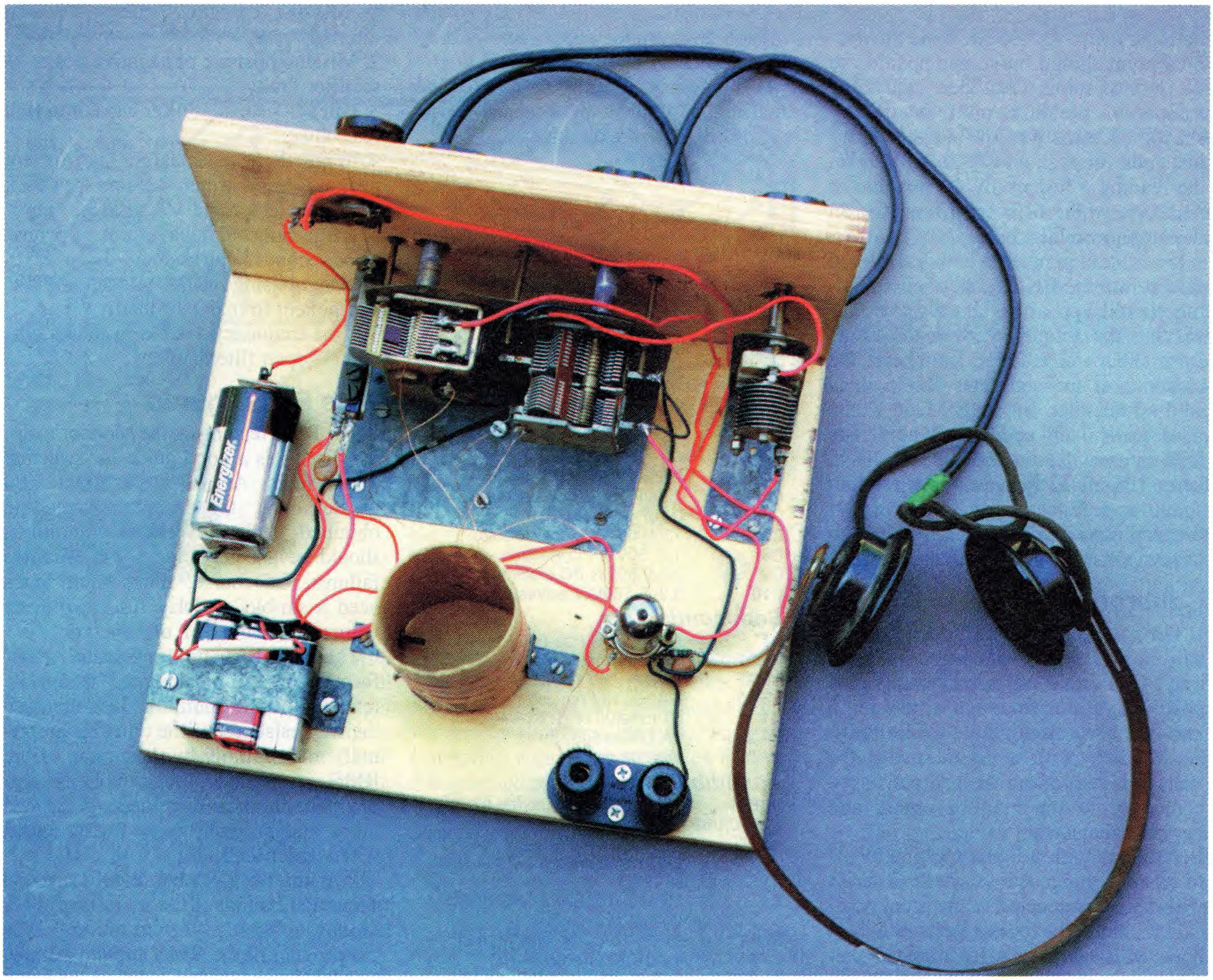


Special 'nostalgia' project:

BUILD AN OLD TIME ONE-VALVE RADIO - 1

There's a lot of interest nowadays in building simple valve-based radio sets, of the type that were popular from the 1920s right up until the 1960s. Here's the first of two articles which give all the information you'll need to construct an authentic one-valver — starting with a basic 'grid-leak' set and progressing to a regenerative circuit with surprisingly good performance. Enough information is given to allow you to use almost any old valve or other components to hand.

by PETER LAUGHTON

Cleaning out my radio 'shack' (read mess) the other day, I came across a number of radio receivers that I constructed years ago based on valves, and remembered how much fun I'd had, and how much I'd learned. This, along with several recent Letters to the Editor asking for more vintage radio projects, resulted in me talking to Jim Rowe, and the result of that discussion is the following project.

The circuits described can be built using almost any combination of components, even from junked valve TV sets. But for convenience and safety, they will be described using a 1.4 volt battery valve that is still available: the 1T4. The filament of this valve is supplied from a single 1.5V alkaline battery, whilst the 'high tension' comes from two or three 216-type 9V batteries connected in series. The parts to construct the radio are also available from the Vintage Wireless Radio Company in Sydney if your junk box doesn't have enough 'bits and pieces' in it. (See end of article for prices etc).

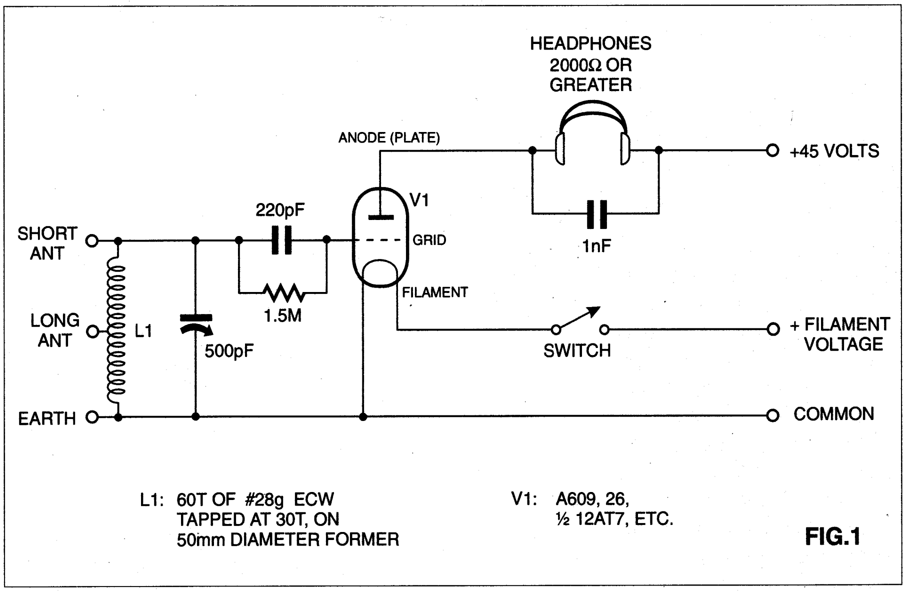


FIG.1

A basic 'leaky grid' receiver circuit, using either a triode valve or a multi-grid valve connected as a triode. This type of set uses the valve's grid and cathode as a detector diode, and then the valve as a whole to amplify the resulting audio.

