by PETER LANKSHEAR

The advent of American metal valves

Sixty years ago, there was a lot of covert research going on in a laboratory of America's General Electric Company. The ultimate outcome was a revolutionary family of octal-based metal valves which were to have a considerable influence on valve development for more than a decade.

During 1930, in a major restructuring resulting from both internal pressures and the threat of US Government anti-trust litigation, RCA, which had previously been only an operating and marketing organisation, took over from two of its principals — General Electric and Westinghouse — the manufacture of its own receiving valves and radio equipment. An outcome of the legal negotiations, which were not resolved until the end of 1932, was that GE agreed to provide a measure of competition by resuming radio manufacture by mid-1935.

GE had disbanded its valve and radio manufacturing facilities in 1930 and now, at the beginning of 1933, had to reinstate these organisations in readiness for the new venture. One thing was clear right from the start. To succeed in the by-now very competitive market, the new GE receivers would need to offer something radically different.

The aspect decided on was valve development, and initially a lot of research was carried out on what was to become the beam tetrode. But it soon became clear that this was not going to be novel enough to base a new venture on.

While this work was under way, an associate company in the UK, British General Electric (Osram) introduced in May 1933 their 'Catkin' metal valves, described in this column for November 1988. Also, since 1931, the industrial section of American GE had been studying the possibility of making thyratrons (gas-filled valves) in metal envelopes. There were many detail problems to be solved, especially welding and seals, but by late 1933 GE had, based on this research, produced a practical design. Metal valves could, it seemed, work — and they might provide the novelty for the new venture.

Meanwhile RCA, by now a major valve manufacturer, had been busy with their own research and development. Early in 1933 they had produced the 'Acorn' valve, which could be used for much higher frequencies than conventional valves. This led to the developmental forerunner of what became the button base — familiar in the later 'all glass' miniature and noval based valves.

'Flat press' base

As an offspring of the electric lamp, early valves had evolved with the same method of electrode support. As can be seen in the left of Fig.1, a glass sleeve had one end flattened and embedded in this were the electrode support and lead out wires. The other end of the sleeve was fused to the bottom of the envelope.

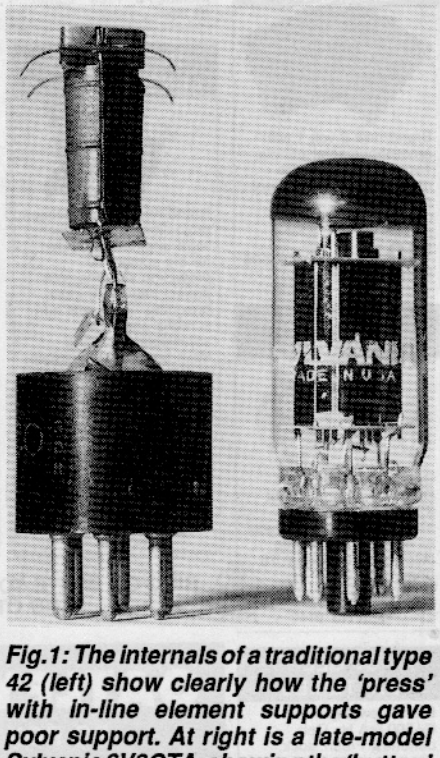


Fig.1: The internals of a traditional type 42 (left) show clearly how the 'press' with in-line element supports gave poor support. At right is a late-model Sylvania 6V6GTA, showing the 'button' type base which was first developed by RCA for the 'bullet' tube, and then used in the metal octal valves.

This form of construction had several shortcomings. It produced an undesirably tall assembly, with the extra length of the leads degrading high frequency performance. With electrode support in only one plane, mechanical stability was also poor. A further weakness was the separate base, cemented to the glass, which frequently became loose.

By mounting the supports in a circle in a flat button of glass, RCA solved all these problems in one move. Not only was the new assembly more rigid, but the lead length was significantly reduced and it was even possible to eliminate the base by embedding the contact pins in the glass button.

RCA had heard rumours of mysterious goings-on with metal valves at GE, and so embarked on a programme of development of an alternative valve to be filed away 'just in case'. The outcome was the 'bullet tube', incorporating the button base and fitted with a metal shield. Significantly, the final version had a revolutionary new eight-pin base with a locating spigot.

The bullet tube/valve was never put into production, although as can be seen from the right-hand side of Fig.1, the button base and the octal socket ultimately came together in a late form of the GT valve, to produce something very similar. Not until 1939 did the all-glass button base appear in production valves, the first being the miniature 1.4 volt battery series.

