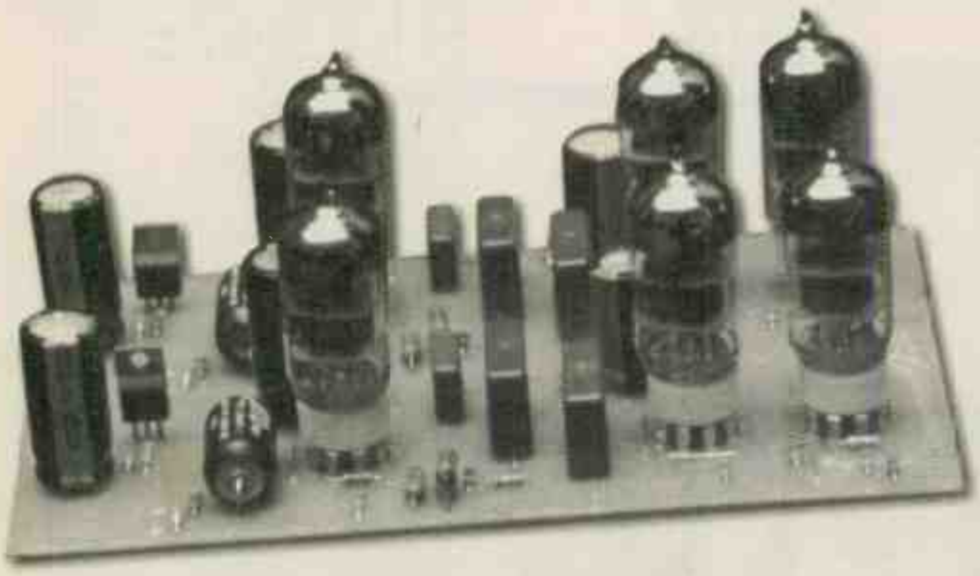
Hi-Fi WORLD

Hi-Fi WORLD

NO.33 DECEMBER 1997

SUPPLEMENT

BUILD A VALVE MM/MC PHONO PREAMPLIFIER



24 bit, 96kHz DIGITAL CD TECHNOLOGY

Book Reviews

PORT TUNING OUR KLS3 GOLD LOUDSPEAKER

FREE D.I.Y. SUPPLEMENT No.33

PRICE VALIDITY TO END OCT 1997 - ASK ABOUT ANY TYPES NOT ON THIS LIST

CVC CHELMER VALVE COMPANY

for High Quality Audio Tubes

Everybody in the tube business knows that the justly famous Brand names of yesteryear like BRIMAR, GEC, MULLARD, RCA & TELEFUNFKEN Etc. Etc. are scarce and often very expensive. Although we supply all major brands when available (and have many in stock) our policy is to offer a range of tubes, mostly of current manufacture, the best we can find from factories around the world, which we process specially to suit audio applications. The result - CVC PREMIUM BRAND. Our special processing includes selection for LOW NOISE, HUM & MICROPHONY and controlled BURN-IN on all power tubes to improve STABILITY and select out tubes with weaknesses Etc.

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PRE-AMP TUBES	
ECC81	5.00
ECC82	5.00
ECC83	5.00
ECC85	6.00
ECC88	5.00
ECF82	5.00
ECL82	5.00
ECL86	5.00
EF86	5.50
E80F *Gold Pin*	10.00
E81CC *Gold Pin*	6.80
E82CC *Gold Pin*	8.00
E83CC *Gold Pin*	7.50
E88CC *Gold Pin*	8.00
6EU7	6.00
6SL7GT	4.50
5SN7GT	4.50
6922	5.20
7025	6.50

POWER TUBES	
EL34G	7.50
EL34 (*TESLA)*	8.00
EL34 (*Large Dia.)*	8.50
EL84/6BQ5	4.70
EL509/519	13.00
E84L/7189A	6.50
KT66	9.50
KT77	12.00
KT88 (*Standard)*	12.50
KT88 *(Gold Special)*	21.00
KT88 *(Gold Lion Pair)*	60.00
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211	22.00
300B	50.00
6C33C-B	27.00
6L6GC	6.50
6L6WGC/5881	8.00
6V6GT	5.00
6080	11.50
6146B	10.50

POWER TUBES (continued)	
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6550A	11.00
6550WA or WB	13.50
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807	9.00
811A	11.00
812A	34.00
845	30.00

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GZ34	6.50
GZ37	7.50
5U4G	5.00
5V4GT	4.50
5Y3GT	4.00
5Z4GT	4.50

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B9A *(Chassis or PCB)*	1.60
B9A *(Ch or PCB) G/Plated*	3.00
Octal *(Ch. or PCB)*	1.80
Octal *(Ch. or PCB) G/Plated*	4.20
4 Pin *(For 2A3, 300B etc.)*	3.30
4 Pin *(For 2A3, 300B etc) G/ Plated*	5.00
4 Pin *Jumbo (For 211 etc.)*	11.00
4 Pin *Jumbo (For 211 etc.) Gold Plated*	15.00
5 Pin *(For 807)*	3.00
7 Pin *(For 6C33C-B)*	4.50
9 Pin *(For EL, PL509, Ch. or PCB)*	5.00
Screening Can *(For ECC83 etc.)*	2.00
Anode Connecter *(For 807 etc.)*	1.50
Anode Connecter *(For EL509 etc.)*	1.70
Retainer *(For 6L6WGC etc.)*	2.00

and a few "Other Brands" (inc. Scarce types).

5AR4/GZ34 *MULLARD*	20.00
5R4GY *RCA, STC*	7.00
5R4WGY *CHATHAM USA*	10.00
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5Y3WGT *SYLVANIA*	5.00
6AS7G *RCA or SEIMENS*	12.00
6AU6WC *SYLVANIA*	3.50
6B4G *RAYTHEON*	27.00
6BW6 *BRIMAR*	5.00
6BX7 GT *SYLVANIA*	8.50
6CG7/6FQ7*SYLVANIA*	7.50
6CL6 *RCA or GE*	5.00
6CW4 *RCA*	11.00
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6SN7GT *BRIMAR*	5.50
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12AZ7 *GE*	7.50
12BH7A *GE or RCA*	13.00
12BY7A *GE*	9.00
12E1 *STC*	12.50
13E1 *STC*	110.00
805 *CETRON*	50.00
5842A *GEC*	15.00
6080W *TUNGSTOL*	12.50
6550A *GE*	22.00
6146B *GE*	17.00

ALL PRICES IN U.K. POUNDS £

Please note carriage charge extra + VAT (EEC Only) - When ordering state if matching required (add £1.00 per tube). Payment by CREDIT CARD (ACESS, VISA, MASTERCARD) or BANKERS DRAFT, TRANSFER or CHEQUE (UK ONLY). FAX or POST your ORDER - We shall send PROFORMA INVOICE if necessary.

Valve Amplifiers sound better still fitted with CVC PREMIUM Valves!

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Chelmsford, Essex CM2 0RG. England.
✆ 44 (0)1245 355296 Fax: 44 (0)1245 490064

D.I.Y. Supplement

Contents

KIT NEWS

FRESH SUPPLIES

Antique Audio Supplies of Arizona have announced the release of their 1998 catalogue. This will be positively crammed full of 'new old stock' valves as well as currently-manufactured items. Also stocked are many hard to find parts and supplies for audio, amateur radio and antique radio restoration. A large range of books and literature for valve enthusiasts is available too.

Antique Electronic Supplies
6221 South Maple Avenue,
Tempe,
Arizona 85283
Tel: (001) 602 820 5411

FALCON'S NEW STOCK

Falcon Acoustics have announced a whole slew of new products. They now stock sculpted damping foam (egg-box type) in sheets of 1000mm by 500mm by 40mm which cost £6.20 each. Three sizes of variable-length loudspeaker ports are available as well. These have diameters of 51mm, 67mm and 110mm and cost £2.40, £3.00 and £5.60 respectively.

New books on offer are AES Loudspeakers - An Anthology, vols three and four, each at a price of £30 and the Beginner's Guide To Tube Audio Design by Bruce Rozenblit for £18.

In addition, Falcon can supply a variety of computer programmes. To help you build horn 'speakers there's Bass-Horn Design software which aids the design of catenoid, exponential and hyperbolic horns (£19.17). For £176.50 B2 SPICE Ver. 2.1 offers an analogue simulation programme with a Windows schematic interface. Just enter the circuit with component values and it works out the 'net list'. CAAD-330 WIN low-frequency 'speaker simulation programme goes for £43.25 and AudioCad Pro, which manipulates MLSSA, IMP, LMS and Audiolab data with cabinet and crossover data, will set you back £98. Last but not least, an ECHO DSP Sound Card for Audiosuite modified by Liberty is yours for £155.75.

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

LIFESTYLE THE RUSS ANDREWS WAY

Audio component supplier Russ Andrews has just released its Audio Lifestyle Brochure. This contains accessories such as cables, Oak Cone feet and ReVeel CD cleaner.

Russ Andrews Accessories
Edge Bank House,
Skelsmergh,
Kendal,
Cumbria LA8 9AS
Tel: 01539 823247

DOWN TO A 'T'

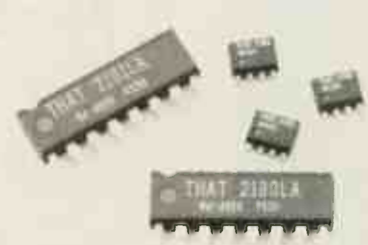
Tenby-based component specialist AudioCom now stock the recently-introduced T-Network electrolytic capacitors by DNM Design. The T-Network cap is constructed using the Slit-Foil method to produce a high-quality power supply filtering capacitor with low impedance. Availability of the T-Network capacitor is at present limited to 63V/10000uF and the price is £24.25 each.

AudioCom
Unit 6,
Tindle Enterprise Centre,
Warren Street,
Tenby,
Pembrokeshire SA70 7JY
Tel: 01834 842803

THAT'S BETTER

There is a new family of high-performance voltage-controlled amplifiers (VCA) from the THAT Corporation. The 218X VCAs provide a significantly better distortion performance than either the well-known 2150A or SSM2018/T. Available in both trimmable (2181) and trimless (2180) versions, the 218X VCAs can be used in any quality audio application like power amp input stages.

Also new is the 4301 Dynamics Processor which provides a VCA and RMS level detector in one IC package. This comes in both DIP and surface-mount packages and provides a single-chip solution for use in compressors, limiters and gates. Prices are as follows: 2180 - £3.91, 2180 demo board - £65.00; 2181 - £3.67, 2181 demo board - £65.00; 4301 - £5.51, 4301 demo board - £60.00. All prices are plus VAT.



Profusion
Aviation Way,
Southend,
Essex SS2 6UN
Tel: 01702 543500

Watford Valves

3 Ryall Close Bricket Wood,
St Albans Herts AL2 3TS
Phone: 01923 893270
Fax: 01923 679207

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QUAD II OWNERS	
KT66/7581A PHILIPS USA, the best replacement	~~£20~~ now £18 each
GZ32 New old stock	~~£15~~ now £10 each
EF86 SIEMENS and TELSA	~~£9~~ now £8 each
LEAK & RADFORD OWNERS	
E34L TESLA BLUE GLASS widest frequency response	~~£12~~ now £10 each
EL34WXT SOVTEK increased spec best yet from Sovtek	~~£7~~ now £6 each
EL84 JAN PHILIPS USA a true audio EL84	~~£12~~ now £10 each

ECC81	PHILIPS	£4.50
ECC82	PHILIPS	£4.50
E83CC	SIEMENS	£10.00
EL519	E.I.	£10.00
PL519	E.I.	£10.00
PCC88	PHILIPS	£3.00
6SL7WGT	PHILIPS	£7.00
6SN7WGTA	PHILIPS	£7.00
5687WB	PHILIPS	£5.00
5842WA	RAYTHEON	£6.00
6550C	SVETLANA	£16.00
6922	SOVTEK	£3.00

KT66 GEC ORIGINAL limited supply matched pairs p.o.a.

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Prices exclude VAT and carriage.

VISA

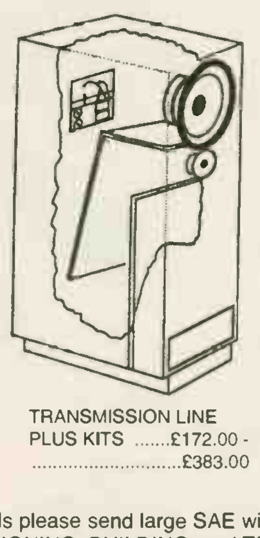
SPEAKER KITS FROM IPL ACOUSTICS

Over a 9 year period I.P.L. ACOUSTICS have developed a range of high quality speaker kits, using the best units from SEAS, MOREL, AUDAX, and I.P.L. and have produced a comprehensive range of speakers which will compete with the most expensive of commercial designs.
All speakers have biwired crossover kits containing high quality components and terminals.