Understanding feedback

Before we start, a few words about *feedback*. To many people this is usually associated with a rude, loud noise from a PA amp at a concert, etc. But technically the term means something much more useful, which can exist in two forms: positive and negative.

Basically, feedback is achieved by feeding back energy from the output of an amplifier to its input. If the signal fed back is *in phase* or in step with the original signal, then it adds to it and this is called *positive* feedback. This type of feedback tends to exaggerate or enhance any frequency selectivity; hence the effect with PA amps, where the sound begins to 'ring' at a particular frequency before a condition is reached where the whole set-up becomes unstable — i.e., begins oscillating.

The effect of positive feedback is to increase the signal available at the output over what was there before — i.e., the effective gain increases, as well as the selectivity. If there's too much positive feedback, the amplifier will become an oscillator. Another word for positive feedback is *regeneration*.

Conversely, if the feedback is *out of phase* or out of step with the original input signal, so that it subtracts from it, then it is said to be *negative* feedback. In this case the total amplification is reduced.

Commonly called *degeneration*, this type of feedback tends to smooth out any frequency selectivity, and also reduce the amount of distortion produced by an amplifier — as the output distortion is present in the signal fed back to the input. The amplified feedback distortion is in opposition to the output distortion (as it's out of phase) and thus tends to cancel it out.

Negative feedback also tends to compensate for changing characteristics of components in a circuit as well as the effects of temperature, especially with solid state components. Negative feedback is commonly found in audio amplifiers, and can be applied to several stages of an amplifier at the same time.

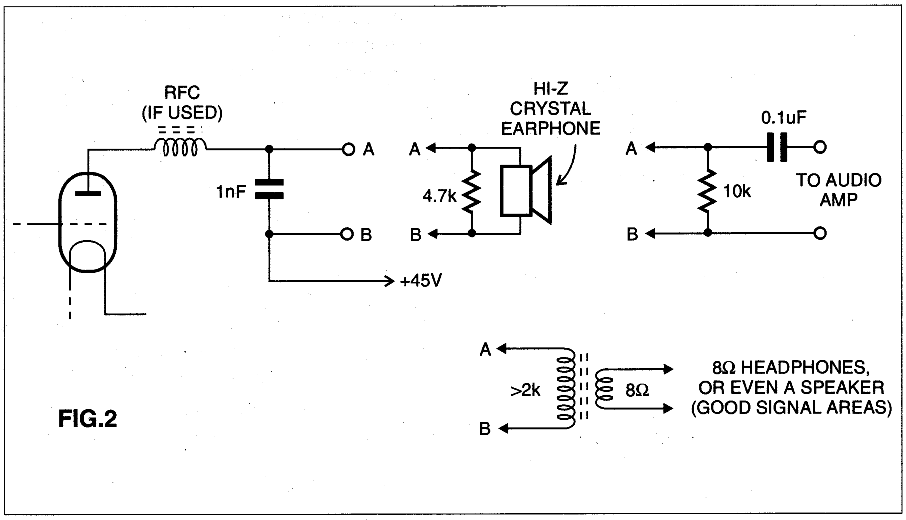


FIG.2

Three different alternative ways to use the output from the basic receiver of Fig.1 — or those of Fig.3, 5 or 6 — if you don't have a pair of high-impedance headphones.

Grid detectors

The basic circuit for a grid or cumulative type of detector is shown in Fig.1. As can be seen, apart from a crystal set, nothing could be simpler.

Interestingly, there is no solid state equivalent for the 'grid leak' type of detector shown here. Even the field effect transistor, whose characteristics approach that of valves, doesn't work as well as a valve does. Therefore this circuit arrangement is unique to valve technology.

In this type of detector, the grid corresponds to the plate of a diode, which works together with the valve's filament or cathode to detect the incoming RF signals — fed to it from the tuned circuit formed by L1 and the 500pF capacitor. As a result of this diode action the rectified RF produces a varying DC voltage across the 1.5M 'grid leak' load resistor, with the 220pF capacitor acting as a low impedance to the RF signals. The varying DC voltage then causes the grid to vary the electron flow to the plate, giving some audio amplification at the same time. Note that at this stage we haven't applied any regeneration or feedback.

Typical component values are given and almost any triode valve, or any valve wired as a triode, can be used.

For example, the 12AT7 and 12AU7 range of double-triode valves, etc., are all satisfactory (using only one half of the valve, of course). With these valves, filament voltage can be either 12.6V at 150mA or 6.3V at 300mA. High tension with these TV type of valves needs to be around 60 to 90 volts for satisfactory operation. Battery operation is not really practical as the plate current drain will be around 20mA or so, and the 10 or so 9V transistor radio batteries that would be required to obtain the necessary high tension voltage are expensive!

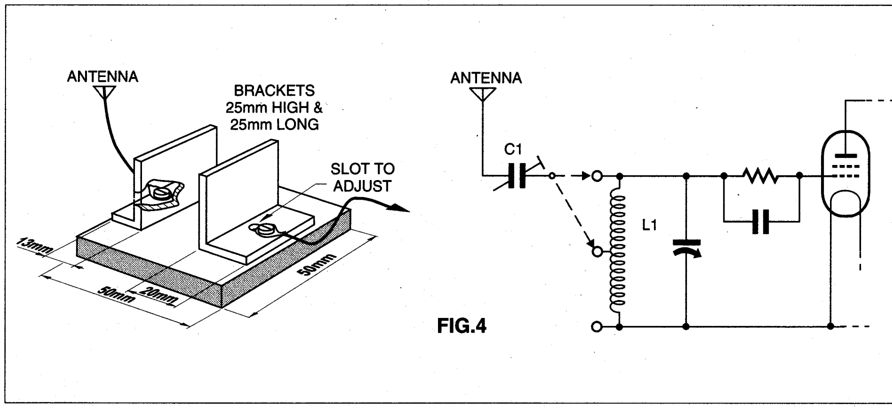
Other triodes, such as the battery types, including the 2V and 6V series of battery valves like the A609 can also be used. Pin connections for some typical valves that can be used in this circuit are at the end of this project (Fig.9). Just make sure that you use the correct filament voltages and currents.

A 6U7 pentode from the octal era can also be used. Just connect the screen grid to the anode to convert it into a triode and supply the filament with its 6.3V at 300mA.

The valve used in the prototype was a 1T4 miniature seven-pin battery pentode, wired as a triode, (grid 2 on pin 3 connected to the anode). The output is to a crystal earpiece, or high impedance headphones, or some low impedance stereo type headphones (using a matching transformer), or even to an external amplifier using any of the circuit arrangements shown in Fig.2.

