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JUNE 1974

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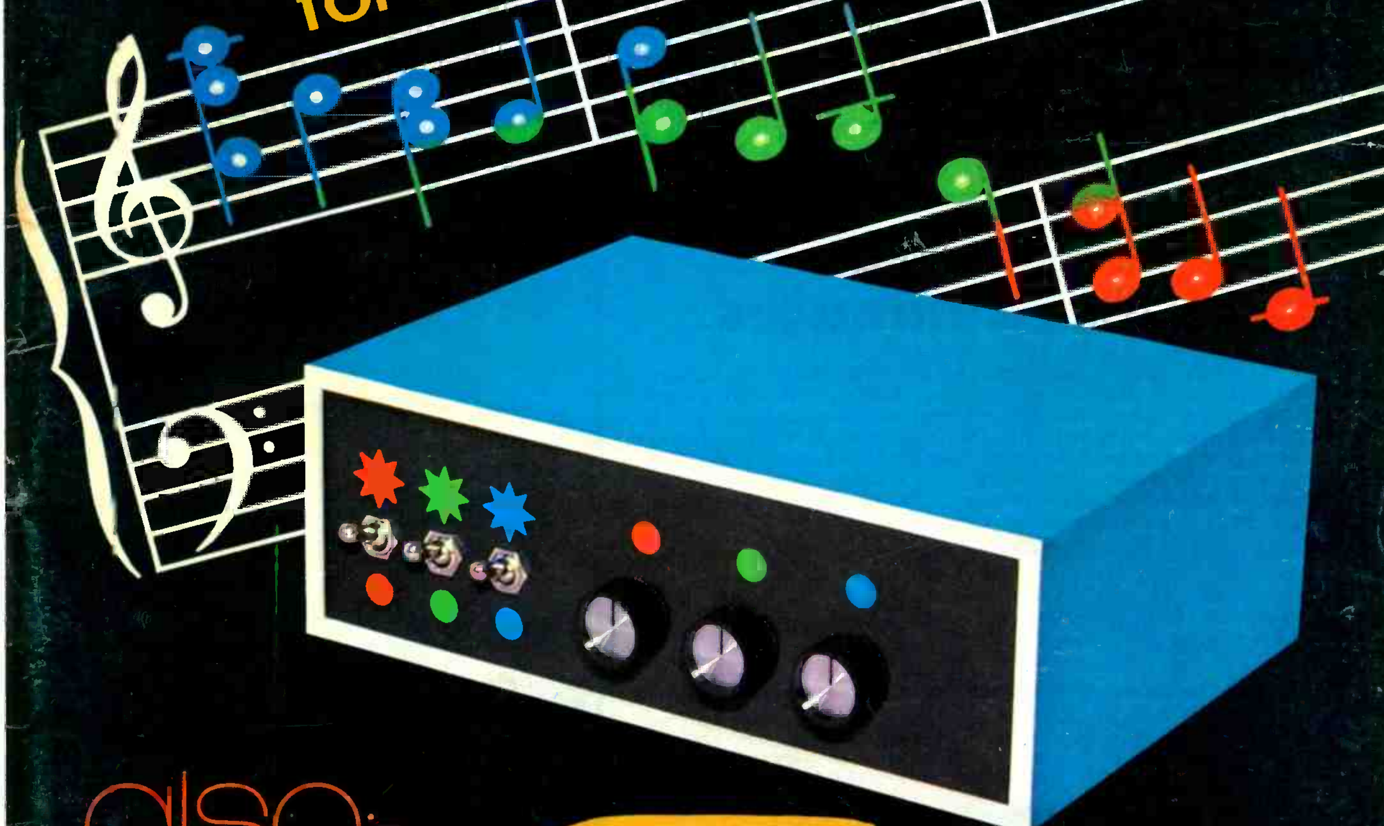

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BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

PRACTICAL WIRELESS

VOL. 50 NO. 2
ISSUE 808
JUNE 1974

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

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We regret that we are unable to supply back numbers of Practical Wireless. Readers are recommended to enquire at a public library to see copies. Requests for specific back numbers of *Practical Wireless* and *Television* only can be published in our CQ Column.

● NEWS & COMMENT

● CONSTRUCTIONAL

● OTHER FEATURES

● SPECIAL ANNOUNCEMENT

RSC DISCO SYSTEM

50 WATT SPEAKER — 100 WATT AMPLIFIER — 50 WATT SPEAKER

HEADPHONES MICROPHONE — TWIN TURNTABLE WITH PRE-AMP

Units listed below
(a) 100w POWER AMPLIFIER
(b) PAIR OF HI-FI HEAD-PHONES
(c) MATCHING DYNAMIC 'MIKE' (attached to h'phone)
(d) PAIR 50 WATT SPEAKERS Black Rexine covered Cabinets Size approx. 18" × 18" × 8"
(e) RSC TDI DISCO CONSOLE

(a) (b) (c) (d) & (e) Carr. £3·00 **£149·95**

Terms Deposit £50 and 18 monthly payments of £7·06 (Total £177·08).

RSC TDI DISCO CONSOLE

Incorporating twin Garrard SP25 or BSR MP60 type turntables and Sonotone or Acos Cartridges with diamond stylii. Separate Vol. controls for each turntable. Also MONITORING FACILITIES, plus Treble and Bass Controls. Separate input for 'mike' with vol. control switch. Black Vynide covered Cabinet with lid, see illustration on left. Or Dep. £23·50 and 12 mthly pymts £4·54 (Total £77·98) **£69·95** Carr. £1·50

R.S.C. COLUMN SPEAKERS

IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

All types 15 Ohms covered in Rexine and Vynair

TYPE C132 30-40 WATTS Fitted two exceptionally efficient, low feedback howl characteristic high flux 13" × 8" 20 watt speakers. Terms: Dep. £3·95 and 8 m'thly payments £2·67 (Total £25·31) Carr. 65p. **£21·95**

TYPE C818 50 WATTS Low feedback characteristic. Fitted three 13" × 8" deep cone high flux speakers with high power voice coils. Size approx. 54" × 14" × 11". Dep. £4·72 & 8 mthly pymts £4·15 (Total £37·92) Carr. 85p **£32·72**

TYPE C4100 100 WATTS inc. four 12" 50 watt speakers for conservative rating. Extra heavy construction. Size approx. 58 × 16 × 10" Acoustically filled and pressurised. Terms: Dep. £20·00 & 12 mthly. pymts. £3·90 (Total £66·80). Carr. £1·50. **£59·95**

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All power ratings are R.M.S. continuous. 2 YEARS' GUARANTEE High flux ceramic magnets. ALL CARRIAGE FREE.

'POP' 100	'POP' 60	'POP' 50
18" 100 Watt	15" 60 Watt	12" 50 Watt
14,000 gauss 8/15Ω	14,000 gauss 8/15Ω	13,000 gauss 15Ω **£12·99**
£29·70	**£16·95**	Dep £1·95 and 8 monthly payments £1·71 (Total £15·63)
Dep: £3·80 and 8 mthly payments £3·80 (Total £34·20)	Dep. £2·17 and 8 monthly payments. £2·17 (Total £19·53)	PAIR SUITABLE ALL PURPOSES

FOR BASS GUITAR, ELECT. ORGAN, ETC.

