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A beginner's guide to restoring old valve equipment, part 1

An affectionate look back to the days of radios that glowed in the dark and, should you be lucky enough to obtain one, how to go about restoring it to working condition.

The day I fell in love with radio and thermionic valves was in 1969, when as a 14-year-old I was shown into the radio room of the local Sea Cadet Corps. Three strongly-built benches were stacked end-to-end with a multitude of blue, grey and khaki-painted steel boxes. On their fronts were dials and meters and on their sides were what looked like air vents – which were emitting soft orange, yellow or green glows.

Sitting in front of them, wearing a pair of military headphones, was a tall lad a couple of years older than myself. Very faintly, I could hear a sound coming from the boy's headphones that I realised was Morse code. With the colours, lights and the tinkly sound of Morse, it seemed a strange, mysterious and magical world. From that day on, I was hooked.

When I was 16, my Uncle George found me a 1940s-vintage National HRO MX for £10, bought using money I earned from delivering newspapers. With its huge black dial, inset with numbers that changed as you spun it, and orange-glowing S-meter, it seemed alive. When I passed my Morse test and became G3ZZD, George built me a 1.8MHz AM/CW transmitter using B7G and B9A-type miniature valves, in a beautiful Hammerite-painted case. However, I liked the glow of the valves so much that the case was immediately discarded.

My friend G8EPD thought my attitude to these old-fashioned devices was crazy – Mick was thoroughly modern and used to build equipment using the latest Mullard semiconductors. I would tell him that transistors were a load of trendy rubbish and what good was a device that didn't glow and you couldn't tell by just looking when it was overloaded, off-tune, about to explode or had died. In turn, Mick would roll his eyes as if to say "G3ZZD is a sentimental fool".

Well, this is possibly true, but enough story-telling. The object of all this is to explain a little of the passion that valve radio equipment can produce.

The author Steve Ireland, VK6VZ, with RCA AR88D (left), and Kingsley AR7 (top).

CHOOSING THE OBJECT OF YOUR AFFECTION

There is a considerable variety of valve communications equipment available for restoration. There are also different challenges facing the would-be restorer, depending on what era of radio they would like to restore. In the VK6VZ shack, I have two main varieties of valve radio equipment – ex-military stuff from WWII, and commercial gear from the 'golden age' of amateur radio in the 1960s/1970s. In both cases, this is equipment I became familiar with when I first became interested in radio.

Although the attraction is the same, the restoration problems are somewhat different. In general, equipment from the WWII era is *much* bigger and heavier than similar equipment from the '60s / '70s, making it physically much more difficult to work on. For example, an RCA AR88D receiver weighs over 100lb and is almost 20in long by 20in deep and a foot high: a very imposing set to move about on a work-bench! In contrast, a 1970s Drake R4C receiver weighs less than one fifth of the AR88D and is less than a quarter of the size.

My choice for a first radio to restore would be one that has some nostalgic value to me, but doesn't fetch a premium price. A friend of mine in the UK likes restoring Heathkit SB-101s, as they were the first serious HF radio he used, while another favours KW Electronics gear. Luckily, these two marques are relatively cheap to buy and relatively plentiful. Last year, I bought an old KW160 1.8MHz AM/CW transmitter for £55. One of these, or a similar-aged Codar AT5, would make a good starting point for the would-be restorer.

Another thing to consider is whether you want a radio to restore to its original condition, or would rather just put the radio back on the air for fun, using whatever components are to hand. Since I became interested in restoring old radios, I have discovered there are huge differences between these two approaches, and restorers tend to belong to either one camp or the other. My approach is the less conservative of the two, but I have a friend who is of the electronic Conservative camp. When he restores an old receiver, he immediately purges it of any non-original components or 'modifications'. In one case, he bought a Kingsley AR7 receiver which had been modified by the government department that originally purchased it with a product detector. Like many other countries, Australia made two versions of the HRO receiver around WWII, the AWA AMR100 (made in Sydney) and the Kingsley AR7 (made in Melbourne). Although this modification actually improved the performance of the AR7 substantially, my friend immediately dismantled the product detector and replaced it with the original circuitry.

