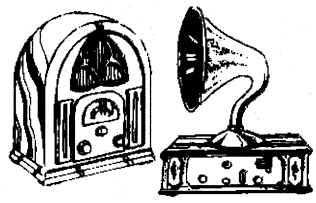
Vintage Radio

by ROGER JOHNSON



One-Valve Receivers (1): from 1916 to 1926

One might think that the humble one-valve radio was so simple that there would not be much to discuss. However, reference to the resource material has yielded so much information that to tell the story properly will take two articles. Here's the first episode, where we look at the designs and models that appeared before 1927.

In the early and middle 1920s, when it was realised by all and sundry that radio or 'wireless' was here to stay, a one-valve receiver was seriously considered as a budget priced alternative to a multi-valve, loudspeaker radio. Remember too, that for a 'skilled worker', five pounds per week ($10) was considered quite a good wage at the time, and that even a one-valver could cost up to three weeks wages when batteries and earphones were included.

The one-valver was popular, too, with home constructors. For the extra price of a valve and batteries, two or three fixed components and an perhaps an extra tuning capacitor, the crystal set could be 'upgraded' (to use modern parlance!) to a much much better receiver.

Where it all began: WW1

Although the triode had become established by World War 1, it was still in the realms of a piece of laboratory apparatus; hand made, expensive, fragile and none too reliable. But as WW1 progressed, the military chiefs realised the importance of radio in particular for the artillery observers to reliably report upon their fall of shot. (WW1 was largely an artillery war. Entire woods, forests and farm lands were laid to waste by incessant artillery bombardment.)

The French wireless engineers developed what has become known as the 'R' type valve, sometimes called the 'French valve', which was quite superior to practically anything else, mainly because of its ruggedness and reliability. It is interesting to note that the base connections of the 'R' type became the standard base connections for what is known today the 'European 4-pin' or 'British 4-pin' triode.

1916 then is a useful starting date to talk about triodes and one-valver radios for what eventually became domestic use.

In these early sets it is not uncommon to see the valve being used purely as a diode detector. Military radio collectors will know that the 'Mark III' tuner, made between 1916 to 1918 in large numbers, was a very elaborate and well designed crystal set, in which the operator could switch from a galena diode detector to a biased carborundum detector. There was provision for a valve to be connected externally as a signal diode detector. This provision was to enable the operator to obtain the most reliable and audible signal.

The other use to which the early valves were put was as an add-on audio amplifier for a crystal set.

The 'wireless receiving apparatus' of those early days were totally reliant for their selectivity and sensitivity upon the quality of the tuned circuits (i.e., their freedom from losses), and the efficiency of the antenna system. Circumstances would arise where the detected audio signal would be barely audible, if at all, in the headphones. Hence the need for an audio amplifier.

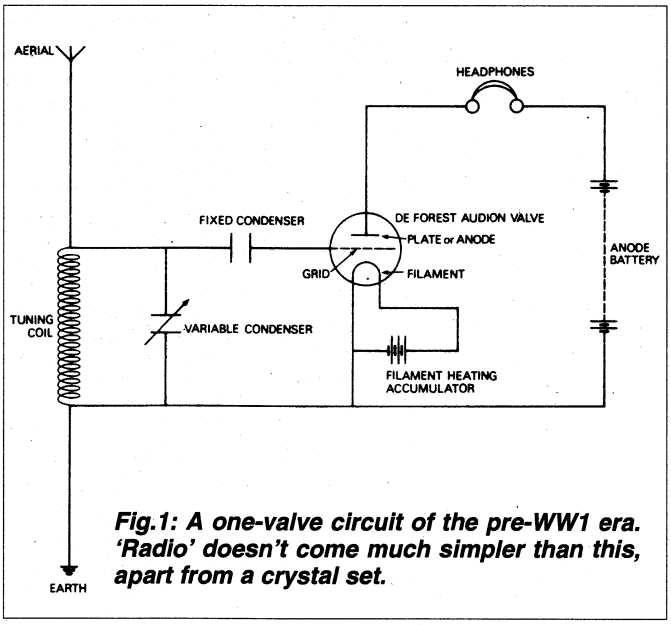


Fig.1: A one-valve circuit of the pre-WW1 era. 'Radio' doesn't come much simpler than this, apart from a crystal set.

The earliest valve sets

Fig.1 is representative of a very early one-valve receiver, dating from perhaps before WW1; as such it is beyond the reach of the majority of collectors. Such a receiver would be a very poor performer by today's standards. Firstly, there is no means of coupling the antenna to the tuning circuit.

It must be remembered that around 1912 there would have been very few stations on the air. There were certainly no broadcast stations as we know them. The signals would have consisted of long wave spark transmissions of Morse code in the 1000m to 3000m wavelength (300kHz to 100kHz) band. The rudimentary long wire antennae may have assisted in providing some sort of antenna tuning to increase selectivity, if required.

Note the apparent absence of a 'grid leak' resistor. In the absence of a grid leak, the electrons travelling from cathode to anode accumulate upon the grid element and build up enough electrostatic charge to bias the valve almost to cut-off. Also, there is no provision for the grid capacitor to slowly discharge, thereby affording 'demodulation' or detection.

