Hi-Fi WORLD

# Hi-Fi WORLD

NO.40 NOVEMBER 1998 SUPPLEMENT

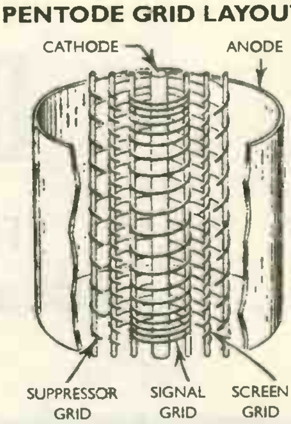
## MESSAGE IN A BOTTLE II

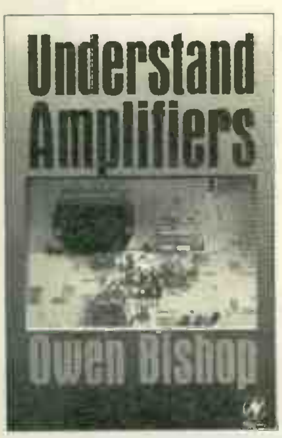
**Building the KEL34 valve integrated amplifier**


## TIPS ON TUBES

**Know your valve technology**

PENTODE GRID LAYOUT




## BOOK REVIEWS:

Understand Amplifiers by Owen Bishop

# FREE D.I.Y. SUPPLEMENT No.40

# D.I.Y. Supplement

# Contents



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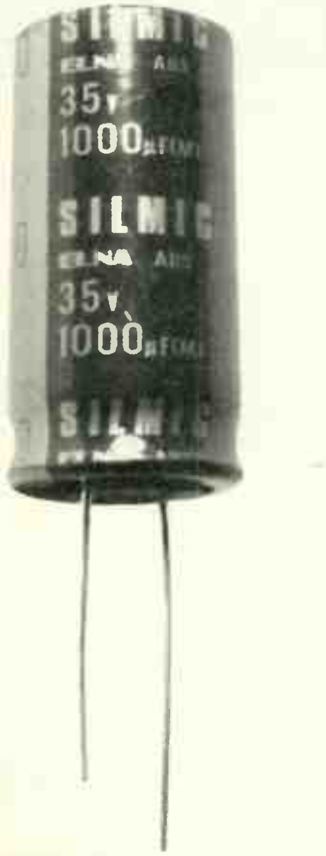
# KIT NEWS

## SILKY SMOOTH SOUND?

AudioCom are now selling Elna's SILMIC series of capacitors. Incorporating silk fibres in their construction, these capacitors sit at the top of Elna's capacitor podium. AudioCom say the new design and materials (such as lead-out wires of Oxygen-Free Copper) result in benefits such as increased signal transfer speed and lower distortion figures. SILMICs come in voltage ratings from 25V to 100V and are priced at £1.44 up to £39.80. AudioCom will also be accepting all major credit cards from late September.

**AudioCom**
**Units 4 and 6,**
**Trindle Centre,**
**Warren Street,**
**Tenby,**
**Pembrokeshire SA70 7JY**
**Tel: 01834 842803**




## TUNNEL VISION

The Svetlana Tube Zone (www.svetlana.com) is the name for the Russian/American valve manufacturer's new web site. Here you'll find a veritable mine of technological information on all things thermionic. Data sheets on Svetlana products are downloadable in Adobe Acrobat, and on-line technical support (including advice on how best to use Svetlana's valves) is available through contacting the company's engineers via e-mail. Finally there's a number of pages called On The Music Scene, which link up musicians and bands who can swap valve anecdotes.

## WILMSLOW GET CONNECTED

Wilmslow Audio, famous for their distribution of drive units and 'speaker kits, have announced that the Musitube range of interconnects they distribute are now 'pre-conditioned' to improve performance. Apparently, this process opens the sound out and improves clarity, as well as removing the need to 'burn in' the cable.

As well as interconnects, this technology has also been applied to Wilmslow's mains leads, made of high-quality, silver-plated cable rated at 500V.

**Wilmslow Audio**
**50 Main Street,**
**Broughton Astley,**
**Leicester LE9 6RO**
**Tel: 01455 286603**

## MONACOR ALL THEY SURVEY

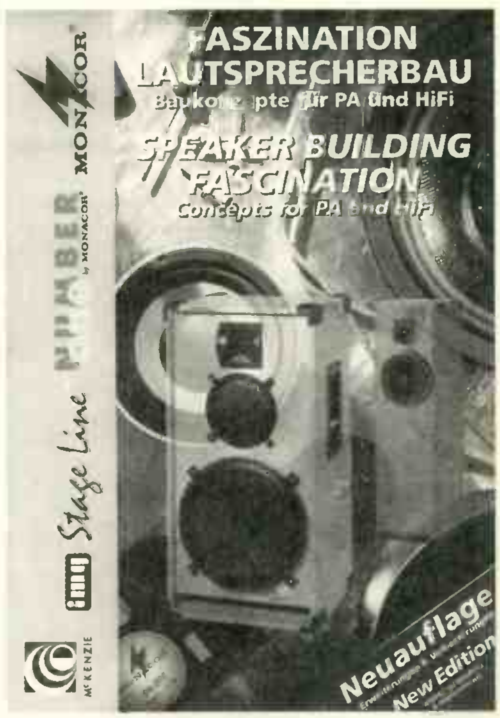
Monacor of Germany are well-known as manufacturers of loudspeaker drivers and related sundries. Now, to assist the tenderfoot 'speaker builder, they have published a new edition of Speaker Building Fascination - Concepts For PA And Hi-Fi', published in both German and occasionally-amusing Germlish at £6 + £1 P&P.

This 95-page A4 pamphlet gives instructions, drive unit data and plenty of back-up on five PA and no less than 15 hi-fi designs. Project complexity spans beginner's level to moderately difficult, taking in a goodly spread of basic loudspeaker concepts. Unusually for a modest text of this sort, graphs of the impedance and frequency response are given for each loudspeaker.

In case hammered thumbs and glue on the carpet don't strike you as the best way of learning, there is a concise guide to the major 'speaker types at the back with explanatory diagrams and the odd formula.

All of the designs rely on drivers from the Monacor catalogue, which can be bought from their UK importer, Cricklewood Electronics.

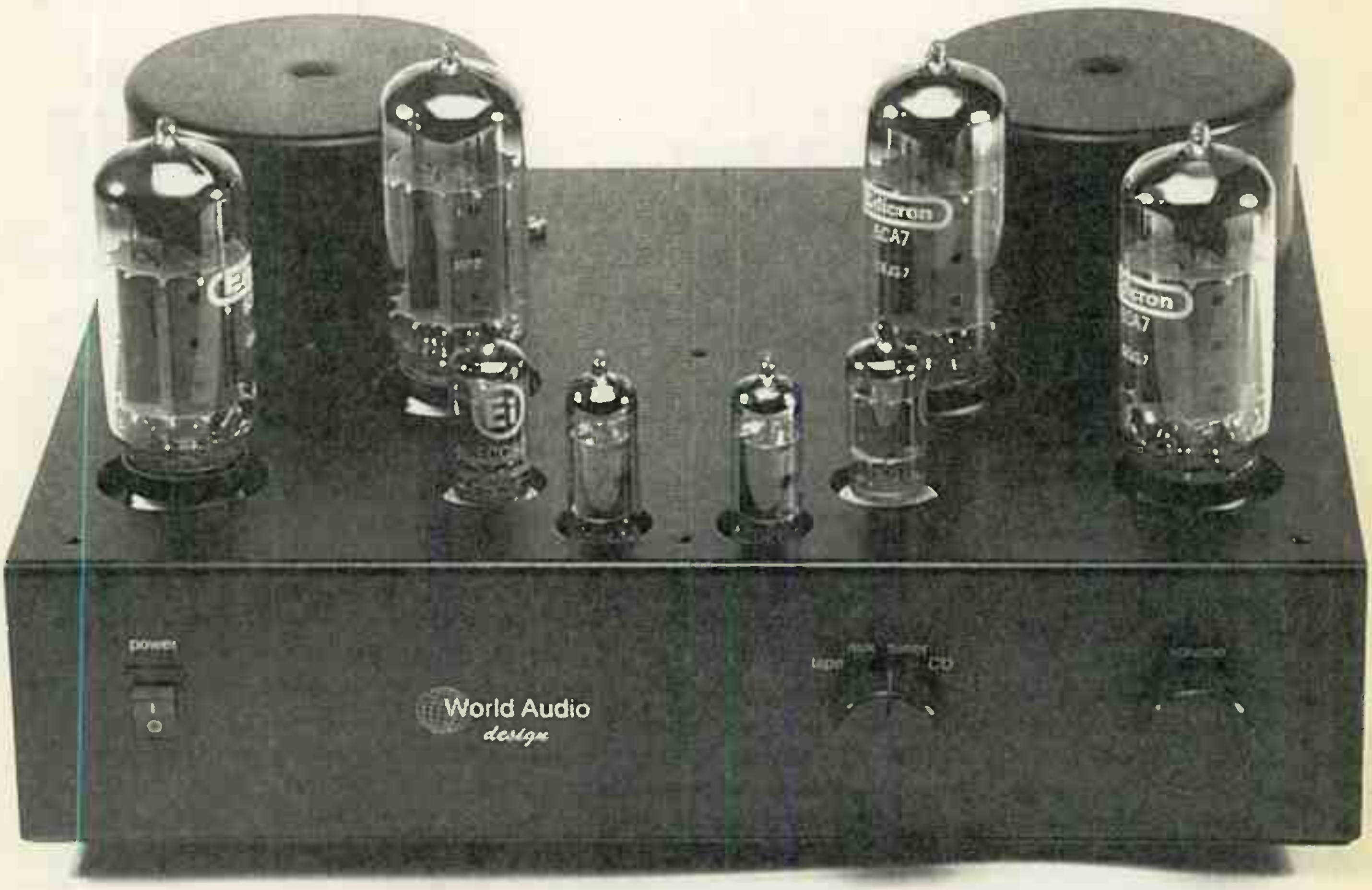
**Cricklewood Electronics**
**40-42 Cricklewood Broadway,**
**London NW2 3ET**
**Tel: 0181 452 0161**



# KEL34 40W VALVE AMPLIFIER

## Part II

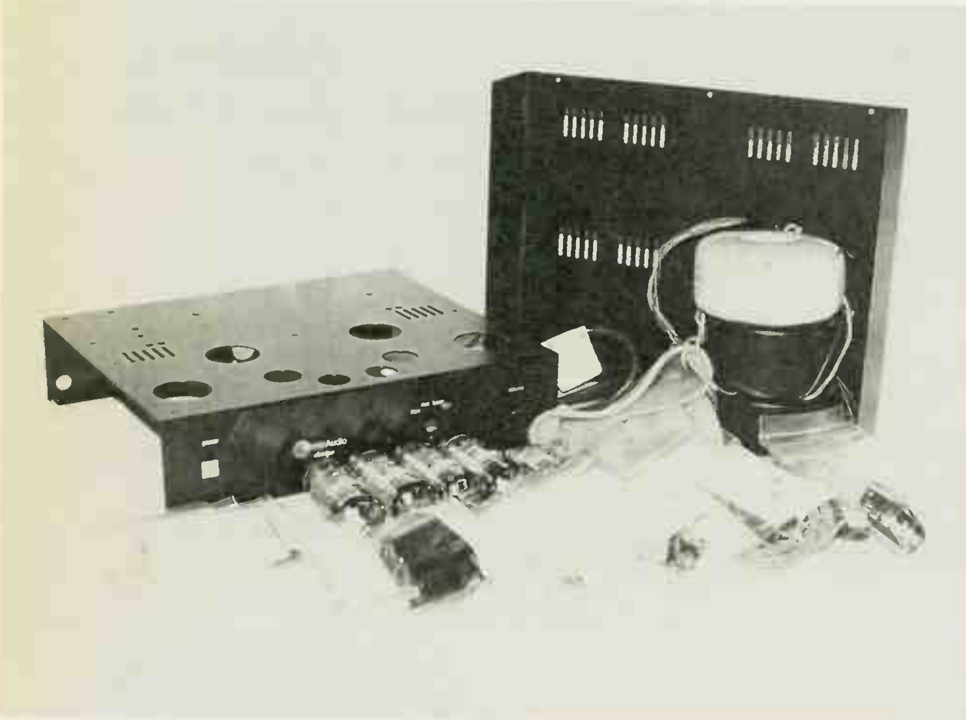
**In last month's Supplement we introduced KEL34, our brand new 40watt valve integrated. Now, Nick Lucas explains how to build the amp and the World listening team check out its sound.**




Our aim with KEL34 was to design an amplifier with the budding DIYer in mind, one which would be both easy to build and easy to maintain. The result is an integrated amplifier, so a pre-amp is unnecessary.

As is common practice, we run all the inputs directly into the volume control to avoid input overload. Most of the parts sit on a circuit board in the kit, which is marked with component positions to reduce the likelihood of incorrect placement. Making adjustment simple is the fact that bias adjustment isn't required as the amp is self-biasing and balancing. Finally, KEL34 delivers a good 40watts from a push-pull output stage using a modern, European valve in current production, one that is not too expensive.

