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OCTOBER 2000 No53

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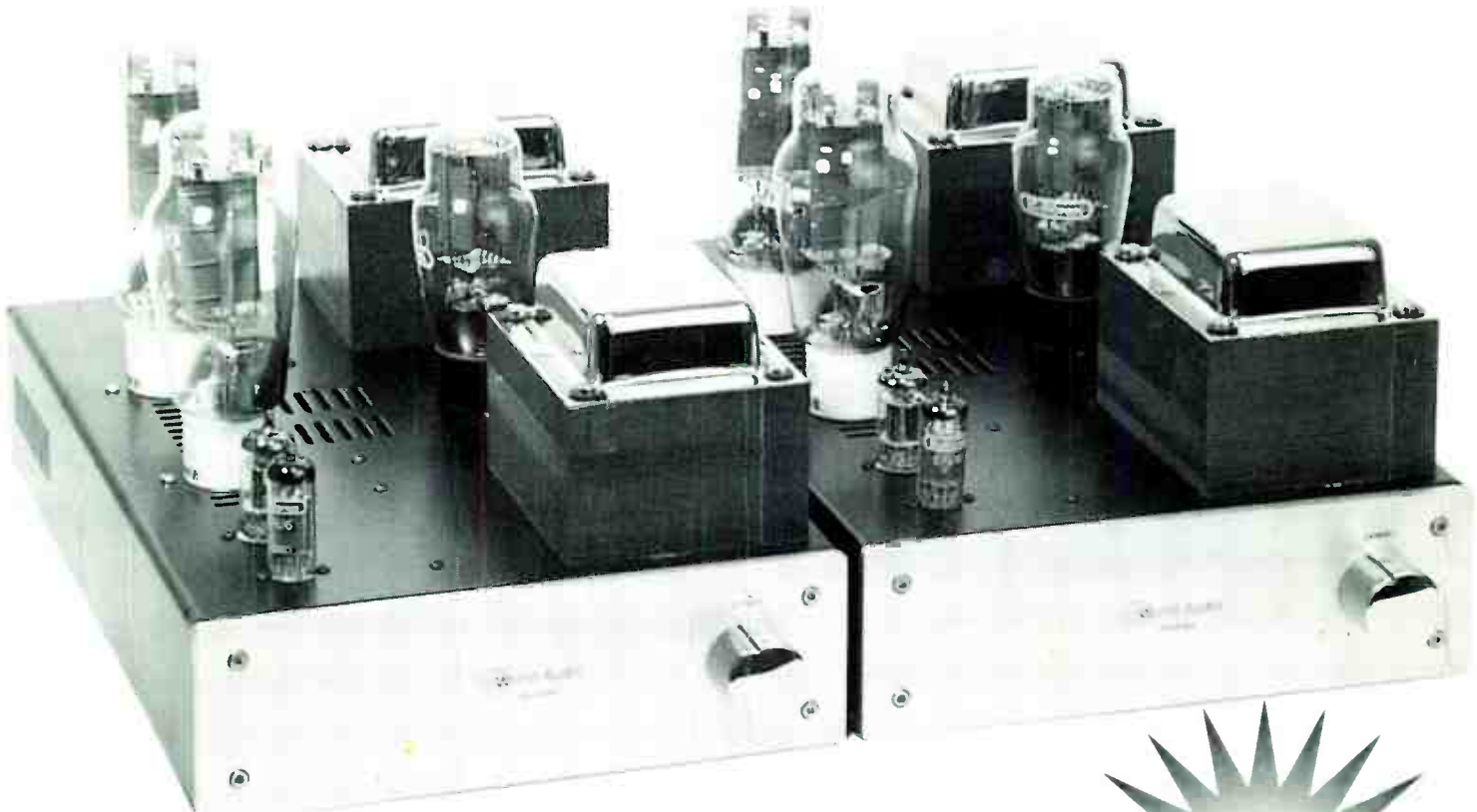

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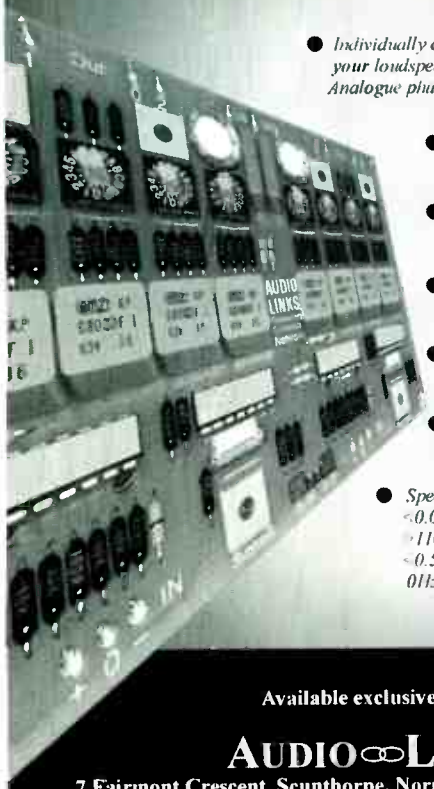

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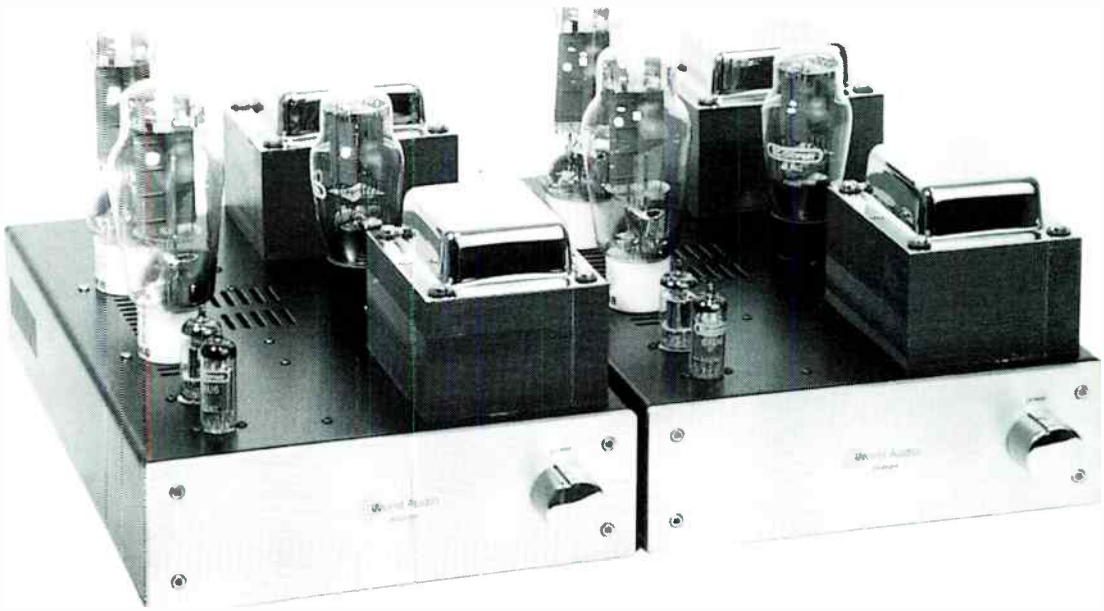

KIT AND COMPONENT NEWS

SYNTRILLIUM RELEASES PRO EQ PLUG-IN FOR COOL EDIT 2000

Cool Edit Pro

Syntrillium Software has released the newest member of the Cool Edit 2000 family of products: the Pro EQ Plug-In.

The manufacturer's press release says: "Cool Edit 2000 ($69) is a professional yet affordable audio recording and editing application for Windows 9x, Windows NT and Windows 2000. The Pro EQ Plug-In adds advanced equalization and filtering tools to Cool Edit 2000. With it, Cool Edit users can apply a subtle or powerful frequency bias with the 10-, 20-, or 30-band Graphic Equalizer. Boost or cut up to five bands with adjustable widths and centre frequencies with the Parametric Equalizer.

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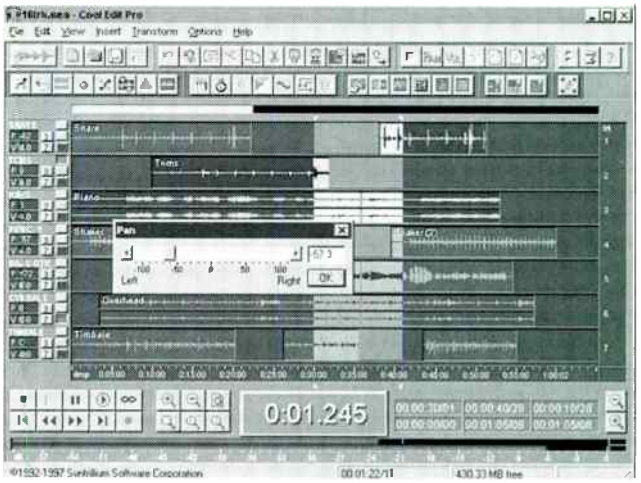

Cool Edit 2000: http://www.syntrillium.com/cooledit, or download the Pro EQ Plug-In directly from http://www.syntrillium.com/download.html?021.

CHELMER VALVES ON WEB

Chelmer Valve have just upgraded their web site to incorporate a discussion forum **(www.chelmervalve.com)** to allow site visitors to exchange news and information on audio tube and amplifier performance.

Chelmer Valve Company was founded in 1961 initially with the objective of supplying electronic valves as spares to government, the military and broadcasters. As well as continuing to supply these customers, the business has expanded over the years both in terms of its worldwide markets and its product portfolio. Semiconductor supply has now become one of the company's core activities.