Fig.3 gives the same circuit in which a multi-element valve, such as the 1T4 pentode, is now used as a pentode rather than wired as a triode. The sensitivity of this type of detector is considerably increased by using a pentode valve. As before no feedback or regeneration is applied as yet. Filament voltage is still 1.5V DC, whilst 18 to 27 volts DC (two or three 9V radio batteries) are satisfactory for the high tension (HT) requirements. Battery life will be several months of intermittent use, with the filament drawing 50mA at 1.5V and the anode current about 3mA at 27V.

Fig.3 also shows how a radio frequency choke (RFC) can be used, giving more stable operation of the circuit especially when used on short wave.



How to make your own very simple adjustable series capacitor, to allow a longer antenna wire to be connected to the receiver's tuning circuit without loading it down too much. A fixed mica or ceramic capacitor of about 200pF can be used instead, if you wish.

The grid leak type of detector is sensitive, but it 'loads' the tuned circuit, resulting in relatively poor selectivity (the ability to resolve different signals close to each other). The linearity is poor, as is the signal handling capacity. This means that it is easily overloaded by a strong signal, which can completely drown out a weaker signal adjacent to it. Note also that if the plate voltage is made too high, the no-signal current can increase beyond the ratings of the RFC, headphones, or transformer and they can be permanently damaged.

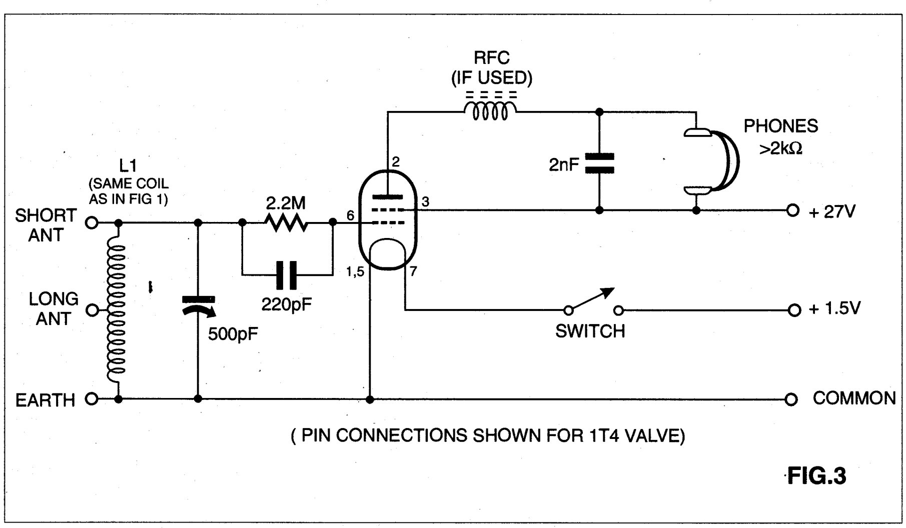
Try experimenting with lower values for the grid leak resistor (down to 100k) and lower values for the associated condenser (to say 100pF). Also try connecting the grid leak resistor to the cathode or earth side of the valve instead of the coil. The result should be much the same.

By reducing the R and C values, the detector turns into a so-called 'power grid' detector. The advantage is an increased overload point, but at the expense of increased distortion, increased loading of the tuned circuit, and a decreased audio high frequency response.

The values given for the coil will result in operation on the AM broadcast band. For operation on the short wave bands, a different number of turns are needed. (See the section called 'winding the coils' in part 2).

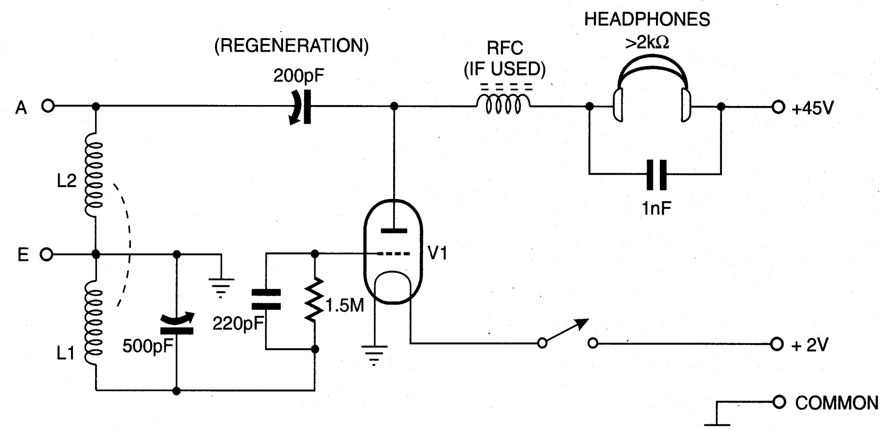
Series aerial capacitor

A series-pass capacitor is needed to prevent the aerial from loading the tuned circuit too much. A small tuning capacitor scrounged from a junked



How to use a multi-grid valve like the 1T4 as a leaky-grid detector. Although not shown, there is a third grid in this pentode valve, connected internally to the filament (pins 1 and 5). The optional RF choke can be used as shown, to improve performance and stability.

The sensitivity and selectivity (tuning sharpness) of the leaky-grid receiver can be improved dramatically by adding some positive feedback or 'regeneration', by means of a second coil L2 coupled magnetically to the tuning coil. The 200pF variable capacitor is used to adjust the feedback so that it isn't enough to cause oscillation or 'howling'.



L1: 110T #30G ECW ON 30mm DIA FORMER
L2: 30T #36G ECW ON SAME FORMER
V1: A609

FIG.5

AM/FM radio is perfect, if you use the FM tuning section (this is the one with the least number of plates). Alternatively, try a standard broadcast tuning capacitor. The adjustment isn't too critical and, once set for your particular length of aerial and location, shouldn't need altering.

For those not wanting to go to these lengths, any small mica or ceramic capacitor of value to 200pF or so will work instead. The object of it is to reduce the aerial coupling a bit, which reduces the loading on the tuned circuit and increases selectivity — although at the expense of volume. Fig.4 shows how to construct a suitable small value capacitor from scrap metal, and how it's connected.

Regenerative detector

Now let's have a look at making the basic grid leak detector a bit more efficient. To do this we add a controlled amount of positive feedback, in the form of regeneration. This forms the basis of the regenerative detector, which was in use almost since radio began right up until after World War 2. The results from such simple circuits can be amazing, with after-dark broadcast band reception of England and the Continent, and daylight reception of interstate broadcast radio stations not uncommon during radio's early years.

Note that this type of detector is very different from the 'reflex' type, as reflex detectors use the valve twice — first as an RF amplifier before detection, and then as an audio amplifier after detection.

Also note that the regenerative detector about to be described is different from a *superegenerative* detector, which is actually a regenerative detector adjusted to oscillate, and then 'quenched' at a high frequency of 20kHz or so to enable it to be operated as an extremely sensitive detector — although one that tends to cause interference to other receivers.