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Gauss 15,000 Imp 8/15Ω Or Dep £2·45 & 8 monthly payments £2 (Total £18·45) Carr. Free

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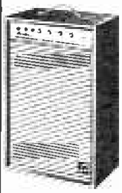
FANE CRESCENDO SPEAKERS

Full range available at ALL BRANCHES

MINSTREL 8W GUITAR AMP.



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PR. FANE POP 25/2 25W L/SPEAKERS £17·98
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F.A.L. PHASE 50 MK.III AMPLIFIER £39·93
PR. FANE POP 50 L/SPEAKERS £25·98
£65·91
Terms: Deposit £20 and 12 monthly payments of £3·90 (Total £66·80)
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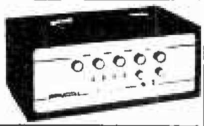
F.A.L. PHASE 50 AMPLIFIER £39·93
PAIR L12/20 SPKRS (in Cabinets) £26·30
£66·23
Terms: Deposit £20·00 and 12 monthly payments £3·90 (Total £66·80)
PACKAGE PRICE **£59·99** carr. £2·00

FAL PHASE 50 Mk. III AMPLIFIER 50 WATT



Solid state. 4 Separately controlled inputs Plus master vol. control. Ind. Bass and Treble Controls. Protective Circuitry against serious output overloading. Output for Speaker/s 3 to 30 ohms. Size 17" × 7" × 7½". 200–250v. A.C. mains. Output 50 watts music rating. Or deposit £9·93 & 8 monthly payments £4·31. Total £44·41. **£39·93**

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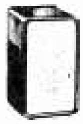

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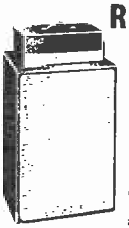
RSC PHANTOM '50' Combined 50W Amplifier and 12in. Loudspeaker.

For Lead Guitar, Mic., Gram, Radio, Tape (Not for use with Bass instruments). Inc. 3 inputs and 2 vol. controls plus Treble, Bass and Presence. Output Jack for additional 15 ohm Speaker. Attractively finished in black with silver-finished fascia and trimmings. Compact size. Fitted carrying handle. Terms: Deposit £6·39 and 8 monthly payments £6·39 (Total £57·51). Carr. £1·50 SAE for leaflet UK Mainland **ONLY £49·95** For one month only, normally £59·95

REGENT 50 AMPLIFIER



A powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak Output rating. Loudspeaker unit either horizontal or vertical mounting.

★ Two extra heavy duty 12in. 50w Loudspeakers.

★ Four Jack inputs and two Volume Controls for instant use of up to four pick-ups or "mikes". Bass and Treble controls. Send S.A.E. for leaflet.

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For Guitar, Vocal or Instrumental Group

A 4 input, 2 vol. control Hi-Fi 30 watt unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/silver P.V.C. fascia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet.

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GXC 38D	£99·95	£139·90	4000 DS	£95·95	£132·50
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AUDIO FIDELITY MODEL 60 AMPLIFIER.
PAIR AUDIO FIDELITY MARQUESS 30 SPKRS.
GARRARD SP25 Mk IV or McDONALD MP60
with G800 Cartridge. Ready wired on Plinth with Cover.
Cabinets finished in Teak Veneer. Send S.A.E. for leaflet.

£99·95 Total Value approx. £165 Carr. £3

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Teak veneer finish. Acoustically lined. Sizes approx. Carr. 45p per enc.

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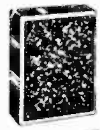
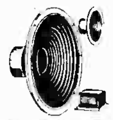


SE10 For outstanding results with 10in. Hi-Fi spkr. Size 25½ × 16 × 9in. Ported **£6·75**

SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter 25½ × 16 × 9in. **£7·95**



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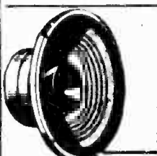
Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£7·45** Carr. 45p
OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£7·95** Carr. 50p



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Response 25 Hz to 15 KHz. Gauss 13,000 Imp 3 or 8–15Ω. **£5·50** List £6·99

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200-250v. AC mains operated. Response 30-20,000 c.p.s. −2dB. Separate Bass and Treble 'lift and cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3–15 ohm spkrs. Max. sensitivity 5mV. O/P rating I.H.F.M. Enclosed enamelled case 9¼ × 2¾ × 5½in. Silver finish facia 10¼ × 3¼in.
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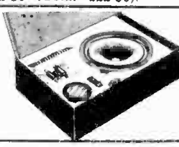
COMPLETE KIT OF PARTS WITH FULL WIRING DIAGRAMS & INSTRUCTIONS **£12·99** Carr. 40p.
Factory built with 12 mths guarantee **£16·95** **Or in Teak** Veneer housing **£19·95** Dep. £2·50 & 8 mthly pymts £2 50 (Total £22·50).

AUDIO FIDELITY FR1 SPEAKER KIT



Response 30Hz-15KHz. Rating 15 watts in sealed cabinet. Imp. 8-15 ohms. 8″ Bass Unit with P.V.C. Cone surround for ultra low resonance. Pressure Tweeter. Printed Circuit. Inductive/Capacitive Cross-over. Damping Material, Screws, Terminal Panels.

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- Jack Socket for Headphones
- Neon Indicator
- Satin Silver Finish Metal Fascia
- Solid State Circuitry
- Twenty Silicon Transistors
- Four Diodes, Four Rectifiers

Send S.A.E. for full descriptive leaflet.

For Magnetic or Ceramic Pick-Ups regardless of Price. Output (per channel) 15 watts RMS into 8Ω. Frequency Response 7 Hz to 70 KHz ± 1½ dB.

COMPLETE KIT (less cabinet). Carr. 70p. Cabinet if req. £5 extra. **£22·50**

R.S.C. STEREO FM III TUNER. in cabinet Visually matches Super 30 Mk. III **£37·50**

FACTORY BUILT UNIT INC. CABINET with 12 months' guarantee. Or Dep. £7 and 8 monthly payments £5·17 (Total £48·36). **£42·50**

'YORK' HIGH-FIDELITY 3 SPEAKER SYSTEM

★ Moderate size only 25 × 14 × 10in. approx.
★ Response 30-20,000 c.p.s. Impedance 15 ohms

Performance comparable with units costing considerably more **COMPLETE KIT £25** Carr. 75p

Consists of (1) 12in. 15 watt Bass unit with cast chassis. Roll rubber cone surround for ultra low resonance. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker. (4) Dome Pressure Tweeter. (5) Quantity acoustic damping material. (6) Handsome Teak veneered cabinet. (7) Circuit and full instructions. Terms: Deposit £3·71 and 8 monthly payments £3·12 (Total £28·67).

