

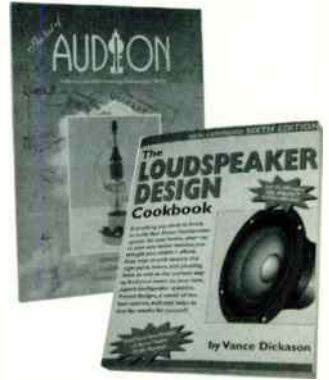
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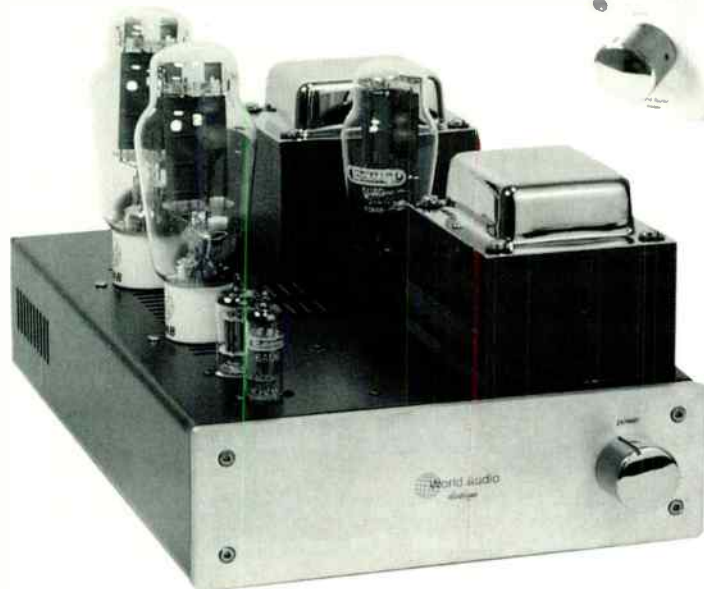


THIS MONTH'S BOOK REVIEWS:

The best of Audion editorial projects & Loudspeaker Design Cookbook 6th edition

PART II OF KIT34

FINALISING OUR 32W AMPLIFIER WITH TUBE AND CHOKE POWER SUPPLY



TUNING OUR HIGH-END 300B SINGLE ENDED POWER AMPS

Plus: ● news, letters, books and more...



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IMEX HOUSE,
THE PARK BUSINESS CENTRE,
KILBURN PARK ROAD,
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NEWS & LETTERS e-mail
diynews@hi-fiworld.co.uk
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Subscriptions & Back Issues
9.30am - 2.30pm
+44 (0)1923 270833

Private & Trade Classified Ads
020 7625 3134
Fax: 020 7328 1844

Contact Numbers
9am - 5pm Mon - Fri

Editor
Nick Lucas
+44 (0) 1908 218836
nick@worldaudiodesign.co.uk

Technical Editor
Noel Keywood
publisher@hi-fiworld.co.uk

Design & Production
Faiza Chunara
020 7625 3129
Fax: 020 7328 1844

Photography
David Noble
020 7625 3134

Sales and Marketing Manager
Andrew Maynes
020 7604 4890
Fax: 020 7328 1844

Accounts
Michael Ogazi
020 7625 8032
Fax: 020 7328 1844

Credit Control
Louise Palfrey
+44 (0)1923 270833
Fax: +44 (0)1923 270833

Publisher
Noel Keywood

WORLD AUDIO DESIGN
Technical Manager
Nick Lucas
Tel/Fax: +44 (0)1908 218836
nick@worldaudiodesign.co.uk

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Tavistock Road, West Drayton,
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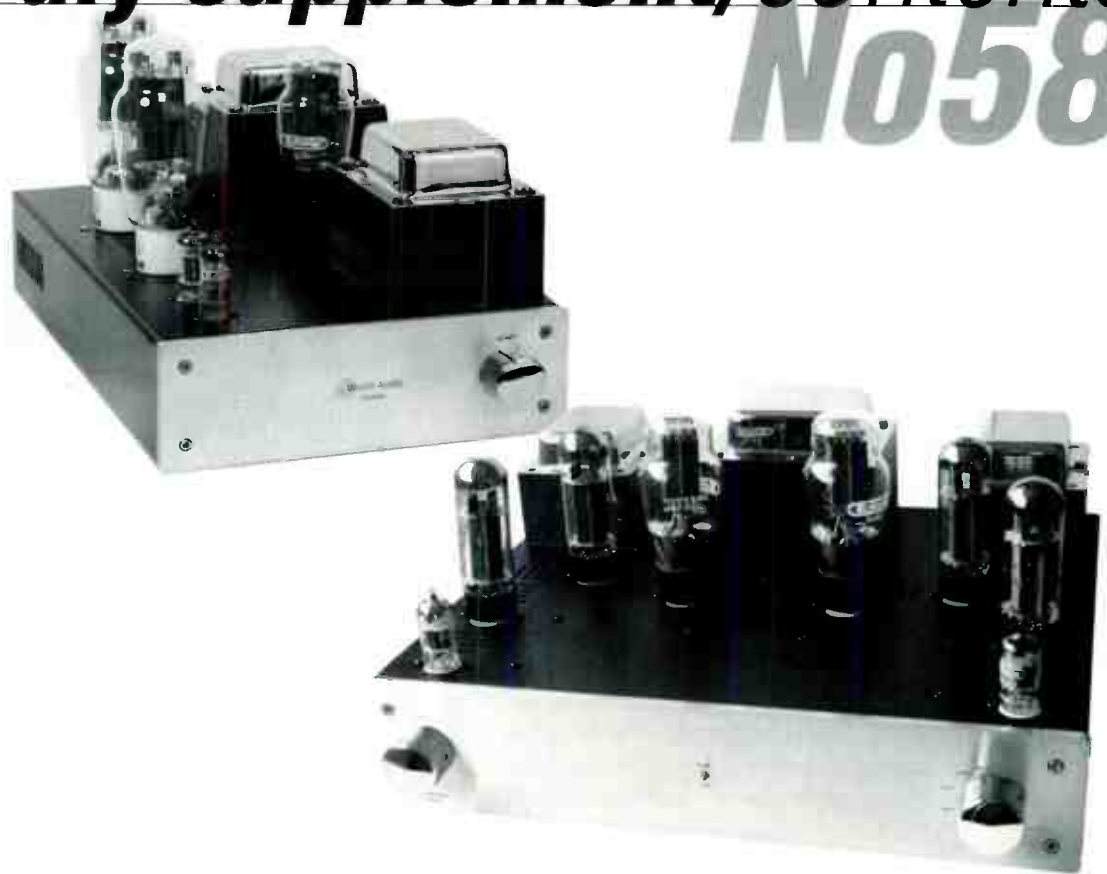
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diy supplement/contents

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e-mail us with news at - diynews@hi-fiworld.co.uk

KIT & COMPONENT NEWS



► NEW DIGITAL AMP ON A CHIP FROM TEXAS

Digital audio gets ever more attention from big chip manufacturers worldwide. There's a race on to produce Class D digital amplifiers free from the serious problems that have hobbled them to date. At the end of March 2001 Texas Instruments announced a new super-amp chip that, they claim, offers a complete solution to all current problems, paving the way to digital amplifiers in the home.

Aimed directly at the hi-fi market, their new TASS015 is capable of directly accepting DVD-Audio. Whilst this sort of product is directed at manufacturers, it will surely find its

way to the hobbyist/DIY market as the technology becomes honed and more commonly available. Here's what Texas say about their new development.

"Texas Instruments today announced a new digital amplifier featuring the highest performance all-digital solution available today. The new chip is the first to operate at the sampling rate of 192 kilohertz

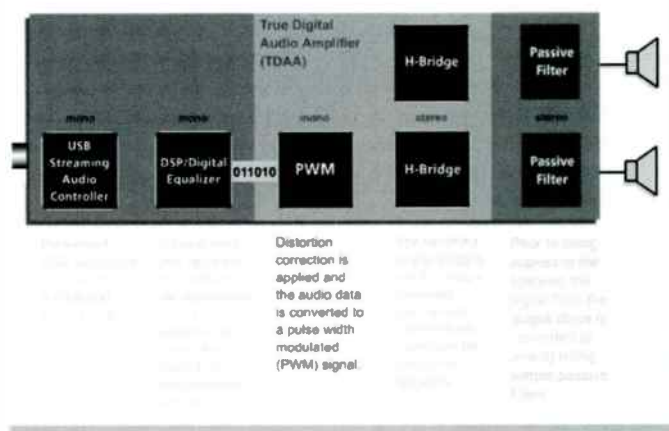
(kHz) with a Dynamic Range of 110 decibels (dB) measured at the speaker. The TASS015 features highly flexible inputs supporting all major audio standards on the market, including DVD-Audio, with sample rates ranging from 32kHz to 192kHz. (See <http://www.ti.com/sc/digitalaudio>.)

The TASS015 Pulse-Width Modulator (PWM) includes a discrete power stage, enabling the digital audio amplifier solution to drive speakers digitally for greater power efficiency and higher audio fidelity. This allows the device to perform with power levels exceeding 300W with THD+N below 0.03%.

"With the TASS015 chip, TI is the first IC supplier to offer these performance levels in an all-digital audio chain compatible with DVD-Audio," said Niels Anderskov, WW Marketing Manager, Digital Audio.

192kHz DVD-Audio chipsets aimed at the mass market will be available in Summer 2001, enabling new and exciting consumer and PC audio products in the mainstream market.

PC Digital Speakers



The TASS015 chip provides signal quality that pushes digital sound reproduction to the highest level of fidelity available today. The TASS015 modulator accepts standard I2S, left and right justified 16- to 24-bit data streams sampled at 32 to 192 kHz, then processes the pulse-code modulated (PCM) input into a pulse-width modulated (PWM) output.

A discrete power stage (available under equibit license from TI) then converts the PWM signal into the digital power level required at the speaker, providing a very clean and crisp all-digital sound, while dissipating less than one-tenth the power of conventional Class A and Class AB amplifiers."

Until recently digital amplifiers produced a lot of noise and distortion. These problems are being overcome, resulting in a new breed of chip based designs ready to attack the hi-fi market. Cirrus Logic and Zetex also offer Class D amplifiers. It won't be long before we see this technology attractively packaged by a well known brand name and launched into the marketplace. Digital amplifiers are coming. First you'll see them as well known brand names, then they'll become available to one and all - including DIYer's. ■ ▲

TI's Digital Amplifier Paradigm Shift

Using the PCB as a heatsink, TI's PowerPad™ surface-mount packaging simplifies manufacturing and enables extremely low-profile, more reliable designs.

Generating less than one tenth the heat than analog solutions, the high efficiency digital amplifier eliminates heat sinks, D/A converters and low-efficiency analog amplifiers. The result — crisp and powerful digital sound in a full surface-mount solution.

Size and weight of future audio systems can be reduced by a factor of 5 to 10 when using TI's power management products in the full digital audio solution.

► AUDIOCOM DISTRIBUTE INTERTECHNIK PARTS

Audiocom are pleased to announce new distribution in the UK for the full range of Intertechnik products of Germany.