If there is enough interest, a simple, mains powered, regenerative all-band receiver will be described in a future article. The simple receiver about to be described can also be modified into a reflex receiver that can operate a loudspeaker on local stations, still using the one valve.

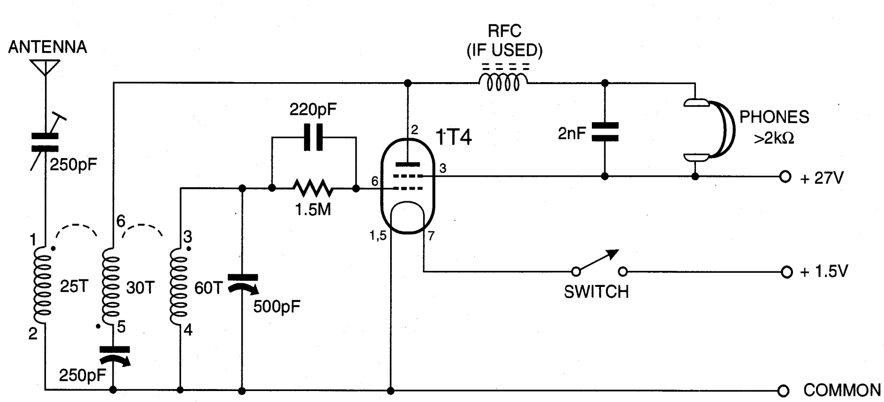
In Fig.5, we have the basic circuit of a regenerative detector. It is shown based on an A609 triode valve, although a 1T4 pentode wired as a triode by connecting grid number 2 to the plate will also work satisfactorily. The circuit is almost the same as the previous one for the grid leak detector, but with regeneration added via feedback coupling coil L2 and its adjustable 200pF series capacitor from the valve plate.

In this circuit, the regeneration increases the effective Q (quality) of the tuned circuit. This occurs because maximum regeneration occurs only at the frequency to which it is tuned. The values for components are almost the same as for the grid leak detector. Obviously, the amount of regeneration must be able to be controlled somehow and is usually held to a point just before the valve goes into oscillation. This point also varies with frequency, so the tuning of a regenerative detector is a two-handed affair!

Fig.6 gives the circuit of a regenerative receiver using a pentode battery valve, with separate windings for the aerial, tuned and feedback coils.

In the second of these articles, we'll look at winding the coils and actually building the practical regenerative one-valve receiver shown in the photo.

(*To be continued.*) ❖



NOTES: 1. THE DOTS SIGNIFY THE START OF EACH COIL WINDING
2. THE CURVED ARROWS REPRESENT THE MOVING (FRAME) SIDE OF THE VARIABLE CAPACITORS

FIG.6

The circuit of a complete one-valve regenerative receiver, using a 1T4 pentode. Although still very simple, this type of set is capable of surprisingly good performance. Full construction details will be given in the author's next article.

Special 'nostalgia' project:

BUILD AN OLD TIME ONE-VALVE RADIO - 2

Here's the second of two articles designed to help you build an authentic one-valve radio: a regenerative circuit with surprisingly good performance. In this article the author covers winding the coils, assembling the components and getting it all going. He also explains how to operate it to get the best results.

by PETER LAUGHTON

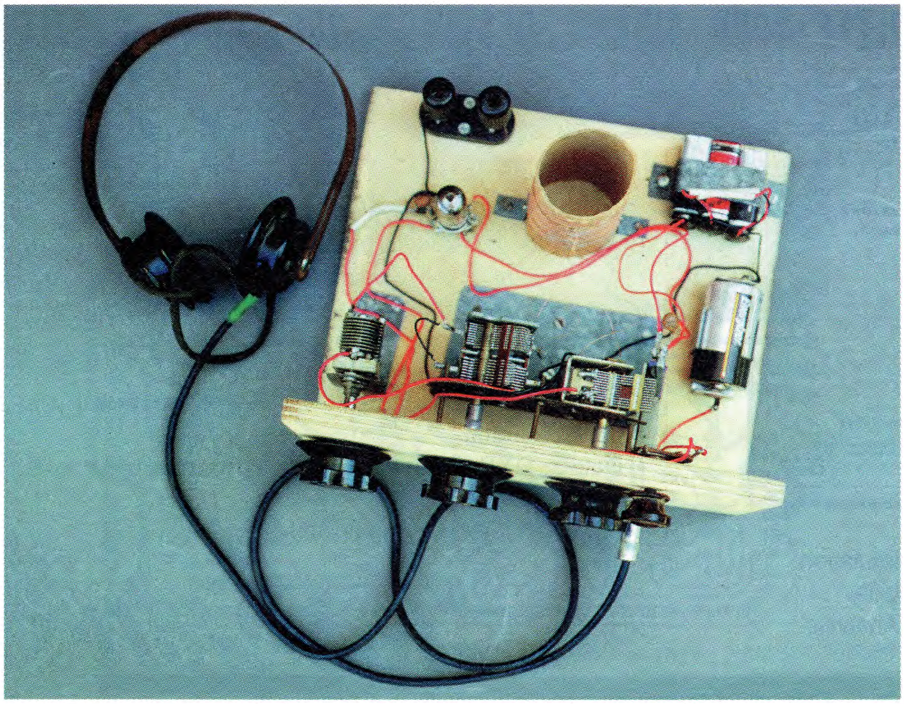
To guide you in building the receiver, Fig.7 gives details of a typical layout and placement of parts. Note, however, that the placement of parts is not critical and almost any layout that will accommodate them can be used.

Start by obtaining two flat pieces of wood. I used five-ply, but other materials like chipboard or MDF will work. My front panel was 10" x 6" and the base was 10" x 8" (this is supposed to be an old time project, so no metric dimensions are given; but multiplying the inches by 25 and calling it mm would be close enough). The two were glued together and then nailed, giving an L-shaped chassis with the 10" x 6" piece becoming the front panel.

Next the holes were drilled for the three tuning capacitor spindles, along with a 1/2" hole for the headphone socket and a smaller one for the power switch. These items were then mounted on the front panel, and some L-shaped brackets made from scrap tin plate to mount the tuning capacitors on the base, in the correct positions. (Old fruit tins can be recycled here!)

Next came the valve socket, mounted on the baseboard using a couple of one-inch long 1/8" machine screws with extra nuts used to space it up and allow access to the connection lugs (which were bent outward at about 45°, to make soldering easier).

The aerial/earth terminal block was then screwed to the back of the baseboard, and the 1.5V 'D' battery holder up the other end behind the power switch. Then a couple of small brackets were cut from the same fruit tin to hold the three 9V 'B' batteries.



Another view of the author's prototype, showing the general layout he used.

My coil was wound on a section of cardboard mailing tube, but you could also wind it on a 125mm length of 50mm-diameter PVC pipe if you prefer. Either way, use the information in Fig.8 as a guide. I used some enamelled copper winding wire from a defunct video recorder head motor, but there are many other such sources around to buy or scrounge some small diameter wire. (Firms like Dick Smith Electronics will sell you rolls of it.)

