Hi-Fi WORLD SUPPLEMENT

No. 14 APRIL 1995

P. Jones

BOOK REVIEWS - LOUDSPEAKER ENCLOSURE DESIGN and GEC AUDIO VALVE AMPLIFIER DESIGN

LETTERS AND Q&A

BUILD THIS HDA TRANSMISSION LINE MONITOR LOUDSPEAKER

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FREE D.I.Y. SUPPLEMENT No. 14

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D.I.Y. Supplement

Contents

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4.7nF	.65	330nF	1.00
10nF	.65	470nF	1.00
15nF	.65	680nF	1.25
22nF	.65	1nF	1.50
33nF	.65	1.5nF	2.00
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KIT NEWS

NEW SERVICES FROM GT AUDIO

GT Audio have recently discovered a new range of capacitors which are particularly suitable for Quad II valve amplifiers. They are available separately or can be incorporated into GT Audio's restoration service. Also new from GT is a 4mm socket and plug suitable for amplifiers, made from silver plated copper. 4mm sockets are available for £2 each and the matching plugs cost £2.50.

Because of the difficulty finding original Philips ECG 8417 output valves for Quicksilver monoblocks, GT Audio have developed a conversion which allows the reliable and more available 6550 output valve to be used instead. GT claim that this not only makes the amplifier more reliable, but also improves sound quality. The price for the modification, including valves, is £275.

GT Audio are also offering an upgrade service for Audio Research SP6/8/9/10 preamplifiers. Prices start at £100.

All labour carried out during restoration and parts purchased from GT Audio (except valves) are covered by a full 2 year warranty.

GT Audio
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Bucks, UB9 5EJ
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SINGLE-ENDED HEADPHONE AMPLIFIER FROM HART

New from Hart is a high quality single-ended headphone amplifier, the Chiara. Available as a kit, it comes complete with a printed circuit board which takes all components in order to make construction precise and easy. High quality audio grade components such as an Alps volume control are included. The Chiara has a signal link through to enable it to be connected between pre/power amplifier or to a tape monitor circuit.

The Chiara has two outputs suitable for headphones with an impedance greater than 30Ω. In addition there is a high level output, which can be used to drive long cable runs to a remote power amplifier for example, and a passive output. Both are controlled by the Alps volume control.

A complete kit of parts including casework is available for £109.50.

Hart Electronic Kits
Penylan Mill,
Owestry,
Shropshire. SY10 9AF
Tel: 01691 652894

NEW SPEAKER KITS FROM FOCAL

Falcon Acoustics have just announced a new range of Focal loudspeaker kits. There are eight to choose from, ranging from centre channel 'speakers to a three way floorstander using a 10" bass unit. The range includes several designs using Focal's polyglass and polykevlar drivers, and all are high sensitivity designs making them especially suitable for low power solid state and valve amplifiers.

Once you have built your own loudspeaker, Falcon can also supply the IMP loudspeaker measurement system reviewed in the February '95 Supplement. For further details contact:

Falcon Acoustics
Tabor House,
Norwich Road,
Mulbarton,
Norfolk. NR14 8JT
Tel: 01508 578272

MORE ISSUES FROM GLASS AUDIO

Glass Audio, the American magazine aimed at tube enthusiasts, is about to increase frequency from quarterly to every other month. For further information about Glass Audio and other Audio Amateur publications, contact:

Audio Amateur Publications
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305 Union Street,
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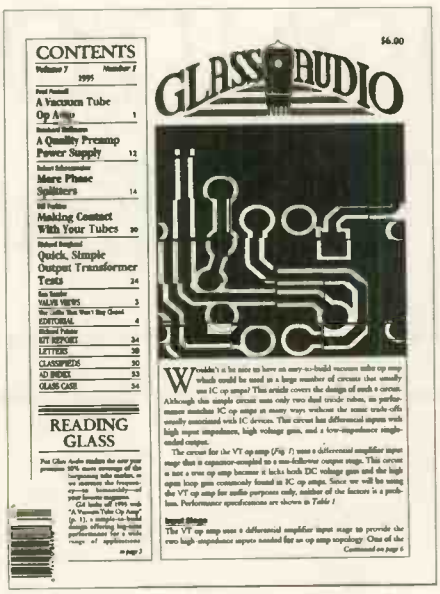
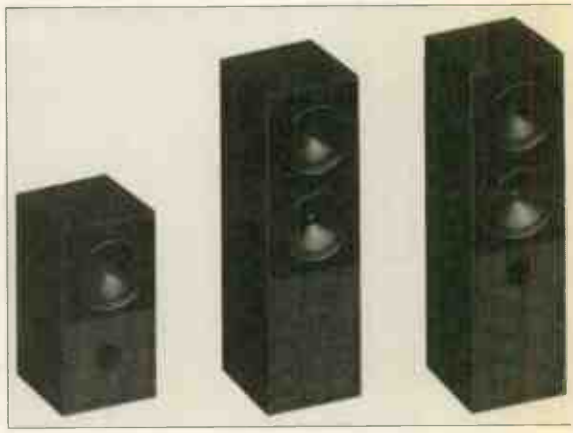


WILMSLOW MAKE CABINETS AVAILABLE FOR KEF'S CONSTRUCTOR SERIES

Wilmslow have a number of new products that will be of interest to the DIY enthusiast. Firstly there is a range of flat pack cabinets under development for the recently launched KEF Constructor Series. Wilmslow can also supply drivers, crossover and any other components necessary to complete the kits.



Wilmslow Audio are also stocking the new D2905/9300 tweeter from Scanspeak. This new textile dome HF unit reaches 30kHz, giving it a very smooth response within the audio band. Sensitivity is a healthy 90dB and impedance a nominal 8Ω. The D2905/9300 retail at £59.50 each.

Wilmslow Audio
Wellington Close,
Parkgate Trading Estate,
Knutsford,
Cheshire. WA16 8DX
Tel: 0565 650605

SOLID STATE REPLACEMENT FOR VALVE RECTIFIERS

RATA have introduced a solid state plug-in rectifier to replace GZ34 and GZ32 rectifier valves. The rectifier is mounted on an octal valve plug, so can be simply plugged in. In some cases it will be necessary to alter the HT dropper resistor to re-adjust for optimum working, RATA are able to advise on this.

RATA
Edge Bank House
Skelsmergh,
Kendal,
Westmorland. LA8 9AS
Tel: 0539 823247

KLS5 HDA TRANSMISSION LINE MONITOR LOUDSPEAKER

Dominic Baker takes up his saw to build these High Definition Aerogel transmission line monitor loudspeakers.

To date, we've produced four loudspeaker designs in the pages of the DIY Supplement, the most recent two using Audax's Carbon Fibre drive units. Now it's time for Audax's High Definition Aerogel (HDA) drivers to make an appearance, in this compact standmounting transmission line monitor.

Transmission line loudspeakers are known for their deep, powerful bass and the way they grip a room, filling it with a full scale performance. But they have their downsides too, notably the difficulty of tuning the line, which

appears to be one of the blackest of arts.

Until recently we hadn't considered attempting such a design, but reviewing the book Quick & Easy Transmission Line Speaker Design by Larry Sharp, and a lengthy conversation with John Wright of TDL, a leading expert in transmission line loudspeaker design, prompted us to have a go.

The first cabinet worked very well, better than I'd hoped for at a first attempt. Bass was deep and powerful, but could become a bit monotonous. Shifting the internal baffles around gave me an idea of which way I needed to go to improve the bass quality, and the second prototypes were built. These were a great improvement, giving just about exactly the bass quality I wanted. It was still as deep, but the upper bass was faster and played tunes better, giving them a far more lively balance.

A couple more prototypes saw KLS5 quickly progress to its final form, thanks to our Hewlett-Packard HP3561A FFT analyser and an accurate measuring microphone.

One great thing about a transmission line loudspeaker is that once the cabinet dimensions have been optimised and fixed, it can be subtly tuned to give the bass quality you want in your room, just by altering the amount and density of long hair wool in the line. This makes Transmission Line loudspeakers extremely versatile for home constructors, which combined with their superb subjective performance, is why they're becoming increasingly popular once again.

TL DESIGN

A practical Transmission Line (TL) has two main effects that are advantageous to loudspeaker design. Firstly, the sound venting from the end of a quarter-wavelength transmission line is 90° out of phase with the signal from the back of the cone which drives the line, which itself is 180° out of phase with front radiation. This ensures that radiation at lower frequencies is progressively moving into phase and will add, rather than subtract, to the forward response.

Also, a practical transmission line loudspeaker is lined with acoustic felt and wool, so that the majority of upper bass and midrange energy is absorbed before it reaches the end of the line and the outside world. Lower bass energy gets through, making low bass apparent. In electrical engineering terms, a transmission line port is a low pass filter with a 270°+ phase shift.

One problem with a transmission line loudspeaker is its low efficiency. To overcome this, we have used the latest high tech. High Definition Aerogel (HDA) drivers from Audax, which have a super light cone and a powerful magnet to give them high sensitivity. Another area where TL loudspeakers receive criticism is midrange colouration. To overcome this we used a number of sensible design features. If the line is made exactly 1/4 wavelength, it tends to act like a tuned pipe which introduces colouration. Making the line slightly shorter (my thanks to John Wright of TDL for this valuable tip) reduces this colouration without adversely affecting bass quality.

In TL loudspeakers where the line is folded quickly behind the cone, the strongly reflected sound wave from the cabinet wall can give a 'clatter' in the midrange. For this reason, the rear wall of the cabinet was kept as far back as possible, and fitted with a generous covering of soft, absorbent carpet felt.

Of course, on top of all this, KLS5 uses a super high quality Audax HDA driver, which is exceptionally clean and clear in the midrange to start with. So this area of concern was quickly eliminated.

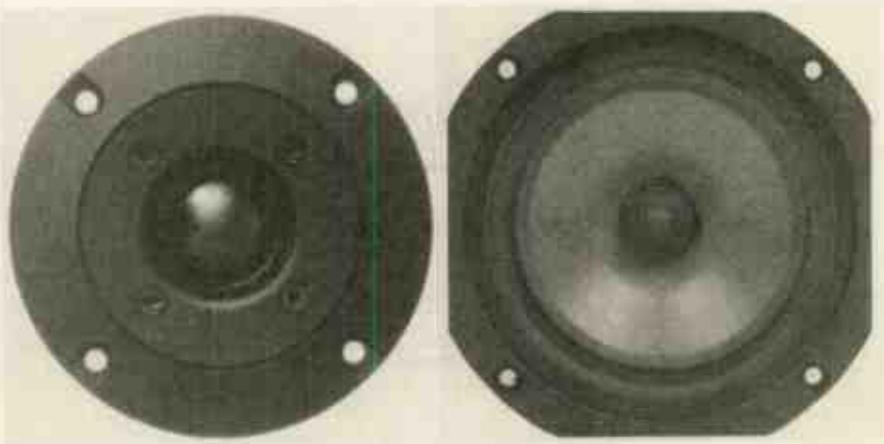
One thing about a transmission line 'speaker that particularly appealed to us was the highly damped impedance peak. Normally you see impedance rise strongly in the bass, but with a transmission line 'speaker impedance is very smooth, something that is important for owners of low or zero feedback amplifiers which are adversely affected by impedance variations. Our smooth impedance curve proves true transmission-line behaviour in KLS5.

So, with a sensible design approach and modern, super quality drive units, KLS5 manages to control or eliminate many of the problems normally associated with TL loudspeakers, and retain its advantages.

THE DRIVE UNITS

The TW025M0 tweeter used in KLS5 is very similar to the M1 version used in KLS3 and KLS4. It uses a 25mm soft fabric dome which gives it a sweet and open sound. It is more flexible for two way designs though, as it goes lower before rolling off.

The bass unit is a 6.5inch High Definition Aerogel (HDA) unit. HDA is made from a controlled matrix of acrylic polymer gel in which an optimised proportion of Carbon and Kevlar fibres are embedded. This makes it extremely light and stiff, as well as giving it high internal damping.



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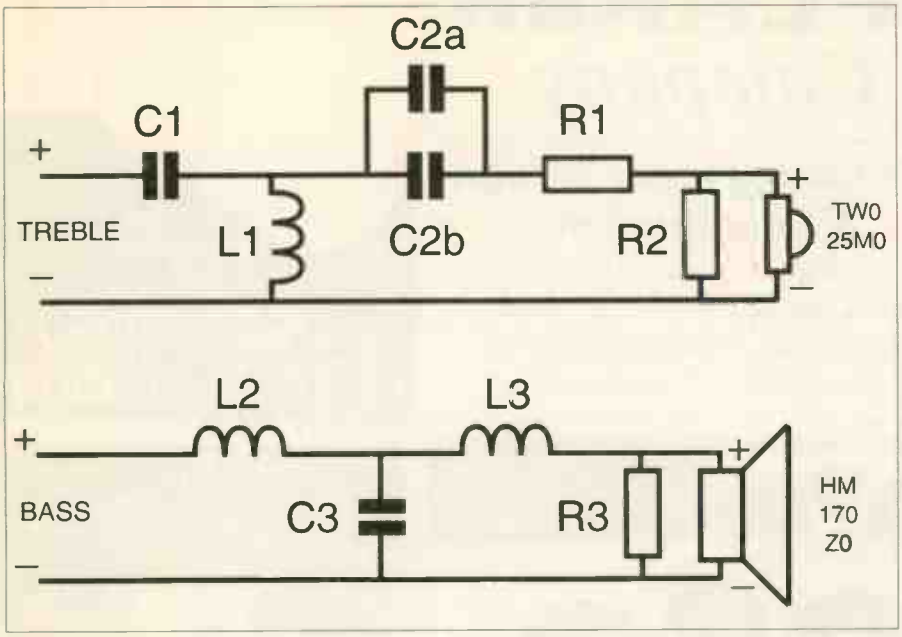
THE CROSSOVER



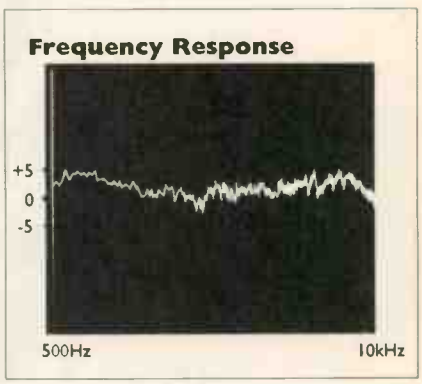
midrange output from the bass/mid driver. R2 is connected in parallel across the driver terminals to damp the impedance curve through the midrange, and provide a smooth and predominantly resistive load that makes them exceptionally easy for all amplifiers to drive, including low power, feedbackless, single-ended designs.

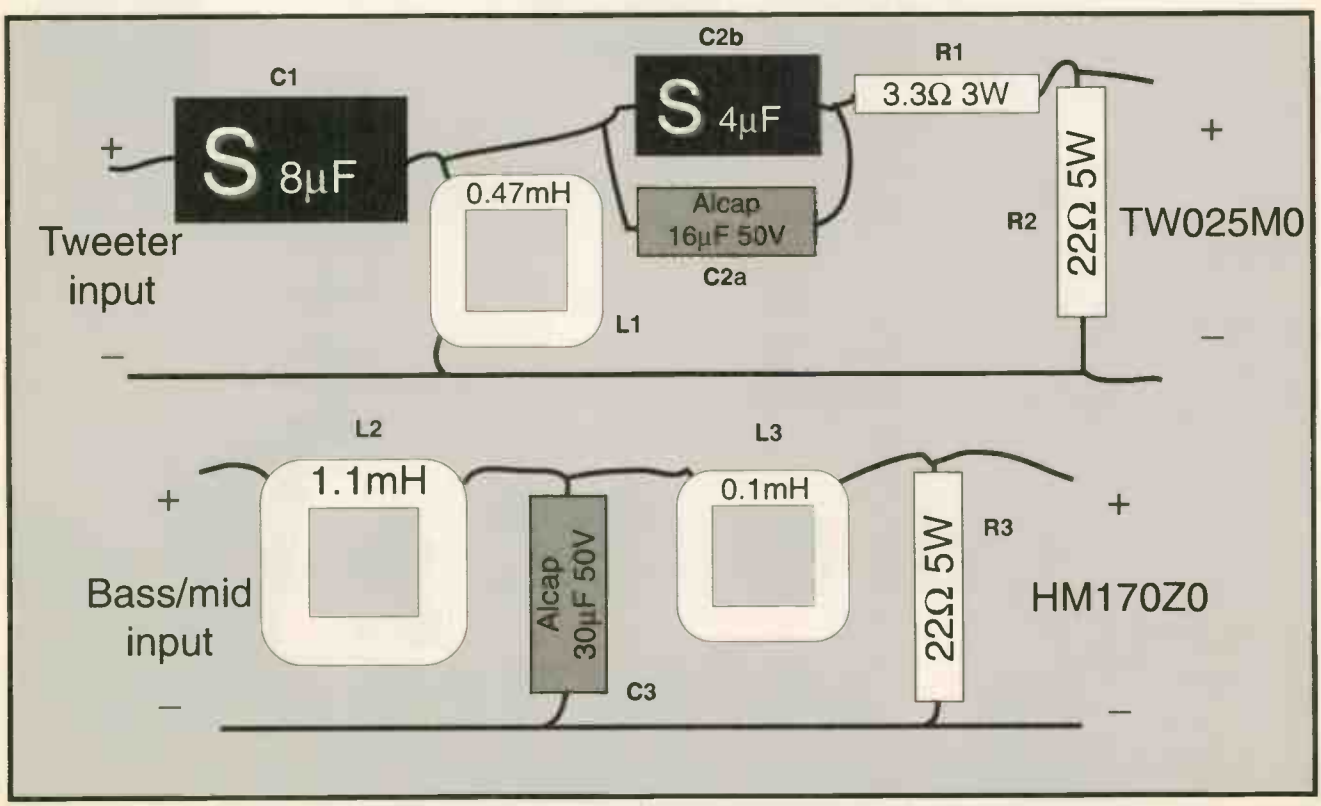
The crossover for the bass/mid unit again makes use of the parallel connected 22Ω resistor to damp impedance rise caused by the voice coil inductance.

