Vintage Radio

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The batteries used to power vintage radios

This view shows an assortment of old Eveready 1.5V cells and batteries, together with a 3V battery at far right. A Burgess 4.5V battery is also shown.

Many valve radios were battery-powered but a lot of the battery types used are now obsolete and no longer available. However, with a little ingenuity, sets that would otherwise be static displays only can be restored to full working order.

WHEN WE STOP to think about it, our civilisation would almost grind to a halt without batteries. Without them, there would be no iPods, no mobile phones, no handheld remote controls, no torches, no hearing aids, no battery-powered radios, no cordless mice or keyboards and no cordless telephones, to name just some of the equipment we now take for granted. Even worse, we would have to hand-crank our cars to start them if we didn't have batteries to do the job for us!

Batteries were used to power many early valve radio receivers, particularly in areas where mains power was unavailable. These batteries consisted of both primary (non-rechargeable) and secondary (rechargeable) types. A primary battery is one that uses up its chemicals in an irreversible reaction and is disposed of after use (ie, after it has gone "flat"). By contrast, secondary batteries can be recharged because the chemical reactions that take place inside them are reversible.

Primary cells

Many types of primary cells had been developed by the early 20th century. These included the Fuller bichromate cell, Edison cell, Grenet Bichromate cell, Bunsen cell, Daniell cell, Gravity cell, Daniell gravity cell, Grove cell, Poggendorff cell, silver chloride cell, air depolarised cells and last but not least, Leclanche cells. Many of these cells were a variation on a theme and all were an attempt to provide electrical energy in an economical and convenient way.

Because quite corrosive chemical solutions were used in many of these cells, considerable care was necessary when handling them. In fact, none of these cells were convenient to use in radios in their original format. However, the Leclanche cell was eventually modified to give us the now familiar "dry cell". This is now the most common primary cell used in portable radios.

Typically, a Leclanche dry cell has a positive carbon pole contained in a porous container filled with manganese dioxide which acts as a depolariser (the depolariser is used to remove the hydrogen gas that is developed on the carbon pole). This assembly stands in a container of ammonium chloride paste which also includes a negative zinc pole. It produces an output voltage of nominally 1.5V.

One of the accompanying photos shows three glass-encased cells. The front one is an early Leclanche cell. However, we are more familiar with the normal torch cell in the same photograph, which is basically a refined version of the Leclanche cell and is much easier to use.

Secondary cells

By contrast with primary cells, secondary cells are a more recent development which occurred around

Dry batteries designed to power valve radio sets came in all shapes and sizes. The units shown here are now all obsolete.

1800. However, practical cells did not become available until about 1880.

As stated above, secondary cells are rechargeable and include lead-acid car batteries and the nickel-cadmium (nicad) and nickel-metal hydride (NiMH) cells now used in many electronic devices. Because they are rechargeable, they can significantly reduce long-term battery costs in many applications. Early secondary cells include Plante cells, Faure cells and alkaline cells, with quite a few variations on a theme.

During the early 20th century, secondary cells were classified according to their construction as follows: lead sulphuric acid cells, lead-zinc cells, lead-copper cells and alkaline zincate cells. The lead-acid cell is now the main secondary cell used in the automotive industry, while NiFe cells (nickel and iron electrodes) and, more recently, nickel cadmium cells are the main alkaline-based electrolyte secondary cells commonly in use.

Maintenance

Rather than being discarded, early primary cells were refurbished. The elements that were used up in the chemical reactions were replaced, after which the cell was again ready for use. However, this was a messy and quite often expensive exercise. Furthermore, the chemicals could be quite corrosive, so care was essential.

Almost without exception, primary cells now are thrown away when they become exhausted. Chinese "D" cells may cost from 25 cents upwards while high-quality alkaline cells may cost in the region of $2.00 each but will give superior service.

It's also interesting to note that some attempts were made to recharge primary cells back in the 1950s and early 1960s. During that era, a number of portable radio manufacturers installed a "re-activation" circuit into their radios. When the portable was connected to the mains, the set would work directly off the mains and the supply circuitry would also be used to "recharge" the installed dry batteries.

In practice, various protocols had to be followed to recharge the batteries and the number of recharges the batteries could successfully take was decidedly vague. Usually, the instructions were not to use the batteries in the set to the point of being completely discharged before plugging the set into the mains again. Even four to five semi-successful "recharges" was considered good value, as the batteries were quite expensive.