A few years ago, I purchased a Drake R4C for restoration, which was something of a 'dud'. It had been neglected for most of its life and needed a lot of work, both mechanically and electrically. Rather

The restored RCA AR88D. This receiver is far from being in original condition, with its first RF stage replaced with an miniature EF183 valve and its metal cabinet replaced by a wooden one, made from Western Australian jarrah. However, it works well and is a great talking point.

Close-up of part of the Kingsley AR7 front panel. This example is very original.

than trying to restore it to its original condition, the R4C ended up being 'gutted' and some of its valves actually replaced with semiconductors. Whilst the modified R4C now outperforms everything else in my shack for receiving signals on the 1.8, 3.5 and 7MHz bands – including a Yaesu FT-1000MP – my conservative friend regards it as a great waste of a classic receiver.

MAKING YOUR PURCHASE

First of all, the best idea is to decide what sort of valve receiver you would like to restore, taking into account the factors we have just examined. This choice will also have an effect on where to look for such a receiver.

My first inclination when looking for a receiver to restore is to ask around at the local radio club and friends and acquaintances who are interested in amateur radio. The world is full of radio amateurs who put old pieces of equipment to one side in their garage with the idea of 'one day' restoring them. Often they never quite get around to it, and are quite happy to part with their piece of old gear at a very good price to someone who is keen to do something with it.

The next best places in my experience are hamfests, mobile rallies and ham junk sales of all kinds. In preference, make sure you are on-site well before the events actually start, so you can help sellers unload their cars and trucks – and get first pickings of the gear before the doors open to the rest of the world. The old notion that someone's rubbish is someone else's gold is as true as ever.

The 'special interest' Internet reflectors are also an interesting place to look for gear to restore; there are reflectors for Drake, Collins and Heath gear, plus several devoted to 'boat anchor' radios. If you are really desperate, you could try looking on *ebay* sites on the Internet, but this is may only frighten and depress you, with the ridiculous prices asked for some old radio equipment. On the other hand, the odd reasonably priced piece of valve radio gear does come up on *ebay* from time-to-time – the only problem is you are likely to be competing with half the world to get it.

If you don't already know, the term 'boat anchor' is principally used in connection with the very heavy radio equipment used in the 1940s/1950s, in particular of the war-surplus type. The ruggedness of this equipment is legendary. For example, the story goes that hundreds of RCA AR88s were used as 'hardcore' for an extension to a runway at Heathrow airport after WWII. If you are interested to know more about the different types of 'boat anchor' receivers, I would thoroughly recommend getting hold of the book *Communications Receivers – The Vacuum Tube Era: 1932-1981* by Raymond S Moore [1]. I learnt a lot of what I know about the history of valve receivers from this book.

Another good option is a 'wanted' advertisement in *RadCom* or even in the local paper. A friend of mine who is a non-licensed radio enthusiast has used the latter method for years with great success. He simply puts something like "Wanted – a valve radio, preferably of the shortwave communications type", plus his phone number. He has 'hooked' all sorts of amazing radios in this manner, including ones made by Collins, Drake, Hammarlund and National.

One of the best reasons for buying locally is not only you can see what you are buying, but you can carry the equipment away (OK, stagger off with it) yourself. The cost of transporting a KW Electronics KW77 or an Eddystone 888 is likely to be a lot better than a Hammarlund SP-600 or an RCA AR88D, but it is going to be a *lot* worse than a Kenwood TS-450S or an Icom IC-706.

STARTING THE RESTORATION

Let us assume you have made your purchase of a piece of valve radio equipment and it is sitting on the operating table. The first thing you have to do is to avoid the obvious temptation of applying some AC mains power to it. If you are *absolutely certain* the radio has been in recent regular use, then this is probably OK. If there is any doubt, don't do it! Whatever anyone has said about an old valve radio being used recently, it never gets switched on in the VK6VZ shack until it has a thorough electrical cleaning and check-over. Also, AC mains power is always applied in steps to the radio via a 'variac' – a continuously variable AC transformer – which allows the electrolytic capacitors inside the receiver to 'reform' so they work correctly and do not overheat. Variacs are often communally-owned by radio clubs or sitting gathering dust under the bench of ancient G3-era licensed radio amateurs like myself, who will loan them out. More about this next month.

