

Some popular output triodes — part 2

Right from the early days of broadcasting, large output triodes have been linked with high quality sound reproduction, and even today are in demand by a select group of enthusiasts — who are convinced that the triode is still unrivalled in providing the ultimate sound. In this second part of the story, we look at some of the 'second generation'.

Last month took us to 1929 and the arrival of the popular type 45 triode. In Holland, Philips research had in 1927, developed the very first of a promising new type of valve: the output pentode, which overcame two weaknesses of the triode — lack of sensitivity and inefficiency. Meanwhile, the trusty 45, generally operating in push-pull, continued to serve America well in the new generation of big mains powered receivers.

The Americans took until 1931 to produce what they considered to be satisfactory pentodes: the Arcturus PZ, followed by the similar RCA 47. With their greater power efficiency and higher amplification factor, the pentodes soon displaced the 45. The Great Depression restricted demand for expensive cabinets, and con-

venience and economy ensured the success of the 'midget' mantel receivers that took their place. With its greater sensitivity the pentode output valve was a natural choice for these new receivers, as no expensive and unreliable interstage audio transformer was necessary.

One characteristic of the pentode assisted its popularity for small cabinets. As we saw last month, a desirable feature of the triode is its low anode resistance which assists in damping speaker cone resonances. Pentodes on the other hand, have a very high anode impedance and in the absence of negative feedback, provide little speaker damping.

The public were becoming aware of the extended frequency range of the moving coil loudspeaker. 'Listen to the

bass!' was a popular advertising slogan, but the shift from console cabinets to the limited speaker baffling of small cabinets restricted low frequency performance. However, there was some low fidelity compensation from the pentode's lack of damping, which permitted cone resonances to boom away without inhibition — increasing the apparent bass performance.

Despite its inferior fidelity, the pentode was rapidly accepted and, together with the later beam tetrode, dominated output stage design right to the end of the valve era.

British breakthrough

But back to 1929. Although an improvement on its predecessors, and quite popular, the recently introduced type 45 nevertheless had some serious limitations. As with most engineering, valve design was a compromise. Amplification factor in triodes had to be traded against anode resistance. A low anode resistance was desirable, but it was achieved at the expense of amplification factor, and therefore sensitivity.

For example, a push-pull pair of 45's with an amplification factor of only 3.5 needed at least 100 volts grid-to-grid drive, for full output. This placed considerable demands on the driver valve, whose distortion could easily exceed that of the output stage. Transformer coupling eased the problem considerably, but good quality examples were very expensive.

The only way to raise the amplification factor of a valve without sacrificing low anode resistance was to increase the mutual conductance. This could be achieved by reducing grid to cathode spacing, which was difficult to do reliably with existing assembly methods, or alternatively by increasing the cathode area.

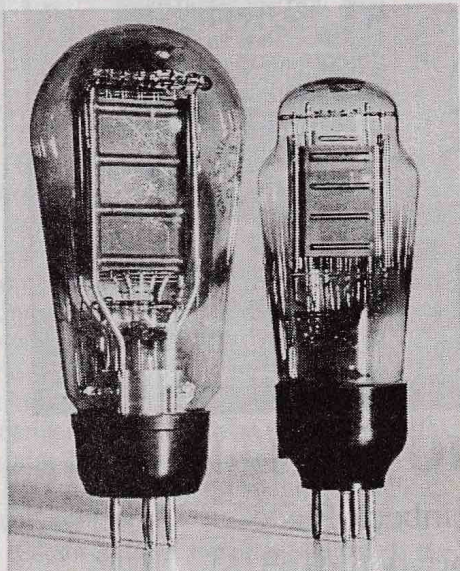


Fig.1: Marconi-Osram's PX4 of 1929 represented a major advance in British power triode development, and was copied by other makers. A typical example is the Cossor 4XP, on the right. At left is the massive PX25, the largest PX4 derivative and a favourite British power triode.