Several coils were wound and tried, with wire from 1mm in diameter to 30 gauge (very fine). All worked satisfactorily, and if you can get hold of some old-style 'Litz' type wire, slightly better results will be obtained on the broadcast band with better results on short wave.

Make sure that all the windings are wound in the same direction. The dots on the circuit diagram in Fig.6 indicate the start (or finish if you want) of each winding. Just keep the windings in the same direction and enjoy winding the coils.

To wind on the turns, start by drilling two holes in the end of the tube, about 8 to 10mm apart. These will be to anchor the wire. Thread one end through both holes such that the wire reappears on the outside of the tube, then wind on about 25 turns. Drill another two holes as before, and cut off enough wire to feed through the holes. This is the aerial winding. (A small piece of Sellotape helps here to hold the winding in place).

Now drill two more holes adjacent to these last ones, and once again thread the wire through them. This time wind on 30 turns, and drill two more holes to act as anchor points. Make a small loop in the wire, to form a tapping, but don't cut the wire short. This centre tapping will be used later to 'reflex' the receiver. As this is the main tuning winding, wind on another 30 turns, making 60 in all. Then

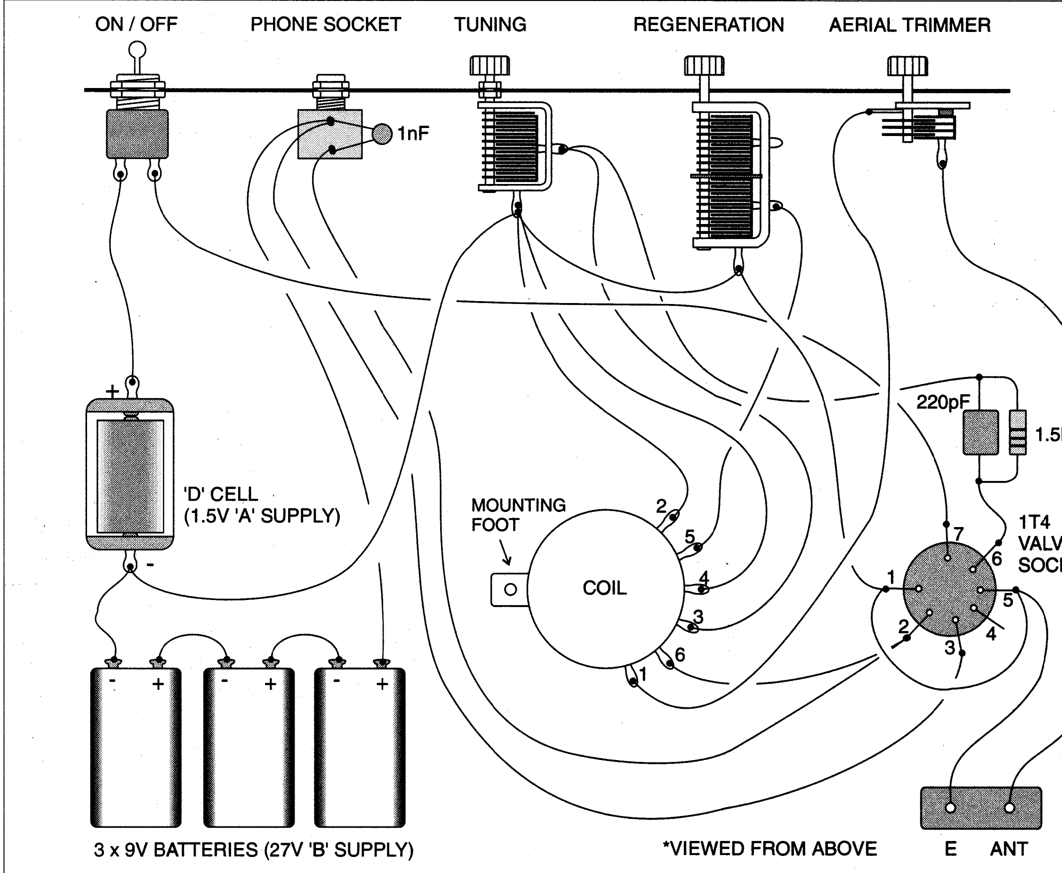


Fig.7: The author's wiring in detail, for the radio built using a 1T4 miniature valve. The exact layout is not critical, especially if you build the set for the AM broadcast band.

drill another two small holes and anchor the wire as before.

Finally, drill two more holes and wind on the feedback winding of 30 turns. Drill a final two holes and anchor the wire.

Don't worry unduly if the wire breaks as you are winding it on; second-hand wire tends to do this as it may be kinked, etc. Just solder it back together and keep winding.

The actual construction takes less time to do than to describe. Also, a few more or less turns don't matter, as the tuning capacitor generally has enough adjustment range to compensate.

There are several ways to mount the coil on the baseboard, from some small tinplate L-brackets to a piece of timber the same diameter as the coil and screwed to the baseplate. Try to keep large bits of metal away from the windings though, as the coil's efficiency will be decreased by any in the vicinity.

Finally the other miscellaneous components are fitted, and everything wired up using Fig.7 as a guide. Note that the 1.5M grid-leak resistor and its bypass capacitor are wired directly in place between pin 6 of the valve socket and the tuning capacitor stator lug.

When finished, leave the valve out of its socket and connect the 1.5V and 9V batteries up. To test that the wiring is OK, connect a 2.5V torch bulb temporarily in place of the valve by soldering short lengths of wire to its terminals and poking them into the filament holes on the socket. For the 1T4 these are pins 1 and 7. If the bulb just glows red, that's OK; if it blows then you have a problem — but luckily bulbs are cheaper than valves!

If all was well, turn off and fit the valve. Then connect the wireless to a aerial at least 10 metres long, and a decent earth — not a mains earth if you can avoid it, as these can have a small voltage drop across them and cause hum in the headphones. Use a wire clamped to a water pipe (scraped clean first), if you possibly can.

To start with, set the aerial trimmer to maximum (closed) capacity and the regeneration capacitor to minimum (fully open). Then slowly turn the regeneration control until the set breaks into a squeal (oscillates), and back it off a bit until the squealing stops. Now operate the tuning capacitor to look for a station, whilst at the same time adjusting the regeneration control as necessary to ensure that the set is *not* oscillating, but as close as possible to the point where it would. (That's the condition of maximum gain and selectivity.)

When you find a station, adjust the aerial trimmer for maximum volume (or minimum interference from adjacent stations) and then just nudge the regeneration control a bit to get maximum sensitivity without oscillation.

It probably sounds complicated, but it's really quite easy and after a few minutes of use it becomes second nature.

If you can't get the set to squeal at all, then try reversing the connections to the regeneration winding (5 and 6 on the circuit in Fig.6). There really isn't much that can stop it from working apart from flat batteries or faulty headphones.