Intertechnik offer over 2500 products covering electronic components, pro audio, car audio and home audio products. They include OFC Copper Foil inductors, Audyn cap Film & Foil capacitors, high power resistors, spikes and damping materials, high-end cable, crossovers, drive units, plus over 50 loudspeaker kits.



A 2001, 355 page handbook is available at £3.50 (UK) and £5.00 (overseas).
Tel. 01646 685601,
or E-mail: info@audiocom-uk.com

► NEW 6L6 FROM ELECTRO-HARMONIX

Electro-Harmonix announced in April that they were releasing a new higher voltage/power 6L6 beam tetrode. Although modelled on RCA's original 6L6 the E.H. tube has larger plate (anode) dimensions and an improved grid structure for raised power handling. The plate is tri-laminated for good rigidity and emission. It is supported on phosphor bronze side rods. Mica spacers with metal springs eliminate tube rattle and microphonics. Electro-Harmonix claim their new 6L6 "absolutely thrives on high voltages".



Electro-Harmonix
Tel: 00 1 212 529-0466
Fax: 00 1 212 529-0486
www.ehx.com



► VACUTRACE KIT

Of all the esoteric wonders of the web, this must be one of the most obscure. It's a valve-tester kit. We know, however, that valve testers are rare items these days and if you deal in valves, a tester is vital. With strong interest in valves, or tubes, being fuelled by the web perhaps a valve-tester kit isn't such a strange idea.

Hagerman Technology is a small American company that has two products, the VacuTrace and an Inverse RIAA network, an item that is also used for testing. The VacuTrace can be bought built for \$999, or as a kit for \$899. Of the kit Hagerman say "The kit version is for serious DIY builders only. You should not attempt this as your first kit. The

motherboard comes pre-assembled and tested, but there is a lot of mechanical assembly and soldering involved.

VacuTrace is a sophisticated piece of test equipment comprising more than 500 parts, including 21 integrated circuits, 38 transistors, and 7 circuit boards."

"The VacuTrace is a Vacuum Tube Curve Tracer for the analysis, characterization and matching of vacuum tubes. It uses an analog oscilloscope as an X-Y display. Its novel A/B alternating sweep capability overlays the curves of two different tubes (or sections within a dual type) for the ultimate comparison. In addition to sweeping curves, measurements of voltage, current, transconductance gain and output conductance (1/rp) can be read on the 3.5 digit LED display.

Wooden side panels give the contemporary cabinet design a retro appearance. The circuitry is completely analog and everything happens in real-time. Removable socket adapter cards accommodate the many possible tube pinouts. They also keep wiring safe and short. Three pre-made cards cover most of the popular tubes in use today. A blank socket adapter card is included for your own customization. Extra

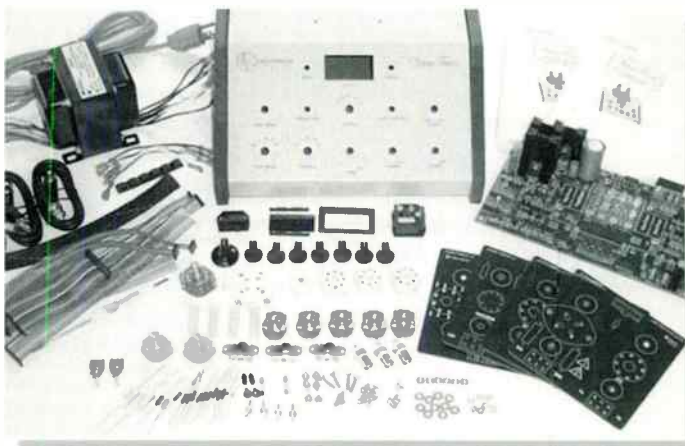
blanks are available for purchase (see order form). VacuTrace is completely hand crafted to ensure quality.

Features

- * Generates characteristic curves for diodes, triodes and pentodes in real-time
- * Tests both small signal (12AX7, 6SN7) and power tubes (5Y3, KT88, 300B)
- * Performs matching, even on dual tubes
- * Sweeps to 400V plate, 200mA cathode, -70V grid and 40W power
- * All analog design with digital readout of voltages, current, transconductance gain and output conductance
- * Four socket adapter cards accommodate most popular tubes and pinouts
- * Uses oscilloscope (not included) as display
- * Overload protection on all outputs.

For more info go to

<http://www.hagtech.com/>



KIT34 PART II

This month we look at the practical side of building our new 32W valve amplifier, as well as describing sound quality.

Intro by Noel Keywood

Kit by Nick Lucas

Sound quality by Simon Pope

KIT34 designed by Andy Grove



Part one of this article appeared in our April 2001 DIY Supplement. It covered the thinking behind this new design, basic theory, the circuit and fundamentals. To recap quickly, KIT34 is a stereo integrated valve amplifier, providing 32watts into an 8 ohm load.

The key feature of this amplifier is its valve rectified power supply, with choke. Enthusiasts have long held that the traditional valve/choke supply offers better sound quality than the modern diode bridge/capacitor smoothing arrangement that is found in most valve amplifiers today, as well as transistor amplifiers of course. We agree. Trouble is, supplies like this are costly and bulky. Modern versions of compact rectifier valves like the GZ34 have been a little unreliable at high voltages, which reduces design options. In KIT34 we have used two relatively large but reliable 5U4 double-diodes which, as you can see from the picture, dominate the skyline of the amplifier. Underneath is another expensive and bulky component, a 2.5H, 350mA choke,

that smooths the incoming d.c., cutting down ripple and noise. So a valve/choke supply is a bulky addition.

Many solid-state designers of experience suspect the apparent graininess of transistor amplifiers may be connected to noise, especially from power supply regulators, which are used abundantly nowadays. A classic valve/choke supply like this one is innately silent, and it also pulses the mains less heavily than a modern power supply - something electricity generating companies object to by the way. So there are some very real benefits behind the seemingly archaic power supply arrangement we use here, which likely explains the sound quality improvements these supplies give. And of course, a supply like this turns on slowly as the rectifier heaters come up, so there's no switch on thump. The slow run up of H.T. extends output valve life too.

So much for the main features of KIT34. The kit we offer comes with an appropriate transformer set with an isolated 5V, 6A heater

winding for the two 5U4s, as well as large E/I output transformers with Ultra Linear taps. There are five line level inputs, plus a tape in and tape out, all controllable from a front panel rotary selector switch. The mains is connected via an IEC lead and the speaker outputs are the gold plated 4mm type.

The amplifier uses an ECF80, a triode/pentode, to amplify and phase split to drive a pair of EL34s in push-pull configuration, the output transformers having 14% Ultra Linear taps to suppress distortion.

In this second and final part we discuss building the kit and then describe sound quality. Also, we are introducing a power amplifier version, KaT34. This can be used with any preamplifier, valve or transistor, active or even passive. An independent power amp can be more convenient since it can be put on the floor or the bottom shelf of a rack to give those big 5U4s plenty of breathing space and keep the main system looking tidy and compact.

THE KIT

The kit has a 2mm mild steel chassis with a black powder coat finish, providing an extremely strong platform on which to mount all 15kg of iron; I speak here of the mains, two output transformers and the 2.5H choke, all of the E/I type. The externally mounted transformers are topped with chrome plated caps.

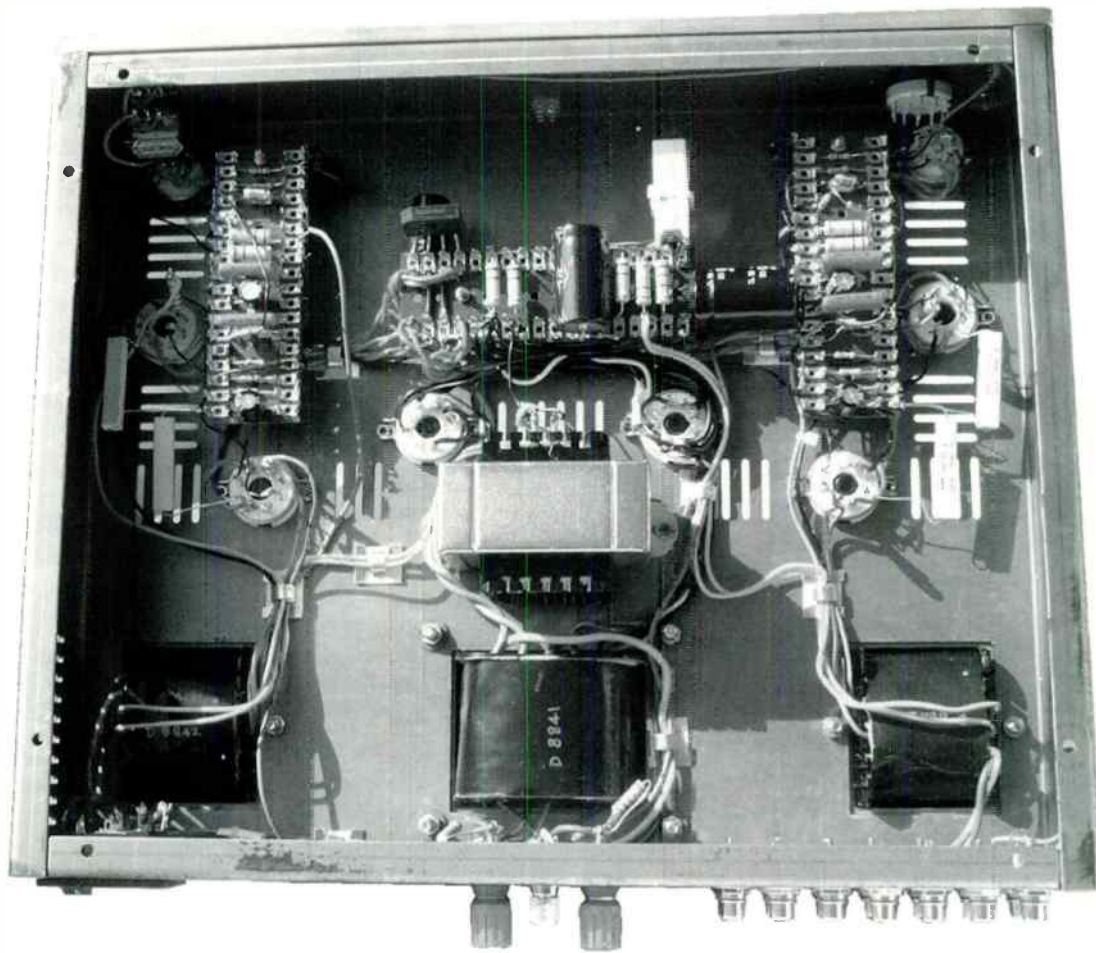
The chassis is fronted by an attractive 6mm thick anodized alloy plate that bolts in place. With the KiT34 version, the front plate holds two custom made chrome plated knobs for operating the volume control and the input selector switch.

All eight valves are exposed, giving the 34 amps. with a superb

look. The rear mounted IEC mains socket also carries the on-off switch, which is easily reached from the front because it is situated at the left corner of the amp. A rear panel location avoids an internal mains loom which in a valve amp in particular, with its high input impedances, is a bad idea, as hum pick up can occur, especially if the mains loom gets anywhere near the input valves, which is inevitable with front located on-off switches.