FANE HIGH FIDELITY LOUDSPEAKERS AT LESS THAN HALF-PRICE

UNREPEATABLE OFFER · BRAND NEW · BOXED · FULLY GUARANTEED for High-Fidelity NOT Group Disco use
Available by Mail Order only due to small quantities of some models. SAE for leaflets. Please state impedance required.

Model No.	Price (incl. VAT)	Model No.	Price (incl. VAT)	Model No	Price (incl. VAT)	Model No.	Price (incl. VAT)	Model No.	Price (inc. VAT)	Model No.	Price (incl. VAT)	Model No.	Price (inc. VAT)
505	£2·73	1002	£4·19	121/15	£4·61	138/15	£4·51	122/10TLR	£6·36	122/14LR	£9·19	152/10	£9·26
506	£2·61	1005	£3·65	121/15LR	£5·33	138/15LR	£4·83	122/12	£6·75	122/14ALR	£9·52	152/12	£10·84
507	£1·08	1006	£3·50	138/10	£2·18	138/15TLR	£4·96	122/12A	£7·08	122/17	£10·26	152/12A	£11·33
508	·96	1008	£2·93	138/10T	£2·31	101/10A	£4·27	122/12D	£6·88	122/17A	£10·59	152/14	£12·49
801	£3·93	1001LR	£5·09	138/10LR	£2·50	101/14	£6·64	122/12T	£7·08	122/17T	£10·59	152/17	£14·96
802	£3·69	1005LR	£4·37	138/10TLR	£2·63	101/14A	£6·74	122/14	£8·47	122/17LR	£10·98	153	£17·48
802T	£3·82	121/10	£3·17	138/11	£3·55	122/10	£5·16	122/14A	£8·80	122/17ALR	£11·31		
805	£3·25	121/10T	£3·37	138/11LR	£3·87	122/10A	£5·49						
806	£2·56	121/11	£3·58	138/13	£3·83	122/10LR	£6·03						
1001	£4·37	121/11T	£3·78	138/13LR	£4·15	122/10T	£5·49						

All Transformers available as previously advertised

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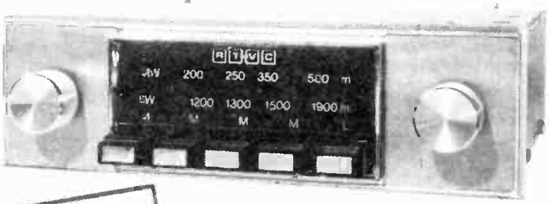
PUSH BUTTON(*) CAR RADIO KIT

The first time* Motor *magazine have nominated a push button car radio for their Top Ten Accessory Awards



NOW BUILD YOUR OWN AWARD WINNING PUSH BUTTON CAR RADIO

Technical specification:
1.) **Output** 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
2.) **Integrated circuit** output stage, pre built three stage IF Module.
Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.
Size Chassis 7 ins. wide, 2 ins. high and 4 5/16 ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p. free with kit.

Car Radio Kit
£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
£1.65 + 23p. postage & packing.

Recommended **Car Aerial** - fully retractable and locking.
£1.35 post paid.

STEREO 21

QUALITY SOUND(*) FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit, - no soldering required. Includes:—
BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
For the technically minded:—
Specifications:
Input sensitivity 600mV: Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. 15½" × 8" × 4". Complete deck and cover in closed position approx. 15½" × 12" × 6". Complete only **£18.95** + £1.60 p & p.
Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**

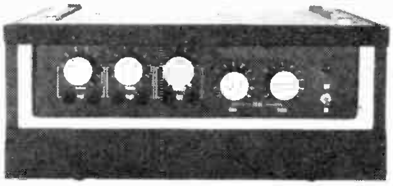
DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

INPUT SENSITIVITIES

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. 12½ ins × 6 ins × 3½ ins
£15.00 + 60p. postage & packing

DISCO 50



45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER

Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19¼ × 10½ × 8ins. approx. Amplifier **£27.50 + £1.50 p. & p**

Special Offer: Disco 50 plus two 15" E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00 + £4.00 p&p.**

COMPLETE(*) STEREO SYSTEM

£51·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes,
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble 12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) −58dB.
Crosstalk better than 35dB on all inputs.
Overload characteristics better than 26dB on all inputs. Size approx. 13¾″ × 9″ × 3¾″.
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½″ × 10¾″ × 6″ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter

Complete System £51.00

£69·00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers—
Enclosure size approx. 31″ × 13″ × 11½″. Finished in teak veneer. Drive units approx. 13½″ × 8¼″ with 3¼″ HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p.
total	£59.20

Available complete for only **£51.00** + £3·50 p. & p.

PRICES: SYSTEM 2

Viscount R102 amplifier	£24·20 + £1·00 p. & p.
2 Duo Type IIIA speakers	£39·00 + £4·00 p. & p.
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21·00 + £1·75 p. & p.
total	£84·20

Available complete for only **£69.00** + £4 p & p.

EMI SPEAKERS AT FANTASTIC REDUCTIONS

THE ULTIMATE COMPLETE SPEAKER SYSTEM
EMI LE 315 listed price £86·00

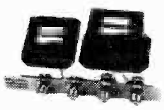
A professional standard five way speaker system with enclosure giving top quality performance.
Enclosure Dimensions
approx. (3ft × 2ft × 1ft.)
Drive Units
Hand built – 15″ diameter bass with 3″ voice coil, – two 5″ diameter Mid Range units, – two 3½″ HF units, plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.
Power Handling
Continuous rating 35 W rms., Peak power rating 70 W.
Frequency Response
20 Hz 20,000 Hz. Imp. 8 ohms.

Our price £45·00 + £3·50 p. & p.

15″ 14A/780 BASS UNIT
Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz, flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3″ voice coil.

Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p & p

950 KIT
Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
Huge 19″ × 14″ (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each 3¼″ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2″, others 0·5″. Recommended list price £44·00. **OUR PRICE £19.50 + £1·50 p & p Special Offer.**



BUILD YOUR OWN STEREO AMPLIFIER(*)

For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

£7·64 + 55p. p & p

8TRACK CARTRIDGE PLAYER(*)

Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21.
Technical specification: Mains input, 240V, Output sensitivity 125mV
Comparable unit sold elsewhere at £24·00 approx.