S5TL TRANSMISSION LINE

PLUS KIT £383.00
TOTAL KIT £506.00

FIVE TRANSMISSION LINE KITS



TRANSMISSION LINE
PLUS KITS ....£172.00 - £383.00

M3TL TRANSMISSION LINE

PLUS KITS £172.00
TOTAL KIT £236.00

A2 H.D.A. AEROGEL KIT

PLUS KIT £187.50
TOTAL KIT £259.00

S3TLM METAL TRANSMISSION LINE

PLUS KIT £224.00
TOTAL KIT....£302.50

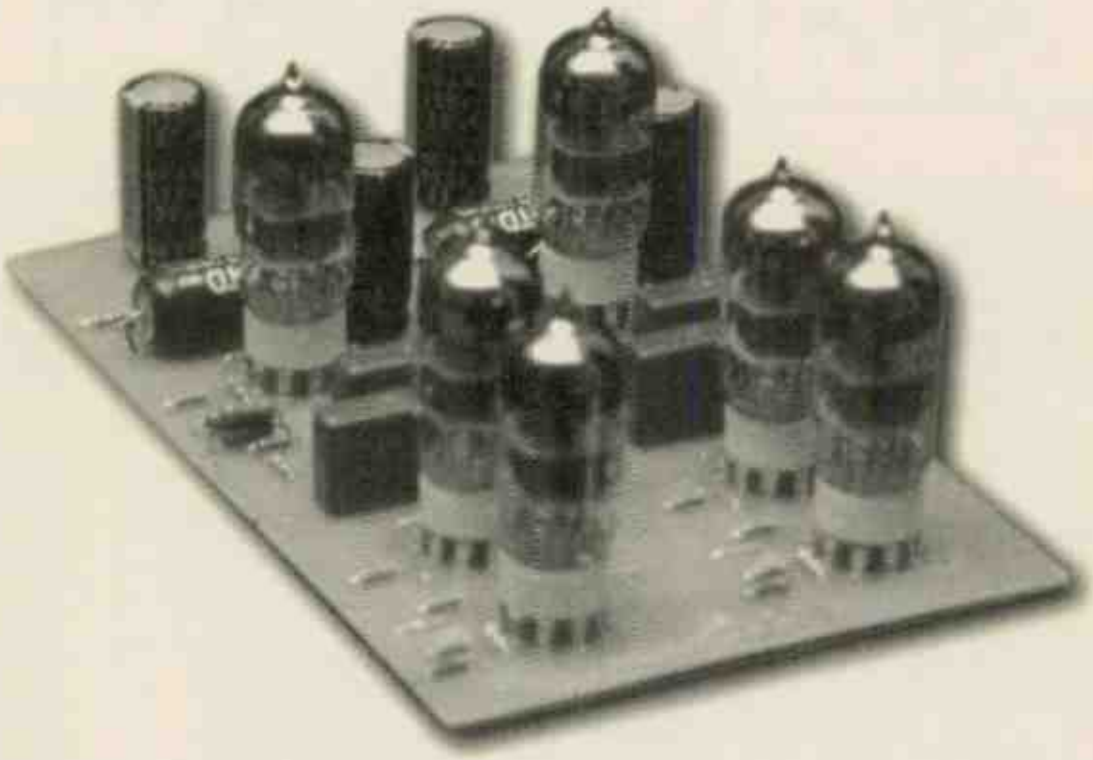
PRE-VENEERED CABINET KITS NOW AVAILABLE. Carriage charge extra on all kits.

If you would like further details please send large SAE with 36p stamp for PAGE SPEAKER BUILDING CATALOGUE, comprising VALUABLE ADVICE on DESIGNING, BUILDING, and TESTING speakers and full technical specifications including response curves of eight kits, drive units and details of SPECIALIST CABLES and ACCESSORIES. KITS FOR A.V. USE NOW AVAILABLE.

I.P.L. Acoustics, 2 Laverton Road, Westbury, Wiltshire, BA13 3RS. Tel: 01373 823333

VALVE PHONO PREAMPLIFIER

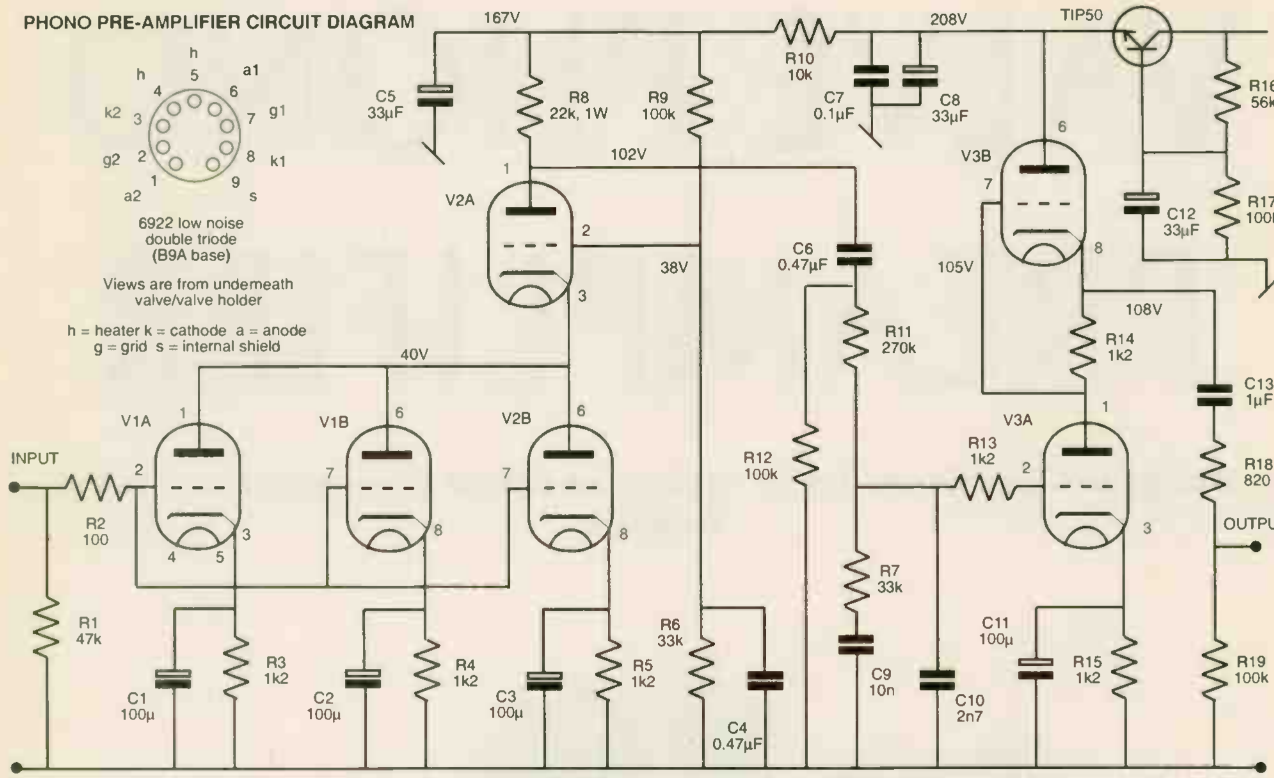
Designer Chris Found brews up a valve phono stage with some novel features.



This design was created as a reflection of old transistor phono stages where parallel input transistors were used to achieve a better than average noise performance. This was important when trying to reproduce the low level signals from a moving coil cartridge, minimising hiss. The use of this type of configuration means valve circuitry can have a similar performance to its transistor brethren.

The circuit is centred around the use of a Cascode input stage to provide the best compromise between gain and linearity. The output stage that follows it uses a Shunt Regulated Push Pull (SRPP) configuration for a compromise between the best drive performance and adequate stage gain. A passive RIAA network is placed in-between the two stages and there is no overall negative feedback.

In a standard cascode valve configuration, the upper section fulfils two functions. Firstly, it drops the voltage down to an acceptable level for the lower section to operate. Secondly it adds an extra stage of gain to the lower section. Because the signal is being fed into the cathode and not the grid of the valve there is lower gain compared to a

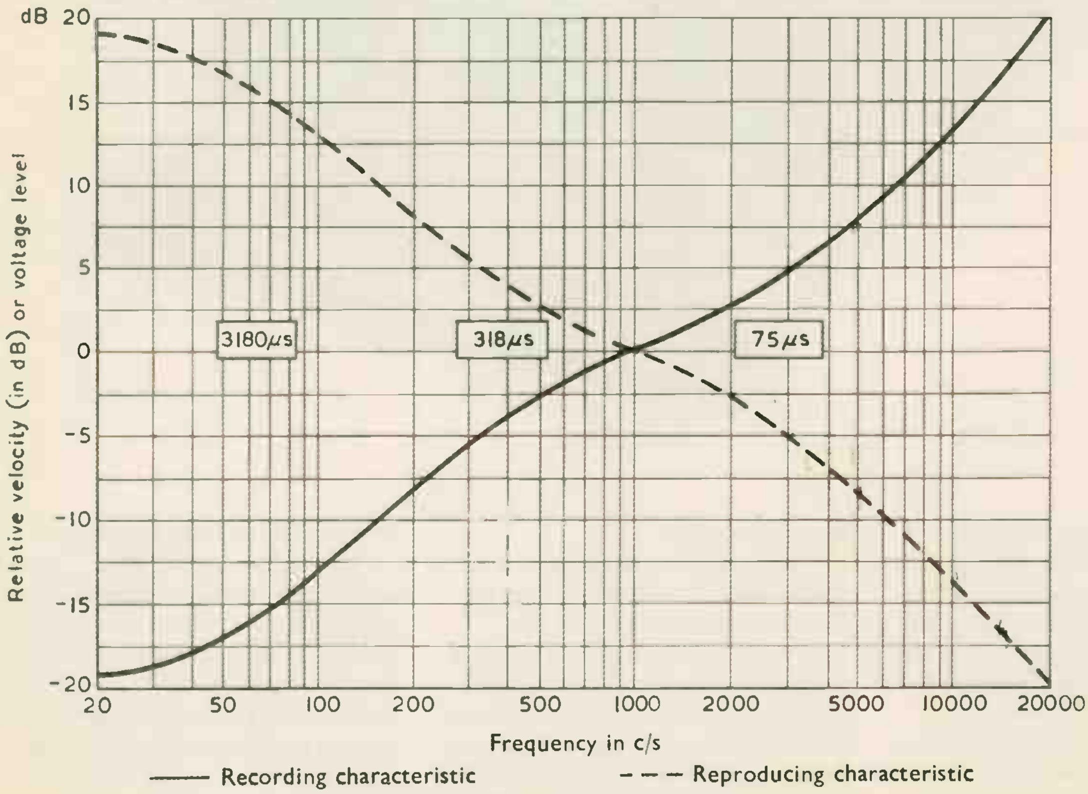


connection to the grid, but the stage is more linear in its operational range and for most people who have studied the sonic differences, they would agree that the cascode configuration has a better sound performance.

To improve the noise performance of the cascode, the input stage has an extended configuration by increasing the lower valves from one to three in parallel, this has two benefits, a small increase in the gain of this first stage and a reduction in the noise by approximately root factor of 1.5.

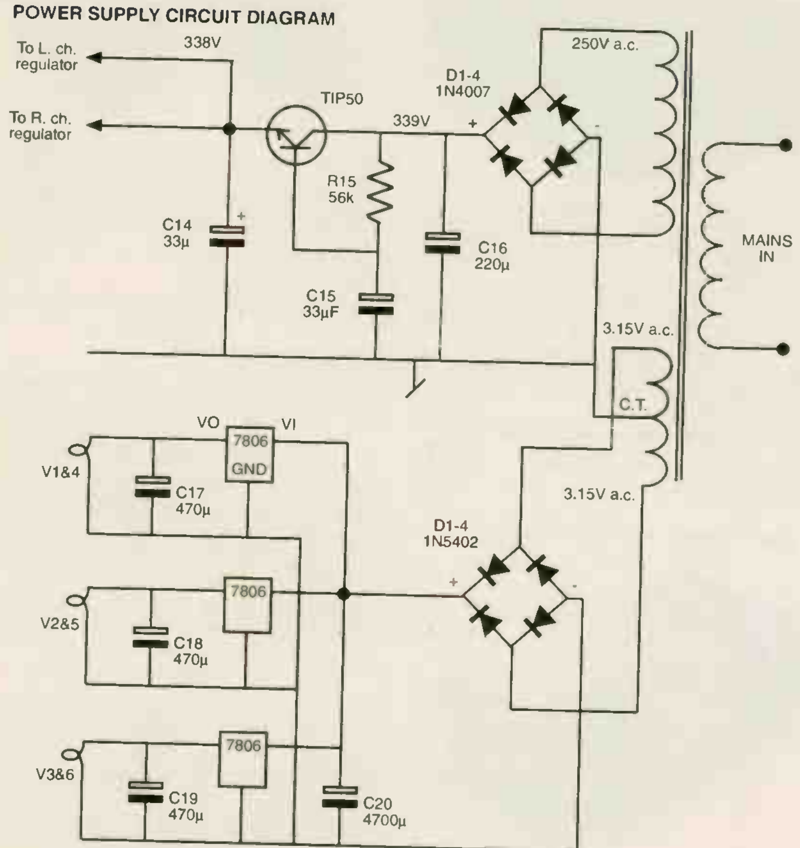
This allows the stage to work at lower signal levels than that possible for a single stage and allow the ideas in this article to work, further, to aid the improved noise performance. The upper section of the cascode is deliberately set to feed a lower than normal voltage to the lower section. This has the benefit of reducing power supply noise even further by isolation and although the overload factor is lower than what would be normally

B.S. 1928 : 1965



Characteristics for fine groove disk records

POWER SUPPLY CIRCUIT DIAGRAM



D.C. HEATER SUPPLIES

obtained with a single cascode, it is still high enough to accept high output cartridges without a problem. The stage is also sonically quieter in terms of noise as some of the rougher sounding noise is partially cancelled out by using it in this application and that allows more information to be presented to the listener.