A near field plot shows good integration between the HDA mid-range and fabric dome tweeter.

Because of the way the KLS5's transmission line has to be fitted into the compact cabinet, the tweeter is mounted below the main Aerogel bass/mid driver. In this situation, it's normally necessary to 'lobe' the loudspeakers output towards the listener, otherwise a large proportion of the output from the tweeter would be firing at the floor or the ceiling. This is possible using third order filters, which although more complex, have other advantages. These include a faster roll-off rate which improves power handling as well a giving less 'overlap' between the two units, which can cause phase cancellations through the vertical axis.

The third order section for the treble arm of the crossover comprises a capacitor-inductor-capacitor circuit (C1-L1-C2), the values selected to provide a smooth response with the -3dB crossover point being 2kHz. Because the tweeter is slightly more sensitive, resistor R1 is used to attenuate it down to match the





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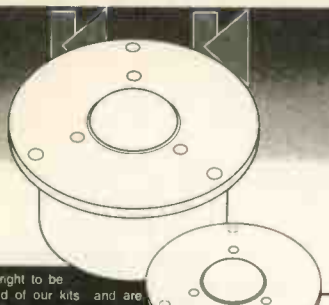

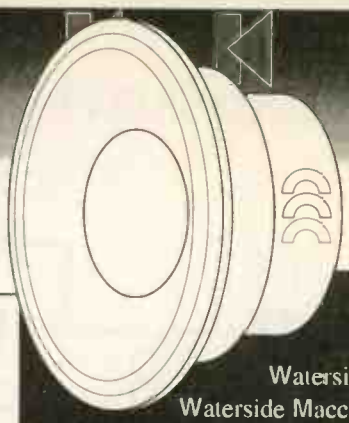

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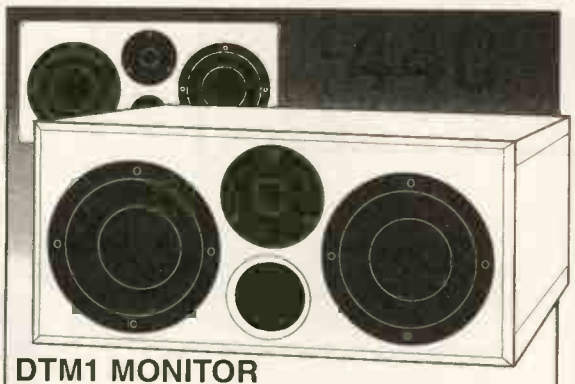
This speaker is well known to all. It uses KEF drive units B101 B and T27 A combined in a small infinite baffle cabinet of only 7 Litres with a high quality crossover incorporating electronic protection S-stop. this is one of the best near field monitors available built in 25mm MDF.



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HPD 10

£745 pair

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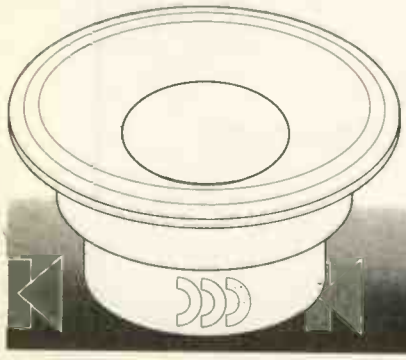
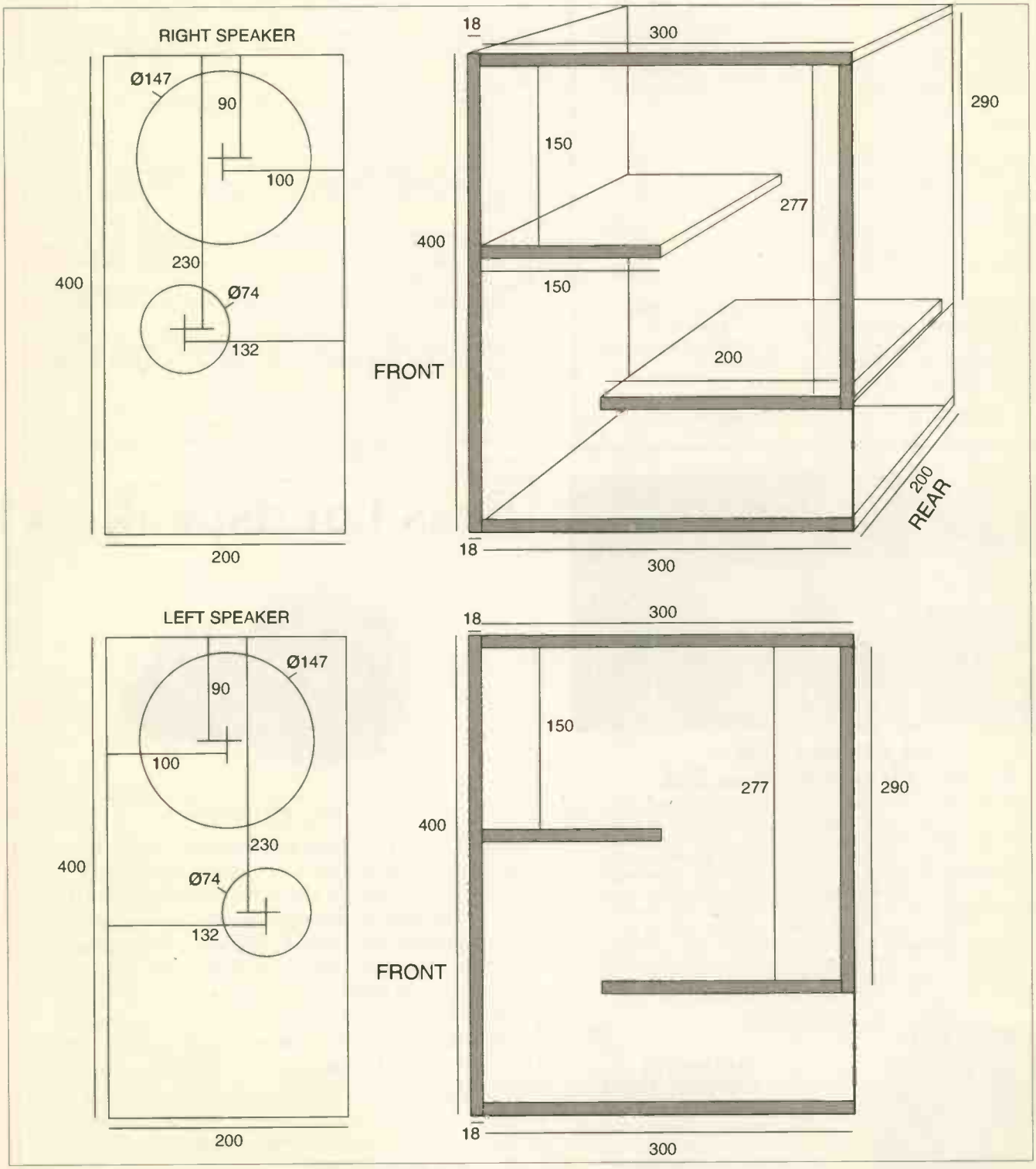


CONSTRUCTION

Building the KLS5s is fairly straight forward, as can be seen from the diagram below. I recommend you build them up on one side, leaving the back off to allow them to be lined with carpet felt and stuffed with long hair wool easily. The wood is thick enough to hold together strongly with just Evostick Resin Wood glue, but can be pinned or screwed together to hold the panels true.

The surface directly behind the bass unit and all of the surfaces in the top chamber should be lined with carpet felt to absorb reflections that would otherwise pass back through the driver. The transmission line needs to be filled quite heavily with long hair wool, around 250gm teased out and graduated so that it's most dense behind the driver and tapers out towards the end of the line.



The loudspeakers are handed for improved imaging qualities. When listening, the tweeters should be on the inside edges.

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PRO 16P* Chassis hook up wire	£1.00 per foot
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Connectors

Neutrik gold plated XLR male	£6.00
Neutrik gold plated XLR female	£7.00
XLO pro phono plugs (4 pack)	£25.00
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XLO Signature XLR chassis mount (2 pack)	£28.00
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XLO BNC connectors (2 pack)	£16.00

* Note that the chassis wire is excellent for loudspeakers internal wiring or to replace the jumper connectors used when Bi-wire speakers are used in single wire mode. When using the wire to carry signals of less that 100hz a double run should be used. High quality preamps should be wired with 16T.

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type	a to a Z	max dc	max power	suggested valve type	price (inc)
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pp 108	5K0	100mA	30W	300B	£64.87
pp 110	6K0	70mA	25W	5881	£59.87

All the above can be supplied fully shrouded, open frame or drop through as required. Please enquire about any requirements not listed here. A large range of mains transformers and power supply chokes is also available. Full "sets" for amplifiers can be supplied:

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Finally we will have a valve phono stage kit available for late February, this will be an excellent MM to line level phono stage, with optical MC stepup transformers. The full kit will include pcb, components, casework, valves and shipping; and will sell for only £360 for the mm version.

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C2b	4µF Solen
C3	20µF 50V Alcap

Inductors

L1	0.47mH air core
	(0.56mm wire for 0.9Ω DCR)
L2	1.1mH air core
	(0.71mm wire for 1.2Ω DCR)
L3	0.1mH air core
	(0.56mm wire for 0.4Ω DCR)

Resistors

R1	2.2Ω 3W WW
R2	22Ω 5W WW
R3	22Ω 5W WW

SOUND QUALITY by David Price

If you've ever experienced the Rolling Stones live and survived, you'll know what I mean when I say the KLS5s are exciting to listen to. Indeed, it was the aforementioned godfathers of rock that I auditioned them with. 'Start Me Up' is a song that spawned a thousand imitators (Primal Scream, you know who you are), and with the KLS5s you can see why - they jumped into the song with fantastic verve.

These loudspeakers sound highly involving. They certainly captured those classic Stones riffs with real power, projecting Mick'n'Keef's magic forcibly into the room. Charlie's rhythms were powered out in a raw yet couth fashion, wholeheartedly convincing me it was music I was listening to, pure and simple.

One of the most pleasing aspects of KLS5 was its cohesiveness. Black Uhuru's 'Emotional Slaughter' proved that in the face of complex, bass driven passages, these 'speakers remained utterly composed and together. They image very well too, forward and completely out of the box. Rhythmically, they remind me of Linn Kans - super fast, with an almost euphonic portrayal of rhythms - foot-tapping is compulsory.

The bass on the KLS5 is ultra fast, well controlled and highly rhythmic. Although surprisingly well extended for the 'speaker's fairly diminutive proportions, the bass isn't going to break windows. Moving the KLS5s away from the walls out into the room provided an extra degree of force in the lower regions. It's often the other way round, but transmission line designs drive rooms best when they've got some room to breathe.

The KLS5's downside is their fussiness - as they don't suffer fools gladly, if the partnering equipment is duff or the recording poor, they won't equivocate - they'll tell you. This means you'll need a smooth sounding front end and amplifier. Don't even think about cheap CD players! If that doesn't dissuade you, you might just find they're an essential purchase.

Drive units available from World Audio Design - see page P. 85 in main issue.

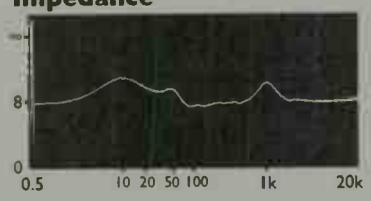
MEASURED PERFORMANCE

The KLS5s have a smooth response, shown in the plot below. There is a slight peak in the midband around 1kHz, but it is narrow and only peaks by 1dB, so shouldn't be a problem in subjective tests. The treble has been gently rolled off at the top end to avoid brittleness or harshness with CD players and give it a sweeter balance.

Bass appears to roll off quite early, but the transmission line vents backwards so a lot of its output is lost with the microphone positioned close to the front of the 'speaker, where best midrange-treble detail can be resolved. All the same KLS5, because of its compact dimensions, doesn't have earth shattering bass. It rolls off gently, so although not strong, will go deep.

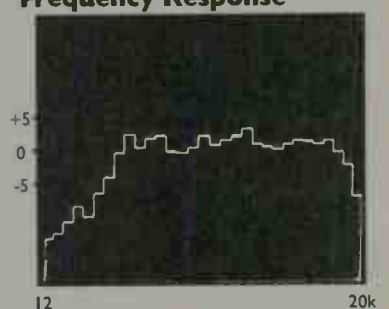
One of the great advantages of transmission line 'speakers is the highly damped impedance curve. Impedance varies little across the entire spectrum, giving them an especially flat impedance curve. This, along with their higher than average sensitivity of 88dB makes them an easy load, especially suitable for zero feedback valve amplifiers. Overall impedance measures 9.3Ω. DB

Impedance



Very flat impedance curve.

Frequency Response



Smooth response.

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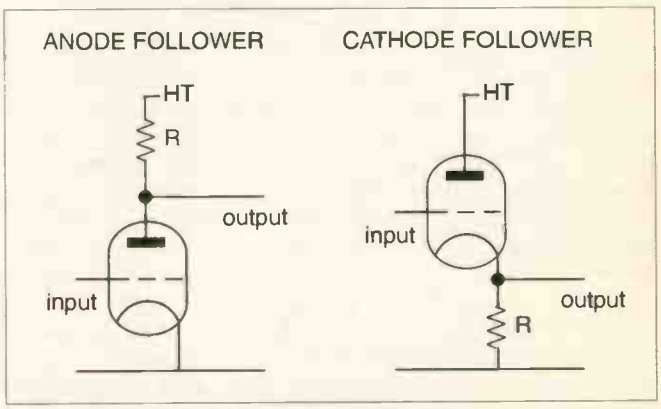
KNOW YOUR PREAMP VALVES

Selecting a valve for use in a preamplifier can be a daunting task, especially with so many to choose from. Andy Grove explains why and where to use nine of the most commonly available preamplifier tubes.

After a rather detailed explanation as to why I had selected a particular valve to use in a preamp, I was met with a blank expression and the reply - "the only way to design an amp is to plug in different valves and try it". You can do this with valves - being robust they won't blow up or burn out and, unlike transistors they will work under horrendously adverse conditions. But this isn't any meaningful way of assessing them. Valves must be run under correct DC conditions and within relevant small signal (AC) conditions before their sonic properties can be validly assessed. Here's a look at the role of various common preamp valves, together with operating conditions.

Before even buying any valves you need to scan the pages of your data books to find ones with the ELECTRICAL characteristics you are looking for. These comprise DC operating conditions and AC small signal parameters. My friend who listened by substitution wasn't considering either. A valve must be run within the manufacturer's specified DC conditions, notably anode volts, heater volts and, especially, grid bias, this last parameter intimately affecting AC performance.

The AC "small signal parameters" are valid only under the DC conditions, but they are not usually met in the real world, because quite often they involve running the valve at its absolute maximum ratings. Remember that manufacturers would try to make their valves look as impressive as possible in an attempt to outsell their competitors. So expect to "interpret" quoted AC performance; it won't turn out exactly as specified.