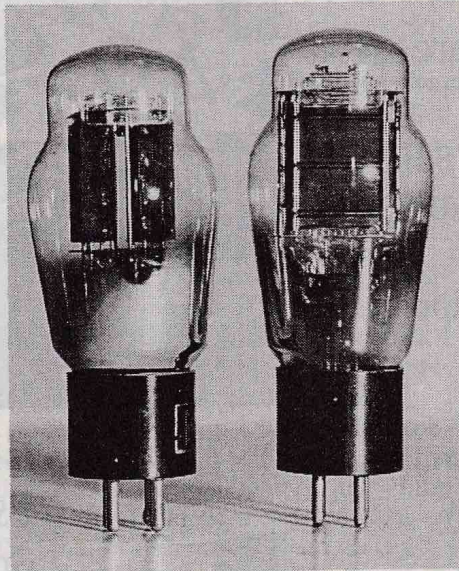
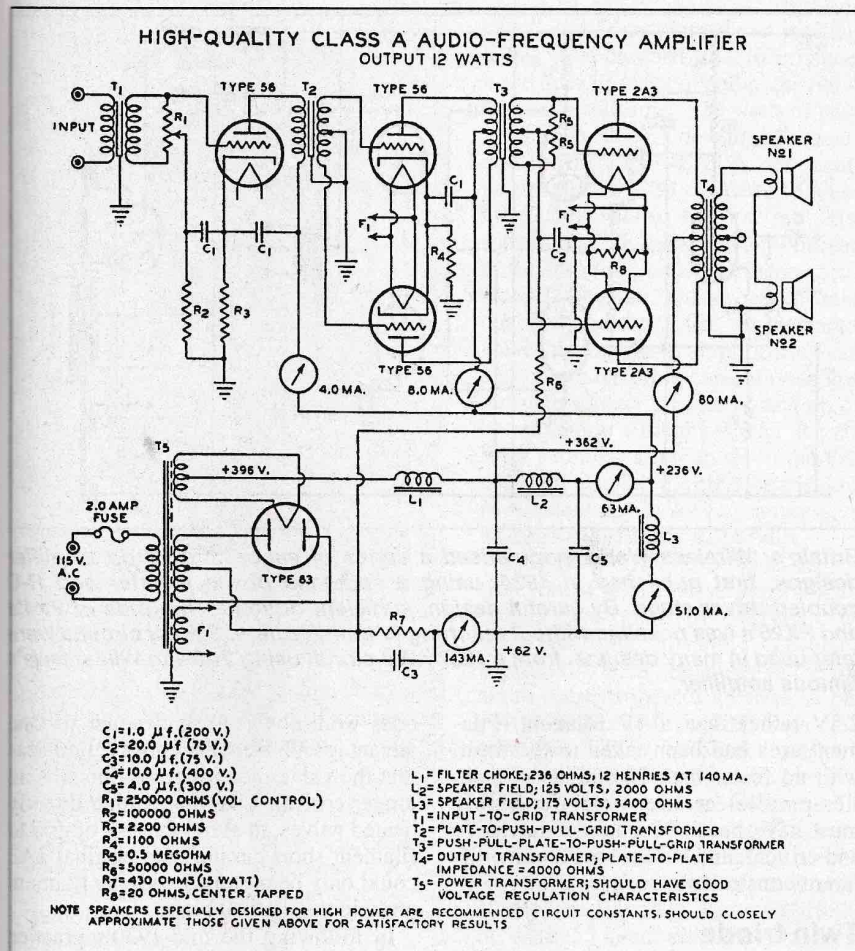


Fig.2: The original American 2A3 on the right had much in common with the PX4, but with a 20-strand filament (the bottom row of hooks is just visible below the anode). On the left is the later and more common pattern, which is effectively two identical triodes connected in parallel.



From the RCA tube manual of 1933, this circuit is typical of American triode amplifier practice in the early 1930's. Transformer coupling simplified the problems of providing sufficient drive for the output stage, but were prone to hum pickup. High quality transformers were also extremely expensive.

In October 1929, shortly following RCA's announcement of the 45, Marconi-Osram in Britain released the excellent PX4. This was to become the first of the new generation of output triodes, achieving a mutual conductance figure of no less than 6mA/V — three times that of the 45 — together with a 40% increase in amplification factor and a considerable increase in power output.

Element spacings were reduced, but most significantly, the cathode area was substantially increased. Whereas output valve filaments previously had been 'M' shaped with four strands, the PX4 had eight strands in a double-M formation.

The improvement was impressive. With an anode resistance of only 830 ohms, an amplification factor of 5, and anode dissipation progressively up-rated from 10 watts to 15 watts, a single PX4 was eventually capable of producing nearly twice as much audio power as a 45, but with less drive voltage. In push-pull, a self biased pair with 350 volts

HT supply was rated at 14 watts output. The PX4 was to remain in the catalogs until about 1960, 30 years after its debut.