This input stage now has the capability of working with medium output moving coil cartridges, of around 0.5mV (ref. 5cms/sec.) without the need to use an input step-up transformer or any silicon based (transistor) amplifier and this should provide an immense benefit to all valve record enthusiasts.

By separating each section of the individual parts of one channel, we will show you how the stages work together.

The input stage although described earlier works on the principle that an active load when added to a standard common cathode class A amplifier circuit, can provide the maximum voltage gain for a given stage. Where a constant current load would just provide a higher gain, this

HOW TO SELECT MM OR MC GAIN

For Moving Coil build circuit as shown, but make R1 match the cartridge used. See below.

For Moving Magnet capacitors C1, C2 and C3 must be removed. This decreases gain from x336 to x78 by adding 'degeneration', otherwise known as feedback.

ADJUSTING CARTRIDGE LOAD

For moving coil find recommended load for cartridge. This is commonly 100ohms, but some cartridges, like Ortofons, require 3-10ohms. Make R1 the value recommended.

For Moving Magnet. keep R1 as 47k since all MMs use this load value.

RUMBLE/WARP FILTER

C6 changes to 0.1µF for 21Hz, -3dB

C11 changes to 10µF for 13Hz, -3dB

PHONO PREAMP PARTS LIST

RESISTORS (all 0.66W carbon film)

R1	47k
R2	100
R3	1k2
R4	1k2
R5	1k2
R6	33k
R7	33k
R8	22k, 1W carbon film/metal oxide
R9	100k
R10	10k
R11	270k
R12	100k
R13	1k2
R14	1k2
R15	1k2
R16	56k
R17	100k
R18	820
R19	100k

CAPACITORS

C1	100µ, 25V electrolytic
C2	100µ, 25V electrolytic
C3	100µ, 25V electrolytic
C4	0.47µ, 250V polyester
C5	33µ/350V electrolytic
C6	0.47, 250V polyester
C7	0.1, 400V, polypropylene
C8	33µ, 350V electrolytic
C9	10n, 1% polystyrene 160V
C10	2n7, 1% polystyrene 160V
C11	100µ, 250V electrolytic
C12	33µ, 250V electrolytic
C13	1µ, 400V polypropylene Solen
C14	33µ,350V electrolytic
C15	33µ,350V electrolytic
C16	220µ,450V electrolytic
C17	470µ,16V electrolytic
C18	470µ,16V electrolytic
C19	470µ,16V electrolytic
C20	4700µ,16V electrolytic

D1-4	1N4007
D1-4	1N5402
V1-6	6922/E88CC

Mains transformer	
primary	240Va.c.
secondary 1	240Va.c.,100mA
secondary 2	3.15-0-3.15V, 2A

HART

The Home of *Hi-Finesse.*

Hart Audio Kits and factory assembled units use the unique combination of circuit designs by the renowned John Linsley Hood, the very best audiophile components, and our own engineering expertise, to give you unbeatable performance and unbelievable value for money.
We have always led the field for easy home construction to professional standards, even in the sixties we were using easily assembled printed circuits when Heathkit in America were still using tagboards!. Many years of experience and innovation, going back to the early Dinsdale and Bailey classics gives us incomparable design background in the needs of the home constructor. This simply means that building a Hart kit is a real pleasure, resulting in a piece of equipment that not only saves you money but you will be proud to own.
Why not buy the reprints and construction manual for the kit you are interested in to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

'AUDIO DESIGN' 80 WATT POWER AMPLIFIER.

Our John Linsley Hood designed 80 watt Power Amplifier continues to amaze all who listen to it, and it is now finding new friends among speaker manufacturers who use it to show their own products to their best advantage. Its flawless performance is a result of the combination of inspired circuit design and the very best components, specified by the designer. Such innovations as the six rail fully stabilised power supply make great contributions to the overall reproduction quality yet are not found on even the most expensive run-of-the-mill designs in the High St shop window.

We have long known that the delicacy and transparency of sound from this amplifier placed it in the world class and side-by-side comparisons with amplifiers costing five times as much still show small performance advantages, which suggests that even the most expensive amplifiers will only equal rather than exceed, its sound quality. All amplifiers in the range have the same basic quality and the decision about whether to use a preamplifier is governed by the facilities you need. The STANDARD amplifier has switching for up to three inputs, if you need more than this then a preamplifier feeding a SLAVE power amplifier will give you up to seven inputs.
If you would like to hear this incredible amplifier in action then arrange a visit to Wilmslow Audio's new premises at Broughton Astley, near Leicester. Their phone number is 01455 286603, speak to Shaun or Terry.

All amplifiers are available in kit or factory assembled form.

K1100 Complete STANDARD Amplifier Kit £415.21
A1100 Factory Assembled version £515.21

K1100S Complete stereo SLAVE Kit £353.62
A1100S Factory Assembled £522.22

K1100M MONOBLOC Amplifier Kit £271.20
A1100M Factory Assembled £351.20

Super Audiophile (SA) Versions of all the above come with selected audiophile components at an extra cost of only £39.30 per channel.
All HART kits are designed for easy home construction to the very highest standards, and can be built by anyone of average manual ability. If you are still not convinced how easy it is to build it yourself with a HART kit you can order the Instruction Manual to read for yourself and we will refund the cost when you buy your kit!.

JOHN LINSLEY HOOD 15W SINGLE ENDED CLASS 'A' POWER AMPLIFIER

A design for the experimenter who wants to try and re-create the warmth and purity of sound given by valve amplifiers from the vintage years, without the problems of cost, deterioration and danger associated with trying to use valves today.
It employs the newly re-discovered single-ended circuit configuration to give total freedom from crossover artifacts and to give a sound that is indistinguishable from the famous 'Williamson' design, the undisputed leader of the field, with its triode connected KT66s and all-triode drivers. See our list for full details.

Reprint of Article £2.50
CM4000 Construction Manual £5.00

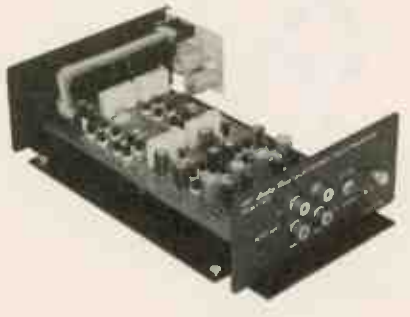
MAINS LEADS & POWER DISTRIBUTION.

All our kits use standard IEC mains leads and these are available for a range of countries. We also stock distribution boxes with IEC sockets to minimise the space needed for power leads. See our lists for details.

"CHIARA" HEADPHONE AMPLIFIER.

Highest quality, purpose designed, 'single ended' class 'A' headphone amplifier for 'stand alone' use or to supplement those many power amplifiers that do not have a headphone facility. Easy installation with special signal link-through feature, the unit uses our 'Andante' Ultra High Quality power supply.
Housed in the neat, black finished, Hart minibox it features the wide frequency response, low-distortion and 'musicality' that one associates with designs from the renowned John Linsley Hood. Volume and balance controls are Alps "Blue Velvet" components. Very easy to build, or available factory assembled, the kit has very detailed instructions, and comes with Hart audiograde silver solder. A valuable personal listening option and an attractive and harmonious addition to any hifi system.
K2100 Complete Standard Kit £112.50
K2100SA 'Series Audiophile' Kit with selected audiophile components £115.46
A2100SA 'Series Audiophile', Factory Assembled £115.46
CM2100 Construction Manual £2.50

SHUNT FEEDBACK PICKUP PREAMPLIFIER



If you want the very best sound out of vinyl discs then you need our high quality preamplifier with Shunt Feedback equalisation. The K1450 also has an advanced front end, specially optimised for low impedance moving coil cartridges as well as moving magnet types. Selected discrete components are used throughout for ultimate sound quality. The combination of John Linsley Hood design, high quality components and an advanced double sided printed circuit board layout make this a product at the leading edge of technology that you will be proud to own. A recent review in "Gramophone" magazine endorsing this view. Bought in kit form our step by step instructions it is very easy and satisfying to assemble, or you can buy a factory assembled version if you wish.
This magnificent kit, comes complete with all parts ready to assemble inside the fully finished 228 x 134 x 63mm case. Comes with full, easy to follow, instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit!
K1450 Complete Kit £116.58
K1450SA Audiophile Kit £138.94
A1450SA Factory assembled Audiophile unit £188.94

"Andante" Linear Technology AUDIOPHILE POWER SUPPLIES

The HART "Andante" series power supplies are specially designed for exacting audio use requiring absolute minimum noise, low hum field and total freedom from mechanical noise.
Utilising linear technology throughout for smoothness and musicality makes it the perfect partner for the above units, or any equipment requiring fully stabilised ±15v supplies.
There are two versions, K3550 has 2 ±15v supplies and a single 15v for relays etc. K3565 is identical in appearance and has one ±15v. Both are in cases to match our 'Chiara' Headphone Amplifier and our K1450 "Shunt Feedback" Pickup preamp.
K3550 Full Supply with all outputs £94.75
K3565 Power Supply for K1450 or K2100 . . . . £84.42
A3550 Factory Assembled Full Supply £147.25

ALPS "Blue Velvet" PRECISION AUDIO CONTROLS

Now you can throw out those noisy ill-matched carbon pots and replace with the famous Hart exclusive ALPS 'Blue Velvet' range components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC motor.

MANUAL POTENTIOMETERS
2-Gang 100K Lin £15.67
2-Gang 10K, 50K or 100K Log £16.40
2-Gang 10K Special Balance, zero crosstalk & zero centre loss £17.48

MOTORISED POTENTIOMETERS
2-Gang 20K Log Volume Control £26.20
2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position £26.98

ALPS PRECISION SWITCHES.

At long last, switches to match the quality of our Alps pots. These switches not only solve the quality gap but also have features facilitating their use in real audio applications. The "Flex" version having a panel mounting control coupled to a rear mountable switch unit by a 190mm Flex Link. Also available is a motor driven option which, like the pots, can also be operated with its control knob.
HC5520. 4P 4W. Manual Control £16.73
HC519. 4P 6W Manual £17.95
HC5545. 8P 5W Flex Switch £21.60
HC5560. 4P 6W Motorised £29.80

SOLDERING

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With its powerful 125 watt output and versatile filtering the ASM 100 is the ideal universal active driver module for all subwoofer requirements.

ASM 100 Module, complete with IEC mains lead, instructions and ASM - W20 cabinet drawings. Pt. No. V7000 . . . . £185.29

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LK5961 Kit £392.42

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Width	300mm
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LK5965 Per Pair £538.70

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W200S 20cm. Long Throw Drive unit. Part No. 9030 . . . . £36.68

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An alternative design by David Purton, from his little "Coupled Cavity Handbook", using the same drive unit but requiring a bit more woodworking skill as the speaker is set on a baffle in the middle of the box. The total box size is even smaller than the ASM T20 at only 418 mm high, 303 mm wide, and 344 mm long.

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BASSBOX 5.0 for WINDOWS. Harris Technologies.

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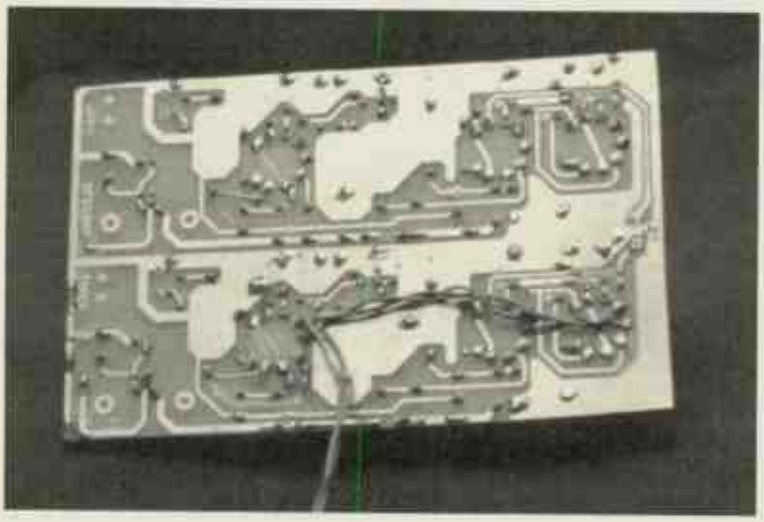
active section has the additional benefit of increasing the lower stage gain, buffering the first stage away from problems such as low impedance, capacitive loads, etc., and this in turn increases the bandwidth of the stage well into the megahertz region (MHz). This stage had a very successful life in tuner and IF circuits of Televisions in the 1960s and some high quality audio manufacturers still use such a configuration for input stages, as in this application.