The company supplies audio tubes under its own CVC brand name and also as requested under third party brand names to customers and distributors around the world.

Regardless of whether the company is providing its own brand tubes or labelling tubes for a third party, the company applies the same high standards for testing tubes. These standards have been developed over many years and are being continuously refined by both in house test engineers and suppliers. Such close co-operation has enabled Chelmer to react swiftly to not only technical issues, but also to requests from customers in terms of technical modifications to valves.

To ensure complete responsiveness to customer needs Chelmer are about to introduce yet another element to the test procedure. Custom built listening rooms will allow evaluation of the audio performance of both existing premium audio tube range and the forthcoming Millennium range of tubes, using a number of different amplifiers. Which just goes to show there's still a lot of interest and business in valve still.

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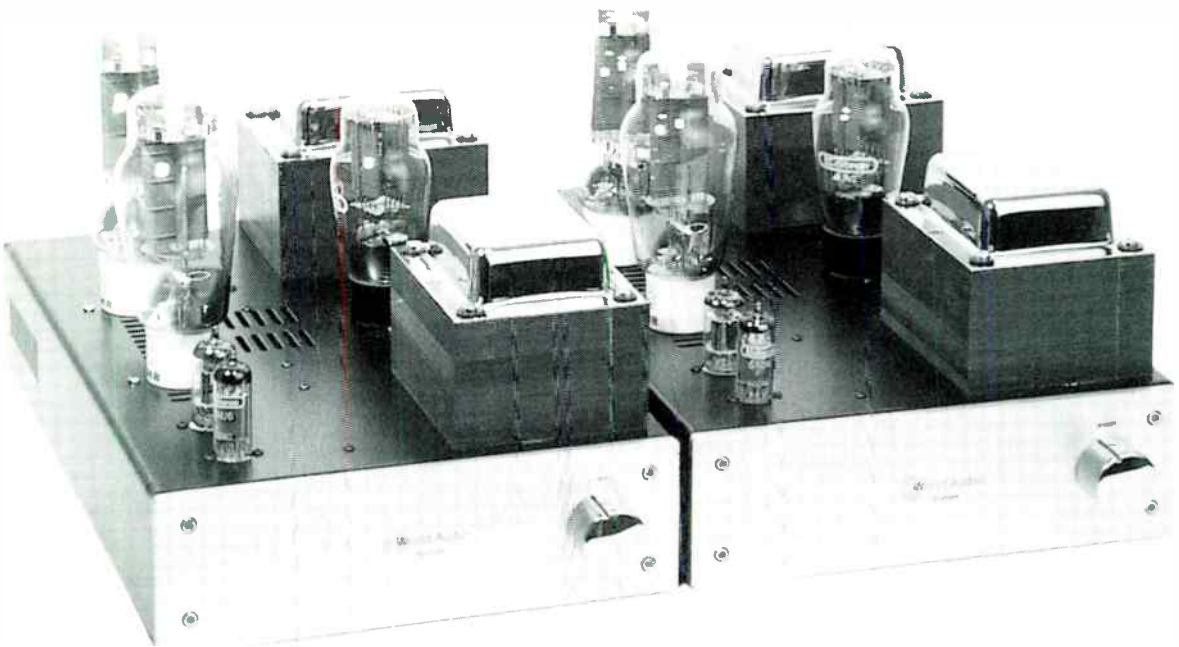


Single-ended amplifiers offer ultimate sound quality. Here's a new, innovative 20W monoblock from expert Gary Devon that advances the state-of-the-art.

INTRODUCTION by Noel Keywood

Just about every amplifier in the world today has a push-pull output stage and negative feedback. The world's first amplifiers, in their extreme simplicity, had neither. Push-pull hadn't been invented, nor had negative feedback, until the late 1930s. Our new amplifier has neither. But, in our case, the adoption of single-ended working isn't an attempt to travel backward in time so much as a desire to produce an amplifier that is fundamentally simple, pure in concept and free from the hidden problems that arise from complexity. It's a drive back to a pure sound untainted by today's overly complex circuits. We've controlled or eliminated the problems that compromised early amplifiers, whilst retaining or even improving upon their simplicity.

Single-ended amplifiers use just one amplifying device in the output stage that drives the loudspeaker. They run in pure Class A to give around 10W per channel from an amplifying device that's dissipating 30W-40W - and getting hot doing so. That's why most single-ended amplifiers produce 3W-10W, hardly enough for even reasonable volume from a loudspeaker. Push-pull gives more power, but it also introduces the need to cross over from one valve or transistor to another, which generates distortion.

It is because push-pull is so much more efficient that every commercial audio amplifier uses it. But is it hi-fi? Not everyone thinks so. It adds complexity, high-order distortion and, some claim, hides low level musical detail in the crossover region. There's no doubt that single-ended amplifiers have an easy going, sweet sound that eludes push-pull designs. That's why we've used it for ultimate audio quality. To get enough power two 300Bs work in parallel share the load, giving 20W per channel.

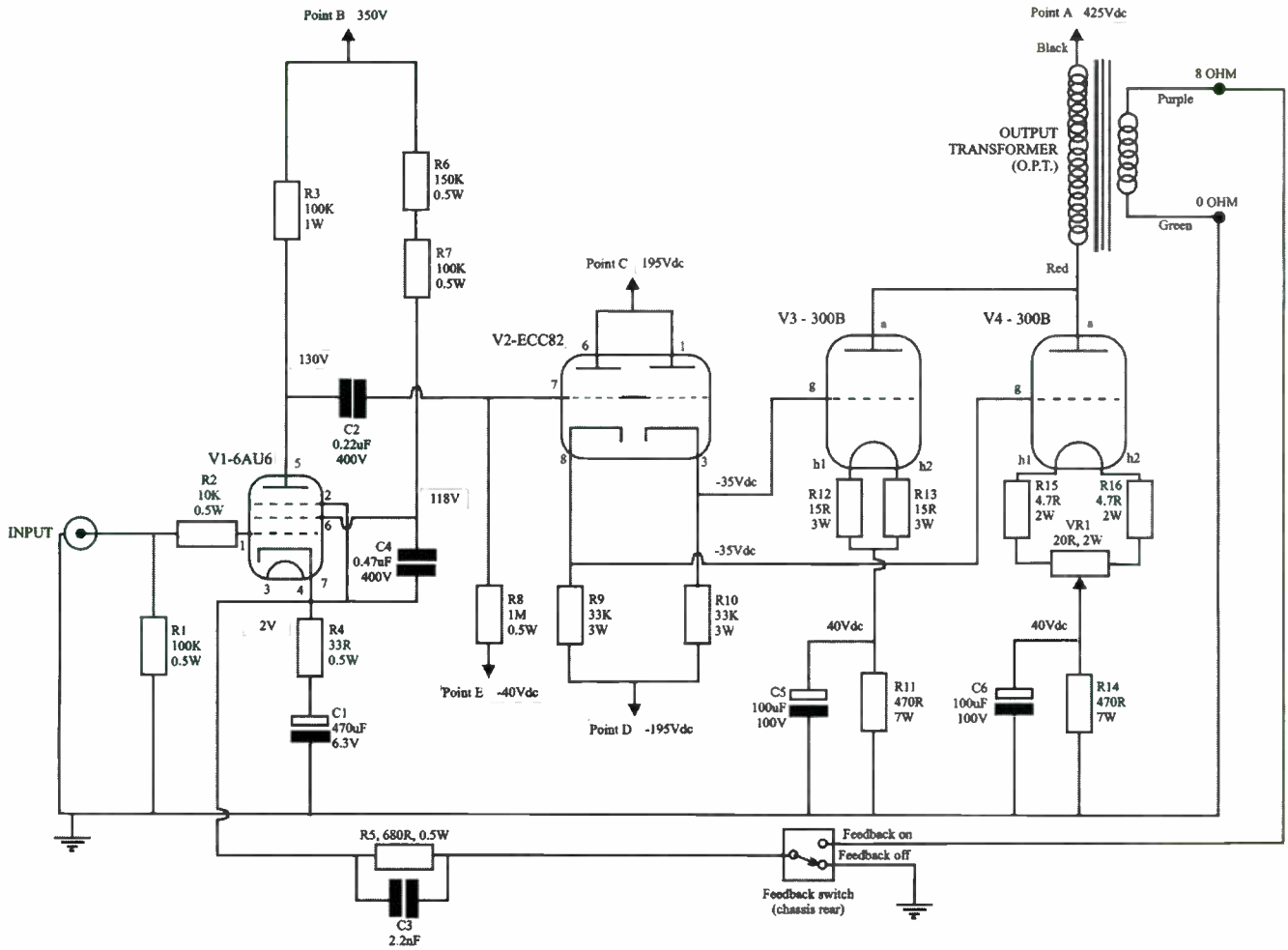
Early single-ended amplifiers produced a lot of second harmonic distortion and could not swing full output at high frequencies. The latter problem in particular was due to poor output transformers. We've tackled this by using large, specially designed output transformers with complex sectionalising to minimise winding capacitance and distributed inductance.

The 300B is a low distortion audio triode. Combined with good transformers distortion has been kept down to acceptable levels even without feedback. Bearing in mind there are no high-order crossover components, second harmonic predominating,, levels around 1-2% are acceptable. All the same, a feedback switch has been included, so users can choose between the two.