Fig.3: Unusual for the USA is this advertisement for a commercially made one-valver, from the September 1924 issue of 'Radio News'.

However, in fairness, demodulation was not an issue for receiving spark transmission. As long as the headphones produced some sort of audible buzz which could be recognised by the operator as Morse code, the reciver had done its job!

In reality there would have been a 'grid leak' in Fig.1, consisting of the losses occurring across the somewhat imperfect grid capacitor. Seldom were those capacitors properly hermitically sealed (or electronically tested!), and there was enough leakage — of even, say, 10 megohms — to provide a high value resistance path from grid to earth. So the grid leak is actually there! Of course as technology progressed, it did not take engineers long to work out that a separate grid leak resistor provided more reliable results.

The grid leak detector

The grid leak detector, or 'leaky-grid' detector as it became known, did two jobs in one. Firstly, the grid and cathode elements of the valve itself become the two electrodes of a diode. This, in combination with the grid capacitor and the grid leak resistor, enables detection or demodulation of the incoming signal. The resulting audio signal across the grid leak is negative with respect to earth, and the valve now acts as an audio amplifier with a fluctuating audio negative voltage impressed upon the grid.

RF potentials are also present at the anode, and once they have passed through a reaction winding, if present, are bypassed to earth via a capacitor connected between B+ and earth.

The other important aspect of the leaky grid detector is that the impedance of the diode load circuit, which for practical purposes is the value of the grid leak resistor itself, is high. The load impedance of say, 5 megohms, could be a factor of 10 higher than that of a lump of galena and steel wire used as a signal diode, feeding directly into headphones. This results in an increase in selectivity.

Something else, too, that the valve detector afforded was the elimination of the so-called 'step voltage' necessary to activate the semiconductor effect of the lump of galena. Put another way, there must be a certain potential, albeit small, to turn the crystal 'on', and as a result a certain small voltage is lost across the device.

Hence, the leaky grid one-valve detector provided an important step in the progress of radio reception. It provided for both greater selectivity and greater sensitivity.

Armstrong and Reinartz

The remarkable Major Edwin Armstrong is regarded as the inventor of regeneration, or 'the reaction circuit', with which many readers may be familiar. Basically, a small portion of the amplified RF signal is coupled back to the tuning coil. If the signal is correctly in phase with the incoming RF signal, the gain of the amplifier is increased and also the 'Q' of the tuned circuit is greatly enhanced, providing even greater selectivity. Of course if too much RF is fed back the valve will oscillate, which is why the reaction or regeneration control must be carefully adjusted for each signal frequency.

An American experimenter, Reinartz, published a very selective circuit based upon the Armstrong regeneration principle in the July 1922 edition of *QST*, the monthly publication of the American Radio Relay League. The circuit, which

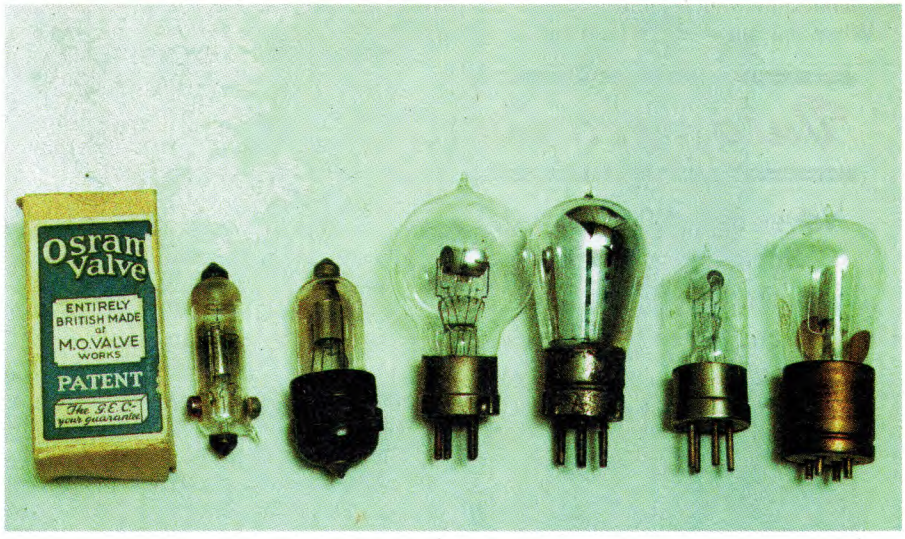


Fig.4: A lineup of the valves which heralded the broadcast era. Left to right are (1) the box for (2) the new Marconi type V24; (3) Airforce type 'C' attributed to Captain Mullard; (4) the Philips type 'E'; (5) the Marconi type '5RV' with BBC emblem: (6) the Philips type 'DII'; and (7) a very early Radiotron type UV-200. All valves are in perfect working order!