The same basic circuit can operate from the broadcast band up to the VHF (144MHz) bands. Indeed 70 years ago the only type of receiver that could be easily and cheaply built to operate above 30MHz was the regenerative type like this. All that's needed to adapt the receiver to shortwave listening is to use a different coil, and perhaps add a small 'fine tuning' capacitor in parallel with the main tuning capacitor to make tuning easier.

Different coils

Winding a coil for covering the short wave bands up to about 15MHz is quite easy. The former can be increased in diameter, to improve its efficiency, while at the same time the number of turns in the windings are reduced. Broadly speaking you reduce the number of turns in each winding to increase the frequencies tuned, and by about the same factor — keeping the ratios between the three windings the same as before.

I used a former 2.5" (60mm) in diameter, made from postal tube. It has an aerial winding of three turns of 26swg wire, a main tuning winding of four turns of 18swg wire spaced 2mm apart between turns, and a regeneration (reaction) winding of four turns of 26swg wire. All of the windings are wound in the same direction as before and connected as for the broadcast band coil.

Incidentally if anyone has some of the Denco range of tuning coils, then the green range will work very well with these sorts of receivers.

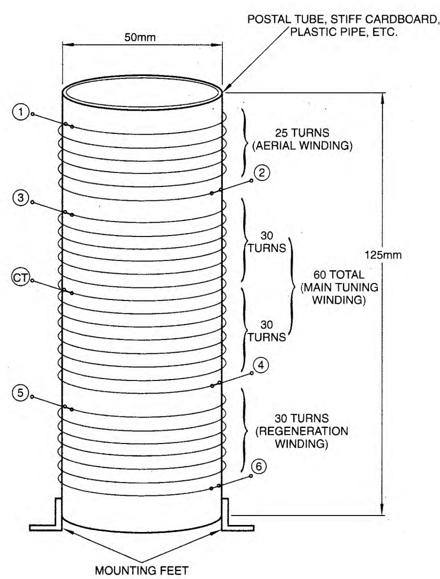


Fig.8: Winding details for the broadcast band coil. A loop through two adjacent holes is used to anchor the ends of each winding.

Here are a few notes to keep in mind when winding coils for other frequencies. When altering the reaction (feedback) winding, keep in mind that too large a winding (too many turns) can give just as much trouble as too small a winding. A large winding will tend to 'kill' or 'dampen' the oscillation, generally over only some of the wavebands. Too many turns on this winding will also mean that the receiver is difficult to keep from oscillating and may be unstable.

On the short wave frequencies, it's wise to use the RF choke in series with the headphones, as this will make regeneration smoother. However if you do use an RFC, then the value of the feedback capacitor (regeneration control) will have to be reduced. It's easy to make a small-value capacitor by removing about half of the plates from a old broadcast tuning capacitor, removed from an old valve radio.

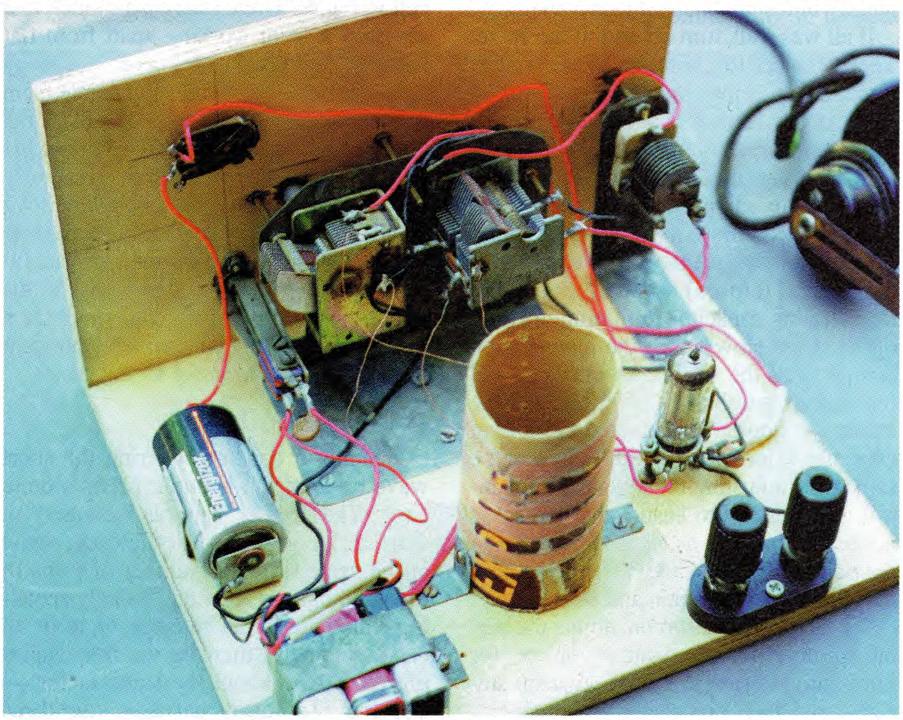
It was customary in the 1930s to make the reaction winding with about 2/3 to 3/4 as many turns as the main winding. I suspect this was done to allow for reliable oscillation with the relatively low-gain valves available then. With the types of valves available today, it will be found that for best efficiency, the winding is wound with the smallest number of turns that will allow the detector to oscillate over the whole band. Try between 1/4 to 1/3 the number of turns on the main winding. It's well worth the time to experiment with the number of turns, and of course this is easy to do when you wind the coils yourself.

If the regeneration isn't smooth enough, try using a smaller value of regeneration capacitor, say 100pF. Generally, if you use more turns on the regeneration winding, then use a smaller value for the regeneration capacitor. This is because it's a series resonant circuit.

On the main winding, to keep the frequency coverage similar if all you have is a smaller value variable capacitor (say 300pF instead of 500pF), then just add 20 to 30% more turns to the coil.

If you wish to wind coils for coverage of the short wave bands, then you may need to reduce the value of the main tuning condenser. This can be easily accomplished by connecting a fixed 500pF (or 470pF) ceramic or silver mica capacitor in series with the 500pF tuning capacitor unit. This will drop its value to 250pF, which will restrict the tuning range a bit.

For operation on the higher short wave bands, say above 10MHz, the main tuning capacitor can be reduced to 200 or 300pF, and the regeneration capacitor reduced to say 100pF. This will enable you to increase the number of turns on the coils, giving a smoother control. The grid leak capacitor can be reduced to 100pF or less and the grid leak resistor can be increased to 5MΩ or greater. A variable resistor could be used for the grid leak, and its adjustment, whilst not critical, can affect the overall 'tone' or sound of the receiver.



A closer view from the rear, showing more of the wiring detail and also how the valve socket is mounted up from the baseboard.

Smoother regeneration

Try connecting a 250kΩ variable resistor in series with the screen grid. By-pass this with a 0.1uF capacitor to reduce the electrical noise that's generated when operating the potentiometer. This is shown in Fig.9. The effect of this is to give more stable control of regeneration, but it also adds another control. (Four hands are needed now!)