A valve radio that is over 20 to 30 years old is always going to have accumulated a lot of dust and dirt inside it, owing to the ventilation necessary for thermionic valve-based equipment. While a dusty or dirty chassis is going to make no difference to its performance, dusty or dirty switch contacts and potentiometers could mean that the radio does work at all.

Several valve radios that seemed 'dead' have been revived at VK6VZ by simply cleaning their rotary switches, valve pins and potentiometers with electrical contact cleaning solvent. ♦

In the final part next month, Steve Ireland goes into more detail about how to 'resurrect' apparently 'dead' receivers and other old valve equipment.

REFERENCE

[1] *Communications Receivers – The Vacuum Tube Era: 1932 – 1981* by Raymond S Moore, 4th Edition, RSM Communications, PO Box 27, La Belle, FL 33975, USA. This is a marvellous book if you are interested in thermionic valve communications equipment it is a must for the bookshelf.

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A beginner's guide to restoring

In the second and final part of his beginner's guide to restoring old radios, Steve Ireland provides some tips on bringing apparently 'dead' equipment back to life, starting with cleaning 'pots' and switches.

Potentiometers are best cleaned by squirting electrical contact cleaner into their cases from an aerosol can and quickly rotating the associated spindle to and fro'. The most effective way of cleaning rotary switches and valve pins I have found is to spray plenty of solvent on the tip of a cotton bud and wipe this briskly over their conducting surfaces. You will find the cotton bud quickly becomes dirty, and you should repeat this process (changing cotton buds) until no more dirt can be removed.

With rotary switches, it is easy to miss some of their contacts, and on the basis of Murphy's Law, particularly those ones which are the dirtiest. It is always worth going over the rotary switches in a radio on *at least two separate occasions* because of this factor.

Once the switches and potentiometers seem clean, it is not a bad idea to clean the inside of the radio with a damp cloth (and the odd spray of contact cleaner). It might not help the radio's performance, but you will feel a lot better for it - and you will be able to judge the condition of its mechanical components far better.

If the radio is really old, the chassis and components such as transformers may have become so oxidised that wire wool or fine emery paper is needed to remove this. If this is the case make sure you carefully 'blow-clean' the radio after any rubbing down has been completed.

For more information on the technical aspects of restoration, see Pat Hawker's, G3VA, excellent 'Technical Topics' column in *RadCom* April 2004 [1].

This is also a good time to familiarise yourself thoroughly with how the equipment is operated, by reading its operational / service manual from cover to cover. If you don't have a manual for the radio concerned, a search using *Google* (or similar) may well throw up a site run by a vintage radio enthusiast where you can download one for free. It is also good to do an Internet search to see what other information on your radio you can turn up. Instructions may be available specifically on restoring a radio of the kind you have.

Restored Panda Cub 50W 1.8 - 28MHz AM / CW transmitter.

THE WEAKEST LINK

The next step is to look very carefully at the condition of the radio's capacitors (in particular, electrolytic and paper ones) and resistors (in particular, the wirewound ones). In my experience, these components are the most likely to suffer electrical failure, a short circuit in particular, much more so than any of the thermionic valves. If any of the electrolytic capacitors show any signs of leakage from their cases, they need to be replaced. Any other capacitors with a leaky or melted look should be replaced as well. While these components may still work OK for now, this situation is not likely to last. My motto is 'if in doubt, take it out' and replace with a modern equivalent.

My suspicion about old electrolytic capacitors is such that these are all automatically replaced in any radio I work on that is older than 35 years or so. If you have ever heard or seen an electrolytic capacitor fail - usually with a sound like a gunshot and an incredible mess - you will understand why.

Although a few years ago it used to be hard to obtain new high voltage electrolytic capacitors, thanks to the common usage of switch mode power supplies, today there is a ready supply of a range of values (eg 10 to 100µF) with a 450V maximum voltage rating. These are ideal for use in most receivers, but in transmitters you may need to use a couple in series, to obtain a suitable voltage rating.

