Hi-Fi WORLD

NO.25 NOVEMBER 1996 SUPPLEMENT

THEORY FEATURE: DESIGNING A SIMPLE OPEN BAFFLE SPEAKER

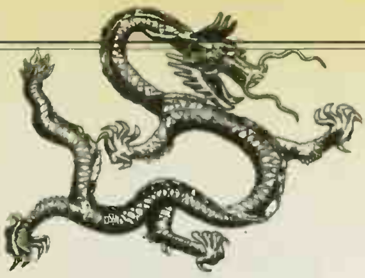
BOOK REVIEW: LOUDSPEAKER AND HEADPHONE HANDBOOK

WE REVIVE QUAD'S FM1 VALVE TUNER

WE FIT K5881 VALVE AMPLIFIER WITH S.R.P.P. TRIODE INPUT STAGE

FREE D.I.Y. SUPPLEMENT No. 25

World Radio History



Golden Dragon

RETAIL PRICE LIST

Golden Dragon Pre-Amplifier Tubes	Singles
6AQ8/ECC85	£6.50
12AT7A/E81CC/ECC81	£6.95
12AU7A/E82CC/ECC82	£6.95
12AX7A/E88CC/ECC83	£6.95
6DJ8/E88CC/ECC88	£10.95
6SN7GT/ECC33	£8.95

Special Quality Golden Dragon Pre-AmplifierTubes	Singles
E81CC-01 Gold Pins Low Microphony Low Noise	£10.50
E82CC-01 Gold Pins Low Microphony Low Noise	£10.50
E83CC-01 Gold Pins Low Microphony Low Noise	£9.50
E88CC-01 Gold Pins Low Microphony Low Noise	£14.50

Golden Dragon Triodes

	Singles	Pairs	Quads
2A3 4PIN	£22.50	£50.00	£100.00
2A3 OCTAL	£22.50	£50.00	£100.00
211	£28.50	£60.00	£120.00
811A	£11.50	£25.00	£50.00
845	£36.50	£75.00	£150.00
805	£36.50	£75.00	£150.00

Golden Dragon 300B Range

	Singles	Pairs	Quads
300B Super	£79.00	£160.00	£320.00
4.300B	£84.00	£170.00	£340.00
4.300BLX Super	£124.00	£250.00	£500.00

Please enquire of any tube types not listed. We have an Inventory of over 2,500 different types in stock.

Golden Dragon Power Tubes

	Pairs	Quads	Octets
EL34/6CA7	£25.00	£50.00	£100.00
E34L	£29.95	£60.00	£120.00
EL84	£8.95	£19.00	£38.00
E84L	£12.50	£25.00	£50.00
6L6WGB/5881	£25.00	£50.00	£100.00
KT66	£25.95	£52.00	£104.00
KT88 (New Design)	£57.95	£116.00	£232.00
KT88 Super (Laminated)	£67.95	£136.00	£272.00
6L6GC	£19.95	£40.00	£80.00
6550A	£42.95	£86.00	£172.00
6550A Special (Gold Plated)	£64.95	£130.00	£260.00
50CA10	£84.95	£170.00	£340.00
807	£25.00	£50.00	£100.00
KT66 Super	£65.00	£130.00	£260.00
KT90	£65.00	£130.00	£260.00
KT90 LX	£75.00	£150.00	£300.00

Ceramic Sockets and Hardware

	Standard	Gold Plated
Locking 4 Pin (300B etc.)	£6.95	£15.00
4 Pin UX4 (300B etc.)	£2.5	£3.50
Jumbo (211 etc.)	£12.50	£25.00
Octal Chassis (EL34 etc.)	£1.25	£3.50
Octal PCB (EL34 etc.)	£1.25	£3.50
B9A Chassis (pre amp)	£1.25	£2.50
B9A PCB (pre amp)	£1.25	£2.50
Screening Can & Skirt (pre amp)		£8.50
Damping Can (pre amp)		£4.50
Power Valve Retainer (EL34 etc.)		£5.50

NEW FROM Golden Dragon

274B	**£14.50 each**
350B	**£29.95 pair**
EL156 Octal	**£75.00 pair**
EL34 Super	**£25.00 pair**
EL34M	**£25.00 pair**

Carriage charge £2.50 on any U.K order. Cash with order or Visa - Mastercard accepted. 24 Hour Answerphone Service.

We have a vast range of tubes available from manufacturers all over the world including rare and vintage types. A 70 page booklet of valves available is updated monthly and can be provided at a cost of £2.50 per copy including U.K postage or you may telephone our Sales Desk for a prompt quotation. Prices exclude VAT. Please add VAT at 17.5%.

A selection from our stock of over 2,500 different audio quality valves. Please enquire for items not listed

ECC81	BRIMAR	4.50
ECC81	TEONEX	3.50
ECC82	TEONEX	3.50
ECC83	TEONEX	3.50
ECC85	TEONEX	3.50
ECC88	TEONEX	4.50
ECC88	BRIMAR	4.50
ECF82	RCA	3.50
ECL86	TEONEX	3.50
EF86	TEONEX	4.50
EF804S	TELEFUNKEN	36.00
EL34	TEONEX	6.50
EL86	MULLARD	4.50
EL504	TEONEX	3.50
EL519	PHILIPS	15.00
GZ32	MULLARD	8.50
GZ37	MULLARD	4.50
GZ34	TEONEX	5.50
G237	GEC	5.50
KT66	TEONEX	6.50
KT88	TEONEX	12.50
M8136/ECC82	MULLARD	8.50
M8162/ECC81	MULLARD	8.50
M8137/ECC83	MULLARD	24.00
OA2WA	TEONEX	4.50
PCC88	BRIMAR	3.50
PL36	MAZDA	3.50
PL519	THORN	5.95
TT100	GEC	65.00
U19	GEC	8.50
UCC85	MULLARD	3.50
2A3	TEONEX	15.00
5Y3WGTA	SYLVANIA	4.50
5V4G	BRIMAR	3.50
6AG7	RCA	3.50
6A7G	RCA	8.50
6B4G	TEONEX	29.50
6C8G	RCA	3.50
6K7G	RCA	3.50
6L6GC	TEONEX	4.50
6SN7GT	TEONEX	4.50
6V6G	RCA	6.50
6V6GT	TEONEX	4.50
6X4	TEONEX	4.50
12AT6	BRIMAR	2.50
12AV6	RCA	2.50
12BA6	WESTINGHOUSE	3.50
12BH7A	USA	12.00
12E1	STC	15.00
13D3	BRIMAR	6.50
85A2	MULLARD	6.50
300B	TEONEX	50.00
807	TEONEX	6.50
1625	RCA	6.50
5687	USA	6.50
5814A	GE	5.50
5881	USSR	6.50
6072A	USA	8.95
6146B	TEONEX	8.50
6158	BRIMAR	6.50
6189	SYLVANIA	4.95
6189W	GE	5.95
6201	GE	6.50
6463	USA	4.50
6550A	TEONEX	12.50
6870	BRIMAR	11.50

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Sales Desk Tel: 01474 560521. Fax: 01474 333762

World Radio History

D.I.Y. Supplement

Contents

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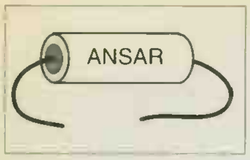
All of the projects in this supplement have gone through rigourous listening and test procedures. The performance and specification of these projects can only be guaranteed on kits bought directly from World Audio Design Ltd.

World Radio History

The secret's in the material



Manufactured specifically for high end audio, these polypropylene capacitors offer exceptional value for money as they use a [illegible] imported high purity metalised polypropylene film [illegible] smooth, natural and transparent sound quality and extremely low distortion, whether they are placed directly in the signal path [illegible] or for decoupling etc. [illegible]

Part No	Value	Price
CW100N	CAP PROPYL 100nF	£1.25
CW150N	CAP PROPYL 150nF	£1.25
CW220N	CAP PROPYL 220nF	£1.25
CW330N	CAP PROPYL 330nF	£1.25
CW470N	CAP PROPYL 470nF	£1.25
CW680N	CAP PROPYL 680nF	£1.25
CW1U0N	CAP PROPYL 1µF	£1.25
CW1U5N	CAP PROPYL 1.5µF	£1.50
CW2U2N	CAP PROPYL 2.2µF	£1.50
CW3U3N	CAP PROPYL 3.3µF	£1.85
CW4U7N	CAP PROPYL 4.7µF	£2.00
CW6U8N	CAP PROPYL 6.8µF	£2.50
CW10UN	CAP PROPYL 10µF	£3.10
CW15N	CAP PROPYL 15µF	£4.10
CW22U	CAP PROPYL 22µF	£6.[illegible]
CW33N	CAP PROPYL 33µF	£[illegible]
CW100U	CAP PROPYL 100µF	£20.00

Low value capacitors are extremely good in amps & preamps [illegible]. By changing to polypropylene you can [illegible] [illegible] better sound [illegible] in the treble [illegible]

Part No	Value	Voltage	Price
[illegible]	CAP PROPYL [illegible]	250V	£0.15
[illegible]	CAP PROPYL [illegible]	250V	£0.15
[illegible]	CAP PROPYL [illegible]	250V	£0.15
CPP220P	CAP PROPYL 220pF	250V	£0.15
CPP330P	CAP PROPYL 330pF	250V	£0.15
CPP470P	CAP PROPYL 470pF	250V	£0.15
CPP1N0	CAP PROPYL 1nF	250V	£0.15
CPP1N5	CAP PROPYL 1.5nF	250V	£0.15
CPP2N2	CAP PROPYL 2.2nF	250V	£0.15
CPP4N7	CAP PROPYL 4.7nF	63V	£0.50
CPP10N	CAP PROPYL 10nF	63V	£0.65
CPP22N	CAP PROPYL 22nF	63V	£0.85
CPP47N	CAP PROPYL 47nF	63V	£1.00

Low Impedence High Temperature 105 C Radial Electrolytics + 5%

[illegible]

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

Elna Solder Lug Reservoir Capacitor [illegible]

[illegible]

Part No	Value/Voltage	Price
[illegible]	CAL ELNA 10000µF [illegible]	£11.00

Monacor Air Cored Inductors

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

Part No	Specification	Price
P15	150µH 0.15Ω [illegible]	£2.[illegible]
P22	220µH 0.15Ω 48x19mm	£2.50
P33	[illegible]	£3.00
P47	[illegible]	£3.50
P68	[illegible] 59x19mm	£4.50
P100	[illegible]	£5.50
P150	1.5mH 0.5Ω 70x30mm	£6.50
P220	2.2mH 0.6Ω [illegible]	£8.00
P330	3.3mH 0.75Ω 70x30	£10.00

Monocor Ferrite Inductors

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

Part No	Specification	Price
F220	2.2mH 0.15Ω 400W 55x31mm	£6.50
[illegible]	3.3mH [illegible]	£9.50
F470	4.7mH 0.25Ω 140W 65x39mm	£11.00
[illegible]	6.8mH 0.35Ω [illegible]	£12.00
F1000	10mH 0.45Ω 160W 65x39mm	£13.50

Quality Valves

Affordable range of High Quality valves

Part No	Description	Price
6550	OUTPUT VALVE	£26.00
6L6GT	OUTPUT VALVE	£4.50
6V6GT	OUTPUT VALVE	£4.50
6V6GT	OUTPUT VALVE	£3.95
ECC81	TRIODE	£4.50
ECC82	TRIODE	£4.50
ECC83	TRIODE	£4.50
EF86	LOW NOISE PENTODE	£3.50
EL34	OUTPUT VALVE	£8.50
EL84	OUTPUT VALVE	£3.50
GZ34	RECTIFIER	£5.50
KT88	OUTPUT VALVE	£20.00

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

Part No	Description	Price
B9AC	B9A VALVE HOLDER CERAMIC	£1.50
B9AU	B9A VALVE HOLDER CERAMIC	£2.00
CC	SCREENING CAN	£2.25
OCTC	OCTAL VALVE HOLDER CERAMIC	£2.00
OCTP	OCTAL VALVE HOLDER PHENOLIC	£1.50

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

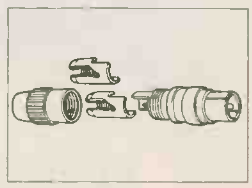
Part No	Description	Price
PPG5M2	PAIR GOLD PLUGS for up to 5mm CABLE	£1.50 pair
PPG8A2	PAIR GOLD PLUGS for up to 8mm CABLE	£1.50 pair

Very High Quality Phono (RCA) Plugs

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

Part No	Description	Price
PPG6M2	GOLD PTFE PLUGS for up to 6mm CABLE	£3.50 pair
PPG8M2	GOLD PTFE PLUGS for up to 8mm CABLE	£3.50 pair

Neutrik Pro Audio Super Quality Gold Plated Phono (RCA) Plugs



Superior pair of phonos each includes 2 cable grips for 3.5 5.5mm 6.5 [illegible] 3mm [illegible] for a wide range of cables. These connectors make contact with ground first at insertion to eliminate pop

Part No	Description	Price
PPN2	NEUTRIK PRO AUDIO	£12.00 pair

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

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

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

Bass Reflex Tuning Ports

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

Part No	Dimensions	Price
R35	d=35 L=110-210	£2.50
R50	d=50 L=150-280	£3.00
R70	d=70 L=125-245	£3.50
R100	d=110 L=160-122	£5.50
R85	d=85 angled 45° for narrow cabinets L=210-310	£6.50

High Quality Components at the right price Please ad £2.00 carriage + VAT to all orders Credit Card phone orders accepted

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01923 679207

QUAD 11 OWNERS

WE HAVE THE ONLY REAL KT66 REPLACEMENT. THIS N.O.S. ITEM WAS MANUFACTURED IN THE UNITED STATES AND CONFORMS TO THE HIGHEST MILITARY STANDARDS. THE SOUND QUALITY IS EQUAL TO THE G.E.C KT 66. WE OFFER THESE AFTER A BURN IN, LISTENING & MATCHING PROCESS AT £40.00 PER PAIR. HOW MUCH FOR A KT 66 !

PHILIPS/G.E.		TESLA/SVETLANA	
ECC81/6201	£4.00	EL34	£8.50
ECC82/6189W	£4.50	E34L	£8.50
ECC83/12AX7WA	£5.11	6550	£15.00
ECC83/5751	£5.11	6550C GOLD	£16.00

NEW OLD STOCK		SOVTEK	
ECL86	£4.00	12AX7WA/WB	£3.25
EF86	£9.00	12AX7WXT	£2.77
EL84	£6.00	12AX7 PREMIUM	£4.50
6L6WGB/5881	£10.00	EL34	£4.90
6SL7WGT	£6.00	EL84M	£5.00
6SN7WGTA	£6.00	6L6/5881	£4.90
6V6GT	£6.50	6922	£4.00
6550A	£30.00	7199	£8.00

FREE MATCHING on EL34 and 6550. Huge range held. All new, boxed & guaranteed. Prices are plus VAT & carriage.

THE Service Specialists

From **Classic Valve** to **Digital LaserDisc...**
You supply the Problem, We supply the Solution!

QUAD • GRANT • LEAK • RCA • REVOX • ALTOBASS • RADFORD • PIONEER • LUMLEY • TEAC • YAMAHA • AVANTIC etc.

For over 20 years we have provided un-matched technical services to Enthusiast and Pro. alike. We've satisfied customers at all points of the compass - even in Australia!
What makes *us* so popular? Simply, **we're the best!**

RESTORATION. Messrs, Leak, Walker, Radford *et al.* got it right! Yesteryear's great designs are, in the main, fine. They certainly don't need converting into something else, which seems to be a current trend. We will carefully restore your classic using modern high-quality components; this alone frequently improves the sound quality enormously. We will not, though, alter the original design in an attempt to "improve" it. Enjoy owning and listening to a Classic... not a latterday fad.

REPAIR/CALIBRATION. Even the finest equipment's will suffer an occasional breakdown and need meticulous repair, calibration and alignment. The **only** standards we recognise and work to are Manufacturers Original. Our Test & Measurement facilities are probably the best in this sector of the Industry... and we know how to use them!

KIT-BUILDING. There are numerous kits around nowadays. They all require skill/experience to build satisfactorily and, in the case of valve equipment, safely. Some designs are good, others ....well, let's just say their 'designers' would benefit from a sojourn on that celebrated desert island with only Terman and Langford-Smith for company!
Whichever kit you choose, though, it will benefit from a professional build. We will build it, de-bug it and give you a set of Final Test figures from your sample.

KIT-RESCUE. In trouble? It won't work? *Nil desperandum.* Contact us about a rescue/re-furbish.

For more details of our comprehensive services, 'phone or fax:-

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World Radio History

KIT NEWS

THE NEW POWERS THAT BE

Svetlana Electron Devices of Huntsville, Alabama, have just introduced four new power triodes intended specifically for use in high quality amplifiers. Like the 845 and 211A, these new Svetlanas have direct-heated, thoriated tungsten filaments, but come with massive graphite anodes. Rated at 125w, there's power on tap even in single-ended operation.

Four amplification factors are offered for circuit design flexibility, with the SV572-3, for example, claimed to give a clean sound without feedback, while a pair of SV572-160s can produce 300w output in Class B.

Svetlana Electron Devices
8200 South Memorial Parkway,
Huntsville, AL 35802
Tel: (205) 882 1344
Fax: (205) 880 8077

MORE SVETLANA GOLD

Watford Valves have started importing the latest Svetlana EL34 and 6550C Gold power valves. The latter benefits from a new tri-plate anode, precise grid/screen alignment and gold-plating on the grid itself. There is also a free matching service on both valves throughout October.