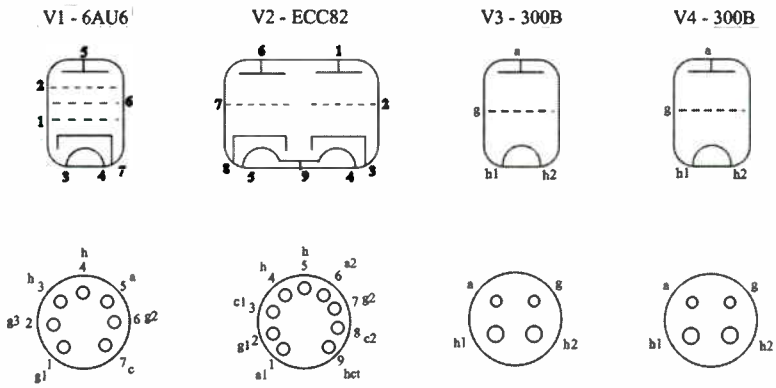
This is more to demonstrate a point than indecision on our part. Applying feedback improves measured performance but, on a

300B PSE MONOBLOC CIRCUIT DIAGRAM

SIGNAL CIRCUIT



VALVE PIN LAYOUT

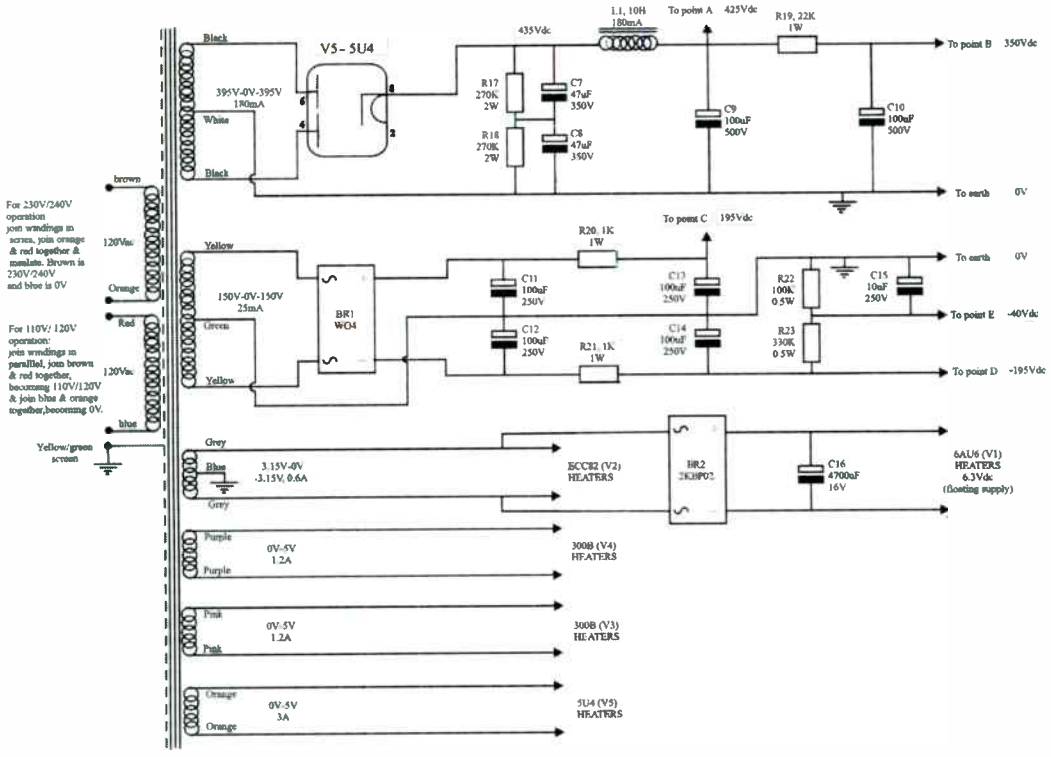


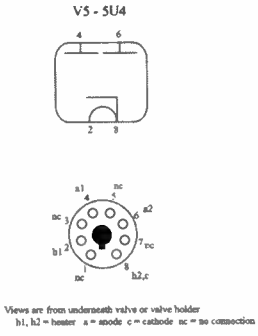
Views are from underneath valve or valve holder
h, h1, h2 = heater hct = heater centre tap c = cathode a = anode g = grid nc = no connection

valve amplifier at least, does not necessarily improve sound quality. In truth, sound quality changes, most people preferring not to use feedback, we found back in 1996, when we produced a 300B push-pull amplifier with optional feedback. Switched off, the sound was easier going and more spacious - very spacious in fact. Feedback tightens and tidies the sound, but it also dries out fluidity, reducing subtlety of expression and greatly compressing the sound stage.

It isn't possible to remove feedback from most amplifiers, and certainly not solid-state amplifiers. The design must be fundamentally linear in the first place. If feedback is needed to improve an amplifier, then by definition the amplifier wasn't good enough to fulfil its role in the first place. If the basic circuit is not good enough to amplify music then can it be made so merely by applying feedback? Solid-state amplifiers must have feedback applied and give acceptable results. Valve amplifiers like this one move beyond the necessity of constraining feedback though. Very few amplifiers in the world truly have no loop or local feedback, because their fundamental quality is sufficiently high not to need it.

CIRCUIT DIAGRAM
POWER SUPPLY CIRCUIT





Views are from underneath valve or valve holder
h1, h2 = heater a = anode c = cathode nc = no connection

THE CIRCUIT **by Gary Devon**

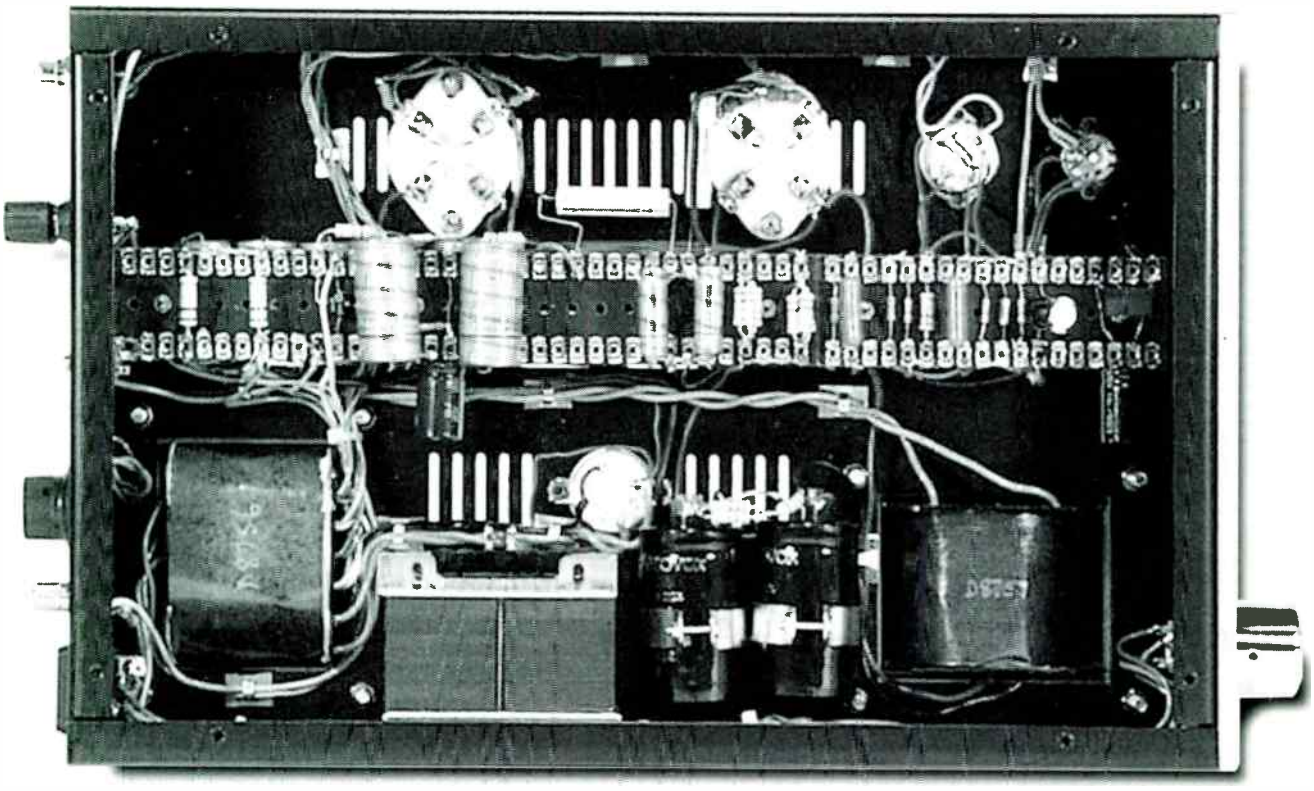
When designing a single-ended triode amplifier there are alternative valves to the 300B, like the 10Y and 2A3. Unfortunately they produce such low power they are pretty useless unless you have very high sensitivity loudspeakers. Any amplifier needs to produce a reasonable amount of power in order to drive an ordinary loudspeaker. Apart from either very rare types like the DA60, or high voltage transmitter triodes, there isn't much around to use in a realistically powered amplifier except the 300B. This valve has achieved cult status due to its heritage, ease of use and luxurious sound quality. A single 300B will deliver around 8W to 10W, possibly more if pushed. To get more power two must be paralleled.