Yours for only £10.95 + 90p. p & p

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BD2 Chassis	29·50
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EMI 13" × 8" 3, 8 or 15 ohm	
Plain	2·15
with Co-Axial Tweeter	2·30
Twin Tweeter	3·95
Type 350 8 ohm or 15 ohm, 20 watt	7·99
6½" 8 ohm, 10 watt	2·65
8" 8 ohm, 10 watt	3·90
12" 8 ohm, 20 watt	5·75
8" × 5" C/Mag. 5 watt	1·40
8" × 5" Dualcone 8 ohm 10 watt	2·70
FANE 7" × 4" 3 or 8 ohm	1·15
8" Dualcone 8 ohm	2·50
CELESTION 8" 15 ohm	1·75
ADASTRA 10" 8 or 15 ohm, 10 watt	3·25
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12" 8 or 15 ohm, 25 watt	7·75
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12 × 12 × 6 with 8", 8" × 5", or 6½" and 3½" cutout	2·75
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EMI 3½" 3 or 8 ohm C/Mag.	1·10
Cone Tweeter 8 or 15 ohm, 10 watt	2·50
Cone Tweeter 8 ohm, 3 watt	1·50
Horn Tweeter 8 ohm, 20 watt	5·95
Dome Tweeter 8 ohm, 30 watt	4·95
Crossovers CN23 (3 ohm), CN28 (8 ohm), CN216 (16 ohm)	1·15
CARTRIDGES	
ACOS GP91/2SC or GP91/3SC Stereo comp.	1·05
GP93/1 Stereo crys.	1·35
GP94/1 Stereo crys.	1·75
GP95/1	1·35
GP96/1	1·75
GP101	·75
GP104	1·65
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9TAHC Stereo ceramic, diam.	1·80
9TAHC/G Slim fit, stereo cer. diam.	1·80
19-TI Stereo crystal	·85
BSR SC5M Stereo ceramic	2·25
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CASSETTES

Type	Low noise	Phillips	Memorex	Ampex
C45	—	—	50p	45p
C60	35p	50p	55p	55p
C90	45p	69p	75p	75p
C120	55p	105p	110p	110p

Cassette Head Cleaner	·45
BIB Stereo Test Cassette	1·65
AMPEX Head Cleaner Demagnetiser	1·65

PLASTIC LIBRARY CASES for 5" Reels 20p. 5¾" Reels 25p. 7" Reels 30p.
CASSETTE CASES 12p

TAPES	Stnd.	L.P.	D.P.
5"	55p	65p	80p
5¾"	65p	75p	£1·00
7"	80p	£1·05	£1·40

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1. Pr. of 10watt 8ohm 2 speaker system in deluxe teak veneer cabinet 18" x 11" x 9" wired, inc. plugs. £25·00 per pair.
2. Pr. of 20watt 8ohm 2 speaker system freq. response 50c.p.s. to 17,000c.p.s. Teak veneer cab. 21½" x 12" x 9" with 12ft. cable and plugs. £29·95 per pair.

AKAI TAPE DECK	
4000DS Tape	99·95
GXC40B Cassette	83·00

HEADPHONES		£
AMSTRAD	HPS5A	4·95
ROTEL	430	4·90
	630	6·20
	700	8·95
AKAI	ASE 115	5·75
	ASE 20	7·95
KOSS	K711 (Black or Red)	9·95
	K6	11·95
	K6LC (with Vol. control)	13·25
	K0727B	15·75
	K0747	19·50
	HVI	19·50
	PRO4AA	26·95
	PRO5LC	28·75
	ESP6	42·75
LEESSON ELECTROSTATIC		19·50
Mono/stereo super de luxe 8–16Ω		2.75
Headphone Adaptor		2·50
Curly Ex, Lead 20ft.		1·10

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Car Cassette Stereo Player and Two Speakers	20·95
Car 8-track Stereo Player and Two Speakers	16·50
Pair of Car Stereo Speakers	3·85
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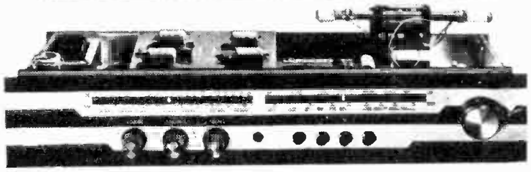
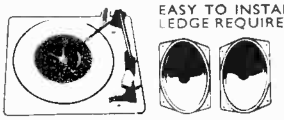
THE AVON AUDIO SYSTEM



The uncabineted system is ideal as an economical replacement for an outdated chassis. Stereo Amplifier for Stereo/Mono record reproduction. Tuner with medium, long and short wavebands provides Worldwide coverage, even the weakest continental stations can be received with superb clarity. Push button band selection, 10 watts total output. Frequency response 25-18000 Hz.

LATEST BSR STEREO/MONO RECORD CHANGER plays all types of 7in., 10in., and 12in. Mono or Stereo records. Manual or automatic play.

TWIN ELLIPTICAL SPEAKERS These low impedance, permanent magnet units have been specially selected to provide the fullest range of audio reproduction.



EASY TO INSTALL—NO TECHNICAL KNOWLEDGE REQUIRED. List Price £45·74. OUR PRICE £35·00. Credit Terms £3·50 deposit plus £2 Post & Packing followed by 9 payments of £4·10 (Total Credit Terms £44·40) Don't miss this bargain.

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BSR HI-FI AUTOCHANGER

STEREO AND MONO

Plays 12", 10" or 7" records Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 18¾ × 11¼in. Above motor board 3¼in. Below motor board 2½in. With STEREO and MONO XTAL **£6·75** Post 35p.

PORTABLE PLAYER CABINET

Modern design. Size 18" x 15" x 7" Black rexine covered. Silver front grille. Padded Lid. Chrome fittings. Motor board cut for above BSR deck. **£4·50** Post 45p.

4 TRANSISTOR MONO AMPLIFIER

Powerful 3 watt output. 15 ohm. AC mains operated with transformer. 3-Controls, volume, treble, bass and On/Off switch with knobs. Ready made on printed circuit board. Fused inputs and outputs. Famous make. Size 8in. wide × 4in. deep × 3in. high. Suitable 7" × 4" speaker, £1. **£5·95** Post 25p

BSR JUNIOR SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono compatible cartridge. **£4·95**

GARRARD DECCA HI-FI DECK

Single play Stereo/ Mono Deram transcription head and arm. Four speeds. 10½in. turntable. Anti-rumble filter. Bias compensation. Laboratory motor.

SPECIAL PRICE **£18·50** Post 25p Ideal for Disco-Deck

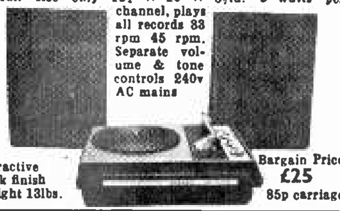
METAL PLINTH AND PLASTIC COVER

Cut out for most Garrard or B.S.R. Most will play with cover in position. 12½ × 14¾ × 7½in. Covered in black leatherette. **£4·95** Post 45p

ALSO AVAILABLE IN SOLID NATURAL MAHOGANY WAX POLISHED FINISH—£5·95

COMPACT PORTABLE STEREO HI-FI

Two full size loudspeakers 13½ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13½ × 10 × 8½in. 3 watts per channel, plays all records 33 rpm 45 rpm. Separate volume & tone controls 240v AC mains



Attractive Teak finish Weight 13lbs. Bargain Price **£25** 85p carriage

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0-60 MINUTES

Single pole two-way Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights etc. Variable knob Turn on or off at full or intermediate settings. Fully insulated. Makers last list price £4·50. Brand new and fully guaranteed. OUR PRICE **£1·65** Post 25p.

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ALUMINIUM PANELS 18 s.w.g. 6 × 4in 12p; 8 × 6in 19p; 14 × 3in 2up; 10 × 7in 24p; 12 × 5in 25p; 12 × 8in 34p; 16 × 6in 34p; 14 × 9in 40p; 12 × 12in 47p; 16 × 10in 60p.