Watford Valves
3 Ryall Close,
Bricket Wood,
St. Albans,
Herts. AL2 3TS.
Tel: 01923 893270

BACK TO THE FUTURE

PM Components are taking a trip down memory lane with their new Retro range of valves, recreations of original designs from companies like GEC and Marconi. Thus far two valves have been produced, the KT88-R and KT66-R, both using the same materials in their construction as the originals and built to the same standard. For prices and more information contact:

PM Components
Unit B3
Springhead Enterprise Park,
Gravesend,
Kent DA11 8HD
Tel: 01474 560521

AUDIOCOM GO ALUMINIUM

Audiocom are now able to supply 450v aluminium capacitors from Panasonic. These have a large ripple current capacity and can be used in valve amp power supplies and the like. Audiocom are also offering 10% off prices of OS-CON capacitors and high purity silver wire during November, and any order over £25 will include a free metre of silver solder.

Audiocom
2 Swallowtree Gardens,
Saundersfoot,
Pembrokeshire SA69 9DE
Tel: 01834 814036

CHELMER'S LION

Chelmer Valve Company can now supply a version of the KT88 which is a close copy of GEC's Gold Lion valve. The valves are manufactured in Europe and come in matched pairs with individual test reports at £60 a set.

Chelmer Valve Company
130 New London Road,
Chelmsford,
Essex. CM2 0RG.
Tel: 01245 355296

SJS TRANSFORMATION

Extending their existing range of valve amplifier output transformers, SJS Electroacoustics are now producing four new single-ended transformers designed for maximum bandwidth with interleaving and split bobbins. For those who like transformers in their pre- as well as power amps, there are also new arrivals on the interstage and pre-amp output transformer scene, SJS claiming a bandwidth of 120kHz for both types. For the final aesthetic touch, black, chrome and brass finished caps are available.

SJS Electroacoustics
Ben-Dor,
Lumb Carr Road,
Holcombe, Bury,
Lancs. BL8 4NN
Tel/Fax: 01706 823025

SIMPLE SWITCHERS

If you'd like to follow Linn down the road to high efficiency switch-mode power supplies, then Farnell might have what you're looking for.

They now stock the new £7.50 LM2825 from National Semiconductor, which contains a complete 1A switching regulator on a single chip - all you need to add for a 5v or 3.3v output is a 7-40v input. Also available is a variety of regulators from Melcher's IMR6 range, concentrating mainly on 5v and 12v supplies with prices starting at £28.69.

Farnell Electronic Services
Edinburgh Way,
Harlow,
Essex CM20 2DF
Tel: 01279 626777

World Radio History

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Phone 01691 652894 Fax. 01691 662864

Hart Audio Kits and factory assembled units use the very best audiophile components in circuit designs by the renowned John Linsley Hood 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 tag boards! Many years of experience and innovation, going back to the early Dinsdale and Baily classics gives us incomparable design expertise in the needs of the home constructor. The current range of Hart kits is designed to give you all the components for a matching ensemble of audio excellence.

K1100 AUDIO DESIGN 80 WATT POWER AMPLIFIER

This fantastic John Linsley Hood designed amplifier is the flagship of our range and the ideal powerhouse for your ultimate hi fi system This kit is your way to get £K performance at bargain basement prices Unique design features such as fully FET stabilised power supplies gives this amplifier World Class performance with startling clarity and transparency of sound allied to the famous HART quality of components and ease of construction
Useful options are a stereo LED power meter and a versatile passive front end giving switched inputs with ALPS precision Blue Velvet low-noise volume and balance controls
Construction is very simple and enjoyable with all the difficult work done for you, even the wiring is pre-terminated, ready for instant use. All versions are available with Standard components or specially selected Super Audiophile components at £29 60 extra per channel plus £2 40 if you want to include Gold Plated speaker terminals

K1100 Standard Stereo Amplifier	**£415.21**
K1100SA Audiophile Specification	**£493.81**
K1100R Relay Switched Input Version	**£454.64**
K1100S Stereo Slave Amplifier	**£353.62**
K1100M Monobloc Power Amp	**£271.20**
RLH10 Reprint of Latest Amplifier Articles	**£4.50**
K1100CM Construction Manual with Full Parts List	**£5.50**

All SA Super Audiophile versions come with upgraded capacitors and Gold plated input and speaker terminations

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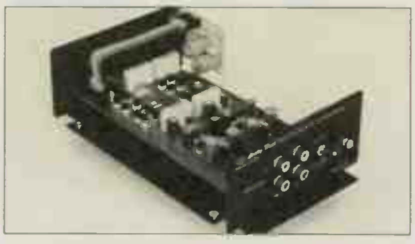

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World Radio History

Reviving the Quad FM1 valve tuner

Noel Keywood investigates the restoration of the Quad FM1 valve tuner.

I've seen boxes of unloved Quad FM1s tuners sitting under trestle tables, to clear for around £10 apiece. Why does a lovely valve tuner like this so commonly inhabit the lowlier regions of a vintage swap-meet? A Leak Troughline these days goes for £50 minimum - and often a lot more. There is a reason Quads remain ignored of course, but it isn't related to performance.

The big drawback with the Quad FM1 is that it is powered from the Quad II valve power amplifiers (yes, both of them), via the preamplifier. It is also switched by the Quad II preamplifier. So an FM1 is the most inert tuner going if you don't happen to own an entire Quad 22/II set up. Peter Walker, founder of Quad, showed some ingenuity with his first integrated system arrangement (he did beat B&O), but he didn't do much for second hand prices.

Unbelievably, to split the load, the Quad 22 preamp and the FM1 draw L.T. for their heaters (6.3V) from one power amp, and H.T. (330V) from the other power amp. The mains connection to the preamplifier exists only so that the whole shooting match can be switched on by the volume control. In those days - the late 1950s - power amps were hidden away, leaving a set up as compact as any today, and certainly more elegant, but difficult to switch on without a complex arrangement like this.

For me, the volume control mounted power switch and illuminated Quad legend were distinguishing features of Quad pre/powers, not to mention the delightfully solid cast fascias. I was going to say they don't build 'em like it today, but they do.

Both Mission and Linn acknowledge the example of Quad in this respect, and both use complex castings that cost a fortune to tool up. Trouble is, neither really exploit the styling benefits casting provides, certainly not in the way Quad did with the FM1, sculpting wonderful curves, bevels and ledges, difficult to achieve by any other method. Linn and Mission castings are too planar to clearly advertise their uniqueness and - woe! - they are painted black.

So that's the glory of the FM1: it's beautiful to look at and to use, one of a kind, but a trifle difficult to get going. What do you expect for a tenner? There's definitely leeway here for many evenings entertainment, restoring an

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FM1, so as usual let me first pour a little cold water on the idea.

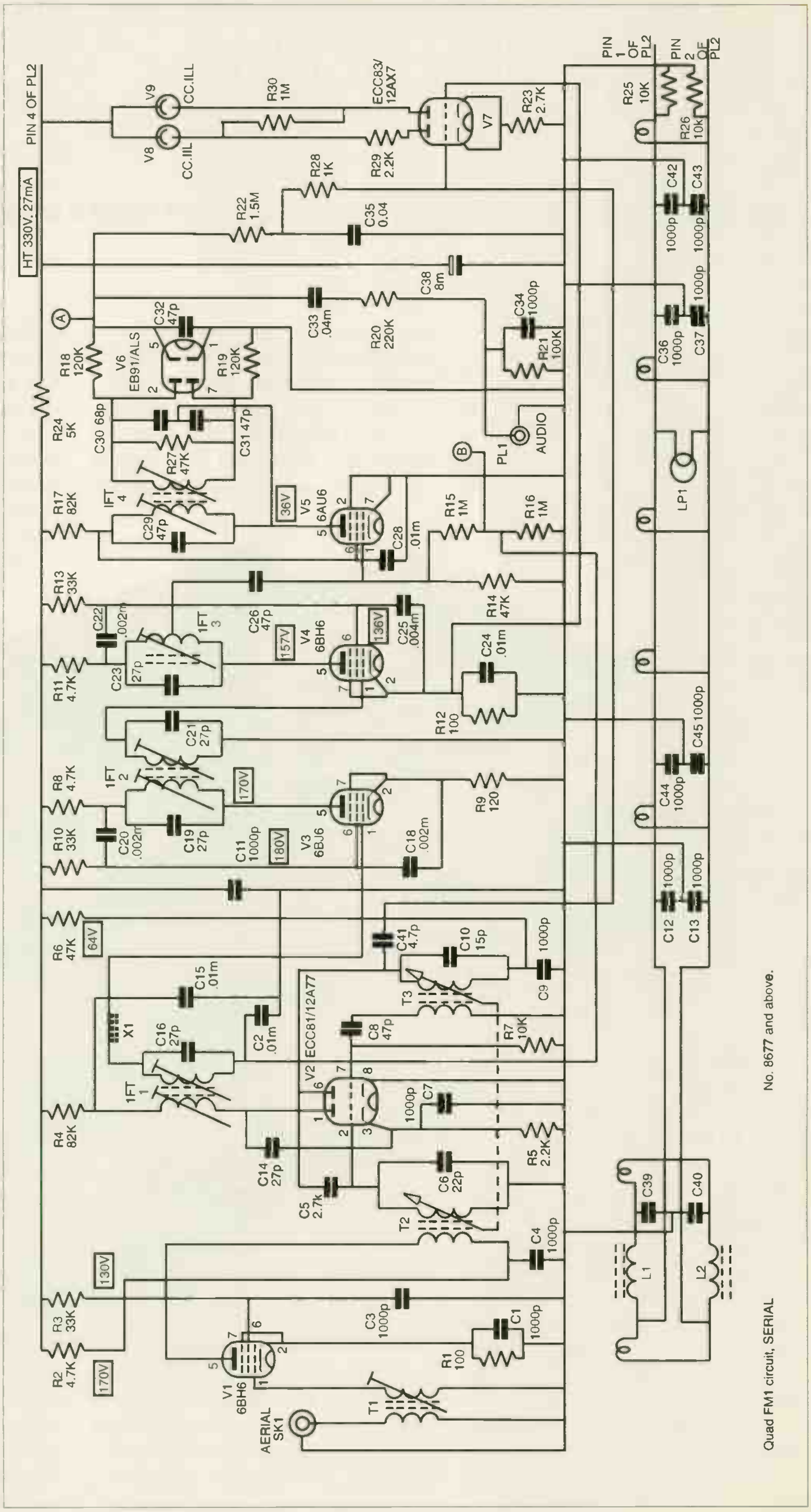
Building a power supply for the FM1 gets it up and running as an independent unit. This is a simple enough task for anyone conversant with electronics, but dangerous if you don't know how. The FM1 needs 330V H.T. (High Tension). The good news is that a complete supply will cost just £20 or so.

The other big problem with old tuners is alignment. This is quite likely to be awry and tuner realignment is not an easy task. If a simple RF generator is used it requires skill and experience. A poorly aligned tuner will distort, be insensitive and suffer interference. But I have more good news: Quad offer an alignment service that costs £40.

Ageing valve units like this - and the FM1 is now 40 years old - usually have a lot of resistors and capacitors that need replacing, since old components drift in value over the years and fail. The few decent condition FM1s I've encountered to date worked in a fashion, but not properly. However, armed with a circuit diagram and a good electronic multimeter it isn't difficult to repair a tuner like this, if you have a little electrical knowledge. Fail, and you have either lost £20 or so, or you can ask Quad to bail you out, since they still service and repair the FM1.

I need to point out that this article is a guide to getting the FM1 going, identifying the main problems. You must have some electronic knowledge to be able to tackle such a project. This is not a subject for beginners and this article is not meant for those with scant knowledge.

Circuit Diagram



Quad FM1 circuit, SERIAL No. 8677 and above.

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CIRCUIT DESCRIPTION

Here is Quad's circuit description: "A broad band fixed tuned transformer couples the low impedance aerial to a RF pentode (6BH6) the output of which is transformer coupled to a low noise triode (one half of 12AT7) mixer stage.

The local oscillator (other half of 12AT7) is fully temperature compensated and provides an output 10.7MHz above the signal frequency. It is capacitively coupled to the mixer grid.

Both the mixer grid and local oscillator circuits are ganged and permeability tuned by special low loss cores driven from the spindle via a precision worm drive mechanism.

The resultant 10.7MHz IF signal at the mixer anode is transformer coupled to the automatic gain controlled first IF stage (6BJ6). A combination of critical and over coupled circuits and a single tuned circuit in the second IF stage (6BH6) together with a close control of the Q of these circuits ensures a wide passband with a steep cut-off outside the band.

The second IF anode tuned circuit is coupled via a short time constant CR circuit to the limiter valve (6BH6), the anode of which contains a transformer with a capacitively centre tapped secondary winding feeding two diodes (6AL5) in a phase discriminator circuit. Again, the coupling and Q are chosen to give low distortion in the audio output.

The audio signal is fed via a two position switch either, in the unmarked mono position, to the appropriate de-emphasis network and DC blocking condenser, or in the red spot position, to the output cable when an uncorrected signal is needed for feeding into a stereo decoder.

The DC component at the discriminator output whose magnitude is proportional to the amount of mistune and of polarity dependent upon the direction of mistune, is fed to a cathode coupled phase invertor stage (12AX7) which contains a miniature neon in each anode. Slight mistuning extinguishes one neon, showing the direction of mistune, while even illumination of both indicates correct tuning. In addition, this stage provides Automatic Frequency Control, one section of the double triode acting as a reactance valve across the local oscillator tuning coil."

CHECKING WITH A MULTIMETER

Quad quote the H.T. as "between 250V and 350V". However, the nominal is 330V, the exact value being determined by mains supply volts and component tolerances, etc. The tuner consumes 27mA. The heaters consume 1.5A, and there's a 0.3A lamp, making for 1.8A total L.T. consumption, at 6.3V. These values must be checked with a multimeter.

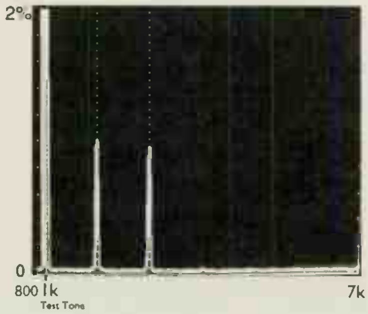
The valves V1 (6BH6), V3 (6BJ6) have around 170V on the anodes, and V4 (6BH6) has 157V. Around 0.75V-1V should exist on the cathodes. The mixer/oscillator, V2 runs at lower voltages and the limiter, V5, works in saturation mode. It has no grid bias, so the cathode is connected to ground, and it has just 35V on the anode. All the main voltages are marked on our circuit.

Ken Bunting, who has been with Quad servicing their products since 1970, told me that all the resistors in the high voltage lines tend to go high; one of ours had drifted from 82kΩ up to 103kΩ over the years, for example. They inspect and replace these first. The old capacitors, he told me, might look a little rough by modern standards, but they were more likely to be acceptable. In 'our' FM1, a tidy unit supplied by Graham Tricker I should point out, all the capacitors had been replaced, but not the resistors. In spite of the resistors being generally high, and the voltages a little low, it worked well. However, it was obvious to me from distortion figures, frequency response and the way it tuned into and out of stations that alignment of our FM1 was out, and the de-emphasis needed tweaking. So, be aware that just checking all DC voltages with a meter is not enough.

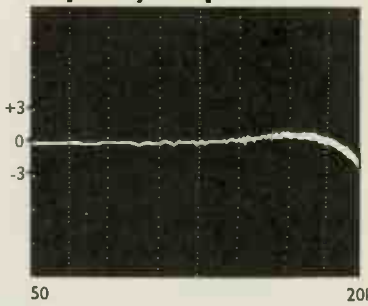
Ken Bunting, who has been with Quad servicing their products since 1970, checked and re-aligned our FM1 for optimum performance.

QUAD FM1 TEST RESULTS

Distortion



Frequency Response



Frequency response	14Hz-16kHz
Stereo separation	mono
Distortion (50% mod.)	1.3%
Hiss (CCIR)	-81dB
Signal for minimum hiss	2mV
Selectivity (at 0.4MHz)	54dB
Sensitivity	
mono	4μV

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6X4W Raytheon USA	3.00	ECC83/ECC803S Tesla	13.13
6336A	66.00	ECC83 Yugoslavian	2.93
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DE-EMPHASIS & DECODING

Demodulation from a 10.7MHz IF (Intermediate Frequency) signal to audio takes place in V6, which is a shunt-loaded Foster Seeley discriminator. So the audio signal (mono) passes through few components on its way to the output socket, ignoring for a moment the need for a stereo decoder.

Our circuit shows an early mono FM1 with an internal de-emphasis network. Later stereo compatible units have a two-position switch that, moved to the Red position, switches out de-emphasis to give a raw feed for a stereo decoder. This must be used to feed either Quad's own original decoder or the modern design such as the 1310 based design Graham Tricker can supply. De-emphasis is then applied later, within the decoder. Quad told me that C32 between the discriminator cathodes should be reduced to 15pF or so (from 47pF) when feeding a decoder direct, in order to strengthen the 19kHz pilot tone.

I should explain here that in order to lessen the audibility of hiss an FM signal is pre-emphasised above 2kHz (i.e. has treble lift) by the broadcaster to increase treble energy. The signal is then de-emphasised (i.e. has reciprocal treble fall) after demodulation in the receiver to give a net flat response. This technique is used in mono and stereo FM transmissions alike.

The Zenith GE stereo system, introduced in the late 1950s and used today, possesses a 19kHz pilot tone and a 38kHz suppressed sub-carrier, modulated with the stereo information. De-emphasis would ruin this composite signal, so it is applied after stereo decoding. So a stereo decoder always takes a raw audio feed, lacking de-emphasis.