Expect to see more of this valve, the 6CA7, because its performance is impressive. A modern version of Philips'



**KEL34's chassis comes in two U-shaped sections for easy assembly. The three transformers - mains and output - are all toroidal types.**

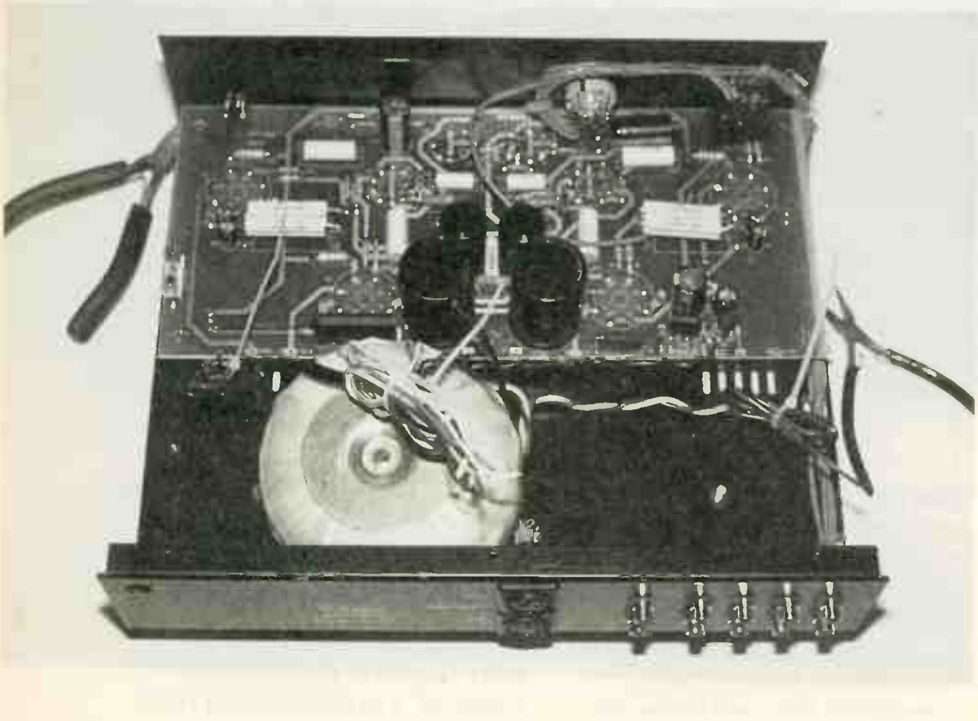
EL34 power pentode, it has a beefed up anode which accepts higher voltages and dissipates more power than the famous original.

In this second instalment of the KEL34 story, we detail the build sequence and give a break-down of what we are offering. Obviously, those readers who can obtain all the parts can build the amplifier from our published circuit. However, there is always demand for a kit, complete with specialist parts like output transformers, whose quality allows Hi-Fi World valve amps to achieve the same even tonal balance as a solid-state amplifier but with the advantages of valves - namely clean treble free from grit and an open, atmospheric sound stage. KEL34 has some serious power too.

Nothing has been left out of the kit; all you need provide are a soldering iron, some solder, a multimeter, a pair of loudspeakers and a musical source.

We have incorporated a couple of features into KEL34 to prevent the sort of errors which usually cause the wrong components in the wrong places. The 30+ parts bags each contain only one value of component and are clearly labelled. The text in the instructions is also backed up with plentiful diagrams and pictures of the kit in various stages of completion. There's a fault-finding section as well, in the unlikely event that constructors run into difficulties. For safety we supply high-voltage protective gloves and, should anyone be unable to complete a kit or make it work, we will sort the problem out.

**A double-sided PCB makes the amp far simpler to build than hard-wiring. In the picture below, you can see there's plenty of space on the board which eases soldering.**



## THE BUILD SEQUENCE

**1) Fixing the hardware to the chassis**

This straightforward process involves fitting the volume potentiometer, selector, knobs, mains switch, mains lead, output and mains transformers, XLR loudspeaker sockets and the RCA phono inputs.

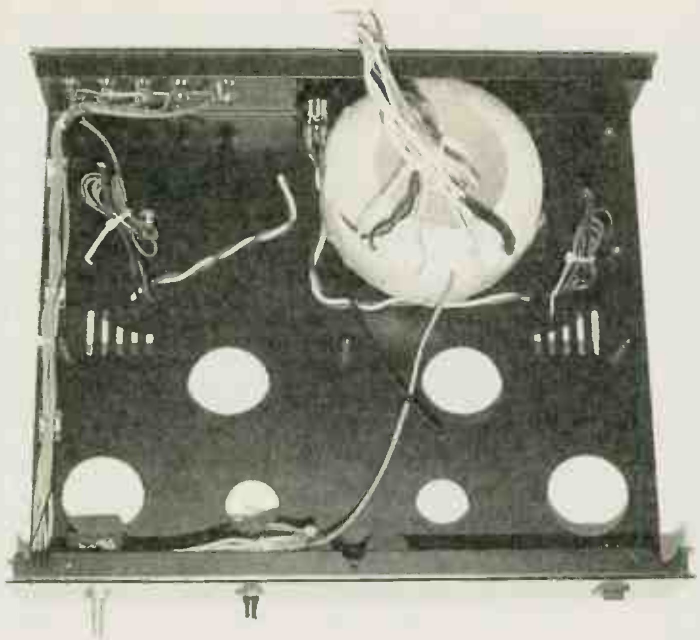
The latter are supplied with M6 fibre washers to isolate them from the chassis. The chassis earth point is at the volume potentiometer, so it's necessary to scrape the paint away internally where the pot. meets the chassis.

**2) Populating the printed circuit board (PCB)**

The ease of build of the KEL34 is largely attributable to the fact that all the valves and passive components sit on the PCB. This is clearly labelled and populating it is very straightforward.

The type of PCB we use is double-sided, hence for all joints except the snap-in electrolytic capacitors you will have to solder both sides of the PCB. We could have opted for the PTH type of PCB (where both sides are joined through the hole), but this would have increased costs dramatically.

The only thing you must double-check while you're populating the PCB is that all the electrolytic capacitors and octal valve bases are correctly orientated. Additionally, some of the resistors in the circuit generate quite a lot of heat, so we recommend raising them above the board to avoid tarnishing its surface.



The input sockets, volume and selector controls should be wired up in the early stages of building.

**3) Valve heater connection**
Once all the components have been fitted, the heaters can be wired up outside of the chassis with the wire provided. On each valve base the heater pins have their own separate tabs to make life easier.

**4) Wiring up the inputs to the selector and volume potentiometer**
Using the twin-screen cable provided and following the diagrams, this is soldering by numbers.

**5) Mains switch through to output transformer connections**
As above, this should pose no problems for competent constructors.

**6) Connecting up the PCB**
This involves soldering around 25 external connections to the PCB from the mains transformer, output transformer, volume control, mains lead, mains switch and feedback points.

**7) Earth wiring**
As you may well know, with valve amplifiers it is of the utmost importance that the earth lines are laid along the correct path and in the correct sequence. This is why we have dedicated a diagram in the instructions to this subject to ensure it is done properly. Otherwise hum may infect this otherwise very quiet amplifier.

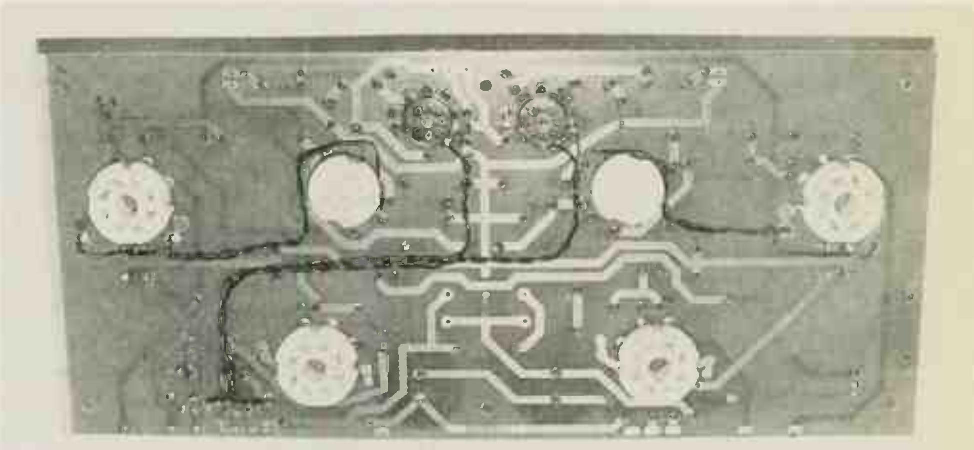
**8) Fixing the PCB inside the chassis**
Now that all the various connections between chassis-mounted components and the PCB have been made, the board itself can be mounted on the underside of the chassis' top-plate.

**9) Switch on and hi-fi bliss**
Build time is 8hrs-20hrs depending on ability.

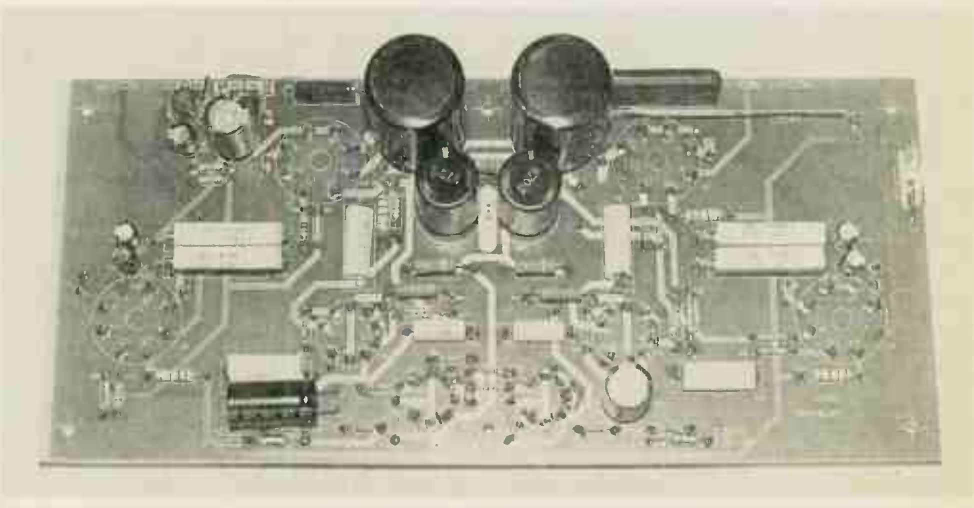
If you do encounter any problems, please refer to the fault-finding section of the instructions, or alternatively call the helpline. If the worst comes to the worst, for a nominal fee we will get your KEL34 up and running.

## MEASURED PERFORMANCE

Our new amplifier uses Ei 6CA7 pentodes from Yugoslavia, conservatively rated at a 25watt anode dissipation. They are an EL34 variant, a modern update in fact. We bias them to 25watts quiescent dissipation, although the anodes are so large they will take a lot more power. Pushing them heavily into class A will not make the anodes glow, as we have found with cheap valves possessing flimsy anodes, but they are run within Ei's specification to avoid accusations of 'over-running'.



On the upper side of the PCB are the valve bases, on the lower all the other components, including the power supply capacitors.



The 6CA7 is robust enough to be able to withstand high HT voltages too, allowing it to deliver oodles of power. It has a massive 800V maximum anode voltage, making it much more robust than Philips' original. Therefore, KEL34 delivers a good 40watts before clipping occurs. In fact, it will swing around 45watts at clip, but a conservative quoted spec is in line with industry practice.

Distortion was low at around 0.15% at ordinary output powers of 1watt-5watts, even though we do not use too much feedback. This figure comprises second harmonic alone, even at high frequencies.

At high power outputs distortion rises to around 2%, as is common with low-feedback valve amps, as the design moves slowly into soft clipping. Since this only effects short-term musical peaks, it is not a major influence upon sound quality.

Frequency response extends from 20Hz-43kHz (-1dB), channel separation measures 60dB and noise a low -96dB. Input sensitivity with the level of feedback applied measures out at 300mV. NK

| | |
|---|---|
| Power | 40watts |
| CD/tuner/aux. | |
| Frequency response | 20Hz-43kHz |
| Separation | 60dB |
| Noise | -96dB |
| Distortion | 0.15% |
| Sensitivity | 300mV |
| DC offset | none |

## SITTING IN THE SWEET SPOT

The Ei 6CA7s certainly looked promising on the test bench with their beefy anodes, but how would they deal with the Jamo Concert 8s? After all, these 4ohm stand mounters usually hit valve amps with a double-whammy of heavy current-draw and the transparency to show up ruthlessly the bass problems this creates.

Driving a 3metre set of Cable Talk's Talk 4.1 bi-wire loudspeaker cable, KEL34 and its compound-biased output stage managed a surprising bass control when dealing with Opus 3's Opera Pearls HDCD. The overture to Bizet's Carmen skipped along with real panache, not a hint of looseness or compression at the bottom end spoiling the rendition.

Where KEL34 rejoined the ranks of hot bottles was in the rich tonal colouring and realism valves are so famous for, as it painted strings of all species from a broad palette. A lack of midrange hardness and those 40watts at the loudspeaker terminals lent themselves to raising the volume too. The neighbours might not be too thrilled at the prospect of this unless they happen to share the same musical tastes, but the dynamics and scale which are the end-product make this a highly tempting proposition.

A valve integrated isn't what you'd normally expect to find glowing along to Dance, but KEL34 confirmed its credentials with a spot of DJ Cher. Into the Jamos, the 6CA7s might not have been able to mimic the downward reach of a megawatt tranny power amp, but they weren't far behind, preferring control and speed to absolute extension. And where some amplifiers with sufficient power to light an oil rig can sound sluggish and blurred, those two pairs of pentodes had a dexterity which guaranteed engagingly musical results even if you're just moshing along to a drum machine.

These two traits suited slower Blues tracks perfectly, the lolloping bass of Joe Beard's Blues Union losing none of its drive or expression. In fact, KEL34 was reminiscent of some of the better classic valve amps working into easy loudspeaker loads - it had crisp lower octaves with a harmonic complexity which the majority of amps, whether solid-state or tube, seem to ignore or miss altogether.

Like all electronics, KEL34 'matures' with time as its constituent parts run in. Vocals, for example, became smoother and more open after a couple of weeks had passed, and the amp delved deeper into recorded ambience to come up with a sound stage any pair of revealing loudspeakers would be happy to relay.

Unlike the majority of its thermionic compatriots, KEL34 doesn't take an idiosyncratic view of tonal balance, preferring to stay neutral in a way that brings to mind transistors more than valves. It is this 'best of both worlds' mix which demonstrates the superiority of valves in a competent design like this.