'Wired in' valves

Meanwhile, by early 1934 the basic design and manufacturing procedures for what was to become the metal series had been completed by General Electric. The proposal was that rather than using sockets, these valves should be wired in permanently; and samples were made accordingly.

Having dismantled their receiving

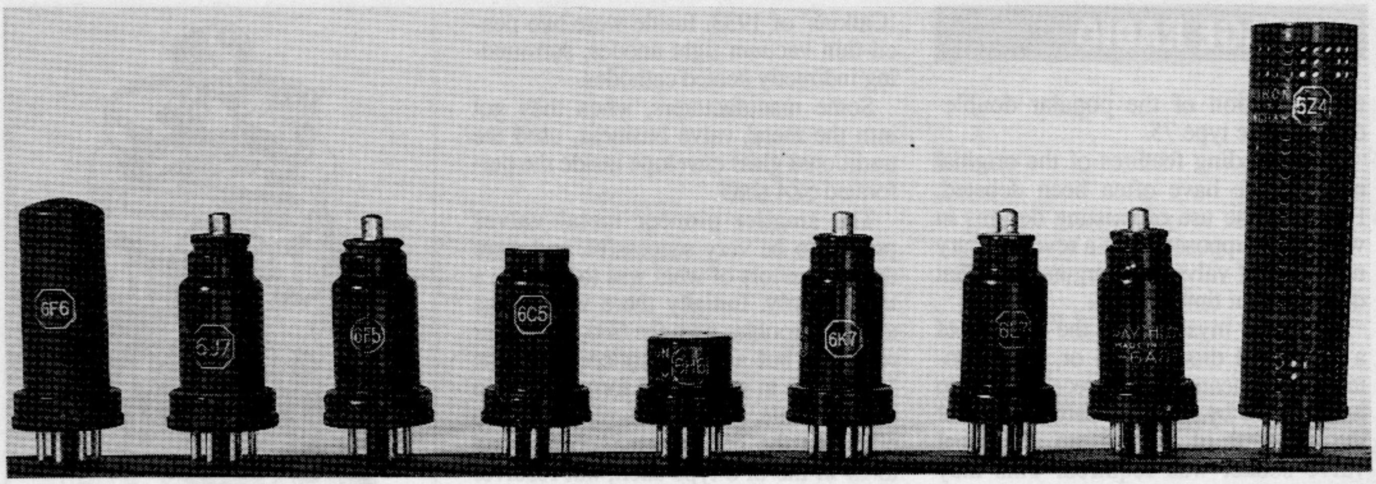
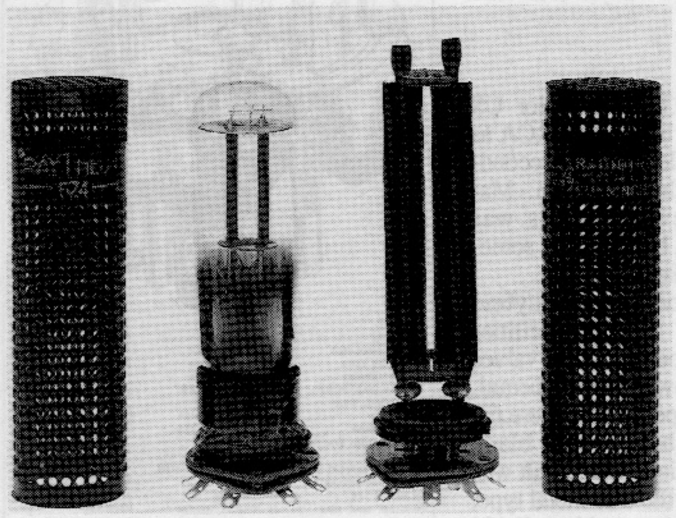


Fig.2: The original nine GE/RCA metal octal valves, as listed in the table at lower right. The 'bird cage' construction used for the 5Z4 rectifier (far right) proved unreliable, and was soon changed into that used for the 6F6 (far left).