The mains transformer has been wound to accept 110V/120Vac or 220V/230Vac depending upon how you wire the primary, so it's suitable for all territories, or those people who like to take their valve amps overseas - if they can afford the 20kg excess baggage.

Being a specialised design the unit is hardwired. Components are located on 18 way tag boards, that are fitted on 25mm standoffs. There are three boards, one per channel and one for the power supply. All valve bases are chassis mount types.



An internal shot of the KiT34 with wiring in progress.

There is plenty of space inside should you want to fit bulkier upgrade components at a later date.

The kit is accompanied by a detailed instruction booklet to aid construction. The booklet runs through the build sequence, describing each step. This is further backed up by clear diagrams and charts. There's a 'What to do if it doesn't work' section based on our experience of commonly encountered difficulties, and a full parts list.

For the EL34s supplied we chose the Tesla JJ brand, as we have done with previous kits. It is a reasonably priced valve, reliable, with a wonderful sound. The ECF80 we have used is NOS (New - meaning unused - Old Stock) and are of Eastern Europe manufacture. ECF80s are no longer made, but are plentiful, so do not fear lack of

availability in the long term.

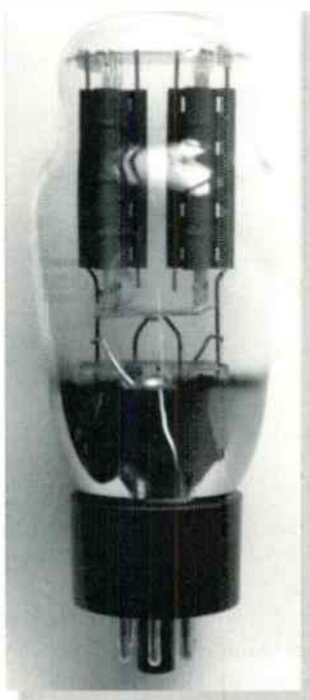
The rectifier valve, the 5U4, is used by quite a few amp manufactures now, most choosing the Russian made tube as it is extremely rugged and can be bought at a good price.

CONSTRUCTION

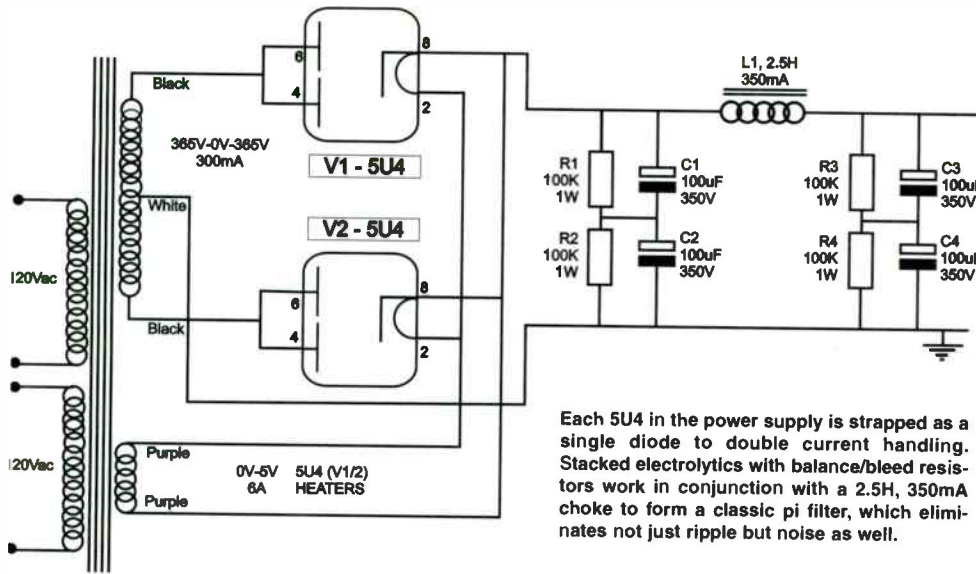
KiT34 & KaT34 are similar in construction. Electronically the difference is just two resistors, but obviously with KiT34 you have the task of wiring up the five line level inputs, tape in and tape out sockets to the selector switch, tape/source switch and the volume potentiometer. This process utilises single screened wire, improving separation from the twin screened wire we have used in the past, but it makes for a lot of wire, around 6 metres in total, so good clean work is a must.

KaT34 basically has left and right channel inputs that feed straight into the input circuitry - nice and easy.

Fitting of the hardware is straight forward enough: all holes are pre-punched - so put that drill down. As the kit is not based on PCB and requires every single point to point connection to be made, there is more work to be done than a PCB design, making it slightly harder to construct. There is no set up procedure, as the kit is auto-biased. As



A 5U4 rectifier valve



though this is an involving sound, you never feel you're trying to hard to concentrate, which is the true test of hi-fi: the music takes preference, full stop.

The Mahler symphony sounded full and remarkably detailed, woodwind colours being relayed naturally and strings woody and rich - exactly as they should sound in the right environment. The whole sound wasn't restricted to the area of the loudspeakers, it was rounded and open, filling the whole room with the music. Who needs surround sound when you can have this? **SP** ■ ▲

long as you are careful, check your work thoroughly you should be successful. In case of difficulty there is a helpline available and a back-to-base repair service. **NL** ■

**SOUND QUALITY
KIT 34**

This new integrated brings together the best sonic virtues of our KiT 88, Kel 34 and top of the range 300B monobloc amps in an affordable package.

The highlights of the sound are a deep and taut bass response, together with an open and highly detailed mid and high frequency presentation that only the best valve designs can achieve. Using a Meridian 206.24 CD player as source and Wilson Benesch's Discovery loudspeakers I listened to the new integrated with a variety of different recordings.

Everything But The Girl's version of the Simon and Garfunkel classic 'Only Living Boy In New York' really made KiT 34 sing. One highlight was the natural and warm vocals of Tracey Thorn which were relayed with a realistic presence, every nuance and consonant bang in place and a part of the music. Bass was especially impressive, with a tautness and depth that was matched with liveliness and bounce.

Where the Kit 34 also excelled was in the top end, delivering a superbly sweet, extended and detailed treble. This feature also graced Mahler's Symphony No.9 conducted by Pierre Boulez. The high percussion had sparkle, life and space that was matched by an open midrange that homed in on the orchestral colours with a naturalness extremely rare in solid state designs.

KaT34

The power amp version, used in conjunction with our modular System II preamplifier showed again that when it comes to depth, detail and sheer listenability, only valves will

do. Everything But The Girl floated beautifully through the Wilsons, with the voice graceful and clean. Also demonstrated here was the excellent depth of sound stage that the KaT34 has. Drums were placed far to the rear of the mix but remained very much part of the picture and the acoustic guitars created air and space to the sound.

Again, bass was superb, deep but with a natural ease that sorts the men from the boys as far as amplifiers are concerned. Even

MEASURED PERFORMANCE

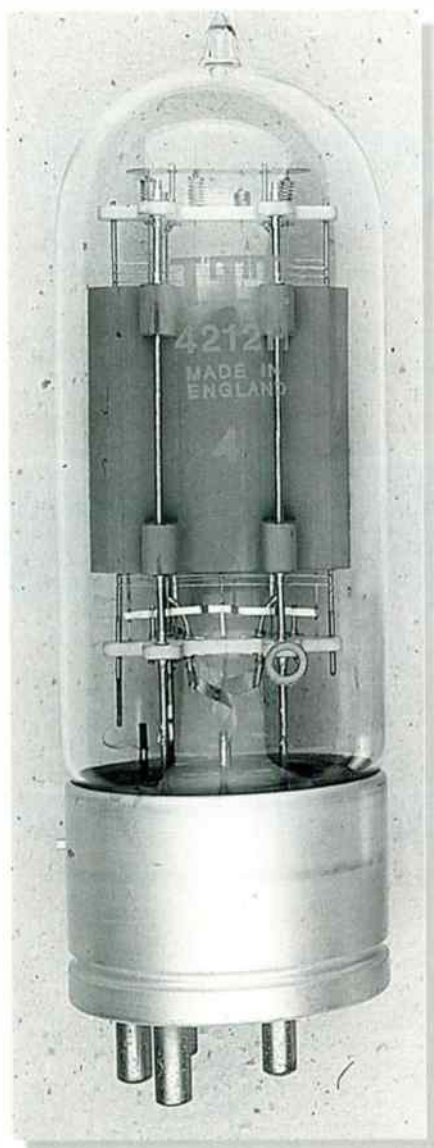
Power	32 watts
Frequency response	15Hz - 85kHz
Separation	60dB
Noise	90dB
Distortion	0.05%
Sensitivity	300mV

KiT34 VALVE AMPLIFIER IS AVAILABLE AS A KIT!

	UK (inc. vat & p&p)	Overseas (exc. vat & p&p)
KaT34-K240/120 (with valves)	£480.00	£410.00
KaT34-K240/120 (without valves)	£415.00	£354.00
KiT34-K240/120 (with valves)	£495.00	£420.00
KiT34- K240/120 (without valves)	£430.00	£365.00
or purchase the components individually:		
KiT34 transformer set	£250.00	£210.00
KiT34 mains transformer	£100.00	£85.00
KiT34 output tranformer(pair)	£130.00	£110.00
KiT34 choke	£45.00	£39.00
Call or fax Nick Lucas on: +44 (0)1908 218836 (9am-5pm, Monday-Friday)		
e-mail address: info@worldaudiodesign.co.uk		
or order on line www.worldaudiodesign.co.uk		
For overseas freight charges, please call, fax or e-mail.		

TURNING DOWN THE HEAT

Andy Grove looks at the fundamentals of thermionic emission, and why the heaters lost their lovely bright glow as valve technology advanced.



These electrons fly off a short distance dependant upon their initial velocity, then fall back to the surface in a continuous process in equilibrium, unless there is a positive charge nearby to draw them away. This process causes a cloud of electrons to be formed above the emissive surface, and is called a space charge. see Fig. 2 It is literally a negatively charged region of space.

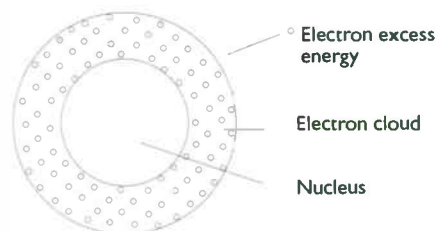
The earliest filaments were of pure tungsten, which had to be heated to a high temperature of 2300 Kelvin to get good electron emission, basically because the tungsten electrons are not easily dislodged.

Later versions of this "bright emitter" type of filament use thoriated tungsten. see Fig. 3 This isn't actually a true alloy of tungsten and thorium, rather the thorium is distributed within the crystalline interstices of the tungsten. When the filament is heated a very, very thin layer of thorium is formed over the surface of the tungsten wire and this forms the emissive surface. As this layer is depleted more thorium permeates from within the wire and replaces that lost at the surface until the thorium is completely depleted and the filament loses it's emission.

Thorium emits electrons more easily than pure tungsten and so a lower temperature is required to get the same emission, from around 1800 Kelvin to 2200 Kelvin.