For mono listening the stereo decoder can be ignored, but then the capacitors C33 (DC blocking) and C34, and resistors R20 and R21 must all be correct value. De-emphasis is carried out by R20,21 and, believe it or not, the output load (100k) all in parallel, in conjunction with C34, to give nominally 48µS de-emphasis time constant (the UK uses 50µS). Incorrect values here upset audio frequency response, as will any stereo pre-amp input impedance other than 100kΩ! So you must pay special attention to these component values and to the item an FM1 feeds if it is to sound right when delivering mono audio direct out.

Because I wanted to assess the basic tuner and not get too involved in the stereo decoder at this time - a whole subject in itself - I chose to set up, use and measure the FM1 in mono (dual-channel). Feeding an Audiolab 8000S preamplifier I found putting 47kΩ in series with the output and increasing C34 to 1250pF gave a flat response to 16kHz (there's no mpx filter to limit treble extension), shown in our spectrum analysis.

A Leak Troughline suffers none of this interfacing trouble, having a buffered output. And it is self powered of course, so now you know why the FM1 comes cheap nowadays. Audio output from our FM1, without decoder, measured 600mV at 100% modulation (i.e. full output).

Most FM1s are fitted with a piggy-back Quad stereo decoder, which is solid-state, using old germanium type transistors like OC44s (which some people insist sound better than modern silicons). By and large, early decoders give somewhat mediocre results, and Quad's has a complex power supply arrangement, which is why I've not concentrated on it here. My apologies if this is a slur on Quad's first decoder. I suggest the use of a modern stand-alone decoder such as Graham Tricker's.

I visited Quad to get our FM1 aligned. Ken Bunting confirmed that it was in fair working order, but it could be improved by resistor replacement. He had some other interesting observations to make.

The neon tune indicators have 'popeye' lenses on them and, also, they produce RF interference that causes spurious whistling when tuning into and out of stations. Since the original popeye types are not now available Quad choose to fit a small circuit board carrying LEDs that do the same job, but better.

Many chip-based stereo decoders have been brewed up over the years for the FM1. National Semiconductor publish a circuit in their Audio Handbook that uses a LM1800 chip.

Quad have most parts for the FM1, but not the front panel. The gold bands normally corrode, making the FM1 look tatty after a time. Graham told us that "ours" (his in fact!) was the best sample he'd ever seen, and Quad agreed. Re-alignment showed that the IFs were too peaked. Ken flattened the passband and ensured the demodulator was fine.

This work optimises selectivity, minimises distortion and, very importantly, gives and optimum tune point. Where the tune indicators had appeared not to work properly, after alignment they did. Having built quite a few valve receivers myself in the past I knew not to bother assessing the FM1 until it had been aligned properly.

The Quad FM1 is simple enough inside to make servicing and renovation fairly straight forward. Quad themselves and specialists like GT Audio can help here if you're unsure what to do.

Tracking across Band II (88-108MHz) cannot be made perfect. Quad ensure the tuner is station accurate at the bottom end of the band (Radio 2/3/4) but admit it may be up to 1MHz out at the top end, around Radio 1, for example. Also, component position in the RF head (the metal box into which the tuning shaft goes) affects tracking so if any component is disturbed or replaced here - and it is likely that some resistors will need to be - then tracking needs to be reset.

You might have gathered there's a bit too all this. Sadly, there seem to be few books available now on this subject, especially referring to valve tuners. Just bear in mind, if you are looking for a book on the subject, that a tuner like the FM1 is configured much like any superheterodyne receiver, AM or FM, right up to its demodulator.

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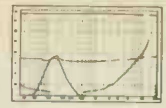

As Featured In the Hi-Fi World DIY Supplement No,s 22 & 23 (June, August 1996). Still available to Hi Fi World readers at the Reduced price :- £89-00 Inc Plus £5-00 P&P

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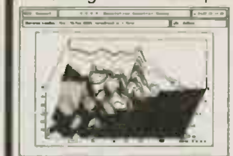

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World Radio History

THE POWER SUPPLY

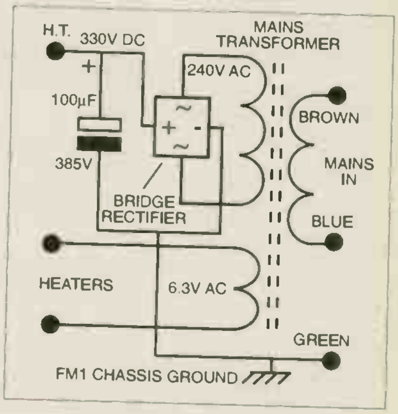
Very conveniently, 330V happens to be the peak value of 240V rms. This means that a mains 1:1 transformer can be used, since with a bridge rectifier, electrolytic smoothing capacitor and low current drain of 27mA we can expect 330V to be achieved almost exactly - and it was. Even more conveniently Maplin have just the right transformer. It delivers 240V AC at 100mA, plus 6.3V at 1.5A.

Whilst we need a little more than the rated LT current, it's an extra 2VA from a 34VA transformer, and since we are 8VA short from full drain on the HT I'd not expect core heating. In practice this was the case; the transformer ran cool and the LT didn't droop, giving 6.3V at 1.8A, with 240V AC in. Maplin identify this part as Valve Transformer XP27E, priced at £12.99, on p991 of their Sept-Aug 96 catalogue. I bought one from Maplin's Hammersmith branch in West London one Saturday morning.

You need a bridge rectifier of 1A-1.5A capacity rated at a minimum of 260 forward volts, and 400 Peak Inverse Volts (PIV) minimum. The electrolytic needs to be around 100µF, rated at 385V or more. You'll have difficulty detecting hum (a buzz in fact) with this. However, to get rid of it completely a 1kΩ/1W resistor should be used with up to 100µF either side, in π filter arrangement. Better still the resistor should be replaced by a choke.

These parts must be mounted in an earthed metal box, or a plastic box, for safety. It should be fitted with a mains switch.

Connecting up the power supply to the FM1 is easy enough. I'd suggest the existing power leads and, especially, the horrid 4-pin plug, now unavailable, are cut off and replaced by modern cable. Trace the power lead back into the tuner and you will find it terminates at three feed-through insulators. A new cable can be soldered in here. Note that the heater feeds are not grounded, but the HT is, so there are two heater lines and one (red) HT line. HT negative runs via the chassis and there is a suitable solder tag close to the feed-throughs.



Building a separate power supply can be easily done with standard components from Maplin Electronics

PERFORMANCE

Under measurement, frequency response was flat, our de-emphasis values giving a little +0.5dB lift at 8kHz. Mono noise figures are always much better than stereo, but the FM1 was still very good, giving -81dB hiss no less - better than most solid-state tuners. Mono -50dB sensitivity was a healthy 4µV and quieting so good that the FM1 will, in mono, should work well even with a poor aerial. Selectivity was a bit lop sided on ours, giving a mediocre 48dB rejection to stations +0.4MHz away, but a healthy 60dB to stations -0.4MHz away.

In listening tests I was not surprised to find the FM1 lacked the hardness of tone, flatness of imaging and treble glare that can afflict solid-state designs. It wasn't as sweet and deeply atmospheric as our Troughline, that's for sure, and I have to say that I did have to wrestle it into action with a lot fiddling to ensure the de-emphasis components matched the preamplifier load. Since this was done with the aid of a stereo generator and spectrum analyser, to ensure a flat frequency response, the investment here was not inconsiderable. There's a good case for letting Quad's excellent service department sort out this sort of thing. You will have to pay of course, but their charges are reasonable.

Both Classic FM and Radio 3 transmissions lacked hiss, hardly surprising considering the unit's fabulous -81dB noise figure. To eliminate hum completely power supply smoothing must be very good. The FM1 also has its own internal smoothing capacitor, C38, which needs to be checked.

Lacking inter-station muting, and working from a large outdoor aerial, the FM1 picked up many "ghost" stations. These were distant transmitters in fact, solid-state tuners experiencing the same effect with muting out (mono mode). The difficulty here was tuning into the proper station in the absence of a signal strength meter. I listened for hiss and crackles; local transmissions are always quieter (stronger signal). The FM1 also produces images above and below a wanted signal, something modern tuners avoid, but the tune indicator indicates an off-tune condition to them.

With good solid bass and clean, well differentiated treble free from solid-state grain and rasp (excellent tuners like NAD's 412 excepted) I felt the Quad FM1 more than justified its £30 or so basic outlay. It pulled in myriads of stations, proving very sensitive, and it separated most satisfactorily. However, to be realistic, getting it running properly wasn't without its problems, making this a project for engineers with a bit of time on their hands. The FM1 is an elegant looking tuner though, and it's lovely to use as well. I hope to be able to tackle the stereo decoder problem in future.

Our thanks to:

GT Audio, tel: 01895 833099

Quad, Tel: 01480 52561

Classique Sounds, Tel: 0116 283 5821

World Radio History

AUDIO NOTE

AUDIO NOTE AUDIO COMPONENTS PARTS & PRICELIST

[illegible]

AUDIO NOTE 10 LOUDSPEAKER DRIVERS & KITS

[illegible]

OTHER AUDIO NOTE COMPONENTS OR KITS

[illegible]

SOUND PRACTICES

[illegible]

POSITIVE FEEDBACK

[illegible]

LISTENER MAGAZINE

[illegible]

COMPLETE KITS

[illegible]

AUDIO NOTE OUTPUT TRANSFORMERS

[illegible]

AUDIO NOTE AUDIO QUALITY OUTPUT TRANSFORMERS

[illegible]

AUDIO NOTE CHOKES & INDUCTORS

[illegible]

AUDIO NOTE DRIVER, INTERSTAGE & PRE-AMPLIFIER OUTPUT TRANSFORMERS

[illegible]

AUDIO NOTE PAPER IN OIL SIGNAL CAPACITORS

[illegible]

AUDIO NOTE PAPER IN OIL COPPER & SILVER FOIL SIGNAL CAPACITORS

[illegible]

AUDIO NOTE SILVER FOIL SIGNAL CAPACITORS

[illegible]

AUDIO NOTE PAPER IN OIL RESERVOIR CAPACITORS

[illegible]

AUDIO NOTE ACID & CLORIDE FREE SILVER SOLDER

[illegible]

AUDIO NOTE CABLES & WIRES

[illegible]

World Radio History

This is the wiring recommended for all [illegible] projects, the same wire is used in the AN-V interconnect and as signal wiring in all Mr. Kondos amplifiers and pre-amplifiers, available in red, white, green and black. We will sell as little as 25cm of each colour, so buy a little and see if it makes a difference in your amplifier, a good place to start is on the Phono or CD input
AUDIO NOTE Internal Tone Arm Silver Wire
The ultimate wire for rewiring your tonearm, made from 3 individually insulated strands of 0.05mm Audio Note 99.99% silver wire, this is not just the best sounding tonearm wire, it is also the most flexible, so why not upgrade the sonic performance of your tonearm dramatically with a rewire?

Order Code Wire Gauge/Strands	Colour	Insulation	Price Ex. UK Vat
AN-WIRE-300 0.05 mm 3 twisted strands	Clear/SilverPolyurethane 6 coats		33.61 price per meter

AUDIO NOTE Cone Interconnect Cables

Order Code	Type/Colour	Construction	Price Ex. UK Vat
AN-CABLE-120	AN-a yellow	symmetrical 6N copper litz cone,	15.32
AN-CABLE-150	AN-C red	symmetrical OFLC copper litz cone,	29.79
AN-CABLE-200	AN-S dark grey	symmetrical 99.99% silver litz cone, 15 strands 0.09 mm	84.75
AN-CABLE-250	AN-V silver grey	symmetrical 99.99% silver litz cone 15 strands 0.09 mm	52.35
AN-CABLE-300	AN-Vx silver grey	symmetrical 99.99% silver litz cone 30 strands 0.09 mm	382.98
AN-CABLE-400	AN-Vz silver grey	Dual symmetrical 99.99% silver litz cone 60 strands	1,174.47

All Audio Note interconnect/cone cables are priced per stereo meter

AUDIO NOTE Speaker & Wiring Cables

Order Code	Type/Colour Code	Construction	Price Ex. UK Vat
AN-WIRE-500	AN-D green or red	single conductor 6N copper speaker wiring	6.85
AN-WIRE-550	AN-B blue white writing	double strand, screened 6N speaker wire	12.34
AN-WIRE-600	AN-L blue black writing	double strand screened 6N litz copper speaker wire	25.11
AN-WIRE-650	AN-SP silver	single core 15 strand 99.99% litz silver speaker wire	106.38
AN-WIRE-700	AN-SPx silver	single core 20 strand 99.99% litz silver speaker wire	382.98
AN-WIRE-800	AN-SPz brown	Single core 4 [illegible] conductor 60 strand 99.99% silver speaker wire	2,085.11

All Audio Note speaker cables are priced per mono meter
PTFE Insulated Silver Plated Copper Wires
We can also provide less expensive wiring wires for hard wiring circuits, these PTFE insulated silver plated copper wires are 19 strand of 0.15 mm wire and come in brown, black, blue, red, green, orange, violet, white and red/white, they cost £1.60 per meter in any colour

AUDIO NOTE HIGH QUALITY STEPPED ATTENUATORS & SWITCHES

These handmade 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/brushes made with an array of tantalum film resistors. The switches feature silver plated contacts and self cleaning action. Used in the newly released M10 pre-amplifier. serious stuff!!

Order Code	Type	Value	Price Ex. UK Vat
SWITCH-260	Stereo Potentiometer/Attenuator	10KOhms	221.75
SWITCH-265	Stereo Potentiometer/Attenuator	50KOhms	221.75
SWITCH-270	Stereo Potentiometer/Attenuator	100KOhms	237.75
SWITCH-270A	Stereo Potentiometer/Attenuator	250KOhms NEW	262.55
SWITCH-270B	Stereo Potentiometer/Attenuator	500KOhms NEW	267.45
SWITCH-280	2 Channel switch	6-way adjustable	98.75
SWITCH-290	4 Channel switch	6-way adjustable	124.75

AUDIO NOTE HIGH QUALITY CERAMIC VALVE BASES

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

Order Code	Description	Mounting	Pin Contacts Plating	Price Ex UK Vat
VBASE-185	14-pin UX4 for 300B/2A3/801A	Chassis	Gold	8.25
VBASE-180	14-pin UX4 for 300B/2A3/801A	Chassis	Nickel	17.25
VBASE-170	14-pin UX4 WE-type for 300B/2A3/801A	Chassis	Silver	14.75
VBASE-175	14-pin UX4 [illegible]	Chassis	Silver	48.95
VBASE-190	14-pin Jumbo 4 for 211/VT4C/845	Chassis with bayonet	Silver/chrome	59.95
VBASE-150	15-pin GT5 for 807	Chassis	Gold	9.75
VBASE-100	7-pin B7 for 6X4, OA2	PCB	Gold	6.15
VBASE-105	7-pin B7 for 6X4, OA2	PCB	Silver	7.85
VBASE-110	7-pin B7 for 6X4, OA2	Chassis from above	Silver	6.75
VBASE-115	7-pin B7 for 6X4, OA2	Chassis from above	Gold	7.95
VBASE-160	8-pin UX8 for EL34, 6550, 5U4G, 6Z34 6L6, etc	Chassis	Silver	5.65
VBASE-165	8-pin UX8 for EL34, 6550, 5U4G, 6Z34 6L6, etc	Chassis	Gold	8.65
VBASE-005	9-pin B9 for ECC83, ECC88, 5687, 6350	PCB	Silver	3.5
VBASE-010	9-pin B9 for ECC83, ECC88, 5687, 6350	PCB	Gold	5.75
VBASE-015	9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from above	Silver	4.45
VBASE-020	9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from above	Gold	6.75
VBASE-025	9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from below	Silver	4.95
VBASE-030	9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from below	Gold	7.15
TOPCAPS				
TVBASE-1000	Topcap	For 807 pentode etc	Nickel	9.75

You may want to start your project with less overall cost and for this purpose we can offer the following "industrial grade" ceramic valve bases.
Industrial Grade Valve Bases

Order Code	Type/Valve	Mounting	Price Ex UK Vat
VBASE-215	7pin for OA2 6X4	PCB	2.55
VBASE-205	8-pin for EL34, 6550, KT66, 6L6G	Chassis with bracket	1.45
VBASE-3001	9-pin for ECC83, ECC88, 5687, 6350	Chassis with shroud	1.85

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 the production of our own amplifiers, they fall into two categories, standard production items and old stock, mainly NOS (New Old Stock) valves which are no longer in production. We have compiled a special list of the NOS items, which is available against a stamped self addressed envelope, if you live outside the UK, send US$ 2.00. You should be aware that the valves on this list are NOT cheap, but we have stock of original GE, RCA and Tested Electronics 211, [illegible] 845 Westinghouse, VT25/10/T01, VT62/801A, WE300B, STC4300A, Mullard 6Z34/CV1377, Tungsol 5U4G (best sounding 5U4G I have ever heard!) Chatham 5Z4/VT[illegible] and many others
Standard Stock Items.