THE ORIGINAL NINE METAL VALVES

TYPE	FUNCTION	CHARACTERISITICS
5Z4	RECTIFIER	SIMILAR TO 83V
6A8	PENTAGRID OSCILLATOR/MIXER	REPACKAGED 6A7
6C5	GENERAL PURPOSE TRIODE	MODIFIED 6C6/77
6F5	HI MU AUDIO AMPLIFIER	NEW DESIGN
6F6	OUTPUT PENTODE	REPACKAGED 42
6H6	DOUBLE DIODE	NEW DESIGN
6J7	SHARP CUTOFF PENTODE	REPACKAGED 6C6/77
6K7	VARIABLE MU PENTODE	REPACKAGED 78
6L7	PENTAGRID MIXER/AMPLIFIER	NEW DESIGN

Fig.3 (left): The internal structure of the 5Z4 'bird cage' rectifier (right) resembled the earlier English Marconi-Osram Catkins, with their vacuum-tight anodes. Raytheon's first version of the 5Z4 (left) retained the traditional glass technology, and should strictly have been called a 5Z4MG.

valve manufacturing division four years previously, GE must have been unsure of their ability, in the time available, to undertake the massive tooling and establishment necessary for the mass production of a radically new type of valve. Instead, approaches were made to RCA to undertake the manufacture of the metal valves. RCA agreed and towards the end of 1934, in great secrecy began to set up the necessary machinery.

The octal base

One aspect of the GE design that RCA was unhappy about was the elimination of the valve socket. GE agreed that the metal valves should have plug-in capability, and accordingly they were fitted with the same octal base that RCA had developed for the bullet valve.

That this was a good choice has been confirmed by history. The octal socket has proved to be one of the most successful, versatile and reliable of the numerous types that appeared during the long history of the thermionic valve. At the practical level, the spigot makes accurate location in the socket much easier than does most other types and, significantly, the octal socket has been adopted for other purposes such as plug-in relays.

On April 1st 1935, RCA and GE unveiled the revolutionary new all-metal valves, to be featured in their new season's receivers due for release in September. This move put the rest of the industry, who were already committed to production of their new season's models, into shock. There followed a high powered advertising and publicity campaign, and RCA and GE made a killing with the 1936 models.

The technical press had a field day, some writers even implying that technicians would have to learn a new advanced technology! In Australia, AWV gave full details of the series in the October 30th 1935, issue of *Radiotronics*.

Family of nine

Unlike the English Catkins, which never had a frequency converter, diode or rectifier, the American metal valves entered with a full range. This was a strong selling point, as metal valved receivers could use completely new types.

As shown in the table, there were nine different types in the initial RCA release, but only three were completely new designs. Five were based on currently popular valves, and the rectifier was a derated version of an existing type.

Of the new types, the 6L7 was the most revolutionary, being effectively an RF pentode with two control grids. Its chief function was as a frequency converter, with a separate oscillator valve. This combination, intended for more elaborate receivers, was superior to that of the 6A8 pentagrid oscillator/mixer whose performance fell off seriously above about 15MHz.

The 6H6 was the first double diode, apart from rectifiers, in the 'main stream' American range. With independent cathodes, it had a potential versatility that was rarely used fully. The 6H6 was often used in combination with the third of the new designs, the high-mu 'resistance coupled' 6F5 triode — which was more or less the equivalent of the triode section of the popular double-diode-triode type 75.

Two puzzling features of the original metal range have often been debated. First was the use of existing designs in what was supposed to be a revolutionary new type of valve. One argument is that development time ran out.

The other mystery was the absence of a combined diode/triode or diode/pentode. This meant that if a receiver was to have AGC, by now standard on all but the cheapest of models, an additional valve socket was required. This may have been a ploy to foil last minute changes to the new valves, by manufacturers already tooled up for the new season's models.

An unconvincing argument was that too many difficulties were encountered in initial attempts to make such a combination valve. But after all, there were several such valves in the RMA range by that stage.

Now, after more than half a century, complete answers to these questions are unlikely ever to be found.

The missing tenth

One strange aspect of the metal valve saga was the existence in the initial series of a tenth valve. Early pre-release advertisements list nine valve types, but instead of the 6F5 high-mu resistance coupled triode there is a 6D5, using the same shell as the 6F6.

The *Australian Radio Trade Annual* for 1936 includes all 10, but RCA valve manuals have never acknowledged the 6D5. There is little evidence of its ever having been used in a receiver, but specimens exist. The 6D5 was an indirectly heated output triode, with characteristics intermediate between the old 45 and those of a triode connected 6F6. Apparently it was realised that there would not be be much demand for such a valve, and by the release date, the 6F5 had taken its place in the RCA list.

There were initially three envelope patterns, plus a short lived 'bird cage'. The 6H6 was unique with a very squat shell, whilst the high-dissipation output and rectifier valves had the plain taller cylindrical envelope. More shapely, with stepped tops, were the 6C5 and those with grid caps.

The original 5Z4 was anomalous, in that its appearance and construction were unlike the rest of the metal family. In fact with its perforated protective cover and internal construction, it closely resembled the Marconi/Osram 'Catkins' of 1933. Inside were two pencil-thin vacuum tight anodes, surrounding indirectly heated cathodes.