# HART

## Electronics

Wilmslow Audio have believed for a long time that the **Hart** kit amplifiers were amongst the best sounding amps on the market at any price, so much so that we have bought the company, Hart Electronic kits. We are now able to demonstrate these remarkable amplifiers and welcome you to come along and compare the sound quality with your own equipment.

**We feel that these amplifiers sound better than most others irrespective of price !!**

'AUDIO DESIGN' 80 WATT POWER AMPLIFIER.

**80w Standard Amplifier** designed by John Linsley Hood continues to amaze all who listen to it. The delicacy and transparency of sound coupled with its flawless performance and overall reproduction quality, enables it to be compared with amplifiers costing 5 or 6 times as much. This versatile amplifier is offered in three options allowing you to choose which product will suit your own system.
All amplifiers are now produced in **Super Audiophile** versions only.

Standard Amplifier kit....................................................**£493.81**
Standard Amplifier Factory Assembled..........................**£593.21**

Stereo Power Amplifier kit.............................................**£432.22**
Stereo Power Amp. Factory Assembled.........................**£522.22**

Monoblock Amplifier kit..................................................**£306.90**
Monoblock Amp. Factory Assembled..............................**£386.90**

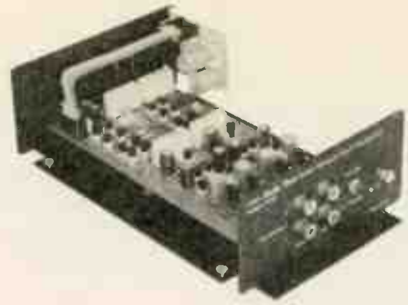
**1400 Pre Amplifier** has been specially designed to offer the added benefit of more inputs than the standard amp. It also offers more comprehensive signal handling with facilities for 2 tape recorders and an in built headphone amplifier. Complete with separate external **Andante** power supply.

1400 Pre Amplifier kit....................................................**£343.49**
1400 Pre Amplifier Factory Assembled..........................**£443..49**

"CHIARA" HEADPHONE AMPLIFIER.

Chiara Headphone Amplifier designed by John Linsley Hood is a singled ended class Amplifier for stand alone use or to supplement those power amps that do not have a headphone facility.
A valuable personal listening option and an attractive , harmonious addition to any hi-fi system.
Used in conjunction with Andante power supply.

Chiara Headphone Amplifier kit.......................................£115.46
Chiara Headphone Amp. Factory Assembled..................£152.46



SHUNT FEEDBACK PICKUP PREAMPLIFIER

**1450 Phono Preamplifier Stage** is able to amplify the minute outputs from moving coil or moving magnet pickups up to a suitable level to feed into any amplifiers standard auxiliary input. The RIAA standard circuitry provides very accurate shunt feedback equalisation.
Used in conjunction with Andante power supply.

**Winner of Gramophone audio choice 1997/98**
**Hi-Fi Buyers Guide**

1450 Phono Preamp kit....................................................**£138.94**
1450 Phono Preamp Factory Assembled.........................**£188.94**

"Andante" Linear Technology
AUDIOPHILE POWER SUPPLIES

**Andante** power supplies are specially designed for exacting audio use requiring absolute minimum noise, low hum field and total freedom from mechanical noise. Available in 2 versions:

The 3550 having 3 - 15v positive and 2 - 15v negative output rails which is ideal for use with our 1400 Preamplifier, Headphone and Phono Amps.
The 3565 having a single 15v supply for use with any one single item only.

Andante 3550 Power Supply kit.......................................**£94.75**
Andante 3550 Factory Assembled...................................**£147.25**

Andante 3565 Power Supply kit.......................................**£84.42**
Andante 3565 Factory Assembled...................................**£133.42**

**400 FM Tuner** is a high quality analogue tuner system designed by John Linsley Hood gives the greatest possible sound fidelity from the FM broadcast media. The incorporation of two circuit features around the stereo decoder and IF/demodulator produces results that are staggering, especially in the clarity, transparency and extended frequency response.

Tuner kit...........................................................................**£256.82**
Tuner Factory Assembled...............................................**£336.82**

### Printed Circuit Board Solder Practice Kit

Unsure whether you can construct a Hart kit ? - This is your chance to try ! Included is a typical PCB, a range of modern components, a roll of the correct grade solder and full set of instructions.

Solder Practice kit...........................................................**£4.99**

# BOTTLE BUILD

**Ever wondered just what makes a valve tick? Noel Keywood reveals the thermionic ingredients.**

Watching the anode of a 6L6 valve slowly starting to glow cherry-red surprised me. I was running this sample at its rated maximum, so the maximum rating was exactly that - the very upper limit. A valve cannot be run long-term like this in practice, yet other 6L6 samples had handled power levels above their quoted maximum. The physical structure of a valve and the materials used in it are subjects worth studying in themselves, and useful to anyone running a valve amplifier.

Edison inserted a plate in an electric lamp and observed that a current flowed between this plate and the positive side of the filament supply. He had invented the diode, but at the time (1883) patented it as a galvanometer. This clearly shows how the valve sprang from the electric lamp.

The valve was the world's first electronic amplifying device. It was developed from the light bulb, an ancestry which shows through in its construction. Staying with the triode, let's look at the different issues raised by its physical properties.

## ANODE

Area and thickness effect heat dissipation and power rating, so generally speaking greater power handling means a bigger anode and a bigger valve. Hot spots occur if anode thickness is not uniform, a sign of poor-quality materials.

Anodes are made from nickel or nickel-plated iron. The surface is then carbonised to increase heat dissipation. High-power valves use graphite, tantalum or molybdenum instead. For example, an 845 anode (rated at 70watts) is coated with graphite.

The bigger the anode, the more power it can handle, so power valves are always big, unless water-cooled.

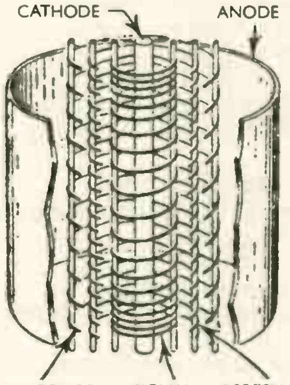
The point at which the anode glows determines the power rating of a valve (calculated as the voltage across the valve multiplied by the current passing through it). To cope with anode variability and keep temperature down to avoid gassing, it is common to set power dissipation 10%-25% below this limit. However, where a manufacturer's spec is already conservative, the valve can be run at its maximum rated power.

Overheating drives out occluded gas and degrades the vacuum within the glass envelope. The electrodes and glass of later valves were out-gassed to minimise this.

## ELECTRODES

Grids are usually made of molybdenum wire, down to 0.025mm diameter in later valves. Wire grids are commonly wound concentrically around nickel supports, as our diagrams show. To improve mutual conductance, spacings were progressively decreased and tolerances improved to prevent electrodes touching. Grid-to-cathode spacings of just 0.1mm were achieved in later valves, at which point heat from the cathode and consequent thermal expansion made further progress difficult.

**PENTODE GRID LAYOUT**

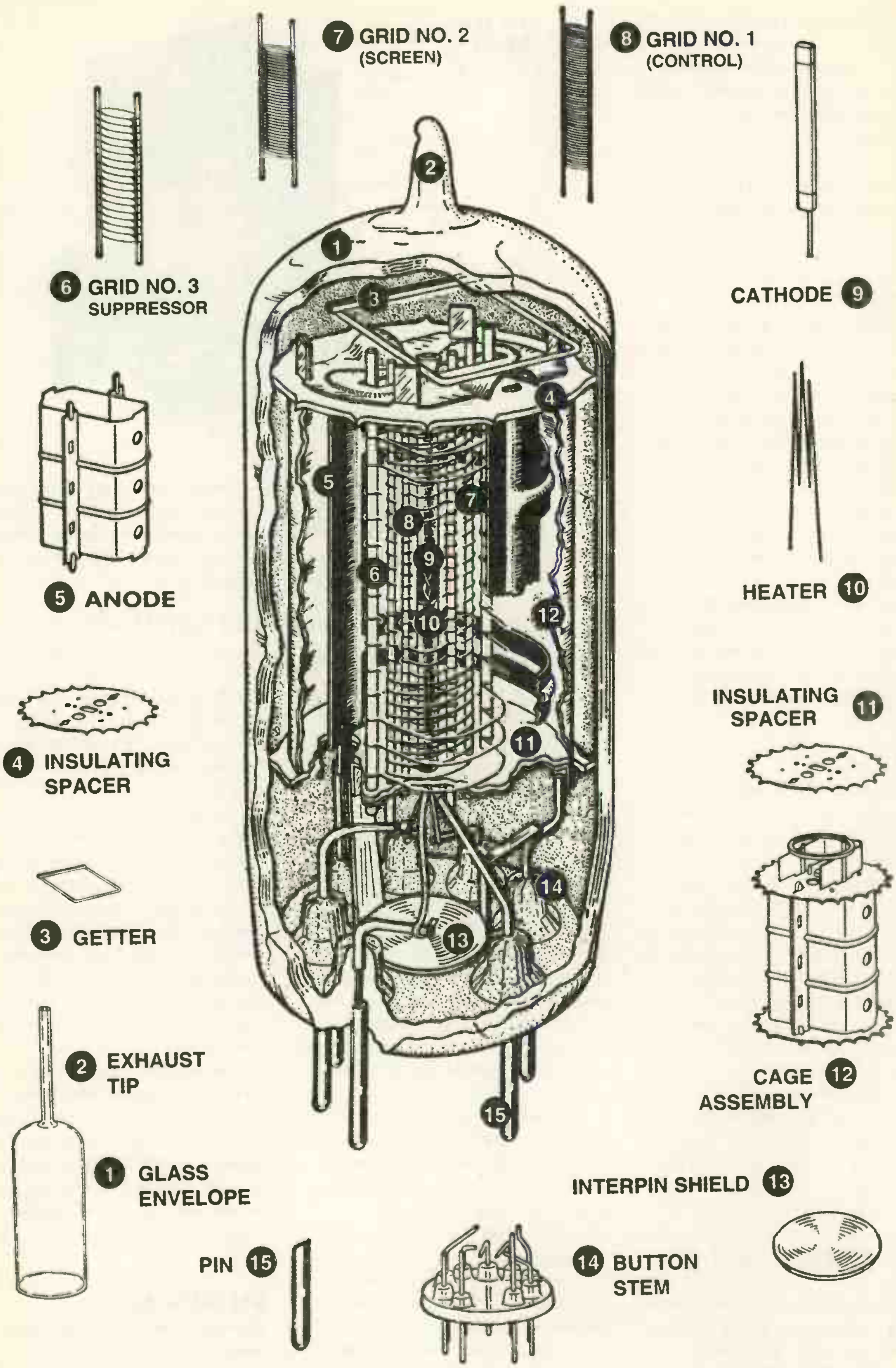



This is a representation of a pentode. At centre lies the emissive cathode. At the periphery lies the anode. Between these electrodes lie the signal grid, screen grid and suppressor grid. The electron stream flows from cathode out to anode, being influenced by the grids on the way. Source: Sonic Frontiers.

## CATHODE

Electron emission in early valves came from a thoriated-tungsten filament. This is seen most dramatically in the bright emitter of the 211 power valve, where the heater filament is suspended on springs to minimise microphony and cope with expansion.

High emission at lower temperatures




This illustration shows the parts used in the construction of a modern pentode, where the pins are fused into the glass base. At the centre lies the cathode, within which sits the heater. Around the cathode are the grids, arranged concentrically. On the outside lies the anode, which is usually visible. The whole assembly is supported by rigid wires and cushioned against the glass by spacers. Source: Sonic Frontiers.

was the goal achieved with alkaline earth metals such as calcium and barium, or their carbonates. From the late-Twenties on, nickel was coated with these materials to form a cathode, which surrounded the heater, to form an 'indirectly heated' valve.

The lower operating temperature (1000K instead of 1800K) raised filament life from 1500 hours to many thousands of hours.

## FILAMENT

It was about 12 years (1903-1915) before tungsten could be made ductile enough to be used as a heater filament. Untreated tungsten filaments glow almost white, running at 2500K. When coated with thorium to improve emission they glow red, running at 1800K. The duller the glow, the longer the life.

The presence of gas in a valve poisoned the filament, shortening life. This problem was overcome by the mid-Twenties.

Most modern valves have cathodes, emissive plates that surround the heater filament. The heater can be seen glowing only where it protrudes from the cathode. Valves for battery operation are directly heated.

## VACUUM

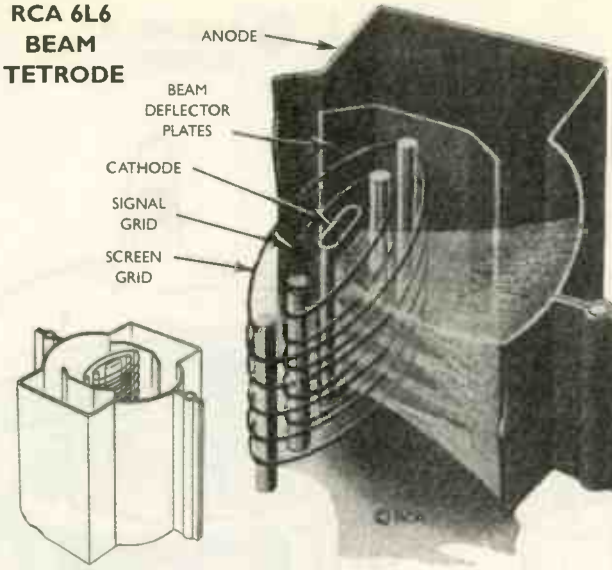
The air inside a valve is pumped out (evacuated) to allow unimpeded passage of electrons from cathode to anode, and to give useful heater life.

The first US valves, assembled by Langmuir in 1913, relied on a new form of German pump to get a sufficiently high vacuum: pumping was crucial. Eventually vacuums of one-hundredth to one-thousandth of a millionth of an atmosphere were produced. It was unnecessary to go further. Other matters then had to be considered.