HMV recommended that the batteries in their sets be "re-activated" for six hours for every hour of operation. They believed that a set was typically used for around two hours a day, so an overnight charge would be the most convenient way of doing this.

However, HMV also inferred that the batteries must be reactivated as soon as possible after any discharge, otherwise recharging would not be successful. Apparently, using the batteries on successive days without reactivation would make later attempts futile.

I have no idea as to whether this idea would work with today's dry cells, including alkaline types. However,

High-discharge testers like this unit were used for checking lead-acid cells. The battery is shown for size comparison.

An assortment of transistor radio batteries. These are mainly 9V types, the main exception being the 2510 at right which had 2 x 7.5V outputs.

the instructions on many of these batteries indicate that it should not be attempted. Perhaps this is because people may endeavour to recharge the cells at too high a rate which could cause them to explode. You have been warned!

During in the 1960s and 1970s, Astor and AWA also made some portable-cum-car radio transistorised receivers that used rechargeable nicad AA cells. These sets were rather advanced for their time and they were fairly expensive.

Secondary cell problems

A disadvantage of early lead-acid secondary batteries was that it was necessary to keep an eye on the charging procedure. This involved using hydrometer to check the charge condition of each unsealed lead-acid cell. A high-discharge cell tester was also commonly used with car batteries.

During this procedure, it was very important not to smoke or create any sparks. This was to prevent the hydrogen gas given off during charging from exploding. It's a warning that's still valid today.

Early valve radios

Early valve radios commonly used the 201 or the later 201A triode valves. These required filament voltages of 5A at 1A and 5V at 0.25A respectively.

In practice, these valves were commonly run from a 6V lead-acid battery with a rheostat in series with the filaments to reduce the applied voltage to 5V.

By contrast, the high-tension (HT) voltage for the 201 & 201A varied from around 22.5V to about 135V, depending on the valve's function in the circuit. The HT current drain was usually less than 25mA for the entire receiver.

Another handy test tool was the hydrometer, used to test the specific gravity of the electrolyte in lead-acid cells.

In the early days, miniature lead-acid batteries were sometimes made up to supply the HT requirements of such receivers. Just imagine a bank of 60 cells supplying 120V to a receiver, then imagine having to check the electrolyte in each of these cells each time they had to be charged! That would really have been fun!

I have only ever seen one example of these miniature batteries so I suspect that they weren't all that popular.

An alternative involved using a bank of dry cells to provide the necessary HT voltage and current for the receiver. For a 135V HT rail, this involved connecting 90 cells in series.

It's worth noting here that dry cell manufacturers standardised on the size of the cells used in their batteries at an early stage. For the HT batteries, they used A-size cells which are smaller than C-size cells. We don't see them around these days but one is shown in the lead photo, standing alongside the cyclindrical No.6 cell.

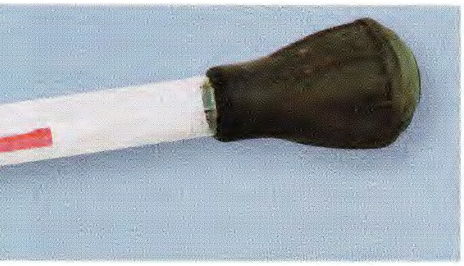
Dry cell deficiencies

Unfortunately, early dry cells did have some deficiencies. First, the insulation used between the cells in a battery was commonly cardboard and in a moist environment this became slightly conductive. As a result, the batteries would discharge and go flat over a period of several months, a problem that was particularly evident in hot, humid areas.

In addition, some early dry cells had a "breather" vent and the moisture in the paste-type electrolyte evaporated over a period of several months. As a result, early dry cells had a rather limited shelf life.

The earliest Traeger pedal radios (for the Flying Doctor Service) were commonly used in tropical areas and in an endeavour to overcome the discharge

Eveready made a wide range of dry batteries for valve radios, the larger "B" units shown here delivering 45V. Diamond also made a range of dry batteries.



problems in dry cells, only 9V of HT was used from two 4.5V batteries.