Some manufacturers, when they got into the metal valve business, used the traditional glass envelope inside the perforated 5Z4 shell.

The smaller pioneer metal valves proved to be very successful, and were the progenitors of what was to become a large family. Initially there were some teething troubles with the 6F6, to be later rectified, but a major concern was the 5Z4 which in its original form proved to be unreliable. It was soon redesigned to eliminate the breakdown problems and to fit in the 6F6 type shell, but receiver manufacturers remained suspicious and thereafter favoured the proven glass-shell 80 — resurrected with an octal base as the 5Y3G.

Hybrids

By the end of 1935, five major US valve manufacturers had joined RCA as metal valve makers, leaving the second-ranking makers with a problem. Machinery for the new processes was extremely expensive, but they had somehow to be in the market.

The initial solution was the hybrid 'metal glass' valve. Existing facilities were adapted to produce glass valves with slightly narrower than normal, straight-sided envelopes. These were fitted with an octal base and a black painted thin metal shield. The result was quite a bit taller than the true metal type, but the metal glass valves, with an 'MG' name suffix, served until the industry sorted itself out a year or so later.

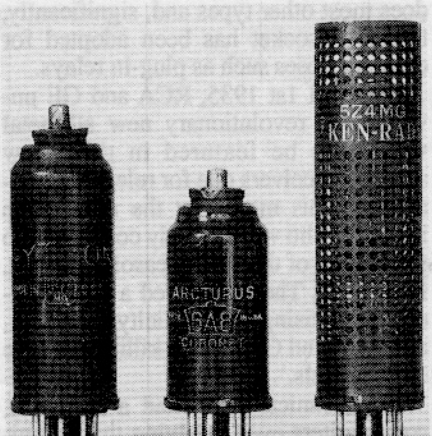


Fig.4: The 'metal glass' construction was the easy way out, for some makers faced with massive re-tooling costs. Hytron's 6Q7MG (left) used a tubular glass envelope with a metal shield; the Arcturus 'Coronet' series (6A8,centre) looked less traditional, but still had an internal glass envelope; while Ken-Rad (right) only progressed to metal valves in 1935, making the MG type until then.

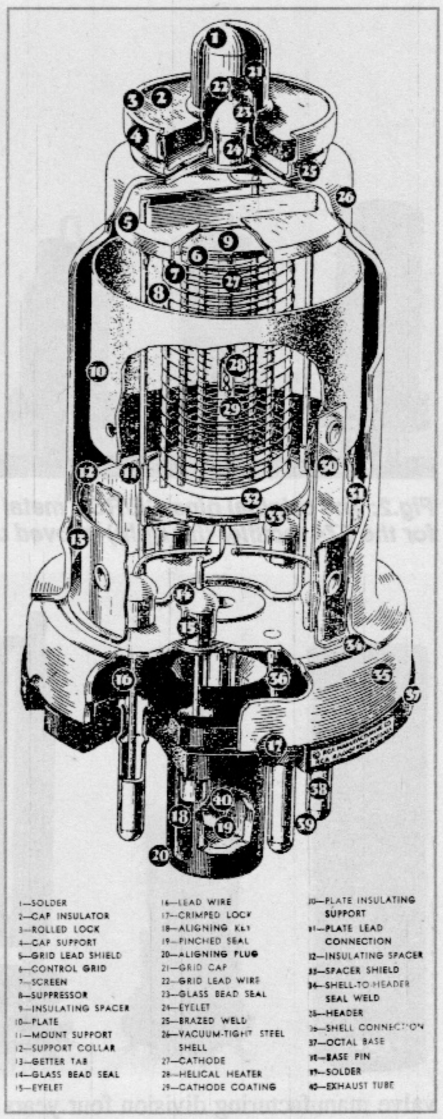


Fig.5: A cutaway drawing of the inside of a 6K7 metal octal valve, as shown in early RCA (and AWV) data books. The various components are identified; note the exhaust tube inside the octal base's central spigot.

One variety of metal glass valve deserves special mention. Arcturus, notable earlier for their blue glass envelopes, produced their 'Coronet' metal clad series. The stem, instead of ending in a flat press, had a circular crown of support wires — hence the name.

This construction permitted the Coronets to be shorter than the other makes of MG valves, and Arcturus even made earlier valve types with the MG construction and including the octal base! This led to the slightly ridiculous situation of early 2.5-volt filament types like the 27 being available in Coronet form, but needing octal conversion adaptors to fit the receiver sockets.