Ideally, the regenerative detector should go into and out of oscillation smoothly, with no effect on the frequency of that oscillation. It would not be affected by hand capacity, would give the same value of regeneration regardless of the frequency used, and not be affected by the aerial swaying in the breeze (changing aerial capacitance to earth and therefore its loading). But in a practical design, these requirements are often conflicting.

Regardless, it is best to wind the 'tickler' or feedback winding of the tuning coil at the ground or cathode end of the main tuning or 'grid' winding. Use as few a number of turns as necessary to get the detector to reliably oscillate over the whole tuning range desired.

If the valve breaks into oscillation suddenly as the regeneration is advanced — i.e., is uncontrollable — try altering the value of the grid leak resistor to a higher or lower value. Also, operating the valve with too high a plate voltage or, in the case of a pentode, too high a screen voltage will cause this problem.

When connecting an aerial, the tighter the coupling (or higher the induced signal) the more regeneration will be needed to achieve good selectivity. So try changing the number of turns on the aerial coupling winding. A small series aerial condenser, as mentioned before, can also be used in the aerial circuit to reduce these effects.

If you are using an aerial whose length is approaching resonance at the frequency you are listening on, then the absorption of energy from the detector will increase and it may not be possible to get any regeneration. This should only occur with really large aerials, say over 50 metres long. In any case, using such a long aerial with these simple detectors will result in overload from local stations, unless you live in the bush and don't have any powerful radio stations nearby.

Overloading problems from strong local stations can be sometimes fixed by connecting the aerial to a tapping on the aerial coil, or even a separate smaller winding (i.e., fewer turns) wound over the main aerial winding. This reduces the aerial coupling and makes the coupling from the aerial to the grid of the valve 'looser'.

Several other effects may be noticed. The first of these is drifting due to the presence of your hand. This is caused by your body's capacitance and manifests itself by not being able to keep the station in tune when you move your hand away from the receiver.

Several things can be done to minimise this effect. The easiest is to make sure that the set has a good RF earth path. Check whether the earth isn't efficient by moistening your finger and placing it on the radio's earth terminal. Any change in the signal strength or drift is evidence of an inefficient earth connection. The cure to this may mean a separate metal earth stake, driven into a moist position and connected to the receiver.

Altering (usually reducing) the value of the small aerial coupling capacitor mentioned above can also prevent this

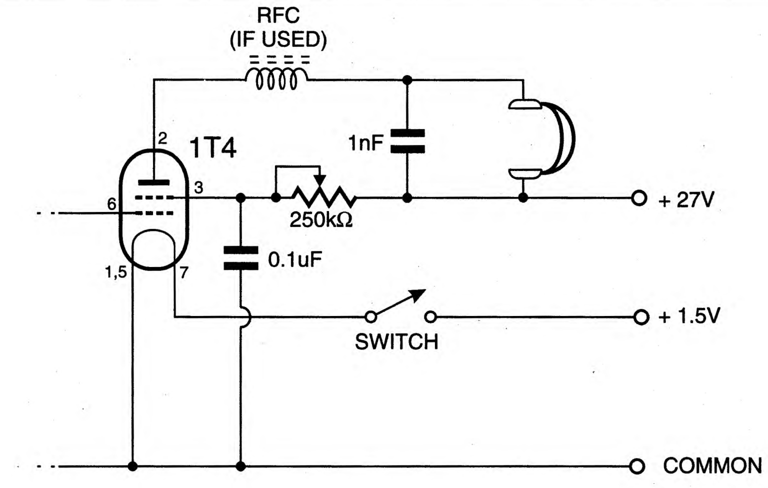


Fig.9: With pentodes, smoother regeneration control can be achieved by using a pot in series with screen grid.

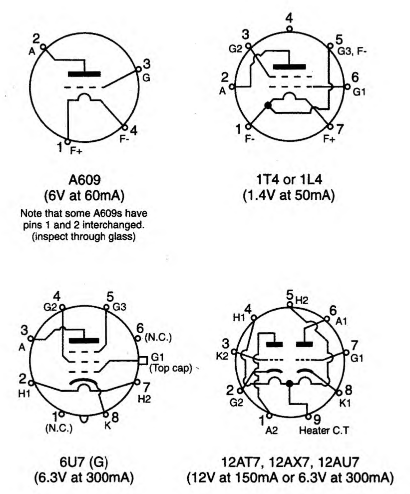
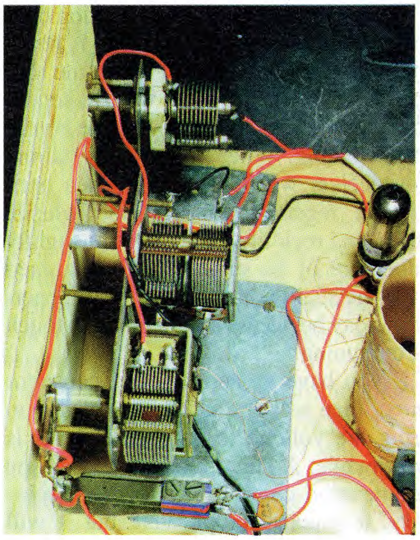


Fig.10: Base connection diagrams for the various valve types that can be used in the receiver. All are shown viewed from below.



This shot shows how the capacitor spindles are extended through the front panel — see text.

effect, as the aerial coupling may be too 'tight' or the aerial too long. RF filtering of the headphone leads with small series RF chokes and a 1nF capacitor across them can help.

Sometimes hand capacity effects are caused by leakage in the RF choke, and one with more windings or a greater inductance can also help. Just make sure that the DC resistance of it isn't too high, or too much high tension voltage will be dropped across it.

If all these measures fail, then screening of the front panel of the receiver is necessary. A separate metal (galvanised, copper, aluminium, or a piece of unetched PCB laminate etc) shield can be made up and fitted 10mm or so behind the front panel. The three tuning controls can be brought out through this panel with insulated extension shafts (say nylon, ebonite or Bakelite). This panel must be connected to a good earth connection.

If this is too difficult, then lining the inside of the cabinet with aluminium foil and connecting it to the earth terminal can help. If you are using an audio amplifier with the receiver, then connecting a RF choke in series with the power supply to it can also help.

It is easy to make up insulated extension shafts for the tuning capacitors. All that's needed is a small length of stiff but flexible plastic tubing as used in the fuel system of diesel vehicles, and an aluminium screw or bolt of the same diameter as the shaft of the capacitor.

Usually, most shafts on older type of

capacitors are 1/4 inch, and modern tubing is the metric size of 6mm, which is slightly smaller than 1/4". Warm the end of the tubing up with some hot water and force it over the end of the capacitor shaft. Cut it off to say 20mm long, and warm the open end in hot water. Then force the bolt or screw into it, cut the head of the bolt off, attach a knob to the end and your non-conducting shaft extension is finished.

Operating tips

As mentioned before, operating a regenerative receiver sometimes calls for three hands, with possibly a extra one for adjusting the volume control if you are using an audio amplifier! That said, it's not difficult and after a few minutes use, you should find it easy.