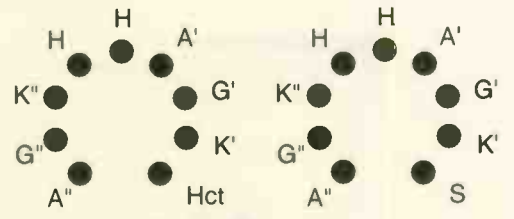
The anode follower circuit arrangement is used where gain is needed from a stage, such as an active preamplifier, phono stage or the input stage of a power amp. The cathode follower has a gain of less than 1, but ts high input impedance and low output impedance make it ideal as a low distortion buffer stage.

The small signal parameters for valves are gm - Transconductance (once called Mutual Conductance), μ (mu) - Amplification Factor, and ra - Anode Resistance. From these it is possible to get a good idea of how the valve will perform. Really μ, the amplification factor, is not strictly necessary because it is a product of gm and ra: $\mu = gm \times ra$. It is usually included because it makes life easier by simplifying some of the equations used to determine gain etc.

Now we have listed the parameters, what do they mean? They are really all about the anode current Ia, in relation to the anode voltage Va and the grid bias voltage Vg:
1) Transconductance, gm, describes what happens to Ia when Va is held constant and Vg is varied.
2) Anode resistance, ra, describes what happens to Ia when Vg is held constant and Va is varied (note that ra is the valve's internal resistance, not the anode load, denoted Ra).

These parameters are used to find a valve's stage gain. The equation is: $A = (\mu \times Ra)/(ra + Ra)$ where A is gain and Ra is the anode load impedance, ra and μ are as before. The anode load Ra could be a resistor, a transformer (inductive) or another valve (active load), as in a cascode stage.

The small signal parameters are AC parameters. They describe VARIATIONS in voltage and current and should not be confused with the valve's DC operating conditions. Also the words "Small Signal" are important, this phrase is the electronic engineer's way of describing the mathematical term "∂" (lower case delta), a vanishingly small variation. Larger real world signals can alter parameters gm and ra, and also that they will continuously change over the AC cycle. This of course means that the gain of the valve alters with the signal. There is a term for this - nonlinearity.



The valve bases for each valve are shown at the bottom of each description. They are viewed from beneath.

Key: A - Anode, G - Grid, K - Cathode, H - Heater, Hct - Heater centre tap, S - Screen

ECC81/12AT7

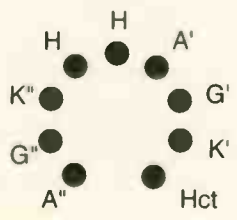
The ECC81 is a double triode on a B9A base with 12.6V/6.3V series/parallel heater. It didn't really catch on as an audio valve, and in the data books it is actually listed as a VHF type. Its highish mutual conductance of 5.5mA/V together with its high amplification factor make it ideal as a cathode follower or cathode coupled phase splitter.

The ECC81 has a much higher gm than an '83 so gains in the region of 40 can be achieved with a single section, even though it's μ is only 55. The '81 will also work well as a cascode or at low voltages (Va=75V) and its noise is low. The lowered anode impedance allows a better HF response than the '83 and better drive capability. Linearity isn't really this valve's forté though so I wouldn't recommend it in very high level applications such as driving power triodes.

The sound quality is like a chrome plated version of the ECC83, with a bright, almost metallic upper midrange and much less of the '83s warmth. Some people like it, I don't. Amplifiers with ECC81s include Tube Technology and Beard.

Equivalents:
12AT7 - USA, 6201 - USA mil version, 6060 SQ version, B309 - GEC. The ECC85 is very similar but has a different pinout.

Characteristics:
μ=55, gm=5.5mA/V, ra=10k
at Va= 250V, Ia=10mA, Vg=-2V



ECC82/12AU7

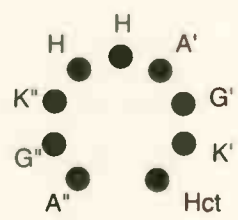
The ECC82 is again a double triode with series/parallel heaters and a B9A base. In fact the ECC81, ECC82 and ECC83 are all exactly the same valve, but with varying electrode spacing and grid pitch to achieve the different characteristics. The ECC82 is intended as a low impedance driver valve. Gains of around 12 are typical for a single stage, but more can usually be squeezed out if needed.

The '82 can deliver quite large currents at low anode voltages, making it useful as a cathode follower when a small amount of power is needed to drive the output stage. As a simple anode follower the '82 often finds itself as the last stage in preamps or as a driver for parallel-pair output stages. It is also sometimes used as a phase splitter/driver. If used in cathode coupled configuration, anode resistors must be adjusted to obtain balance.

Sound quality can vary depending on which type is used and of course how it is used. Generally it has quite a dull, unexciting sound, but this could be viewed as a lack of colouration. The ECC82, like the ECC83, is used by a lot of manufacturers, Audio Innovations and Border Patrol are good examples.

Equivalents:
12AU7 - USA, 6067 - SQ version, B329 - GEC, 5814A mil version, 6189W mil version.

Characteristics:
μ=17, gm=2.2mA/V, ra=7.7k
at Va=250V, Ia=10.5mA, Vg=-8.5V



ECC83/12AX7

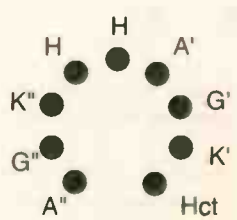
This has to be the most widely used modern low level valve known to man. A double triode with 12.6V/6.3V series/parallel heater, B9A base and high amplification factor make it convenient to use in a wide variety of applications. Gains of 60 to 70 in one stage can quite easily be achieved. This allows one section of an '83 to replace a pentode in a lot of circuits, leaving the other section free for some other use.

The very high gain of this valve also makes it ideal for cathode coupled phase splitters, ensuring accurate balance. The Mullard 5-20 used one for exactly this reason. The valve is quite linear, but because of its high impedance it doesn't accept high input/output signal levels. A good ECC83 has a warm, smooth sound, really valvey sounding - the Sovtek ones really excel.

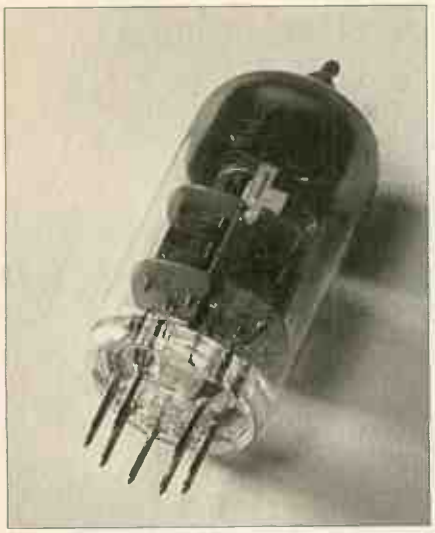
Noise may be a problem in MC stages because of its rather low gm. I won't bother listing who uses ECC83s because there isn't enough room in the magazine!

Equivalents:
7025 - a selected version for audio, 12AX7-USA, B339-GEC, 6057 - SQ version and 6L13 - Mazda. Type 5751 is similar but not identical, type 6EU7 is identical electrically, but has a different pinout.

Characteristics:
μ=100, gm=1.6mA/V, ra=62.5k
at Va=250V, Ia=1.2mA, Vg=-2V



ECC88/6DJ8



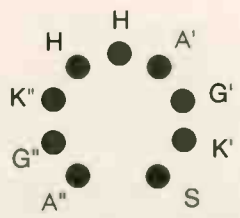
The ECC88 is a double triode on a B9A base, with 6.3V only heaters and an internal screen. This is a special type of valve called a "Frame Grid Triode" so called because the grid is tightly stretched over a rectangular frame to allow very close spacing of the electrodes and hence the high gm.

Most ECC88s are INCREDIBLY microphonic! The very close spacing of anode-grid-cathode also means that the maximum voltage they can be used at is very limited or damage may occur. Standard ECC88s are almost exclusively used for preamps where they (if you know the right ones to use to avoid microphony) are very low noise, suitable for MC stages. The Sovtek 6922 however is useful as a driver valve as it has a higher voltage rating and anode dissipation.

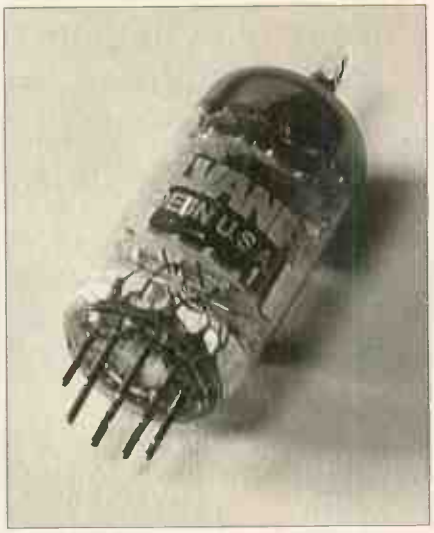
Sound quality is very variable, some are horribly grainy, others mechanical, but some are crystal clear and smooth. The Telefunken E88CC is good, as is the Sovtek 6922 we use. ECC88s are very popular in the USA, especially with Audio Research and Conrad Johnson.

Equivalents:
6922 - mil spec, 6DJ8 - USA and 7308 - mil spec. The ECC189 is also very similar but with a slightly lower anode impedance.

Characteristics:
μ=33, gm=12.5mA/V, ra=2.65k
at Va=90V, Ia=15mA, Vg=-1.2V



12AY7/6072



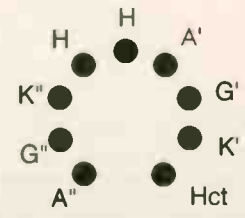
This valve is similar to the ECC83 and has the same heaters/pinout. It was intended as a low noise preamp valve for audio use and as such it is excellent. Its characteristics are just about ideal for preamp applications, a gain of around 30 is typical for one stage and with a reasonably low output impedance.

Microphony on a good example is just about nonexistent, noise is low but an ECC88/6922 will win in the end due to its "brute force" gm. It would be sacrilege to use a 12AY7 as a driver valve, there are valves which are much better at being forceful. When used as intended though this particular valve has a rich, smooth and open sound which is very hard to beat.

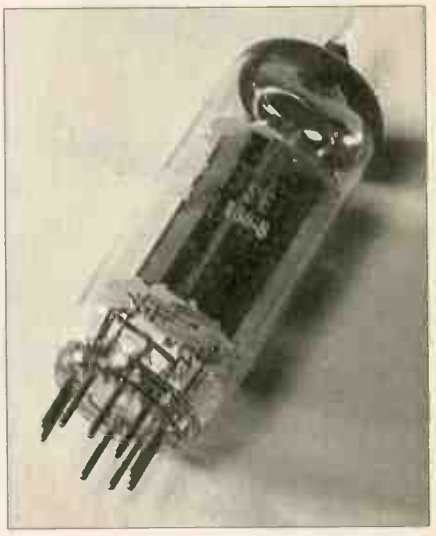
The 6072 version is the high reliability/ruggedised military version and in my opinion it wins over its commercial cousin in the sound stakes, being slightly clearer and more coherent. The 12AY7 is slightly softer and more euphonic. The only people I know using the 6072/12AY7 are AudioNote and World Audio Design (in our 300B amplifier). The only problem with these valves is their price. Although not stratospheric, they are more expensive than the plain old '83. Stock levels are high but I wish someone would start making it again.

Equivalents:
6072 and 12AY7!

Characteristics:
μ=40, gm=1.75mA/V, ra=22.8k
at Va=250V, Ia=3mA, Vg=-4V



12BH7/A



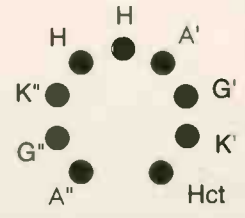
The 12BH7 again has the series/parallel heaters and basing/pinout of the ECC81/2/3 type valves. Designed for use as a vertical deflection amplifier in TVs, its main application in audio is as a high powered driver valve. It looks like an ECC82 that's taken an overdose of anabolic steroids and spent too long in the gym. The advantage with the 12BH7 is its anode dissipation of 3.5W and maximum anode voltage of over 300V. It can also deliver a lot of current (essential for deflection amplifiers) at Vg=0 making it a good choice for cathode followers.

To supply the very high voltage drive requirement of their distributed loading output stage McIntosh use 12BH7s with bootstrapped anode load resistors. Conrad Johnson and Audio Research also use them for similar reasons. The large voltage swing capability and low impedance make it a contender for driving triode output stages, although there are better, more linear valves.

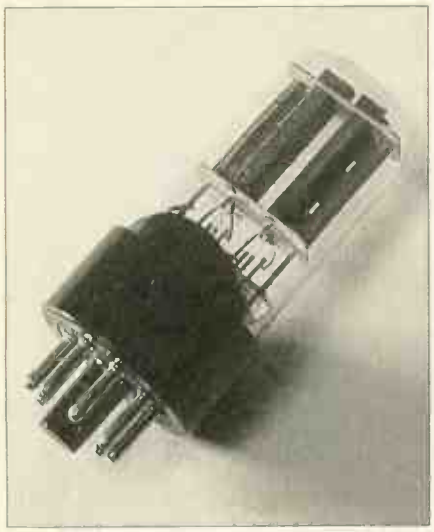
As the 12BH7 can be used in such a variety of ways it is difficult to pin down its sound. In circuits I have tried it in though it sounds much like "an ECC82 with boots on".

Equivalents:
I couldn't find any equivalents but the 12BH7/A is very common so supply will not be difficult.

Characteristics:
μ=16.5, gm=3.1mA/V, ra=5.3k
at Va=250V, Ia=11.5mA, Vg=-10.5V



6SN7



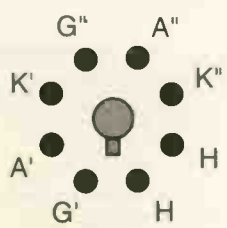
An Octal based double triode with 6.3V only heater, the 6SN7 ranks along with the ECC83 as one of the most popular valves of all time. A quick flick through the Radio Designer's Handbook shows its pages are littered with 6SN7s. It is one of the most linear valves of its class. A gain in the region of 15 for one stage is normal.

Generally noise and microphony are low, making this valve suitable in preamps as well as power amp driver stages and I would use it in place of an ECC82 in almost every application. The military used 6SN7s by the truckload and had special versions made. There is even an ultra high reliability version for missile and space applications - the 5692, famous for its bright red base, but don't try to buy any unless you've got a bulging wallet!

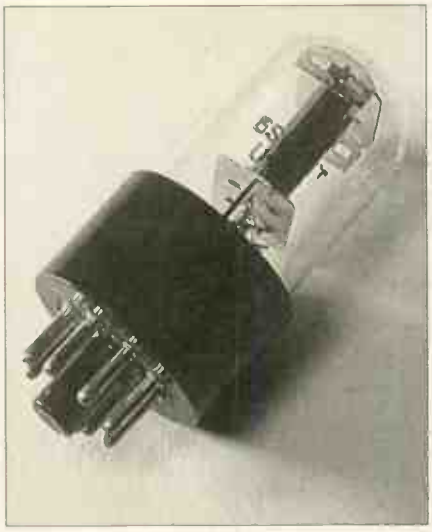
The sound quality of most 6SN7s is excellent, but like wine tends to get mellower with age. The later 6SN7WGB or STC types have a lean, clean sound. The earlier ones are slightly softer, but all have a very open, natural quality. The best known application of 6SN7s in the UK is in the Williamson amplifier, which used GEC B65s.

Equivalents:
B65 - GEC, 5692 - Mil, B36 - GEC with 12.6V heater and 12SN7 - USA with 12.6V heater. The 6CG7 is a 6SN7 on a B9A base.

Characteristics:
μ=20, gm=2.6mA/V, ra=7.7k
at Va=250V, Ia=9mA, Vg=-8V



6SL7



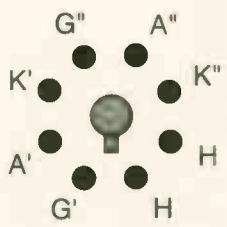
An Octal based high mu double triode with 6.3V heater. Like the 6SN7 this valve has been around for a long time and there are quite a few versions to choose from. The 6SL7 would be used in similar applications to the ECC83, phase splitters, low level preamp stages etc. Linearity is good but as with other high mu valves large voltage swings aren't possible. As a driver it will perform better than an '83 but not by much, its anode impedance is too high.

Although slightly less than that possible from an ECC83, a stage gain of around 50 is available from the 6SL7. Generally, microphony and excess noise are low but as its gm is low at 1.6mA/V mc input stages aren't really practical.