Glass and metal give off occluded gases when heated, and these destroy a vacuum. The seal around the valve's pins must not leak and the glass must not be porous either. The pins and glass are therefore matched to have similar coefficients of expansion. In addition, the electrode assemblies are heated to drive out gas.

Finally, the vacuum is hardened further by firing a 'getter'. Early getters comprised a strip of magnesium, heated by an external coil carrying a Radio-Frequency current until it fired. Carried out after pumping and sealing, this process removes all traces of oxygen by forming magnesium oxide. The silver coating seen on the inner surface of many valve envelopes comes from a magnesium getter.

In the end, alloy getters of barium combined with aluminium or magnesium were used to remove all major gases: oxygen, nitrogen, hydrogen, carbon monoxide and dioxide, plus water vapour.




**The pentode was developed and patented by Philips in 1926, in order to overcome the distortion produced by standard tetrodes. Faced with this, the Americans developed the more efficient beam tetrode in 1936. Invented by British engineers in 1933, EMI passed the patents to RCA, believing the valve could not be built. To this day US output valves are, by preference, beam tetrodes. Source: History Of The British Radio Valve To 1940. Diagram: Sonic Frontiers And RCA**

## GLASS BULB

The outer envelopes of most valves are made from soft soda glass. Those with a glass foot (B9G, etc) have soft glass bases through which pass pins of chrome/iron alloy (Philips), or a hard glass base and pins of nickel/iron/cobalt alloy. In both cases, the pins have to match the thermal expansion rates of the glass to maintain a seal.

This technique superseded the use of a glass support stem inside the valve through which passed copper lead-out wires, an idea copied from light-bulb manufacture. These wires were connected to the pins in a moulded, phenolic base.

Long, parallel wires exhibited enough inductance and capacitance to effect high-frequency behaviour, though. For VHF radio and radar use, after 1940 better connection methods were needed. Later RF valves like the EF50 and EF86 benefitted from the layout of the B9A base.

## SIZE AND SHAPE

The valve traces its technological roots back to the electric light bulb, so early designs were sized and shaped similarly, with an internal stem carrying the electrode structure fused into the glass envelope and a phenolic base attached after evacuation.

There was a major need to reduce power consumption, weight and size to create valves suitable for high-frequency work. Excessive inter-electrode and lead-out capacitance and inductance also had to be addressed. The natural conclusion of these improvements was the Nuvistor of the early 1960s. It operated at just 135V, and raising the supply voltage above this would cause flashover.

The development of the 6L6 power valve reflects the progress of valves as a whole. Early samples were big, dissipated 23watts on their anodes and could only stand up to 350V HT. Later versions could dissipate 28watts from 550V HT and deliver more power from a smaller envelope.

## REFERENCES


History Of The British Radio Valve To 1940
by Keith Thrower.

A Taste of Tubes
by Sonic Frontiers

# SONIC SURGERY

**Nick Lucas and Richard White warm up their soldering irons and turbo-charge our 300B amplifier with specialist components.**


This short introduction is especially for all you DIYers and prospective DIYers out there. It tells the story of Bob. After 30 hours of toil and serious concentration, Bob is rewarded with a kit amplifier that sounds sweet and involving. He can now relax in his listening chair and wallow in the fruits of his musical labours.

For the first 12 months he is in hi-fi heaven. The second year begins with a slight inkling that he's missing something, but he can't put his finger on what it is. After 18 months he finds this elusive missing link quite by accident, curled up and sleeping. Bob still has his soldering iron from his kit-building hey-day and is ready for some more action. Bob looks up and utters, "It's time for an upgrade." Bob has truly been bitten by the hi-fi bug.

Component upgrading is a reasonably cheap and simple way of improving your sound without going for a trade-in. It is also character building and quite an eye-opening education. The industry has acknowledged the popularity of this process judging by the number of companies specialising in audiophile components, most of whom are mines of information happy to give valuable advice on how a particular component will sound in a specific location.

In past articles we have selected components to uplift World Audio Design kits such as our K5881 push-pull power amplifier, KLP1 line-level pre-amplifier and KLPP1 phono pre-amplifier. Now it's the turn of our creme-de-la-creme valve amplifier, the 300B. This push-pull 28watter runs its two pairs of 300B triodes in pure class A with feedback switchable in or out on the back panel. In the kit, we supply components of good quality along with two specially-designed Ansar reservoir capacitors and two Solen signal caps. The resistors are carbon films (which work very well with valve equipment, complementing its warm tones) and wire-wound, ceramic-bodied, high-power resistors.

To make the upgrading easier, we have broken them down into four sections. Our source for components was Paul Morawski of AudioLinks who, upon receipt of a 300B circuit diagram, came up with a list of suitable components.

## UPGRADE 1 - THE POWER SUPPLY

The first section up for a revamp was the power supply. Both channels' HT lines are derived from the same secondary winding on the mains transformer before solid-state rectification. This allows the use of a larger electrolytic reservoir cap, giving improved smoothing and lower noise over valve rectifiers (whose partnering caps are limited to a maximum of around 50uF).

This partially smooth voltage then passes through a GZ37

Long known as specialists in rare tube brands, Billington Export provides a line of premium-grade valves to fill the increasing demand for hard-to-find tubes! BILLINGTON GOLD features specially tested valves selected for long life, low microphony and low noise. Versions with gold plated pins are available. BILLINGTON GOLD brand comes from a variety of countries around the world. We have carefully chosen the best manufacturer for each type, with an emphasis on the highest audio quality and product reliability. We stock one million valves including: BRIMAR, GE USA, GEC UK,MAZDA, MULLARD, RCA, RUSSIAN/SOVTEK/SVETLANA, SYLVANIA, TESLA, THERMIONIC, TUNGSRAM and other rare brands, as well as stockets and CRTs.

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| 2A3 | 17.25 |
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| E81CC-01 | 9.50 |
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| E82CC-01 | 8.50 |
| E83CC-01 | 8.50 |
| E88CC | 8.00 |
| ECC81 | 5.70 |
| ECC82 | 5.70 |
| ECC83 | 5.55 |
| ECC88 | 5.25 |
| EF86 | 9.90 |
| EL34 | 7.50 |
| EL84 | 4.80 |
| GZ34 | 8.40 |
| KT66 | 9.50 |
| KT88 Special | |
| GEC replica | 22.50 |
| KT88 | 18.50 |
| TT21 Chinese | 27.00 |

For orders over £600.00 please deduct 33%.
[Does NOT apply to items marked *]

## RARE BRANDS

| | |
|---|---|
| 33A-101K | 5.40 |
| 300B Tesla | 105.00 |
| 3C24EEV | 27.00 |
| 3B28 RCA | 14.70 |
| 4250A/QB35750 Philips | 72.00 |
| 7591A replacement | 39.00 |
| 5Y3GT | 3.90 |
| 6AH4GT USA | 7.50 |
| 6AS7G Russian | 2.93 |
| 6AU5GT GE USA | 3.75 |
| 6AU8A USA | 0.75 |
| 6BE6/5915 ECG Philips | 0.90 |
| 6BH6 RCA | 2.48 |
| 6C33CB Russian | 19.50 |
| 6J4/CV5311 | 1.80 |
| 6Q7G/CV587 STC UK | 3.60 |
| 6SQ7 | 3.00 |
| 6U8A RCA | 1.43 |
| 6V6 RCA Black Metal | 15.00 |
| 6V6GT MWT | 6.00 |
| 12AU7WA RTC France | 7.88 |
| 12AU7WA Cifte France | 7.88 |
| 12E1 STC TTT UK | 16.50 |
| 12SG7 | 1.65 |

| | |
|---|---|
| 13E1 STC UK | 120.00 |
| 85A2 Mullard | 4.50 |
| 350B Chinese | 14.25 |
| 807 Ceramic | 30.00 |
| 807 USA | 6.75 |
| 1625 USA | 3.95 |
| 6587WB Philips | 5.93 |
| 5751GE | 6.00 |
| 5814AECG/Philips | 2.70 |
| 6028 | 0.99 |
| 6463 GE USA | 2.40 |
| A2293/CV4079 | 4.43 |
| C3m Siemens | 15.30 |
| CV4062/E2134 | 5.25 |
| DA42 GEC | 28.50 |
| DG7-32 Mullard | 21.00 |
| E80CC Mullard | 45.00 |
| E80F Philips | 18.00 |
| E80L Philips | 31.50 |
| E88CC Tesla Gold Pin | 8.85 |
| EC92 RFT | 2.70 |
| ECC81/CV4024 Mullard UK | 7.50 |
| ECC82 Sylvania | 15.00 |
| ECC83 Yugoslavian | 4.05 |

| | |
|---|---|
| ECC86 Mullard | 5.93 |
| ECF80/6BL8 | 0.75 |
| ECL82 Tungsram | 3.30 |
| ECL85/805 | 1.49 |
| ECL86 | 2.85 |
| EF39/CV1053 | 1.65 |
| EF95/CV4010 Mullard | 1.95 |
| EF184 RFT | 0.99 |
| EL34 Tesla Blue | 12.00 |
| EL34 Tesla JJ | 8.10 |
| EL38 | 13.32 |
| EL86 Russian | 1.49 |
| EL90 Brimar | 2.70 |
| EZ80 Brimar | 6.00 |
| F2A Siemens | 120.00 |
| F2A11 Siemens | 120.00 |
| KT88 Chinese Unbranded | 12.50 |
| PCL82 Tungsram | 2.15 |
| PCL86 (ECL86) Russian | 0.53 |
| PT4D Ferranti | 22.50 |
| QQV03/20A GEC | 5.25 |
| S11E12/CV4060 | 43.50 |
| Z2b | 27.00 |

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3,000 OTHER TYPES OF VALVES IN STOCK! PLEASE INQUIRE FOR ANY TYPE NOT LISTED.

## WHOLESALE SECTION

| | |
|---|---|
| 6AL5/EB91 Mullard, government box | 100 pieces @ £ 75.00 [£0.75 each]* |
| 9002 RCA USA audio triode | 100 pieces @ £ 60.00 [£0.60 each]* |
| E180CC/7062 Mullard UK box anode GVT | 100 pieces @ £280.00 [£2.80 each]* |
| EF37A Mullard UK Grey | 50 pieces @ £125.00 [£2.50 each]* |
| EF86 Russian, Identical to Svetlana EF86 but no logo | 50 pieces @ £210.00 [£4.20 each]* |
| EL34 Chinese tested - guaranteed | 50 pieces @ £175.00 [£3.50 each]* |
| C3M Siemens, government box | 20 pieces @ £150.00 [£7.50 each]* |

## RARE SOCKETS

| | | | |
|---|---|---|---|
| 47E [for 4212E] | 37.50 | PO5 [for Aa, Ba] | 11.70 |
| 4B4/B5B [for PX4] | [illegible]98 | Octal and B9A sockets IN STOCK...POA | |
| 45DA [for DA100] | 15.00 | Side contact for AZ1 [CT8] | 10.43 |

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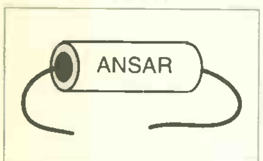
### ANSAR SUPERSOUND
Audio Polypropylene 400VDC±5%

The secret's in the metalised film!




Manufactured specifically for high end audio, these polypropylene capacitors offer exceptional value for money as they use a specially imported high purity metallised polypropylene film, ensuring smooth, detailed and transparent sound quality and extremely low distortion whether they are placed directly in the sigmnal path such as in crossovers or for decoupling etc. Ideal for replacing old, stale and leaky capacitors.

| Part no | Value | Price |
|---|---|---|
| CW100N | CAP PROPYL 100nF | £1.25 |
| CW150N | CAP PROPYL 150nF | £1.25 |
| CW220N | CAP PROPYL 220nF | £1.25 |
| CW330N | CAP PROPYL 330nF | £1.25 |
| CW470N | CAP PROPYL 470nF | £1.25 |
| CW680N | CAP PROPYL 680nF | £1.25 |
| CW1U0N | CAP PROPYL 1µF | £1.25 |
| CW1U5N | CAP PROPYL 1.5µF | £1.50 |
| CW2U2N | CAP PROPYL 2.2µF | £1.50 |
| CW3U3N | CAP PROPYL 3.3µF | £1.85 |
| CW4U7N | CAP PROPYL 4.7µF | £2.00 |
| CW6U8N | CAP PROPYL 6.8µF | £2.50 |
| CW10UN | CAP PROPYL 10µF | £3.50 |
| CW15U | CAP PROPYL 15µF | £4.50 |
| CW22U | CAP PROPYL 22µF | £6.50 |
| CW50U | CAP PROPYL 50µF | £9.95 |
| CW100U | CAP PROPYL 100µF | £20.00 |

Low value capacitors are axtensively used in amps & preamps (especially in tone control, bass & treble etc) By changing to polypropylene you can enjoy an enhaanced lighter - brighter sound especially in the treble aand mid bass range, and a transparent lower bass improvement. Close tolerance & high stability ensure that both channels can be very closely matched.

| Part No | Value | Voltage | Price |
|---|---|---|---|
| CPP47P | CAP PROPYL 47pF | 250V | £0.35 |
| CPP100P | CAP PROPYL 100pF | 250V | £0.35 |
| CPP150P | CAP PROPYL 150pF | 250V | £0.35 |
| CPP220P | CAP PROPY 220pF | 250V | £0.35 |
| CPP330P | CAP PROPYL 330pF | 250V | £0.35 |
| CPP470P | CAP PROPYL 470pF | 250V | £0.35 |
| CPP1N0 | CAP PROPYL 1nF | 250V | £0.35 |
| CPP1N5 | CAP PROPYL 1.5nF | 250V | £0.35 |
| CPP2N2 | CAP PROPYL 2.2nF | 250V | £0.35 |
| CPP4N7 | CAP PROPYL 4.7nF | 63V | £0.50 |
| CPP10N | CAP PROPYL 10nF | 63V | £0.65 |
| CPP22N | CAP PROPYL 22nF | 63V | £0.85 |
| CPP47N | CAP PROPYL 47nF | 63V | £1.00 |

### Low Impedence High Temperature (105° C) Radial Electroytics ± 5%

Superior electroytics at affordable prices. The low impedance end resistance maximises signal purity, whilst the superior temperature characteristics allow the capacitor to remain very stable under the most varying conditions.