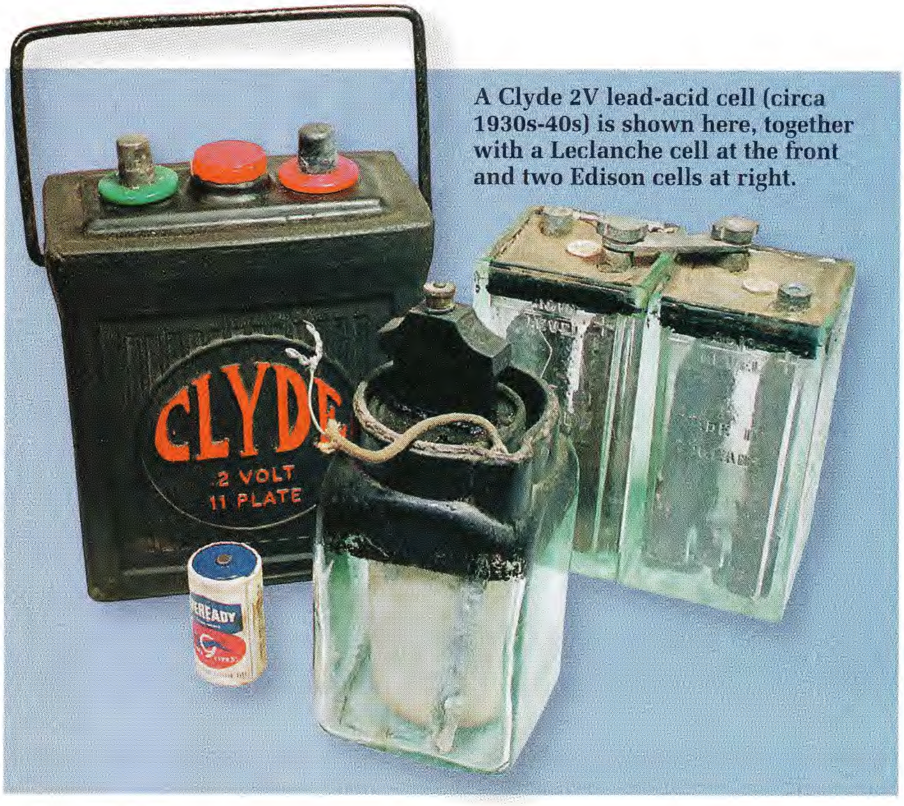
The Australian army also initially had problems with dry batteries in their transceivers in the tropics during WWII. However, they were able to reduce the problems by completely sealing the batteries in wax. Of course, cost was not of prime concern in that instance.

Dry batteries have changed enormously over the years and today's batteries are considerably better than those used during the early valve radio era. In particular, the layer type method of construction was a major advance in packaging and was coupled with good insulation techniques and economy of manufacture. The subminiature overseas-made HT batteries, the Australian 490P & 482 types and transistor receiver batteries such as the 2761, 2362, 2510, 2364, 216 and 286, etc, all used this very efficient construction method.

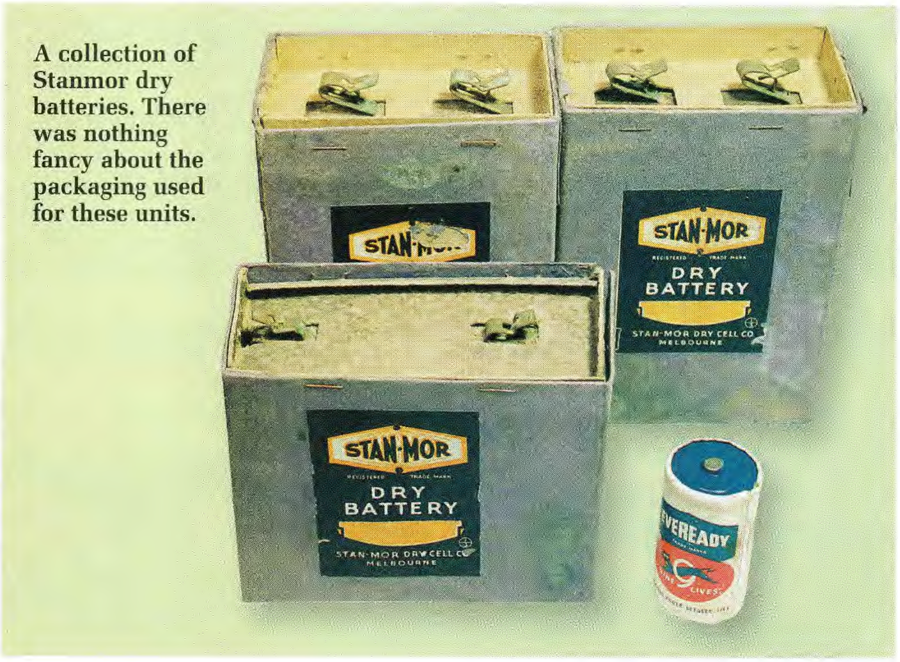
When Australian manufacture of transistor radios ceased, most of the "specials" for the Australian receivers quickly became hard to get and in some cases disappeared from the market. The 276P "evolved" and became a lower grade battery. The layer construction was dispensed with and six "C" cells in a holder were incorporated in its place. This was a backward step, as the contacts in the holder didn't always make good contact and the electrical capacity of the battery was reduced.