The addition of thorium to tungsten also extends the filament's life. It was found that filaments made from thoriated tungsten suffered less from fatigue and re-crystallisation over the life of the valve. For this reason thoriated tungsten is used in modern light bulb filaments to maximise their life before a breakage occurs. Rhenium is used for a similar purpose.

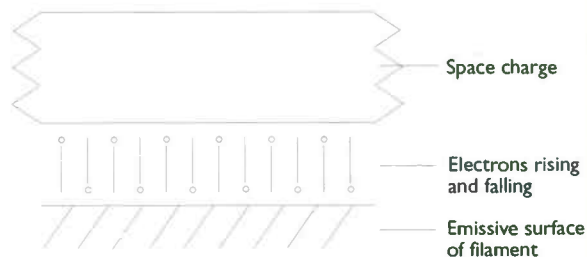
Fig 1- An atom under the influence of heat



Heating a filament to a very high temperature requires substantial electrical power, and is inefficient because much of that power is lost in the form of heat and light - photon emission rather than electron emission.

In scientific language how easily electrons are broken away from the atom's surface is known as the work function of the material. The lower the work function, the lower the temperature required so, basically speaking, the lower the work function the better. Tungsten has a work function of 4.55 eV, thorium 3.5 eV but barium has a work

Fig 2 - The formation of the space charge when a filament is under the influence of heat

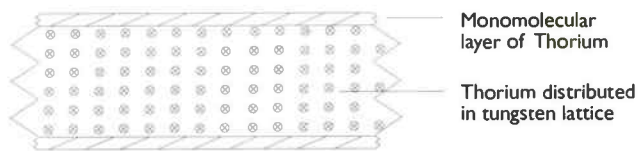


function of 2.5 eV. This is because the alkaline earth metals (calcium, strontium etc.) easily give up electrons. Barium most easily because the outer electrons are partially shielded from the positively charged nucleus by the inner

Valves function by thermionic emission within a vacuum, that is the emission of electrons from a surface by means of heat. Sufficient thermal energy causes the electrons in an atom's outer shells to become agitated enough to break away from the attraction of the positively charged nucleus. see Fig. 1

▶▶ electron shells (radium may have a lower work function but is extremely rare and radioactive).

Fig 3 - The composition of a bright emitter filament (a later version)



emissive surface is "formed". The filament is raised to a high temperature and the carbonates break down into the oxides with the evolution of carbon dioxide, meanwhile the vacuum pump removes this gas to maintain the vacuum. Now the filament has a fused coating of alkaline earth oxides, which

suffers from the disadvantage of being electrically connected to the filament supply. This not only reduces the possible permutations of circuit into which such a valve can be designed but can cause problems with the emission of the filament as there is a superimposed electrical gradient from one end of the filament to the other caused by the filament supply. This situation led to the development of the familiar indirectly heated cathode. Usually this is a nickel tube with an oxide coating and a heater wire inside. The heater wire is electrically isolated from the cathode by a

The alkali metals (sodium, potassium etc.) have slightly lower work functions but are too chemically reactive and volatile to be of practical use in a valve. Therefore barium is generally considered to be the best candidate for electron emissive surfaces.

The development of the oxide coated filament (as used in the 300B) greatly reduced the required temperature of the filament and thereby increased the electrical efficiency. see Fig. 4 Oxide coated filaments operate at around 1000 Kelvin, considerably lower than the 2300 Kelvin required for the tungsten type, and they only emit a dull glow.

The oxide coating functions according to a complex electrochemical process. Firstly the filament material, tungsten or nickel is coated with an aqueous suspension of alkaline earth metal carbonates, principally those of barium, strontium and calcium. When the carbonate-coated filament is safely inside the vacuum the

are very stable.

Next a voltage is applied to the anode. This causes an electrical gradient across the vacuum, and across the filament coating. An electrolysis reaction takes place reducing some of the barium oxide to metallic barium, which permeates to the surface producing a monomolecular layer. It is this layer which is the emissive surface. Over the course of the life of the filament this electrolysis reaction continues as long as there is an anode voltage and sufficient active coating material left, thereby replenishing the barium layer.

Although the oxide coated filament is probably the most efficient form of cathode it

Fig 4 - The composition of an oxide coated filament

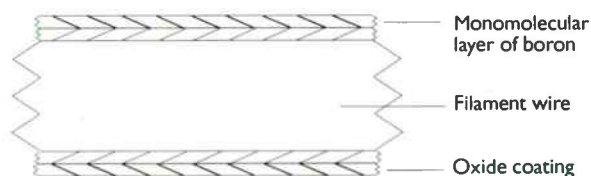
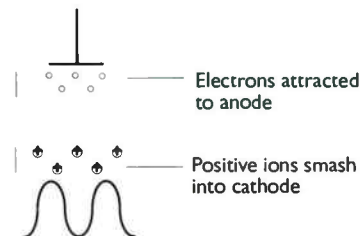


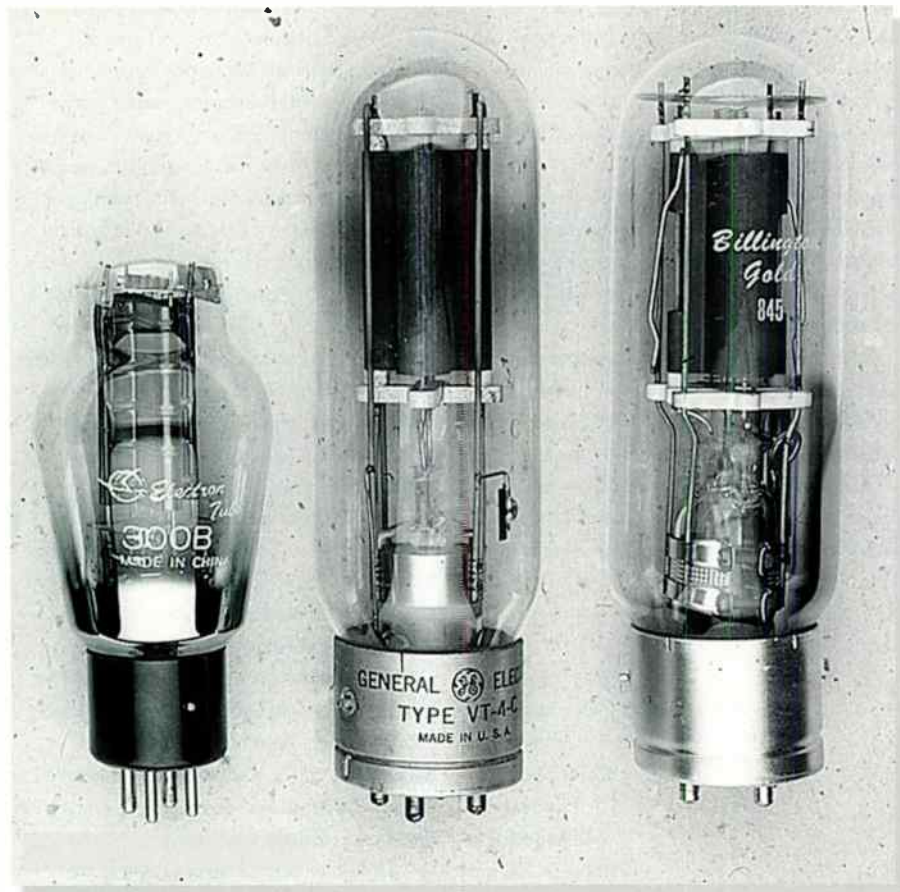
Fig 5 - The movement of electrons and positive ions within a valve



coating of aluminium oxide, which is a good conductor of heat but also a good electrical insulator.

The problem with the oxide coating is that it is relatively fragile. Not only will shock dislodge the coating but the chemical reactivity of the barium coating makes it more sensitive to gaseous impurities in the vacuum so the vacuum must be very good indeed, and must remain that way throughout the valve's life.

In the case of high power, high voltage valves the heat from the anode causes some gas to be evolved from the glass and internal structure. This gas is ionised by the electrical gradient, the electrons are attracted to the anode as usual but the heavy positive ions are attracted to the cathode and literally smash into it due to the high accelerating voltage. If an oxide cathode were used under these circumstances the coating would soon be destroyed. That's why we see bright emitter filaments in large transmitter valves like the 211 and 811. ■ ▲



BOOK REVIEWS

Andy Grove looks at an Italian publication 'The best of Audion' which describes six specialist DIY projects.

Noel Keywood checks out the sixth and latest edition of the Loudspeaker Design Cookbook, a classic of its kind.

THE BEST OF AUDION

▶▶ **T**his book is another Italian stallion from the Audiolamp stable, and once again demonstrates the skill and dedication of the Italian DIY HiFi enthusiasts. The book contains six projects, a technical discussion and some data tables all in English.

Firstly there is a high sensitivity speaker project using Dynaudio drive units, presented by Stefano Bevacqua. This is a two way design using a sealed box and a MTM type layout. The thought processes used to arrive at the final design and plans and crossover circuit diagrams are all included.

Next is small piece about the Philips E88CC valve, a professional version of the ECC88. The article and following data tables are presented by Luciano Macri the editor of the book itself. For those who would like to build a simple, cost effective and good sounding preamp there is the Easy Pre by Marco Bulgarini and Lorenzo Neri. This neat little unit uses ECC83 and ECC82 valves. Full construction instructions are given and circuit boards are available from Audion in Italy (easily ordered over the net). Then we have a very useful cross reference between European/ American and Russian valve types presented by Gino Chelazzi. The next project is a 2A3 design following the lines of the classic Loftin-White, by Marco Bulgarini and Luciano Macri. The technical discussion traces through the original Loftin-White, via the Lux 66 to the author's final amplifier which uses a parallel ECC83 as the driver valve and a valve rectified H.T. Included in the text is some data on the 2A3 valve. This project would be an ideal partner for the Easy Pre as long as you have very sensitive speakers. Next on the agenda is a technical essay upon driving a

single ended triode by Corrado Petri. This is a very interesting discussion, and he examines power supply interaction with harmonic generation by using a shunt beam tetrode in the supply itself as well as the harmonic generation of new type frame grid valves like the ECC88 versus older types. Next is a meaty project using the Russian 6C33CB together with an pentode as the driver valve, the PT49. This project goes by the name "Soviet Panzer" and is presented by Stefan Bevacqua. The 6C33CB is capable of quite high power output, and is pretty mean looking. The last two projects in the book use 300Bs as the output valve. The penultimate, by Fabrizio Cappalletti, uses a single valve per channel in monobloc configuration. It has a two stage driver using 311A and PT8 valves, together with split, valve rectified power supplies. The final project is a stereo design, again by Fabrizio Cappalletti. It uses a PT49 as a single stage driver and a valve rectified power supply.

Overall the book is a good buy, but to build most of the projects requires more skill than a kit. Also some of the valves used, although excellent, are rare and expensive. The data on most of these obscure valves can be obtained from Audiolamp, as can the majority of the components such as output transformers. **AG ■**

LOUDSPEAKER DESIGN COOKBOOK 6th Edition

Commonly quoted as something of a loudspeaker designer's bible, there's no doubt the Loudspeaker Designer's Cookbook is one of the most comprehensive and up-to-date tomes on loudspeaker design available. It's as near as you can get to The Radio Designers Handbook in terms of stature, and for some very good reasons. It has now reached the 6th edition, the first being published in 1977, so it's a large work that runs to 288 almost-A4 sized pages, packed with diagrams, text and graphs.