Order Code	Valve Type	Description/Recommendations	Price Ex UK Vat
[illegible]	E83CC/12AX7WA/7025	Switchable triode	2.95
[illegible]	E83CC Super/12AX7WB	Sovtek, high gain super low noise	3.95
[illegible]	ECC83/12AX7WXT	Sovtek, super low noise, low microphony audio version of [illegible]	2.85
VALVE-0080	[illegible]	General Electric, USA, double triode, low gain ECC83 type, exceptional sounding used in ONGAKU M7Tube Silver. KEGON [illegible] best sounding ECC83 GE USA low microphony version of 6072A	11.45
VALVE-0081	12AT7		
[illegible]	[illegible]	Sovtek double triode, low microphony	4.75
[illegible]	[illegible]	Philips/ECG USA, low microphony & noise, good sound	
[illegible]	[illegible]	Russian made version of the good pentode	6.45
[illegible]	[illegible]	Philips/ECG USA, double triode, mid gain	5.95
VALVE-0140	[illegible]	Tungsram, best ECC82 available from new production	4.95
VALVE-0142	[illegible]	double triode, UBS base	3.75
VALVE-0180	6SN7WGTA Sylvania	double triode original US-made, low microphony, super sounding	10.95
[illegible]	6SL7GT	double triode, UBS base	3.25
[illegible]	[illegible]	US-made double triode, fine driver	14.35
VALVE-0190	5687WB Sylvania USA	double triode, powerful driver used in ONGAKU	9.85
VALVE-0260	E182CC/7119/7044 General Electric USA	double triode very powerful driver, pre-equivalent of 5687WB	14.75
[illegible]	ECL82/6BM8	Sovtek mid-triode	2.65
[illegible]	EL84/6BQ5	Russian small power pentode	1.55
[illegible]	EL84M 6BQ5WA	Russian small power pentode, mil spec version	4.51
[illegible]	6V6GT	Sovtek small power tetrode	2.45
[illegible]	6L6G	Sovtek medium power pentode	2.75
VALVE-0400	5881/KT66/6L6WGC	Sovtek medium power tetrode	4.51
VALVE-0430	5881WXT	Sovtek medium power tetrode, standard base	5.55
VALVE-0440	6CA7/EL34 Fat Boll!	Sovtek power pentode	8.85
VALVE-0460	EL34G	Sovtek power pentode	6.45
VALVE-0480	300B	power triode, Audio Note branded and tested to our specification, Chinese manufacture	56.45
VALVE-0500	UV211	power triode, Audio Note branded and tested to our specification, Chinese manufacture	29.45
VALVE-0520	AN-845	power triode, Audio Note branded, tested and tested Chinese made	33.45
VALVE-0540	6C33	powerful Russian made regulator, indirectly heated triode	24.65
VALVE-0560	6AS7/6080	strong Russian regulator, indirectly heated triode	6.45
VALVE-0580	2A3 4-pin or 8-pin by Audio Innovations Second Audio	directly heated small power triode Chinese made	17.95
VALVE-0600	5U4G Russian	HT-rectifier	3.25
VALVE-0620	5Y3GT Russian	HT-rectifier	2.25
VALVE-0640	5Y3GT Sylvania	HT-rectifier	3.95
VALVE-0680	6Z34/5AR4 Russian	HT-rectifier	8.75
VALVE-0700	6Z34/CV1377 Mullard	HT-rectifier	49.95
VALVE-0720	6Z37/CV378	UK-made HT-rectifier equivalent to 6Z32/34 but better sounding	9.55
VALVE-0740	5R4WGB Cetron USA	Very powerful HT-rectifier, 2.500volt at 100mA!	24.55
VALVE-0760	6X4	HT-rectifier very good for pre-amplifiers, 7-pin base	3.75
VALVE-0780	6X5	Russian reverse pin version HT-rectifier for pre-amplifier & power amplifier front-with UBS base, Russian made	4.25

Please note, our 300B's are manufactured in China by Gold Dragon/Shuguang, but are tested in-house under real working conditions to parameters somewhat more stringent than is otherwise done. No, they do not sound quite as good as original Western Electric or RCA 300B's or STC 4300A's, nor do they carry the same premium price, please consider the following, unless you have absolutely tons of money or you happen to have them in your attic, do not consider original 300B's, it is in most cases far better to invest the money in more permanent features of the amplifier project, like better output transformers, better signal caps or resistors or the like, valves wear out (unlike quality passive components last much longer. A pair of original WE 300B's cost at least £1,200.00, on a good day, so instead of being obsessed by getting the best valves at any price, think in terms of an overall price comparison, you can get some fabulous sounding passive components for the difference in cost between a pair of Chinese 300B's and the original WE's, and in many cases the improvement in sound quality is greater than what the WE 300B's will contribute to, AND the contribution to sound is permanent consider that when you plan your project or revolve your existing amplifier

Resistors

We endeavour to stock the entire E12 range of all the different makes of resistors that we stock, except the very lowest ohmic values which are extremely costly as a rule we do not stock values 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 of finished products, there will generally be stock available within 4 weeks.

Beyschlag
We offer three quality levels of resistor quality, all are 1%, starting with the Beyschlag metalfilm, 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-made amplifiers up to and including quality Level 3, the [illegible]/P3/P4. 300B no-feedback triode amplifiers.
Beyschlag 1 watt 1% resistors up to 500KOhm, £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 "standard grade" metalfilm resistors available. They have very small downside, as they are quite fragile, and require careful handling, do not bend the legs too close to the body, HOLCO resistors are sensitive creatures and become noisy very easily

HOLCO resistors type H2 50PPM cost, £3.06 each from 1 R0 to 5R0, £0.89 each from 5R1 to 19R9, £0.36 each from 20Ohm to 230KOhm, £0.41 each from 231 KOhm to 1 MOhm, £1.02 each from 1 M1 to 2M0, £1.24 each from 2M1 to 4M0, and £2.21 each from 4M1 to 5M0

SHINKOH Tantalum Film Resistors

This is definitely the best sounding resistors available, forget the VISHAY, which may be ok in high feedback transistor amplifiers, but in our opinion quite uncomplimentary to the qualities of real Audio Amplification (i.e. directly heated triode amplifiers using no feedback [illegible] 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 stock available

AUDIO NOTE 1/2 WATT TANTALUM RESISTORS

With our in-house usage of tantalum resistors increasing all the time and Shinkoh becoming less and less able to supply, we have found it necessary to second-source the 1/2 watt value in addition to the 1 watt already offered, the AN-Tant are non-magnetic and share all other aspects of the Shinkoh, except the colour. They will be available by the time you read this in the following values: 10R, 12R, 16R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 91R, 100R, 120R, 150R, 160R, 220R, 270R, 330R, 390R, 470R, 560R, 620R, 680R, 820R, 910R, 1K0, 1K1, 1K2, 1K24, 1K33, 1K5, 1K8, 2K0, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 9K1, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 62K, 68K, 75K, 82K, 91K, 100K, 120K, 150K, 178K, 180K, 182K, 220K, 250K, 270K, 330K, 390K, 470K, 51K, 560K, 620K, 680K, 820K.

The 1/2 watt Audio Note tantalum resistors cost £1.99 each

AUDIO NOTE 1 WATT TANTALUM RESISTORS

Up to now 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 widen the range of 1/2 watt and reintroduce the 1 watt range which becomes an exclusive range for AUDIO NOTE, we consider this to be major breakthrough, since without a reasonable range of values in the 1 watt range it is practically difficult to get the very best out of the best circuits. The 1 watt Audio Note tantalum film resistors are available in the same values as the 1/2 watt, with the addition of the 1 MO and 1 M5

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

AUDIO NOTE 2 WATT TANTALUM RESISTORS

Firstly to complement the range of Audio Note 1 watt tantalum resistors we have started stocking a limited number of 2 watts, namely, 1 Meg, 1 M5 and 2 Meg

The AUDIO NOTE 2 watt 1% tantalum resistors cost £5.85 each

We shall now be working on getting a fuller 2 watt range and start stocking the 3 Watt tantalum resistors as well, and who knows perhaps we will be able to build amplifiers in a year's time that have all tantalum resistors in all parts of the circuit

AUDIO NOTE PRECISION CARBON FILM RESISTORS

In addition to the non-magnetic tantalum resistors, we are going to stock a range of precision goldplated carbon film resistors, in many cases the carbon film resistor is preferable if you are building an amplifier based on an old circuit. Use for example the WE91 or number [illegible] of similar 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 us by a major manufacturer

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

ALLEN BRADLEY 1 Watt 5% Carbon Film Resistors

Due to popular demand, and a general lack of other sources we have started stocking a range of Allen Bradley carbon film resistors, many experienced DIYers, like our friend Herb Reichert, consider these the very best sounding for many applications

Available in the E12 range of values, the 1 watt cost £1.43 each
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 a small range and expanding it as we go along, at the moment the following is available, all these resistors are 5% tolerance and glazed

Order Code	Wattage	Value	Tolerance	Price Ex UK Vat
RES-0328	6 watt	47R	5%	0.86
RES-0330	6 watt	100R	5%	0.86
RES-0340	6 watt	470R	5%	0.86
RES-0360	6 watt	1K0	5%	0.86
RES-0369	6 watt	2K2	5%	0.86
RES-0380	6 watt	15K	5%	1.32
RES-0381	6 watt	20K	5%	1.32
RES-0382	9 watt	100R	5%	1.24
RES-0384	9 watt	1K5	5%	1.24
RES-0386	9 watt	1K8	5%	1.24

More values will be added over the next 6 months, together with some non-inductive wirewounds!
BLACK GATE ELECTROLYTIC CAPACITORS, High Performance, Graphite foil capacitors.
Firstly, I would like to categorically state that any rumours about Black Gate capacitors being unavailable or discontinued are totally unfounded, malicious and incorrect, AUDIO NOTE is currently the sole source in Europe that holds any significant range of values in stock, we are literally 1000's in production, as we were the first company to realise the tremendous benefits that Black Gate capacitors offer, and we are to date the only high-end audio company in the world to incorporate Black Gate capacitors consistently in our finished products. There are very few audio parts that promise a guaranteed improvement when replacing virtually any other part, but this is what 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 greatly improve sound quality. We are working on some guidelines as to where, how and which types of Black Gates to use in different circuits, the first such technical guideline is available now and is called "Improving your CD-Player" and can be obtained by sending a stamped self addressed envelope, [illegible] AUDIO NOTE Level 2 Signature products [illegible] Black Gate [illegible] is critical in [illegible] power supply functions. It is very important to note that all BLACK GATE capacitors take time to charge-up or stabilise, when first put in circuit depending on type and application this "maturing" time can be between 100 and 300 hours. Black Gate call this the "idling process", our enclosed list of available values. We feel, however, that this process takes longer [illegible]!

We are about to stock the entire range of values on the enclosed list, so a separate pricelist is attached to the list of Black Gate program available. Ask us to send you this list as it is too long for an advertisement or to incorporate in our standard component list, otherwise it is not included in full. Again, as always, we appreciate a stamped self addressed envelope, it greatly influences the expectancy this end

The high voltage power supply capacitors type WKz have been replaced by an even better version, the WKz-Type, unfortunately the price has increased substantially as well, we have purchased a huge back up stock of the WKz's (in fact most of what Black Gate in Japan had left in stock!!) so I am lowering the WKz-Type on this pricelist until we run out of stock of each WKz item. Meantime we have introduced the Cerafine high voltage capacitors as a cheaper alternative

IMPORTANT NOTICE!

PLEASE NOTE THE PRICELIST FOR BLACK GATE CAPACITORS IS A GUIDELINE ONLY, DUE TO THE CONTINUOUS STRENGTHENING OF THE JAPANESE YEN, IT IS IMPOSSIBLE TO PRINT UP-TO-DATE PRICES MONTHLY, SO ASK FOR PRICE WHEN YOU ORDER

Order Code	Value	Voltage	BG-Type	Recommended Use UK Vat	Price Ex
CAP-9000	47mF	25volt	PK	Anywhere	1.65
CAP-9005	33mF	35volt	PK	Anywhere	1.75
CAP-9010	0.47mF	50volt	PK	Anywhere	1.05
CAP-9015	1mF	50volt	PK	Anywhere	1.12
CAP-9020	2.2mF	50volt	PK	Anywhere	1.73
CAP-9025	3.3mF	50volt	PK	Anywhere	1.38
CAP-9030	4.7mF	50volt	PK	Anywhere	1.68
CAP-9035	10mF	50volt	PK	Anywhere	1.87
CAP-9040	22mF	50volt	PK	Anywhere	2.68
CAP-9045	47mF	1.6volt	Standard	Anywhere	2.82
CAP-9050	33mF	1.6volt	Standard	Anywhere	3.42
CAP-9055	47mF	1.6volt	Standard	Anywhere	4.11
CAP-9060	330mF	1.6volt	Standard	Anywhere	6.68
CAP-9065	1.0mF	50volt	Standard	Anywhere	2.97
CAP-9070	4.7mF	50volt	Standard	Anywhere	4.41
CAP-9075	100mF	1.6volt	Standard	Anywhere	4.73
CAP-9080	1.00mF	50volt	Standard	Anywhere	5.47
CAP-9085	220mF	50volt	Standard	Anywhere	10.41
CAP-9090	1.0mF	1.00volt	Standard	Anywhere	3.71
CAP-9095	22mF	100volt	Standard	Anywhere	6.31
CAP-9100	47mF	100volt	Standard	Anywhere	8.54
CAP-9105	100mF	100volt	Standard	Anywhere	7.75
CAP-9110	[illegible]	100volt	Standard	Anywhere	22.18
CAP-9115	1000mF	16volt	Standard	Anywhere	8.72
CAP-9120	1000mF	50volt	Standard	Anywhere	24.55
CAP-9125	220mF	1.6volt	Standard	Anywhere	4.35
CAP-9130	470mF	1.6volt	Standard	Anywhere	6.35
CAP-9135	2200mF	1.6volt	Standard	Anywhere	13.45
CAP-9140	10,000mF	80volt	Standard	PSU smoothing	234.65
CAP-9145	4700mF	[illegible]	Standard	Anywhere	14.25
CAP-9150	47mF + 47mF	500volt 550v surge	WKz-Type	PSU filter capacitor	85.95
CAP-9155	100mF+100mF	500volt 550v surge	WKz-Type	PSU filter capacitor	101.95
CAP-9160	100mF	500volt	WKz-Type	PSU filter capacitor	72.75
CAP-9165	220mF+220mF	350volt 400v surge	WKz-Type	PSU filter capacitor	99.65
CAP-9170	100mF+100mF	350volt 400v surge	WKz-Type	PSU filter capacitor	75.35
CAP-9175	100+100mF	500volt 550v surge	WKz-Type	PSU filter capacitor	195.35
CAP-9180	47+47mF	500volt 550v surge	WKz-Type	PSU filter capacitor	159.85
CAP-9185	[illegible]	500volt 550v surge	WKz-Type	PSU filter capacitor	144.55
CAP-9190	100+100mF	350volt 400v surge	WKz-Type	PSU filter capacitor	151.74
CAP-9195	220+220mF	350volt 400v surge	WKz-Type	PSU filter capacitor	181.95
CAP-9200	22mF	350volt	VK-Type	[illegible] or filter capacitor	8.95
CAP-9205	150mF	350volt	VK-Type	PSU filter capacitor	41.73
CAP-9210	0.47mF	50volt	F-Type	Low ESR, Low [illegible] use anywhere	1.11
CAP-9215	22mF	6.3volt	F-Type	As above	1.22
CAP-9220	100mF	6.3volt	F-Type	As above	1.56
CAP-9225	220mF	6.3volt	F-Type	As above	2.11
CAP-9230	220mF	6.3volt	F-Type	As above	4.76
CAP-9235	47mF	16volt	FK-Type	Ultra low ESR version, comparable to film caps	7.15
CAP-9240	100mF	16volt	FK-Type	Ultra low ESR version, comparable to film caps	13.71
CAP-9245	220mF	16volt	FK-Type	Ultra low ESR version, comparable to film caps	19.95
CAP-9250	100mF	25volt	FK-Type	As above	14.28
CAP-9255	220mF	25volt	FK-Type	As above	21.43
CAP-9260	100mF	50volt	FK-Type	As above	15.71
CAP-9265	1000mF	50volt	FK-Type	As above use anywhere	58.71
CAP-9270	2200mF	35volt	FK-Type	As above use anywhere	55.71
CAP-9275	2200mF	63volt	FK-Type	As above use anywhere	101.43
CAP-9280	100mF	100 volt	FK-Type	As above use anywhere	32.85
CAP-9285	2.2mF	50volt	C-Type	For circuits with DC potential difference	2.[illegible]
CAP-9290	4.7mF	50volt	C-Type	For circuits with DC potential difference	3.35
CAP-9295	[illegible]	50volt	Bipolar	For loudspeaker crossover networks	12.65
CAP-9300	[illegible]	50volt	Bipolar	as above	16.85
CAP-9305	22mF	50volt	Bipolar	as above	23.95
CAP-9310	47mF	50volt	Bipolar	as above	3[illegible].95
CAP-9315	0.47mF	50volt	BG-Nx Type	For PSU decoupling	12.35
CAP-9320	220mF	6.3volt	BG-Nx Type	For super low noise PSUs	11.85
CAP-9325	100mF	16volt	BG-N Type	For super low noise PSU's	24.65
CAP-9330	470mF	16volt	BG-N Type	as above	28.95
CAP-9335	4700mF	35volt	BG-N Type	as above	210.45
CAP-9340	1mF	50volt	BG-N Type	as above	5.45
CAP-9345	4.7mF	50volt	BG-N Type	as above	6.65
CAP-9350	10mF	50volt	BG-N Type	as above	7.55
CAP-9355	47mF	50volt	BG-N Type	as above	13.75
CAP-9360	100mF	50volt	BG-N Type	as above	20.35
CAP-9365	1000mF	50volt	BG-N Type	as above	99.95
CAP-9370	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 their sizes, best usage etc.
Lastly, we can supply a range of more modestly priced components, still good quality, but more [illegible] grade, if you like
CERAFINE Powerhead Current Electrolytic Capacitors.
We have at long last secured a reliable source for these fine power supply filter capacitors, a must in any single-ended project of NOTE! We will start with two values of 350 and 500 volt, 100+100mF each, as these cover Black Gates where the prices for the [illegible] are prohibitive. We have increased the range of Cerafines we stock quite recently, and strongly recommend the Cerafines as a far superior replacement or substitute for ordinary electrolytics, and at the prices offered that should be within most budgets. All power supply Cerafines are supplied with a capacitor clamp and are upright mounting