Other British valve makers soon produced their equivalents of the PX4, and — true to form — used their own identification systems. Cossor barely dis-

SINGLE VALVE: TYPICAL CHARACTERISTICS

TYPE	ANODE VOLTS	ANODE mA	ANODE RES	AMP. FACTOR	GRID BIAS	MUTUAL COND	POWER O'PUT
50	450	55	1800	3.8	84	2.1	4.6
PX4	300	50	830	5.0	45	5.0	3.5
PX25	500	50	1265	9.5	50	7.5	8.5
2A3	250	60	800	4.2	45	5.25	3.5
300B	300	62	700	3.8	58	5.4	4.5
KT66	400	62	1450	8.0	38	5.5	5.8

The published characteristics of valves were somewhat idealised. Production tolerances could vary 25% above or below the nominal figure.

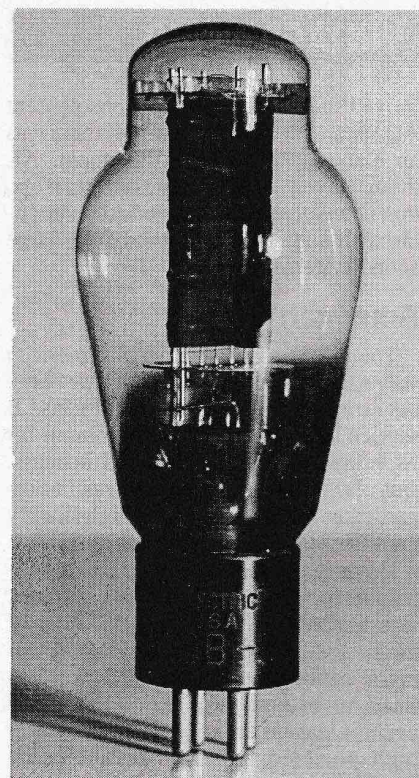


Fig.3: 1933 saw the final development of the traditional power triode. For many enthusiasts the Western Electric 300B, still in production after 60 years, is the finest of its type ever produced.

guised their version as the 4XP; Mullard made the ACO44; Ferranti produced the LP4, Mazda the PP3/250 and Tungstam had the P12/250. British researchers had been working on new pentodes also and by 1931 England led the world in output valve design.

In 1932 Marconi-Osram produced the gigantic PX25, the suffix '25' referring to the anode dissipation of 25 watts. With a mutual conductance of no less than 7.5mA/V and an amplification factor of 9.5, the PX25 was a considerably im-

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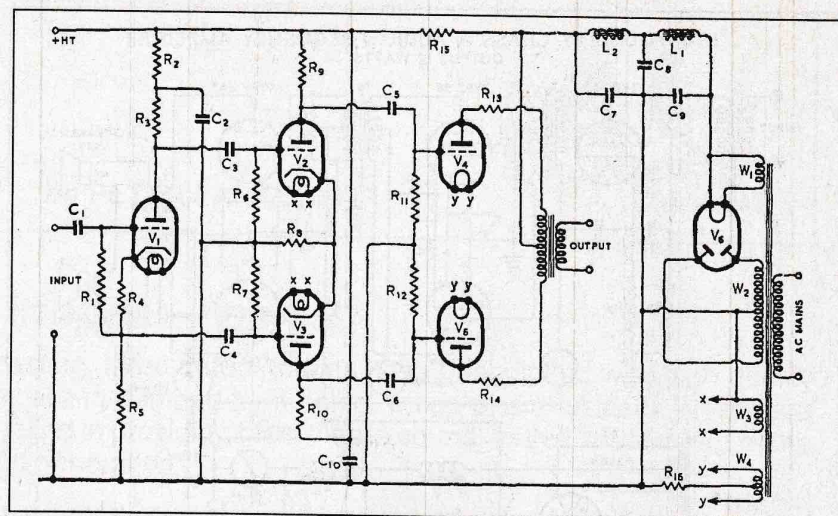
proved successor to the now obsolescent American 50. As with the PX4, there was an elaborate eight-strand filament. Although rarely used in domestic receivers, this new valve was destined to be popular with audio enthusiasts and for large sound systems.

American revival

There was a resurgence of American valve development in 1932. One large new triode, the 46, intended for Class B service and described in this column for November 1991, had limited success. But class B valve operation was not regarded as being suitable for high fidelity amplification.

However, a new triode, expressly intended for high quality audio systems, was announced early in 1933. One of the first valves to use the new alpha-numeric naming system, the 2A3 was destined to become a classic. For many years it was a favourite for high quality high powered applications, including up-market receivers, gramophones and the new electronic organs. Although eventually superseded in many applications by the 6L6 and similar beam tetrodes, as late as 1961 the 2A3 was listed as a current type in the RCA valve manual, and is still available today — but now made in China!