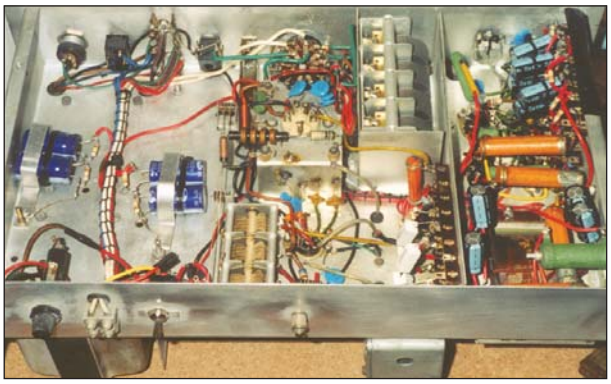
I recently replaced an old 16µF 500V electrolytic in a 1950s Panda Cub AM / CW transmitter with two 10µF 450V electrolytics in series. When you are using capacitors in series in this manner, a 100k 0.5W resistor should be placed across the pins of each of the capacitors used. This helps to ensure that the voltage across each of the two capacitors in series is about the same. The Panda Cub transmitter was designed by the legendary Louis Varney, G5RV, and commercially manufactured during the 1950 / 1960s, from WWII surplus components. Another useful thing to know about these modern electrolytics is that are sometimes referred to as 'TKR capacitors' - not sure why, but they are.

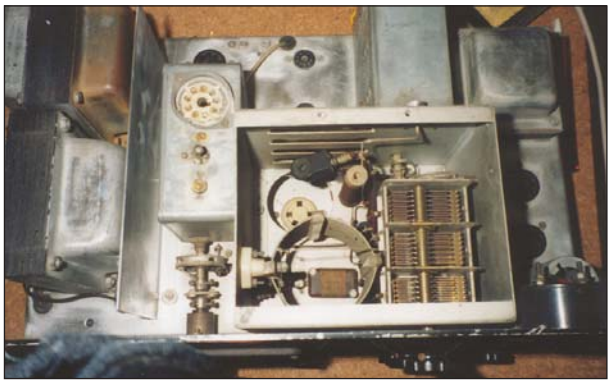
The other component type that is likely to fail in an old valve receiver or transmitter is a resistor. Any that look as though they may have been overheated at some time should be replaced with one of identical value and wattage (which will usually be considerably smaller than the original component). In the case of wirewound resistors, I usually check their continuity / value with a multimeter, just to make sure they haven't gone open circuit. Some values of wirewound resistors are hard to find these days, in particularly those with dissipations higher than 5W, so you may have to replace a resistor of this kind with either a series or parallel combination of smaller wattage resistors.

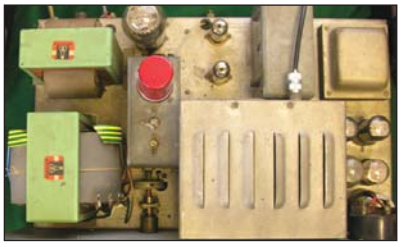
The main problem with carbon (conventional) resistors that are 30 to 60 years old is that their value may have altered, sometimes by as much as 30%. Disconnecting one end and checking the value with your multi-meter is the only sure-fire way to check if this has occurred. If a resistor's value has altered by more than 10% or so, it is best to replace it with a modern resistor of identical value and wattage.

I also generally replace the AC rectifier valve with solid state rectifier diodes (eg IN4004 type), observing the correct polarity. These can be soldered across the valve rectifier base, in the appropriate places. A valve rectifier won't start conducting until about half the input voltage (ie 125V) is applied, while silicon rectifiers will - this is important when re-forming electrolytic capacitors.

old valve equipment, part 2







Top left
Underside of Panda Cub transmitter. All the original electrolytic capacitors have been replaced by modern TKR electrolytics. To the left, TKR-type electrolytics are used in series with 100k equalisation resistors (these replaced six 'square' electrolytics about 10 times their size). The original slightly melted paper capacitors have been replaced by 3kV disc ceramics.