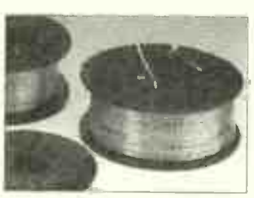
| Part No. | Value | Voltage | Price |
|---|---|---|---|
| 1H50 | LO Z HI TEMP 1µF | 50V | £0.25 |
| 2U2H50 | LO Z HI TEMP 2.2µF | 50V | £0.25 |
| 4U7H63 | LO Z HI TEMP 4.7µF | 63V | £0.25 |
| 10H63 | LO Z HI TEMP 10µF | 63V | £0.25 |
| 22H63 | LO Z HI TEMP 22µF | 63V | £0.30 |
| 47H63 | LO Z HI TEMP 47µF | 63V | £0.35 |
| 100H63 | LO Z HI TEMP 100µF | 63V | £0.50 |
| 220H50 | LO Z HI TEMP 220µF | 50V | £0.75 |
| 470H63 | LO Z HI TEMP 470µF | 63V | £1.25 |
| 1000H35 | LO Z HI TEMP 1000µF | 35V | £1.50 |
| 2200H50 | LO Z HI TEMP 2200µF | 50V | £2.25 |
| 4700H25 | LO Z HI TEMP 4700µF | 25V | £2.50 |

### Trobo Solder Lug Reservoir Capacitor 10,000µF 80V

Choosing the right electrolytic for power supply use is very important in keeping down hum whist allowing maximum current flow for good transient & bass response. Elna capacitors are respected the World over for their exceptional audio attributes.

| Part No | µF/Voltage | Price |
|---|---|---|
| 10000C80 | CAL ELNA1000µF/80V | £11.00 |

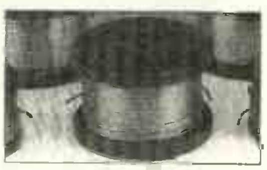
### Monacor Air Cored Inductors.



A range of professional air cored inductors for 8Ω or 4Ω crossovers/filters for use up to 300W. 1.2mm enamelled copper wire wound on air soaked plastic bobbins.

| Part No | Specification | Price |
|---|---|---|
| P15 | 150µH 0.15Ω 8x19mm | £2.00 |
| P22 | 220µH 0.15Ω 48x19mm | £2.50 |
| P33 | 330µH 0.2Ω 8x19mm | £3.00 |
| P47 | 470µH 0.25Ω 50x19mm | £3.50 |
| P68 | 680µH 0.35Ω 59x19mm | £4.50 |
| P100 | 1mH 0.4Ω 59x19mm | £5.50 |
| P150 | 1.5mH 0.5Ω 70x30mm | £6.50 |
| P220 | 2.2mH 0.6Ω 70x30mm | £8.00 |
| P330 | 3.3mH 0.75Ω 70x30 | £10.00 |

### Monacor Ferrite Inductors



A range of professional high efficiency ferrite cored inductors with very low ohmic losses for 8Ω or 4Ω crossovers or filters for use up to 400W
1.4mm enamelled copper wire (1.3mm on F1000) wound on plastic bobbin.

| Part No. | Specification | | Price |
|---|---|---|---|
| F220 | 2.2mH 0.15Ω 400W | 55x31mm | £6.50 |
| F330 | 3.3mH 0.2Ω 330W | 65x39mm | £9.50 |
| F470 | 4.7mH 0.25Ω 140W | 65x30mm | £11.00 |
| F680 | 6.8mH 0.35Ω 120W | 65x39mm | £12.00 |
| F1000 | 10mH 0.45Ω 100W | 65x39mm | £13.50 |

### High Quality Valves

| Part No. | Description | Price |
|---|---|---|
| 6550C | OUTPUT VALVE | £26.00 |
| 6L6GT | OUTPUT VALVE | £4.50 |
| 6SN7GT | OUTPUT VALVE | £4.50 |
| 6V6GT | OUTPUT VALVE | £3.95 |
| ECC81 | TRIODE | £4.50 |
| ECC82 | TRIODE | £4.50 |
| ECC83 | TRIODE | £4.50 |
| EF86 | LOW NOISE PENTODE | £9.90 |
| EL34 | OUTPUT VALVE | £8.50 |
| EL84 | OUTPUT VALVE | £3.50 |
| GZ34 | RECTIFIER | £6.50 |
| KT88 | OUTPUT VALVE | £20.00 |

### Valve Holders - High quality valve bases. Chassis mounting with screw fittings.

| Part No. | Description | Price |
|---|---|---|
| B9AC | B9A VALVE HOLDER CERAMIC | £1.50 |
| CC | SCREENING CAN | £2.25 |
| OCTC | OCTAL VALVE HOLDER CERAMIC | £2.00 |
| [illegible] | OCTAL VALVE HOLDER PHENOL | £1.50 |

### Fully Gold Plated Phono (RCA) Plugs with spring coil cable grip.

| Part No. | Description | Price |
|---|---|---|
| PPG5A2 | PAIR GOLD PLUGS for up to 5mm CABLE | £1.50 pair |
| PPG8A2 | PAIR GOLD PLUGS for up to 8mm CABLE | £1.50 pair |

### Very High Quality Phono (RCA) Plugs

Very high quality satin grey metal with heavy gold plated connections. Top collet cable grip & PTFE insulators. Very low noise.

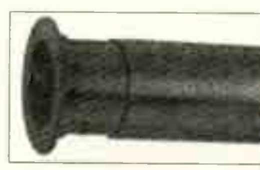
| Part No. | Description | Price |
|---|---|---|
| PPG6H2 | GOLD PTFE PLUGS for up to 6mm CABLE | £3.50 pair |
| PPG8H2 | GOLO PTFE PLUGS for up to 8mm CABLE | £3.50 pair |

### Extra High Quality Gold Plated Phono Oxygen Free (RCA) Leads (pairs)

Available in 2 colours & 3 lengths. Highly flexible oxygen free cable with extra moulded-in control / grounding wire.

| Part No. | Length/Colour | Price |
|---|---|---|
| LPP1QG | 0.8 Metres/Green | £5.50 |
| LLP1QV | 0.8 Metres/Violet | £5.50 |
| LPP2QG | 1.5 Metres/Green | £6.50 |
| LPP2QV | 1.5 Metres/Violet | £6.50 |
| LPP5QG | 5 Metres/Green | £11.00 |
| LPP5QV | 5 Metres/Violet | £11.00 |

### Bass Reflex Tuning Ports



A range of adjustable plastic ports for use in various sizes of loudspeaker cabinets. d=diameter L=adjustable length (mm)

| Part No. | Dimensions | Price |
|---|---|---|
| R35 | d=35L=110-210 | £2.50 |
| R50 | d=50L=150-280 | £3.00 |
| R70 | d=70L=128-245 | £3.50 |
| R100 | d=110L=160-122 | £5.50 |
| R85 | d=85 angled 45° for narrow cabinetsL=210-310 | £6.50 |

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Cricklewood Electronics Ltd, 40 & 42 Cricklewood Broadway, London NW2 3ET. Tel: 0181 452 0161 Fax: 0181 208 1441 rectifier valve, whose anodes are paralleled up, as are its cathodes. In essence, it is behaving like a super-diode, giving the valve touch to the power supply and hence the sound. It also ensures that the 300Bs are not harmed with a surge of current at switch-on since the GZ37 has to warm up for around 30 seconds before current can flow. At this point, the supply splits to separate 3H chokes and 22uF 630V Ansar polypropylene reservoir capacitors.

The first component for replacement was the 1.6A, slow-blow fuse, which was swapped for a miniature circuit breaker. The former is a weak link as you have the fuse wire itself (which is not made of the best audio-grade material) as well as the two touch contacts of the fuse holder. The circuit breaker is an automatic reset device that can be easily soldered straight onto the back of the mains input socket. I used short lengths of 1/1.13mm solid-core wire for rigidity. The breaker's internal contacts are constructed of material superior to fuse wire, yielding a very low internal resistance.

New diodes (D1-4) were called for. These are MUR1400E, which are ultra-fast, soft-recovery types with a very fast switching time of 75ns compared with the 300ns you get with the original BYV96E. They also switch very softly, so they are quiet in operation.

## TAKE THE BYPASS

The next three component changes, the bypass caps, are additions to the circuit and warrant an explanation. In audio, an ideal capacitor would have the same characteristics over the entire audio frequency band - its impedance/frequency trace should be a horizontal line. In reality, the trace is more likely to be a parabolic curve with varying angles and depths depending on the value and type of capacitor used. Large value capacitors have a low ESR (Equivalent Series Resistance), troughing at a certain frequency and producing a broad curve. As the frequency increases, so does the resistance, resulting in the curve climbing upwards. Generally, a high-value capacitor gives good bass, smaller ones producing a narrower curve that bottoms out at higher frequencies. Placing the two capacitors together in parallel, the curves bisect to form a 'W' shape, providing an extended impedance/frequency curve which is a lot flatter. This effect can be extended by adding capacitors. As a general rule a bypass capacitor is normally 1/10th minus 1/500th of the previous value. Another bypassing bonus is that smaller capacitors charge and discharge far quicker than their larger companions. The end result is an increase in dynamics and spaciousness.

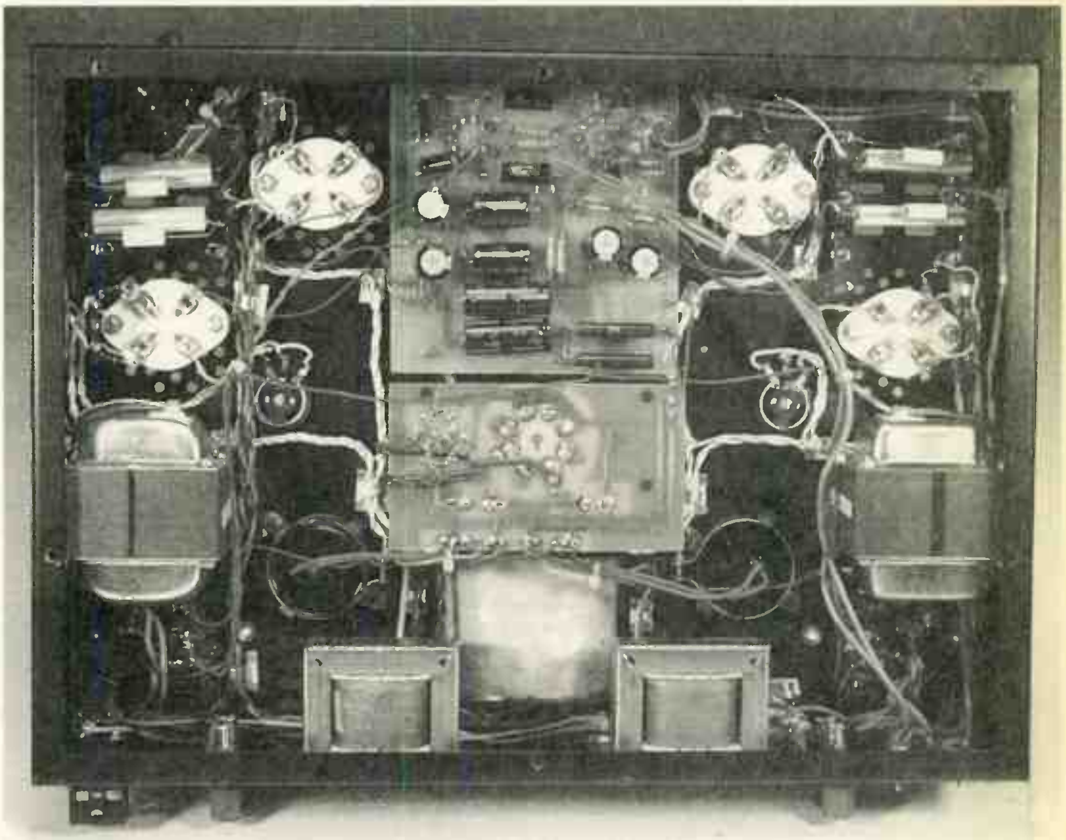
C9 and C10 were therefore double-bypassed with an Ansar 4.7uF/450V and a 0.1uf/630V M CAPzn™, both of polypropylene. C11 and C12 were bypassed with a 0.22uf/630V M CAPzn™. These fitted easily around the power supply printed circuit board.

## UPGRADE 2 - THE SIGNAL PATH

This time we tried out some resistor changes too, and replaced R1, R2 and R10 with a mix of Vishay and Welwyn Bulk Foil resistors. They are non-magnetic and non-inductive and come terminated with copper lead-outs.

For C1 and C4 we used good, old Os-Con SGs. These are constructed of solid aluminium and black salt to give a series of capacitors which are almost vibration-free and possess very high ripple-current ratings, low ESR and very quick charge/discharge times.

For C3 we returned to an M CAPzn™, while C8 was made up of two Scan-ex polystyrenes in series. All second-section components fit on the driver printed circuit board.



Before the changes - 300B with its complement of standard components which tend to be far smaller than the audiophile parts.

## UPGRADE 3 - DECOUPLING

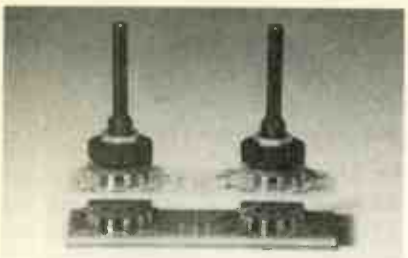
This section entails swapping and bypassing C2 and C3 with a combination of Ansars and M CAPzn™. This was where we started to run into space-management problems. With the larger size of these polypropylene capacitors, along with the replacement and bypass capacitors in the fourth section, make sure you spend some time getting their arrangement within the chassis sorted out - always do a dry-run to make best use of the available space. Then fix the components in firmly with tie-wraps and self-adhesive stickers to avoid vibrational changes.