Initially, the 2A3 construction had more than a superficial resemblance to the PX4. It also had significantly similar characteristics, although with a



Britain's 'Wireless World' popularised a series of successful triode amplifier designs, first published in 1934, using a split-load phase inverter and R-C coupled driver stage. By careful design, sufficient drive for the grids of PX4's and PX25's was possible without resorting to transformers. Similar circuits were later used in many designs, from a 1937 AWW circuit using 2A3's to Williamson's famous amplifier.

2.5V rather than a 4V filament. Filament area had been taken to the limit, with no fewer than 20 strands in a series-parallel arrangement. Assembly must have been very labour intensive and critical, and before long a quite different construction appeared.

Twin triode

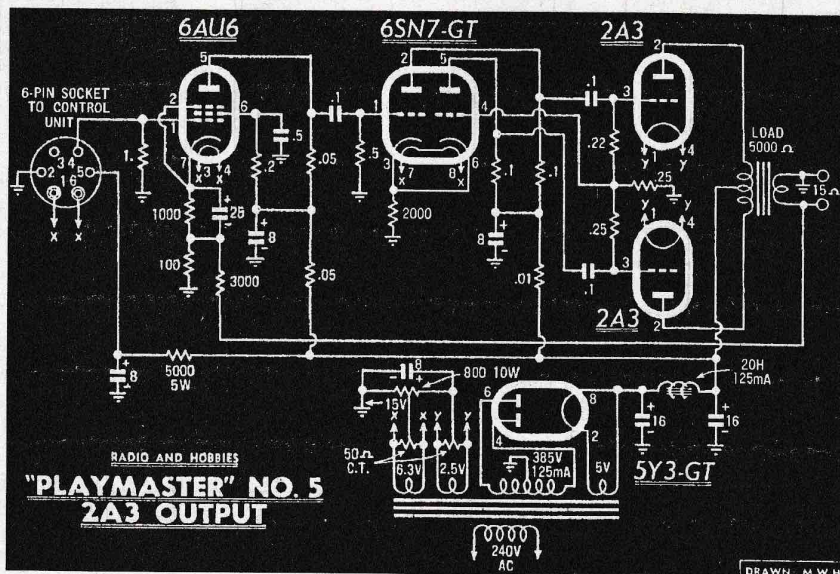
This second type of 2A3 was really two valves in parallel, each with the simpler four-strand M filament. Some makers used a single assembly for the two anodes, but in other patterns the two tri-

odes were physically independent. One advantage of the new construction was that the valve mounting position was no longer critical. Like many other directly heated valves, to avoid the risk of grid to filament short circuits, the original 2A3 could only be mounted with the filament array in the vertical plane.

In following the mid-1930's practice of duplicating the 2.5-volt filament series of valves in the 6.3V range, some American valve manufacturers made the otherwise identical 6A3. Whether or not this duplication was warranted technically is open to question, as individual transformer windings for the directly heated triodes were recommended anyway, and there would have been fewer hum problems with the lower voltage filaments. Later, around 1937, again to keep up with fashion, the 6A3 was given an octal base and titled the 6B4G.

There was yet another modification attempted by at least one manufacturer. All the big triodes had directly heated filaments, as before 1933, indirectly heated cathode technology had not advanced sufficiently to cope with heavy anode current demands. Around 1935, however, there was a strange variation from Raytheon, and possibly other makers. The 2A3H was fitted with cathode sleeves connected, not to a separate terminal pin, but to the centre point of the heater.

Similarly, there was a 6.3V indirectly heated octal equivalent, the 6A5G. Possible reasons were hum reduction, or perhaps to provide delay in current demand at switch-on when used with mercury



John Moyle used 2A3's in the 1952 R&H 'Playmaster' No.5. Although push-pull drivers were best, a few phase inverters such as the paraphase type used here, were capable of meeting the stringent drive requirements of the 2A3 grids.

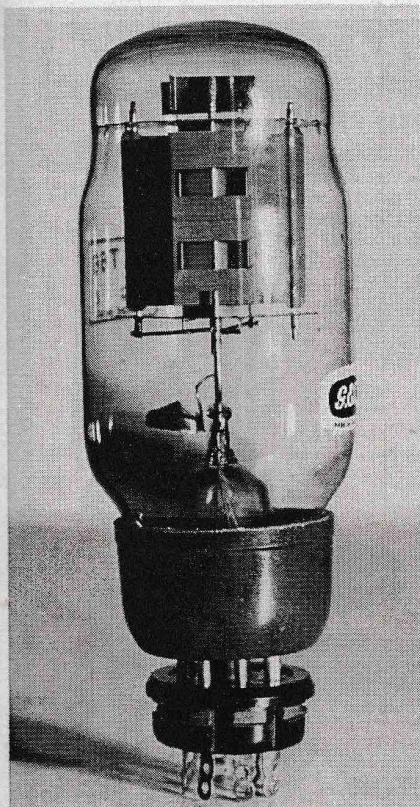


Fig.4: Although a very successful beam tetrode, Marconi-Osram's KT66 achieved considerable international popularity as a triode in amplifiers like the Williamson.

vapour rectifiers. Had the cathode been insulated from the heater, grid biasing might have been simplified, but as it was these valves soon vanished.