Order Code UK Vat	Value	Voltage	Recommended Use	Price Ex
CAP-9740	100+100mF	350 volt	Power supply filtering	19.95
CAP-9750	220 + [illegible]	35[illegible] volt	Power supply filtering	2[illegible].15
CAP-[illegible]01	47mF	50 volt	Power supply filtering	12.95
CAP-9[illegible]10	4[illegible]+47mF NEW!	500 volt	Power supply filtering	19.95
CAP-9930	[illegible]+100mF	500 volt	Power supply filtering	29.95
CAP-9750	[illegible] NEW!	500 volt	Power supply filtering	29.95
CAP-9760	[illegible]+220mF	NEW 1500 volt	Power supply filtering	39.75
CAP-9970	[illegible] NEW!	500 volt	Power supply filtering	34.95
CAP-9580	[illegible]	100 volt	Power supply filtering	34.95
CAP-9530	4[illegible]	6.3 volt	Heater filtering	4.95
CAP-9670	100mF	100 volt	Bypass anywhere	2.95
CAP-9550	1.0mF	50 volt	Bypass anywhere	1.95
CAP-9640	22mF	100 volt	Bypass anywhere	8.95
CAP-9560	220mF	50 volt	Bypass anywhere	2.[illegible]5
CAP-9570	470mF	50 volt	Anywhere	5.55
CAP-9580	22 mF	50 volt	Anywhere	1.15

We shall continue to expand the range of Cerafine electrolytics over the next few months, so keep an eye on this space! POTENTIOMETERS. Best available from sound quality, price viewpoint, made by Noble in Japan, high quality conductive plastic film.
Volume Controls

Order Code	Impedance	Construction	Price Ex UK Vat
SWITCH-200	10KOhm Stereo, logarithmic	Frame-type, PCB mounted	4.95
SWITCH-210	10KOhm Stereo, logarithmic	Encapsulated type, PCB mounted	18.65

A better alternative is the KO-ON volume controls which are used in pre-amplifiers like the M7Tube, M7Line, and in a mono version on the input on the NEIRO, KASSAI, KEGON and GAKU-ON, these are very good sounding parts by any standard

Order Code	Impedance	Construction	Price Ex UK Vat
SWITCH-271	10KOhm Stereo logarithmic	Encapsulated	32.25
SWITCH-272	10KOhm Mono, logarithmic	Large Encapsulated	70.65
SWITCH-273	10KOhm Stereo logarithmic	Large Encapsulated, high quality	107.45

Balance Controls

Order Code	Impedance	Construction	Price Ex UK Vat
SWITCH-205	100KOhm	Frame type, PCB mounted	5.45
SWITCH-211	100KOhm	Encapsulated type, PCB mounted	19.25
SWITCH-274	100KOhm KO-ON	Encapsulated, PCB mounted	32.25

STANDARD TYPE SWITCHES

Order Code	Type	Facility	Construction	Price Ex UK Vat
SWITCH-[illegible]	Standard	6-way, 2 channel adjustable	PCB mounting	5.95
SWITCH-[illegible]	Standard	6-way, 2 channel adjustable	PCB mounting	30.65

This switch is adjustable 2 - 6 - way, it has gold plated contacts and a stainless steel ball for best possible [illegible] protection and contact. The KO-ON offers a very nice quality sealed switch. 6 way 2 channel at £ 90.[illegible]5 each
RCA, BNC, BANANA, PLUGS, RCA SOCKETS, SPEAKER & GROUND TERMINALS & LOUDSPEAKER SPADES
RCA Plugs

Order Code	Type/Description	Price Ex. UK Vat
[illegible]	Standard Gold plug	1.55
[illegible]	AN-C Gold plug	3.65
[illegible] 311	AN-GP AUDIO NOTE gold plug	8.51
[illegible] 308	AN-P AUDIO NOTE Solid Silver plug, teflon insulated, non-magnetic	25.5[illegible]

RCA Sockets

Order Code	Type	Mounting	Price Ex. UK Vat
CON-03[illegible]/032	RCA socket nickel plated	Chassis mounted	0.41
CON-037/038	RCA socket gold plated	Chassis mounted	0.65
CON-034/036	AN-CS AUDIO NOTE non-magnetic, teflon insulated socket, gold plated	Chassis mounted	3.65

BNC Plugs & Sockets

Order Code	Type	Price Ex. UK Vat
CON-050	Standard BNC plug	3.45
CON-051	BNC Silver plated socket chassis mounted	2.05

Banana Plugs, Loudspeaker Cable Spades, Chassis Loudspeaker Terminals
Type Price Ex. UK Vat

Order Code	Type/Description	Price Ex. UK Vat
CON-040	AUDIO NOTE Banana plug, gold plated, spring loaded tension	2.45
CON-045	AUDIO NOTE Loudspeaker Cable spade, silver plated, non-magnetic	4.65
CON-020/025	AUDIO NOTE AN-ST Speaker Terminal chassis mounts, nickel plated, red or black	1.85
CON-026/027	AUDIO NOTE AN-ST Speaker Terminal, chassis mounts, gold plated, red or black	2.75
CON-028-029	AUDIO NOTE AN-STR Speaker Terminal chassis mounts, fully gold plated 1 non-magnetic, red or black	4.75
CON-015	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 adverts in Hifi World and Hifi News

FERRITE RINGS

In many systems, especially ones using transistor based amplification, there is often a problem of incoming RF noise into the feedback loop, especially from connected CD-players, clamping a ferrite ring 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

ORDER CODE CON-018
AUDIO NOTE Moving Coil, CD Line & Input Matching Transformers
I have received many requests for moving coil, CD and input matching transformers, and since we already make and use these, it might be a good idea to offer them for general sale. Common to all of these small signal transformers is that they come in a mumetal screening can with a threaded spindle with a nut for mounting

Type	Colour code	Size	Primary/Secondary Impedances - Main Use	Price Excl. UK Vat
TRANS-465	TT7687	Brown	3 & 12Ohm - 10KOhm, copper wired MC matching	51.50
TRANS-470	TT7688	Red	15 & 600Ohm - 10KOhm, copper wired, MC matching	51.50
TRANS-460	TT7690	Yellow	3 & 12 Ohm - 10KOhm, copper wired high Quality MC matching	78.20
TRANS-455	TT7691	Green	15 & 6[illegible]Ohm - [illegible]KOhm, centre tapped copper wired High Quality MC matching	78.20
TRANS-450	TT7692	Blue	150 & 600Ohm - 2K5 & 10KOhm, copper wired High Quality line matching	78.20
TRANS-475	TT7693	Violet	25 & 100Ohm - 2K6, copper wired High Quality line matching	78.20
TRANS-410	TT7694	White	150 - 150Ohm copper wired High Quality line matching	101.50
TRANS-415	TT7694H	Clear	150 - 600Ohm copper wired High Quality line matching	101.50
TRANS-420	TT7695	Silver	150 - 150 Ohm silver wired High Quality line matching	378.60
TRANS-476	TT7696	Black	3 & 12Ohm - 100KOhm silver wired MC matching	378.60

The moving coil matching transformers are suitable for all moving coil cartridges, the low impedance versions are suitable for cartridges like the Audio Note Io, most better Ortofons, the Goldring, Koetsu's and some Koetsu's, the high versions are meant for Goldring Eroicas, most Denons, Clearaudios, Van den Hul cartridges, the Ikeda and a few higher output Koetsus.

The line matching transformers can be used in a number of applications, inter-component isolation and matching (as we recommend between CD-Player and pre-amplifiers, to separate earth planes and RF transfer), as pre-amplifier input or output transformers or wherever else you can think of

We shall expand this range to include more types as we go
AUDIO NOTE Chassis Sets
We have decided to offer for sale the two standard chassis' that we use for production of the OTO/SORO/DAC range of UK-made AUDIO NOTE products. Chassis's are notoriously difficult to get on a one-off basis, so here you are. We will only sell the chassis that we have rejected for production, due to minor failures in the finish, they still look alright, but are not strictly of a flawless, finished product quality

Order Code	Type	Width/Depth/Height	Price Ex. UK Vat
[illegible]	Chassis 1 [illegible]	[illegible]	£ 84.50
[illegible]	Chassis 2 [illegible]	[illegible]	£ 69.50
[illegible]	Chassis 1 Copper	[illegible]	£ 198.50
[illegible]	Chassis 2 Copper	[illegible]	£ 165.50
[illegible]	[illegible] KIT THREE Chassis, [illegible]	[illegible]	£ 78.90
[illegible]	[illegible] KIT THREE Chassis mild steel, painted chassis [illegible]	[illegible]	£ 116.70

You have to specify, when you order, whether you want chassis 2 for pre-amplifier or power amplifier use, the pre-amplifier has inputs on the side of the top cover, the power amplifier has many more ventilation holes, top and side. If you want a PCB with the input sockets mounted with the pre-amplifier cover, add £ 19.75 to the cost of the chassis and remember to specify this when you order. Please note that no copper pre-amplifier lid is currently available for Chassis 2. From time to time we will have more damaged or scratched chassis's, if you are not bothered about the finish or general appearance, or you intend to refinish the chassis anyway, you can have one of these for 50% of the above prices, just thought you should know, so enquire if this is of interest

AUDIO NOTE COMPLETE KITS

As mentioned earlier, we are developing a range of complete kits, to give 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

The AUDIO NOTE 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 all 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 powersupply is a capacitor-choke-capacitor with a 5U4G HT rectifier, the heaters are AC heated. Component quality is similar to our Level [illegible] AUDIO NOTE paper in oil signal capacitors, Beyschlag 1watt 1% metalfilm resistors, good quality electrolytics (sorry NO Black Gates!) and a simple, attractive stereo chassis in grey paintwork. Protecting cover is extra. We have several upgrade kits available for Kit One, ask for details.

Price £ 799.00 incl. Vat, which includes all valves (yes, also the 2 x 300B needed) but not postage/packing which to UK customers is £ 12.00, topcover is £ 99.00 extra. Kit One is also available with a polished chrome chassis and chromed transformer bell-ends, this makes the Kit One a real "stunner"! Add £ 200.00, to total £ 999.00. The Kit One is available now

KIT ONE ORDER CODE AN-KIT-001

The Kit One has recently been awarded the title "The Greatest Audio Bargain of the Twentieth Century" by Dick Olsher [illegible] in a review on the Internet, not bad

The AUDIO NOTE KIT TWO

Kit Two features a single 6550 tetrode 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. KIT Two is currently only available without valves for £ 570.00 incl. UK Vat. If used with Chinese 6550, no claims for faults in powersupply or output transformers will be accepted!!!

Price £ 599.00 incl. Vat, excludes valves, but not postage/packing, cover is extra at £ 99.00. With polished chrome chassis and chromed bell-ends on the transformers £ 799.00

KIT TWO ORDER CODE AN-KIT-002

The AUDIO NOTE 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 a 6SN7GT double triode as input valve and a pair of 5687 double triodes running in SRPP as drivers. The KIT THREE is essentially a mono version of the KIT ONE with double the power, the same component choices and on two chassis instead of one

The KIT THREE costs £ 1,550.00 and is available now. Cover is £ 99.00 extra per chassis (£198.00 for two). Polished chrome chassis and bell-ends is also available at £ 430.00 extra. Several upgrade kits are available for Kit Three as well, ask for details

KIT THREE ORDER CODE AN-KIT-003

The AUDIO NOTE KIT FOUR

The KIT FOUR is really our introduction to valve amplifier kit building, circuit and power supply mounted on one single printed circuit board, with two OTO type push-pull output transformers, all mounted in a small P1SE type chassis, covering everything, so nobody will be able to see that you have [illegible] to the lore of the valve amplifier, which is sweeping the world. The circuit consists of two 6V6GT tetrodes running in Push-Pull class A, yielding about 10 watts, driven by a 6SN7GT and a ECC83 input stage. Easy to build, even for the beginner

The KIT FOUR costs £ 249.00, as of March 1st, 1996

KIT FOUR ORDER CODE AN-KIT-004

The AUDIO NOTE Pre-Amplifier Kit

A kit loosely based on the AUDIO NOTE M7Tube pre-amplifier circuit is now available, initially we offer it in 3 versions, with the basic version, Version One consisting of only the instruction manual, the trackless PC boards for hardwiring the circuit, the mains transformer and the choke costing £ 99.00 inclusive of UK Vat. The trackless PC Boards are available at £49.95

Version Two, includes version one with the addition of a set of basic components, Beyschlag resistors, Roederstein Pol-ester signal caps, standard electrolytics, standard valve bases but no valves, Noble home volume and balance controls with PCB, input sockets with PCB, output sockets with PCB, but no chassis, at a cost of £ 199.00

Version Three adds the valves (4 x ECC83/1 2AX7WXT, 2 x ECC82 and 1 x 6X4R) and the chassis and upgrades the volume and balance pots to Noble encapsulated types. A complete pre-amplifier kit of the highest quality at £ 299.00 inclusive of UK Vat at 17.5%

Versions offering more sophisticated components will be introduced when we have enough parts in stock to support them, the most obvious upgrade would be to replace the Roederstein polyester with Audio Note paper-in-oil caps, either aluminium foil or copper foil and combine that with Audio Note tantalum film resistors, Audio Note silver wiring wire, change the EIAA valves to 6072A/12AY7's or use 6SN7WGTA Sylvania, Philips ECG instead of the ECC87's (please note that you need a different line board for this). Further improvements can be introduced with Cerafines or Black Gates, silver signal caps, copper [illegible] etc

Write to

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Sussex, England Telephone 01273 220511 (6 lines), fax 01273 731498. Direct line to sales 01273 770778

RUSSIAN Federation please contact ESOTERICA Ltd. Tel. 095 917 4385 Fax 095 917 8762

HUNGARY please contact [illegible] 54. U. Radey Fsz. 2 H-1092 Budapest, HUNGARY Tel/Fax 01 215-2612

HOLLAND please contact, de Jong Componenten, Langdonkerstraat 11, NL - 5605 LV Eindhoven Holland, Tel. 040 257 4744, Fax 040 257 4904

USA please contact Angela Instruments, [illegible] Guilford Road, Suite [illegible], Annapolis Junction, MD 20701, Tel 301 725 0451 Fax 301 725 8823

ITALY please contact AUDIO NOTE ITALIA Srl. 7/A Via F. Cossa 23014 [illegible] Tel. 0331 415 430 Fax 0331 587 661

FRANCE please contact Triode & Cie. 23, 25 Boulevard de l'Yser F - 75017 Paris. Tel. 1 4574 6930 Fax 1 4574 6940

BELGIUM please contact, Tube Audio Philosophy BVBA, Kontichsesteenweg 101 2630 Aartselaar Belgium. Tel 03 458 4846 Fax 03 457 8520

CANADA, ONTARIO, please contact Harry Falcon, Falcon Audio Electronics, 7723 Yonge Street, Olde Thornhill Ont. Canada L3T 3N1 Tel. 905 [illegible]1 5290 Fax 905 731 9[illegible]

AUSTRALIA, contact AUDIO NOTE Australia PTY Ltd. Tel. 03 9819 6478 Fax 03 9819 4299

YUGOSLAVIA, contact KORATO Systems, [illegible] 11000 Belgrade, Yugoslavia. Tel/Fax 011 439976

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AUDIO NOTE

World Radio History

OPEN BAFFLES

Prompted by a reader's letter, Dominic Baker produces a theoretical design for a passive open baffle loudspeaker.

Dolphin Square,
London.

DEAR Hi-Fi World,

I am a regular purchaser and reader of Hi-Fi World (every issue so far) with a particular interest in DIY articles and ideas.

Your recent article describing an open baffle sub-woofer is of interest to me, as I wish to build something a bit similar. Some time ago now I bought a pair of Audax HM170Z0 aerogel bass midrange units from you, with which I have been experimenting. I now plan to use four of these units per channel mounted in vertical array on an open baffle, to cover the frequency range up to about 400Hz in an active loudspeaker design which I am working on.

This will use a Linkwitz type active filter (fourth order Butterworth). The actual crossover frequency is 420Hz. The baffle width would be similar to your sub-woofer design, so I am assuming that the cancellation roll-off effect would set in from below 200Hz, at -6dB per octave, again as in your design.

I wonder if you could help me with three questions. With the units wired in series/parallel (to maintain the same, 8 ohm nominal input impedance as for a single driver), what gain in efficiency could I expect from the quadrupling of total-radiating area? Would it be approximately +6dB, or more? (The more the better, as far as I am concerned)

Related to that, and given sensible usage with predominantly classical and jazz programme, what is the maximum electronic boost (again in dB) that it would be prudent to apply at low frequencies to the four driver array? I had in mind somewhere between +9dB and +12dB, which would extend the 'flat' response down to about 70Hz or 50Hz, respectively, assuming roll-off at -6dB/octave from 200Hz. I would be happy to incorporate a 'bottom end' filter to roll off the input signal more sharply below the driver resonance frequency, in order to reduce displacement and distortion at very low frequencies.