## UPGRADE 4 - THE CATHODES

The fourth section involved replacement and double-bypass of C6 and C7 with Ansars and M CAPzn™ caps. Also, in place of

# Rothwell

## THE ULTIMATE VOLUME CONTROL



The Rothwell Stepped Attenuator is truly the ultimate volume control. Two 12 way dual gang (stereo) devices are used, one for coarse control, the other for fine. The combination gives 132 volume settings with steps of less than 1dB, and channel balance better than 0.1dB. No pot can come close to the performance of this unit. The sound quality of the attenuator can be staggering when compared to a pot - even the expensive "audiophile" pots using plastic film or cermet tracks pale in comparison. Space, imaging and sheer detail are unsurpassed. This unit may look like an overkill solution to the problem of poor pots, but hearing it proves that it *is* justified.

And using two 12 way devices instead of one 24 or 36 way device not only results in more volume settings - it keeps the price realistic. Instead of the three figure price tag normally associated with stepped attenuators (if you can find one at all), the Rothwell attenuators cost just £79 inc. VAT and postage. Both 10k (ideal for passive pre-amps) and 100k (ideal for valve pre amps) are available, and each unit comes with free application notes giving suggested circuits for various pre amp configurations.

*For further details of these attenuators or the other innovative products from Rothwell, (including the only* ***gold*** *interconnects currently available), please contact;*

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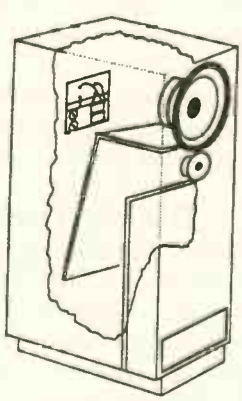

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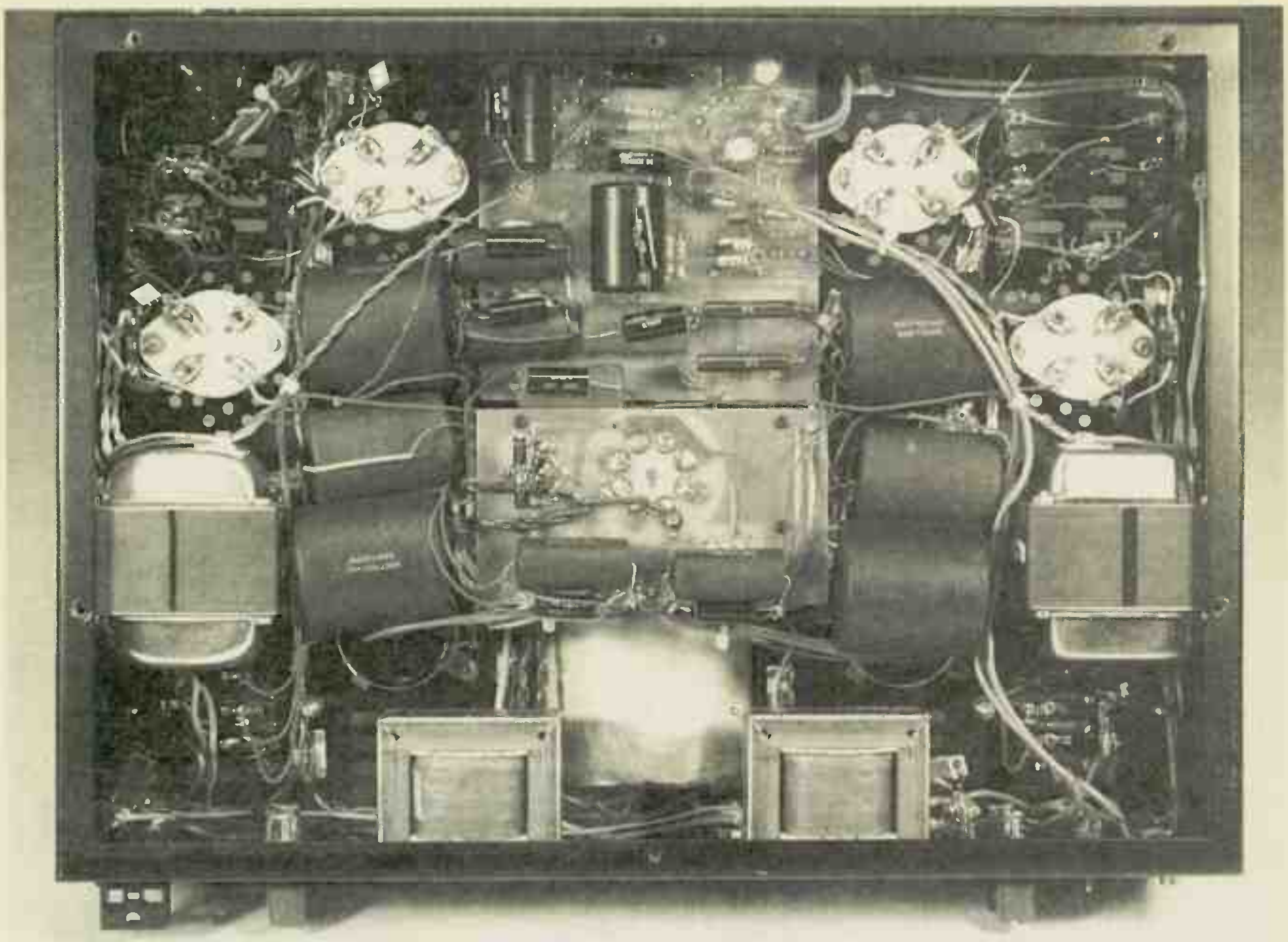

After the modifications, space is at a premium inside the 300B, especially when the polypropylene reservoir caps have been soldered in.

the standard R12 and R13 we used two Caddock high-power, bulk-foils in series mounted on a heatsink. These fitted easily as the bulk foils come in isolated packages.

All of these modifications are relatively easy to carry out, the only complication being the location of the larger capacitors. The various new parts where then allowed to burn in over the course of a couple of months. We decided to gauge their effectiveness by removing them and soldering back in the original components.

## SOUND QUALITY

Undoing an upgrade project like this can be an ear-opening experience. More worryingly of course is the fact than you are removing improvements and trusting that an amplifier will still be worth listening to when you've done.

Removing (with a stifled sob) the Ansar and M CAPzn™ cathode network and replacing the standard ceramic resistors and electrolytics laid a light veil over the sound, particularly vocals. Bass remained coherent but just a smidgen less incisive than the fully-modified version, while the midrange was largely unaltered. Blues Union with Joe Beard had drive to spare and the 300B was not dynamically challenged in the least.

The next stage of deconstruction took out the bypassed de-coupling capacitors and, in the process, left what now seemed to be wide open spaces under the bonnet. Although the choice of de-coupling caps can make or break an amp (or fry it, if they fail!), to the credit of the original design the difference between the two sets of components was not painfully wide.

As demonstrated by the cor anglais in the opening of Stravinsky's Rite Of Spring, this time there was unquestionably a heavier veil drawn over the proceedings. That said, in spite of the sound lacking a little detail, the amp as a whole sounded more 'at one' with itself and cohesive, the quacking of the bass clarinet possessing a real 'Bronx Cheer' quality which showed that frequency and dynamics were still on board.

Eric Bib and his very acoustic recordings were enjoying a particularly valvesque sound. Bass had become more of a back-seat driver but the performance maintained a real sense of coherence and overall musicality. The reduction of input stage power-supply filtering obviously glossed over some of the finer points of treble insight but, as remarked above, the whole caboodle was still sounding very sweet.

Un-picking the resistor changes and regressing to the standard electrolytics on the input cathode bias gave the amplifier a smoothness which, to some, is identified with the past and names like Peter Walker, Harold Leak et al. Blues Union still packed an addictive punch - in that area the characteristic of the amp had altered little - but the more incisive presentation had softened and bass was tending to slow down.

The last step saw the power supply denuded of its extra capacitance. I had my fingers crossed about the effect this un-smoothing of the current would have; I needn't have worried. Admittedly, for the first time since I began poor recordings could sound slightly grainy but the 300B was far from defeated. Every one of the steps above had made an audible difference, yet the amplifier standing in nothing but its socks still had more than enough to keep a music-lover happy.

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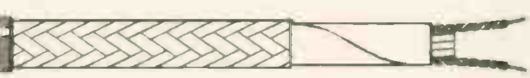

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# UNDERSTAND AMPLIFIERS

## By Owen Bishop

### Reviewed by Haider Bahrani.

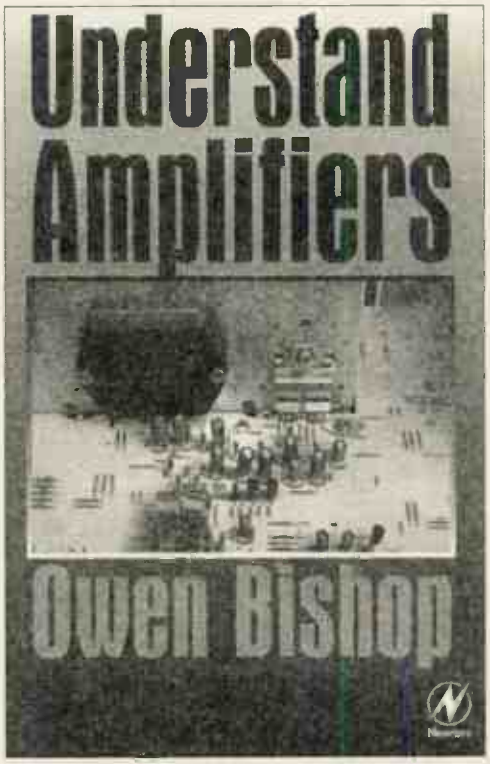
When Understand Amplifiers dropped onto my desk I was hovering over a prototype amplifier, cursing it for the trouble it was giving me. Our beloved editor had clearly foreseen my difficulties and realised I was in need of help through a therapeutic book review.

Understand Amplifiers is, as the title suggests, a book about amplifiers, the electronic kind that is. When we think of amplifiers, many of us (and especially owners of hi-fi) will picture a box filled with transistors or stacked up with valves ready to pump out music. Amplifiers are, of course, used in many areas of electronics and at frequencies well above and below the audible spectrum. They all, however, stem from the same basic principles, and it is these to which this book is dedicated.

The first chapter basically focuses on the nature of a signal and what is meant by amplifying it. Sine waves play a large part in the explanations, which lead on to more complex periodic signals before moving on into clear and easily comprehensible descriptions of both current and voltage gain.

On the final page of this chapter we meet with one of Owen Bishop's explanatory boxes. The author uses these little asides to add extra detail and depth to the main points. In this case he gives a brief and unambiguous description of noise in electronic circuitry.

The second chapter starts to get a little more technical, but not dauntingly so, as the behaviour of a simple amplifier comes under the spotlight. The circuit in this case is a single-transistor MOSFET amplifier. The reason given for this choice of device is that MOSFETs (Metal Oxide Field Effect Transistors) are the easiest to understand. If truth be told, as a student it took me a great deal longer to understand these devices than other types. However, reading about them here they certainly seem straightforward enough. The chapter then goes on to explain biasing, coupling, input resistance, etc with plenty more explanatory boxes to keep the reader out of the dark.




Field Effect Transistors are given more airtime (or should I say page space) with that imaginatively-titled chapter, More FET Amplifiers. This section introduces one or two other types of FET, but concentrates mainly on using MOSFETs in a source-follower configuration, the formation that is common in the output stages of MOSFET power amplifiers.

Chapter Four steers away from solid-state circuitry for a while and looks at the great favourite of the troops at World Towers, the valve amplifier. Although a much older and quite different technology, the basic principles of valve amplifiers are much the same as the ones described in the previous chapters, and the reader is left in no doubt of this fact. The author then goes on to introduce a number of different valves.

From Chapter Five onwards, the device that most electronics dabblers think of when the word "transistor" is used (the Bipolar Junction Transistor, or BJT for short) is examined. Chapter Six gives the BJT and its implementation in basic amplifiers the once over, as per its cousins above.

Things hot up a little when bootstrapping, differential amplifiers and constant-current sources start creeping into the frame. Many of the techniques and circuits are shown using BJTs because this is how they commonly appear in practice although, as before, the principles are much the same and, particularly with FETs, can mostly be duplicated with the other devices.

Power amplifiers are honoured with a chapter of their own and again, most of the formats are described using bipolars. The chapter begins by detailing the class A power amplifier before ascending the efficiency scale via classes B, C and D, with more than a brief mention of their functioning and application. As well as the basic circuits, temperature stabilising techniques are covered as well.

The eighth chapter is dedicated to high-frequency amplifiers, along with all the pitfalls and problems that can cause designers headaches. Amongst these are the evils of stray capacitance, the Miller effect and the results of phase response on a circuit's behaviour. Also discussed are the benefits of different types of devices in the various high-frequency applications.

What follows thereafter is a chapter all about the imperfections that amplifiers (and all electronic circuits) exhibit, including noise, group delay, harmonic distortion, etc. The descriptions are backed up with a well-presented example.

The book is brought to a close with two short chapters on the operational amplifiers which are used in most small-signal circuitry these days. These sections serve as a good general introduction to the subject of op amps.

As an introduction to the topic, or even as a reminder of the vital basics, the Understand Amplifiers path is an excellent one to tread. I would also recommend it as an engineer's handbook since I have recently discovered (for the nth time) that nearly all problems have their roots in basic principles.

**Understand Amplifiers**
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**ISBN: 0750637439**

# DIY Letters

## HOT SOURCE

If memory does not fail, I think I have read that putting sorbothane on top of capacitors and chipsets can be a good tweak. I am somewhat concerned about heat in digital ICs, though. Do you think this modification will shorten their life, or even damage them?