I begin by turning the regeneration control until a hiss or even a whistle is heard in the headphones. Then I move the tuning capacitor very slowly, whilst keeping the regeneration control just on the border of oscillating. When you pass a station, the receiver will whistle; you then back off the regeneration until the whistle stops, and rock the tuning control slightly either side of the station. When it's tuned in, some slight adjustment of the regeneration may be necessary, then a final touch of the tuning.

If you have an aerial tuning capacitor fitted, then a slight adjustment of this to bring the volume to its loudest level is worthwhile. A slight readjustment of the regeneration control may be then necessary. It sounds complicated, but it will soon be second nature.

It's not good practice to operate the receiver with the regeneration control causing the detector to oscillate, as this will cause interference to adjacent radios.

The radio is capable of receiving both SSB and CW signals as well. To tune in these types of transmissions, the regeneration is advanced until it just starts to oscillate. This will be noted by an audible 'hiss' or even whistling in the headphones. At this point the SSB signal can be tuned in with the tuning dial, and the regeneration adjusted to peak the signal strength. Both controls need to be adjusted together as they interact with each other.

If you operate the detector into regeneration too far, as well as causing interference, the battery and valve life will both be reduced and the detector will not be operated at its most sensitive point.

Note that when listening to a CW signal, there will be a point where the signal seems to disappear into a zero beat, and a low pitched beat note can't be obtained. This is because the detector 'pulls in' or 'blocks', because the signal controls the detector's oscillation frequency. This can sometimes be remedied by increasing the regeneration slightly, or loosening (reducing) the 'tightness' of the aerial coupling by opening the plates of the aerial coupling capacitor (reducing its capacitance). Note that increasing the regeneration, as well as preventing blocking, will tend to reduce the sensitivity for weak signals.

TABLE 1: Getting some of the parts

If you find difficulty in obtaining the following parts, they are available from Valve Electronics Pty Ltd at 239 Australia Street, Newtown 2042; phone (02) 9557 2212. The prices that were current at the time of writing are also shown:

1T4 valve	$10.00
Socket to suit	$ 1.50
Two ganged tuning capacitor (only one gang used)	$ 7.50
Old style knobs, each	$ 5.00
Winding wire, roll of 26 gauge (enough for 1/2 dozen radio coils)	$ 7.25
High impedance headphones (2000Ω)	$60.00
Old style terminals post, each	$ 3.50

Valve Electronics can also supply various other 'vintage radio' components.

The miscellaneous small components are available from Dick Smith Electronics, Jaycar etc.

Refinements

A slow motion dial can be added to the tuning control to make it easier to operate. If you wish, one can also be added to the regeneration capacitor as well, but it's not really necessary.

Instead of a slow motion dial, a small variable capacitor of about 50pF or so can be added in parallel with the main tuning capacitor. This will give a 'bandspread' action, or spread out the range of the main tuning dial. To operate this way, set the main tuning dial to approximately the setting you wish to use, and the operate the bandspread dial instead of the main tuning dial. The reaction control should be operated the same way as before — i.e, follow the main tuning dial across the band, keeping the receiver just on the verge of oscillating.

A small variable capacitor of 20pF or so can also be put in parallel with the regeneration ccapacitor to give improved control. (Now six hands will be needed!)

An old ferrite rod aerial from a dead transistor radio was also tried, with the oscillator winding becoming the aerial winding and the original aerial winding the main tuning winding. (The oscillator winding is the one with the least number of turns). Another 20-odd turns were added to the end of the rod for the feedback winding.

If enough interest is shown, an article may follow giving details of an audio amplifier, based on the same range of battery valves. A further refinement may well be an RF stage, giving a TRF or tuned radio frequency receiver of the type that was top of the line and all the rage in the 1920s. We could also try reflexing of the single valve to give loudspeaker reception of local stations from one valve.

Calibration

There are several 'frequency standard' shortwave stations on frequencies from 3MHz to 15MHz. As these are very stable and on known frequencies, they can be used to calibrate the receiver. Be aware though that the calibration of your receiver will vary a little, depending on the amount of regeneration that is being used and the length of the aerial.

Performance

The performance of such simple sets can be quite outstanding. Indeed, worldwide reception of broadcast stations was commonplace in the 1920s using almost identical circuits.

The performance of the set shown in the photos is amazing, considering the small number of parts used. It's superior to that of a radio based on the ZN414 IC radio chip, and, in terms of sensitivity, is much better than that of a typical $5.00 Japanese transistor radio — except that we are using headphones and not a loudspeaker.

If you happen to live within 7km or so of a AM broadcast station, then this receiver could give loudspeaker reception of the station if a suitable speaker coupling transformer were used.

At the writer's own location on the south coast of NSW, about 120km south of Sydney, daylight reception of all the Sydney AM radio stations was possible, with some interstate stations quite clear in the headphones at night. Some NSW regional stations were audible during daylight, such as Dubbo and Kempsey.

All the local AM radio stations were crystal clear, with no sign of interference, and it was easy to differentiate between stations. there was no overlap of any of

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One-Valve Radio

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them, which was really surprising considering there is only one tuned circuit involved. They are between 20 and 30km away from me. The aerial is an 'inverted L' about 10m on one leg and 30m the other leg. In actual fact, the local stations were almost too loud for comfortable listening with the headphones, and the regeneration control had to be backed off to reduce the volume a bit.

Whilst it was once possible to 'hear the World' with this type of receiver, remember that there probably were no more than 1000 radio broadcasting stations in the whole world in the 1920's. Now we have 1000s just in Australia, and interstate broadcast band reception on such a simple set is more a matter of luck and conditions, rather than design limitations of the receiver...

However, given a reasonable aerial (say greater than 30m and as high as possible) and some skill, a lot of fun and enjoyment can be had from such a modest receiver.

The fun is in getting the best from the receiver. In most modern receivers the gain is set and all you can do is reduce it, but with the type of set just described, *you* control the gain and can set the detector to its most sensitive point for every station — not just an average for the whole range covered, as is the case for a modern receiver design.

I'd like to end with a quote from a 1920s *Wireless World* magazine: 'Be a good radio neighbour and don't let your receiver howl (or oscillate) as it spoils the radio reception for others around you'.

References

If you can get hold of any of these books, they'll provide interesting further reading:

Newnes Television and Short Wave Handbook, published by George Newnes Ltd 1934.

RCA Receiving Tube Manual series RC-20-1953.

The Radio Amateurs Handbook, published by ARRL America (almost any year).

Fun With Radio, by Gilbert Davy, published by Edmund Warden Ltd 1971.

Fun With Electronics, by Gilbert Davy, published by Kaye and Warde Ltd 1972.

The Oscillation Valve, by R.D. Bangay, published by The Wireless Press, London 1920.

Philips 'Miniwatt' Technical Data Book, 7th edition 1972.

Radio TV & Hobbies, November 1950, page 74. ❖