The 300 (A and B) valve was designed by Western Electric, and used in their Westrex cinema reproduction amplifiers, most notably the WE91. This amplifier used a 310 pentode to drive the 300, with a 274 valve rectifier for the H.T. in a circuit that is regarded as a classic. It is unfortunate that nowadays the small-signal pentode has fallen from grace in popular estimation; something along the lines of output pentodes are bad, therefore ALL pentodes are bad.

Notwithstanding this, there are good reasons for using a pentode to drive a 300B. First - and possibly most important - only one stage is required to achieve the necessary gain; two triode sections are required in the place of the pentode, with attendant phase shift and colouration build-up. Secondly, there is a philosophy which dictates that in this type of amplifier each stage should be of a different type, again to avoid the build-up of any particular character.

The general problem with small signal pentodes is their high output impedance, which is more or less equal to the anode load resistor. This creates two problems: the loading effect of the triode will cause a reduction in bandwidth and increase distortion at the overload point, where the output valve grid reaches 0V, there is a very harsh clipping point and grid rectification causes a change in output stage quiescent current. This effect is present when any RC coupled power stage reaches its 0V grid voltage point, whether driven by a triode or a pentode.

In order to overcome these problems our 300B design has a dual cathode follower placed between the pentode and the 300Bs. Each 300B's grid is direct coupled to its own cathode follower driver. This eliminates the problem of grid current at overload and provides the pentode (a 6AU6 in this case) with



Internal view of the 300B PSE Monobloc

a high interface impedance. With this topology there is only one capacitor in the signal path, one gain block and the driver and output valves.

The amplifier has a feedback loop, giving around 6dB of feedback, which is a low value but it serves a useful purpose. Without feedback the output impedance would be about 2Ω. Because the input impedance of most loudspeakers varies considerably, the high output impedance will cause a change in the frequency response of the speaker. The small amount of feedback helps to bring all of this under control, by increasing the so-called damping factor. It is possible to modify the amplifier slightly to take away the feedback if so desired (see circuit description).

This amplifier also uses a valve rectifier for the H.T., a 5U4. Nowadays most valve amplifiers use solid-state rectification, but the valve rectifier gives a far smoother, more relaxed sound than a silicon diode bridge. Even here a compromise has had to have been made and the cathode follower's separate supply uses silicon diodes, but the cathode follower is far less sensitive to its supplies than the input and power stages.

The power transformer is of the laminated EI type, which eliminates any possible saturation problems when the power line has a small amount of DC on it - a surprisingly common problem. Toroidal mains transformers have a very small core area and a large number of primary turns which makes them very susceptible to mains DC offset.

To complete the picture: the input valve is the old favourite 6AU6 pentode. This time it is actually connected as a pentode with its screen grid supplied by R6/R7 and bypassed by C4.

C4 is connected directly between the screen grid and the cathode to keep the recirculating screen current within a small loop.

R3 is the valve's anode resistor, R2 the precautionary grid stopper and R1 the grid leak. R4 and C1 form part of the feedback network with R5/C3. The bias voltage is built up across R5, the feedback resistor. The amplified input signal is coupled to the two cathode followers via C2. R8 is connected to a negative potential of -46V to supply a portion of the 300Bs' bias.

The cathode followers have their own power supply of 200V, R9 and R10 being the cathode resistors for the followers. The outputs of the cathode follower drivers are taken directly to the 300B grids, providing direct drive and a portion of fixed bias. The two ends of the 300Bs' filaments are taken via a hum-bucking network to the cathode resistors R11 and R14, which are bypassed by C5 and C6. The anodes of the 300Bs are taken to the output transformer which has a primary impedance of 1.5kΩ. The output transformer is a hefty chunk of iron, far larger than that which would be used for a push-pull amplifier of similar power output. In fact the transformer's core area is 3.37 square inches. This huge lump is used because there is a considerable standing current in the primary winding which magnetizes the core, decreasing the available swing over the iron's BH curve. An air gap is incorporated to set the iron's optimum operating point.

The power supply is straightforward: the main H.T. is rectified by V5, a 5U4 directly heated rectifier valve, and is smoothed and filtered by C7, C8, C9 and L1. R19 is a dropper resistor for the input stage and C10 is that stage's power supply decoupling capacitor. The driver stage's power supply is conventional with a bridge rectifier with smoothing and decoupling components. R22, R23, and C15 provide the negative bias voltage.

MEASURED PERFORMANCE by Noel Keywood

A modern, sensitive eight-ohm loudspeaker, like the World Audio Design KLS-9, which produces 90dB or so from one watt, needs a minimum of twenty watts to produce reasonably high volume in the average sized room. The World Audio Design monoblocks produce 20watts, or a little more with feedback off and working into soft clip. The large output transformer core allows full output to be delivered at 40Hz, so there's no limitation in bass power.

Single-ended amplifiers produce distortion but it is largely second harmonic, which has no impact upon sound quality below levels of around 3-5%. Above this it lightens timbre; it does not add coarseness or any other nastiness. These monoblocks produce pure second harmonic distortion at one watt output, level measuring 0.2% with feedback on, or 0.55% with it off, irrespective of frequency. There's no rise in distortion with frequency in a single-ended too.

Close to full output, levels rose to 0.8% with feedback on and 2% with feedback off. Our 300B push-pull amplifier with switchable feedback, now discontinued, showed that most listeners preferred feedback off, in spite of similar figures. Subjectively, it gave a more open, relaxed and natural sound.

Frequency response was wide, extending from 20Hz to 34kHz with feedback off. The output transformer rolls off smoothly, possessing no resonant peaks. It does not slew at high outputs and high frequencies too, as the 0.8%/2% distortion figure at 10kHz, full output shows.

The 300B is a linear audio triode with a great set of properties suited to feedbackless amplification. However, it has direct heaters, lacking a cathode. Hum bucking must be used, but there's always a little remaining hum. At 2mV with feedback on it's small and inaudible at the listening position, if not at the loudspeaker. With feedback off this figure rises to 4mV which may just be audible at the listening position, in a quiet room. It is inaudible with music playing, even at the lowest level. There's no hiss.

If used with feedback, 1V of input is needed for full output. With feedback off the figure drops to 380mV. A CD player, with its 2V maximum output, will provide full drive through a passive preamp., but otherwise an active preamp. will be needed.

An inherently linear 300B based single-ended amplifier without feedback is notionally the simplest and therefore the most ideal form of amplifier it is possible to design. This one has a measured performance that meets hi-fi criteria, with sufficient power bandwidth to handle modern music properly, plus low enough distortion to avoid any influence upon sound quality.

Power	20watts
Frequency response	20Hz-34kHz
Noise (CCIR wtd)	-102dB
Hum (f.b./no f.b.)	2mV/4mV
Distortion (f.b./no f.b.)	0.2% / 0.8%
Sensitivity (f.b./no f.b.)	1V / 380mV

THE KIT by Nick Lucas

Our 300B PSE Monobloc kit bears an affordable price tag of £795 per monobloc pair (excluding valves) - far less than the £2500 plus of some of its ready-built competitors. Despite this, we offer professional-look kits with a 2mm mild steel chassis with black powder coat finish. Both visible transformers are topped with chrome transformer caps and the front sports our familiar 6mm anodised fascia with chrome power control knob. Chassis dimensions of each monobloc are 250mm(w) x 380mm(d) x 220mm(h) with valves inserted.

Tag boards and hard-wiring provide a cleaner sound than printed circuit boards, and you get to know what is actually going on inside your amplifier better. On the down side, this technique makes building slightly trickier.

With our original 300B push-pull amp we used solid-state rectification on the H.T. line but incorporated a valve to achieve a soft start. This time we have gone straight for valve rectification with the help of the 5U4 of Russian manufacturer (still made). These are extremely robust, reliable and look good too.

This amplifier uses an E/I transformer for the mains, a heavy beast of the same proportions as the output transformer, plus a 10H smoothing choke to provide a pure H.T. line, essential with directly heated triodes to suppress hum.

The kit is of the high standard associated with all our kits. Input is via chunky gold-plated insulated phono sockets, with mains through an IEC lead into the chassis mounted socket. We fit the same gold plated 4mm speaker connectors now common on commercial amplifiers. The white ceramic valve sockets are chassis mounted, fixed through the chassis without exposing the ring fittings. Three lengths of tag board are provided, each carrying 18 pairs of terminals.

The components in this kit are good quality of course: Nover type TE and BC Component axial electrolytics; Panasonic M series radial electrolytic; a couple of Aerovox electrolytic radial cans; Philips orange 386 series signal capacitors; carbon film resistors and silver plated copper wire for all low current links.

We have arranged with our valve supplier to get the best prices to keep the price of a valve set to the minimum. We have selected Eastern European 6AU6 and ECC82 and the Tesla 300B for quality.

The 300B PSE Monobloc kit offers a challenge due to its hard-wire construction, but there are plenty of diagrams for guidance. As long as you follow the instructions carefully it should be plain sailing. There are no tricky setup procedures; the only thing that needs adjusting is the hum-bucker potentiometer which adjusts the 300B valves for minimum hum. We have a help-line manned 9am to 5pm weekdays, and a full back up service including arranging the collection of your amplifier should difficulties arise.

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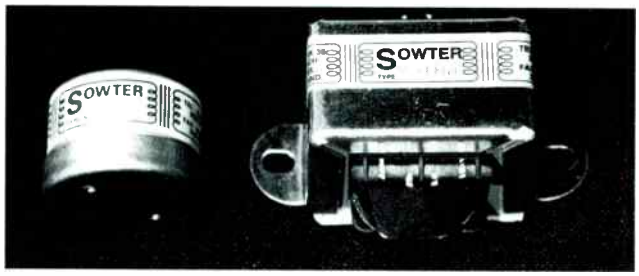

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300B PSE SOUND QUALITY

Simon Pope

Not to put too fine a point on it, the sound that these monoblocs create is among the finest that can be encountered in hi-fi. The feeling of sheer space and breadth that we heard during listening tests was simply breathtaking.