The benefit of adding two extra gain elements to the lower section increases the gain and in turn lowers the noise by the same factor, thereby creating a low noise input section suitable for use in low noise areas, such as this phono stage. Following this cascode amplifier is the passive RIAA network. This has three operating points and being passive, attenuates the mid-band signals by a factor of 10 (20dB). The network is split into two sections to aid discussion of each section.

The first section of the RIAA network deals with the low frequency boost required to correct the balance of the low frequency cut of the original mastering on the record, used to limit groove excursion. It follows a 6dB per octave slope from 50Hz (3180μS) to a flat response at 500Hz (318μS). Although there were many alterations from the original American standard of 1955 such as the IEC curve of the mid 70s, I feel that the 1955 original has the best sound. The curve was inducted into British Standards, as our copy of BS1928: 1965 shows.

An additional cut point on the RIAA curve has now to deal with the boost in high frequencies made during recording to lessen disc surface noise. As the impedance of the boost network is now set for frequencies above 500Hz, it is a simple matter of adding an additional capacitor to provide this cut in high frequencies from 2.1215kHz (75μS) upwards, to finish off the correction network.



Following the passive RIAA network, we have the second gain stage (V3, A&B) that increases the signal up to a level that is suitable to be used for a pre-amplifier or line amplifier input. This stage follows a simple configuration that is similar to the cascode front end but instead of the upper section providing gain, this section now just buffers the anode by means of a simplified cathode follower.

As with the first stage, the lower section of this SRPP stage sees an active load and therefore provides almost the maximum gain available that is possible from such a configuration. Also, with the cathode follower (V3B) above the lower section (V3A), the output impedance is reduced to a level suitable for driving connecting cables.

RUMBLE FILTER

There is some controversy around the use of a rumble filter. For LPs with warps, which generate very large subsonic signals below 10Hz this almost a legal requirement in order to prevent cone flap with reflex loudspeakers. It also attenuates idler drive rumble, although with a good turntable this should not exist.

Both Noel and myself believe that there should be some form of low frequency filtering to stop this unnecessary information from getting through to the amplifier and speakers. I believe that the filter should be designed into the circuit and not added on as an additional stage; Noel prefers switchable filters, since bass weight is lost by such a filter.

So in this article, I have chosen to provide two sets of component values, one for those who require low frequency attenuation and the other for those who want deep, deep bass at all costs (the Japanese prefer this option).

With attenuation of this nature it is imperative to understand what is really required from a warp/rumble filter and the implications on the low frequency response in terms of sound pressure of your listening room.

For most listening rooms in the UK, it is very difficult to achieve a true 20Hz bandwidth, this is partly caused by the size of the room and also the low frequency capability of the speakers. Many sub-woofers do not reproduce signals at these frequencies and the only musical note that I know of that gets anywhere near is the 16Hz church organ pedal, rare except in the biggest organs.

So in real terms, there is no requirement for a system to reproduce any frequencies below approximately 25Hz in my view. Now, this is where arguments can start as the home cinema system has the ability on some sound tracks to reproduce down to 10Hz, so where do we stop. So I have left the choice up to you.

It is gratifying to think that that even for most high end designers, listening pleasure is increasingly being found from the LP again. Ironic that such a thing should start to happen as the world ever increasingly takes to digital technology. Valves are making a bigger comeback of course. For many years enthusiasts have had to put up with transformers or solid state amplifiers, but now enjoyment can be had from valve systems. For many years I have used valve electronics and feel that enjoyment must take precedence over technology. I hope you agree my design here meets this aim. May the records always be with you!

Chris Found

TURNING to TUNING

Noel Keywood reveals how to get better performance in larger rooms from our KLS3 Gold Dome MkII loudspeaker by tuning its reflex-loading ports.

We designed the original KLS3 back in the summer of 1994, three years ago, and since then demo models have travelled far and wide. There's nothing quite like using a loudspeaker in a variety of rooms to find out how it fares and KLS3 has always done well, often yielding bass where other designs fail. It works happily in small to medium-sized rooms, which means in the home. We designed it to produce strong bass around 50Hz, critically above the half-wavelength low-frequency limit of rooms of more than 11ft. length or so.

The fact that KLS3 can over-excite room modes in smaller rooms with similar length/breadth dimensions, plus my experiences port-tuning KLS9, prompted me to look at an alternative port tune that would better suit large rooms.

The revised set-up will favour larger rooms, 16ft. or longer, in particular. This new port arrangement is an alternative to the original, not necessarily an improvement. That's why, in the revised KLS3 cabinet plans published last month, we put the twin ports that once sat on the front baffle on to a removable rear panel. This facilitates port-tuning and makes experiment with port size much easier.

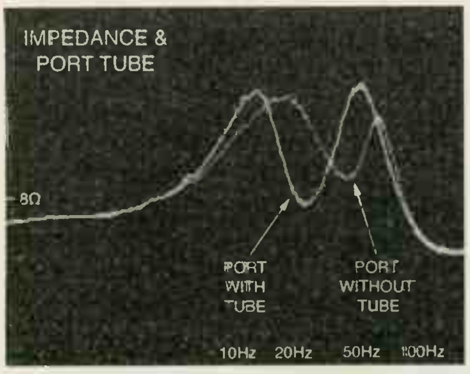
Variable length tuning ports are available from Falcon Accoustics on tel: 01508 578272. For more information, see this month's kit news.

For most circumstances, I believe the original ports are best, but the glory of building something yourself is having the freedom to experiment - and there's a lot that can be done here. Making the port panel removable enables a loudspeaker to be tuned to a room and to suit personal preferences.

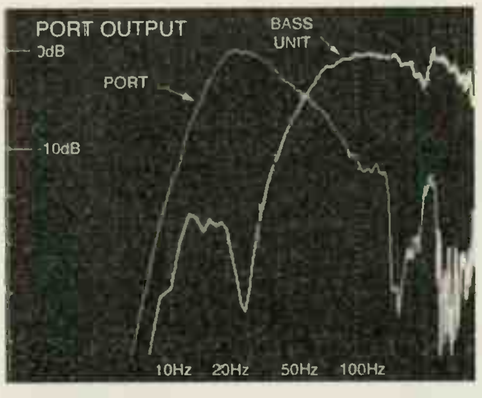
The function of a port in a reflex loudspeaker is reasonably straightforward in basic intent. It is an anti-resonant system, the like of which has been used elsewhere, by Shure in their V15 cartridge for example, to suppress the effects of primary resonance.

In loudspeakers we are faced with the natural resonance of the bass unit where cone mass in conjunction with suspension compliance results in resonance (Fs or Fr) at low bass frequencies.

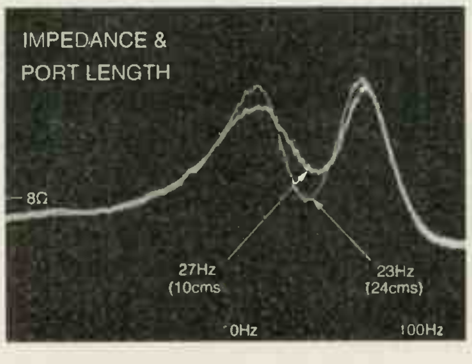
Audax quote the free-air resonance of their HM210CO bass driver used in KLS3 as 31Hz. In use this is modified by the compliance of the air in the cabinet to become the 'box frequency', Fb, which



KLS3 with single 6.5cm port, without rear tube and with 24cm long tube. The tube adds air mass, lowering resonance as indicated by the electrical impedance curve from 36Hz to 23Hz.



Frequency response (near field) of the HM210CO bass driver and port output. The port peaks acoustically at 20Hz, maintaining output down to this low frequency.



At its minimum length of 10cms the port peaks at 27Hz. Extended to its full length of 24cms the acoustic output peaks at 20Hz, so KLS3 can be tuned between these limits by adjusting port length.

measures 38Hz in KLS3. This is the system's primary bass resonance (measured without ports). It puts a large peak into the electrical impedance curve at 38Hz. The anti-resonant system formed by the port is contrived to resonate out of phase at this frequency so that it opposes cone motion.

There's been no end of research on this phenomenon, for it became obvious back in the 1930s that a port can be used not only to control bass resonance but also to extend frequency response downward by a useful amount, often an octave or so. This is a big benefit for a hole in the cabinet. But its behaviour is complex and not easily exploited, which is why ports come in all shapes, sizes and positions in commercial loudspeakers.

What I need to point out is that, with port-tuning, we are faced with such a wide array of variables that one simple, optimum solution cannot exist. Where to tune the port and why depends upon the parameters a designer is seeking to optimise. Modern texts on port behaviour spend a lot of time talking about linearity and power compression effects, for example, whilst ignoring the difficulties and trade-offs that must be made in basic tuning - should a port be tuned for lowest bass response, which will provide the best measured result, or should it be tuned to put audible bass into real-life rooms? This then raises the question: what is a real-life room? And where does an issue like power compression come in?

Awkwardly - and for complex reasons - port size must be reduced to lower its frequency of operation (resonance), but this also reduces port output and increases bass distortion at higher powers. So tuning by varying size can only be carried so far. To overcome this limitation we use a ducted port - a tube or duct behind the hole which puts extra mass in the air path, lowering frequency by another means. This is illustrated in Fig 1, which shows the behaviour of KLS3 with a 6.5cm diameter open port (no tube in place) and with a rear tube 24cms long.

With the tube in place the frequency of port resonance, indicated by the trough between the two impedance peaks, moves from 36Hz down to 23Hz - a very large difference indeed. So putting a duct on a port has a big impact on its resonant frequency and potentially gives much lower bass.

However, the impact of a duct upon port frequency response is of mainly subjective effect. Whilst the impedance curve tells an interesting story, it does not say much about sound quality. The sound radiated from a port takes over from the main drive unit at, and around, the port's resonance. A port in effect knocks the main driver dead at its resonant frequency, usefully lowering cone excursion and raising power handling. It also makes the port responsible for low-bass quality. A ducted port offers better damping of bass and therefore better bass quality. Although reflex bass does go very low it is often criticised for its quality, and damping has a lot to do with this.

The original ports of KLS3 were sized in terms of area to work higher up, at 35Hz-40Hz or so. The new port at full extension (24cms) works much lower down, at 23Hz our analysis (Fig 2) shows. This will suit larger rooms in particular. I was surprised by the bass performance of KLS9, which uses a larger cabinet, and the fact that so many constructors appreciated deep bass extension in their homes, so hopefully the deeper bass offered by this optional port arrangement for KLS3 will not go unnoticed.

So what about adjustment? Frequency can be increased by shortening the port from 24cms to its minimum of 13cms. The result this has depends upon box volume. With KLS3's 55litres there's relatively little difference, moving port frequency from 23Hz up to 27Hz. The longer port is better damped however. It is best to adjust length for best subjective sound quality.

The new port gives KLS3 more powerful and better damped bass in larger rooms. Large ports radiate a broad spread of energy and sound better controlled. As a result bass becomes drier and less 'enthusiastic', but more solid too ●

BIT PART

The future is digital and it doesn't revolve around CD. Chris Found explains and looks at a 96kHz, 24-bit DAC for tomorrow's hi-fi.