**Joaquín Mejía**
**quijanotercio@mx2.redestb.es**

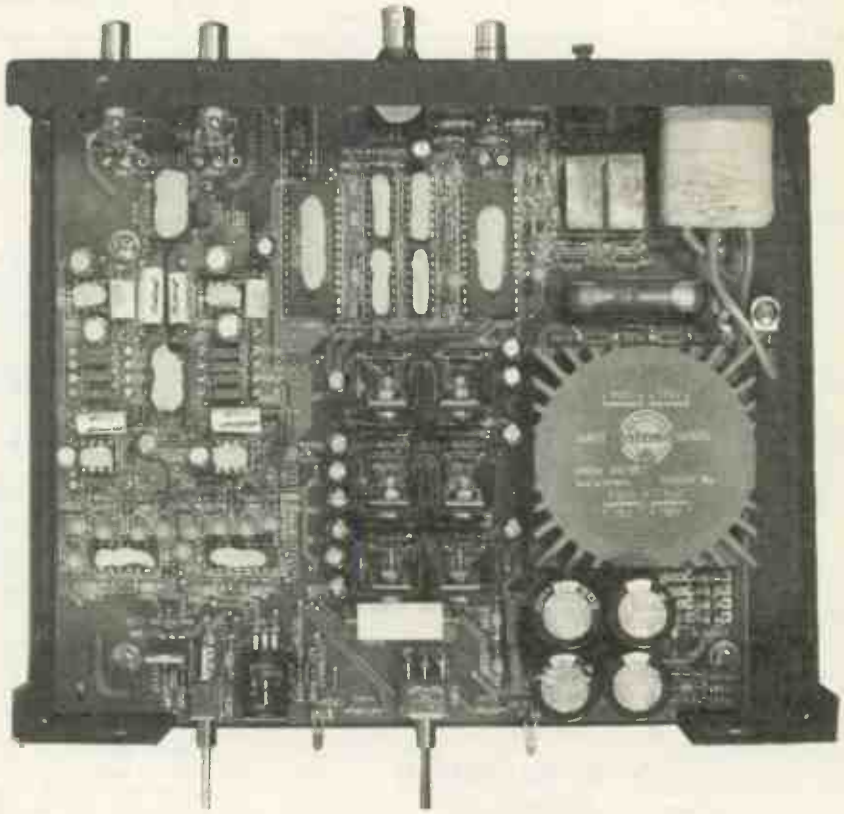
*A fairly simple gauge of whether or not you can stick sorbothane (or thin patches of Blu-Tack for that matter) to an IC is how hot it feels to the touch when it's powered up. If it's cool, sorbothane away; if it's warm or hot, steer well clear. JM*

## HI-FI ACTIVITY

Here are some notes on the Maplin DR66 active crossover unit. My initial reactions to the DR66 were similar to K. Foster's (Supplement No36), although prolonged auditioning proved slightly tiring.

I spoke to hi-fi designer John Cheadle, who suggested that what I was hearing may have been due to poor componentry and a cheapo power supply. With his help, I constructed a power supply taken from one of my Arcam A60 amplifiers (now used solely as power amps) which resulted in a considerable improvement.

John also advised me to change the capacitors, diodes and op amps for better items. These modifications really improved the sound quality in all departments. I have included a separate description of this work. I also lengthened the ports on my 'speakers by about 1in. to optimise the bass performance with the new crossover characteristics.



**Another way of cutting out vibration in ICs is a little of the tweaker's best friend, Blu-Tack.**

Although very pleased with the sound, I am still not sure if it is the optimum arrangement, so I plan to take some measurements when I can get hold of a sound level meter. Falcon Acoustics suggest that a ported 'speaker cabinet will often need to be enlarged after conversion to active operation. I hope to experiment with larger enclosures soon.

Overall, I thoroughly recommend the DR66. Active crossovers have so many advantages over their passive counterparts. And since many of us now have two amplifiers, the DR66 provides a very cost-effective way of going active.

My system now comprises a Cambridge CD-45E CD player,

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a home-built passive pre-amp featuring a Rothwell stepped attenuator (a bargain), the DR66, two upgraded Arcam A60 amps and a pair of kit speakers from IPL; total cost, a little over £1000! I had no previous electronics training and owe many thanks particularly to Rothwell, IPL and AudioLinks for their generous help.

I am now going to build the active crossover unit into the same case as my pre-amp, thus dispensing with the need for interconnects. This will leave a pair of two-metre interconnects per channel (bass/midrange and tweeter). Can you recommend cables which would be particularly suitable for each job? As my equipment is situated adjacent to the TV and video, the cables will need to be screened. I had thought of routing the cables through copper pipe to provide the screening. Does this work, and are there any caveats?

**Nick Whetstone**
**Somerset.**

*Upgrade Ingredients*

*If you can use a soldering iron and desolder pump, you should be able to carry out the following work. You will need the following components:*
*Small-value capacitors - polystyrene, polycarbonate or polypropylene - in these values:*

*2 x 3900pF*
*3 x 10nF*
*5 x 8200pF*
*2 x 39nF*
*6 x 82nF*

*Os-Con SG capacitors:*
*8 x 10uF, 16V*
*4 x 470uF, 16V (100uF or 150uF would also be fine)*

*You could bypass the larger caps too, say with 4.7uF Os-cons and 0.1uF box polypropylenes.*

*Schottky Diodes:*
*4 x 11DQ10*

*Burr Brown Op Amps: 2 x OPA4134 PA*

*You can also fit heatsinks to the op amps (Maplin KU44X) using heatsink compound (Maplin HQ39N).*

*The above components are available from AudioLinks (tel: 01724 870432), AudioCom (tel: 01834 842803) and Maplin (tel: 01702 554000). The total parts cost is about £50.*

*THE RECIPE*

*Remove the four small, black screws around the base of the unit and take off the base-plate. Remove all the small, black screws on the front of the unit as well. Then take off the four control knobs by carefully prising them upwards. Now remove the five black screws from the top of the unit. NB: the screw in the central position is a self-tapper and must be put back in the same location.*

*Partially remove the main PCB and disconnect the lead from the LED. Now pull out the main PCB and its smaller companion which carries all the input/output connectors.*

*The order for changing the components is not too important, but I suggest starting with the smaller capacitors before moving on to the op amps. This process will be considerably easier if you remove the metal plate which is tight against one of the op amps. Undo the nuts on the shafts of the level controls, then unscrew the two bolts holding it onto the PCB (these are on the underside of the PCB). This will enable you to use the special insertion tool (Maplin FR25C), which makes the job far easier.*

*One word of warning: make sure you earth yourself while handling and working on the op amps as static electricity can easily damage them. Also remember to insert the new op amps with their indents facing in the same direction as those on the original ICs.*

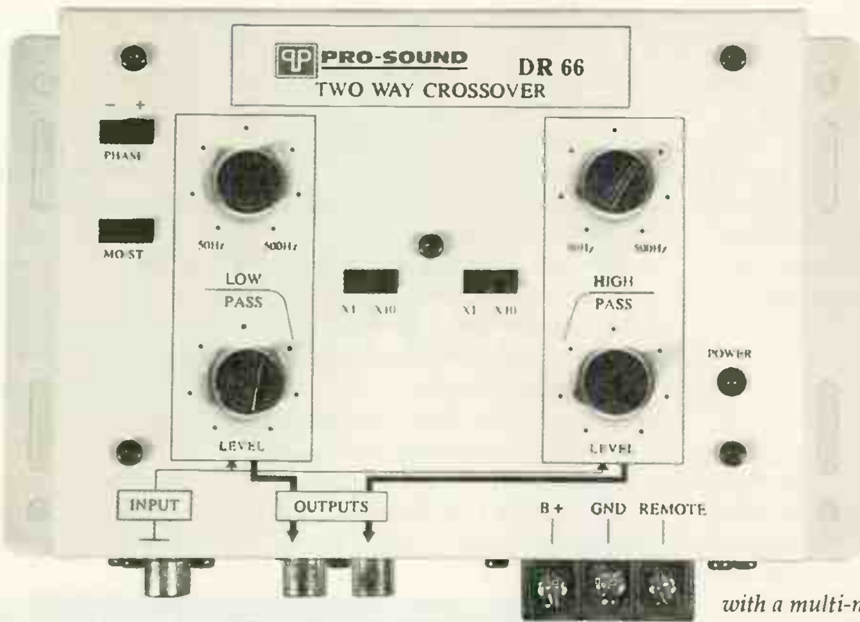
*CAPS OFF*

*Next, replace the six 10uF capacitors with the Os-Cons. Finally, remove the existing 470uF caps; the Os-Cons are placed on the underside. To fit the Os-Con you will need to carefully cut out a 10mm square piece of the smaller PCB, which will allow it to be laid flat. Carefully bend the legs of the Os-Cons to fit through the appropriate holes in the PCB and solder them in place, making sure that they are not in contact with any part of the PCB.*

*The weight of the Os-Cons will tend to pull the PCB tracks away from the board, so put a blob of solder on the legs where they protrude through the topside to help take the strain. Now trim the legs to equal height leaving enough to attach the bypass caps if you are fitting them.*

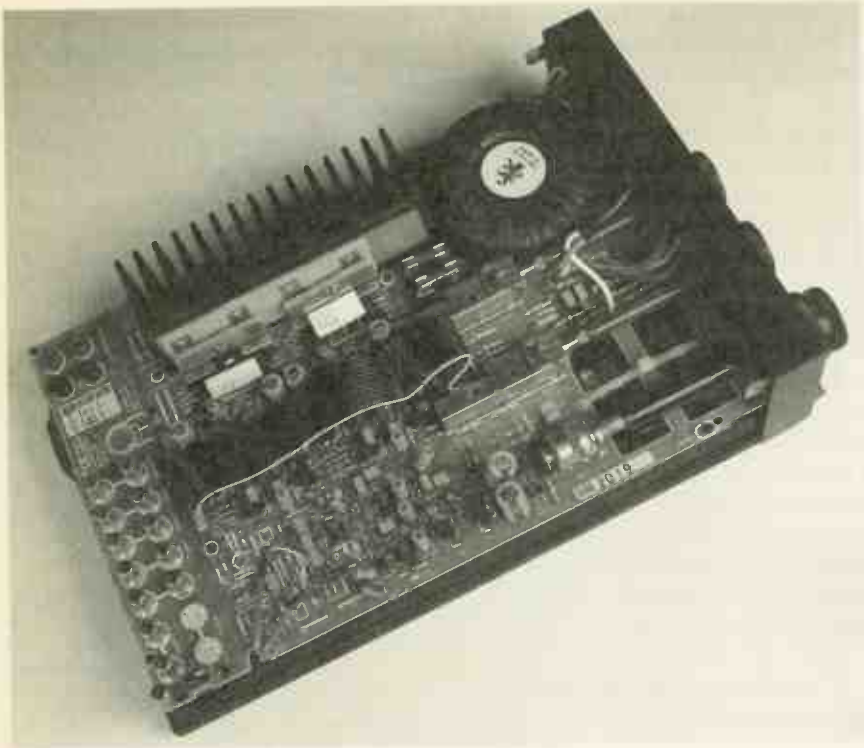
*Finally, slip some insulating sleeve over the Os-Cons on the underside of the PCB. If you have fitted the 470uF caps, you will find that replacing the base of the case presses them against the PCB.*

*Before re-assembling the unit, check all the soldered connections with a multi-meter. Then carefully position the PCB carrying the socketry and secure it in place. Connect the lead from the LED to the PCB. Offer up the main PCB assembly to the top of the case and replace its screws too. All that remains is to push the control knobs back on and replace the base-plate.*




## MODS FOR ROCKERS. . .

I have an original Mission Cyrus I integrated amplifier from 1986. I've owned it since new and it has steadfastly refused to be replaced. It has never gone wrong and, even though I get the upgrade bug about once every two years, I have never found a replacement (much to the consternation of a variety of hi-fi dealers in



Like NAD's 3020, Mission's Cyrus 1 integrated is a classic well worth modifying.

the Thames Valley). Until now that is. The Cyrus is finally being pushed aside in favour of a Yamaha DSP-A1.

As I'll never get rid of the amp, what I'd like to do is modify it without destroying its character. Have you ever published any articles on tweaking this amplifier? If not, do you have any general recommendations?

**David Ricketts**
**ricda06@mail.cai.com**

*We've yet to publish any Cyrus-specific upgrades, but as a Cyrus I owner myself, I've tried out a few at home. One which works well is to replace the standard 20mm fuses within the amp with 'polyswitch' types of the same rating. These polyswitches look similar to small disc ceramic capacitors and are available from Maplin and RS amongst others. Their advantage is a lower series resistance, which can be heard as faster, harder, deeper bass and a generally cleaner, more sharply-focused sound.*

*Schottky diodes in the power supply have a similar effect. RS sell some tasty versions which can handle up to 10A at 100V - a little OTT for this application perhaps, but worth tracking down nonetheless.*

*A change of volume potentiometer brings some of the biggest gains in clarity, speed, detail and involvement. An Alps Blue is one candidate, although if you feel like pushing the boat out, there's Panasonic's For Audio at £64 from AudioLinks (tel: 01724 870432)*

*The ribbon cable which connects the sources to the source selector is another prime candidate for replacement. Silver-plated OFC in a PTFE jacket is one option, although it might push the Cyrus' sound to the wrong side of bright. Plain OFC in a PVC jacket might be the answer, if this turns out to be the case.*

*Although the Cyrus I has a blanking plate on its socket panel to cover it, there is space for connecting a PSX-style power supply. I haven't carried out this mod myself, but I suspect a 500VA external transformer, Schottky rectifiers and DNM's 10000uF T-Network reservoir capacitors feeding the amp would make a very, very big improvement without drastically altering its character. And don't discount battery power, either (see last month's Supplement for details of how to wire up a split-rail battery PSU). Audiophile resistors (like Holcos) directly in the signal path will help too. JM*

## . . . AND EVEN MORE MODS

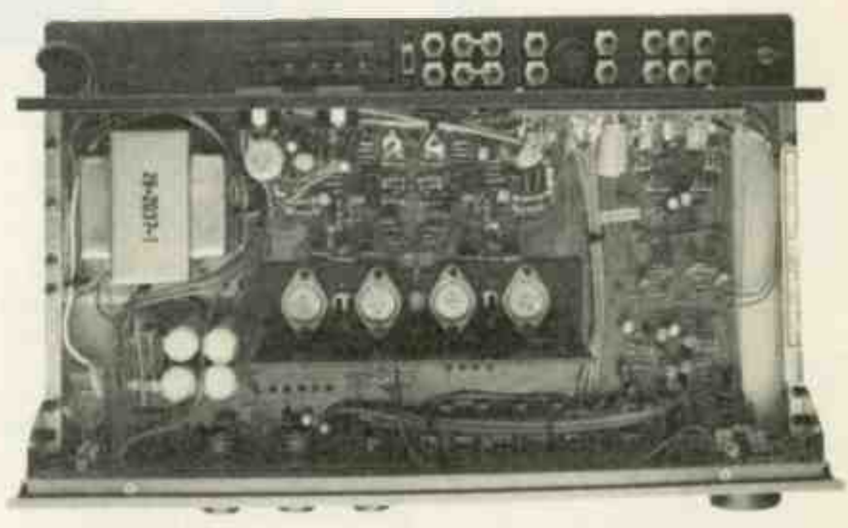
I was delighted to read your article on the NAD 3020 amplifier in the August edition. I recently dusted off my 3020B with a view to modifying it. I can highly recommend tweaking this amplifier as the removable base-plate and top cover allow easy access to both sides of the PCB for component removal.