Top right
The surface of the Panda Cub chassis and its main transformer, choke and modulation transformers have been carefully cleaned with wire wool to get rid of oxidisation.

Above left
The majority of these components showed signs of overheating or age and so were removed from the Panda Cub and replaced with modern equivalents.

Above right
Top view of a fully restored and working Panda Cub.

POWERING UP

Once the radio has been thoroughly cleaned and its components checked, we can finally *think* about applying power via a variac, as discussed last month. However, power should first be applied with all the valves from the radio removed.

The reason for this two-stage process is that if anything is wrong with the radio, it can make diagnosis of the fault much easier (by removing one of the potential sources of failure from the equation, so to speak). Before removing the valves, make sure you have a drawing / plan that shows which valve belongs in which valve socket.

Once the valves have been removed, for safety reasons replace the radio in its case. Never forget that the kind of voltages used in thermionic valve equipment - ie over 200V - can be fatal. Great care must be taken that you *never* handle the radio with AC mains power connected to it when it is out of its case. *Always* switch off the receiver, switch off the power at the mains outlet and then unplug the radio's power cord from the mains outlet before removing the radio's case. Once this has been done, *do not* reconnect the AC mains connection to the radio until it is safely back in its case.

Before going any further, check that the mains input of the radio has been set to whatever is your local mains voltage. I know a few sad stories where 110V AC radios have been plugged into 230V AC mains supplies.

With the variac's voltage control set to zero volts and its output connected to the radio's AC mains input, the variac's input can be plugged into the AC mains. Now, carefully increase the voltage control to about 50V (assuming you are on 230V AC mains) and leave the receiver alone for a couple of minutes. Then increase the variac control to about 100V and repeat the process.

This gradual build-up of the AC mains voltage allows the electrolytic capacitors inside the radio to charge up slowly making it much less likely for their dielectric to break down and for them consequently to go short circuit and explode.

The process is repeated in steps of less than 50V, until the full local AC mains voltage is reached. If the radio has dial lights, these will illuminate as the voltage is increased.

Once the full mains voltage has been reached, the radio is left with the voltage at this level for about half an hour, with you in attendance. After 30 minutes has passed, the variac is reduced to 0V, the radio switched off, the power outlet to which the variac is attached switched off and the variac's power cable removed from the mains outlet.

The radio's case is then removed and the valves are carefully replaced in their sockets, first spraying each socket's receptors with electrical contact cleaner before inserting each one. Once this has been done, the radio's case is replaced, the power cable is reconnected to the variac and the AC mains switched on.

Once again, in a similar manner, the variac is increased in 50V steps until the full mains voltage is reached. When the mains voltage reaches about 50% of the maximum, you will notice the heaters of the valves start to illuminate. If any of the valves fails to light up, their heaters may be burnt out and the valve concerned should be replaced by one of an identical kind (or its equivalent).

As before, leave the radio running in this state for a further 30 minutes, with you in attendance. Obviously, if the equipment is a transmitter, it should *not* be switched to transmit during this time.

READY TO GO?

In 95% of the radios that I have restored, following this process has resulted in a working radio. You also should look at the mechanical aspects of the radio, in particular the main tuning mechanism, and check that this is working correctly. If not, some reference to the manual or Internet sources of information may be necessary.

If your radio fails to work, it is a matter of carrying out some old-fashioned fault-finding. In contrast to the surface-mounted solid-state equipment of today, if you have a basic knowledge of electronics and are armed with a manual, a circuit diagram and a multimeter, you have a good chance of actually being able to find and fix the problem yourself.

Working on 1950s and 1960s valve radios is very satisfying as long as you are patient and, as has been covered earlier in this article, take very good care to abide by some basic rules of electrical safety.

Good hunting, if you decide to become involved in this fascinating aspect of our hobby. For me, a valve radio is alive in a way that its semiconductor sister just isn't. ◆

REFERENCE

[1] 'Refuse bin? Repair? Restore? Rebuild?'; 'Technical Topics', Pat Hawker, G3VA, *RadCom* April 2004.