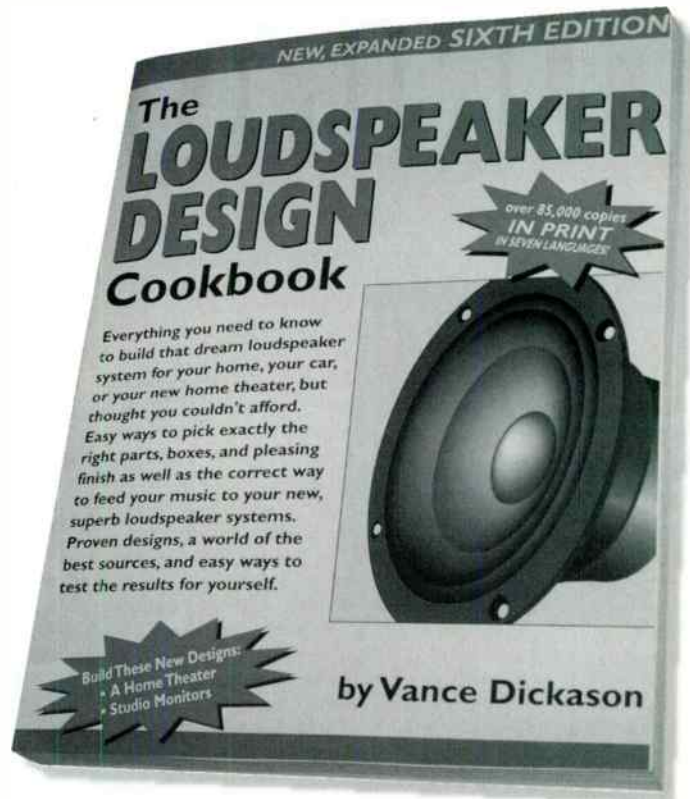
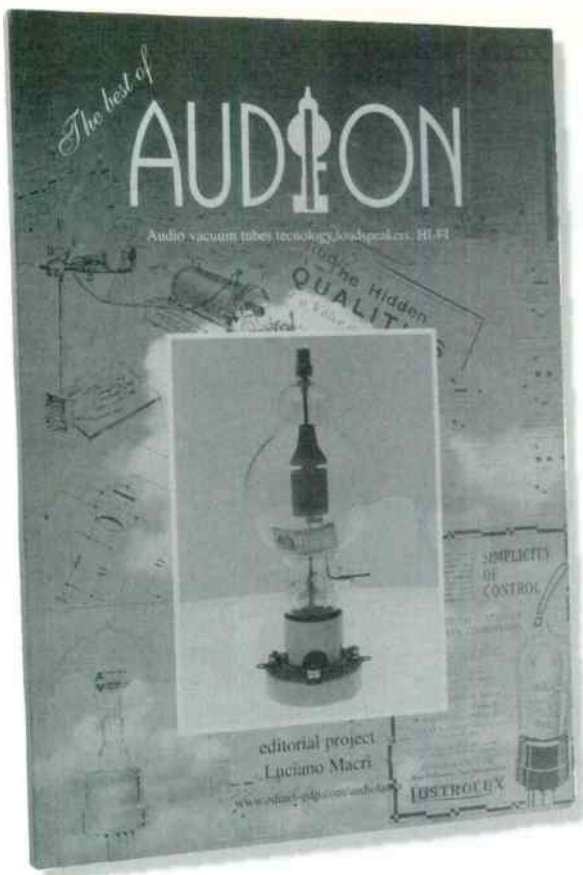
For a designer Dickason's research is reassuring and his relatively neutral stance ensures different ideas get a good airing free from polemic. That means, with the benefit of time also, the book covers an increasing amount of theoretical and practical ground in an even natured manner.

The sixth edition, Dickason points out in his introduction, covers Earl Geddes new Acoustic Lever system, low frequency woofer design including high frequency radiation behaviour, a completely new Transmission Line chapter, CAD software, curvilinear vents, dipole home theater loudspeakers, imaging in-car and, finally, a revised Projects chapter.

As someone who designs loudspeakers I have always found the Loudspeaker Design Cookbook an absorbing read as well as a useful practical guide and much of this edition's new data caught my attention. The only point I would like to make straight away though is that, although not difficult to understand, this is a specialised and detailed look at loudspeakers, something of an overkill for anyone casually interested.

The other point I always make is that

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there's no easy way to design and build your own loudspeaker satisfactorily - they are just too complex. The only way you'll meet the rather crude front cover claims - not written by Vance Dickason I'd guess - is by building one of the two projects, but since one is a 'home theater' system and the other a peculiar form of (small) studio monitor, neither are very enticing, nor representative of what the book otherwise does so well: describe modern loudspeaker theory and engineering.

Of interest to me was Dickason's expansion of the subject of drive unit behaviour and design. Drive unit quality is so fundamental to the performance of a loudspeaker that it cannot be ignored, so this expansion of detail is appropriate and very welcome. It can still be taken further, into materials technology for example, but for the time being the new material is welcome.

Of more interest though was the new chapter on Transmission Lines. The pool of knowledge on them is widening and deepening, and here Dickason brings together the results of much continuing research and practical work, as well as providing a history (as he does with the other loading types). I agree with his view that for their complexity and size TLs don't seem to offer much benefit over simpler cabinet arrangements, especially reflexes. However, he doesn't in this summary of them, take into account impedance. Their flat impedance curve shows that acoustic loading of the bass unit is optimal, far better than a reflex or closed box, and their amplifier matching is near perfect. TLs are, as Dickason

notes, an interesting area for DIYers, and they will get the best out of amplifiers - valve and transistor - in a way simpler commercial designs cannot. The book is good for laying out the table and Dickason assembles data and discussion on TLs impressively.

The Loudspeaker Design Cookbook has twelve chapters, which I'll briefly describe. The first covers drive units and now goes into useful detail about high frequency radiation from 'dustcaps', as well as design parameters for different types of box loading. Dickason also covers driver design software, so this para. is getting serious.

It is followed by 'Closed Box Systems' (infinite baffle), Vented Box Systems (reflex) and Passive Radiators (ABR). These chapters were the original core material and are extensive, talking much about alignments etc. All modelling is based around Thiele-Small parameters.

Transmission Lines follow which, not being a closed/vented box as such, are quite different. After this there's a short chapter - just five pages - on cabinet construction followed by another short discussion of midrange and high frequency drivers and their loading techniques.

Then comes a long chapter on Crossovers, which Dickason rightly says deserves a book in itself, but in line with the Cookbook approach he deals mostly with accepted methods.

Loudspeaker Testing is next up and this appeals to me of course. Many of the techniques Dickason describes are basic and relatively simple, making them suitable for

home constructors. He hasn't yet got around to fully embrace recent developments, like inexpensive PC based A/Ds and FFTs, all of which help the (serious) experimenter. However, computer design software does now have its own chapter, and room acoustic programmes get a look in too. It's quite obvious, looking at the growing catalogue of products here, and their complexity, that this area will be expanding greatly over the next decade, which is very good news for computer savvy DIYers.

Home Theater (U.S. spelling) gets its own chapter, and so does Car Audio, but only eight pages.

The last chapter presents the two projects I mentioned earlier.

At the rear is an 'advertising resource' of predominantly U.S. suppliers, but it's easy enough to buy from the States and there are some interesting products, some not easily found in the U.K.

The Loudspeaker Design Cookbook only gets better. It remains an engrossing read on loudspeakers, one that's accessible to the non-technical. If you are interested in loudspeakers this is one of the most comprehensive views available. It's not to be missed. **NK** ■

Loudspeaker Design Cookbook
(Sixth Edition) by Vance Dickason
available from our World Library - see p76-79
for order form.

Price £29.50 + £4.00 p&p (UK)

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TUNING 300B PSE

Our specialised Parallel Single-Ended 20W amplifier becomes even more esoteric. Nick Lucas, Andy Grove and Simon Pope tune it up.

Intro by Nick Lucas

Sound quality by Simon Pope

Technical by Andy Grove

Designed by Andy Grove



It is amazing what a difference a few years can make to the popularity of a valve - in this case the 300B. I recall the launch of our original 300B Push-Pull amplifier over six years ago, a stereo design with an output of 28 watts per channel. A specialised and hefty amplifier, it generated interest among those aware of the wonderful sound the 300B valve possess, but a lot of the budding hobbyists were put off by the £260.00 cost of a valve set. Most went for a less expensive valve design, such as 5881 or EL34 based amplifiers.

Now, following the publication of our 300B PSE monobloc design in *Hi-Fi World*, October 2000 DIY Supplement, it appears that appreciation of the excellent sonic performance of the 300B has spread among the valve community. Our 300B PSE has generated tremendous interest. It appears that a lot of budding DIYers have developed a taste for the high-end.

Our 300B PSE is the type of amplifier that you will probably keep for many years or perhaps ever. It's a highly specialised design possessing dramatic sound quality and an amplifier like this that is fundamentally pure and simple is amenable to tuning with special parts. This is helped by the fact that it is very 'tweak' friendly as all components are located on tag boards and there is a lot of room inside, making component swapping easy.

Each tag board (three in each monobloc) is built up of twin-row, 18-way hot-tinned tag boards that are very durable, unlike printed circuit boards that do not, as a rule, like a lot

of soldering and desoldering. Such a process requires a lot of heat, this breaks down the copper track-to-board material (epoxy woven glass-fibre) bonding, thus the track can lift off and, being thin, will break quite easily)

Judging by the number of 300B PSE entries on our bulletin board a lot of you have already started tuning. Here is our idea of a good start-off upgrade kit. We have concentrated on the signal circuitry combined with an easy 300B heater conversion from ac to dc to take hum levels down to an incredible 0.8mV without feedback. This will interest all you super high efficiency speaker owners. Andy Grove will be discussing the pros and cons of such a move later.

There are those who will be wondering why we never touch the power supply unit (PSU), especially in this case as there is a quite a high component count for the PSU. We may well do in the future, to Cerafines for the high voltage 500V capacitors, if I can find them (production has now ceased), Black Gates for the other capacitors and extra fast recovery diodes to replace the two bridge rectifiers.

With our upgrade articles, we tend to stick with capacitors. Pound for pound, they do make the most dramatic difference, especially now we are getting Jensen paper-in-

oils in.

For the coupling capacitor C2, and feedback path capacitor C4, we have chosen Jensen's aluminum foil, paper-in-oil. When it comes to valve amplifiers these Danes really do make the best capacitors.

For C1, C5 and C6, all cathode bypass capacitors for the 6AU6 and the two 300Bs, we went for the magnificent Black Gate organic electrolyte capacitors.

There are circuit additions too. The 300B heater bridge rectifiers are a 35A package, over rated purposely to handle the high current pulse at switch-on. The associated smoothing capacitors are standard radials to smooth out the rectified DC voltage.

Fitting the components is straightforward enough, but all components are directional so great care must be taken in orientation. The Jensens are marked with a line on the body of the cap at one end, denoting the position of the ac voltage end (highest potential). This orientation simply ensures the best sonic performance; they won't go 'puff' if wrongly positioned.