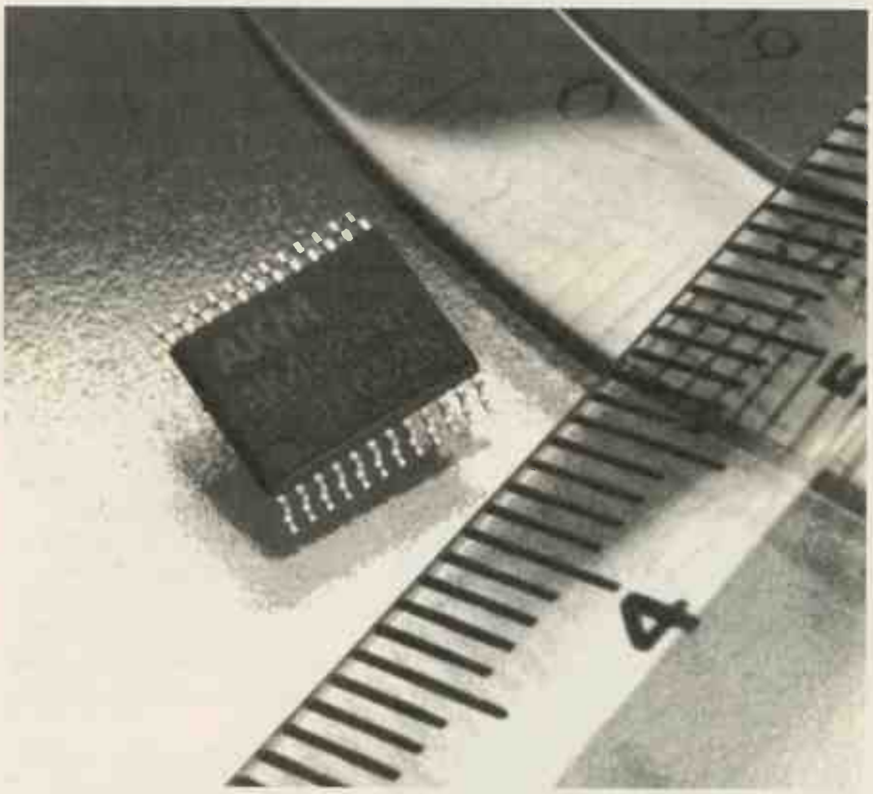
INTRODUCTION

The world of digital audio is now changing extremely rapidly after 14 years of slow but steady improvement in the quality of CD (44.1kHz) audio. At last it looks like CD's long-lived but low-resolution standard might be replaced with one that high-end hi-fi designers have been asking for since the Compact Disc was first released onto the market.

All through the life of CD, advocators of the vinyl LP have criticised the digital disc's flaws and compromises. Records cut before the advent of digital master tapes have a wide bandwidth of over 40kHz whereas CD chops off all signals above 22.05kHz.

Most non-technical people would back the argument that what you can't directly hear doesn't matter, but that is now known not to be the case because part of what CD's encoding is removing from the music are the harmonics, and they play a vital role in the quality of the recorded sound. Harmonics are fundamental to the character and tonal colour of everything we hear. Any sound, from a violin note to the roar of Concorde flying overhead, includes masses of harmonics throughout the audio spectrum.

Recently I was able to listen to various 24-bit recordings with a sampling rate of 44.1kHz on a professional Nagra digital open-reel recorder. This showed just how much was missing from standard CD with its 16-bit coding - the increased realism, ambience, subtlety and fine detail that could be heard through this system made it one of the best I have listened to in a long time.



Unfortunately, because the AKM 4324 Digital to Analogue Convertor is a highly miniaturised device, it can be difficult to work with.

BEYOND CD

Although Digital Video Disc and its proposed use as a medium to carry 24-bit 96kHz-sampling recordings is relatively new to the hi-fi industry, several manufacturers have already launched products to accommodate the possible new world order.

Earlier this year, Asaki Kasei Microsystems announced their first product in the high-resolution marketplace. The AK4324 is a true 24-bit, 96kHz-sampling compatible Digital to Analogue Convertor chip and I was happy to be asked by te Asaki Kasei to evaluate one of the samples from the first production batch. My listening tests confirmed this chip is going to be something special.

Now before you start thinking about modifying your CD player, I must underline some of the problems in designing a system around this chip.

Although the Analogue to Digital and the Digital to Analogue chips are readily available, the interface electronics required to connect them together are not. There are no consumer interface transmitters or receivers at the present time designed to handle the 96kHz sampling rate. That means this chip is limited to signals of no higher than DAT's 48kHz sampling rates until these devices arrive. I do, however, have it on good authority that their first release is only a few months away - December '97/January '98.

There is only one true digital audio tape machine around at the moment which is designed to operate with the 96kHz sampling rate and that is the rather expensive (£15000-£20000 depending on the specification) Nagra open-reel machine.

All DAT machines are internally limited to a maximum 48kHz - even Pioneer's 96kHz sampling DAT portable works by doubling tape speed, and so is not compatible with the systems that are currently being proposed.

Nor are the Digital Video Disc and Digital Sound Disc (from Sony) compatible with 24-bit/96kHz for the time being, and there is little in the way of information to suggest that these discs have been settled on as carriers for 96kHz, 24-bit recordings by the music business. In fact, the wrangling going on over DVD standards for video use makes it unlikely this might happen any time soon.

INSIDE THE AK4324

The AK4324 chip has a parallel processing architecture, where two separate sigma-delta, 1-bit Digital to Analogue Convertors are placed in a single tiny SSOP surface-mount package. The use of two convertors ensures high phase accuracy performance between channels and the minimum of interaction. The chip has the ability to operate from most digital data streams - 32kHz, 44kHz, 48kHz and 96kHz - either from interface receivers or the decoders in CD players.

The chip's clock is switchable between the standard frequencies of 11.2896MHz, Philips' 256 x sampling frequency (Fs) and 16.9344MHz (Sony/Pioneer. etc. at 384Fs) for normal operation, with further options of 128Fs and 192Fs respectively to accommodate the higher sampling rates.

Jitter is dealt with by the IC's own internal processing and is reduced to a minimum level, providing that the master clock produces a relatively clean square wave signal. Poorly defined clock waveforms at this stage will result in a high noise floor. Internal facilities include automatic digital de-emphasis, soft muting and digital attenuation to an accuracy of 24-bits.

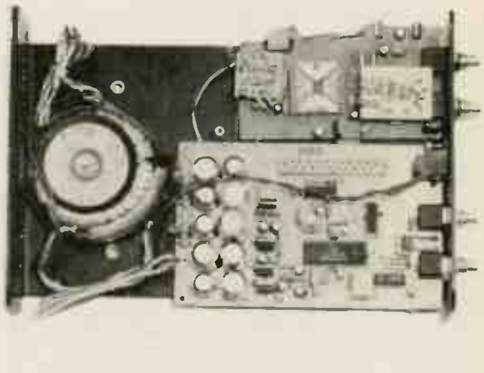
To complement the expansive array of input facilities, the audio output signals are sent through an output buffer to the outside world in a high level (1.4V) balanced form to permit maximum rejection of noise. The AK4324 has on-board first-stage analogue filtering which yields lower levels of out-of-band signals beyond its frequency limit.

BUILDING A PROTOTYPE DAC

An original prototype that was put together relatively quickly exceeded the noise floor specification of the data sheet by 3dB, so the book spec. is only a guide.

The sole area where the chip falls down is the 0dB output level distortion which measures around -94dB. If, however, you take the output signal down to -10dB, the distortion drops into the noise floor. The linearity of the chip is excellent, being a virtual straight line from -10dB to -105dB, and this is remarkable considering this is a relatively inexpensive device.

The prototype was designed to create a starting point for all of my future developments and since its first incarnation there have been just a couple of modifications to the original circuit, to improve certain areas that required a little tweaking.



Looking inside an early incarnation of the AKM DAC you can see the toroidal mains transformer and the staggered-value reservoir capacitors to its right. The AKM 4324 DAC IC itself is sitting in the middle of the upper PCB.

The initial design brief I gave myself was very simple - get the chip working with a sufficient level of sound quality that would justify the time spent on the unit. I started out with tried and tested digital building blocks.

The input section comprises an RS232 interface receiver which accepts the signals from a CD player or DAT machine and increases them to a level where they are suitable for the rest of the digital electronics.

The input section also has two inputs - Direct Coupled and Capacitor Coupled. The quality of the data transfer and therefore the sound is directly related to the quality and construction of the isolation transformer which the signal flows through in the CD player or transport. For some machines a small capacitance in the data line can work wonders in taming an aggressive sounding transport.

Next is the interface receiver. This employs a universal standard 'Low Jitter' Crystal Semiconductors CS8412 in its latest incarnation. This decodes the data signal, locks it to the correct master clock frequency and finally separates the data signals into streams that the following electronics can deal with.

Following the CS8412 is a data buffer and clock regenerator which clean the waveform of the data before it enters the convertor. A re-timing circuit comes next. This reduces any jitter that may be introduced by PCB tracking or connection cables as applied in the prototype. This technique tightens up the sound staging of the convertor and fixes the positions of

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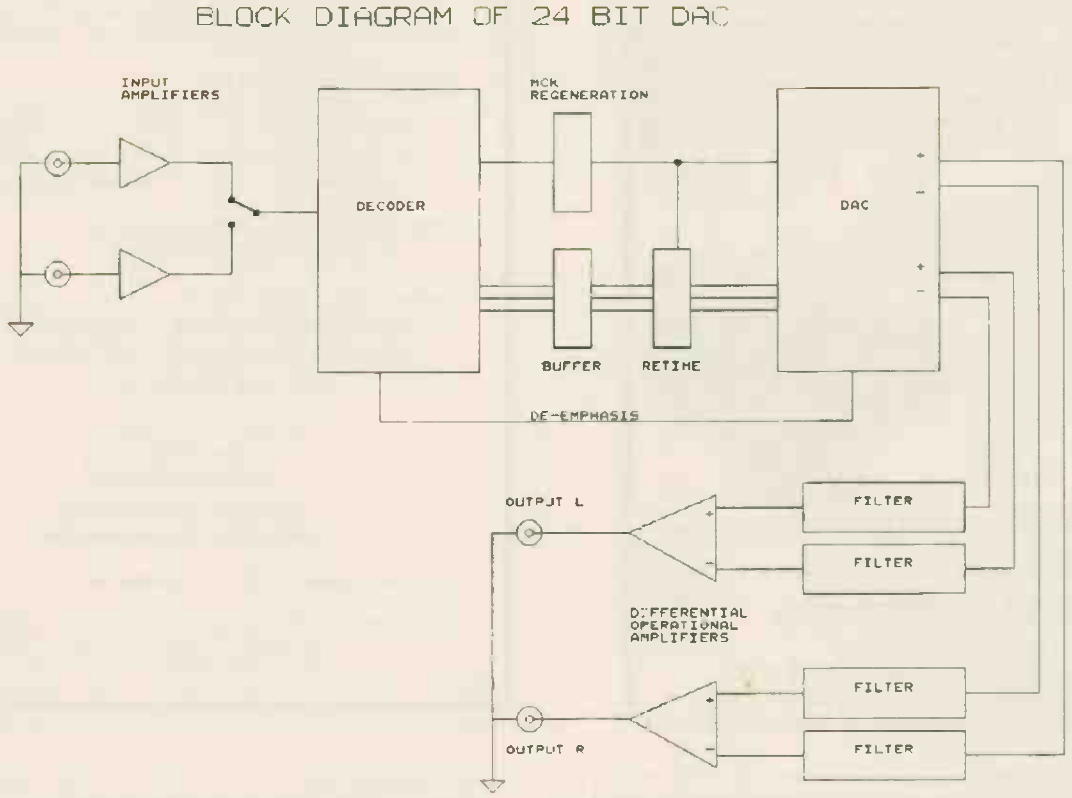


This block diagram shows the basic on-board operations the AKM 4324 Digital to Analogue Convertor carries out

certain instruments, such as the high notes of a piano, in their correct spatial position.

Now for the DAC itself. It's positioned as close as possible to the retime chip to keep data lines to the DAC as short as possible. I could have used a surface-mount chip in this position but I did not feel there would be any benefit and it is a lot easier to lay out a standard package in this position.

The DAC chip is mounted on a dedicated surface-mount PCB with ground planes to keep Radio Frequency radiation and interaction at the lowest possible levels.

Following the DAC is a high-performance, fast, dual op amp that converts the balanced outputs of the DAC to single-ended and introduces a small amount of Radio Frequency filtering to keep out-of-band signals within respectable levels.

The power supply employs a technique I'm very fond of - staggered values of reservoir capacitors that create a fast but stable supply. High-performance LM317/LM337 variable voltage positive and negative regulators are employed for all digital stages to keep the supplies as clean as possible and there's double regulation for the DAC chip in order to maintain a constant voltage irrespective of power loading. Finally, the toroidal mains transformer was slightly over-rated in terms of capacity for improved performance.

SOUND QUALITY

In a direct comparison between 44.1kHz at 24-bit and standard 44.1kHz at 16-bit Compact Disc, the 24-bit recording really showed what we are missing, even with a basic sampling rate of 44.1kHz.

The sound stage stretched far wider than the loudspeakers' cabinets and deeper before. Vocals, whoever the artist, were positioned at the correct height and I could clearly hear the singer taking a breath in between the words of the song. Backing vocals were also defined in their own space behind the lead singer and in front of the instruments.

The instruments themselves took on a new dimension, each taking up their own proper position with a clearly defined space around them. Rhythm fans will admire the bass, which was not only more powerful but better defined as well.

Certain instruments that are normally ill defined on CD take on a real atmosphere of their own. Cymbals, for instance, sounded totally different - I could clearly hear wood against metal, with the proper shimmering effect as the cymbal rocked from side to side when struck. Its decay lasted longer too. Another example was when the drummer changed from sticks to brushes - I knew exactly when and what drum he was using.

Piano created a special musical illusion. I could discern almost every last detail positioned across the sound stage. The operation of the foot pedals with any of their accompanying squeaks came through clearly and the tonal differences that set apart a grand and mini piano were clearer than before.