By contrast, large low-voltage dry batteries did not depart from the original concept of wiring multiple A, C, D, E & F cells in parallel (I've never found any reference to a "B" cell). An advantage here was that insulation was not a problem with such low voltages. We are all familiar with the "C" and "D" cell sizes and the "A" was basically a little brother to the "C" cell. Batteries such as the X250 and 745 1.5V types used the "F" cell.

Towards the end of the valve era,



A Clyde 2V lead-acid cell (circa 1930s-40s) is shown here, together with a Leclanche cell at the front and two Edison cells at right.



A collection of Stanmor dry batteries. There was nothing fancy about the packaging used for these units.

portable receivers often used a combined low-tension (LT) and HT battery in the one case. Apparently, the HT sections were of layer construction while the LT sections were built using "D", "E" or "F" cells.

One such battery was the 759 which supplied 1.5V and 90V. This was suitable for household sets but was too big for portables. Another battery pack for use in rural areas was made by Eveready and contained one X250 1.5V battery and two 470 22.5/45V batteries. Although they were not all in the same case, they were all supplied together in the same delivery carton.

Of course, using an "all in one" meant that if one section failed, the whole battery had to be replaced.

Lead-acid batteries were predominantly used for supplying valve heaters and for powering vibrator HT power supplies. In practice, 2V cells varied from 25Ah capacity to 130Ah, while 6V batteries varied between 60Ah and 160Ah in capacity. In 1937, these

Diamond made a large variety of dry batteries for valve radios, including 45V "B" batteries and 4.5V and 1.5V "A" batteries.

varied in cost from about 17/6 ($1.75) to about £5/11/6 ($11.15). At that time the average weekly wage was about £4/10/- ($9.00), so they were quite expensive.

The use of 2V lead-acid cells declined quite rapidly when 1.4V filament valves were introduced, replacing those with 2V filaments. However, 6V (and occasionally 4V) lead-acid batteries remained in use with vibrator-powered receivers until around the mid 1950s.

Battery life

Most radio batteries were rated for a 20-hour discharge rate. In practice, a typical 5-valve receiver using 2V valves draws 720mA. This meant that a fully-charged 25Ah cell would need recharging after about 35 hours, whereas a 130Ah cell would operate for about 180 hours.

Similarly, vibrator-powered radios with efficient power supplies typically drew around 1A from a 6V battery. That makes the maths simple – a 60Ah battery would last around 60 hours and a 160Ah battery would last around 160 hours.

As with lead-acid batteries, dry battery life depends on the battery capacity, the current drawn and the amount of time that current is drawn during each listening session. In practice, the battery life in transistor receivers varies from around 30 hours for a 9V 216 battery to about 300 hours for a 276P battery and up to 1000 hours for a 286 (as quoted by Kriesler for one of their sets).

In typical valve portable receivers, the life of a 1.5V 745 battery allied with a pair of 45V 482 batteries was usually somewhere around 300 hours. The Australian "miniature" portables used two 950 cells to provide the filament current and a 467 67.5V battery to supply the HT current. In operation, the two 950 cells would last around 30-40 hours, while the 467 HT battery would probably last up to twice as long.

By the way, if a restorer aimed to power the filaments of such a set from "D" cells, a pair of alkaline cells would give up to 150 hours before dropping to the cut-off voltage of 1V.

The much larger dry battery packs designed for household receivers would have lasted much longer than the 745/482 combination. In fact, some combinations may have had an operational life of around 1000 hours or more. However, I have no means of being entirely sure of these figures (or the other figures quoted above), as I haven't actually put this to the test.

Battery receiver power

Providing battery power for early portable transistor receivers is not

Valve radio batteries were typically quite large and were not cheap.

an impossible task. For example, 216 batteries are still used in many transistor receivers and myriads of other electronic devices. They can often be used in transistor receivers where much larger batteries were originally specified.