We started the ball rolling with Massive Attack's 'Blue Lines' album on vinyl. Using a Michell Gyrodec SE, modified Rega RB300 arm and an Ortofon MC30 Supreme through World Audio Design's Series II preamp and the matching Phono II in MC mode. We fed the 300B PSEs a healthy dose of 'Unfinished Sympathy'. KEF's Reference One - Two 'speakers were driven easily with great control, with the volume pot barely turned! After the spacious sound of the opening reverbed scratching, the bass kicked in with power and a stamp of authority. The feedback switch was tried first in 'feedback-less' mode, making vocal lines and strings open and airy, with a sweet treble exclusive to the tube sound (ideal for acoustic music), whilst in 'feedback' mode the sound was tightened and more sheer clout was present.

'Musical' is a word used often (and all too wrongly) in hi-fi reviews, but here it seems the only word to describe the 300B PSE sound. Line phrases and intricate details are exposed as a part of a large tapestry of sound that brings listening to a different level. Backing vocals and electronic effects in the Massive Attack track become part of the music rather than mere effects in a sound scape.

To try out the speed and power of the 300B PSE amps, we next treated them to the excellent sound of Stravinsky's The Rite Of Spring on the Reference Recordings CD with the Minnesota Orchestra. This is one of the finest audiophile recordings on the market and a brilliant demo disc. The last five minutes of this piece are enough to test the mettle of both the finest equipment and performers alike and the 300Bs made swift work of the multi-tiered orchestration. Deep percussion was lightning fast and tight, whilst screeching woodwind and raspy trumpets were exciting but remained smooth and well-rounded. Sound staging was simply jaw-dropping, the bass drum being perfectly placed to the back left and the timpanist sitting smack bang in the bay window behind the hi-fi rack!

Another fine trait these amps have that was highlighted by the Stravinsky recording was dynamics: one moment the orchestration cuts down to the bare bones; the next all is let loose, including the kitchen sink. With these effects the 300B PSEs showed that they could handle these contrasts perfectly, with headroom to spare.

The 300B PSEs are very fine amps indeed that show up everything that's enjoyable about a good valve amp. Tonal colour, balance and dynamics all add up to a very affordable taste of real high-end!

300B PSE PARTS LIST - (FOR ONE MONOBLOC)

RESISTORS: SIGNAL CIRCUIT

R1	100K, 0.5W	1
R2	10K, 0.5W	1
R3	100K, 1W	1
R4	33R, 0.5W	1
R5	680R, 0.5W	1
R6	150K, 0.5W	1
R7	100K, 0.5W	1
R8	1M, 0.5W	1
R9	33K, 3W	1
R10	33K, 3W	1
R11	470R, 7W	1
R12	15R, 3W	1
R13	15R, 3W	1
R14	470R, 7W	1
R15	4.7R, 2W	1
R16	4.7R, 2W	1
VR1	20R, 2W	1

RESISTORS: POWER SUPPLY CIRCUIT

R17	220K, 2W	1
R18	220K, 2W	1
R19	15K, 1W	1
R20	1K, 1W	1
R21	1K, 1W	1
R22	100K, 0.5W	1
R23	330K, 0.5W	1

CAPACITORS: SIGNAL CIRCUIT

C1	470uF, 10V	1
C2	0.22uF, 400V	1
C3	22nF, 160V	1
C4	0.47uF, 400V	1
C5	100uF, 100V	1
C6	100uF, 100V	1

CAPACITORS: POWER SUPPLY CIRCUIT

C7	47uF, 350V	1
C8	47uF, 350V	1
C9	100uF, 500V	1
C10	100uF, 500V	1
C11	100uF, 250V	1
C12	100uF, 250V	1
C13	100uF, 250V	1
C14	100uF, 250V	1
C15	10uF, 250V	1
C16	4700uF, 16V	1
BR1	WO4 bridge rectifier	1
BR2	2KBP02	1

TRANSFORMERS

OUTPUT	E/I 120 lam	1
MAINS	E/I 120 lam	1
CHOKE	10H	1

wire	various
tag strip	3
chrome knobs	1
chassis	1
front plate	1
safety gloves	1
instruction book	1

VALVES

300B Tesla	2
5U4	1
6AU6	1
ECC82	1

HARDWARE

mains switch rotary	1
feedback toggle switch	1
Fuse 1A slow blow	1
Black phono socket	1
red phono socket	1
4mm speaker sockets	1
IEC lead	1
self adhesive feet	4
IEC + fuse inlet socket	1
Chrome 120 caps	2
stand-offs 25mm	4
earth post	1
knob for VR1	1
M3 x 10 but screws	16
M3 x 10 screws	12
M3 nut	12
grub screw	1
cable ties	5
cable clips	5
capacitor clips	2
UX4 valve bases	2
Octal valve base	1
B9A valve base	1
B7G valve base	1

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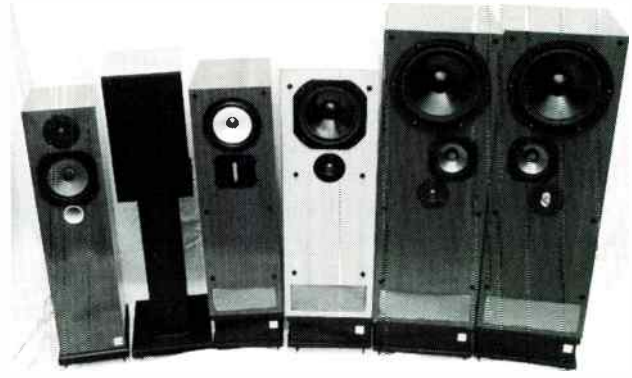

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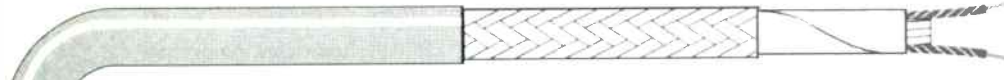

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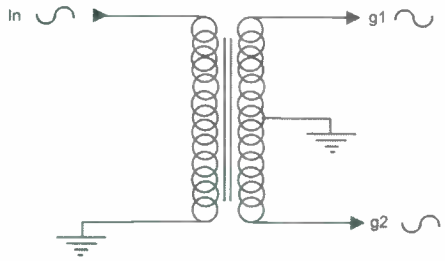
Phase Splitters

A push-pull amplifier needs a phase-splitter. This is the circuit single-ended amplifiers lack. Designer Gary Devon explains how they work - and the problems.

Diagram 1



Phase splitting can be achieved by transformer (left). This shows the basic principle.

In any push-pull amplifier some sort of phase splitter or phase inverter is required as the two output valves are driven antiphase to each other. The current in one valve is increasing while in the other it is decreasing over the signal cycle. This mode of operation brings performance benefits such as increased maximum power output, lower distortion by cancellation of even harmonics and better use is made of the output transformer iron's B/H curve which results in more bass power per cc of iron. There are many and varied ways of achieving the two antiphase signals from the original (usually) single-ended input. Accurate balance of the two drive signals is important to realise the full benefits of push-pull, and this balance must be maintainec across the full bandwidth of the system.

The conceptually simplest phase splitting method is passively via the use of a transformer with a centre-tapped secondary, often 1:1+1 ratio, (Diagram 1). The signal at the two transformer outputs marked g1 and g2 are 180 degrees out of phase with each other, and the centre-tap is grounded. Transformers like this have advantages and disadvantages. The grids of the output valves have a low impedance DC ground path which makes recovery from overload clean, and prevents any nasties due to excessive grid current. The problem with it is that one half of the secondary is in phase with the input signal and the other half is out of phase with it. Capacitive coupling from primary to the secondaries necessitates the use of primary to secondary electrostatic screens to achieve a balanced output but at the expense of bandwidth. Good performance is possible but the costs mount up.

It 's possible to rig up a triode with 100% feedback from it's anode to it's grid giving an output gain of approximately -1 (a gain of 1 but 180 degree phase shifted), (Diagram 2). If we used the original input signal plus the signal which has passed the anode follower we have a pair of antiphase signals. By careful adjustment of the resistor values an accurate -1 signal can be gained from the output of this phase inverter with good stability over time and with good bandwidth because of the high feedback ratio. An improved version would buffer the input signal with a cathode follower to increase the circuit's input impedance and to achieve similar source impedances for the two antiphase signals (Diagram 3).