PAXOLIN PANEL 10 × 8in 20p.

1½inch DIAMETER WAVECHANGE SWITCHES, 25p. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way, 25p each. 1 p.1 2-way, or 4 p. 2-way, or 4 p. 3-way, 25p.

TOGGLE SWITCHES, sp. 18p; dp. 22p; dp. dt. 22p. Sub-miniature, sp. 33p; dp. 40p; dp. dt. 50p.

R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode. Printed Circuit Bridge Rectifiers and Double Wound Mains Transformer. Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1½ × 1½in. **£2·20** Post 20p

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Ideal for Mike, Tape P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. D.C. operation. Size 1¾" × 1¼" × ¾". Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	16+16+16/275v	45p
4/350V	14p	500/25V	20p	50+50/300V	50p
8/450V	18p	1000/25V	35p	60+100/350V	85p
16/450V	22p	1000/50V	47p	32+32/250V	20p
32/500V	50p	8+8/450V	22p	32+32/450V	60p
25/25V	10p	8+16/450V	25p	350+50/325V	55p
50/50V	10p	16+16/450V	40p	100+50+50/350V	55p
100/25V	10p	32+32/350V	40p	32+32+32/350	65p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p ; 25V 20p ; 50V 30p.
1000mF 12V 20p ; 25V 35p ; 50V 47p ; 100V 70p.
2000mF 6V 25p ; 25V 42p ; 50V 57p.
2500mF 50V 62p ; 3000mF 25V 47p ; 50V 65p.
5000mF 6V 25p ; 12V 42p ; 25V 75p ; 35V 85p ; 50V 95p.

CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.

PAPER 350V-0·1 4p; 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.

SILVER MICA. Close tolerance 1%. 2·2-500pF 8p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p each.

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Slow motion drive 365pF+365pF with 25pF+25pF, 50p; 500pF standard 65p.

SHORT WAVE SINGLE. 10pF, 30p; 25pF, 55p; 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. Values up to 100pF. **50p** each. Section Couplers supplied FREE with two or more gangs.

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RESISTORS. ¼ w., ½ w., 1 w., 20%, 1p; 2 w. 5p. 10 Ω to 10M.

HIGH STABILITY. ½ w. 2% 10 ohms to 6 meg., 10p. Ditto 5%, Preferred values 10 ohms to 10 meg., 4p.

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ALL POST 25p each

Eagle MT12 12-0-12v 50MA 90p
250-0-250 80 mA. 6·3 v. 3·5 a. 6·3 v. 1 a. or 5 v. 2 a. £2·50
350-0-350 80 mA. 6·3 v 2·5 a, 6·3 v. 1a. or 5 v. 2 a. £3·00
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5, 8 and 13 v. 5 amp. £1·20. 3 amp., 3, 5, 8, 10, 13 and 5-0-5 v. £1·30, Ditto 5 amp. £1·50; 6-0-6 v. 500 mA 90p. 9 v. 1 amp 95p. 12 v. 300 mA 75p. 12 v. 500 mA 85p. 12 v. 750 mA 95p. 40v. 1 amp £1·75.

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FULL WAVE BRIDGE CHARGER RECTIFIERS : 6 or 12v. outputs. 1½ amp. 40p; 2 amp. 55p; 4 amp. 85p.

MAINS ISOLATING TRANSFORMER

Primary 0-110-240v. Secondary 0-240v. 3 amps. 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19) OUR PRICE **£10** Carr. 50p. Can be used as 800 watt auto transformers 240-110V.

SET OF 3 MOTORS FOR COLLARO STUDIO 115 volt TAPE DECK £2·50 Post 50p.

VOLUME CONTROLS

Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

80 Ohm Coax 5p yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £2; 60 yd. £3.

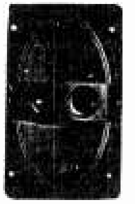
FRINGE LOW LOSS Ideal 625 and colour. **10p** per yd

Wirewound controls 1½in. diam. 3 watts. 10 ohms to 100K British made with long spindles ¼in. dia 45p ea.

HELICAL POT 10k LIN List £3, Bargain 75p.

DUAL CONCENTRIC POT 500k LOG + 500k LIN D.P. switch. Inner spindle 3½in; outer spindle 2½in. 75p.

E.M.I. 13½ × 8 in. SPEAKER SALE !



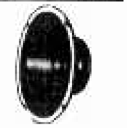
With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·75** Post 25p

Bookshelf Cabinet

16 × 10 × 9in. Teak Veneer **£6·60** Post 35p

E.M.I. 6½in. HI-FI WOOFER



8 ohm, 10 watt. Large ceramic magnet Special Rubber cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns, Hi-Fi Enclosure Systems, etc. **£4** Suitable cabinet 12 × 8 × 6 £4·00. Suitable Tweeter £2·00.

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 8½ × 3½ × 2in. deep. Rating 10 watt, 3 ohm. Crossover £1.25 Post 20p **£1·90**

GOODMANS 8 in. WOOFER

8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi systems **£3·75**

LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in. £1·25; 6½in. £1·50; 8 × 5in. £1·60; 8in. £1·75; 10 × 6in. £1·90; 10in. £2·00.

SPECIAL OFFER LOUDSPEAKERS! All Brand New. 3 ohm, 2½in; 2¾in; 3½in; 5in. 8 ohm, 2½in; 2¾in; 5in × 3in; 5in. 15 ohm, 3½in; 5in; 6 × 4in; 5in × 3in; 7 × 4in; 8 × 5in. 25 ohm, 2½in; 3in; 3in; 5 × 3in; 5in. 35 ohm, 2in; 3in; 5in. 80 ohm, 2½in; 2¾in. **£1** EACH

RICHARD ALLAN TWIN CONE LOUDSPEAKERS, 8in. diameter 4W £2·50, 10in. diameter 5W £2·50; Post 25p. 12in. diameter, 6W, £2·95; 3 or 8 or 15 ohm models.

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Horn Tweeters 2-16Kc/s. 8W 8 ohm or 8 ohm £1·95.

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TWO-WAY 3,000 c.p.s. CROSS OVERS 3, 8 or 15 ohm £1·25

TWO-WAY CROSSOVER NETWORK 3,000 c/s

With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5½in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm impedance. **£3·75** Post 20p

ELECTRO MAGNETIC PENDULUM MECHANISM

1·5v d.c. operation over 250 hrs. continuous on SP2 battery. fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome; strobe etc. 95p, Post 20p

R.C.S. VALVE AMPLIFIER

2 Stage Triode Pentode valve. 3 watts 3 ohm output. Volume on/off and tone controls AC mains. Complete and tested. £4·50. Post 25p.

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P50/3CC-40p.	LFDT4. 65p.

Printed Circuit 60p. Twin Gang 75p.

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p OUTLET BOXES, SURFACE MOUNTING 25p.

BALANCED TWIN RIBBON FEEDER 300 ohms, 5p yd.

JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 5p. Phono Socket 5p

JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.

VALVE HOLDERS 5p; CERAMIC 10p; CANS 5p.