Of course, the life of the 216 will be noticeably less than the battery it is replacing. The 276P was a commonly used battery but is rarely seen these days. However, WES Components in Ashfield NSW have 276 batteries with adaptors to convert them to the 276P type.

Alternatively, you can often use several AAA, AA, C or D cells in multiple cell battery holders if a 216 or a 276 battery is not appropriate.

Battery-powered console, table and mantel radios that used 2V accumulators and three 45B dry batteries in series are a different story, as suitable batteries are no longer made. However, such sets can be operated from a mains power supply that's been designed to deliver the necessary DC rails at the required current.

Another way of powering such sets is via DC-to-DC inverters. These are typically designed to work from a 6V or 12V lead-acid battery. This method is closer to the original method of supplying power, as the receiver is independent of the mains.

Valve portable receivers

Valve portable receivers provide a much greater challenge. Certainly, a mains type power supply will do the job but this means that the set can no longer be used as a portable.

A cumbersome method of supplying the HT voltage is to string together the requisite number of 216 batteries. Ten 9V batteries in series to supply 90V does look a bit odd though! Similarly, alkaline D cells can supply the filament voltage quite easily.

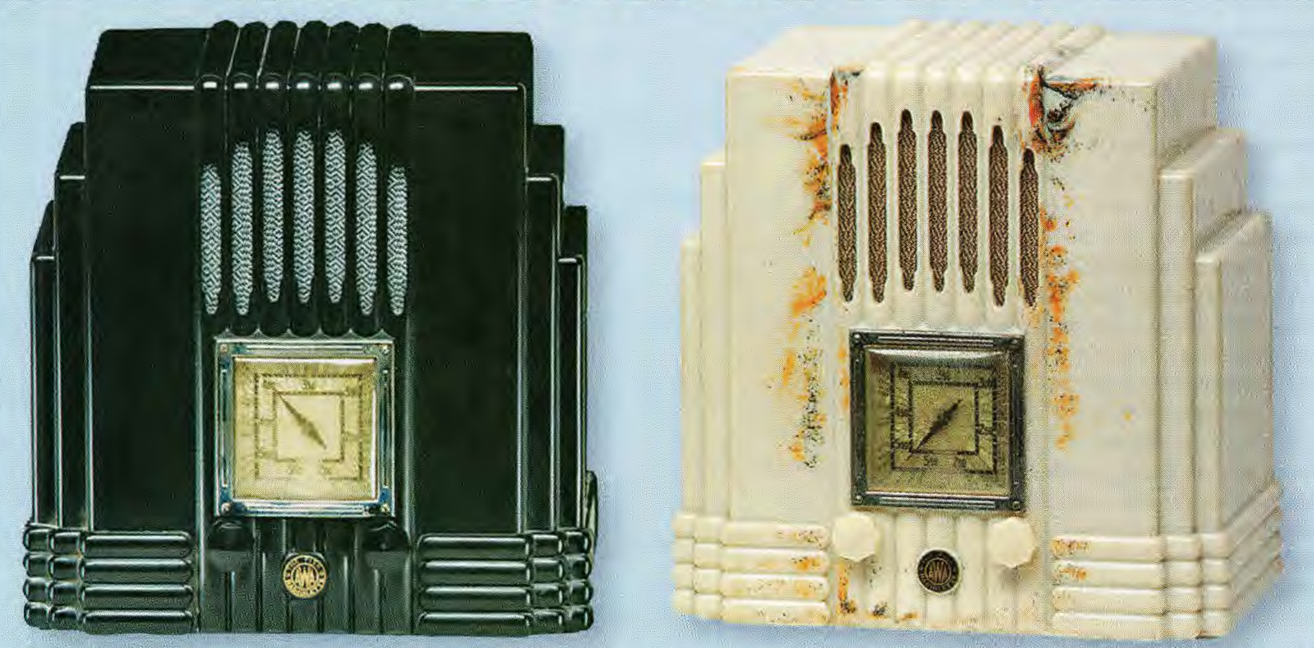
A better method of supplying the HT rail is to use a DC-to-DC inverter that will fit inside the receiver. However, this can be quite a challenge with the small miniature receivers of the late 1940s, although the full-sized portables shouldn't pose too many problems. The filament supply can still be supplied by heavy-duty alkaline cells, with the inverter supplying just the HT requirements of the receiver.

Supplying bias to battery sets is comparatively easy as no current is usually drawn from these supplies. Sometimes, the original batteries in 30-50 year old receivers still supply nearly the correct bias voltage (they will not supply any current though). Basically, it's just a matter of using suitable small batteries to do the job (AAA or 216-size batteries may suit individual receivers).