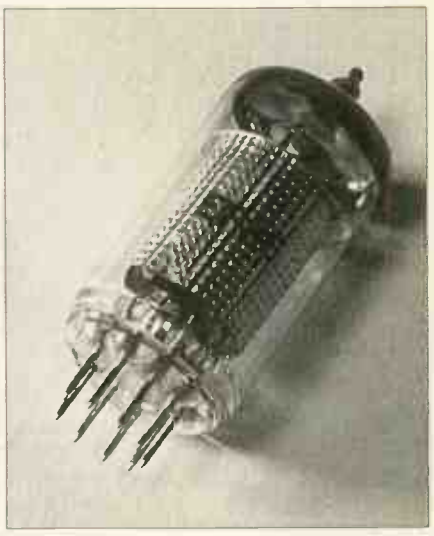
There are military versions which are ruggedised, ultra reliable and of course ultra expensive. The 5691 is the missile silo/Cape Kennedy version and is regarded as the best example. Used in a lot of older American equipment the 6SL7 has a warm but very clear sound. The later versions have a different presentation to the older types as with the 6SN7. Modern 6SL7 users include Cary and AudioNote.

Equivalents:
5691 - Mil, 6SU7 - matched sections for differential use and 12SL7 - 12.6V heater.

Characteristics:
μ=70, gm=1.6mA/V, ra=44k
at Va=250V, Ia=2.3mA, Vg=-2V



EF86



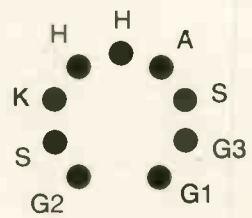
The EF86 is a low noise pentode on a B9A base. It is intended for audio and designed with internal bracing to eliminate microphony, and a helical heater/internal screen to prevent hum. The pins are arranged to minimise leakage from the anode and heater to the input grid.

Generally pentodes generate more noise than triodes because of the partitioning of current between the anode and screen grid. The EF86 has a special internal structure to minimise this problem, allowing high gain and low noise in a single valve. The gain available from a single EF86 will usually be in the 100 to 200 range, though going for the 200 mark may present linearity and frequency response problems.

The main use of this valve will be in the front ends of both preamps and power amps. There are some mega versions of the EF86, namely the Telefunken EF804S and GEC Z729/CV4085 both of which are expensive. The EF86 was used as the input stage of many Mullard and GEC circuits, our K588I also uses one.

Equivalents:
6267 - USA, 6F22 - Mazda, Z729 - GEC and EF83. There are two similar valves, the 6BS7 and 6BR7 based on the 6J7, an octal pentode. These however have different pinouts and one has a top-cap.

Characteristics:
gm=1.85mA/V, ra=2.5M
at Va=250V, Vg2=140V, Ia=3mA,
Ig2=0.55mA, Vg1=-2V



Audio Note

AUDIO NOTE AUDIO COMPONENTS PARTS & PRICELIST.

The increase in interest in all things single-ended, especially the triode non-feedback variety, is now so great that even the mainstream valve manufacturers are about to follow suit, so if you are looking for a single-ended product beware of the false prophet, who speaks of things he did not believe in, until it becomes financially expedient or downright necessary to have a single-ended amplifier in the program. So whether you are building a single-ended amplifier yourself, or looking to buy a manufactured single-ended product, please remember that it was AUDIO NOTE, who, in the face of the usual industry hype about continual "progress", brought this technology to the attention of the press, public and general audio industry alike, not because it would lend a quick buck to the purse, but because we firmly believe that it is a superior way of amplifying any music signal, and therefore deserves to be resurrected as the preferred technology for anyone who wants the genuine aesthetics and beauty of real music reproduced in their home.

Now that we stand on the boundry of this, the brave "new" world of 1920's circuitry, we note with interest the number of manufacturers who have manufactured valve amplifiers for many years, but who only now have "discovered" the value of the single-ended stage, and who in the past have been the strongest proponents of the high power "high quality" valve amplifier, watch them, as they now, for commercial gain embrace the world of high loudspeaker efficiency and single-ended triode amplification and then draw your own conclusions about their sincerity and competence in overall knowledge of the technology of Audio. AUDIO NOTE were first and remains the last word in sonic quality if you appreciate music properly reproduced.

To enhance your ability to design and manufacture your own special version of any of the single-ended circuits being discussed, whether old or new, we will continue to expand on what is already the most extensive range of ultra high quality components that the discerning "do-it-yourself" valve amplifier enthusiast can use to construct any single-ended or (shame on you!) push pull amplifier, whether triode or pentode. All of these parts are used in various models of the manufactured line of the AUDIO NOTE amplifiers. These components include mostly specially made items like ceramic valve bases with either silver or gold plated pins, paper in oil aluminium foil signal capacitors, copper & silver foil signal capacitors, Black Gate graphite electrolytic capacitors, acid/corrosive-free silver solder, copper and silver wired audio output transformers, non-magnetic tantalum resistors, non-magnetic RCA and speaker terminals, valves and many other useful bits and pieces for upgrading old or constructing new valve amplifiers.

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We accept VISA, Mastercard, Access, Diners, and Amex, to pay this way, we will need your address, card no. with start and expiry dates, you can also pay by bankers draft. Euro cheque or cheques drawn on a UK bank account. Please note that there is a minimum charge on credit card transactions of £20.00.

Delivery is normally about 14 days from receipt of cleared funds, but please allow up to 60 days for some items, if not stock at the time or order.

If any of you reading this have possession of any books which contain information relevant to the subject of Audio Design and which would be useful to share with others, please let us know either by fax or telephone, there is an award of £20.00 (payable in valves or other bits, post free) to anybody who sends us a book which contains useful information about valve amplifier design or theory.

CIRCUITS, VALVE DATA & BASIC TECHNICAL INFORMATION.

If you would like some suggestions which to base a future project around, then we shall be happy to provide you with a circuit pack containing good circuits like ONGAKU, KEGON/KASSAI, NEIRO, GAKU-ON plus several other power amplifier circuits and the M7 Tube pre-amplifier, which is the best pre-amplifier circuit we have come across. Just send a stamped self addressed A4-size envelope, together with 5.00 pounds in small denomination UK stamps, or if you live outside the UK, US $15.00 in $ bills will do, please do not send Bankers Drafts in US$, International Response Coupons or International money orders, as they cost more to cash than their value.

We can also supply a set of data sheets for the most commonly used valves, ECC82, ECC83/6922, 12AY7/6072A 7025/12AX7WA/ECC83, 6SN7, 300B, 211/VT4C, 845, EL34/6CA7, 2A3, 6X4, 5U4G, GZ34/5AR4, EL84/6BQ5, 6V6GT, 6L6G, 5881/6L6WGC/KT66. Again send a stamped self addressed A4 envelope together with £4.00 in small denomination stamps or if outside the UK another US$ 15.00 will suffice.

Since nothing really exists which gives a reasonable background to the subject of valve amplifier circuit design, Guy Adams and I have written and assembled a number of articles and extracts from old books which give some background to the subject, do not expect to become an instant expert, but it will serve as a useful reference, for the beginner as well as the more advanced, we have expanded this info-pack to include even more useful information, so if you have already bought the old pack, just send £2.00 or US$ 5.00. For the full pack a small charge is required, this time £7.00, in small denomination stamps with a stamped self addressed envelope, or outside the UK, please send US$ 25.00.

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It is not every day that you can announce the arrival of a new triode, this courageous endeavour is designed and made in the Czech Republic by a brilliant young engineer, Alesa Vaic, the VV30B is compatible with the 300B, but in circuits designed specially for it will yield 30 - 50% higher power! As can be expected the VV30B will not be cheap, at probably £300.00 each plus Vat. Life expectancy is minimum 10 hours at maximum power, guaranteed for 2 hours or 1 year. Full specifications available on request, please enclose a stamped addressed envelope.

SOUND PRACTICE

I am pleased to announce that Issue 7 is now in, Joe Roberts is definitely getting into the swing of things now, with almost one issue per 3 months, not bad for a one-man-show! Issue 7 contains some real gems, like, The Promise of Horns, Mass Suicide!, Good Old Quads, On The Frontier, the VV30B, Suggested 300B SE Circuits, Junk Box Cholkes and many other gems for audio amateurs, cheapskates and other such junkies! A good read! As usual £5.00 plus a stamped self addressed envelope will suffice.

POSITIVE FEEDBACK.

This is one type of feedback that we are not entirely against! Positive Feedback is the club magazine for the Oregon Triode Society with aspirations towards greatness, not unlike the great underground magazines of the 1970's. It is a quarterly publication of zany, controversial commentary, by in-house writers, members, as well as various industry doyens on the subjects of music, audio, technology and the quest for musical satisfaction. I for one, think it is an excellent read and provides a good alternative view to most of the established press, which tends to view the world in the context of what new product is available right now, without giving much perspective backwards. Positive Feedback's latest issue is just off the press and is available at £6.00 per issue.

COMPLETE KITS.

At the current moment the following kits are under development, and should be available during 1994, the sequence of introduction may be different from the number, we have the KIT THREE available for shipment now.

KIT TWO 6550 single-ended, 15 watts Class A, on a stereo chassis, expected cost £ 599.00 incl. Vat. Delivery Oct. 1994.
KIT THREE 300B parallel single-ended, mono chassis, 16/17 watts Class A, cost £1,450.00 incl Vat.
KIT FOUR 6V6 push pull, 10 watts Class A, stereo chassis, expected cost £179.00 incl. Vat, delivery Dec 1994.
KIT FIVE 211 single-ended, 15 watts Class A, mono chassis, expected cost £2,250.00 incl. Vat, delivery Jan/Feb 1995. We hope!
KIT SIX 300B single-ended, 7/8 watts Class A, stereo chassis, expected cost £499.00 including valves and Vat, this will be our "entrypoint" or "gateway" to single-ended triode bliss or rock and roll, if you prefer. Available November/December 1994.

If you are in doubt as to whether a kit project is suitable for you, we suggest you spend £10.00 on buying the instructions for the KIT ONE, single 300B amplifier, this will give you a good idea whether a kit project is for you, if you decide to buy a kit then the £10.00 will be refunded against the cost of the kit. As the other kits become available their instruction manuals will also be available at £10.00 each. We have the Kit One instructions available in English and Italian.

AUDIO NOTE OUTPUT TRANSFORMERS.

We are in the process of building up four separate ranges of Audio Note output transformers, in order to offer the best possible outputs at different price points, they will fall into four categories.

A) Economy range, where the price/quality relationship is carefully calculated to ensure audio quality in a compact package. Initially we will only be offering 3 single-ended output transformers in this range, push-pull outputs are under development, but do not expect to see any on this side of Christmas.
B) Mid-price range, which are the output transformers already on offer, we have made a couple of additions to this range, since the last list.
C) High Quality range, this will be a range of double C-core outputs for single-ended circuits exclusively, no push-pull outputs will be offered, unless demand requires it. Again 3 offerings initially.
D) Super High Quality range, all-silver wired outputs of the best possibly quality, when I say best possible, I do not mean to say that these silver outputs will be as good as the silver output transformers handwound by Audio Note in Japan, they won't, but then again they do not carry the price tag either!

The quality criteria for group A are 20Hz to 20KHz -1 to 1.5dB, they are IE cored with silicon steel laminations and are supplied with frames and solder tags, which will allow good audio quality at the cost. The main cost saving being the use of a smaller c ore, specified to the exact power level required, rather than overspecifying by 50 or 100%, as we do on Group B, the winding quality and copper wire is the same.

Group B are typically 20Hz to 40KHz minus 1.5dB, IE cored with high quality silicon steel laminations, wound with oxygen-free copper wire and supplied with either bell-ends or frames always with flying leads.

Group C are typically 12Hz to 70KHz minus 1.5dB, stripwound double C-cores with the best available silicon steel lamination, these outputs will compare more than favourably with the best available types from days gone by and from other current sources like Partridge, Tango, Tamura etc.

Group D use Audio Note silver wire, need I say more??

SPECIFICATIONS.

PP = Push-Pull. PPP = Parallel Push-Pull. SE = Single-ended. PSE = Single-ended Parallel. UL signifies 43% ultralinear taps, as a general rule we do not condone the use of UL-taps, as we consider these detriment to sound quality. * * Dynaco replacement.

All primary impedances are calculated for Class A operation, with the main consideration given to maximum dynamic power transfer ability and minimum distortion, rather than meaningless steady state sine- or squarewave conditions.

All our single-ended output transformers are airgapped, and the maximum standing current allowed before saturation is shown in column 5.

All our output transformers are tested to insulation levels of minimum 3, volts, all 211/845 outputs are insulated to 5Kv flash, every transformer is tested to this level of insulation.

We generally over specify our transformers by 50% power in Push-Pull (which means that a transformer stated as 25 watts will allow about 35-38 watt peaks, our single-ended outputs are generally over specified by 100%, which means that they will instantaneously allow peaks of double the given maximum power through undistorted, this is necessary due to the better clipping behaviour of the single-ended stage.

We do not give any further technical information on our output transformers, as we do not wish to take part in technical competitions, our products are designed to criteria which are and will be understood once they are listened to!

In addition to the output transformers offered below, we offer a design service, where we can supply almost any requirement for wideband transformers, whether for microphones, moving coil cartridges, line input, phase splitter, interstages, driver or power outpu, we design and manufacture prototypes in-house, the cost for the paper design is £200.00, prototype cost is calculated on a per case basis. We can also produce production quantities.

Sizes are given as Width/Height/Depth, where depth is the depth of the coil itself and width is the length of the core.

AUDIO NOTE CHOKES & INDUCTORS

Value	Size	Price Ex. UK Vat
0.5H/400mA		18.00
3H/100mA		14.00
3H/250mA for ONGAKU/Cu		24.00
5H/150mA		21.00
5H/400mA		31.00
10H/125mA	63x74x76mm	26.00
10H/200mA	98x65x83mm	33.00
20H/50mA	68x56x58mm	24.00

Other values can be supplied to order, ask for a quote.

AUDIO NOTE PAPER IN OIL COPPER & SILVER FOIL SIGNAL CAPACITORS.

We are currently developing two further ranges of paper in oil capacitors where instead of using aluminium foil as in the above caps, in the first range we use oxygen-free copper foil with 99.99% pure solid silver lead out wires, these copper foil paper signal capacitors are considerably better than the standard offerings. Secondly to "bridge" the price - quality gap between the standard paper/oil caps and the Japanese handmade silver foil signals capacitors, we will be offering out own 99.99% pure silver foil signal capacitors, which are pretty staggering in quality, even if I have to say so myself (as I am the only one to have heard the samples so far) the silver foil caps will also have solid silver lead-out wires, To start with there will be a few value/voltages of each available.

AUDIO NOTE COPPER FOIL PAPER IN OIL CAPACITORS.

Value	DC Voltage	Size	Price ex UK Vat
0.047mF	630 volt	28x16mm	12.35
0.1mF	630 volt	33x22mm	14.65
0.15mF	630 volt	35x22mm	16.45
0.22mF	630 volt	56x25mm	19.75
0.47mF	630 volt	56x38mm	27.45
1mF	630 volt	65x44mm	46.85

AUDIO NOTE SILVER FOIL PAPER IN OIL CAPACITORS.

0.047mF	630 volt	14x46mm	41.00
0.1mF	630 volt	16x46mm	74.00
0.15mmF	630 volt	22x36mm	101.00
0.22mF	630 volts	19x46mm	135.00
0.47mF	630 volt	25x46mm	196.00
1mF	630 volt	38x46mm	486.00

AUDIO NOTE SILVER FOIL SIGNAL CAPACITORS

Best signal capacitors available, quality really speaks for itself, used in amplifiers like ONGAKU, KEGON GAKU-ON and M7 Tube Silver, hand-made in very limited quantities at Audio Note's facility in aTokyo, Japan. These capacitors use a fine mylar dielectric, and are manufactured using considerable tension on the foil and dialectric to give the best possible contact and the least scope for internal resonance.

Value	DC Voltage	Price ex UK Vat
0.01mF	500 volt	177.00
0.02mF	500 volt	211.75
0.05mF	500 volt	346.75
0.1mF	500 volt	645.75
0.2mF	500 volt	995.75

AUDIO NOTE CERAMIC STAND-OFFS.

In most hardwired valve amplifiers its is frequently difficult to get the HT and heater rails properly suspended and separated, safely and neatly from the chassis, this especially applies when building amplifiers using the really high voltage, directly heated triodes like 211, VT4-C, 845, 849, 304TL, DA100 etc. When planning designs like this, it is important to incorporate a suitable layout from the start, and the AUDIO NOTE stand-offs should be more or less mandatory in that context. They are screw-in type with staatite insulator and either a wrap-round turned "head" on the single way version or separated solder slots on the multi-way versions.

AUDIO NOTE CERAMIC STAND-OFFS.