BRITISH FM/VHF TUNING HEART

88 to 108 Mc/s British made. 2 Transistors ready aligned—requires 10.7 Mc/s IF. Complete with tuning gang. Connections supplied but some technical experience essential. Our Price **£3·95** Post 20p.

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TRANSFORMERS

New Product
CASED AUTO TRANSFORMERS

240 Volt Mains to 115 Volts, smart steel-cased units coated in tough resin, fitted with power lead, fuse and 115 Volt American type socket up to 500VA. above 500VA cable entry.

VA (Watts)	Price	Post
200 ,,	£5·56	£0·38
500 ,,	£9·50	£0·67
1000 ,,	£15·92	£0·82
2000 ,,	£29·70	£1·50
20VA version uncoated, no fuse	£2·52	£0·30

POWER UNIT Type A125

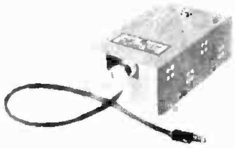
Supplying 6 or 9 Volt DC at 200 mA.

In moulded case forming a 2 pin 5 A mains plug.

2 metre output lead with 4-way multiplug giving 2·1 and 2·5 mm sockets and 3·5 mm plugs.

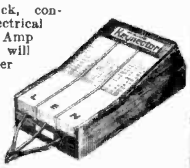
Price £2·25. Post 10p.

POWER UNIT Type P1076



Output switched 3, 4·5, 6, 7·5, 9 and 12 Volts at 500mA D.C. Operates from 240 V. mains, suitable for Radios, Tape Recorders, Record Players, etc. Size 7·5 × 5·0 × 14·0 cm. Price £3·95. Post 25p.

MAINS KEYNECTOR



The safe, quick, connector for electrical appliances, 13 Amp rating, fused, will connect a number of appliances quickly and safely to the mains, ideal for testing, demonstrating, window displays, etc.
Warning Light, interlocked to prevent connecting when live.
Trade Price: £2·95. Post 25p.

PANEL METERS 2″ & 4″

Modern Wide View Face. Moving Coil.
Wired for illumination (lamps extra).
50 mA 1250 ohms
1 mA 170 ohms
VU 5250 ohms (with Detector)
Face Size 60 × 45 × 40mm (2″)
110 × 82 × 43mm (4″)
PRICE: 2″ £2·95 4″ £3·95 + POST 10p

SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with Screen.

VA (watts)	Ref. No.	Price Cased	Price Open	P & P £
60	149	—	£ 3·74	0·38
100	150	—	4·16	0·52
200	151	£ 9·48	7·48	0·52
250	152	12·05	9·57	0·65
350	153	14·00	11·44	0·80
500	154	15·80	13·20	1·00
1000	156	30·70	27·46	1·20
2000	158	60·95	55·44	
3000	159	79·53	72·49	

50 Volts

Prim. 200–240V.
Sec. 19, 25, 33, 40, 50V.

Amps	Ref. No.	Price £	P & P £
0·5	102	£2·11	£0·30
1	103	3·08	0·38
2	104	4·29	0·42
3	105	5·77	0·52
4	106	7·48	0·52
6	107	11·00	0·67
8	118	14·19	0·97
10	119	17·60	0·97

60 Volts

Prim. 200–240V.
Sec. 24, 30, 40, 48, 60V.

Amps	Ref. No.	Price £	P & P £
0·5	124	£2·10	£0·38
1	126	2·97	0·38
2	127	5·77	0·42
3	125	7·15	0·52
4	123	9·35	0·67
5	40	11·55	0·67
6	120	13·57	0·82
8	121	16·00	1·00
10	122	19·40	1·00
12	189	21·62	1·10

12 & 24 Volts Prim. 200–240V.

Amps 12V	Amps 24V	Ref. No.	Price £	P & P £
0·3	0·15	242	1·34	0·22
0·5	0·25	111	1·34	0·22
1	0·5	213	1·59	0·22
2	1	71	2·09	0·22
4	2	18	2·75	0·38
6	3	70	3·56	0·42
8	4	108	3·96	0·52
10	5	72	4·67	0·52
12	6	116	5·67	0·52
16	8	17	6·84	0·52
20	10	115	10·23	0·69
30	15	187	13·75	0·97
40	20	232	18·26	1·00
60	30	226	22·52	1·10

MINIATURE AND EQUIPMENT

Prim. 240V with screen.

Volts Sec. 1	Volts Sec. 2	Milliamps Sec. 1	Milliamps Sec. 2	Ref. No.	Price £	P & P £
3–0–3	—	200	—	238	1·23	0·10
0–6	0–6	500	500	234	1·30	0·10
0–6	0–6	1000	1000	212	1·68	0·22
9–0–9	—	100	—	13	1·23	0·10
0–9	0–9	330	330	235	1·43	0·22
0–8–9	0–8–9	500	500	207	2·28	0·30
0–8–9	0–8–9	1000	1000	208	3·03	0·10
15–0–15	—	40	—	240	1·23	0·10
0–15	0–15	200	200	236	1·30	0·10
20–0–20	—	30	—	241	1·23	0·10
0–20	0–20	150	150	237	1·30	0·10
0–15–20	0–15–20	500	500	205	2·97	0·38
0–20	0–20	300	300	214	1·76	0·22
0–20	—	3500	NO SCREEN	1116	3·00	0·40
20–12–0–12–20	—	700 (D/C)	—	221	1·55	0·30
0–15–20	0–15–20	1000	1000	206	3·80	0·38
0–15–27	0–15–27	500	500	203	3·08	0·38
0–15–27	0–15–27	1000	1000	204	2·24	0·38

30 Volts

Prim. 200–240V. Sec. 12, 15, 20, 24, 30V.

Amps	Ref. No.	Price £	P & P £
0·5	112	£1·58	£0·22
1	79	2·20	0·38
2	3	3·19	0·38
3	20	3·96	0·42
4	21	4·68	0·52
5	51	5·80	0·52
6	117	6·93	0·52
8	88	9·00	0·67
10	89	10·00	0·67

PLASTIC CASED SILICON BRIDGE RECTIFIERS

One Amp	Two Amp	Four Amp	Six Amp
50 P.I.V. 25p	50 P.I.V. 35p	100 P.I.V. 55p	50 P.I.V. 65p
100 P.I.V. 25p	100 P.I.V. 40p	200 P.I.V. 59p	100 P.I.V. 70p
200 P.I.V. 28p	200 P.I.V. 45p	400 P.I.V. 65p	200 P.I.V. 80p
600 P.I.V. 30p	400 P.I.V. 50p	600 P.I.V. 75p	400 P.I.V. 90p

ADD 10p P & P PER ORDER

AUTO TRANSFORMERS (Open)

VA (Watts)	Ref. No.	Price £	Post £
Tapped at 115, 220, 240 Volts			
20	113	£1·32	22p
75	64	£2·63	30p
Tapped at 115, 200, 220, 240 Volts			
150	4	£3·29	39p
200	65	£3·96	40p
300	66	£4·64	52p
500	67	£8·03	67p
1000	84	£13·50	82p
2000	95	£25·30	£1·00
3000	73	£33·00	£1·20

PLEASE ADD 10% FOR V.A.T.