Lastly, can you suggest a circuit which would be compatible with the Linkwitz filter circuit, and would achieve the required bass boost? I ask because I have to hand a circuit and equations - Linkwitz again - for step boost of +12dB per octave with variable turnover frequencies, but not for +6dB per octave boost.

Perhaps I should just add that I plan to use the four Audax units in conjunction with a Lowther Voigt PM5a(f) wideband mid/treble driver, loaded by a short, tractrix profile midrange horn, above 420Hz. Hence the interest in high efficiency, and the attraction of this specific multi-driver configuration below 420Hz, as the effective moving mass would be comparable to that of the Lowther unit, with a better chance of achieving seamless integration. I am more concerned with optimising the midrange and lower treble performance than with extracting very deep bass.

Brian Wadsworth

You're about to open up a large can of worms here, one that'll require a lot of experimentation to get the best performance. Using four drivers, two in parallel then the pair in series gives the same impedance as a single unit, which as you say keeps things at a nominal 8Ω. Because you have four times the cone area though, you will see an increase of 6dB output.

That's the easy bit. You're going to run into phase problems though, where the distance between the drivers is close to the half wavelength of sound you are using them at. This will more than likely cause a lumpy, phasey lower midrange response, something to be avoided if you want a coherent sound. Also, applying +6dB/octave bass lift to a 6" driver, even though there are four of them, is going to push them close to their limits. Basically, I think you're going to struggle with this arrangement, and that's before we even consider the electronics.

For this reason, I'd like to suggest a slightly different approach, one that'll be a lot simpler to build. The bass of an open baffle relies on serious cone area and high power units capable of really shifting air; I'd use a pair of the 13in. professional Audax

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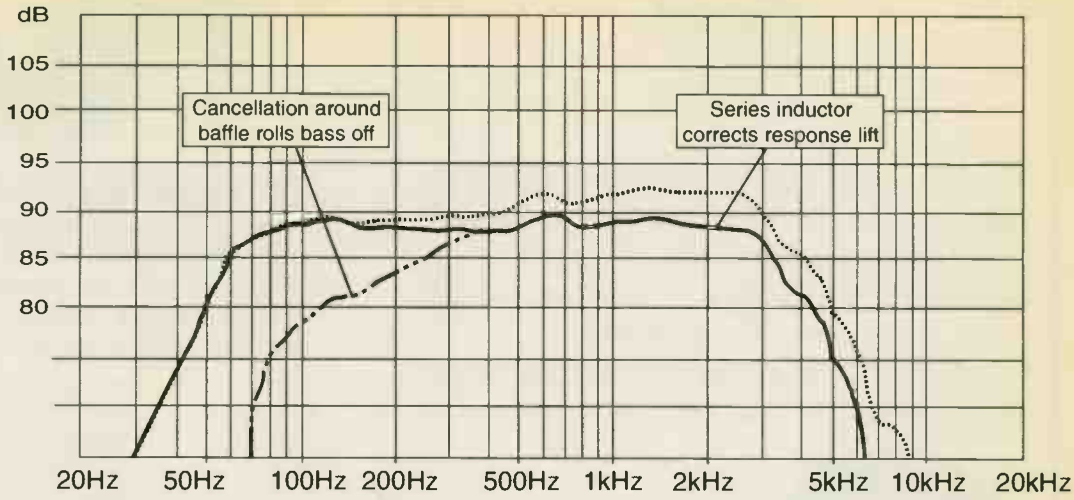
PR330M0 bass drivers for each channel as part of a three-way system on a 450mm wide open baffle. These, in parallel, will draw more current from your amplifier (use a good solid state amplifier and it'll still be able to drive them easily enough though) increasing apparent sensitivity by 3dB. It does this by halving impedance and doubling the amount of current drawn, but a dipole is inefficient anyway, so even if you went the active route you'd need a powerful amplifier. Doubling the cone area by using two per channel adds another 3dB.

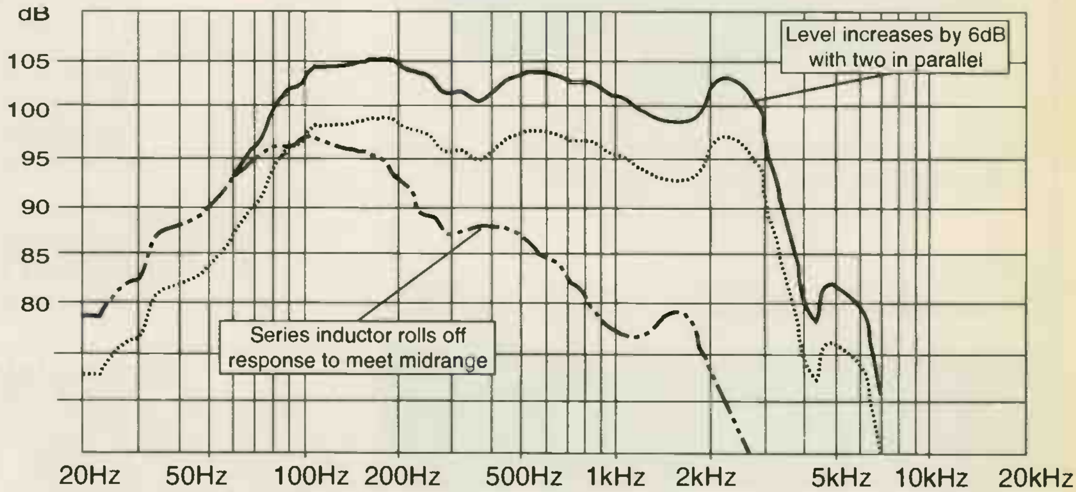
This 6dB on top of its 98dB sensitivity gives you a massive 104dB to play with. Why? With this much sensitivity you can afford to implement the 6dB/octave rise towards low frequencies with a passive circuit, making this system much simpler. Use a series inductor to apply 6dB/octave cut above 60Hz. The effect will be a response that rises at 6dB/octave from 350Hz down to 60Hz, countered by the 6dB/octave roll off of an open baffle.

This combined response should be flat from 350Hz down to 60Hz, with a -6dB (bass cut-off) point of 30Hz. Above 350Hz the response will continue to fall at 6dB/octave under the effect of the inductor.

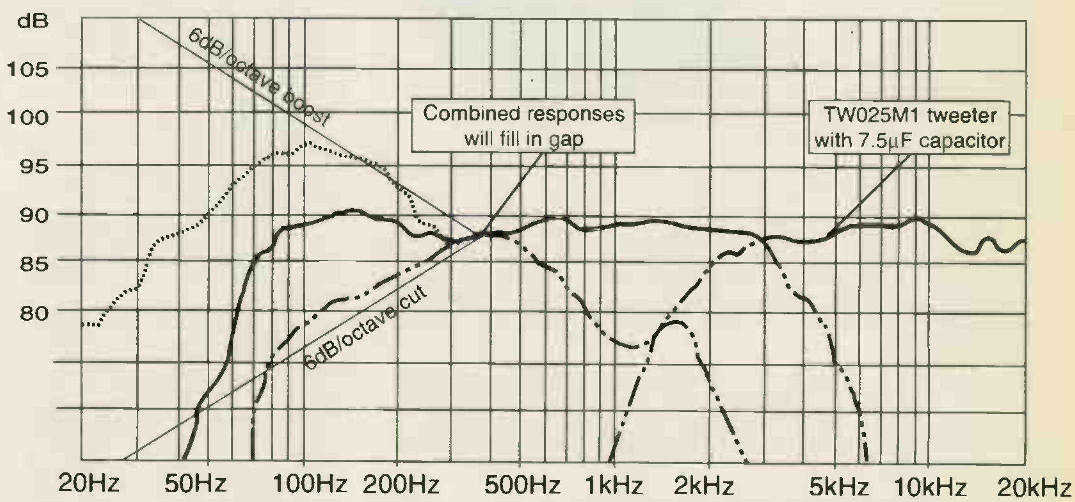
You could then use your HM170Z0 drivers for midrange, one per channel, with a simple series inductor to flatten the response and give a 1st order roll-off characteristic. Around 1mH should be about right, but if you want a slightly softer



The original frequency response of the HM170Z0 driver rises with frequency. This can be simply corrected with a series inductor. Mounted on the open baffle, the lower response will roll-off due to cancellation.



Hovering at around 97-98dB between 100-300Hz, the PR330M0 is a very sensitive bass driver. Using two connected in parallel increases sensitivity by 6dB; +3dB from the doubled cone area and +3dB because connected in parallel they will draw more current. As with the midrange driver, a series inductor will tilt the upper response downwards. This time we are looking to produce a 6dB/octave roll-off rather than a flat response though.



With bass and midrange on an open baffle you can see that the 1st order roll-offs will combine well to give a smooth (predicted) response. The 6dB/octave rise through the bass is cancelled out by the 6dB/octave roll-off caused by cancellation around the baffle, resulting in a flat response. The TW025M1 soft dome tweeter needs just a single capacitor forming a 1st order crossover to get a smooth response, so this could be a good choice for the top end.

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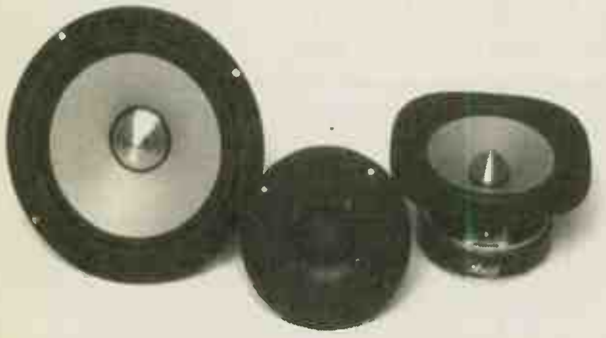

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Technical specification: dual mono construction, 40W/channel, 12Hz to 25kHz power bandwidth, distortion <0.1%, five line level inputs, tape output, 230/240V mains input.

Stereo amplifier circuit board : board only £49.50; component pack (including valve bases), add £63; populated board £125; full valve set, add £45. Power supply board : board only £20.50; component pack, add £44; populated board £66. Input board : board only £15.50; component pack, add £16; populated board £33.

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The chassis, comprising main chassis and transformer cover, is hand polished, welded 1/16" stainless steel - NC machine tooled for a perfect fit and clean finish. Each kit also includes a mesh valve cover and baseplate, finished in semi matt black. Price £310. Also available in mild steel finished in black, £195. For those who wish to use one of these high quality chassis for their own projects, details of the chassis are given in the 4040 reference manual, £6.50.

Connector kit: twelve gold plated phono connectors, two sets of loudspeaker terminals, an IEC mains socket with integral fuse and switch, and an IEC mains lead with fitted 13A plug. £51.50. Cable kit: all cables required for the 4040, £6.

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Stereo circuit board: board only £25; component pack, add £37.50; populated board £70; full valve set £20.

The mains transformer is wound for dual mono construction and is toroidal for low leakage flux. Primary 0-230-240V. Secondaries 2x295V@20mA, 2x6.3V@0.45A, 16V@1A. Price £30. Other primary voltages can be supplied to special order. These transformers are also suitable for power supplies in preamplifiers and other line level valve circuits - see data sheet for details, £2.50.

The chassis (main chassis and transformer cover) is made from mild steel. Each kit comes complete with a mesh valve cover and baseplate, finished in black. Price £110. For those who wish to use a high quality chassis for their own projects, details of the chassis are given in the P2 manual, £6.50.

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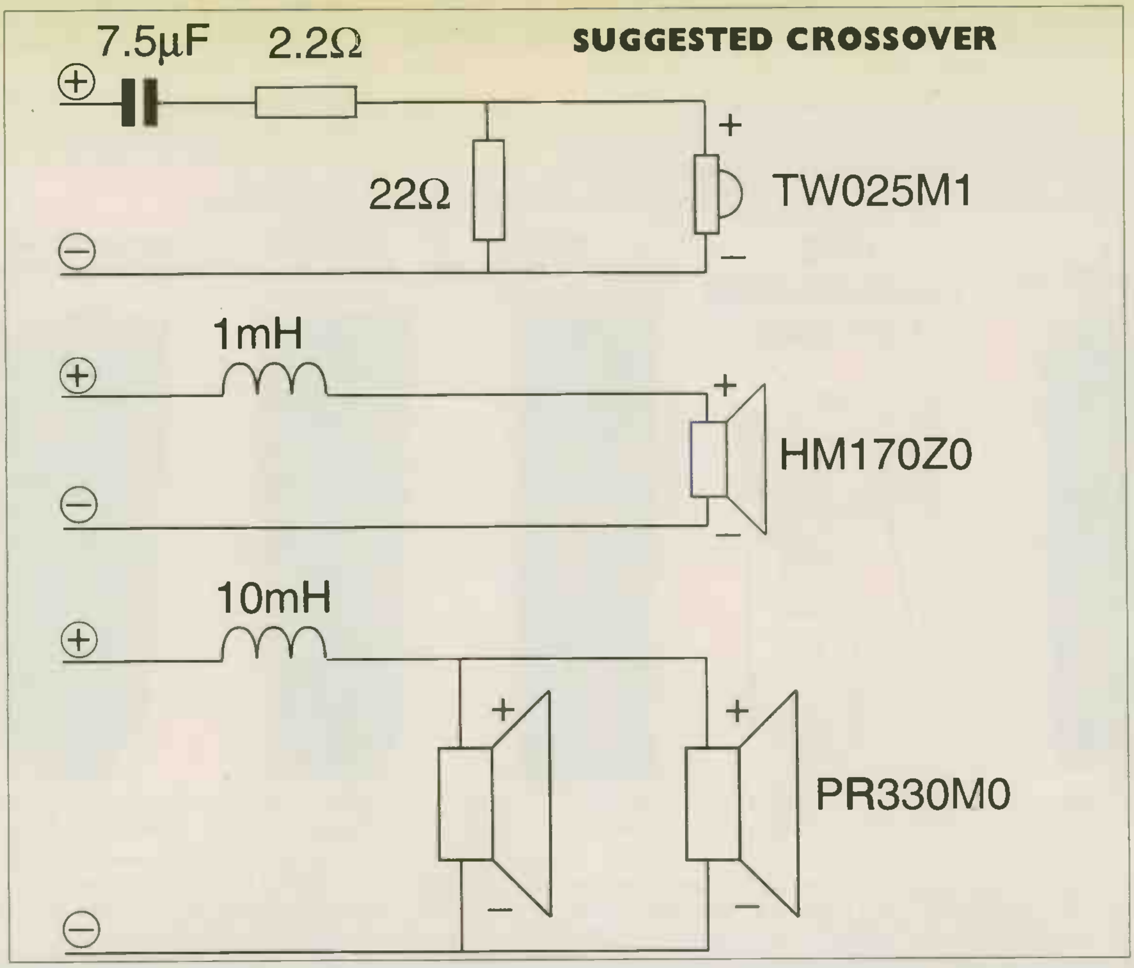

presentation, try upping this to 1.2mH or so. This should match nicely with the TW025M1 1in. fabric dome tweeter, which flattens out very nicely with a single capacitor 1st order filter, allowing it to match the midrange well in terms of phase. Such a simple crossover should give an excellent sound too. The tweeter will probably need about 3dB of attenuation, but this can be easily implemented with a 2.2Ω resistor in series and 22Ω across the driver's terminals.

Because the response of the HDA midrange driver will also be rolling off at 6dB/octave due to cancellation around the baffle, it should match well with the bass end.

This is only a suggestion, and as I have not built one I can't guarantee it will work. But there's definitely potential, and it should produce an excellent sound being so simple; no cabinet and only simple 1st order crossovers. DB

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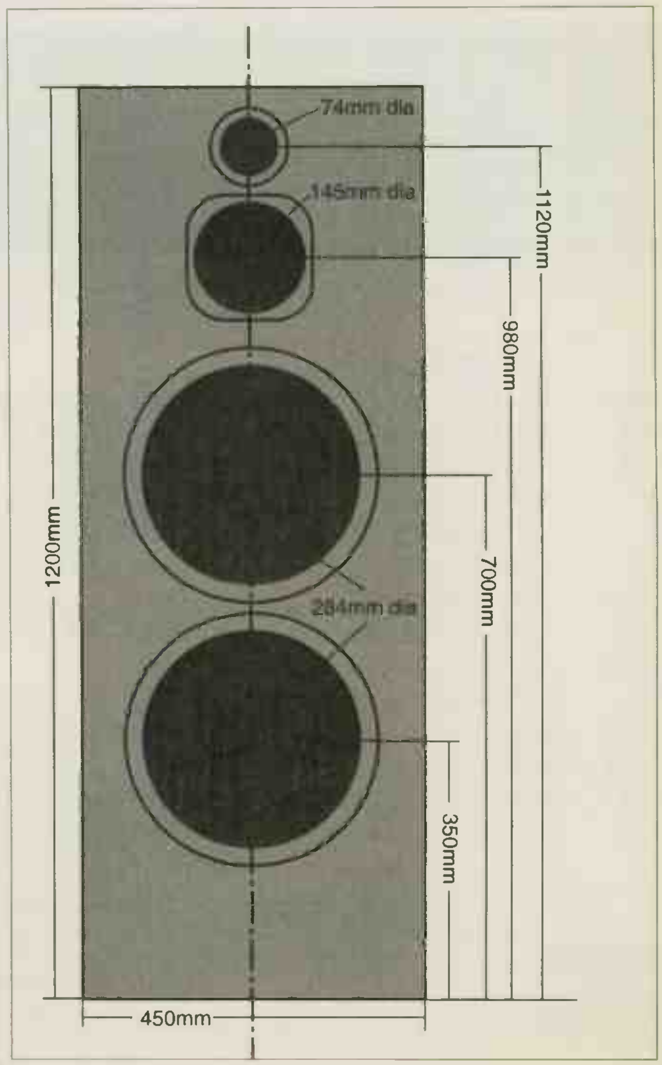

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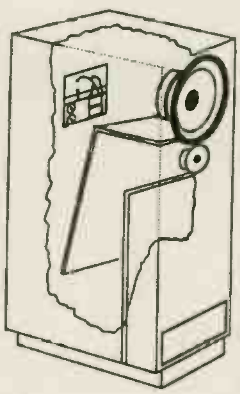

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K5881 MKII VALVE AMPLIFIER

Our K5881 20watt valve amplifier now uses a new S.R.P.P. triode input stage, explains Noel Keywood.