Type No.	Number of Tags	Height/Length	Solder Connection	Chassis Fitting	Price Ex UK VAT
AN-421	1	25.5mm	Wrap-round	Screw-in bolt	1.41
AN-422	1	17.4mm	Wrap-around	Screw-in bolt	1.41
AN-423	1	22.6mm	Solder slot	Screw-in	1.41
AN-452	2	Adjustable 17mm	Solder slots	Double bolt screw-in	2.42
AN-453	3	Adjustable 24mm	Solder Slots	Dual bolt Screw-in	3.05
AN-455	5	Adjustable 32mm	Solder slots	Dual bolt screw-in	4.04
AN-458	8	Adjustable 58mm	Solder slots	Dual bolt screw-in	5.75
AN-460	10	Adjustable 72mm	Solder slots	Dual bolt screw-in	7.31
An-476	6	25mm/45mm	Solder slots	Screw-in bolts	5.35
AN-479	9	25mm/66mm	Solder slots	Screw-in bolts	7.53

AUDIO NOTE AUDIO QUALITY OUTPUT TRANSFORMERS.

Group A
Single-ended Outputs.

Suggested Valve	Max Cl. A Power	Prim-Sec ing	Size/Weight	Max Current	Price Ex. UK VAT
300B/2A3/6B4G	15 watts	2K5 - 4/8 Ohms	80X67X68mm	90mASE	44.50
801A/VT62/845	20 watts	6K - 4/8 Ohms		100mA SE	73.50
300B/2A3/6B4G	20 watts	1K25 - 4/8 Ohms		150mA PSE	84.50
Single-ended Circuits					
Group B					
EL84/ECL86/6V6	20 watts	2K5 - 4/8 Ohms	117x98x90mm	110mA PSE	87.00
300B/2A3/6B4G	25 watts	2K5 - 4/8 Ohms	117x98x90mm	90mA SE	
EL34/6CA7	30 watts	1K5 - 4/8 Ohms	115x98x95mm	180mA PSE	113.00
2A3/6B4G	30 watts	1K25 - 4/8 Ohms	98x82x95	130mA PSE	97.00
5881/KT66	30 watts	2K1 - 4/8 Ohms	115x98x95	140mA PSE	106.00
211/VT4C	30 watts	2k1 - 4/8 Ohms	117x98x100mm	150mA SE	114.00
211/VT4C/845	50 watts	10K - 4/8 OHms	112x134x150mm	150mAS SE	124.00
300B	50 watts	1K25 - 4/8 Ohms	135x115x125mm	180mAPSE	151.00
845	50 watts	2K5 4/8 Ohms	137x114x130m	180mA PSE	172.00
211/VT4C	75 watts	5K - 4/8 Ohms	137x115x145mm	240mA PSE	237.00
EL34/6550/KT88	20 watts	3K - 4/8 Ohms	117x98x92mm	130mA SE	104.00
300B/2A3/6B4G	25 watts	2K5 - 4/8/16 Ohms	117x98x90mm	90mA SE	102.50
6L6G	30 watts	3K - 4/8 Ohms	115x98x95mm	140mA SE	107.00
NEW SE PRODUCT					
6550/KT88	60 watts	2K3 - 4/8 Ohms		110mAPSE	123.00
Group B					
Push-Pull Circuits					
EL84/ECL86/6V6	15 watts	8K - 4/8 Ohms	80x67x68mm	PP	42.00
EL34/6L6G/5881	25 watts	6K - 4/8 Ohms	88x73x80mm	PP	59.00
2A3/6B4G/300B	30 watts	5K - 4/8 Ohms	88x75x80mm	PP	63.00
KT88/6550	50 watts	6K6 - 4/8 Ohms	108x91x90mm	PP	73.00
EL34/KT66/5881845	50 watts	3K - 4/8 Ohms	98x82x83mm	PPP	74.00
KT88/6550	60 watts	4K3 - 4/8/16 Ohms	125x100x113mm	ULPP	110.00
KT88/6550	100 watts	2K2 - 4/8 Ohms	150x147x118mm	ULPP/PPP	134.00
Group C					
Single-ended only					
300B/2A3/6B4G	25 watts	2k5 - 4/8/16 Ohms		90mA SE	360.00
211/VT4-C/845	50 watts	10K - 4/8/16 Ohms	165x148x140mm	150 mA SE	410.00
300B	50 watts	1K25 - 4/8/16 OHMS	165X110X138MM	180MA PSE	396.00
Group D					
Pure Silver Wired Outputs.					
300B/2A3/6B4G	25 watts	2K5 - 4/8 Ohms	117x98x90mm	90mA SE	1,645.00
211/VT4-C/845	50 watts	10K - 4/8 Ohms	112x134x150m	150mA SE	1,975.00

The Audio Note silver wired outputs listed here are designed and made in the UK, we can supply the AUDIO NOTE Japan manufactured outputs for the ONGAKU or the KEGON, but they are exceptionally expensive as you would expect for items that take upwards from 100 hours each to make, for example an output transformer for an ONGAKU costs£16,500.00.

AUDIO NOTE MAINS TRANSFORMERS.

This range relates to our finished products, mains transformers are notoriously difficult items to offer as the number of permutations of HT and HEater voltages are almost endless. We have added mains transformers for making replicas of the KASSAI and ONGAKU, as there has been considerable call for these, likewise we are preparing mains transformers for the WE91 described in Sound PrActices issue 1, we shall continue to expand the range as opportunities and our experience with your requirements improve.

Primary Voltages	Secondary HT Windings	Secondary Heater Windings	Price EX UK VAT
0v/100v/110v/120v	0v - 230v at 350mA	0v - 12.6v at 1 AMP	34.00
0v/220v/230v/240v		3.15v-0v-3.15v at 4 Amp	
\120v /110v/100v/0v	0v- -230v at 0.4 Amp	0v - 12.6v at 1 A	41.00
0v/100v/110v/120v		3.15v - 3.15v at 4 Amp	
120v/110v/100v/0v	300v - 0v - 300v at 60mA	12.6v - 0v at 1.5A	46.00
100v/110v/120v		6.3v - 0v at 600mA for M7 Tube Pre-amp	
with 50H choke input filter			
0v/100v/110v/120v	0v - 290v at 40mA	12.6v0v at 1.5A	26.00
0v/100v/110v/120v		0v - 6.3v at 300mA	
0v/100v/110v/120v	310v - 244v-0v-244v-310v at 3.15v at 4.5 Amp	72.50	
0v/100v/110v/120v	320mA	12.6v at 1.5Amp	
120v/110v/100v/0v	0v-920v at 160mA	0 - 10v at 4Amp, 0v-6.3v at	98.00
0v/100v/110v/120v	150v - 150v at 50mA	1.5A, 0v - 5v at 2.5A	
120v/110v/100v/0v	390v-0v-390v at 200m a	3.15v t 1.2 amp, 7 amp	86.70
0v/100v/110v/120v	170v at50mA	at 3A, 7v at 3A, 5v at 2A	
120v/110v/100v/0v	425 v-0v-425 at 220mA	3.15v-0v-3.15v at 2.5A	95.60
100v/110v/120v		7.0v-0v at 2A 7.0v-0v at 2A	for KIT ONE & KIT
		5.0v-0v at 3A	THREE MONO channel
		3.15v-0v-3.15v at 750mA	
120v/110v/100v/0v	390v-0v-390v at 200mA	170-0v at 50mA, 7.0v - 0v at	107.00
100v/110v/120v		3A, 7.0 - 0v at 3A, 5v - 0v at	
		2A,	For KASSAI replica
		3.15v-0v-3.15v at 1.2A	
120v/110v/100v/0v	380v - 0v 380v at 200mA	150v-0v at 150mA, 10v-0v	137.00
100v/110v/120v		3.25A, 10v-0v at 3.25A,	
		5v - 0v at 3A, 5v - 0v at 3A,	For ONGAKU replica
		5v - 0v at 3A, 5v - 0-v at 3A	
		6.3v - 0 6.3v at 1.25A	

We also have a mains tranformer/choke kit for the WE91 power amplifier as shown in Sound Practices, this combined with our single-ended output transformers with 3K Ohm primary impedance, will make a very fine replica of this classic amplifier total cost £420.40 per set.

We now also have the facility to make any mains transformer to your specification, as long as you order minimum 2 pcs, they can be supplied with solder tags, flying leads, frames or bell-ends. Ask for a quote.

On a more general nor, it is important to understand the specialised nature of the design and manufacture of transformers for audio equipment, in most industrial applications the main criteria are cost, weight or longevity, an audio mains transformer also have to have good regulation under load, must run cool, and generate no mechanical noise orvibration, produce no excessive stray magnetic fields etc. etc., apretty tall order, when one considers that the cost also has to be reasonable. So no matter where you order your mains transformer remember that it should conform to the above criteria, so specify this when youorder. As a general rule we do not recommend ported transformers, as tests have shown these to sound less clear, than unported equivalent!

AUDIO NOTE PAPER IN OIL RESERVOIR CAPACITORS.

Mainly for use in inductor power supplies, but have other uses.

Value	DC Voltage	Size	Price Ex UK Vat
2mF	400 volt	30x40x55mm	26.75
2mF	630 volt	35x45x72mm	33.65
2mF	1000 volt	45x45x72mm	41.75
2mF	1600 volt	50x70x72mm	45.95
4mF	1000 volt	45x45x120mm	49.95
4mF	2500 volt	70x70x120mm	265.75
10mF	1000 volt	70x100x100mm	96.75
12mF	1000 volt	70x100x120mm	109.95
12mF	1600 volt	100x100x120mm	136.75
12mF	2000 volt	100x100x220mm	159.75

AUDIO NOTE PRECISION CARBONFILM RESISTORS

In addition to the non-magnetic tantalum resistors, we are going to stock a range of precision gold-palted carbon film resistors, in many cases the carbon film resistor is preferable if you are building an amplifier based on an old circuit, like for example the WE91 or another circuit of a similiar vintage. We shall be stocking values suitable for projects like the We91 in 1/2 and 1 watt values, these resistors are made especially for ud by a major manufacturer.

They cost for the 1/2 £3.30 each 1 watt £4.85 each 2 watt £6.89 each

AUDIO NOTE PAPER IN OIL SIGNAL CAPACITORS

These hand-made signal capacitors are sonically superior to any of the plastic or other paper types we have come across. If you have never experienced the differences that a really good paper/foil capacitor can make in a valve amplifier, then

you really should try. Our specially made paper/oil caps has a fine, colour,lack of harshness and evenness of dynamic behaviour across the frequency range, which is guranteed to brighten up your day!! Recommended as replacements in old and new amplifiers alike (and even in the odd transistor amplifier), and essential for DIY projects. In line with environmental standards, all AUDIO NOTE paper in oil capacitors contain non-toxic, biodegradable vegetable oil, the paper is a specially treated and impregnated by a method that enhances longevity and sound quality, to ensure optimum performance all round. As you will see, we are slowly incorporating solid 99.9% pure silver leadouts on this range of paper in oil capacitors as well, in common with coppre and silver foil types. There are several new values available, including the 2.2mF/50 volt caps made fro speaker crossovers and the 0.56mF/200 volt suitable for solid state amps.

Value	DC Voltage	Size	Price ex UK
Vat			
2..2mF	50 volt	21x9mm	11.65
0.56mF	200 volt	25x36mm	4.95
0.015mF	400 volt	21x9mm	2.85
0.022mF	400volt silver leadout wired	35x10mm	4.45
0.047mF	400 volt	32x11mm	4.10
0.082mF	400 volt	33x14mm	4.25
0.12mF	400 volt	33x14mm	4.75
0.15mF	400 vol silver leadout wires	34x16mm	6.65
0.18mF	400 volt	32x16mm	5.15
0.22mF	400 volt	35x18mm	5.85
0.33mF	400 volt	43x18mm	6.75
0.14mF	400 volt	70x24mm	14.95
0.0015mF	630 volt	17x9mm	2.85
0.022mF	630 volt silver leadout wires	20x10mm	4.45
0.033mF	630 volt	32x11mm	3.75
0.056mF	630 volt	33x15mm	4.25
0.058mF	630 volt	33x14mm	4.25
0.060mF	630 volt	33x14mm	4.25
0.065mF	630 volt	33x16mm	4.25
0.068mF	630 volt	33x16mm	4.25
0.071mF	630 volt	33x16mm	4.35
0.072mF	630 volt	33x16mm	4.35
0.073mF	630 volt	33x16mm	4.35
0.074mF	630 volt	33x16mm	4.35
0.075mF	630 volt	33x16mm	4.35
0.078mF	630 volt	33x16mm	4.35
0.082mF	630 volt	33x16mm	4.55
0.1mF	630 volts	34x16mm	6.65
0.18mF	630 volt	43x18mm	5.45
0.22mF	630 volt silver leadout wires	52x19mm	7.25
0.27mF	630 volts	53x22mm	6.15
0.33mF	630 volts	52x22mm	7.25
0.36mF	630 volts	43x25mm	7.45
0.39mF	630 volt	52x26mm	7.95
0.47mF	630 volt silver leadout wires	52x26mm	9.85
0.22mF	1000 volt	56x26mm	6.95
0.39mF	1000 volt	61x26mm	11.65
1.2mF	1000 volt	61x26mm	16.75
0.22mF	1600 volt	60x26mm	9.65
0.22mF	2000 volt	70x29mm	11.55

All AUDIO NOTE paper in oil signal capacitors are axial type. We are preparing a range of very small piccolarad value paper in oil capacitors at the moment in addition to the above. The range of AUDIO NOTE paper in oil signal capacitors is steadily expanding, so ask for values that you do not see.

AUDIO NOTE ACID & CHLORIDE FREE SILVER SOLDER.

The best solder we have been able to find, does not contaminate the junction, which over time increases junction resistance. Used in all our amplifiers from OTO to the GAKU-ON.

Weight/Measure	Price Ex UK Vat
50 grammes or about 9 meter 1mm diameter	19.95
1 kilo roll of 1mm diameter	210.65

AUDIO NOTE CABLES & WIRES.

We are proud to offer the AUDIO NOTE range of high high quality copper and silvercoax, speaker and wiring cables, which, depending on the overall price of the project, will do justice to any hi—fi system, regardless of price.

SOLID 99.99% PURE AUDIO NOTE SILVER WIRE

Gauge	Insulation Material	Price per Meter Ex. UK
Vat		
0.05mm	polyurethane	16.75
0.2mm	Polyurethane	22.75
0.35mm	MIL	24.95
0.6mm	MIL	27.85
0.8mm	MIL	31.75
1mm	MIL	36.75

The above solid silver wires are suitable for inductors for speaker crossovers, both active and passive or for internal wiring in tonearms, amplifiers etc.

AUDIO NOTE COAX INTERCONNECT CABLES.

Type/Colour code	Construction	Price per Stereo Meter Ex UK
Vat		
An-A yellow	symmetrical 6N copper litz coax	15.32
AN-C red	symmetrical OFHC copper litz coax	29.79
AN-S dark grey with yellow stripe	symmetrical 99.99% silver litz coax	84.25
AN-V silver grey with yellow stripe	symmetrical	382.98

It is recommended to use the internal twin silver wires in the AUDIO NOTE coax cables as internal wiring cable, this is what we so in amplifiers like the ONGAKU, M7 Tube etc.

AUDIO NOTE SPEAKER & WIRING CABLES.

Type/Colour code	Construction	Price per Stereo Meter Ex UK
Vat		
AN-D green	single core 6N copper speaker wiring	6.85
AN-B blue white writing	double strand, screened 6N speaker wire	12.34
AN-L blue black writing	double strand, screened 6N litz copper speaker wire	25.11
AN-SP silver	single core 15 strand 99.99% litz silver speaker wire	106.38
An-SPx silver	single core 20 strand 99.99% litz silver speaker wire	382.98

PTFE INSULATED SILVERPLATED COPPER WIRES.

We can also provide less expensive wiring wired for hand wiring circuits, these PTFE insulated silver plated copper wires are 19 strand of 0.15mm wire and come in brown, black, blue, pink, red, green, orange, violet, white and red/white, they cost £1.60 per metre in any colour.

AUDIO NOTE HIGH QUALITY STEPPED ATTENUATORS & SWITCHES.

These hand-made attenuators and switches are manufactured by a friend of Mr Kondo of AUDIO NOTE and represent the best available volume controls and switches you can use in your pre-amplifier, the attenuator is 48 steps and with silver /rhodium plated contacts/bushes made with an array of tantalum film resistors. The switches feature silver plated contracts and self cleaning action.