A conceptual development of this anode follower type is to drive the input of the inverting follower from another valve, this time with gain. This can be done as (Diagram 4) which is similar to the phase splitter used in the QUAD II, where a potential divider reduces the amplitude of the signal from V1 by a ratio which is the same as that of V2's gain (Diagram 4). Then the two signals should be antiphase with each other and equal in amplitude. This type is known as the Paraphase circuit. The problem with the paraphase is that unless measures are taken to prevent it, the output balance will vary with time as the valves age and their gain drops. Also the frequency response of the two output signals is different resulting in distortion at high frequen-

Diagram 2

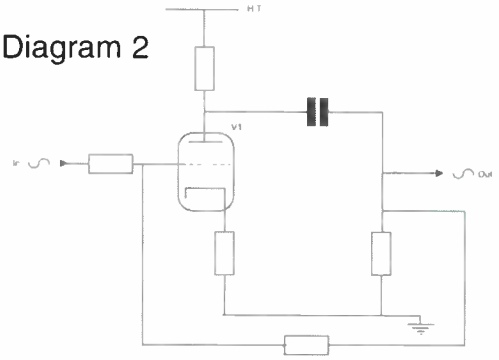


Diagram 3

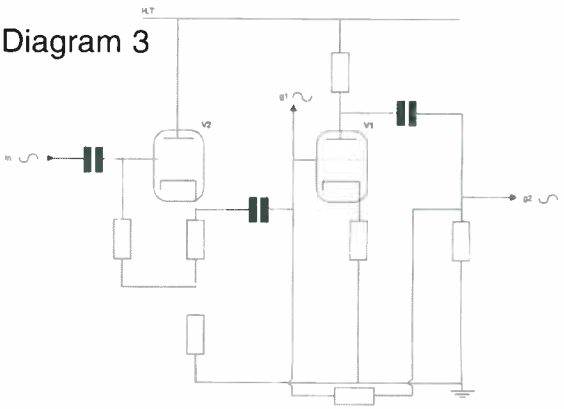
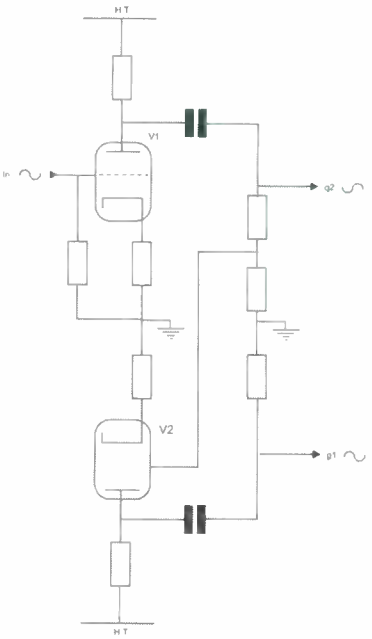


Diagram 4



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cies as balance is lost. An improved version of this concept is diagram 5 called the See-Saw or Floating Paraphase. Here the point at which the signal for the inverter valve is taken is not referenced to ground but floats. By making R2 slightly larger than R1 to make up for the finite gain of V2 a balanced output can be achieved. Here V2 has a large amount of local feedback so that there is much less drift over time, and the frequency response is better than that of the standard paraphase. The floating paraphase is not perfect though and suffers from differing output impedances for the two output signals.

Now we go to a far simpler phase inverter, the Concertina (Diagram 6). Here a single valve is used with equal anode and cathode resistors. It is easy to see how this one works. Consider a positive input signal at V1's grid. This will cause a similar voltage rise at the valve's cathode across R2, drawing a current which causes a drop in voltage at V1's anode. As R1 and R2 are the same value the voltages will be the same but antiphase. There are some disadvantages with the concertina. Firstly the stage has no gain, but as triodes are usually available in dual packages another gain stage can be put in front so maybe that isn't a problem after all. There is also the problem of differing and somewhat high output impedances at the two output nodes. This results in imbalance at high frequencies. I have seen suggestions of placing a resistor in series with the cathode-sided output, but in practice it doesn't actually work that well, and may as well be left out. The concertina will remain well balanced at low frequencies for the life of the valve due to the high feedback ratio.

Now we progress to the cathode-coupled, or Long Tailed Pair phase splitter so often seen (Diagram 7). Here it is presented with a current source as a tail load, which is the ideal case. A signal at V1's grid causes the current through the valve to increase, as the tail load is a constant current source then the current through V2 must decrease by exactly the same amount. Therefore the amplified signals at the anodes of V1 and V2 are equal but antiphase. It is also possible to apply a signal to the grid of V2. Circuits similar to this are used at the inputs of operational amplifiers and most other types of solid-state amplifiers using FETs or bipolar transistors instead of valves. The circuit will try to reject signals which are the same at both grids (common mode) but will amplify those which are different (differential mode). If the signal from another phase splitter is fed to the grids of the long tailed pair it will improve the balance of those signals. This is what D.T.N. Williamson did in his famous amplifier. See Diagram 8. If a resistor is used as the tail load then the efficiency of the circuit is reduced, and the load resistor of V2 must be made slightly large to compensate. This is how the cathode-coupled circuit is usually seen in valve amplifiers.

Williamson tried to achieve excellent AC balance to the output valves in his amplifier in order to reduce distortion as much as possible. His circuit performs well, but the distortion of a valve amplifier can be reduced further with the use of more sophisticated circuitry, I have found, without greatly increasing feedback.

Diagram 5

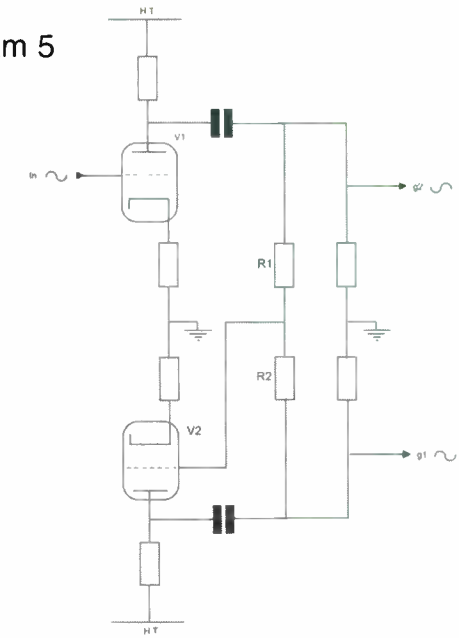


Diagram 6

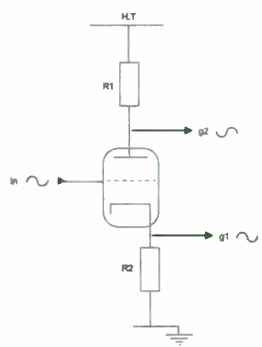


Diagram 8

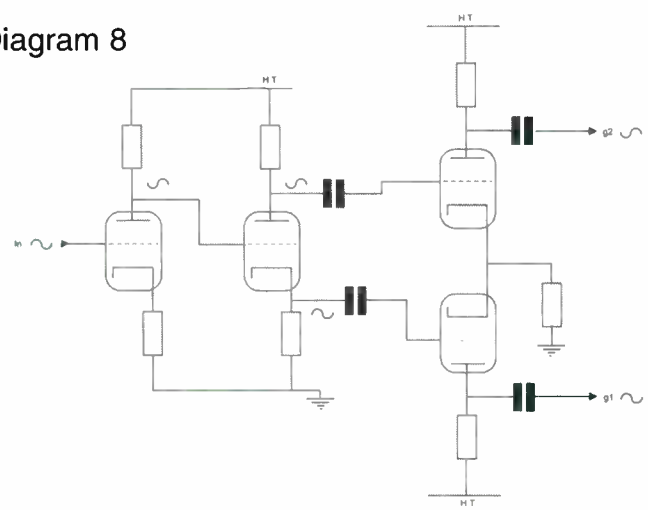
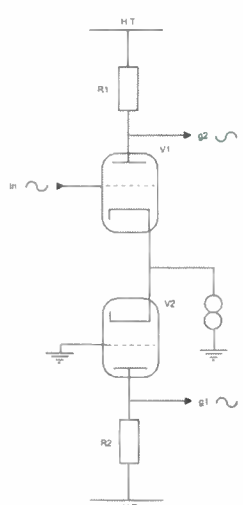


Diagram 7



KOLLECTORS KORNER

Richard White takes a jumbler's look at some audio books of the past.

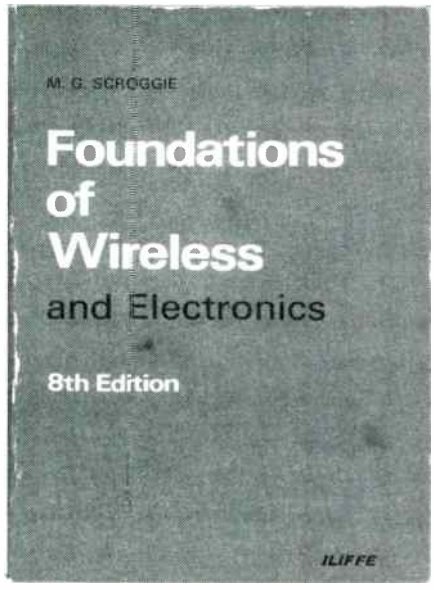
When scanning the enormous assortment of gear which surfaces at an Audio Jumble, the more impressive items obviously catch the eye first. For instance, there might be a particularly bright specimen of a venerable amplifier or tuner; you pass a few words with the vendor, praise the condition of the thing and move on, noting the premium which an all-but flooded market puts on un-chipped paint and tarnish-free brightwork. You may wish you had more space for those coal-bunker loudspeakers, or wonder whether your record collection really warrants a fourth turntable.

Once the concrete has been dealt with in this way, you may have the leisure for something a little more abstract and it's here that the usually generous supply of books comes into its own. At the very worst, you will be able to put certain hi-fi developments into proper historical perspective. What's more, books change hands for considerably smaller sums than equipment, so you can gain knowledge at the same time as saving cash.

Because the borders between radio, audio and hi-fi tend to blur a bit, it is easy to be caught out; radio and audio technology has tended to date very easily. In the days of the 'radio hobbyist' it was assumed that practically everything but the valves would be made either from scratch or from parts (capacitor vanes etc) supplied by the trade. Although of considerable historic interest, sheer difficulty in finding components rules these out, although it's interesting to see very early designs for amplifiers - straight triodes, transformer coupled - looking quite up-to-date!