Going back to CD I found virtually everything sounded different. There was a kind of haze to the upper registers, the bass had lost most of its definition and the music just didn't sound natural. Vocals were flat, almost lifeless, in their presentation, and often blurred together with backing vocals ●

TUBE AUDIO DESIGN

by Bruce Rozenblit

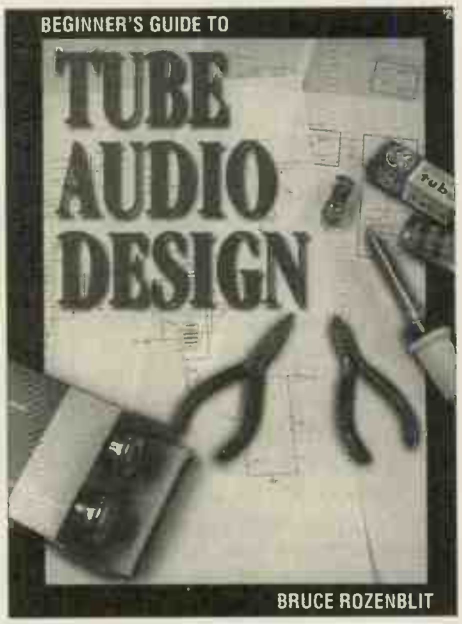
Reviewed by Noel Keywood.

When a monster like the legendary Radio Designers Handbook cannot cover all aspects of valve (tube) circuitry, a relatively compact book like the 133 page Beginners Guide to Tube Audio Design must have limitations. Ironically, because author Bruce Rozenblit has plenty of experience and displays confidence in his writing, his necessarily brief coverages of a wide range of tube topics can be a little frustrating. But this is a beginners guide and I found it was well written for its purpose. It covers a lot of fascinating territory, giving useful insights, if not comprehensive analyses.

For example, perusing the Table of Contents I noticed Chapter 10 was titled Stability Networks - crucially important, yet a topic not commonly explained in any sensible manner for the practising engineer, when it can be found at all in electronics books. Stability is related to Feedback, found earlier on at Chapter 4, since applying feedback often results in stability problems, the reasons being fairly difficult to understand for the layman not versed in basic concepts. Bruce Rozenblit candidly admits so on page 62, stating "when I first started working with tube circuits and ran into stability problems I didn't know what to do and I'd give up." I know from our mail how instability can be a pig to understand and cure for home constructors and of course I've been through this mill as well!

I was disappointed that Bruce misses the obvious by omitting to explain the first move when encountering instability should be to reverse feedback polarity of an amplifier with loop feedback, but this is a 'hunt the thimble' type oversight I'm sure, where the most obvious is missed. Otherwise I found Bruce's explanations sufficiently jargon free and succinct to be useful to beginners, and the range of problems/cures covered usefully wide.

The book starts out with a very brief page of basics before diving into valve



construction, biasing and characteristics. Bruce Rozenblit has an easy explanatory style, but I would have liked to have seen some typical d.c. voltages and operating currents put into a simple example, say a triode stage working from 250V, to give an idea of what to expect. Single stage basics gives a.c. gain equations, impedances and what have you, getting quite complex with a cascode model, but considering a.c. conditions is a distant luxury if the valve isn't biased and, therefore, working properly. Establishing d.c. operating conditions might usefully have been a bit more thorough, because this is a very significant beginners topic.

A good range of topics are dealt with. After chapters on the 'vacuum tube' (this is an American book), Single Stage Basics (chapter 2), Simple Gain Circuits (chapter 3) and Negative Feedback (chapter 4), Bruce Rozenblit moves on to feedback circuits and circuit building blocks like cascode stages, etc. Chapter 8 covers output stages and transformers and 9 covers power supplies, then we meet Stability Networks in chapter 10. In effect, this is the end of the beginners section, for on page 63 to book moves to Classic Designs. As valuable and interesting as such examples are, by definition they are not beginners territory. UK readers will recognise Williamson and Leak amplifiers, but otherwise the line up comprises American amplifiers after World War II, with the exception of a Jefferson 2A3 from 1933.

At page 83 the book publishes actual circuits designed by Bruce, acting as contributing editor to Glass Audio, from whence this book derives. I was surprised and impressed to see a direct coupled design included. Emphasising the melange this book is, pages 100 onward to the end carry advertising. Most of it derives from U.S. companies, making available a fascinating range of specialist products. Since this significantly increases the resources available to U.K readers, 'cos these days the water in-between isn't much of a barrier, it's an unusual and valuable addition.

This is a very good book for beginners, that's for sure. Most of the info derives from first hand experience, imparting a relaxed and easy style to the writing. Because it promises so much and the potential to deliver is there I felt it a shame that the text for beginners was wrapped up by page 63, but then at £15.50 this is also a very inexpensive book and great value, so I do strongly recommend it for beginners and even for those with experience. There's something for everyone in the pages and much of it is good hard-core, hands on stuff ●

Beginner's Guide to Tube Audio design
author Bruce Rozenblit
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THE ART AND SCIENCE OF ANALOG CIRCUIT DESIGN

Edited by Jim Williams

Reviewed by Haider Bahrani.

Good basic knowledge aside, there is no substitute for experience. Personal experience is preferable, but the fledgling designer/engineer should still be more than keen to draw on other dabblers' thoughts. The Art And Science Of Analog Circuit Design is partly aimed at fulfilling such a need.

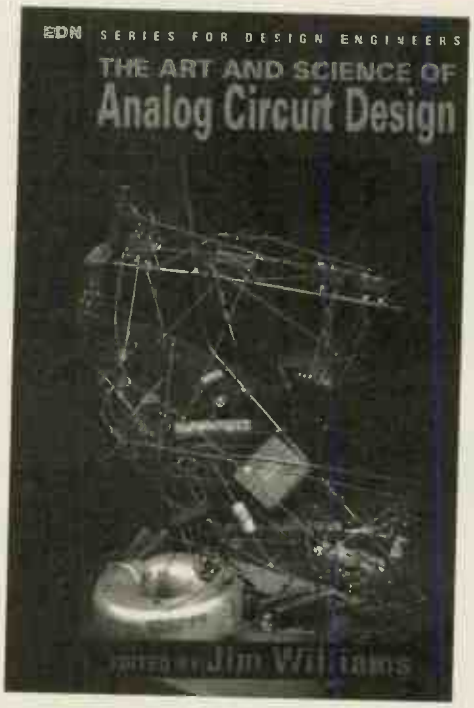
As a follow-up to a similar publication this book is a collection of essays and articles written by self-confessed analogue design engineers expressing thoughts, describing experiences, getting a little technical and sometimes trying to lay down the law. Every now and then reality rears its slightly balding head and the sheer creative madness of it all is exposed.

The book's main attraction is that there is no particular style to unify each contribution. Each of the chapters in each of its four sections captures the theme, but follows its own route to a unique end. The authors have been given licence to open their minds and have done so more than willingly.

As I have already mentioned, the book is divided up into four sections. The first of these effectively grabs the new graduate electronics engineer by the ear and introduces them to the hot end of the soldering iron and points out the three legs of a transistor. Well, actually it doesn't cut that close to the bone, but the message is loud and clear - you haven't started your learnin' till you've completed your learnin'!

Jim Williams and friends take us through different journeys, some serious, some anecdotal and some just plain funny. Chapter Five is well worth a read, particularly the part written by Gregory Kovacs' wife as the significant other in the analogue engineer's life (excepting the oscilloscope, soldering iron, multimeter, late-night pizza, etc.)

Part Two of the book is all about turning concepts into real, working circuits. This is where the co-authors



start talking with circuit diagrams and graphs, so hard hats on, folks.

Chapter Seven's Steven Roach gives a clear and interesting overview of oscilloscope design while William Gross takes us on a "... trip down the IC development road". Chapter Nine is all about breadboarding. The reader is led through the pitfalls of prototyping and bad circuit layout. A sense of humour is essential and thankfully the author has it in abundance.

The penultimate chapter in this section goes back to oscilloscopes and the design of the wide-band member of the species. Finally, we have another Jim Williams vignette on problem solving.

The third part of the book covers selling the product, which can be either the fruit of the engineer's craft or the engineer's craft itself. Chapter Thirteen places the designer in the hot shoes of the product trying to sell itself - the application letter for a job, the interview and even some sample questions are thrown in.

The final section of the book gets a little more general, with authors' views expressed on topics ranging from 'managerial' innovation to the laws of nature. The first of these, titled 'Moore's Law,' simply states that memory density increases four-fold every three years. This is digital fighting back, or at least breathing life back into analogue: hence they are nothing without each other. Chapter Sixteen is one I am about to frame on my office wall. The author, John Willison, claims the prerequisite for being a good analogue designer is to know about 57 important facts on the subject. He lists only 37 as he seems to have forgotten the rest. Myself, I could probably muster about ten with luck!

Chapter Seventeen documents the virtues of having a lab of your own at home and how it is the single best aid to a productive design career. Barrie Gilbert then uses the eighteenth chapter to speak out on a subject that sums up the position of small hi-fi designers and manufacturers and why they seem to produce far more innovative products than the big boys. The answer is that simple team-work is left until a later stage in the development of the product: a team that takes a project from concept to production is more likely to produce an adequate product that fits well in the market place. The following chapter examines the roots of inspiration before the last one takes a philosophical look at costing, designing by mistakes and the inevitable botch of a circuit that doesn't work.

The final word? Buy this book and gain twenty years of experience ●

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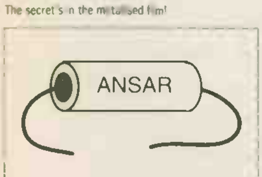

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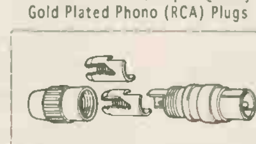

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D.I.Y. Letters

HOW AND 'Y'

I'm not sure whether this qualifies as a query for the main magazine or the DIY Supplement. Many of the DIY letters delve into mystical areas and talk of grid stoppers, phase shifts and other strange beasts with which I am not yet conversant. However, since I did a bit of soldering and opened the lids of not one but two amplifiers, maybe I qualify as a DIY probationer.

I recently purchased a second Ion Obelisk 3X integrated with X-Pak off-board PSU to use in bi-amp mode with my existing amp. Having internally separated the pre-amps from the power amps by cutting the clearly marked internal links, I then proceeded to use one pre-amp to drive both power amps, using the Pre Out and Power In sockets, connected by a 'Y' lead arrangement. This allows me to feed my bi-wireable 'speakers with one power amp each - in effect each half of the crossover has a channel to itself.

The arrangement works well and sounds better than with a single amp. Having achieved bi-amping with £1200 worth of amps (at 1990 prices) for the second-hand sum of £350, I was fairly chuffed. However, two points are puzzling me and it is these with which I hope you can help.

Firstly, I do a lot of headphone listening and quickly found that the headphone socket is driven from the power amp, not the pre-amp as I had assumed. This meant making up another rather clumsy 'Y' lead to get a stereo signal to the 'phones - not a very elegant arrangement. Can you suggest a way round this?

Secondly, being a hi-fi nut, I am never satisfied. Therefore I tried rearranging the cables to allow me to drive the 'speakers 'top and bottom', rather than left and right, by using one amp to drive the tweeters and the other the woofers. The result was horrible distortion with an intermittent quality. I have double-checked all connections but still can't get this arrangement to work, which is a pity because it would obviate the need for my first query!

Finally, would it be within the capabilities of an electro-moron like myself to bridge the power amps and would it be worthwhile? Also, is there a way I can use the extra inputs on the redundant pre-amp?

Rather a lot of questions I know, but if you can help me I promise to try actually building something. Then I'll be able to write proper DIY queries!

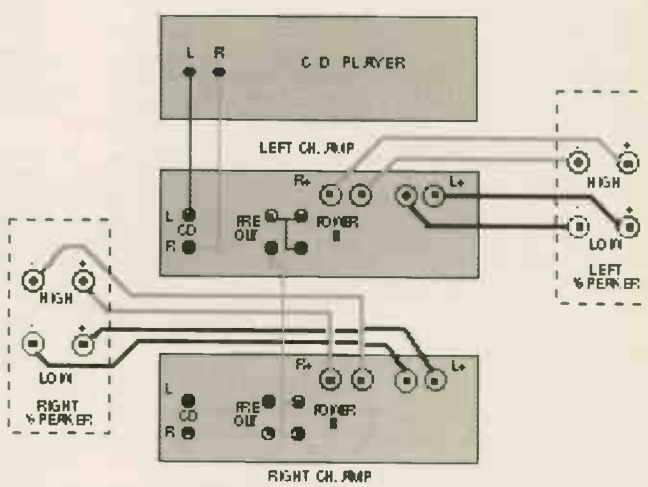
Colin Beresford
Billinge,
Lancs.

With reference to the headphone question, you have two possibilities. One, to buy a dedicated headphone amplifier that would connect to the pre-amplifier outputs. Creek Audio do a high-quality compact unit. Alternatively, make up a small box that contains a stereo jack socket and feed the 'speaker wires to this new box. You'll need some attenuation to reduce the volume to an acceptable listening level and this is easily done by wiring a 220ohm 1watt resistor in series with each positive wire in the box. If you find the level is still too high, increase this resistor in incremental steps of 100ohms until you get the setting you want.