Type	Value	Price Ex UK Vat.
Stereo Potentiometer/attenuator	50K Ohms	196.75
Stereo Potentiometer/Attenuator	100K Ohms	207.75
2 Channel switch	6 - way adjustable	78.75
4 Channel switch	6 - way adjustable	101.75

AUDIO NOTE SELECTED AUDIO VALVES.

Our valves are selected from the best available sources and are tested to the same stringent standards that we apply in production of our own amplifiers, they fall into two categories: standard production items and rare, mostly NOS (New Old Stock) valves which are no longer in production. We have compiled a special list of NOS items, which is available on request, beware, the valves on this list are not cheap.

Standard stock items.

Type No.	Type	Price Ex. UK
Vat		
ECC 13/12AX7WA/7025	double triode	2.95
E88CC/6922/6DJ8WA/7308	double triode	3.95
EF86/6267/Z729	pentode	2.45
ECC82/12AU7/5814a	double triode, mil spec	5.95
6SN7GT	double triode, U8X base	1.75
6SL7GT	double triode, U8X base	2.65
6SJ7	pentode	1.75
5687WA	double trode very powerful	4.55
6350WA	double triode	4.75
EL84/6BQ5	small power pentode	1.55
EL84M/6BQ5WA	small power pentode, mil spec version	4.51
6V6GT	small power pentode	2.45
6L6G	medium power pentode	2.75
5881/KT66/6L6WGC	medium power tetrode	4.51
6CA7/EL34 Fat buff'	power tetrode	8.85
EL34G	power pentode	6.45
6550/KT88	large power tetrode	12.45
6C33	powerful regulator, indirectly heated triode	24.65
6AS7/6080	strong regulator, indirectly heated triode	6.45
2A3 4-pin	directly heated small power triode	17.95
300B	directly heated power triode	57.95
VAIC WV30B	directly heated power triode	300.01
5U4G	HT-rectifier	3.25
5Y3GT	HT-rectifier	2.25
5V4GT	HT-rectifier	2.25
GZ34/5AR4	HT-rectifier	8.75
6X4	HT-rectifier, very good for pre-amplifiers, 7-pin base	2.65
6X5	HT-rectifier, for pre-amplifiers & amplifier front-ends, U8X base	2.65

Please note, our 300bs are manufactured in China by Gold Dragon/Shuguang, but ar tested in-house under real working vonditions to parameters somewhat more stringent than otherwise done. No, they do not sound quite as good as original WE 300Bs or STC 4300As, nor do they carry the same premium price, please consider the following, unless you have absolutely tons of money orhappen to have them in your attic, do not consier the original 300Bs. It is rv most cases far better to invest the money in more permanent features of his amplifier project, like better output tranformers, better signal caps or resistors or the like, valves wear out, better quality passive components last. A pair of original WE 300Bs cost at least £1,200 on a good day, think in terms of an overall price compromise, you can get some fabulous sounding passives for the difference in cost between a pair of Chinese 300Bs and the original WEs and in many cases the improvement in sound quality is greater than the WE 300Bs will contribute, and the contribution in sound is permanent, consider that when you plan your project.

RESISTORS

We endeavour to stock the entire E12 range of allthe different range of resistors that we stock, except ythe very lowest ohmic values, which are etremely costly, as a rule we do note stock below 10 Ohms or above 3M3. Whilst we always try to have every single E12 value in stock, this cannot be guaranteed, delivery, especially on the Holcos and tantalum film resistors can be very long indeed, however, since most are used in our production or finished products, there will generally be stock available within 4 weeks.

Beyschlag.

We offer three levels of resistor quality, all are 1%, starting with Beyschlag metal film which are slightly magnetic (as are the vast majority of other makes of metal film resistors) but nonetheless very good sounding, as used in all our UK-mase amplifiers, up to and including quality Level 3 ,the MEISNUP3/P4, 300B no-feedback triode amplifiers.

Beyschlag 1 watt, 1% resistors up to 500MOhm, £0.11, above 500KOhm £0.13 each.

Holco.

Better sound quality can be achieved with the H2, 1 watt, 1% non-magnetic resistors, which we regard as the best 'industrial grade' metal film essistors available. They have one small drawback, as they are quite fragile, andrequire careful handling, do not bend the legs tooclose to the body, they may become noisey.

HOLCO resistors type H2 50PPM cost, £3.06 each from 1RO to 5RO, £0.89 each from 5R1 to 19R9, £0.36 each from 20 Ohm to 230K Ohm, £0.41 each from 231K Ohm tp 1m Ohm, £1.02 each from 1M1 to 2M0, £1.24 each from 2M1 to 4M0 and £2.21 each from 4M1 to 5M0.

AUDIO NOTE HIGH QULAITY CERAMIC VALVE BASES.

All of our valve bases are of the highest possible quality, made from steatite and using hte best metal parts from alloys which retain their spring tension around the valve pin for longer. They recommended as upgrades to most valve amplifiers and should be an essential part of any DIY project.

Type	Mounting	Plating	Price ex UK
Vat			
4-pin UX4 for 300B/2A3/801A	Chassis	Gold	8.25
4-pin UX4 for 300B/2A3/801A	Chassis	Nickel	7.25
4-pin UX4 WE-type for 300B/2A3/801A	Chassis	Silver	14.75
4-pin UX4 WE-type with bayonet mounting	Chassis	Silver	48.95
4-pin Jumbo 4 for 2111/VT4C/845	Chassis with bayonet	silver/chrome	159.95
5-pin UY5 for 807	Chassis	Gold	9.75
7-pin B7 for 6X4, 0A2	PCB	Silver	6.15
7-pin B7 for 6X4, 0A2	PCB	Gold	7.85
7-pin B7for 6X4,0A2	Chassis from above	Silver	6.75
7-pin B7 for 6X4 0A2	Chassis from above	Gold	7.958
-pin U8X for EL34, 6550, 5U4G, GZ34, 6L6G,etc.	Chassis	Silver	5.65
8-pin U8Xfor EL34, 6550, 5U4G, GZ34, 6L6G, etc.	Chassis	Gold	8.65
9-pin B9 for ECC88, 5687, 6350 etc.	EC8	Silver	3.85
9-pin B9 for ECC83 ECC88, 5687, 6350, etc.	PCB	Gold	5.75
9-pin B9A for ECC83, ECC88, 5687,. 6360 etc etc.	Chassis from above	Silver	4.45
9-pin B9A for ECC83, ECC88, 5687, 6350, etc. etc.	Chassis from below	Silver	6.75
9-pin B9A fro ECC83, ECC88, 5687, 6350, etc. etc.	Chassis from Below	Silver	4.95
9-pin B9A fror ECC83 ECC88, 5687, 6350, etc etc.	Chassis from below	Gold	7.15
Top cap	For B07 pentode etc	Nickel	9.75

You may want to start your project with less overall cost, and for this purpose we an offer the following 'industrial -grade' ceramic valve bases.

Type	Mounting	Price Ex .UK Vat.
8-pin for EL34, 6550, KT66, 6I6G	Chassis with bracket	1.45
9-pin for ECC83, ECC88, 5687,6350	Chassis with shroud	1.85

BLACK GATE ELECTRON TRANSFER, HIGH PERFORMANCE, GRAPHITE ELECTROLYTIC CAPACITORS.

There are very few audio parts that promise guranteed improvement when replacing practically any othcrpart, but this is ehat the BLACK GATE capacitors actually do. Exchanging any electrolytic capacitor anywhere in the circuit of an amplifier or in the crossover of a speaker will generally improve sound qaulity. We ar working on some guidelines as to where, how and which types of Black Gates to use in different circuits, the first such technical guidaline is available now and is called 'Improving your CD-Player' and can be obtained by sending a stamped addressed envelope to us requesting this leaflet. All AUDIO NOTE Level 2 Signature products use Black Gate Electron Tranfer in critical signal/power supply junctions. It is very important to note that all BLACK GATE capacitors take time to charge up or stabilize, when first put in circuit, depending on the type and application this 'maturing' time can be between 100 and 300 hours. Black Gate call this the 'idling process', se enclosed list of available values. We feel ,however, that this process takes longer, hc hum!

We ar about to stock the entire range of values on the enclosed list, so a separate price list is attached to the list of Black Gate program available. Ask us to send you this list as it it is too long for an advertisement, therefore it is not included in full. Again ,as always we appreciate a stamped self addressed envelope.

Value	Voltage	BG-Type	Suggested Use	Price ex UK
Vat				
47mF	25volt	PK	Anywhere	1.65
33mF	35volt	PK	Anywhere	1.75
0.47mF	50volt	PK	Anywhere	1.05
1mF	50volt	PK	Anywhere	1.12
2.2mF	50volt	PK	Anywhere	1.23
3.3mF	50volt	PK	Anywhere	1.38
4.7mF	50volt	PK	Anywhere	1.68
10mF	50volt	PK	Anywhere	1.87
22mF	50volt	PK	Anywhere	2.68
100mF	50volt	Standard	Anywhere	5.47
100mF	100volt	Standard	Anywhere	7.75
1000mF	16volt	Standard	Anywhere	8.22
1000mF	50volt	Standard	Anywhere	24.55
220mF	16volt	Standard	Anywhere	4.35
470mF	16volt	Standard	Anywhere	6.35
2200	16volt	Standard	Anywhere	13.45
10,000mF	80volt	Standard	PSU Smoothing	234.65
4700mF	16volt	Standard	Anywhere	14.25
47mF	500volt-550v surge	SKz-TYpe	PSU filter capacitor	85.95
100mF+100mF	500volt-550v surge	SKz-TYpe	PSU filter capacitor	101.95
100mF	500volt-550v surge	SKz-TYpe	PSU filter capacitor	72.75
220mf+220mF	350volt-400 surge	SKz-Type	PSUfilter capacitor	92.65
100mF+100mF	350volt-400v surge	SKz-Type	PSU filter capacitor	75.35
22mF	350volt	VK-Type	Dcoupling or filter capacitor	18.95
150mF	350volt	VK-Type	Filter capacitor	67.85
220mF	16volt	FK-Type	Ultra low ESR version, comparable to film caps	9.95
100mF	50volt	FK-Type	As above use anywhere	43.95
2200mF	35volt	FK-Type	As above use anywhere	58.55
2200mF	63volt	FK-Type	As above use anywhere	98.85
2.2mF	50volt	C-Type	For circuits with DC potential difference	2.07
4.7mF	50volt	C-Type	For circuits with DC potential difference	3.35
1mF	50volt	N-Series	Bi-polar for use in negative feedback circuits etc.	4.95
4.7mF	50volt	N-Series	as above	5.75
10mF	50volt	N-Series	as above	6.95
47mF	50volt	N-Series	as above	13.75
100mF	50volt	N-Series	as above	18.95
6.8mF	50volt	Bi-polar	For loudspeaker crossover networks	8.95
10mF	50volt	Bi-polar	as above	10.85
22mF	50volt	Bi-polar	as above	17.45
47mF	50volt	Bi-polar	as above	27.95
0.47mF	50volt	BG-NX Type	for PSU de-coupling	12.35
220mF	6.3volt	BG-NX Type	For super low noise PSUs	11.85
100mF	16volt	BG-N Type	For super low noise PSUs	24.65
470mF	16volt	BG-N Type	as above	28.95
4700mF	35volt	BG-N Type	as above	210.45
4.7mF	50volt	BG-N Type	as above	6.65
1000mF	50volt	BG-N Type	as above	99.95
2200mF	100volt	BG-N Type	as above	423.35

In our component list you will find a listing of all available Black Gate values, together with their sizes, best usages etc.
Lastly we can supply a range of more modestly priced components, still good quality conductive plastic fill.

SHINKOH TANTALUM FILM RESISTORS.

This is definitely the best sounding resistors available, forget the VISHAY, which may be OK in high feedback transistor amplifiersm but in our opinion quite uncomplimentary to the qualities of real Audio Amplification (i.e, directly heated triode amplifiers running feedback free in single-ended Class A), this is where you will need the tantalum film resistor for the best results.

The 1/2 watt Shinkoh tantalum resistors are non-magnetic and cost £2.26 each. Some values are available in 1 watt from Shinkoh at £4.60 each, list of stocks available.

AUDIO NOTE 1 WATT TANTALUM RESISTORS.

Up tonow the tantalum film resistors have been extremely difficult to get, however, after much persuasion and against a minimum quantity guarantee from Audio Note UK, the manufacturers have agreed to wien the range of 1/2 watt and re-introduce the 1 wat range which becomes an exclusive range for AUDIO NOTE, we consider this to be a major breakthrough, since without a reasonable range of values at the 1 watt rating it is pretty difficult to get the vey best out of the best circuits. As with most hand-made specialist items, which covers most of the list, delivery can be quite long on some values, so be prepared to wait if the value is/was not in stock.

The AUDIO NOTE 1 watt 1% tantalum values are £3.70 each.

We shall now be working on getting 2 and 3 Watt tantalum resistors made available as well, and who knows perhaps we will be able to build amplifiers in a years time that all have all tantalum resistors in all parts of the circuit.

HIGH WATTAGE WIREWOUND RESISTORS.

As a new item we shall start offering a range of 2 - 15 watt wirewound resistors, we shall be starting with small range and expanding it as we go along, at the moment the following is available, all these resistors are 5% tolerance and glazed.

Wattage	Value	Tolerance	Price ex Vat
6 watt	47R	5%	0.86
6 watt	100R	5%	0.86
6 watt	470R	5%	0.86
6 watt	1K0	5%	0.86
6 watt	2K2	5%	0.86
6 watt	15K	5%	1.32
6 watt	20K	5%	1.32
9 watt	100R	5%	1.24
9 watt	1K5	5%	1.24
9 watt	1K8	5%	1.24

More values will be added over the next 6 months, together with some non-inductive wirewounds!

VOLUME CONTROLS.

Impedance	Construction	Price Ex Uk
Vat.		
100k Ohm Stereo	Frame type, PCB mounted	3.45
100K Ohm Stereo	Encapsulated type, PCBmounted	12.65

A better alternative is the KO-ON volume controls which are used in pre-amplifiers like the M7T Tube, M7 Line and in a mono version on the input on the NEIRO, KASSHI KEGON and GAKU-ON, these are very good sounding pots by any standard.

Impedance	Construction	Price Ex UK Vat
100K Ohm Stereo	Encapsulated	32.25
100K Ohm Mono	Large encapsulated	70.65
100K Ohm Stereo	Large Encapsulated, high quality	107.45

BALANCE CONTROLS.

100k Ohm	Frame type, PCB mounted	3.95
100K Ohm	Encapsulated type, PCB mounted	14.15

KO-ON also makes a very good quality 100K Ohm balance control, similar to the encapsulated 100K pot, this costs £32.25.

STANDARD TYPE SWITCHES.

This switch is adjustable 2-6 way, it has gold-played contacts and a stainless steel ball for best possible corrosion protecton and contact. price ex UK VAT£3.30.

Again, KO-ON offers a very nice quality sealed switch, 6-way 2channel at £90.65 each.

STANDARD ELECTROLYTIC CAPACITORS

Good quality standard industrial types.

Vale	Voltage	Size	Price Ex UK
Vat.			
100mF	10volt	18x6mm axial, 11x7mm radial	0.23
100mF	16volt	15x6mm axial	0.29
220mF	10volt	11x8mm radial	0.31
220mF	40volt	13x10mm radial	0.42
100mF	63volt	13x10mm radial	0.47
4700mF	16volt	38x18mm radial	0.82
2200mF	50volt	35x18mm radial, 41x16mm axial	0.87
10mF	50volt	15x10mm radial	0.56
22mF	350volt	25x12mm radial	1.25
22mF	450volt	41x16mm axial	1.89
47mF	385volt	25x21mm radial	2.16
56mF	400volt	30x21mm radial	2.37
68mF	400volt	30x22mm radial	2.68
100mF	400volt	30x25mm radial	3.26
220mF	350volt	52x30mm radial can	4.45
220mF	450volt	40x30 radial can	5.85
220mF	550volt	112x35mm radial screw terminals	27.65

RCA, BNC BANANA, PLUGS, RCA SOCKETS, SPEAKER&GROUND TERMINALS & LOUDSPEAKER SPADES.

RCA PLUGS.

Standard Gold plug	1.55
AN-C Gold Plug	3.65
AN-GP AUDIO NOTE gold plug	8.51
AN-P AUDIO NOTE Silver plug, teflon insulated, non-magnetic	25.53

RCA Sockets.

Type	Mounting	Price ex UK
Vat		
RCA socket nickel plated	Chassis mounted	0.41
RCA socket gold plated	Chassis mounted	0.65
AN-GS AUDIO NOTE non-magnetic teflon insulated socket, gold plated	Chassis mounted	3.65

BNC Plugs and Sockets

TYpe	Price ex UK Vat
Standard BNC plug	3.45
BNC Silver plated socket, chassis	2.05

Banana Plugs, Loudspeaker Cable Spades, Chassis Loudspeaker Terminals.