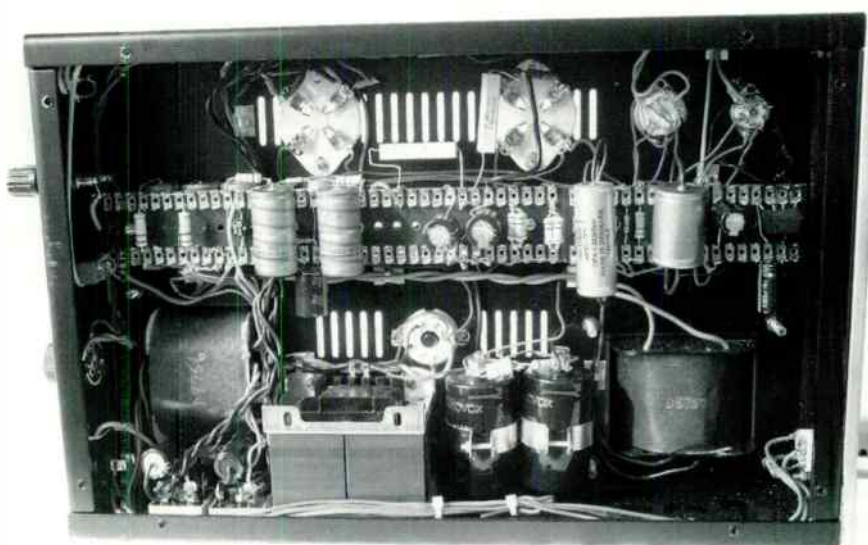
The bridge rectifiers are fitted near to the mains input socket so care needs to be taken here. They are fitted using m3 x 20mm screws, which pass through the vents, so no

drilling is required. All the radial capacitors require sleeving on their leadout to prevent contact with other parts of the circuit.

SOUND QUALITY
300B KIT - NO UPGRADES

The sound of these monoblocs 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. Starting with 'The Only Living Boy In New York' by Everything But The Girl, the 'speakers were driven easily with great control with the volume pot barely off minimum! In 'feedback-less' mode Tracey Thorn's vocal lines and the accompanying acoustic guitars were open and airy, with a sweet treble of the like exclusive to tubes (ideal for acoustic music), whilst in 'feedback' mode the sound was tightened and more sheer clout was present.

In Mahler's Symphony No.9 conducted by Pierre Boulez a feeling of spaciousness and depth was present and the instruments had natural sounds and colours, especially woodwind and percussion. Strings were smooth and fluid, with the violins rounded and lyrical. These amplifiers represent all that is great about the valve sound: space, depth and sheer listenability.



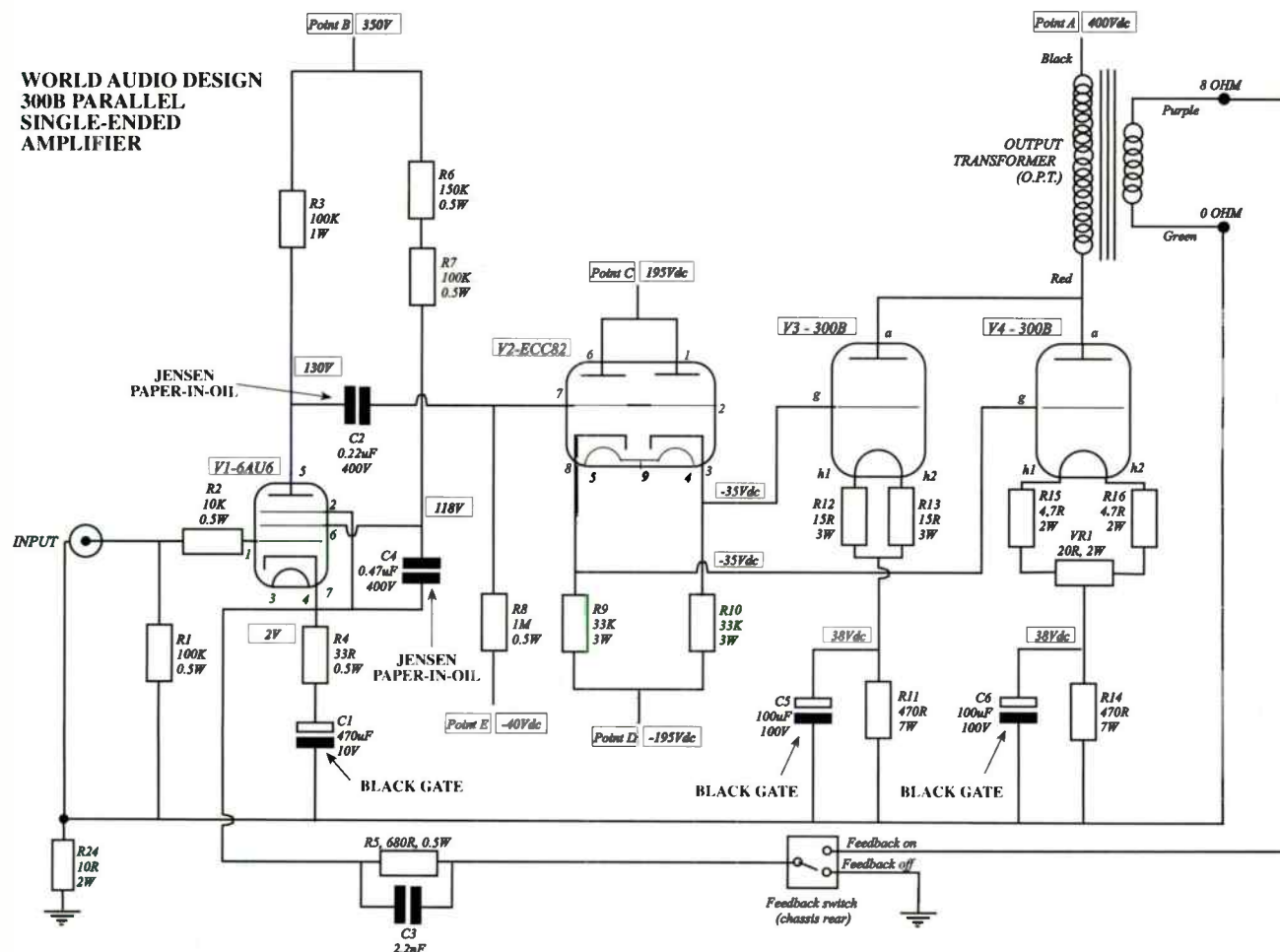
300B WITH BLACK GATE CAPACITORS

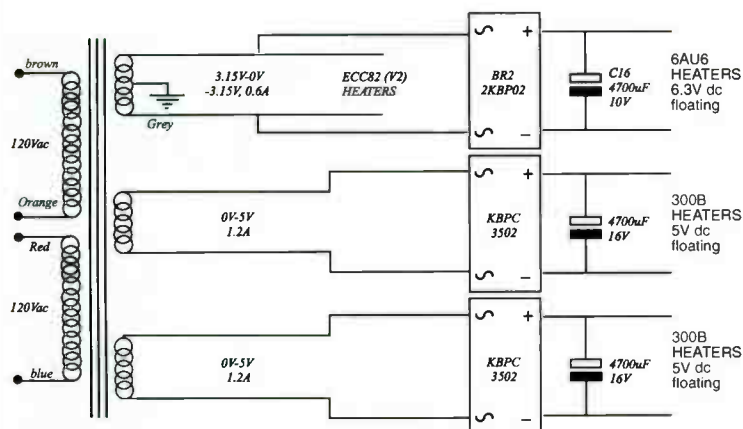
With the addition of the Japanese Black gate capacitors the sound possessed more detail and intricacy, mixed with an easy going warmth. In the Everything But The Girl track, the voice was brought further forward in the mix and intricacies such as consonants were better defined, with a higher retrieval of detail. This also went for the instrumentation, which was now livelier and better focussed. Drums were well separated and set right back

in the deep soundstage. Bass was tighter, with a better developed body.

With the classical orchestral piece, the Black Gates worked their magic on instrumental timbres, coaxing the best out of the wide range of instruments Mahler uses in his orchestra. Right across their wide bandwidth these amps presented with excellent balance and poise, from taut bass drums thumps right up to sparkingly real triangle strokes. The overall sound was open and free but with deft rhythmic control, to boot.

WORLD AUDIO DESIGN
300B PARALLEL
SINGLE-ENDED
AMPLIFIER





►► 300B WITH BLACK GATES AND JENSEN CAPACITORS

The addition of Jensen's paper-in-oil capacitors raised sound quality to that of a mega high end valve sound. If you're a fan of the venerable tube then it doesn't get much better than this.

The Everything But The Girl track sounded highly detailed and lifelike, without having the analytical and sterile quality that's often the baggage that comes with high end audio. Tracey Thorn's voice was so realistic, so simply there, that she could have been sitting in the bay window. The accompanying instruments around her supported her voice well, with every nuance and quirk in the mix jaw droppingly relayed.

Mahler's gigantic orchestra floated through the speakers with grace and power. There was oodles of space discernable between the instruments and the level of transparency was almost unsurpassable. This is combined with a natural warmth, though, that makes this sound relaxing to listen to, despite the high level of detail and involvement - the true sign of a superb valve sound.

Happy tweaking!

300B DC HEATERS

- by Andy Grove

For those high sensitivity speaker users who might find the 300B PSE hum level of 4mV a bit too high we have been experimenting. Of course, speakers come in varying sensitivities and some people find hum more irritating than others do.

We fitted a rectifier/capacitor combination to our prototype to provide DC heaters for the 300B output valves. In fact some eager experimenters have already done this with their kits with good results.

We used a 35A bridge rectifier and 4700uF, 16V electrolytic capacitors to provide DC. This effectively dropped the hum levels down to 0.8mV on feedbackless mode and to 0.4mV on feedback-on mode. The bridge rectifiers may seem a little on the large side

but they are still inexpensive and their size allows direct chassis mounting of all the components, easing fitment.

Also the very low DC resistance of the filament when cold and the high initial charging current of the reservoir capacitor is less likely to stress the rectifier if oversized. This initial surge can be so serious that it can literally blow the tracks off a PCB if they are not beefy enough.

Generally I prefer to use AC heaters if I can get away with it. Firstly, aesthetically an AC heated amplifier is more minimalist and traditional in style, which I personally like (designers aren't emotionless machines!).

Secondly, in my experience I have found that using a rectified heater, especially with directly heated valves, can add an edge to the sound. RF switching pulses, generated by the solid state rectifier could cause this. In some of the mad experiments conducted at Audio Note we used a choke-input filter to try to overcome this problem.

There is another niggling problem and that concerns the

filament itself. To explain this some background theory and history is required - see my potted thermionic emission technobabble below.

D.C. DRAWBACKS

As the oxide coated filament functions via an electrochemical process any electrical potential across the filament itself (i.e. filament voltage) will have an effect upon it. If the filament is fed with AC this effect is zero if averaged over any reasonable length of time. If we use DC the voltage compared to the anode (and of course the grid) at each end of the filament is different, permanently, which can cause problems in terms of filament life and valve performance. Most commercial 300B (and other Directly Heated Triode) amplifiers, however, use DC filaments and still achieve good results and life expectancy from their valves. All the same low hum is a priority in many people's minds, so DC heaters are for them.