Typical Eveready Battery Types For Valve & Transistor Radios

Type	Voltage	Comments
Bias Batteries		
794	9V	Tapped bias battery
714	4.5V	Battery to suit "baby" pedal radio
W95	9V	Bias battery tapped at -1.5, -3, -6 & -9V
761	4.5V	Bias battery tapped at -1.5, -3 & -4.5V; uses 3 'D' cells, 100 x 35 x 87mm
Low-Tension Batteries		
X250	1.5V	30 x 'F' cells; companion to the older and larger 470
745	1.5V	8 x 'F' cells, 270 x 34 x 97mm
739	9V	Battery for series-wired portable set filaments; uses 6 x 'F' cells
717	7.5V	Filament battery; 5 x 'C' cells
–	1.5V	Large battery; same size as the 45V 770
High-Tension Batteries		
467	67.5V	45 layer type cells; 72 x 34 x 90mm
482	45V	Layer type construction; 90 x 43 x 138mm
470	45V	Large 45V battery, newer type; 126 x 100 x 148mm
770	45V	Large 45V battery, 22 times the volume of the 467
Transistor-Radio Batteries		
286	9V	2 x 276P batteries in parallel, 62 x 50 x 180mm
276P	9V	62 x 50 x 90mm
733	9V	57 x 52 x 90mm
2362	9V	33 x 25 x 76mm plus terminals
2364	9V	
216	9V	Miniature transistor battery
2761	9V	
2582	2 x 6V	
2510	2 x 7.5V	
2512	2 x 9V	
General Purpose Batteries		
742	1.5V	4 x 'F' cells
509	6V	4 x 'F' cells
X-71	1.5V	1 x 'F' cell
703	4.5V	Bias and general purpose battery
–	3V	2 x 'E' cells cycle battery
A	1.5V	Small general-purpose cell
C	1.5V	Small general-purpose cell
D	1.5V	Medium general-purpose cell
E	1.5V	Medium general-purpose cell
F	1.5V	Medium general-purpose cell
6	1.5V	Large telephone & general purpose cell; 17-30Ah capacity, depending on use
Composite Batteries		
759	1.5V & 90V	

Photo Gallery: AWA Empire State Radiolette



PERHAPS THE MOST FAMOUS RADIO made by AWA, the "Empire State" Radiolette was first produced in 1934. It was housed in a bakelite case and came in a variety of colours including black, brown, marbled white and dark green. A black Model 28 (1934) and a marble Model 32 (1936) are shown here. Both are 5-valve superhet receivers and the valve line-up was as follows: 6D6 RF amp, 6A7 converter, 6B7 IF/AF amplifier/detector, 42 audio output and 80 rectifier. Photo supplied by the Historical Radio Society of Australia Inc (HRSA), PO Box 2283, Mt Waverley, Vic 3149. www.hrsa.net.au

An assortment for bias batteries from Eveready, Diamond and Impex. Note the multiple output terminals on each battery, to enable the correct bias voltage to be selected.

A mains power supply or a DC-to-DC inverter supply can also be used to power non-portable battery-operated valve radios. This should be relatively straightforward, as space is not usually a problem in such sets.

In practice, a mains supply can either be designed specifically for particular receiver or designed to supply a range of voltages to suit many different receivers from the 1920s to the 1960s. The same goes for DC-to-DC inverters. Most portables use 1.5V, 7.5V or 9V on the filaments, while the HT requirement is usually either 67.5V or 90V.

Obtaining a battery eliminator

So where do you obtain a suitable mains-powered battery eliminator to run a vintage radio? Well, I currently have a suitable design on the drawing board to be published later in the year. This unit will supply filament voltages of 1.4, 2, 3, 4, 5 & 6V at 1A or so and 7.5-9V at 50mA. It will also supply HT voltages ranging from 22.5V to 135V and there will be a good selection of bias voltages as well.

Suitable DC-to-DC inverters were rather thin on the ground until Tony Maher of the Historical Radio Society of Australia (HRSA) designed a number units in 2001. His first item was designed to replace a 467 battery. It fits into the same space as the battery and is powered by four nicad or NiMH cells.

He has since added a 2V supply for sets using 2V valves and is about to publish a 90V version of his 467 battery-sized supply in *Radio Waves* (the HRSA in-house magazine). **SC**