The only explanation I can imagine for the problem with distorted sound is insufficient earth returns - you may have removed a link that is important in this mode of operation. Check you've split the crossover correctly.

Bridging involves a lot of changes and the designer, when asked to develop a suitable amp, normally re-designs the unit to take the extra loading. You must bear in mind that when an amplifier is operated in bridge mode, each channel of the amplifier sees half of the 'speaker impedance, and if it isn't designed for low-impedance loads, that could push the amplifier beyond its design limits.

The other problem with bridged amplifiers is that each channel must be out



Pre-Amp Out and Power Amp In sockets give you the chance to bi-amp if you happen to have two integrated amps. One way to do this is with 'Y' cables, the bottom of the 'Y' taking the signal from the Pre-Amp Out sockets. The two 'arms' of the 'Y' then connect to the Power Amp In sockets on each amp.

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of phase with its partner. This involves electronic phase reversal and not just swapping the 'speaker connections on the back of the amplifier. Chris Found

RULES AND REGULATION

I have just upgraded my K5881 valve amplifier in accordance with your article in the November issue of Hi-Fi World and I have to say that I agree with your assessment in that the performance is much improved. The upgrade followed your diagram in Hi-Fi World and a number of small points have arisen as a result:

1) What is the grounding philosophy? I have noticed that the amplifier now hums and is noisier than previously, although I have always had a problem with keeping hum below audibility. The circuit now commons R6, C4 and the two 100ohm input resistors, whereas on the EF86 design they were independently taken back to the star earth. Currently my K5881 is wired as the new circuit diagram as it gives lowest hum.

2) Why is R6 changed from 82k to 136k? It is not mentioned in the article.

3) The article states that the sensitivity has increased. I do not experience this; if anything, it has decreased. It is very dependent upon V2 valve types as well. Golden Dragon ECC83s increase the sensitivity but the hum is unacceptable. CVC Premium ECC83s decrease the sensitivity and the hum is just audible. I am using CVC Premium 7025s. What are the optimum valve types/makes? The 7025/ECC83/12AX7WA seem to be equivalents but I am not finding this.

4) What other improvements can be made, eg valve-regulated power supply, more exotic components or making the amp single-ended. Is it worth it? How about another article?

Andrew Riley
North Cave,
East Yorkshire.

With all valve amplifiers, the best ground technique is to star all the earths at one point. This prevents noise from other parts of the circuit affecting the amp's performance. On the original K5881, I believe that there was a star ground which originated around the input.

With all amplifiers where modifications to improve the sound quality incorporate some changes to the feedback components there is a possibility of hum arising. This is due to the way high feedback can mask some of this hum. The earthing arrangements may need to be adjusted to compensate. Even for a competent designer this can take a lot of time to get right, so if it is not too obtrusive I would leave well alone.

If the hum is still there after you've tried everything, then the only option is to have a split heater winding made to cancel out the residue.

The inputs are best connected close together to keep currents in this area low. You can separate each connection and feed it to the star point but I don't think you'd find any benefit.

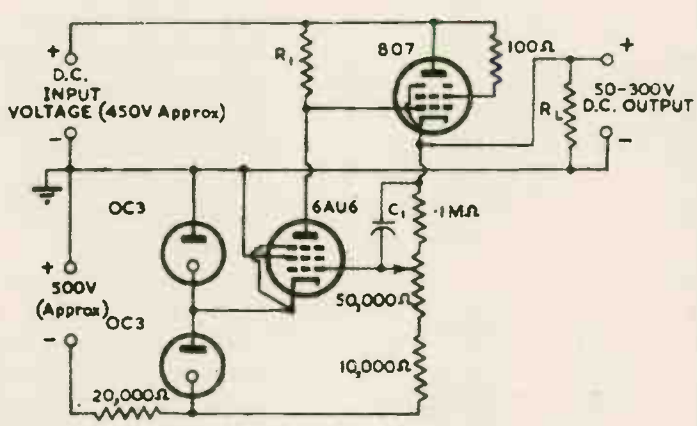
R6 was changed to achieve a better balance of the differential drive circuitry. This stage, when first designed, was set to give more gain than originally intended and this in turn affected the operating conditions and thus the performance.

Other modifications, such as those made to the input components of K5881 MkII, were made to bring operating conditions throughout the stages as close to optimum as possible, and some resistors were adjusted to suit. In the MkI version, the high level of feedback moved the operating points of the various stages from what would be considered ideal.

When you reduce the feedback in any amplifier, the gain increases, but this is dependent upon the gm (transconductance gain) of the valves used. Certain manufacturers sacrifice some gm for a better operating range and therefore the gain of your amplifier may be slightly lower than the original.

As to item 4), cost starts coming into the equation. Valve regulation can be used, but if you want to regulate the whole amplifier including the output stage, the price really does rack up - power valves would be needed to regulate the output stage, with another valve to provide hum cancellation.

We have a single-ended K5881 amplifier available as a kit. The K5881 push-pull is not modifiable for single-ended operation. CF

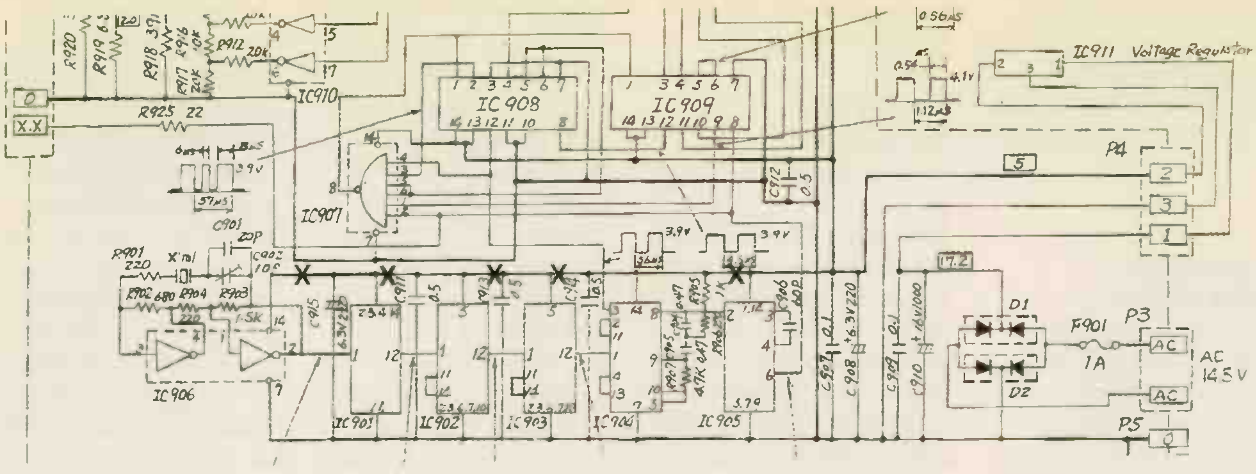


Valve regulation produces some great sounds from the component it's used with, but it isn't going to be cheap.

TALKING TECHNICS TWO

In answer to a letter from David Fellows of Cheltenham about modifying Technics' SL1000/MkII direct-drive turntable, we mentioned some electronic changes. One of these was fitting LM317T regulators. Unfortunately, one fact was left out - the variable resistor in the external PSU which sets the supply voltage for the analogue stages (usually 32.5VDC) needs to be adjusted to give an output of 35VDC because the LM317Ts need a couple of volts headroom to operate correctly. The variable resistor which controls the logic voltage (normally 5V) should be checked to make sure it gives 5.1VDC to 5.2VDC so the low-dropout regulators have the necessary 40mV headroom. Both of these variable resistors are clearly marked on the PCB.

When setting these voltages be VERY careful, as the 140VDC supply for the neon lamp that makes up the stroboscope is on



Inside the external power supply box for the SP-10MkII motor unit is the crystal oscillator circuit which controls the platter's speed. The oscillator's performance can be improved by cutting the PCB tracks and inserting 5V regulators at the points marked 'X' in the diagram.

the same board, as are uninsulated terminals carrying mains voltages.

Once these changes have been made, there's one last mechanical modification which is worth trying.

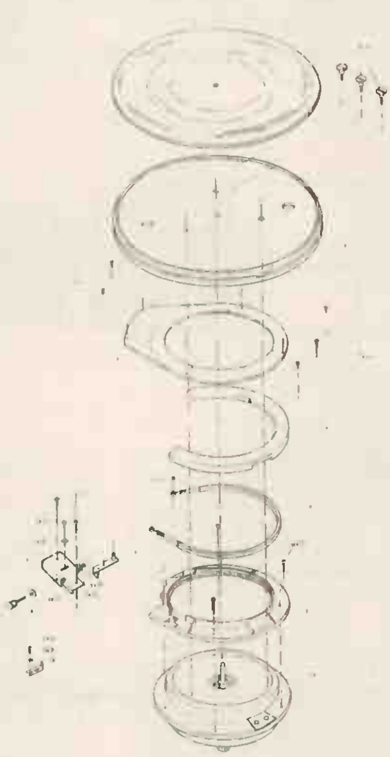
Remove the turntable's aluminium platter and you'll see a black cover plate held in place by five pozi-drive screws. This hides the belt brake and its solenoid. Take off the cover and the grey rubber damping ring beneath it. Next, prise off the circlip which attaches the brake belt at the solenoid end and then undo the single screw which holds the black plate that anchors the belt at its other end. Now you can take the brake assembly off.

The next step is to remove the four bolts which hold the direct-drive motor itself in place. This means you can take off the moulded black plastic ring sitting around the top edge of the motor which these four bolts screw down onto. Once the plate is off, replace the bolts and tighten them.

Getting rid of this plastic plate gives much better coupling between the motor and its mounting, and reduces background noise, improves dynamics, tightens up the bass and makes the sound smoother.

If you're thinking about checking the main bearing's condition, now is

Exploded View of Turntable



How Technics' SP-10MkII direct-drive motor is held in place on its mounting plate.

the time to do it. While the motor is bolted in place, prise off the two black rubber caps which cover the bolts which hold down the curved metal plate that prevents the sub-platter being lifted off the stator. Lift the sub-platter up, put it carefully to one side, and start cleaning out the bearing housing with cotton buds lightly dipped in Isopropyl alcohol.

When I did this, I found some rather dirty oil at the bottom of the housing but the bearing surfaces were fine, even after at least 15 years' use, a testament to Technics' engineering! You can get new oil contained in an easy-to-use syringe from Origin Live (tel: 01703 442183) for £5. This is a special oil used by the military in arctic conditions, according to Mark Baker at OL.

Clean the bearing shaft with a lint-free rag soaked in Isopropyl alcohol and then put a couple of drops of oil into the bottom of the housing and one or two more onto the bearing shaft. It is very important you don't put too much oil into the bearing as the shaft then won't seat properly on the ball bearing at the bottom of the housing.

Slip the shaft back into the housing, let the sub-platter settle down gently into place as the air trapped in the housing seeps out, bolt the curved metal plate back into position and re-assemble the turntable. JM

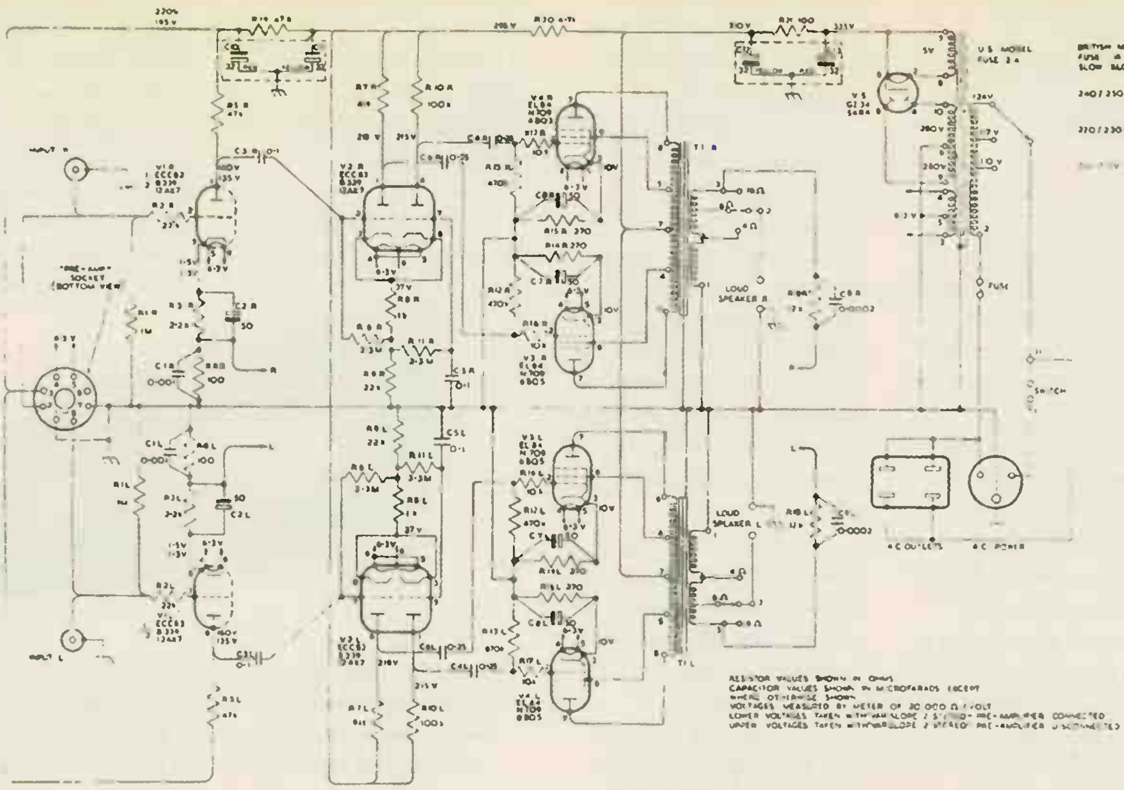
LEAKING

I have completely restored and rebuilt my Leak Stereo 20 valve power amplifier using Holco 0.5% 1watt metal film resistors and high-quality polypropylene capacitors throughout. Even the twin 32uF power supply caps have been replaced with Ansar polypropylene ones supplied by Russ Andrews.