Type	Price Ex UK
Vat	
AUDIO NOTE Banana plug, gold plated spring loaded tension	2.45
AUDIO NOTE Loudspeaker Cable spade, silver plated, non-magnetic	4.65
AUDIO NOTE AN-ST Speaker Terminal, chassis mounts, nickel plated, red or black	1.85
AUDIO NOTE AN-ST/G Speaker Terminal, chassis mounts, fully gold plated, non-magnetic	2.75
AUDIO NOTE AN_STR Speaker Terminal, chassis mounts, fully gold plated, non-magnetic, red or blacl	4.75
Ground Terminal, chassis mounted and nickel plated	1.45

Our range of components is constantly expanding, as we find new or better suppliers, so stay in touch by reading our advertisements in Hi-Fi World and Hi-Fi News.

FERRITE RINGS

In many systems, especially ones using transitor based amplifications, there is often a problem of incoming RF mixing into feedback loop, especially from connected CD players, clamping a ferrite rings around the cable between the CD transport and the DAC or the output of the DAC or CD player and the pre-amplifier input yields surprising results.
A set of two Ferrite rings costs £8.50

AUDIO NOTE COMPLETE KITS

As mentioned earlier, we are developing a range of complete kits, to give to those of you who have the ability, but do not have the time, to develop a project from the ground, so to speak. In order to be able to offer the best possible quality-price relationship, the kits we offer will be good basic circuits, with no-frills power supplies and components, all kits have input volume control to allow use of a single source, like CD-player direct in.

KIT ONE

Based around the justly famous 300B directly heated triode, we see this kit as the introduction to real Audio Amplification, as it covers the important aspects of design necessary, Single-Ended, No-Feedback,Class A Directly Heated Triode, to become a member of this exclusive club of amplifiers.

Kit One has one 300B per channel running at 420 volts with 75mA current giving 9/10 watts of the cleanest power you will ever hear. The input stage consists of a 6SN7GT with a 5687 double triode driver stage running in SRPP. The power supply is a capacitor-choke-capacitor with a 5U4F HT rectifier, the heaters are AC heated. Component quality is similar to our Level 2 finished products, AUDIO NOTE paper in oil signal capacitors, Beyschlag 1 watt 1% metalfilm resistors, good quality electrolytics (sorry, no Black Gates!) and a simple, attractive stereo chassis in grey paintwork. Protecting cover is extra.

Price £750.00 incl. VAT which includes all valves (yes, also the 2 X 300B needed) but no postage/packing which to UK customers is £12.00. Topcover is £99.00 extra. Kit One is available now.

KIT TWO

Kit Two features a single 6550WA Sovtek tetrodes running in Single-Ended mode yielding some 17 watts of pure class A, valve rectified HT for the output stage, stereo chassis, and 6SN7GT input and 5814a/ECC82 SRPP driver stage. componentry and chassis as Kit One.
Price £599.00 incl VAT, (includes valves, but not postage/ packing, cover is extra at £99.00, Available in November 1994.

KIT THREE

Kit Three features 2 X 300b per channel running in single-ended parallel yielding 16/17 watts in pure Class A, this kit is on two mono chassis with valve rectified HT supplies, no signal feedback, it uses 6SN7GT double triode as input valve and a pair of 5687 double triodes running in SRPP as drivers.

KIT THREE is essentially a mono version of the KIT ONE with double the power, the same component choises and two chassis instead of one.

Kit Three costs £1,450 and is available now.

Write to:
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HOLLAND, please contact, de Jong Components, 2, Reggestraat, NL-5704 MT Helmond, Tel 04920 14661 Fax 14773
USA please contact Angela Instruments, 10830, Guildford Road, Suite 309, Annapolis Junction MD 20701, Tel 301 725 0451.
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	Replacement Intermediate drive wheel	19.95	2.85
	Replacement 301 control knobs On-Off/Speed select	pair 20.25	2.55
	Replacement 301 suppressor unit	5.65	2.45
	Replacement 301 motor pulley (-2%), (-1%), (Std), (+1%)	each 12.85	2.25
	Replacement 301 Chrome plated mounting bolts	set 4.75	2.85
	Recommended Lubrication set - early 301 or 301/401 (specify)	5.20	2.25
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	Idler wheel (lock-nut or clip fixing)	19.95	2.85
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	Drive belt	10.25	1.85
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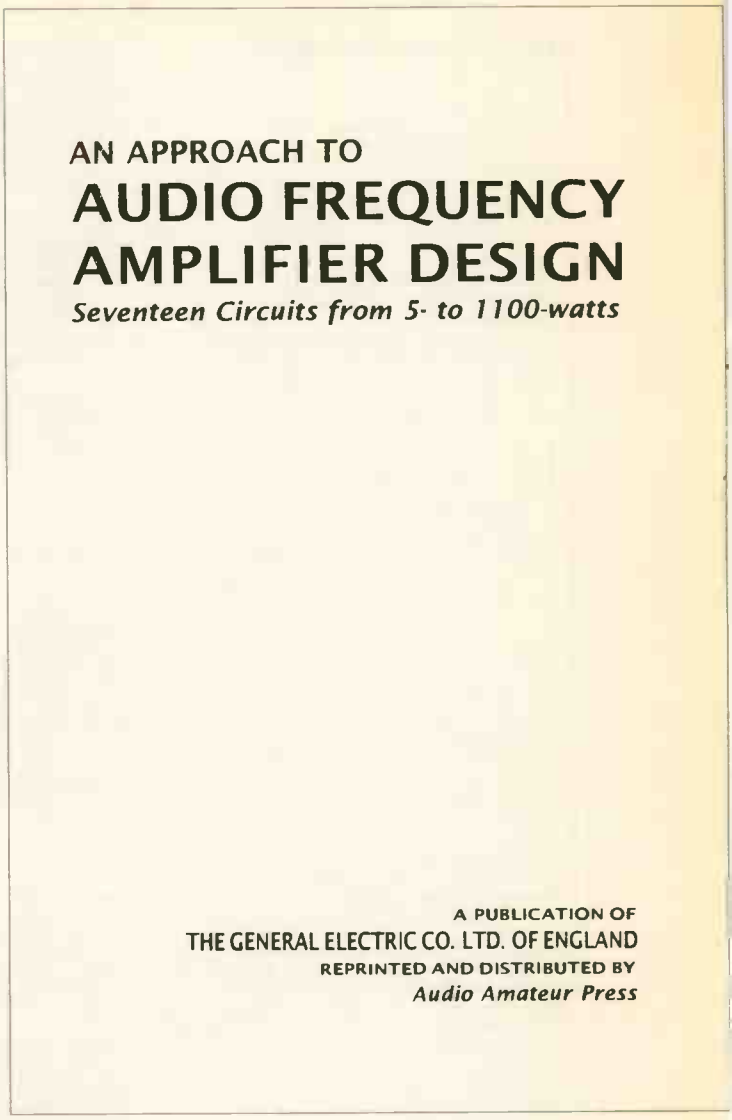
An Approach to Audio Frequency Amplifier Design.

A vintage publication of the General Electric Co., reviewed by Noel Keywood.



It was an anonymous looking little book, with no dust cover and apparently no title, like so many in the box on the floor. Ferreting around has its compensations though. Along the spine, old gold lettering that had dulled through the years read: An Approach to Audio Frequency Amplifier Design - GEC. Inside lay a cornucopia of valve amplifier circuits, ranging from 5watts to 1100watts, no less. The last is a monster, designed for P.A. and distribution work (Rediffusion used them) running with a 2.5kV H.T. line feeding enormous V1505 output triodes. And no, we will not be making this into a kit!

You can, however, now drool over the circuit, should you be of such an inclination, because the book is being reprinted by the Audio Amateur Press, of New Hampshire, U.S.A., the same people responsible for Glass Audio, Speaker Builder and other specialist audio publications. It comes as a softback that retails at £19.95. If you want one you don't have to rise at the crack of dawn on Sunday to get to a swap-meet before the vultures swoop, since we are making it available through our library - an easier and more decorous way of getting books than grubbing around under trestle tables, I can assure you.

This reprint is a one-for-one copy of the original with no alterations or omissions. It contains a wealth of design data and general advice, all of which is invaluable for the modern day experimenter. GEC, like Mullard, kept their feet on the ground, majoring on practicalities and real life circuits, rather than theory. The book describes no fewer than seventeen different circuits, all designed, built and tested by GEC back in the early fifties. Most are power amplifiers, all are push-pull (no single-endeds), and preamps with phono equalisation and tone controls are also covered.

Parts lists, build details and even transformer winding data are given in order to make all the circuits potentially buildable from the book. However, there are some points to bear in mind. I've encountered two commercial amplifiers based on these circuits and neither worked properly. One was the 50watt design that uses KT88s (p55) and in this case the feedback compensation scheme just didn't work. I stripped out the lot, re-compensated and got the design to work well (I can't supply details since this occured many years ago). I suspect this might have been down to transformer differences.

Whatever, do bear in mind that transformer availability and the possible need to experiment with feedback to ensure stability may crop up. GEC discuss this in Appendix B entitled "Output Transformers and Stabilisation". An oscilloscope and square wave generator are helpful in this task.

Also, above 100watts output, obtained from still-available KT88s using fixed bias, GEC use their DA42/100 power triodes, which aren't available any more. So whilst the six circuit descriptions make great reading, discussing Xenon rectifiers, U19s and operating voltages more commonly associated with the National Grid, building some of these designs is just about impossible.

Like the Mullard book on audio amplifiers, this one from GEC is required reading for anyone with a serious practical interest in valve amplifiers. I'm glad Audio Amateur Press have made it available again.

***An Approoch to Audio Frequency Amplifier Design* is available through the Hi-Fi World Library.**

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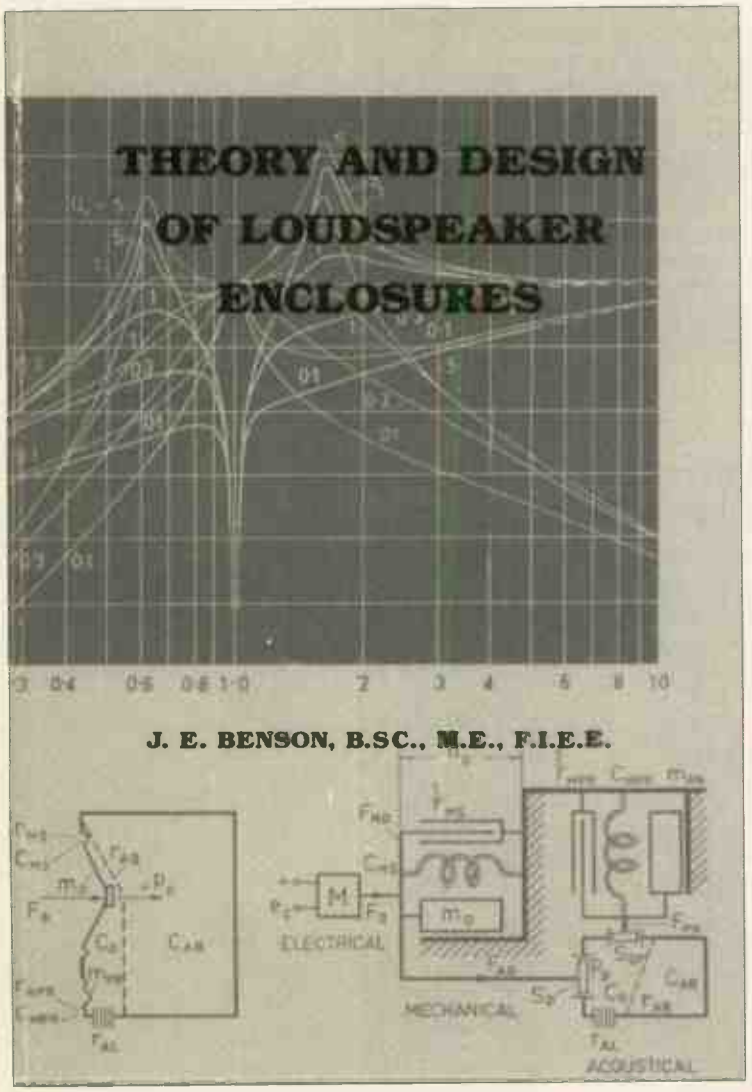
Theory and Design of Loudspeaker Enclosures

by Dr J. E. Benson.



Dr Benson is well regarded among top loudspeaker designers. He was the examiner for Richard Small's (of Thiele and Small fame) PhD thesis. Don Keele, another world renowned expert in the field of loudspeaker design wrote of this book "It is a classic, and even more comprehensive and detailed than Thiele and Small's loudspeaker papers as published in the Audio Engineering Society journal".

As you may have guessed from this introduction, the Theory and Design of Loudspeaker Enclosures is a serious affair, aimed at professional engineers. Much of the basis of the books is about creating a mathematical model of a loudspeaker enclosure, so the maths is quite complex, of degree standard or higher.

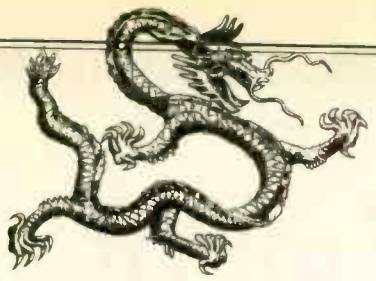
In the first chapter Dr Benson proposes a generalised configuration that encompasses all of the essential features of the various enclosure types, mechanical, acoustical and electrical. By varying the parameters of this generalised enclosure model, each of the individual enclosures (e.g. reflex, infinite baffle, sealed box, etc.) can be described by a mathematical expression.

The second paper then builds on these enclosure models by deriving the basic equations for calculation of the low frequency performance of a driver mounted into each of the different enclosure types. The 'performance' is described by the displacement, velocity and acceleration, sound pressure level and impedance, as well as response graphs. At this point it becomes clear that what Dr Benson is deriving is a set of equations that can be used in conjunction with a particular drive unit's parameters to describe its performance in a box, in exactly the same way as many of the 'low frequency box design' computer packages do.

These first two chapters set the basic equations for modelling a drive unit in an enclosure. The final chapter completes the exercise by introducing other box alignments not covered by the basic types, and introducing the effects of enclosure damping.

It is an extremely thorough book, and even though a lot of my degree maths is quite rusty, I was able to get a good feel for the way the enclosure models were developed and combined with a drive unit's parameters to predict the final performance as a whole. However, unless you're a mathematician with access to a computer who wants to design your own loudspeaker, or want to develop your own program for designing low frequency enclosures, it is a lot simpler to use one of the many computer packages already available. If you do want to know what the maths behind enclosure design looks like and how to use it, the Theory and Design of Loudspeaker Enclosures is one of the few that describes exactly how it's done ●

The Theory and Design of Loudspeaker Enclosures is available from the Hi-Fi World Library



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D.I.Y. Letters

AFFORDABLE PHONO-HEADS

I enjoyed your recent article on phono-head amplifiers, but was surprised to see that you did not include any kits in the test.

For most of us, four or five hundred quid is a lot to pay for part of an amplifier. I built the Hart phono-stage which is powered by two PP3s (9 volt batteries). It's easy to build (it was my first effort at assembling a printed circuit board) and it only costs £75. After the shock of finding that it worked first time, I then discovered it was a dramatic improvement over the phono-stage of my Musical Fidelity A100.

My LP playing system is now a Rock, Moth, Arcam P77Mg, the Hart and then a Beard BB100 into Ruark Talismans. The sound is stunning and I'm sure that any of the phono-amps you tested would have a hard job to improve it.

Why doesn't someone (you?) design an inexpensive battery-powered DAC for those of us just starting DIY hi-fi? Also, please include at least one low-cost kit in your comparative tests. I'm sure Hi-Fi World isn't afraid of embarrassing big name manufacturers! Also as you are always complaining - and rightly so - about the lack of efficient loudspeakers, why devote three pages of your supplement to building some that are only 83dB.

David Kelly
St. Ives,
Cambridgeshire.

The Hart kit was designed by John Linsley Hood and offers fine sound quality. At the price it is exceptional value. Our only small reservation is that for moving coil cartridges, there's a little more hiss than is possible from today's low noise solid state devices. With moving magnets, like your Arcam P77Mg, it will be as quiet as the best, however.

Digital convertors are complex and layout sensitive. They're difficult to offer as a kit unless carefully designed and tested beforehand. Even manufacturers use the chip producer's recommended board layouts, because this technology is so difficult yet critical. Those that don't commonly run into obscure problems concerning RF pickup of high frequency digital in areas where it wreaks havoc.