Many 'radio' books claim to cover audio as well, with sections on loudspeakers, gramophones and the like. With certain exceptions, these also are best avoided since although they are good primers for Ohm's Law and other basics, much that is fundamental to radio is only peripheral to audio and, before FM broadcasting, high fidelity amplification was rather wasted on heterodyne whistles and hiss.

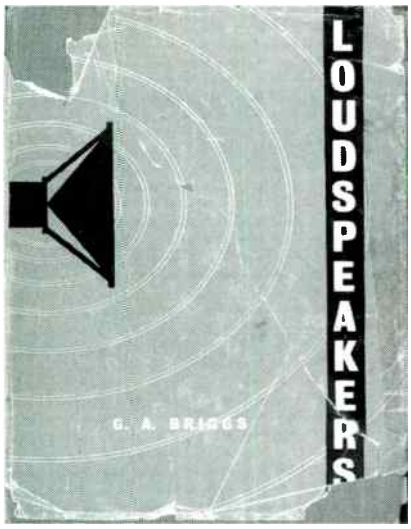
Exceptions to this would be something like Foundations of Wireless, under which title first A L M Sowerby and later M G Scroggie produced a splendid bedside companion for beginner and expert alike. It is principally Scroggie's plain way with English which makes this series of books so valuable. As the title suggests, the books are essentially about radio but there are plenty of tit-bits for the enquirer for other matters, not least full expositions of desiderata for power supplies and amplification stages, which have still much to offer.



Don't miss any opportunity to snap up a Hi-Fi Yearbook. These annual publications were 'the industry on parade'. Every manufacturer of any substance contributed current model lists, with prices and quite often photos too, so practically any of these books is a gold-mine of anorak information. Prices tend to be high regardless of condition and year. They are of considerable value if buying older gear; the fact that you can distinguish top-of-the-range from budget can prevent your fingers getting burnt, not so much at honest audio jumbles but at junk and second hand shops where the vendor's level of expertise may put optimistic prices on 'lovely old valve stuff'.

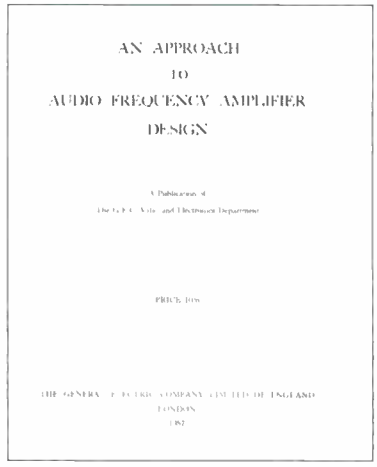
An original copy of GEC's epoch-making Approach to Audio Frequency Amplifier Design has, on the face of it, much in its favour too. Purely a valve book, it sticks to its subject and develops its precepts logically. It is only when you examine the circuit data that doubts creep in; phrases like '5% distortion at

3W' are too frequent to be ignored. In short, this book is a first-class primer for the sort of amplifier which H J Leak & Co built to perfection (with 0.1%), but the circuits themselves are below par for modern high fidelity. The Mullard book on the same lines is better in this respect, if you ignore the pre-amplifiers but since both these books are still available in reprints, originals are of less interest.



One of the pioneers of pure audio books was G A Briggs, founder of Wharfedale. Having acquired quite a collection of his books over the years, I am forced to say that there is Briggs and Briggs. No-one should not at least have looked at the fifth edition of Loudspeakers (1958), with its vast range articles on every aspect of its subject. Modern readers may find Briggs' chatty style irritating but this should not prevent anyone getting to the meat of the thing. Earlier editions of the work, including the reprinted fourth edition, are of more historic than practical interest.

Much the same can be said of his Sound Reproduction which boasts (naturally) an extensive loudspeaker section in addition to many other chapters on acoustics, pick-ups and audio generally. Time has not been especially kind to this book; it predates the general acceptance of microgroove, not to mention stereo.


AN APPROACH
TO
AUDIO FREQUENCY AMPLIFIER
DESIGN

When the time came to revise both Loudspeakers (5th ed) and Sound Reproduction, Briggs opted to split his subjects up into separate topics, hence The Cabinet Handbook and Acoustics among too many others. By this time, the author was retired from active service and there is a touch of 'old man's toys' about these slim volumes. Chattiness has given way to rambling. That's not to say they're without value but readers coming to them without being aware of his earlier opus may easily be put off.

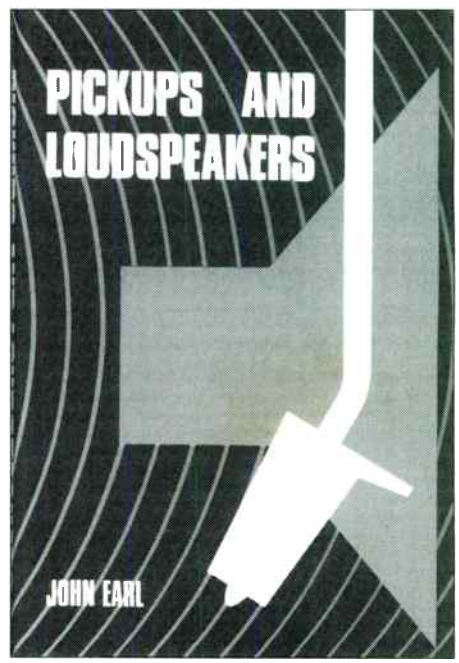
James Moir was not only a technical consultant for some of the Briggs titles also an acoustic technician in his own right. In 1958 he published his own High Quality Sound Reproduction, a work much more technical than the Wharfedale books. In his clarity of style, Moir resembles Scroggie: technically complex matters are rendered in plain English with plenty of diagrams and examples plus lists for further reading. The second edition has a small chapter on Stereo but as this immense step forward was then in its infancy, commercial standards had yet to settle down. As a result, Moir's conclusions in this areaare more general than specific.

Norman Crowhurst was one of the transistor generation who should have carried on the popular path where Briggs and Moir left off. His High Fidelity Sound Engineering is certainly packed with useful information. Chapters like Transducer Matching and Simple Active Circuits remain very pertinent today, particularly since we now value simplicity so much in audio circuitry. Unfortunately, Crowhurst has every virtue except readability. This is certainly a book to look out for but it's just a bit of a drag to keep the pages turning!

Moving into the 1970s, we are faced by a dilemma: suddenly hi-fi was big business and new books roared off the presses to meet the demand. At the same time, as we know, hi-fi 'sound' was at its most variable so it is difficult to strike a balance between the generally sensible technical information and the equipment recommendations.

Prominent among the new authors was John Earl (aka Gordon King) who published a series of books 'How to Choose and Use . . .'. Very much of their time, this series provides a useful snapshot of the new 'hi-fi' hobby, as opposed to 'audio'. No doubts were expressed that transistors were 'better' than valves and that modern equipment was not only 'better' than its valve predecessors but also that the likelihood of its being significantly bettered (at least at the top of the range) was remote. Although possession of a Quad 33/303 then placed your system above criticism, many Far East imports, now huge industry names, were making a name for themselves. These books are a good read and if the products shown had only lived up to their expectations, the story of hi-fi would have been all but over!

In this short article, I have barely scratched the surface, even of my own collection. Audio and hi-fi books are an inexpensive way of getting more out of the hobby than 'what should I buy next'. Equipment comes and goes but the basics of good sound reproduction have remained surprisingly constant. Good Hunting!



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D.I.Y. LETTERS

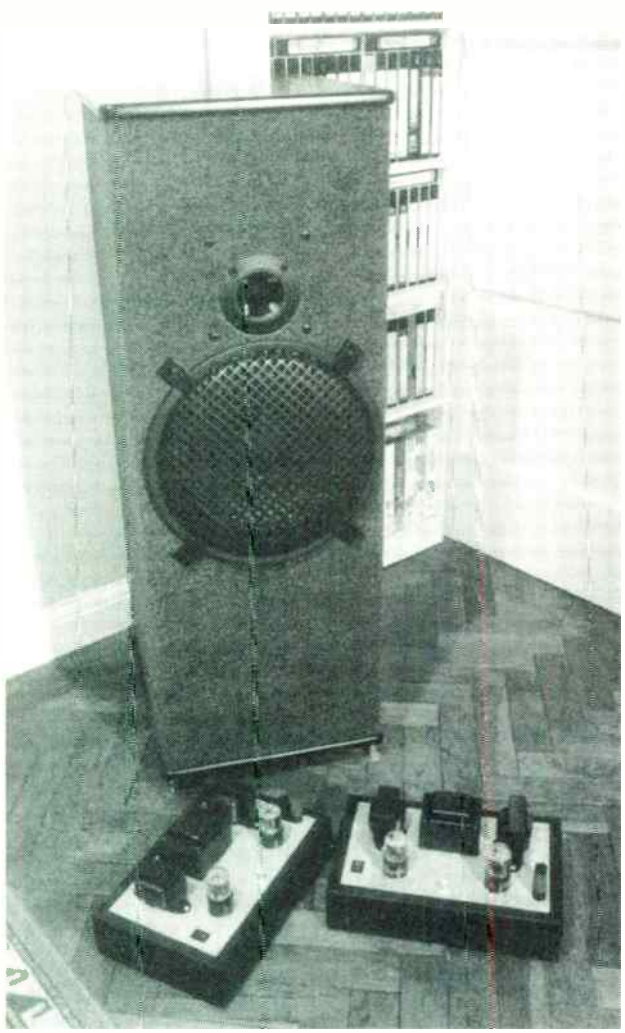
HEAVY EIGHTS

Having succumbed to the lure of single-ended triodes, the decision was taken to replace my old PRO9-TL speakers (84db/w transmission lines from Wilmslow Audio 20 years ago) with KLS8. I'd agreed with my wife that replacements would be something of the same size, so the conversion from stand-mounters to floor-standers was born.