QUALITY INSTRUMENT CASE

Strongly moulded in High Gloss Grey Plastic (Flame Retardant ABS).

Two interlocking halves secured by four corner bolts (supplied).

Interior Size: 6¼″ × 5¼″ × 2¾″.

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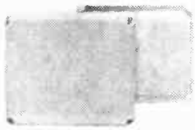
Weight: 11½ ozs.

Price: £1·50. Post 15p.



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POP 40 10" 40 Watt

Impedance 8-15 ohms
Gauss 14,000
Voice Coil Diam. 1¼in
Fitted Tweeter Cone
Range 50-15,000 Hz
Rec. Retail Price

£10·95

Also for those who can afford the very best For Bass Instrument Reproduction

BASS CRESCENDO '12'

12" 100 Watt 3" Pole Diam.

BASS CRESCENDO '15'

15" 100 Watt 3" Pole Diam.

Rec. Retail Price CRESCENDO '12' **£39·95**

Rec. Retail Price CRESCENDO '15' **£48·83**

Please send S.A.E. for leaflet on 'POP' or 'CRESCENDO' Range Speakers

POP 55 12" 60 Watt

Impedance 8-15 ohms
Gauss 15,000
Voice Coil Diam. 2in
Range 50-9,000 Hz
AN ALL PURPOSE UNIT OF HIGH sensitivity
Rec. Retail Price

£15·95

Brief details of other 'POP' Speakers

			Rec. Retail
POP '15'	12"	15 Watt	£5·95
	1" Voice Coil		
POP '25/2'	12"	30 Watt	£8·99
	2" Voice Coil		
POP '50'	12"	50 Watt	£12·99
	2" Voice Coil		
POP '60'	15"	60 Watt	£16·95
	2" Voice Coil		
POP '100'	18"	100 Watt	£29·70
	3" Voice Coil		

There is also a 12" Crescendo Speaker for General Purpose Public Address, and another one for Lead or Rhythm Guitar

NOW AVAILABLE

MODEL 920 High Frequency HORN UNIT

Rating with filter 100 WATTS

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DIGITAL DISPLAY. LEO 1/3" 0-9 DP. DIL. **£1·69.** Minitron type 0-9 DP DIL **£1·19.** SOCKETS **13p.** Calculator batt/mains from **£19.**

CHIPS. Texas etc. with 4 displays **£12·6** displays and chip **£14.**Mostek data and alarm chips with 6 displays **£19.** pcb **£1·49.**
KIT: All parts and case. National chip. 4 digit **£20.** 6 x **£23.**
GAS sensor TGS 308 **£2.** KIT **£4·69.** Fully built **£8.**

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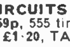
74N TTL low prices



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CAPACITORS: 25V 10, 50, 100 uf **5p**, DISCS **4p**, PRESETS **5p**, CARBON-PTS **11p.** Switch + **11p.** Dual **55p.** ULTRASONIC TRANSDUCERS **£2** ea.

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ZTX108	8p	ZTX331	16p			ZS271	16p
ZTX109	11p	ZTX382	13p	* DIODES *		ZS272	18p
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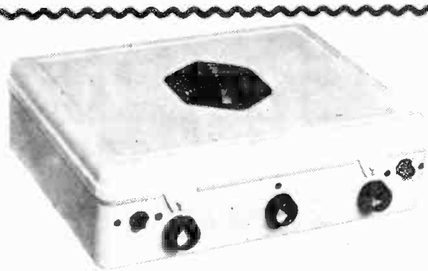

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★ 5 Transistor Push Pull Amplifier.
★ 7 Transistor Loudspeaker Radio MW/LW.
★ 5 Transistor Short Wave Radio.
★ Electronic Metronome.
★ Electronic Noise Generator
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★ Audible Continuity Tester.
★ Sensitive Pre-Amplifier.

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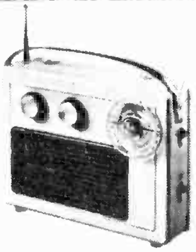
(+ 10% VAT 72p)

Components Include: 24 Resistors ● 21 Capacitors ● 10 Transistors ● 3½" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way connectors ● 2 Volume controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 Yard of sleeving etc. ● Parts Price List and Plans 50p. (Free with parts).

NEW ROAMER NINE

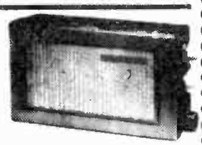
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tuneable wavebands as Roamer Ten Built in ferrite rod aerial for MW/LW. Retractable chrome-plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9¼" × 7" × 2¾" approx. Parts Price List and Plans 30p (Free with parts).

Total Building Costs £6·95 P P & Ins. 44p (Overseas P & P £1·85)
(+ 10% VAT 69p)

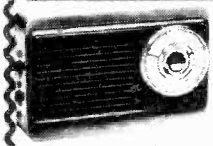
POCKET FIVE



3 Tunable wavebands. M.W. L.W. and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size 5½" × 1¼" × 3½" approx. Plans and Parts Price List 15p (Free with parts).

Total Building Costs £2·28 P P & Ins. 26p
(+10% VAT 22p)
(Overseas P & P £1·25)

TRANSONA FIVE



Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List 15p (Free with parts).

Total Building Costs £2·50 P P & Ins. 26p
(+10% VAT 25p)
(Overseas P & P £1·25)

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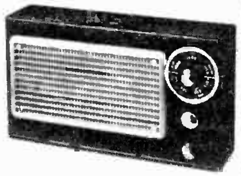


E.V.5. 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" × 5½" × 2½" approx. Parts Price List and Plans 15p. Free with parts.

Total Building costs £2·73 P P & Ins. 30p (+ 10% VAT 27p) (Overseas P & P £1·25)

E.V.6. Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts Price List and Plans 15p. Free with parts.

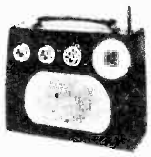
Total Building Costs £3·60 P P & Ins. 30p (+ 10% VAT 36p) (Overseas P & P £1·25)

E.V.7. Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1. SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker. Parts Price List and Easy Build Plans 20p. Free with parts. Overseas P & P £1·05.

Total Building Costs £4·08 P P & Ins. 31p Overseas P & P £1·85 (+ 10% VAT 40p)

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

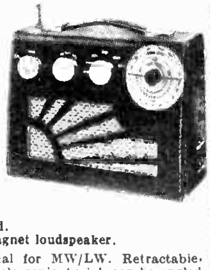


7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt ferrite magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total building costs £6·98 P P & Ins. 47p (+ 10% VAT 69p)
Overseas P & P £1·85)

ROAMER TEN

WITH VHF INCLUDING AIRCRAFT

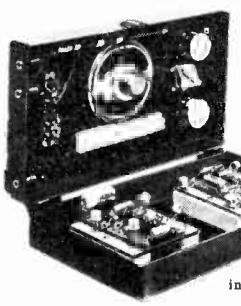


10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers.
9 Tunable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Latest 4" 2 watt ferrite magnet loudspeaker.