I initially replaced the ageing original volume potentiometer with an Alps Blue Velvet, and the electrolytic capacitors in the direct signal path with Sanyo Os-Cons of the same value. This produced a significant improvement in midrange clarity and detail. NAD were very helpful in providing the 3020B/3120 Service Book complete with PCB and circuit layout.

I have since disconnected the power indicator and loudness button, replaced other electrolytics, bypassed the power supply capacitors and replaced the main resistors with Holco H8s (and the internal wiring with silver-plated copper wire). I am still getting improvements in clarity and transparency from this excellent amp, and have been amazed by the effect of simple component changes.

**Roger McPherson**
**mcpherson@enterprise.net**

*Continuing the wire theme, there are large*



NAD's 3020 amp in its many incarnations handsomely repays tweaking efforts.

*gains to be had from point-to-point wiring over PCB tracks which have been cut at both ends (the impact of this on the sound is obviously greater on longer tracks).*

*Unfortunately, Os-Cons were designed for use as PSU decoupling rather than signal caps, and in my experience don't reveal their full potential when used as such. You'd be better off replacing these Os-Cons with low-voltage Black Gates, which aren't excessively costly. JM*

## HEGEMAN UP-DATE

*Many thanks to Mr Crofts of Nottingham for sending in a sketch plan of the Hegeman horn which featured in June's Vintage Virtues.*

*The floating gherkins in the diagram appear to be anti-resonance dowels; unfortunately there are not too many clues as to the best way of mounting the drivers, but we are sure some intrepid reader will be able to work it out!*

*Before we are inundated with requests for copies, dimensions and so on, neither we nor Mr Crofts have any further information; we have put a bit of work into cleaning up the pictures below and Haden Boardman has given us the overall size. After that, I'm afraid you're on your own! RMW*

FOLLOWING

## REGULATIONS

Having cast away some modestly expensive hi-fi equipment due to an upgrade route which resulted in disappointment, my system is now going through a long-term evolution at a pace which is bank-manager friendly.

I first built a World Audio KLPP1, which is more open and neutral sounding and provides more facilities than many pre-amps I tried. This I have plugged into a refurbished Leak Stereo 20 which, just by looking at the tidier design underneath, was a far better quality of product than the Rogers Cadet it replaced.

This leads me on to the next stage of the evolution and raises some questions I hope you can help me with.

There is potential to upgrade the power supply of the Leak Stereo 20 which, from the circuit diagrams I have acquired, looks as though it is rectified through the Mullard GZ34 valve but is otherwise unregulated. I know companies such as Definitive Audio make claims for their power supply which is apparently suited to the Leak Stereo 20, but at £595 I cannot justify in my mind spending that sort of money on an amp which cost me £260. Can you advise me of a method for regulating the power supply, especially if I can build it from a circuit design to save cost.

Ultimately, I want to play the KLPP1 through a 300B amp which I would like to build from a kit. Whilst I have seen the World Audio 300B, there are two things that have so far caused me to resist.

First, I understand the design to be push-pull rather than single-ended, and I am unsure of the sonic advantages of single-ended over push-pull.

Second, I would prefer to build monobloc single-ended 300Bs if they would be available in kit form. Your October issue highlights the apparently greater choice of valve kits in Japan, but I would like to know if a monobloc kit is available in this country.

Finally, one of my latest acquisitions is an Akai 4000DS open-reel tape deck in almost mint condition. This seems to add a greater sound stage to music, especially lifting vocals above the height of the 'speakers. The pre-pre-amp section from the tape heads, however, is putting out a level of hiss which I feel could be improved on (the KLPP1 when played through anything other than the Leak is absolutely silent) and I would like to know if you are aware of any designs that I could replace this section with. Maplin show an EQ2S circuit but this appears to be for battery-operated units and I am unsure if there would be any improvement.

**Adrian Buckmaster**
**Middlesex.**

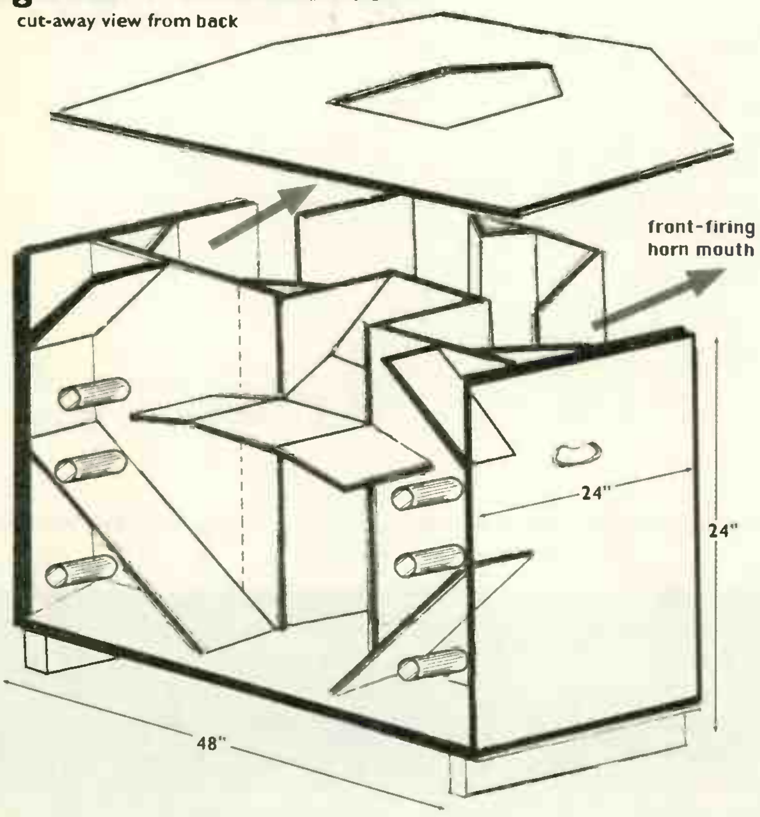
*As you have observed from the circuit diagram, the Stereo 20 has a valve-rectified but unregulated supply. The power supplies of these old amps play a major role in their sound, especially in the bass. Quality can vary from an uncontrolled rumbling to making kickdrums go 'bong' instead of 'thud'. All this bonging is due to a complex interaction between the various inductances and capacitances in the power supply and output transformer, as well as the phase shifts, etc in the feedback loop (if there is one).*

*Even though the amp may measure relatively flat, there are time-effects at low frequencies. Most transistor amps with their big PSU caps and DC coupled circuitry have that super-damped, dry bass which is quite hard to achieve with a valve amp.*

*The Definitive Audio power supply is unregulated but uses a choke-input rather than capacitor-input circuit, and the choke and cap are quite large values. This tightens up the bass quality. The*

## Hegeman Domestic Horn

cut-away view from back




The diagram above shows the immense complexity of the Hegeman's internal cabinet construction.

*component quality is good too, so overall there is an improvement in all areas. Modern electrolytic capacitors are way ahead of their vintage counterparts, especially audio-quality types such as Black Gate and Cerafine caps from Japan.*

*Both the choke input filter and an active regulator require considerably higher voltages from the mains transformer to get the same output as the amp's existing HT voltage, so you couldn't practically use the transformer which is in the amp at present; you would have to get a new mains transformer, new PSU caps and a new choke and build a unit like the Definitive Audio supply. This could turn out just as expensive when the metalwork and so on have been factored in.*

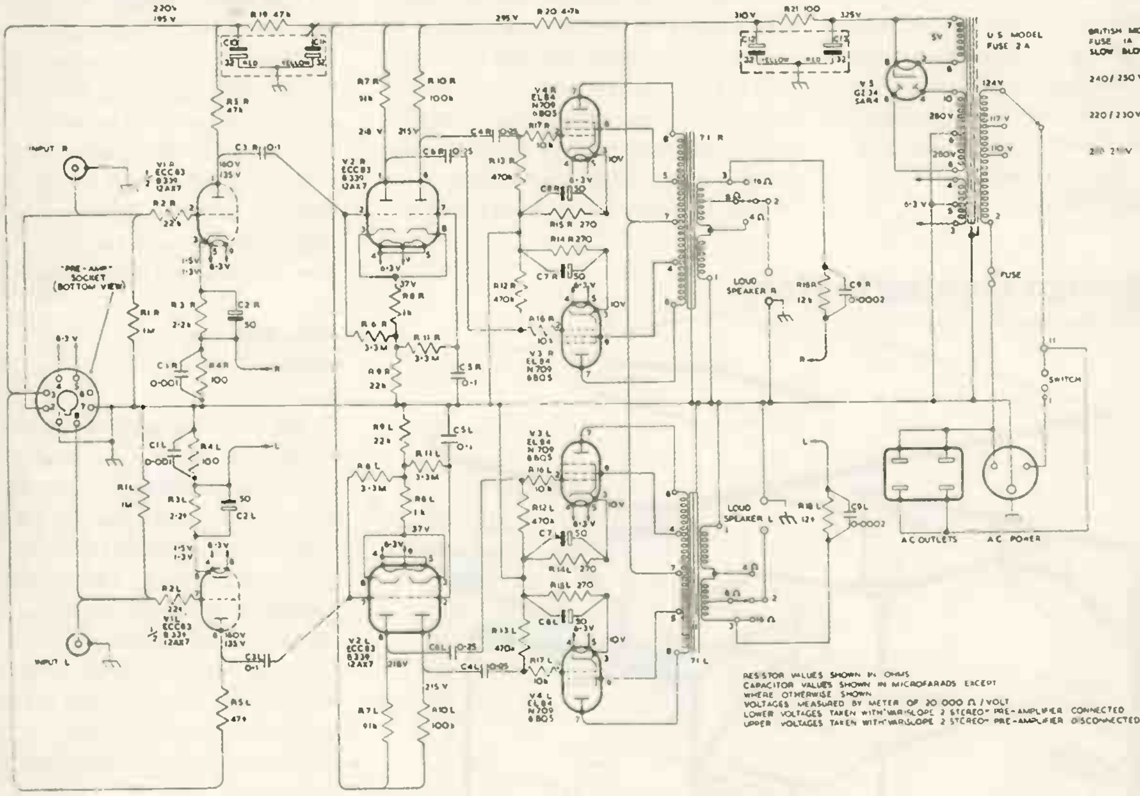
*I would suggest that there are two easier (and cheaper) options. You could replace the PSU capacitors in your amp with modern, audio-grade parts. Then you could search around the surplus electronic shops for an old variable-voltage, laboratory power supply such as those made by Solartron. Disconnect the amp's internal supply and connect up the external one. These supplies are very stiffly regulated and really beef up the bass quality. And of course, if you change amps, you just disconnect the supply and use it on your new one after adjusting the voltage.*

*The original philosophy behind single-ended amplifiers in Japan was very minimalist in that only one output valve per channel is needed for it to work. But there are other advantages to SE working, even when parallel output valves are used.*

*Sonically, if only one valve per channel is used, there is a beauty and subtlety to the sound which I have never heard anywhere else; imagine the difference between a painting done with a brush with one bristle and one done with an emulsion roller. To fully appreciate this though, the components used in the amplifier (especially the output transformer) and the circuit topology must be of a very special quality. And if the rest of the equipment in the system paints with a roller, then there's no point bothering.*

*There are a great many kits available from Japan, from guys like the Audio Professor. Get hold of a copy of MJ Magazine from Japan (which can be ordered from Books Nippon near St Paul's cathedral). Don't rush down the bank to convert your pounds into yen yet though - keep your eyes on our Supplement for a forthcoming SE triode kit.*

*As far as your tape deck goes, make sure you are using a good, studio-quality tape from someone like Ampex, and also get it set up by an engineer before doing any modifications. Misalignment will greatly increase noise. GD*



As you can see from the Stereo 20's circuit diagram above, the power supply is unregulated. With an old valve-based bench power supply, regulation should be easy to achieve though.

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| B9A *(Ch or PCB) G/Plated* | 3.00 |
| Octal *(Ch. or PCB)* | 1.80 |
| Octal *(Ch. or PCB) G/Plated* | 4.20 |
| 4 Pin *(For 2A3, 300B etc.)* | 3.30 |
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| 5 Pin *(For 807)* | 3.00 |
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| 9 Pin *(For EL, PL509, Ch. or PCB)* | 5.00 |
| Screening Can *(For ECC83 etc.)* | 2.00 |
| Anode Connecter *(For 807 etc.)* | 1.50 |
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| 805 *CETRON* | 50.00 |
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