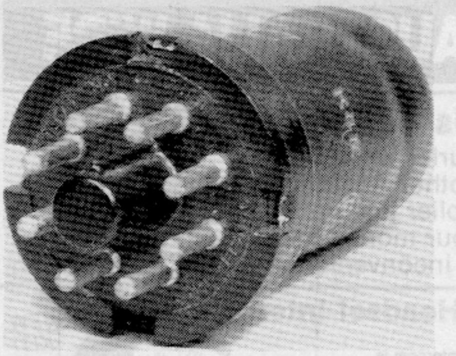


Fig.6: With the metal valves appeared the reliable octal base, which proved to be very successful and long-lived.

Metal valves were not made in Australia, and those with the Philips brand were probably made by RCA. A 1936 *Australian Philips Technical Communication* treads a narrow path between enthusiasm and damning with faint praise, in promoting their American metal valve range. Philips was about to launch its 6.3-volt Red Series, and they stated bluntly that the metal series was, for commercial reasons, released in a 'somewhat imperfect state of development'. This statement reinforces the theory of insufficient time for the design of a full range of new types.

We've only been able to cover the birth of the octal valve, in this article. The subsequent story occupies a significant place in valve history, but will have to wait for a future column.

Several Australian receiver manufacturers were quick to use the new valves, but as time went on, fewer metal valves were used in locally made sets. Next month we will describe one of the early Australian-made receivers using metal octal valves. ❖

Collector's Corner

Where readers display prized items of radios and other equipment from their collections, and/or seek information from other collectors...

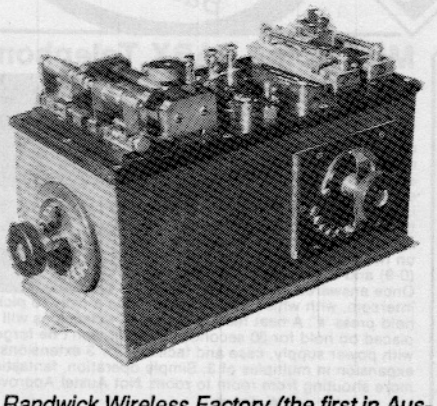
Early RAN set

I noted your new 'Collector's Corner' feature, and decided to write in. Hopefully someone may be able to identify a receiver in my possession; I have been unable to locate any information other than the place of manufacture and a rough estimate of the date. The case is of mahogany, with a top panel of ebonite. All fittings are of brass and ebonite.

The circuit is a loose coupler with two fixed crystal detectors, one acting as a backup. A crystal bias voltage is present, suggesting the original use of carborundum detectors. There are two variable resistors, mounted on slate blocks, to vary the bias supply. Fine tuning is achieved with a sliding air capacitor of the type used in some of the early Marconi equipment.

Two brass brackets are attached to each end of the receiver, to bolt the unit to a table for use at sea. Markings on the top of the set read 'Royal Australian Navy', 'Randwick' and 'N13/25'.

From general wireless history I know that the Navy purchased Father Shaw's



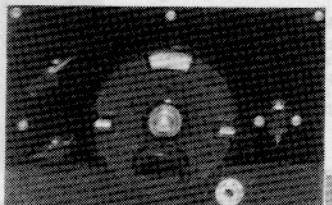
Randwick Wireless Factory (the first in Australia) in 1917, and production ceased in 1922. I suspect this receiver was built between 1919 and 1921, but am not exactly sure.

I would be most grateful if anyone can supply more information on this receiver. By the way, thanks for Peter Lankshear's excellent Vintage Radio column. **(M.F., East Bentleigh Vic.)**

Replica specialist

My hobby is not collecting and restoring old radios, but building replicas of sets I originally built in the period from 1921 to 1941. So far, I have built three crystal sets, four one-valve sets, a short wave set and others. I enclose a couple of photographs. The Ultra Audion one-valve set is my pride and joy.

It gives me great pleasure to listen to these old sets and marvel at their efficiency.



The main difficulty is in finding vintage variable condensers, variable grid leaks, dials, rheostats and valve sockets.

Back in 1921 we had to be satisfied to listen to Morse code, as the only broadcasting stations were over 1000 miles away, and of low power. Boys with only pennies to spend had to make most of their own parts, as well. We even made our own crystals.

By the way, I still have a pair of Stromberg-Carlson headphones as shown on page 30 of the September issue. They still work, too. **(K.J., Nelly Bay, Qld.)**

Need some information on a piece of old equipment? Or perhaps you'd merely like to brag about a prized item in your collection. Either way, write to Collector's Corner, c/- Electronics Australia, PO Box 199, Alexandria 2205. Enclose a photo if possible.