happy to hand wind their own coils.

used within its capabilities, it will give more than a reasonable account of itself.

So too will any other regenerative set. The lack of selectivity may, in some cases, prevent some stations from being listened to, but there will be others that will be received quite OK.

The Howard vs the Seyon

One of my old regenerative sets is a Seyon, a receiver I have mentioned many times in the past. It's not a very exciting set and to use it in my locality really requires a wave trap to block out the swamping effect of a close local station. It doesn't sound that good either, particularly when played through a horn speaker. But that's the way they were, so why use them with anything else? It is good to have these comparisons.

The Seyon's big plus is the fact that it is mains operated. That effectively makes the 3-valve set only a 2-valve set (since the third valve is used as a rectifier), so one shouldn't expect too much from it in such circumstances. A lot of cheap regenerative radios didn't have much going for them.

Now back to the old Howard that I bought recently. This set is a much better receiver than the Seyon in that it has a self-contained loudspeaker, an extra valve and an additional volume control.

The extra valve makes a considerable difference and allows the set to be made selective, yet still retain a reasonable level of volume on distant stations. By comparison, if the Seyon is made selective, the dial becomes strangely quiet on all but the strongest signals.

The Howard also has the added advantage of an 8-inch electrodynamic loudspeaker and a console cabinet which acts as a good baffle for a speaker of that size. The result is surprisingly good audio quality. While it is not as listenable as some of my later model superhet consoles, the sound is quite acceptable and when compared to the average cassette-radio of today, it sounds magnificent.

That's not bad when you think about it - a 60-year old radio receiver that sounds better than those most people listen to today. We will take a closer look at the old Howard in next month's Vintage Radio column. **SC**