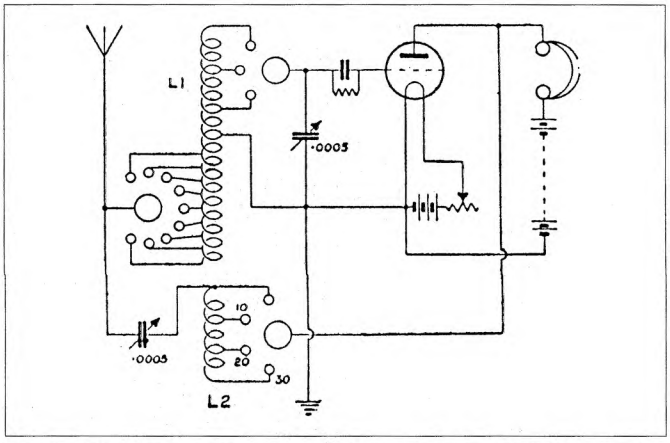


Fig.2: The Reinartz regenerative circuit of 1922. It still bears his name to this day.

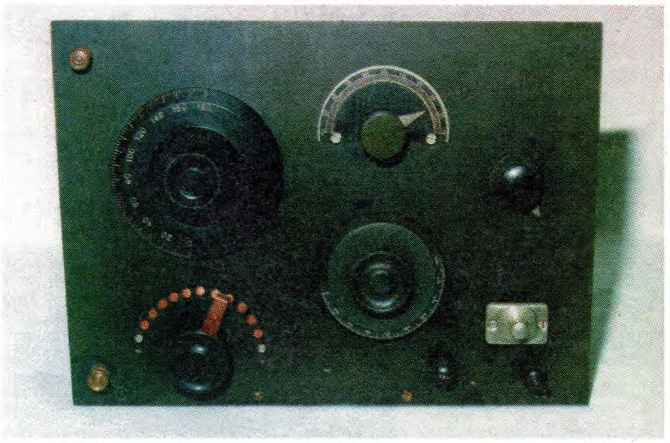


Fig.5: This single valve reflex of dubious provence has an impressive array of controls.

to this day bears his name, is shown in Fig.2. This circuit was said to be particularly good on 'short waves' — which are now the broadcast band frequencies.

Valves at this stage in history had become more reliable, and by virtue of engineering, research and design experiments, had become used as audio amplifiers, oscillators and in multi-valve receiving circuits — not to mention power RF amplifiers, otherwise known as 'transmitters'. The all-valve station was here to stay.

Regenerative detectors

It may be a good idea to give a few words of explanation here about the way regeneration works. It is not labouring the point to state that the explanation is much simplified.

When the tuned circuit is tuned to an incoming signal, the RF feedback has the effect of counteracting the so-called 'positive resistance', or losses, which reduce the performance of any tuned circuit. Positive feedback, or regeneration, effectively increases the 'Q' of the tuning circuit. (One definition of 'Q' is frequency divided by bandwidth. If the frequency remains constant, and the 'Q' increased, the bandwidth must decrease. This means that the circuit becomes much more selective.) As the dampening is reduced, the losses are reduced, and the circuit becomes more sensitive.

The overall 'Q' of the tuning circuit is actually different for each setting of L and C, the so-called 'LC' ratio, which is the reason why the amount of feedback has to be carefully adjusted for each incoming frequency.

Commercial one valvers

Anthony Constable in his book *Early Wireless* tabulated the results of a survey of all manufacturers who advertised their products in the popular press for 1926. Whilst this gives no indication of the numbers of sets actually produced and sold, it gives an insight to the relative quantities of one-valvers.

Constable notes that there were 97 crystal sets, 25 valve-crystal sets, 38 one-valvers, 127 two-valvers, 128 three-valvers and 163 four-or-more-valvers that were available to the British public in 1926. America, on the other hand, was practically bereft of commercially made one-valvers apart from the very earliest days.

In Australia, there is no doubt about the popularity of one-valvers. They were mainly assembled by the dealers, and quite often given some sort of identification by a dealer's name engraved on the panel, or a small brass plate stamped with their names and placed somewhere within the cabinet.

Reference to the advertisements indicates that one-valvers could be made to order, or kits of parts supplied for home constructors. It is safe to say that the big firms did not manufacture or market one-valvers.

Reflexing

Mention of one-valvers would not be complete without at least a passing reference to reflex receivers. A quote from long ago was 'reflexing was the invention of the Devil and Philips'.

Reflexing was an attempt to get the one valve to do two jobs. After using it for RF amplification, the signals were detected and then the audio fed back through the valve once again for AF amplification. Valves of the era were expensive, and if the valve could be made to perform the function of RF amplifier *and* AF amplifier, a cost saving could be achieved for a receiver that supposedly outperformed the usual one-valver.

However there was a trade off. The valve had to be tamed in order to prevent uncontrollable oscillations, and this was achieved by a reduction in gain — either by controlling the emission via a filament rheostat, or reducing the anode voltage. Often, the reduced operating conditions resulted in a performance which did not exceed that of a well-designed Reinartz circuit, in which the valve was operating under maximum conditions!

A closer examination of the reflex sets, and the development of twin triode and triode-pentode valves will complete the one-valver story in a future article. ❖