Some readers have complained that the Audio Synthesis DSM and Audio Technology Sorcerer kit convertors we have tested to date are too expensive. Unfortunately, it isn't necessarily cheaper to make a kit with some products. Volume industrial production has become so automated and fast that the usual savings on assembly and testing time are not there, machinery costs being spread over large production runs and many years.

The expense these days comes in design and development. Kits have to bear this cost, plus the additional expense of comprehensive build instructions. They are low volume items too, which raises casework costs in particular. Consequently, kits aren't necessarily cheap to develop or manufacture. Savings often come in their direct-to-the-customer marketing or, in some cases, low development cost through use of industry-standard circuit arrangements.

The only other way of making a low cost kit is to eliminate all casework, offering only a board and bits.

We are interested in low cost kits and will review them whenever possible; the Maplin Millenium valve amplifier was a good case in point. But there aren't so many real cheapies, for the reasons described. NK

ECC807s SPOTTED

Tsk, tsk. It really won't do! Fancy both Haden Boardman and Andy Gold saying ECC807s aren't available anywhere. According to suppliers' lists (and assuming some swine hasn't bought up the world supply in the meantime), they can be had from Philip Taylor and Valve and Tube Supplies.

The address is: Philip Taylor, 3 Silver Lane, Billingshurst, Sussex. RH 14 ORP (good for obscure types) and Valve & Tube Supplies, Unit 2A, Rink Road Industrial Estate, Ryde, Isle of Wight PO33 2LT Tel: 01983-811386 (large range).

Also, consult the Sound and Vision Yearbook for a fuller list of component suppliers, which is published annually at £3.50.

Andrew Emmerson
Northhampton.

▶▶

Thanks for the reminder, but, I want to know, who's Andy Gold? Is this a hybrid reviewer, part Valve, part Transistor?

Andy Grove, our valve expert, says they're not in production and are rare. Consequently, we are not prepared to encourage people to buy amplifiers that rely on their use, for fear of suffering a more valid complaint, that we've encouraged someone to waste their money.

All the same, I'm sure readers will be glad to know that these valves may be available in small quantities and that a unique directory of valve suppliers is printed in The Sound & Vision Yearbook, available from the Sunrise Press, 2-4 Brook Street, Bampton, Tiverton, Devon EX16 9LY. **NK**

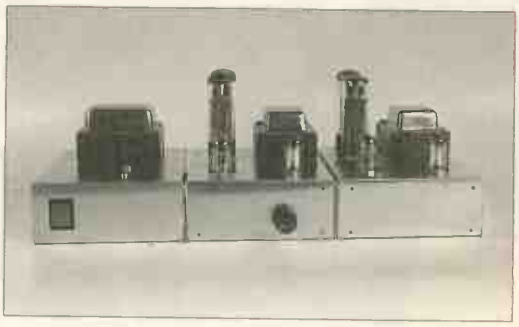
POSITIVE FEEDBACK

Thank you for your review of our valve amplifier kit as published in your constructor supplement, and we are pleased that you found the product very favourable. I am just writing to say that I have taken note of your comments in the 'measured performance' box, and to notify you of other small modifications that the design is currently undergoing.

Due to interest in the U.S. the PSU kit will soon be supplied with a dual 115/230V primary and other components, enabling it to be built and used by both European and U.S. customers. The instructions with the kits are updated accordingly.

The amplifier kit will have revised earthing arrangements designed to improve the stereo image from a stereo assembly, and I have instigated PCB changes to relocate C8 as per the Mullard circuit, as you have suggested in the review (we have also experienced minor oscillation problems on one occasion). However, it is not too difficult to terminate the low side of C8 to the PCB pin of V1 pin 3, instead of its normal PCB, on the original version of PCB by way of modification.

While I had tried to retain some semblance of originality in the Maplin version, so that the design is not obviously a direct copy of the Mullard 520,



Maplin's Millenuim 4-20 reviewed in the November '94 DIY Supplement.

Letter of

VALVE SYNERGY

Thank you for your high standard magazine, especially the Supplement. I am a hi-fi enthusiast for more than 20 years (I'm 39) and I am very tired of seeing the industry moving towards mini-monitors, video and the like. My system is based around a Marantz 7c tube pre-amp, a Marantz 8b amp and a pair of 'small' IMF TLS-50s bought, used, 10 years ago. Many components came and went along the years, such as a Radford ZD-22 and ZD-100 power, but the IMF/Marantz combination proved to be a synergy love affair, as weird as it may look, I know. But the result must be heard to be believed. It seems that the Marantz with its 55 pounds of transformers has no trouble drivng almost anything at reasonable levels while singing; better in fact than my previous 2 x 90 watt Radford which was much more dynamic but totally sterile.

By the way, thank you for your article about "Restore or renovate". Now I know that I will never try to improve the already good work of Saul Marantz.

1) My amp. is 35 years old and seeming in perfect condition, but is there a way to check the values of capacitors, etc. to see if they have kept their values, or must I wait for the day something starts to smell toasted in the room? (who said that valves are not reliable?)

2) I found a pair of 15" Tannoy concentric (silver & 16Ω) in a flea market for about £50. They were in bad home-made enclosures, though. What struck me was their dynamics (wow!) and the fine imaging, coherence and speed. What was wrong was a boomy bass and no low extension, probably due to bad resonant enclosure and 'cup distortion' in the midband that I can't explain. A well-known expert tells me it is usually the amps, can it be so?

3) By the way, Lockwood Audio told me that the GRFs were built around these drivers, but I can't find any plans to build these enclosures. Could you tell me where I could find these plans?

4) The Marantz amp can be run in triode mode, giving them nearly 20 watts instead of its 35 watts, ultra-linear. Would it help in getting a better sound from the Tannoys, or is it a 'fake' triode just for the fun of being a triode?

5) You see me coming! In the near future I plan to build a single-ended amp based on a 300B to drive the Tannoys or some horn 'speakers. Have you any plans to suggest? What do you think of Audio Note's Kit One? and could your 4 watts SE amp drive the Tannoys and eventually a Lowther PM6 horn?

6) Last question: have you heard the PM6-based horn? What are their strong and weak points and do you plan to review them some day? Please publish my phone and fax number.

Sylvain Giguére,
Portnuef-Station,
Quebec,
Canada.
Fax:418 873 3868
Tel: 418 286 4736

Some of the components in your amp may now be out of specification and dirt and dust will have accumulated inside, especially around high voltage points, so checking the amplifier over will be very worthwhile. To fully ensure that the amplifier is in A1 condition is quite involved. All

it is again an example of Mullard getting it pretty well right in the first place, so that it has been extremely difficult to make Millenium different. I have to admit though that the subtleties of the EF86 screen grid uncoupling arrangement eluded me at the initial design stage. Ho hum!

Mike Holmes
Maplin Electronics, Essex.

INFECTED!

Help! Ever since I purchased my Rega Planar 3, which was auditioned through an Audio Innovations valve amp, I have had the valve bug.

My current set-up is a Rega Planar 3/RB300/R100 turntable set-up, Denon PMA-300 amplifier, Denon DCD1290 CD player, Denon TU260L tuner and Tannoy Berkeley 'speakers.

I am a qualified electronics engineer with some time on my hands and as much as I would love an EAR 834 or similar esoterica, I would get more satisfaction from building my own amplifier as well as saving on costs.

I have circuits for the Mullard 5-20 power-amp and pre-amps, and the Williamson amplifier, but I have no idea what these amplifiers sound like.

I read with interest your article last month on the Maplin 4-20 amplifier kit, although I was perturbed by the shortcomings on the transformer front, which is where savings have obviously been made, and also the physical appearance which reminded me of projects I once made at college 25 years ago! I would rather spend some more money on higher-rated transformers and have a reliable amplifier as a result.

Are there any other manufacturers out there who make a classic valve pre-amp and power amplifiers in kit form, and if so, do you have any experience of their sound quality, or indeed that of the original designs.

I have obtained a list of transformers and chokes from E.A. Sowter Ltd. in Ipswich from their advert and I would like to know if these are good quality components which can be recommended?

On the question of power supplies, is it necessary to have a separate supply for each amplifier, or would a single supply give satisfactory results? Also what are the merits of using a solid-state rectifier as Maplin have done in their kit (apart from cost)? Would the large series choke in the supply line still be necessary, or is this all too much of a departure from the original Mullard design?

My apologies for a long-winded letter, but I am sure that there is a path to thermionic heaven out there somewhere!

PS: I abandoned my Garrard 401/SME 3009 S2 due to excessive rumble and I have been very pleased with the replacement Rega. Are 401

The Month

components will need to be tested to ensure that, for example, none of the resistors have drifted out of tolerance and that none of the capacitors are leaking DC current. It may be better to take the amplifier to a good engineer as it is quite a classic and it would be a shame to watch it go up in smoke.

The "cup" type of distortion you are hearing is usually caused by severe frequency response irregularities, so I would immediately suspect the new 'speakers. The cones may be damaged or the voice coils sticking and as these were in home-made cabinets the cross-over may be suspect as well. Make sure you have the 'speakers connected to the right output transformer tap. Connecting a 16Ω speaker to the 8Ω tap usually results in a very thin and weak sound.

Many of the top Tannoy 'speakers used the Dual-Concentric driver in one form or another, so you have quite a lot to choose from. Also, there are other enclosures which would suit the Tannoy drivers very well. How about a scoop horn enclosure or an enclosure based on the legendary Japanese Onken speakers? There are plans for the latter in Sound Practices No 4. Tannoy may be able to help on the GRF enclosures and probably the crossover as well.

My advice about triode connecting is to try it and see. You will probably find that it sounds more dynamic and musical. Triode-connected pentodes normally work well if precautions are taken against parasitic oscillation and I'm sure this is the case with the Marantz.

Keep your eyes peeled for forthcoming circuits and projects in HFW Supplements. S.E. triodes are our speciality and we have 211 and 300B designs coming soon. The Audio Note Kit One sounds great but looks like a dismantled WW1 radio transmitter so if you have any form of partner, cat, dog, children, parents or for that matter anyone with working eyes in your house prepare for trouble.

Our 4W S.E. design will drive the Tannoys loud because they are very sensitive at around 96dB/1W and the Lowthers even more so. The 4W amp has a beautifully warm and sweet sound which I'm sure you would love, and it looks as good as it sounds.

I have only heard vintage Lowther 'speakers but we will be listening to some new types soon. **AG**

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decks redeemable, or should it be consigned to the scrap-heap?

Myles Barrett
Chelmsford,
Essex.

The Mullard and Williamson designs differ considerably in their circuit topologies. The 5-20 was a later design using quite a large amount of feedback and high-gain valves (EF86 and ECC83) with an EL34 ultra-linear output stage. It gave a reasonably large maximum output (35W), low distortion and was cheap and easy to make.

The Williamson circuit could be seen as a more purist design using triode connected KT66 output valves and low-impedance L63/6J5 single or B65/6SN7 double triodes for the preceding stages, but the Williamson circuit is rather more complex and has a limited output of 15W.

In my experience the Mullard circuit gives a warm, rounded sound but can be slightly compressed and lacking in the finest detail. The Williamson is more open and tonally accurate as well as having better dynamic scale, but it is also drier and lacks overall power. The original G.E.C. KT66 valves used in the Williamson circuit are my favourite power pentodes/tetrodes, and a well designed amplifier built using good output transformers, components and original KT66s will walk over most of today's amplifiers.

There are valve kit suppliers (such as ourselves) offering interpretations of classic circuits like these, for example our K5881 kit uses Russian Military 5881 beam tetrodes, the closest current replacement for a KT66, but in a circuit configuration more like the 5-20. This amplifier has the sweetness of the 5-20 with the clarity of the 5881 output tetrodes, it also has a well finished steel chassis and large, generously rated transformers.

I have used Sowter transformers in the past and they were fine, but you will really have to suck it and see if you are going to develop a project of your own. The phase shifts caused by the output transformer are an unknown quantity so you can't really just drop it into a circuit. Some experimentation is necessary with the feedback network. This is one of the advantages of buying a full kit - the circuit has already been optimized.

It is not absolutely necessary to use separate power supplies for each channel but it can help. Solid-state rectifiers are much more efficient than valve rectifiers and help reduce the cost of an amp, but for sonic purity and output valve longevity I can recommend valve rectification.

The 401 can be tweaked up to a very high standard. There are several companies advertising in this magazine offering this service, for example Loricraft, Slate Audio and Technical and General Supplies. **AG**

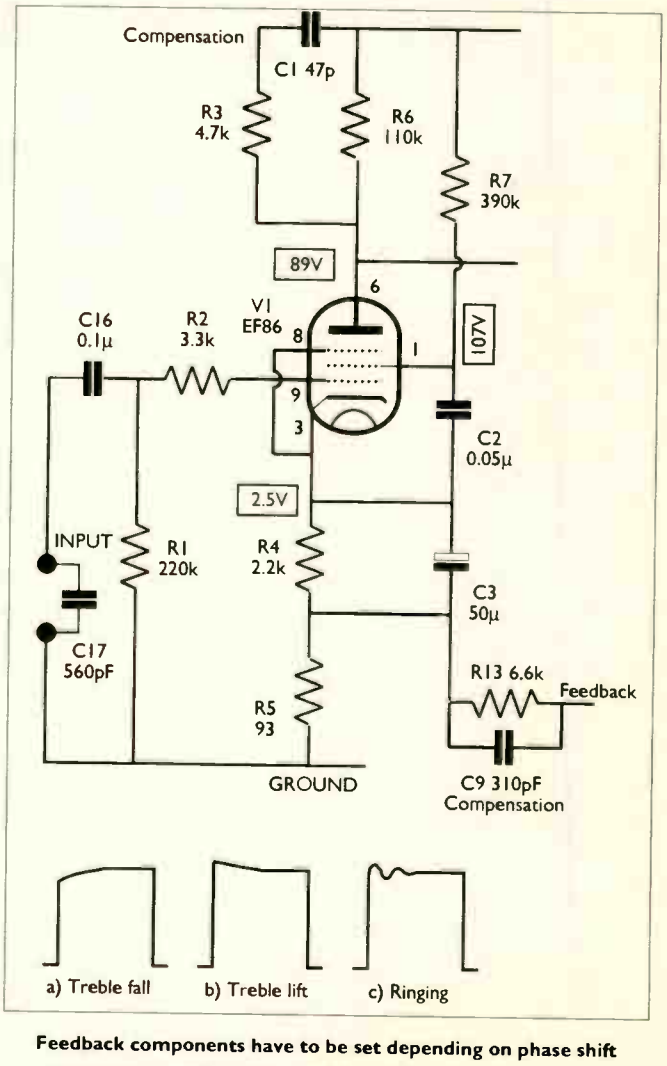
It's very nice to see the original Mullard Circuits For Audio Amplifiers now being reprinted. I still have my original version from the Sixties, which was a source of wonder and much fun at the time. However, more recently I have had to sort out a modern Mullard 5-20 that didn't work properly because of incorrect feedback compensation components, and I have met similar but larger problems with GEC's 50W design.

As Andy says, you have to set these feedback component values depending upon phase shifts around the amplifier, those in the output transformer being particular to the transformer used. Modern transformers often differ significantly to those used by Mullard and the feedback component values have to be adjusted accordingly, those given by Mullard and GEC commonly being unsuitable.

The experimenter can get a long way by applying feedback progressively, starting off with a high-ish value series "dropper" resistor in the feedback loop (say 8k) and dropping slowly until the amp breaks into oscillation, probably around 3-4k. Then increase the value by around 20% to give the unit a reasonable stability margin.

This is a bit ad hoc, but providing you err on the side of caution, meaning a high resistor value (6-8k) and least feedback, then the amp will be plenty stable enough into all loads. Do not try to use maximum feedback; it will not improve sound quality and the amp may well burst into occasional oscillation, which could destroy tweeters. Valve amps like this sound fine with low-ish feedback and in this state they are most stable.

Having set feedback level, the capacitor across R13 (C9) and that in series with resistor R3 (C1), should be adjusted for best square wave response. Use a 1kHz square wave driving 3V into an 8Ω resistor (3-11W). Viewing on an oscilloscope, make sure there's no significant leading edge droop as in a), indicating treble fall and a warm or dull sound, or leading edge peaking as in b), indicating treble lift and a bright or sharp sound. Try to minimise ringing too, as in c), which is indicative of a sharp supersonic treble peak attributable to leakage inductance and winding capacitance forming a resonant circuit. This trimming may increase your stability margin and feedback can be increased a little after if desired. **NK**



Feedback components have to be set depending on phase shift around the circuit. A scope can be used to view square wave performance which gives a useful guide.

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