I would like to change the circuit to use ECC82s in the phase-splitter stage instead of the ECC83s, and remove the feedback from the valve. How would this be done, and what improvements would this alteration make to the amp's performance?

P. Smith
Cambuslang,
Glasgow.

Apart from your suggested modification of changing V2 from an ECC83 to an ECC82, there are other areas that would benefit more from changes, direct coupling V1 to V2, for example. This can be achieved by putting a wire link in C3's place and making a few resistor changes. Remove R8 and



CIRCUIT DIAGRAM

Leak's Stereo 20 valve amp is a bit of a classic and can scale even higher sonic heights with a few well-chosen modifications.

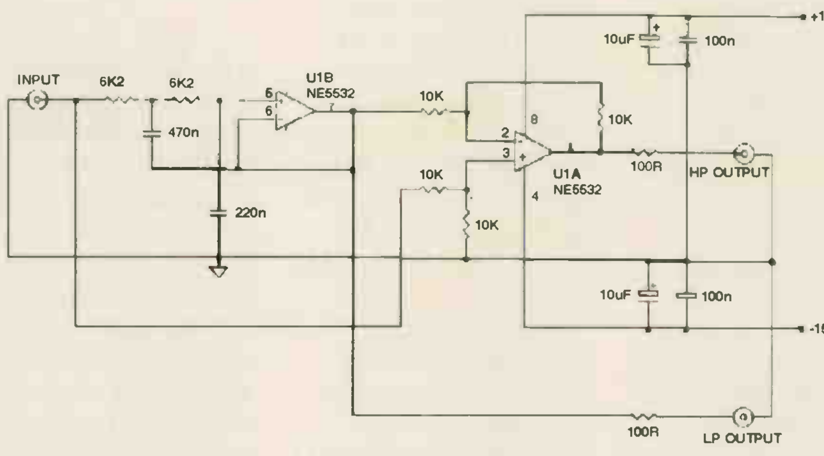
R9, and place a 100kohm resistor from the cathode of V2 to ground. This effectively rebiases the phase-splitter valve for DC operation and the cathode should rise to approximately 2V below the voltage of the anode of V1 (133V approximately).

This action will reduce gain in favour of an improvement in linearity. R6 and R11 now form the bias for V2b and the stage should work correctly, the gain reduced from about x20 to x6.

You can now try an ECC82 in place of the ECC83 as the biasing for this stage will automatically correct itself and there will not be much difference in gain.

Put a resistor of 100ohms in series with the screen connections of each output valve. This will help to isolate the screen of the valve from the transformer winding and reduce interactions that are caused by the capacitance of the screen on the transformer.

You could change the output stage from Class A working to AB1. This will increase power slightly as well. If you decide to do this, change R14 and R15 to 47ohm and remove the ground connections of R12 and R13, connecting them instead to a negative voltage of 10V. This will bias the output valves so that 42mA flows through each of them (2V across each cathode resistor). CF



This active filter will allow you to interface your Mordaunt-Short MS-25is and home-made active subwoofer seamlessly.

ACTIVELY SEEKING A SUBWOOFER

My system comprises a Sony CDP-X555ES CD player, Audiolab 8000S amp and Mordaunt-Short MS-25i loudspeakers. I also have a 'spare' HK1200 amplifier. My question is: I would like to make a pair of subwoofers and drive them using the HK1200 using the pre-amp outputs of the 8000S. Can you suggest a simple active crossover circuit I could place between the 8000S and the HK1200 so that it cuts the signal off at 100-120Hz? Would such a circuit harm either amplifier?

I could of course make a passive crossover inside the subwoofers but this strikes me as inelegant and wasteful

of amplifier power. I would appreciate any suggestions you might have.
Darren Englibretsen
Groningen,
Netherlands.

The MS-25i 'speakers, if my memory serves me well, have a workable response down to 70Hz, so I would recommend that the crossover be changed from 100-120Hz to 80Hz. The subwoofers that would be used after this would provide better control of the bass.

You have not stated what sub you intend to go for, or the drive units proposed, so I am going to assume you intend to use a couple of 12in. drivers in a medium-size box.

The crossover detailed below works on the differential principle where the signal going into one input of an op amp will cancel out the signal feeding into the other input. Therefore, if you feed a filtered signal into one input and a direct signal into the other, the result will be the exact opposite of the filtered signal. This allows easy adjustment of filter frequency. The values shown are set for a 79.6Hz crossover, with a Bessel characteristic chosen because it is effectively linear phase.

The formula for working out the crossover frequency is: $2\pi\sqrt{R1xR2xC1xC2}$

When calculating the values, multiply R1 through C2 first, then root the result. CF

IMPEDED BY IMPEDANCE

At the moment my system consists of a Project 6SA turntable with an Ortofon MC 25FL cartridge, a prehistoric Technics CD player (vintage 1989), Aiwa WX-909 twin cassette deck (three heads, twin capstans), a Rotel RQ-970BX phono pre-amp, Rotel RC/RB-850 pre and power amps and a pair of TDL RTL2s.

The turntable was bought last Christmas and is an excellent performer. I don't like CD much at all so I'm not bothered about changing my player. Maybe I'll wait till the DVD audio format sorts itself out and then decide. As for cassettes, I sometimes play them indoors but mainly in the car, so I'm not worried about changing the deck either.

The system as it stands now is totally unbalanced, so I want to upgrade my amplifier first then my 'speakers next year as finances permit.

My room size is 20ft. x 15ft. and I like Genesis, Vangelis, Jean-Michel Jarre and Pink Floyd at moderately loud volumes.

I have £1500 to spend and was thinking of your KLPP1 pre-amp (ready-built) with possibly two Arcam 9P power amps for bi-amping my current TDLs (careful with the volume control!) Solid-state power amps mean more grunt, which is just what I like. One slight problem I can see was printed in your Supplement dated June 1995, and that is the correct operation of the Low Frequency filter that reduces cone-flap with reflex 'speakers.

I quote, "As part of the phase-shifting network is formed by the input of the power amplifier it is important to note that the LF filter will only operate correctly when working into a 100kohm load, but this is standard with most valve power amps".

Now according to the Arcam brochure, the input is rated at 7.5kohm, but you suggest putting a 47kohm resistor in series with the output of the pre-amplifier. My soldering skills only go as far as making up interconnect leads, but could I get round this mismatch by soldering a 47kohm resistor in the phono plugs? If so, what type of resistors would you suggest, and what interconnect cable would you recommend I try?

I am very keen to purchase a KLPP1 pre-amp shortly, as vinyl is the only format for me, but are there any hi-fi stores doing demos or selling ready-built versions as you once published in Hi-Fi World? I would prefer a test drive before I buy!
Keith Smith
Maidstone,
Kent.

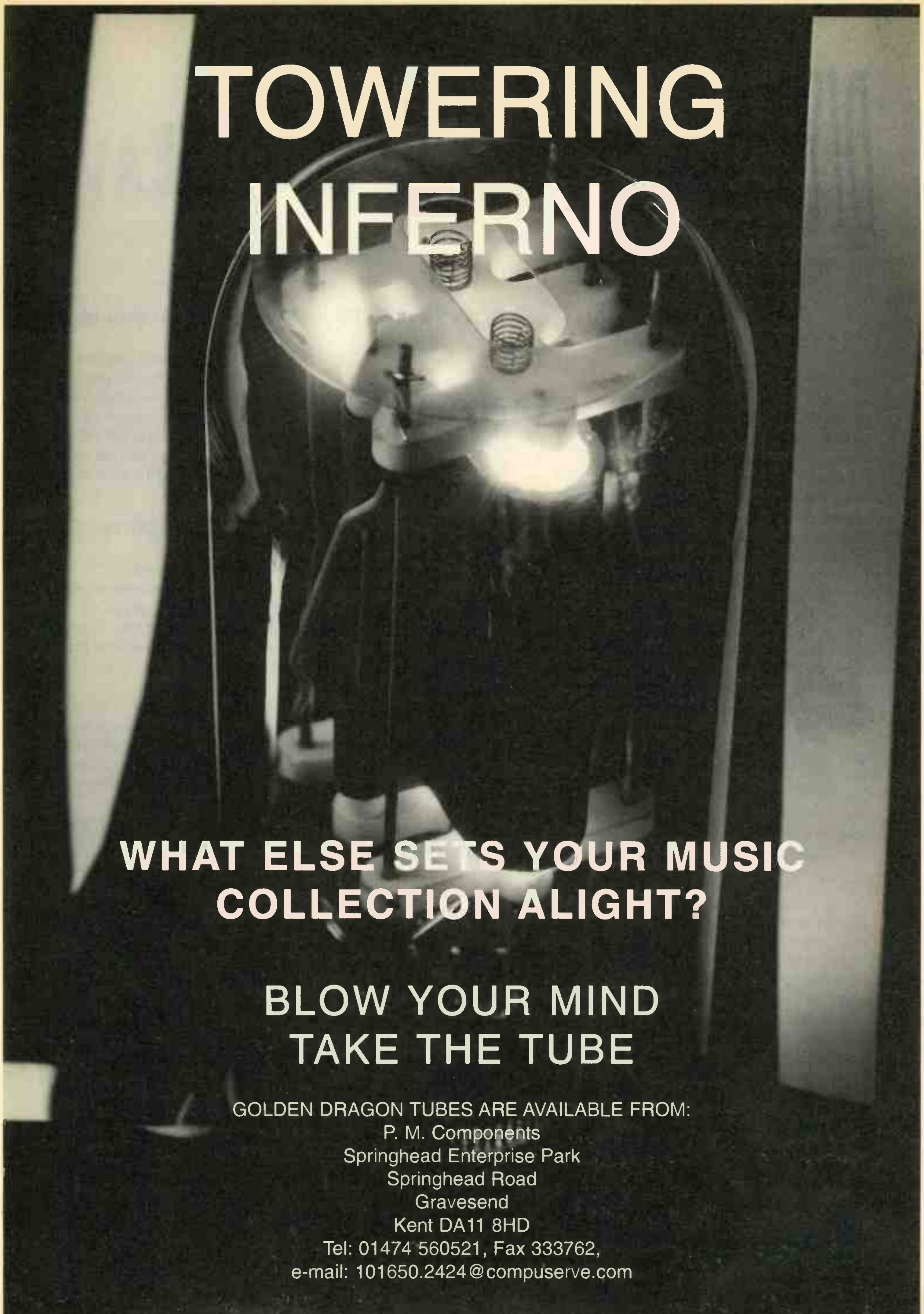
If the input impedance of the Arcam is 7.5kohm, then the loading would indeed be too low for KLPP1's low-frequency filter to operate correctly. A 47kohm resistor in series should do the trick, but it will also attenuate the signal by a factor of 7.3. Therefore for a signal of 1V the input to the amplifiers would be a mere 137mV. The only solution is to build the filter around an op-amp that is capable of driving the low impedance of the Arcams.

To calculate the attenuation ratio, the formula is: R1+R2/R2. The result of this calculation is the amount of attenuation you are introducing. R1 is the resistor in series and R2 is the impedance of the amplifier.

You can also try varying the series resistor until a sonic change is heard. Start at 47kohms and work downwards to a minimum of 15kohm. This should give you a simple solution to your problem. Use metal film or metal oxide resistors and yes, you can fit a resistor in a phono plug with care. Just wrap insulating tape around the resistor to stop it shorting to a metal-bodied plug. CF

KLPP1's warp filter is designed to work into the high input impedance of a valve power amp. However, with the addition of two resistors and an op amp line driver it will work just as well into a solid-state power amp with its lower input impedance.

SUPPLEMENT ADVERTISERS' INDEX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