Greatest triode of all

The 2A3 family was the last, but very successful, effort by the American RMA in producing big low impedance audio triodes. Later there was to be an unusual output triode that eventually faded into oblivion. The 2B5/6B5 and later equivalent 6N6G had such a high amplification factor that they required a positive grid bias! This caused the grid to draw several milliamperes of continuous current, via a direct coupled small triode in the same envelope — incidentally probably the first commercial application of the cathode follower. These odd valves were efficient, but with an anode resistance of 24,000 ohms, behaved generally more like pentodes.

Western Electric had meanwhile been taking stock. Their aging 205 series described last month was, by 1932, inadequate for any but the lowest powered applications, and alternatively, to use transmitting triodes for medium powered

installations was clumsy and inefficient. It has been claimed that, to produce no more than 12 watts of audio, the old 43A amplifier consumed 325 watts of power!

Western Electric developed a new triode, the magnificent 300A, commencing production in 1933. To permit its use in amplifiers using the earlier skirted socket, in 1938 there was a modification in the form of a small pin inserted in the side of the base. Otherwise unchanged but renamed the 300B, this remarkable valve has the same amplification factor and power handling capability as the 50 but with greater efficiency, and an even lower anode resistance than the 2A3. With a similar sized anode to the PX25, the 300B also has the eight-strand double M filament and looks very impressive in its large and shapely ST19 bulb.

STC for a while also made their version, the 4300B. These superb valves, largely hand made by craftsmen, were made available for public sale and are regarded by many devotees as the finest audio output triode of all time. A push-pull pair operating with 325V on the anodes can deliver 15 watts for a power consumption of only 50 watts.

Note that I use the present tense. I understand that the 300B is still in production, although under the brand name 'CETRON'. Valve manufacture ceased at Western Electric's Kansas City plant in 1988, 55 years after the introduction of the 300A, and to the 300B went the distinction of being the last type produced there.

If I have tempted perfectionist audiophiles to contemplate modifying their favourite amplifiers to take 300B output valves, be warned. The US list price of a single 300B is \$170. According to my calculations, the Australian price for a set of four works out at about \$950 without freight! Compare this with a set of Chinese-made 2A3 valves costing about \$110.

Honorary triode

There were to be no more big triodes. Any further improvements would have been marginal and multi-grid valves were by now quite suitable for most applications, and could be operated as triodes if required.

The next major development in this story was the 6L6 beam tetrode released by RCA in 1936, and capable of turning out massive amounts of power efficiently. Negative feedback enabled these new valves to provide a fidelity comparable with triodes, but with greater efficiency.

Marconi-Osram the following year created their own series of 'kinkless

Collector's Corner

Wiring Diagram Wanted:

I am the Scout Leader at Newmarket Scout Group, and we have just acquired an old AWA Wave Meter Class C, No.1, dated 1942. It tunes from 1470kHz to 10.260MHz, in three ranges. We would really appreciate a copy of the original circuit and/or wiring diagram, so we can restore it to operational condition. Can anyone help?

John Parkin, 49 Barwood Street, Newmarket Queensland 4051.

tetrodes'. The largest was the KT66, equivalent to the 6L6, but with increased voltage and current ratings. As a triode, with the screen grid and anode connected together through a 100-ohm resistor, the KT66 had comparable characteristics to the PX25, but with the advantage of an indirectly heated cathode (by now this was possible for large valves).

This application may have been confined to footnotes on valve data sheets, but for the work a decade later by D.T.N. Williamson. As related in this column for July 1990, he gave details in the April and May 1947 issues of *Wireless World* of an amplifier using a pair of KT66 triodes, which was to set new standards of performance.

Such was the reputation of Williamson's design internationally, that through it the KT66 enjoyed considerable popularity. It is likely that because of this at least as many, if not more, KT66's were used as triodes than as beam tetrodes. So although the KT66 is only an 'honorary triode', it seems a worthy example to conclude this saga. ♦

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