The engineering target was a platform for the woofers, which was rigid, acoustically inert and with a minimal amount of reflection from the box back through the cone. Key features are:

Enclosure with a near triangular cross-section. Panels damped with ceramic tiles, aluminium sheet and columns of sand.

Crossovers on two separate boards. Everything else is pretty conventional: carpet felt lining, long-haired wool damping, shelf braces and spikes. Drive units, grilles and end plates are secured with high-tensile steel bolts into tee-nuts. All MDF panels which are bolted in place (without glue) have a bead of silicone sealant applied to give a good acoustic joint. Most of the structure is MDF bonded with PVA.



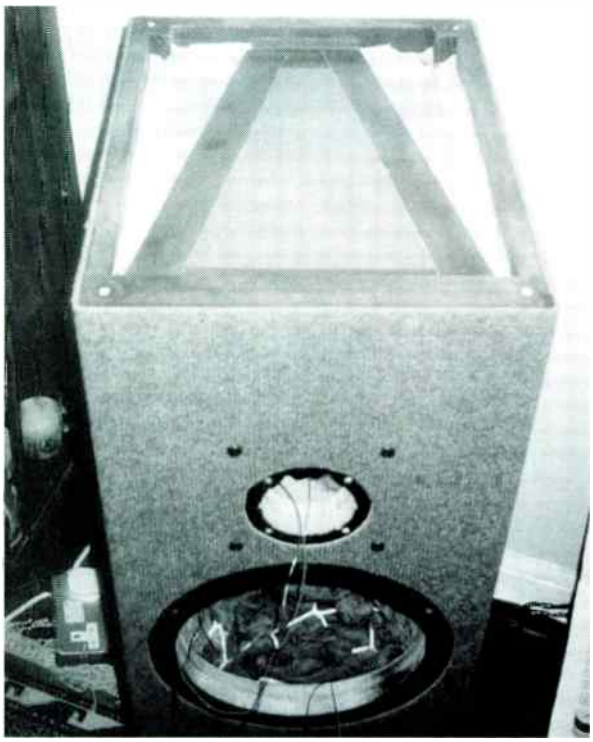
These speakers weigh in at 100kg. To protect the floor I made "pucks" from coins. Put a good-sized centre-punch strike in the middle, then epoxy-resin some inner tube to the lower side. Don't use coins which are legal tender where you use the speakers: US 25c, German 2DM and UK 10p coins are all the right size.

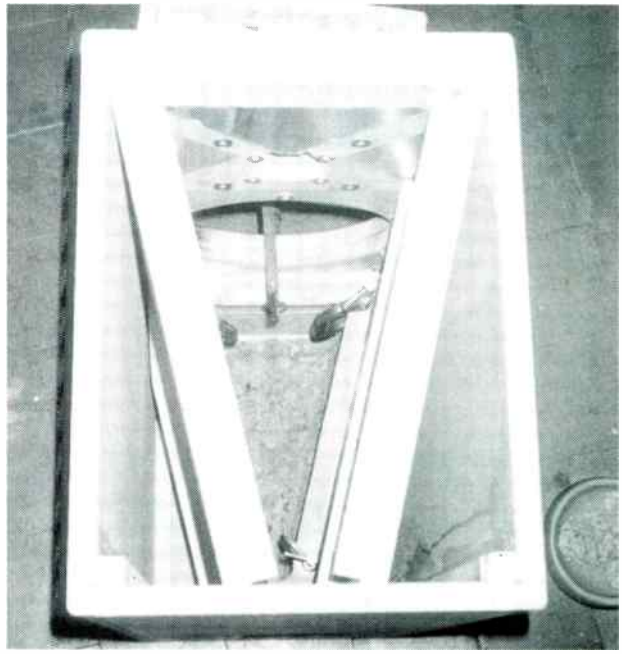
How do they sound? Everything I'd hoped for: no-one could argue with the sound (especially at the price). Final words from my non-hi-fi, tone deaf, tolerant wife: "It sounds more real." Thanks, Ruth!

This project took around 300 hours but a lot of that was design work. For anyone wishing to build a copy, there is a cutting list in html format on my web site: for anyone with AutoCAD Light there are design sketches, too. See http://www.wollaton25.junglelink.co.uk/john/kls8

John Spriggs

(more pictures on p22)





Non-parallel cabinet walls help tune out internal modes, keeping characteristic box 'honks' down. As long as the basic box volume is maintained bass performance will not be affected.

KEL80 AND KT88s

Is there any special reason I can't tweak the KEL80s to use KT88s...?

Cheers

Richard Barton

To answer your question fully, let me first describe the World Audio Design KEL80 monobloc kit to those who do not know. The amplifier has a pentode 6AU6 input valve, a 5687 double triode phase-splitter and four EL34 output pentodes in parallel push-pull mode to provide 80 watts from Class AB working into a 8 ohm load.

There are a few fundamental differences between the EL34 valve and the KT88 valve which would not allow a straight swap betwen them. Firstly, the maximum anode dissipation of an EL34 measures around 25Watts whereas the KT88 will dissipate up to 35Watts. The circuit is designed so that the EL34s are operating at 23 Watts anode dissipation in combination with the cathode biasing arrangement, keeping the valve in a linear portion of its characteristic curve to allow a good response over a wide frequency range.

Placing the KT88 into this set of operating conditions would not be the ideal setting for good performance - it would work but not effectively. You really need to change the operating conditions, increasing the anode dissipation nearer to 35 watts. Trouble is, this would increases the current required, putting the mains transformer under certain distress.

It's for these reasons we use a beefier mains transformer for the KiT88/KaT88 kit compared to the KEL34. So a KT88 amplifier is more expensive than an EL34 amplifier. Also, bear in mind that the heater current for an EL34 is 6.3V at 1.5A, whilst for the KT88 it is 6.3V at 1.8A. With four tubes in place you are looking at a 1.2A increase on the 6.3V heater winding, not an ideal situation.

The pin layout is slightly different. For the EL34, pin 1 is for grid No. 3, but for KT88 it is NC - no connection, as grid No. 3 is on pin 8 with its cathode. But as grid No.3 and the cathode are in effect joined together in the circuit anyway you can actually do it too.

But a word of warning NC stands for "no connection" which I follow to the letter as you can get some dramatic effects with some valves as NC locations are sometimes connected to valve elements.

Physically, the diameter of the EL34 is 100mm whereas the KT88 is much larger measuring 170mm. A rule I use is that output tubes need to be at least 2 fingers apart, insitu, so as not to cause too much mutual heating. Putting a KT88 in, will definitely cause this on the KEL80.

On the plus side, the 6AU6 and 5687 valves up-front would be man enough to drive four KT88s in parallel push-pull, so if these various objections are met the circuit would work.

Your suggestion has been noted. Give it a year or so we at World Audio Design may well able to produce such a kit. It will take transformer and chassis re-design, as well as circuit re-biassing. Keep your eyes open. **NL**

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6SN7GT/ECC33	£ 8.95

KT66R	£69.95 pr
KT88R	£69.95 pr
6550WA	£67.95 pr

Golden Dragon Special Quality Pre-amplifier Tubes

E81CC-01	Gold Pins Low Microphony Low Noise		£10.50
E82CC-01	Gold Pins Low Microphony Low Noise		£10.50
E83CC-01	Gold Pins Low Microphony Low Noise	NEW	£ 9.50
E88CC-01	Gold Pins Low Microphony Low Noise		£14.50

Golden Dragon Triodes	Singles	Per matched pair	Per matched quad
2A3 4 pin	£22.50	£50.00	£100.00
2A3 Octal	£22.50	£50.00	£100.00
211	£28.50	£60.00	£120.00
811A	£11.50	£25.00	£50.00
845	£36.50	£75.00	£150.00
805	£36.50	£75.00	£150.00

Golden Dragon T300B Range

300B Super	£79.00	£160.00	£320.00
4.300B	£84.00	£170.00	£340.00
4.300B LX Super	£124.00	£250.00	£500.00

Golden Dragon Power Tubes	Matched Pair	Matched Quad	Matched Octet
EL34 Super	£25.00	£50.00	£100.00
EL34M	£25.00	£50.00	£100.00
E84L (special quality EL84)	£12.50	£25.00	£50.00
EL156 Octal	£75.00	£150.00	£300.00
6L6WGB	£25.00	£50.00	£100.00
KT66	£25.95	£52.00	£104.00
KT66 Super	£65.00	£130.00	£300.00
KT88	£57.95	£116.00	£232.00
KT88 Special (Gold plated)	£67.95	£136.00	£272.00
KT90	£65.00	£130.00	£260.00
KT90LX	£75.00	£150.00	£300.00
350B	£29.95	£60.00	£120.00
6L6GC	£19.95	£40.00	£80.00
6550A	£42.95	£86.00	£172.00
6550A Special (Gold plated)	£64.95	£130.00	£260.00
50CA10	£84.95	£170.00	£340.00
807	£25.00	£50.00	£100.00

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