I developed our K5881 kit valve amplifier from the Mullard 5.20 circuit many years ago and it has been a delight to us and hundreds of users ever since. Although pure Class A, which can run hot, K5881 has proven wonderfully reliable. It's always been popular because of its reasonable price, coupled with fine performance and low maintenance costs. So why change it?

Predominant comments about K5881 are that it's 'difficult' to build because it does not use a circuit board, that it is of surprisingly high build and finish quality for a kit, and that it has a fast sound with plenty of treble and bass. I've always thought of it as a "bouncy sounding" amplifier, that is, fast, detailed and with lively bass.

What were we going to change? I've opposed moving to circuit boards for simplicity of build. I am not at all certain that the sort of person who needs to build by numbers should be tampering with a valve amplifier like this. K5881 isn't a toy; it has 450V on the H.T. line and we actively discourage people from buying if they have no experience. Furthermore, hard wiring is better in terms of sound quality and easy for a constructor to modify. When we do a real budget amp, then we will use a circuit board, but the chassis work will also be far less expensive than K5881's welded 16gauge steel affair.

We decided instead to hone K5881's sound quality by making it smoother, more neutral and more valve like. In my original re-working of the Mullard 5.20 I discarded ultra-linear operation in the output stage, finding that it wasn't especially linear at all. We have the benefit here of using a fast computing distortion analyser that shows harmonic structure and how it changes with level. My whole basic approach to amplifier design is to optimise open-loop (i.e. no feedback) linearity, then close the loop, using feedback only to tiddle up final results. Feedback skews an amplifier's transfer characteristic and ultra-linear working commits this sin.

A well designed amplifier should offer at least reasonable results without feedback. You might not be surprised to learn that transistor amplifiers are unable to meet this criterion, whilst a highly optimised design like our 300B needs no feedback at all. Like 300B, I ensured good linearity with K5881 by running it at a high 450V H.T. and using relatively high impedance output transformers. Under these conditions ultra-linear gave worse results than simply running the screen grids a few volts below the H.T. line. Some advocate running the screens from half H.T. but this only reduces output power and increases distortion.

Most valve amps run from low 350V H.T. lines so cheap electrolytic capacitors can be used, these items being a major cost in any valve amplifier. K5881 was never meant to be a cheap amplifier though. We use a massive 5H choke in the power supply in conjunction with a special twin 50µF+50µF / 500V electrolytic in classic π filter arrangement. In my view this arrangement incorporates the best of choke-input and capacitor-input power supply arrangements, being effectively a compromise between the two. It pulses the mains transformer less than a pure capacitor input type (which all transistor amps use and which the EC are threatening to ban), whilst offering excellent smoothing and regulation. It avoids the hum fields, mechancial buzz and voltage drop of a choke input filter too.

In my original circuit the EF86 input stage was strapped to run in triode mode. We decided that, in light of experience, the Shunt Regulated Push-Pull stage based around the 7025 double-triode (high performance ECC83) valve would be a good upgrade for the front-end. The Japanese swear by SRPP and, with this valve, I must say it gives superb results. This front-end change has eliminated the bright and treble we were getting with the EF86, bringing a smooth neutrality to K5881.

After finding, from our 300B, that lowering feedback increases the sense of air and space around images on the sound stage, as well as lessening that dry, clinical presentation that is the bane of transistor amps., I decided also to reduce feedback, in so far as this might be possible within the limitations of using output tetrodes. That's why I again spent a lot of time ensuring K5881 was as linear as possible without feedback applied. Feedback was introduced only to maintain bandwidth, set to -1dB at 22kHz. For this I found just 18dB was needed, a reduction of around 8dB from the previous design. Sensitivity has increased to 75mV for full output (20W) whilst distortion remains around 0.1% at full output. The sensitivity is so high, a preamp is not needed, just a volume control.

As expected, lowering feedback opened out the sound and made it more

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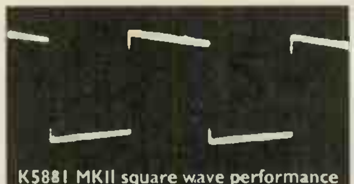
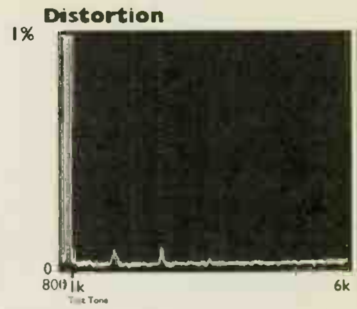
valve like in terms of spaciousness and ease of presentation. This last property is difficult to describe. Some people call it liquidity, a not inappropriate term. Music flows more easily and naturally; it sounds less 'clinical' or 'forced'.

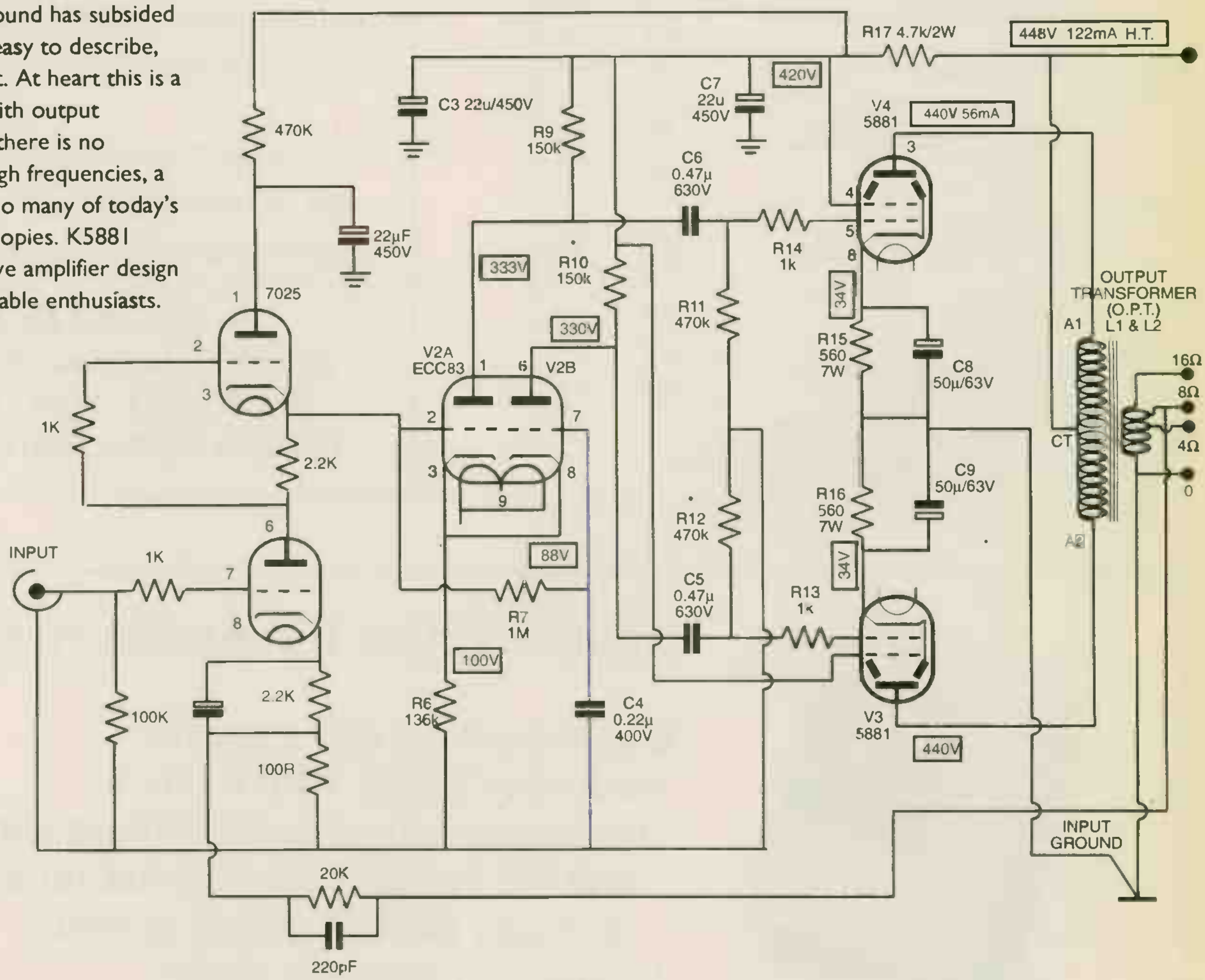
Overall, the amplifier has changed considerably in its sound. It has swung from being distinctive to neutral, which is what I wanted to achieve. There's a better sense of insight than before, plus greater openness and clarity. Curiously, the amplifier's actual sound has subsided so much it isn't really easy to describe, but I'm happy with that. At heart this is a very linear amplifier, with output transformers so good there is no slewing or ringing at high frequencies, a problem that affects too many of today's thermionic "me-too" copies. K5881 remains a first rate valve amplifier design suitable for knowledgeable enthusiasts.

K5881 MkII TEST RESULTS


K5881 MKII square wave performance



Power	20watts	Noise	-94dB
Frequency response	30Hz-22kHz	Distortion	0.012%
Separation	92dB	Sensitivity	75mV
		dc offset	none



K5881 MkII Sound Quality

I souled out to start K5881 off with Marvin Gaye's What's Going On? My tapping feet told me this inherently warm, rhythmic recording was having little trouble making it to our KLS 3 loudspeaker intact. 'Right On' had nimble bass guitar joining with sweet percussion to move the music along. Imaging was stable and detailed, the zither that appears at stage right on this song placed clearly in the soundstage, the feeling of space around it adding to the realism of the performance. Vocals were smooth, flowing naturally with the melody and possessing realistic body and substance. Triangles, drums, bass guitar and vocals knitted together in 'Inner City Blues (Make Me Wanna Holler)', emphasising K5881's smooth, organic delivery.

Musicality and emotional communicativeness featured high on the sonic menu with Rimsky-Korsakov's Scherezade. Strings were smooth, as was the flow of the music, clearly painting a picture of Sinbad sailing across the sea. A nicely proportioned soundstage gave the various sections of the orchestra plenty of elbow room, increasing the sense of involvement with its openess. Raising the tempo in the fourth movement proved K5881 no dynamic slouch, crescendi building impressively on crashing cymbals, powerful snare drums and thunderous tympani.

More heavily processed music punched cleanly out of KLS 3. Upper bass caught leading edges of drum machine notes well and gave synthesisers their full measure of pungency. A valve warmth to the bottom end played a part in giving bass lines weight and an easy foot-tapping quality. K5881's transparency also helped make whatever was coming through it comprehensible, an ability appreciated on thick Rock mixes, where insight stopped the music becoming confused. *Jon Marks*

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Loudspeaker and Headphone Handbook

reviewed by Dominic Baker

Finding a reference book that covers all areas of loudspeaker performance, from design and manufacture to the acoustic interaction within a room, ain't easy. It's even harder to find one that's up to date and thorough. That's the problem editor John Borwick has tried to address with the Loudspeaker and Headphone Handbook, enlisting the help of top industry experts along the way.

Before I go any further, a word of warning. The Loudspeaker and Headphone Handbook is not a gentle read on loudspeakers. It is more of a technical manual, many of the sections launching into quite complex maths of at least 'A' level standard (integration and differentiation). Enthusiasts without the maths to understand the equations shouldn't be put off though, the chapters all provide plenty of easily digestible reading material.

The Loudspeaker and Headphone Handbook starts with the ubiquitous 'Principles of Sound Radiation', this chapter written by R. D. Ford, a lecturer from Salford University's Applied Acoustics department. It's a fairly standard introduction, describing the way sound waves are generated, their dispersion patterns and how they are specified in terms of level.

Next up, Stanley Kelly provides one of the most comprehensive introductions to drive unit mechanisms I've seen. It's a little dated in places "for domestic loudspeaker systems. . . a frequency response of 100Hz to around 7kHz with, possibly, a small tweeter unit added to accommodate the high frequencies". But he does go on to explore various cone materials, profiles, surrounds and diaphragms in useful detail. Most of the chapter, as expected, covers the moving coil driver, but there is also a section on ribbons.

At the beginning of Kelly's chapter is a section on the Ionophane driver, which works by causing an ionic discharge to occur in sympathy with the audio signal. This is done at the bottom of a horn, the gas discharge causing a wave to travel down the horn, producing sound from no moving parts. Unfortunately the Ionophane's discharge was Ozone (O3) which is poisonous (try getting one of these past current safety standards). It is a small section, but the only one I've seen on the Ionophane.

Peter Baxandall takes over next to cover the electrostatic loudspeaker. It is mainly a theoretical look at the principles behind electrostatic operation, suitable materials and their constraints, rather than a practical guide to building one like Wagner's Electrostatic Loudspeaker Design and Construction. It doesn't so much tell you what materials to look for and how to construct an electrostatic, as give you the maths and theory to research the thing for yourself. It was also good to see that the two practical descriptions of commercial electrostatics are of Quad's 57 and 63 models - what else?

The world of the crossover is explored, mathematically, by Laurie Fincham, ex Chief Engineer at KEF, now hidden somewhere deep in the Harman empire over in L.A. This is one of the least accessible chapters for the amateur, launching into the maths almost straight away. The Loudspeaker Design Cookbook would be a better bet if this is your area of interest.

Loudspeaker enclosures, as described by Celestion's Graham Bank and Julian Wright, seems almost lightweight by comparison. Brief descriptions of all the various enclosure types are followed by some useful practical considerations, such as cabinet material, damping and bracing.

The following chapters expand into public address, studio monitoring, measurement and subjective evaluation, to complete a very broad look at the loudspeaker. The chapter on headphones contains useful descriptions of the human ear and the book concludes with standards and definitions, which really are more a commercial consideration than being any particular use to the enthusiast.

In the Loudspeaker and Headphone Handbook, a valiant attempt has been made to cover all aspects of sound radiation. As such, there is little else available today that betters it. Individual areas of loudspeakers are covered in more depth in specialised texts, Robert Bullock's Bullock on Boxes springs to mind in the case of loudspeaker enclosures. But as a single reference work, no engineer or keen enthusiast should be without a copy.

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World Radio History

D.I.Y. Letters

TWEAKING THE UPGRADE BUG

I have the following system: Micromega Drive I and DAC on sorbothane CD feet, Mission Cyrus II and PSX, Mission 751 speakers and Partington Dreadnought stands. Cables are 0.5m Siltech HF6 between CD and DAC, 0.5m Insert Audio Status 3.4 interconnect and Audioquest Indigo speaker cable.

I am thinking of upgrading the speaker crossovers (I am experiencing some sibilance) and would be grateful for your opinion. Would it be worth making up external crossovers? What are the benefits? I would like to upgrade the internal wiring as well.

I want to upgrade the PSX and amplifier either by Russ Andrews' mods, or what about going for a valve kit bearing in mind the speakers? What kit would you suggest, i.e. World Audio, Audio Innovations, Audio Note, and how do you feel about upgrading the parts to Black Gates, etc, or would I be better off going for a transistor pre and power like Audiolab or Naim. I do intend to upgrade the Drive I to Drive 3 status at some point.

Lee Duckett
Wimbledon,
London.

Upgrading the components in your Missions should bring about a worthwhile improvement, if a little care and consideration are taken in doing so. First of all, I'd start by removing the original crossover in its entirety. Build your new upgraded crossover completely separately - that way, if anything doesn't quite work, you have a chance to revert back to the original.

You will need to measure the DC resistance as well the inductance of the coils used in your 751s. I've heard very good things about the CFAC Copper Foil Air Core inductors advertised in the American magazine Speaker Builder, so these may well be worth investigating. They're available through The Parts Connection, Tel: 001 800 769 0747.

For the capacitors I'd use Solen polypropylenes (available from Falcon Acoustics, Tel: 01508 578272), which strike a fine balance between performance and price. If you really want the ultimate, try Hovland's Musicaps, available from SJS Electroacoustics, Tel: 01706 823025. These are smoother, more detailed and open, but you pay for it.

Internal wiring should be at least Ortofon SPK100, perhaps Chord Co. Rumour, if you're using the CFACs and Hovlands so that you capitalise on the improvements. Use a good quality silver loaded solder which not only makes a better electrical join, but is stronger mechanically too. Keeping the whole caboodle out of the boxes and close to the amplifier does have its advantages sonically, as long as you don't mind putting up with two sets of cables lying on the floor.

Upgrading the components in your amplifier is a different matter. You will need to have considerable electronic experience before taking on this task. The Cyrus II with PSX is a fine sounding amplifier, very clean and detailed along with plenty of power. I'd leave it as is, trading it in against a new Cyrus III. To this you could add a Cyrus power amplifier, bi-amping your system which I feel will bring a far greater improvement than tweaking your existing Cyrus II. DB

BRIDGING IT

Here is an idea that might be of interest to anybody experimenting with Motional Feedback.