We are offering an inexpensive kit of parts to convert your kit to DC filament supplies, which will reduce the hum to inaudible levels, even with sensitive speakers. ■ ▲

PARTS LIST (for 2 monoblocs)

Components

C1	470uF 16V, Black Gate, Radial	x2
C2	0.22uF 630V Jensen, Aluminum Foil, Paper in Oil	x2
C4	0.47uF 630V Jensen, Aluminum Foil, Paper in Oil	x2
C5/6	100uF 100V Black Gate, Radial	x4
heater	35A bridge rectifier	x4
heater	4700uF 16V Radial capacitor	x4
Hardware	1/1.2 single core copper wire (bridge rectifiers to 300Bs)	
	& 2m rubber sleeving for isolating Jensen capacitors lead outs	0.3m
	M3 x 20mm screws (fitting bridge rectifiers)	x4
	M3 screws (fitting bridge rectifiers)	x4
	M4 metal washer (fitting bridge rectifiers)	x4

The 300B PSE Upgrade kit and components are available from World Audio Publishing Ltd (UK)

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300B PSE Upgrade kit (a pair)	£150.00	£130.00
or purchase parts individually from our Parts Directory (unit price shown)		
Jensen 0.22uF 630Vdc paper in oil capacitors	£16.00	£14.00
Jensen 0.47uF 630Vdc paper in oil capacitors	£20.00	£17.00
Black Gate 100uF 100Vdc electrolytic capacitors	£10.00	£8.50
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D.I.Y. LETTERS

This month we own up to a miracle that really was a mistake; discuss the pros and cons of Distributed Loading, reveal the secrets of the Loyez phase splitter in intimate detail and talk about tuning our KLS9 loudspeaker. So don your thinking caps and get reading!

► MIRACLES

Have you achieved a minor miracle or am I missing something? In the Kit34 circuit diagram in your April 2001 DIY Supplement the dissipation per EL34 is about 11W, so how do you get an output of 32w per pair? Compare with the K5881. Here the dissipation per output valve is about 25W each and I seem to recall this amp claimed about 28W max output per pair.

**regards,
Nick Coleman**

P.S. Intrigued to see you've gone for Ultra Linear output transformer connection of late in your designs, having previously preferred to avoid it. Is this just the personal whim of different designers? Your K5881 is certainly best with triode connexion with balanced pairs of output valves and common cathode resistors (560 ohm in parallel). It's somewhat overbright with pentode connexion. I also tried with/without cathode R bypass caps and have left in 470 mfd although I couldn't detect any audible difference with or without them.

I have always been somewhat sceptical about component upgrades but must admit your suggestion of Black Gate bypass for SRPP valve did improve bass response and made more difference than paper-in-oil signal caps.

Has anyone tried KT66s here? You said they could be used in your K6L6 amp but can the K5881 mains transformer take the extra heater current?

Hi Nick,
Rather than a minor miracle it appears we made a printing error. The voltage at the cathode of the

EL34s is approximately 26V, not 11V as shown in the diagram - oops! With 26V across the 390R resistor the a+g2 dissipation is approximately 25W.

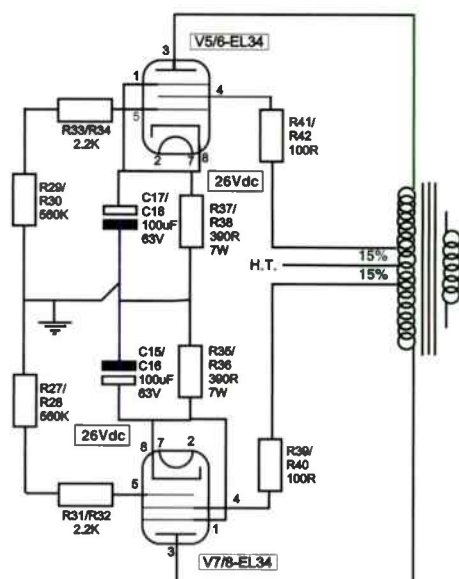
We have started using Ultra Linear transformers as it allows the opportunity for experimentation. It is easy to mod the amp to be triode coupled, Ultra Linear, or pure pentode. If the taps aren't there the scope for this sort of experimentation is limited.

With the new EL34 kit we used approximately 15% Ultra Linear taps, rather than the 43% usually seen. When Mullard designed the 5-20 they really wanted to demonstrate their new set of audio valves so that amp had lashings of feedback and was set up to provide minimum distortion. However, even the original EL34 could be a bit suspect with a high voltage on its screen grid, so today I like to keep that voltage below 400V. If we had used the full 43% the drop in Vg2 with the anode swing would severely limit power output, as Vg2 is only 375V to start with.

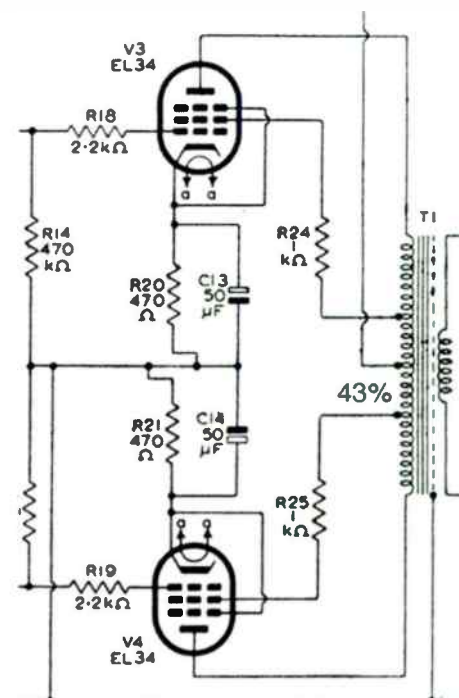
Similar logic was applied to the EL84 kit. I have spoken to a friend and engineer, Mike Pointer, who has had a great deal of experience with vintage amplifier circuits. He maintains that 20% Ultra Linear is the optimum when it comes to sound quality, I am inclined to agree.

NK says:

When developing K5881 I could detect no benefit in Ultra-Linear working through either measurement or listening. Andy came along a little later and he



Above: Kit34 OUTPUT STAGE. The cathodes have 26V on them, not 11V as originally shown. Designer Andy Grove used 15% Distributed Loading to reduce distortion but avoid over stressing the valve. See also Mullard's performance figures on p22.



Right: Mullard's original 5.20 distributed loading arrangement 43% of the primary was shared by the anode and screen. These primary taps provide distortion-reducing a.c. feedback. See Mullard's performance figures on p22.

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Comparison between Triode, Pentode and Distributed-load Operaton of EL34s and EL84s

Valve	Mode of Operation	Operating Conditions					Total Distortion (%)				
		V _a (V)	V _{g2} (V)	R _k (Ω)	R _{a-a} (kΩ)	R _{g2} (Ω)	10W	14W	20W	30W	40W
EL34	Triode connection	400	*	470 (per valve)	10	*	0.5	0.7	—	—	—
	Distributed load (a) 20% common winding	400	400	470 (per valve)	7.0	1000 (per valve)	0.7	0.8	1.0	1.5	5.0
	(b) 43% common winding	400	400	470 (per valve)	6.6	1000 (per valve)	0.6	0.7	0.8	1.0	—
	Pentode connection	330	330	130 (common)	3.4	470 (common)	1.5	2.0	2.5	4.0	6.0
							5W	10W	15W		
EL84	Triode connection	300	*	150 (common)	10	*	1.0	—	—		
	Distributed load (a) 20% common winding	300	300	270 (per valve)	6.6	—	0.8	1.0	1.5		
	(b) 43% common winding	300	300	270 (per valve)	8.0	—	0.7	0.9	—		
	Pentode connection	300	300	270 (per valve)	8.0	—	1.5	2.0	2.0		

Mullard's original performance figures comparing triode, pentode and distributed loading.

*Screen grid strapped to anode

prefers to use it. So there was a difference in design outlook.

The Russian 5881 valve is a very clean sounding valve, but sometimes with a bit of greyness to it's character. The EL34 is a lot more funky sounding, although it also has a touch of grain at the top. At one time I really loved the EL34, because it was big and funky. Then my tastes changed and I was after super smooth treble and dry mid so I left the EL34 and started an affair with the lithe 6L6. Now I am back with my cuddly old girlfriend the EL34, especially in Ultra Linear mode. Designer's whims eh?

The 5881 makes a pretty good triode when connected as such, although you will get a big reduction in power output as triodes have lower power efficiency when operated without grid current. Using a common cathode resistor conveys some electrical and sonic advantages due to the more favourable recirculating current paths. Generally I don't use that method as it is less reliable. If one valve fails the other will self destruct.

As for swapping valve types in the K5881 amp I am pretty sure that the mains TX could take the extra current of a KT66 but the transformer may get warmer than you would like. Instead you could try some N.O.S. 5881s

or 6L6GCs. Svetlana also make an excellent 6L6GC. Alternatively why not buy one of our new kits for a complete change?

As for Black Gate capacitors, they can perform miracles if used in the right place. You may like to ask Peter or Steve at Audio Note in Brighton to send you some information on them. The papers make interesting, and entertaining reading, not least for the quirky Japanese to English translation.

AG ■

► LOYEZ PHASE SPLITTER

I noticed the DIY Supplement of your November 2000 issue carried a letter from Chris Logan, Sydney, Australia, asking about the Loyez phase splitter. As I have done some experimenting with this circuit I decided to reply. The circuit originates in France and has been very popular there. I lived in France for a number of years and was mostly un-employed. I used this time to try out every driver phase inverter circuit imaginable (driving an ultra linear push-pull EL84 with Dynaco output transformers).

The Loyez circuit is very interesting, if not unusual, and performs very well. It utilises various internal feedback loops to reduce distortion and output impedance. In figure 1, you will find the overall circuit diagram as I built it. Similar circuits



Here's a 'lithe' 6L6GC. It might look as sexy as the curvy jobs but it takes more punishment.

were published in French audio magazines as well as in the book, "Initiation aux amplis 'a tubes" by Jean Hilynaya. Read also the article by Gary Devon in D.I.Y letters in the November 2000 supplement of Hi-Fi magazine; there are similarities.

The first stage has a gain of about 12x. The feedback signal from the output transformer secondary is applied to the input stage cathode and drives the lower half of the 12AU7. The value of the 47R resistor was found experimentally for

equal and opposite output swings at the plates of the 12AU7 tube. The input stage is directly coupled to the second stage, whose gain is about 27x. This stage is basically a self-balancing Schmitt inverter.

Feedback loops are applied to the inputs of the grids via 10M resistors. Output tubes used were EL84s, but EL34s can also be used. To reduce the number of tubes one can use a 12AU7 and two ECL86s! The internal feedback contributes about 8 db of feedback (neg.). The phase inverter shows perfect balance and the amplifier is perfectly stable with an additional 20 db overall neg. feedback.

I recommend a heavy-duty power supply with an 8-10H filter choke; with a B+ of 320 volts, the output obtained was 12.5 watts. The distortion is below 1% at 10 watts output (40 Hz to 10,000 Hz), with only 0.1% at 1000 Hz. The frequency response was flat up to 100 kHz and the damping factor a surprising 23! Bass response was exceptional for a pair of EL84s, better than other circuits I tried.

I hope that this information will have answered your questions. I have also built a McIntosh type circuit (also EL84s), with home made output transformer and performed similarly to the Loyez circuit. The EL84 version giving the most transparent sound uses a simple phase splitter but bass response (damping) was not as good:

For additional information, feel free to write to me and I will gladly reply.

Adriaan Hammer,
Lafayette LA 70501, U.S.A

Thanks for enlightening me to the Loyez phase splitter. When I saw your diagram I realised that I had seen a similar topology before somewhere in a French amplifier circuit diagram, possibly Jadis. There are also some examples of the Loyez in the book reviewed recently, *Manuale Hi-Fi a valvole*. It is an interesting application with multiple internal feedback loops and shows characteristic French flair and individuality.

The use of multiple, nested feedback loops can greatly improve the measured performance of an amplifier, by allowing a greater degree of feedback to be applied. In the diagram it can be seen that there are three loops, one inside the other, like Russian dolls. The most immediate is from the output valve's anodes to the drive stage's anode in the form of shunt feedback via the 10M resistors. The next loop encloses this, again shunt feedback via 10M resistors but to the input stage this time - note how the connections are crossed over to ensure the correct phasing.

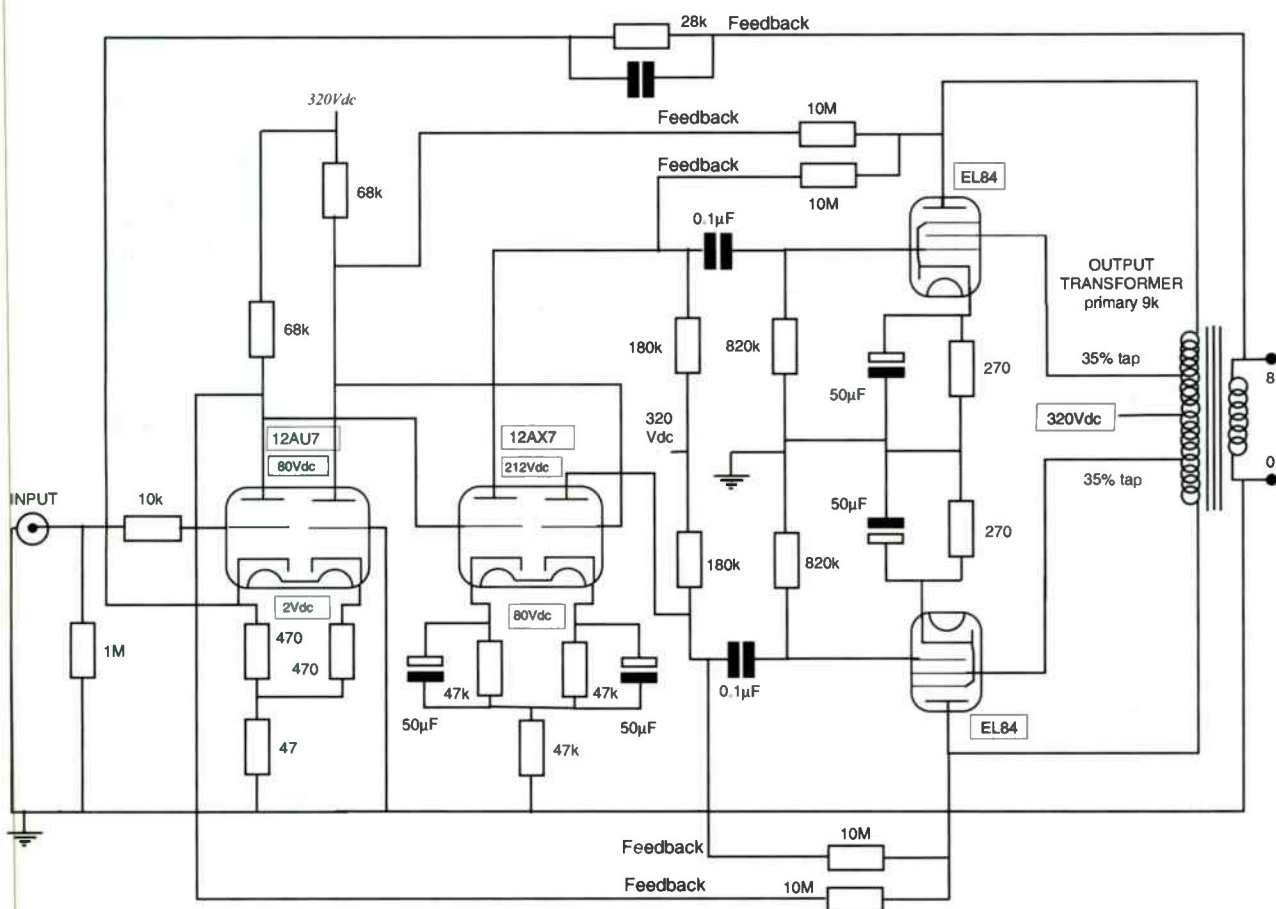
Finally, the overall loop comes from the transformer secondary back to the input valve

cathode. I have not counted the Ultra Linear connection of the output valves, although that too could be viewed as another internal loop.

The overall feedback from the output stage also serves to drive the phase splitting mechanism of the input stage, supplying a signal to the cathode of the inverter half of the input 12AU7. I can see a problem with this though as phase shifts and amplitude variations from input to output will change the AC balance of the phase splitter, although by how much needs to be determined by experiment.

"Russian doll" feedback loops are not confined to valve amplifiers; for example the NE5534 op amp uses nested loops to obtain it's excellent measured performance.

In a nutshell, the amount of loop feedback that can be applied around an amplifier is limited by the phase shift versus gain of the various stages and components within the loop. If we apply a small amount of feedback around one of the stages within the loop then that stage has less phase shift and the outermost loop is more stable. The inner loops are easily stabilised because they are so direct. This approach has been applied to many advanced valve amp designs including those from EAR, Audio Research and Lux, plus the soon to appear project in these pages. **AG ■**



FROM THE BULLETIN BOARD

www.worldaudiodesign.co.uk

I have just finished building a pair of KLS9s almost exactly to Noel Keywood's specs. (April 1997 DIY Supp No28). Actually, when I say 'just', I mean they were finished last night.

So far they seem very "forward", I suppose is the word. I am listening to old faithful CDs and hearing things I never knew existed. The soundstage is massive (wide and tall) and powerful and the bass goes VERY deep, though it doesn't seem the most controlled...yet.

It seems that vocals, male but more particularly female, seem a bit shut in, as if they were singing in a small, slightly echoey room, and the speakers are preventing them from being totally free. Or perhaps this is a faithful portrayal of the recording and my previous speakers never let me hear it before?

Instruments of all types sound very "live" and detailed. However, it seems that with more complex music like rock that all the instruments and vocals are fighting for control of your attention, though this is not to say that they do not have well defined and distinct positioning in the sound stage.

Basically, since they have only been run in for a 3 or 4 hours so far I am assuming that no real judgement can yet be made, and that they may (or may not) settle down to be more controlled and refined as the drivers run in. Therefore, please don't base your decision to build or not build a pair of KLS9s on this report alone. However a think I can say that if you want speakers which are lively, have very good bass, and give the impression that they could eternally cope with your "just turning the volume up one more notch" without losing control, then by all means, I think the KLS9s will not disappoint.

I have a few questions for those with experience in building the KLS9 in the event that my KLS9s do not settle down to a more balanced character in a couple of weeks or so.

1) I lightly filled the upper chamber of the cabinet with long haired wool, will it help to fill the bottom

chamber as suggested by Noel?

2) My bass reflex ports are 7.5cm * 6cm, which is slightly longer than that suggested by Noel, will this make a major difference to the imperfections I describe above?

3) I am using cheap Monster multistrand copper speaker cable for the internal wiring and cheapish polypropylene Audyn (or something) caps in the high pass portion of the crossover. Will changing to multistrand silver coated copper internal wiring or caps help significantly?

Also, is the resistance of the inductor important on the low pass (supposed to be 1.2mH 0.65ohm, but mine are 1.2mh 0.6ohm), and can anyone recommend a good quality inductor of this rating that is easily obtainable?

4) I have heard that the Audax HM210ZO bass/mid driver is very sensitive to internal damping directly behind the driver itself, and currently I have long haired wool (light density) right up behind the driver, will it help significantly to remove/experiment with this?

Again, obviously this is all immaterial until they have had a chance to run in and I will probably post again after this happens with a more concrete analysis.

System: Musical Fidelity XA50s, XPSU and XPRE amplification. Arcam Alpha 1 CDP. Van Den Hul and Audioquest cables. Previous speaker = Ruark Templar Mk 1 (inferior to KLS9 even at their current state of run in).

Related link: <http://geezas.net/kls9/main.html>

Mark Hanagan

(for KLS9 plans see the above site, or www.audax.com <http://tatooine.fortunecity.com/slaine/152/> <http://www.saunalahti.fi/hhaapane/blacken.html>

Hi Mark,

I was fascinated by your site at 'geezas.net' (?) and by your comments on KLS9. I still use and enjoy them. I would like to offer answers to your questions. I hope others will too.

Firstly, the "echoey room" effect is worrying - it shouldn't be there. I suspect 'box

return' from the rear wall. Put a thick pad of bitumen and/or carpet felt on the rear wall directly behind the HM210ZO. Run it full width (30cm high approx) and crinkle it up so there is not a plane surface to reflect energy off this wall and back out of the woofer cone.

You can also try dispersion of this wave by an irregular or angled surface, although absorption is the usual solution.

Keep wool away from the rear of the cone. You'll hear it otherwise (believe it or not!). I suggest you start out with no wool then introduce it progressively, listening to bass quality. Wool should be used at points of maximum displacement, which means in the centre of the cabinet, not at walls. Stretch a mesh across the bracing baffle and lay wool on top. If you use wool behind the bass/mid, keep it 2/3rds the way back.

You might need to use bitumen or carpet felt pads on other walls to stop reflections. But beware of over-damping a reflex. Commercial boxes often have very little stuffing.

Your port should be OK and your bass inductor. However, component quality is an issue and basically use the best you can. I run KLS9s with an external crossover in a plastic box that sits on the floor well away from all vibration. External remote crossovers make a big difference to stage depth and instrument resolution. They're easy and cheap to make.

Make certain you bevel the cabinet edges heavily for best diffraction; this will improve image quality. Also, make sure the cabs are well anchored down to the floor; they must be rock solid for bass suppleness and expression, as well as clean imaging and good time domain resolution.

Running in will take a time and improve things, but there's plenty else to do! Hope this helps. Good luck and have fun.

NK ■

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Unit 14 Haven Workshops
Pier Road
PEMBROKE DOCK
Pembroke
SA 72 6 TR
Tel: +44 (0) 16 46 68 56 01
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Email: service@greenweld.co.uk
Office Hours: Monday - Friday 08.00 to 17.00