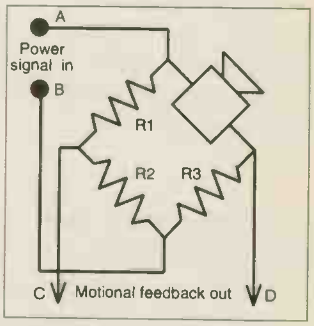
To avoid the complication of a second voice coil and make it possible to use any loudspeaker, why not make the loudspeaker part of a balanced Wheatstone Bridge. The voltage across C-D will be proportional to the signal generated by the motor effect of the speaker. If R1=R2 the system will be only 50% efficient. A 95% efficiency will be achieved by making a 20:1 bridge as shown.

To balance the bridge: replace the power signal with a few volts D.C. across A-B and adjust R1 until there is zero volts across C-D.

Theoretically, a small inductance should be put in series with R3 to compensate the loudspeaker inductance. However, the inductance would be so small that it could probably be ignored.

I must point out that I have not tried out this idea, not having any test equipment.

R. Turner
Chalfont St Giles,
Bucks.



Mr Turners suggestion for a motional feedback system uses a Wheatstone bridge to providing a sensing signal without the need for a second voice coil.

Looks OK to us. But bear in mind that a transformer introduces serious phase shift at the edges of its passband, which reduces the available feedback

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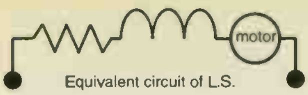
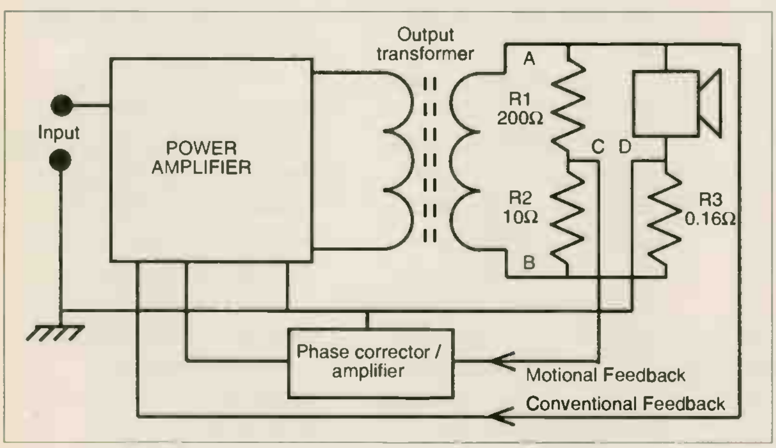


stability margin. In theory a least, the 90 degree swing from the transformer plus the 90 degree swing from the voice coil adds to give a 180 degree total shift, at which point negative feedback is going positive, or positive would be going negative. This will set the stability limits and determine the amount of feedback that can be applied.

In practice the amount of shift will depend upon frequency, motional impedance and other factors, especially if acceleration feedback is used, which introduces a - 90 degree shift. NK



Mr Turner's full circuit for a motional feedback system.

CUTTING OUT THE TRANSFORMER

I would be very grateful if you could spare a few moments to comment on the enclosed circuit diagram of the 25watt output transformerless amplifier. Today one does not see many of these kinds of circuits around and I wonder if they will ever find a place in the current upsurge in interest in valve amplifiers. With all the work that goes into constructing a quality valve output transformer, not to mention the final costs of such an item, one could have purchased a dozen valves and still had some change left over! The fact remains that the output transformer is still, and always will be, the weakest link in any amplifier in which it is used.

While I do not profess to be an electronics expert or a 'Golden-Eared' hi-fi buff, I derive great pleasure from building various valve amplifiers (this being one of them) and exploring ways in which they can be improved. Most of the tests which I was able to conduct on this amplifier do confirm the findings of the designer - flat from near DC to over 158kHz, and still some more. The photo of the square wave test is as it shows. I had to use 6080 tubes as there were no 6082s to hand.

I understand that this push-pull output stage is not the most symmetrical around, but then neither is a npn-pnp transistor output stage. Worse still is the power MOSFET. An obvious safety improvement would be the use of a suitable isolation transformer and reconfiguration of the power supply section. Admittedly, the output impedance is not the norm by today's standards (i.e. 16 ohms) but this should present little problem to anyone interested enough to build the amplifier.

Now onto item no. 2 which is really for the dedicated DIY slave, and those who cannot afford radio-metal iron cores oxygen-free silver wire or toroidal winding machines. I have successfully hand-wound three output transformers on high quality Siemens power transformer cores using the bifilar winding technique of the primary. The secondary was interleaved at three intervals, precise and exact turn ratios were adhered to before all three secondary windings were paralleled.

The diameter of the primary wire was 0.3mm, which was relatively easy to handle. The one output transformer is in service in a home-brew Williamson amp and the remaining two in a Mullard 5-20 type amplifier. Impedance and frequency tests which I conducted on these transformers indicated good results, if not better than a conventionally wound component of good standing. However, one sees little mention of this winding technique in constructional articles or reviews.

The only valve amplifier that I have read of using this winding technique in its transformers was the MacIntosh, where feedback was also fed to the cathodes of the output tubes. Apart from the possibility of a flash-over between the two halves of the primary at high power, and the impossibility of getting a machine to do bi-filar winding. What does this method have against it.

I look forward to many more informative issues of Hi-Fi World's DIY Sections, as well as any circuits (valve of course) that you come up with for home constructors here in darkest Africa.

Garth Moore
East London,
South Africa.

The output transformer can be seen to be the weakest link in an amplifier's signal path. It is the interface between the output stage and the loudspeaker load, made necessary because there are very few valves which can operate into a low impedance load like a loudspeaker voice coil. The 6080 with its 100 ohm anode impedance barely works into a simple 8 ohm load, even if paralleled valves are used. Because of the thermionic nature of valves, relatively high voltages and impedances are needed for successful operation and good linearity, and this is where the output transformer comes in.

It's like a gearbox between the output valves and the speaker. In the same way, a car engine works at low torque and high rpm, so the gearbox steps the torque up and lowers the rpm to effectively transfer power and propel the vehicle. Running the valves into a low impedance without a transformer is like trying to pull away in 5th gear. If the impedance problem can be overcome by using either a large number of valves in parallel and/or using very high current valves (which is like increasing the capacity of the engine), there is still a problem in that the two halves of the output stage operate in totally different modes, one as an anode follower, the other as a cathode follower.

This results in a totally different gain for the two halves, and the generation of large quantities of distortion. This imbalance is far worse than the differences between NPN and PNP devices or FETs. They are nearly always operated as unity gain followers, and as their transconductance is so

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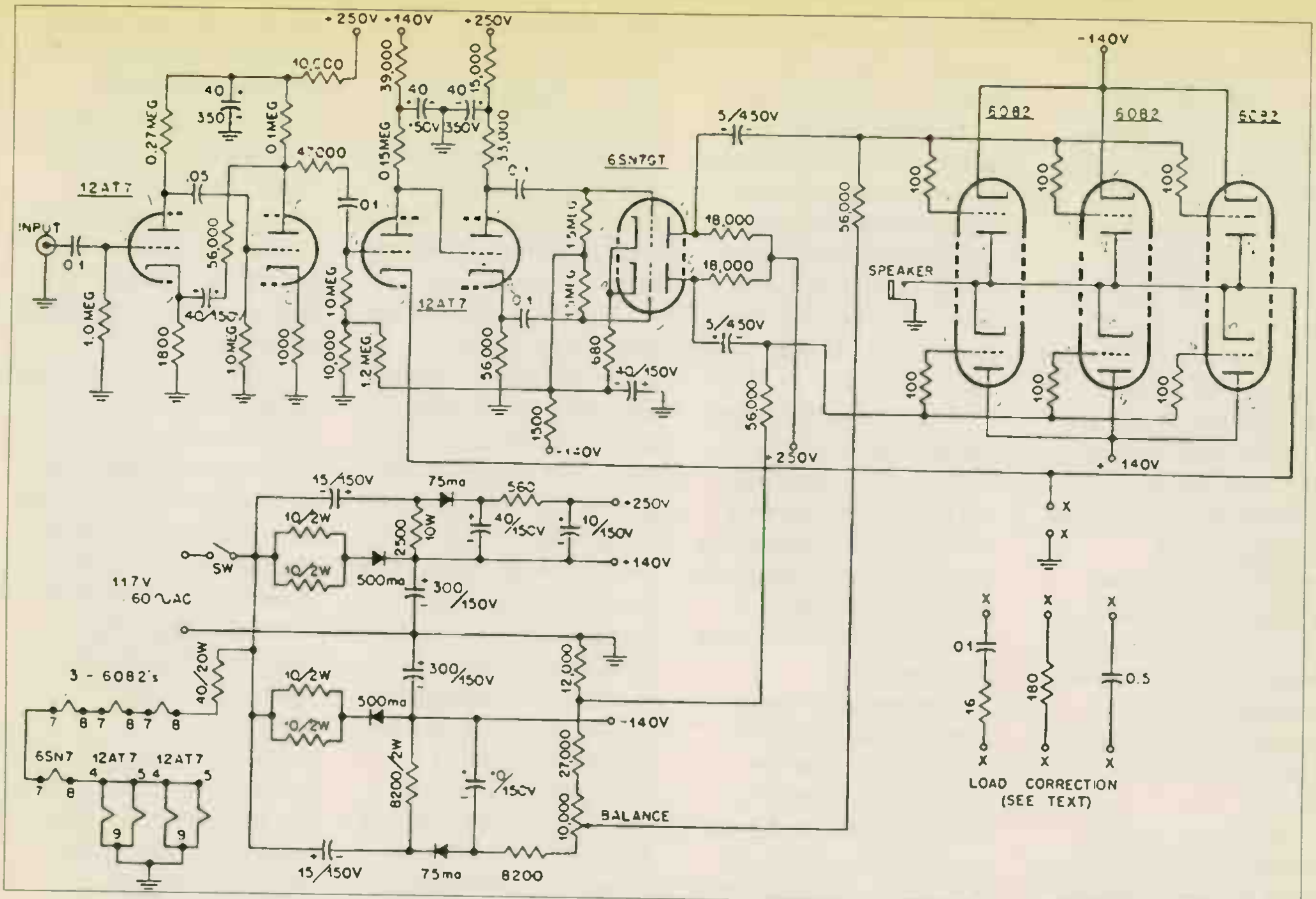

A 25watt transformerless valve amplifier design using the 6082 double triode. Mr Moore intends to build his with the more easily available 6080 double triode.

much greater than that of any valve, the differences are mostly swamped by local feedback. In the OTL amplifier, however, these differences are laid bare. The article mentions that 40dB of feedback has been applied; that is, the gain has been reduced by 100 times. But the distortion of the amplifier at 25W, its rated output, is still 0.4%. Multiply this figure by the 100 times feedback factor to see what the distortion was before feedback and of course you get 40%!

The most ingenious solutions to this problem are generally attributed to Julius Futterman. He used local negative feedback around the phase splitter stage to decrease the gain to the anode follower half of the output stage, and later changed to local positive feedback to increase the gain to the cathode follower half. Check out the Futterman circuits, you could modify your amplifier to work as such and the performance would be much better.

Another improvement would be either to parallel up a lot more 6080s (say 10 pairs per channel) or go to 6C33CBs, or triode or pentode connected PL519s, which would be the cheapest option. The later versions of the Futterman amplifiers used 6LF6s which are big TV valves like the PL519, only a lot rarer. You could end up with an excellent amplifier if you went over to the Futterman topology and threw money at the output stage, but you may also wind up spending more and getting worse performance than, say, a pair of push-pull 845s and wideband output transformer. Additionally, the 845s would be Class A and wouldn't vapourize your speakers if something went wrong with one of them. There have been a few commercial OTL amplifiers such as the Futterman, and there are the Croft OTLs, but the cons seem to outweigh the pros and they are still quite rare beasts.

In bi-filar windings the two wires are wound together and so have excellent inductive coupling due to their proximity, the only downside being a large capacitance between the windings. This can be used to positive effect if the phase of the signal on the two is the same, but if the two halves of a push-pull primary (with 180 deg phase difference between the two valves' anodes) were wound in a bi-filar manner, the capacitance between them would be detrimental, causing the load impedance to decrease at high frequencies.

The MacIntosh amplifiers use a very elegant output stage with a bi-filar wound transformer. The cathode of one valve is coupled to the anode of its partner by bi-filar winding. This works because on each of the valves there is a 180 degree phase shift between its anode and its cathode, so when one's cathode is coupled to the other's anode, they are back in phase again. There is, however, a large DC potential between them. The output transformers for the solid state SE amplifier are bi-filar wound, and in a lot of my driver and output transformers I use bi-filar and even tri-filar up to penta-filar windings depending on the application.

The transformers in switch mode PSUs often use bi- and tri-filar windings, or even Litz wire, which has many strands all insulated from

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each other to reduce the skin effect. When I first started building valve amps, I used to wind my own output transformers with a hand drill and stripped down mains transformers! Grain oriented silicon steel (the most common type is called M6) laminations are quite easy to get hold of if you ask around, and you can make bobbins from thick card. The wire is available from catalogues like Maplin and Electromail, and these companies even offer mains transformer kits which could be adapted to make an output transformer, although the iron is of quite poor quality.

Nickel iron such as Radiometal or Permalloy, which is used in the best transformers, is very expensive and comes in various grades of permeability and hysteresis loss. The core for a small 15W push-pull output transformer, for example, would cost in the region of £70, but offer superior sound and performance if the winding technique is up to the mark. Even higher performance can be obtained with custom-dimensioned C cores, then you could use exotic materials inside like teflon. . . The sky's the limit. AG

NO MOTION AT THE BBC

Your item on motional feedback in speakers (Supplement No. 23) was very interesting. An article worth reading was written by H. D. Harwood, then at the BBC, in "Wireless World", March, 1974 (p51). His thesis was that a well designed non-feedback system could perform as well as a feedback one, and that feedback "possesses no magical properties". The article certainly ruffled some feathers in the Philips camp.

Motional feedback to control an electro-mechanical transducer was patented in 1938 by Western Electric in respect of a moving coil disc cutting head. The principle has been applied to modern stereo heads and offers some points of interest.

The Ortofon head shown uses two feedback coils, wound in phase opposition and placed within opposite polarity magnetic gaps, hence the motionally derived output is summed whilst any coupling from the drive coil's field is cancelled.

The resonance frequency (which would normally be placed at the top of the working range to ensure stiffness control) is placed at the logarithmic centre, e.g. 2 kHz. No mechanical damping is used. The effect of varying degrees of feedback is shown, yielding an optimally flat response after which phase shifts in the upper region begin to cause a peak, which if increased would lead to instability. The difference in the l.f. response between the two graphs is due to an integrating circuit in the feedback amplifier which allows greater control at low frequencies.

Whilst not directly transferable to a loudspeaker system the above may suggest avenues of research.

S. Davies
Aylesbury.

Motional Feedback offers an avenue of escape from the straight-jacket that embraces current loudspeaker design. Most of today's domestically acceptable models are modelled, to a useful degree of accuracy, as networks of masses and compliances (i.e. reactive mechanical elements), with of course the odd resistor thrown in. Thiele-Small equations, which computers gobble up, manipulate these parameters with such speed and accuracy that industry has become completely wired into the idea of designing a loudspeaker's bass section by this method. We use it - and boy does it work.

Trouble is, you become locked into certain immovable trade-offs and ways of thought. That's why 'speakers are so alike these days. Innovation has gone out of the window, to be replaced by convenience and design efficiency. Plus a catalogue of standard trade-offs: for example, increase cone mass to decrease LF resonance to get deeper bass, and you lose sensitivity. It's impossible to use small boxes for deep bass unless the system is made very insensitive. And small drivers in small boxes distort badly.

Motional feedback overcomes these limitations. Most importantly, it can be made to suppress or eliminate the basic box resonance problem that currently sets the low frequency limit and behaviour around that point (i.e. bass quality). So we could hardly agree with Dudley Harwood's observations. Not only can motional feedback reduce the considerable distortions generated by small bass drivers in particular (20% second harmonic, 5% third), it can also provide optimal and adjustable damping. It is quite fundamentally different from what faces us today and also quite radical in what it can achieve. It just cannot be compared with a passive box system, since it overcomes its constraining parameters.

All this is not academic either. Those who have heard Motional Feedback working are struck by the tightness and impact of the bass it can produce. And if the industry is ever to get more or better bass from a small, domestically acceptable box this is one of the only routes available.

Why is motional feedback so rare? We are not entirely sure. We do suspect however that it raises all sorts of marketing and R&D problems for companies that, although thoroughly prosaic, still conspire to keep M.F. off the market. Philips, for example, built their power amps. into their speakers. It seems perfectly sensible, but the sort of buyer knowledgeable enough to choose such a system is likely to want a choice.

We are interested in seeing Motional Feedback brought to market in sensible form. This is likely to be provoked by open discussion, so a wider understanding of its problems and benefits takes place. NK

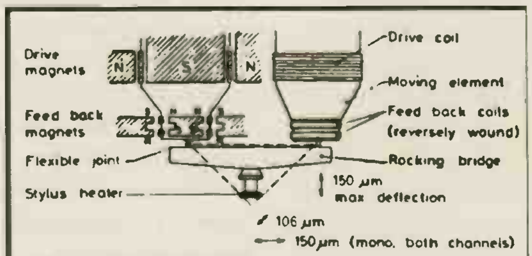

Fig. 1. Fundamental principles of Ortofon Stereo Cutterheads.

Ortofon's motional feedback moving coil disc cutting head

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