Built in Ferrite Rod Aerial for MW/LW. Retractable chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mW Transistors. Car Aerial and Tape Record Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Controls. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs £8·50 P P & Ins. 52p
(Overseas P & P £1·85)
(+ 10% VAT 85p)

"EDU-KIT"



Build Radios, Amplifiers, etc., from easy stage diagrams.

Five units including master unit to construct.

Components include:
Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine Tone 3" Moving Coil Speaker: Terminal Strip: Ferrite Rod Ariel: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ½" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction.
Parts price list and plans 25p (FREE with parts).

Total building costs £5·50 P P & Ins. 33p (Overseas P & P £1·85)
(+ 10% VAT 55p)

TRANS EIGHT 8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

Total building costs £4·48 P P & Ins. 33p
(+ 10% VAT 44p)
(Overseas P & P £1·25)

ROAMER SIX

CASE AND LOOKS AS TRANS-EIGHT

6 Tunable Wavebands: MW, LW, SW1, SW2, Trawler band plus an extra Medium waveband for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Plans and parts price list 25p (FREE with parts).

Total building costs £3·98 P P & Ins. 31p (Overseas P & P £1·85)
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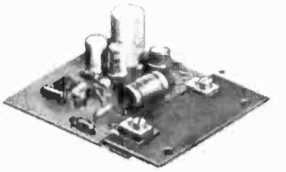
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8 – 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE ± 3dB	Po = 2 WATTS	50 Hz – 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8 Ω f = 1KHz	75mV. RMS
DIMENSIONS	—	3″ × 2¼″ × 1″

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8 Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10.	3 watts	RMS	£2 19
AL 20.	5 watts	RMS	£2 59
AL 30.	10 watts	RMS	£3 01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS SP 12 with Knobs £1·10

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL50) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1 93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response— 20Hz – 50KHz (– 3dB)
Bass control— ± 12dB at 60Hz
Treble control— ± 14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance 30 K ohms
Sensitivity 4mV

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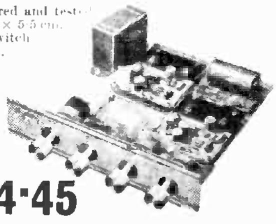
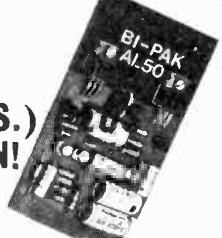
The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls. Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.

£14·45

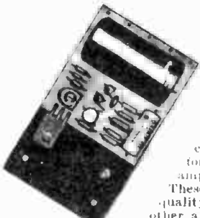
NOW WE GIVE YOU 50w PEAK (25w R.M.S.) THERMAL PROTECTION! The *NEW* AL60 Hi-Fi Audio Amplifier FOR ONLY £3.95



- Max Heat Sink temp. 90°c.
- Frequency Response 20Hz to 100KHz
- 0·1% Distortion
- Distortion better than 1% at 1KHz
- Supply voltage 10-35 volts
- Thermal Feedback
- Latest Design Improvements
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:— Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz – 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20 KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than –65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

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SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25·30 FREE p. & p.

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COMPONENTS 'FREEZE'

NOW that we have a good idea of what effects the 1974 Budget will have, the time is right for a re-appraisal of our spending. There are, as always, two sides to the coin—the reader who may also be a constructor and therefore component buyer; the advertiser or component supplier, usually doing his best to satisfy a demand or looking for a new sales line.

Where shortage of cash and credit may well seriously affect the sales of commercial equipment, the devotee will look more towards cutting his costs by "doing-it" himself. There are, however, some areas that claim buoyant interest and of late this has been in the "ICE" (in-car entertainment) sector in particular.

IN-CAR ENTERTAINMENT

In this issue of Practical Wireless we are publishing two articles on ICE, one on commercial equipment, the other as a technical appraisal. In this latter one we show you a first class design that has been made and is now touring the country in the designer's car.

Of course this particular design was conceived before anyone really believed that the industrial situation was so serious. Here we have an example where energetic investigations to find readily available components for it may have been frustrated. Alas, there is now, not only a shortage of steel and other materials, but price increases are imminent.

We could not in all honesty, commit readers knowingly to become victims of this situation through a popular published project without warning. In particular there are problems in getting the push button tuner head, and other items used by the author; current output is concentrated on long standing orders with commercial manufacturers.

Even so, these difficulities do not deter us completely from publishing an otherwise excellent design for its own sake. We know that British ingenuity will come to the rescue as it so often does. Many of you will have old car radios that need up-dating. In most cases the tuner head mechanism may still be serviceable. Unfortunately we cannot tell you if yours is suitable; we can only suggest that you look into it thoroughly or ask a knowledgeable friend for advice.

COMPONENT SUPPLIES

Readers will probably have read or heard about other component shortages from some manufacturers, coupled with long delivery times and re-organised or rationalised stock holding. At retail level this is now being felt, although most of our advertisers may still boast large stocks. It all depends really on whether they have what you want at the right price.

We hear a great deal about the "information and communication rift" between suppliers and customers. On the one hand there are those suppliers who do not keep customers fully informed about delays, so aggravating customer relations and creating unnecessary complaints; on the other hand there are those constructors who do not make out their orders in a clear and concise manner, and often pose irrelevant questions or fail to send adequate money to cover VAT and carriage charges.

To solve all these problems to everyone's satisfaction is almost impossible with the limited resources at our disposal. What we can do is to help inform readers through the magazine.

BUYER'S GUIDE

We are planning to launch a special supplementary operation in the autumn aimed to provide readers with details of product lines and trading terms or retail component outlets. To carry any measure of value to both parties we need your help. However, there are limitations and we cannot hope to please everyone.

We shall be adding to our normal October issue an extra centre pull-out section which will contain information on components, components suppliers and trading terms. Unfortunately this has to be limited in size, so we shall be including further sections in the following three issues. You will be able to collate all these sections to form a valuable "Buyer's Guide" reference book which you will always want to keep handy.

INVITATION

Component suppliers in the retail sector, who sell through shops or by mail order, are invited to submit catalogues or price lists of components only that they always carry in stock or are likely to have in stock regularly by the end of 1974. Trading terms must be included stating minimum order charge (if applicable), carriage and packing terms and quantity discount arrangements (if any). Any non-availability or waiting time in excess of one month for items listed should be indicated. The closing date for sending information to us is 17th June.

We regret that we cannot entertain telephone queries in respect of this operation. All correspondence should be addressed to *"P.W. Electronic Components Buyer's Guide", Practical Wireless, Fleetway House, Farringdon Street, London EC4A 4AD.*

Component suppliers will be pleased to learn that extra space is being made available for inclusion of their own personal announcements in the booklet, offering a permanent record to all readers. Special publicity support is being organised so that the best advantage will be taken to circulate this information among a larger audience.

Full details of the advertisers' announcements facility are available from our Advertisement Manager and bookings for space (no matter how small) should be made by the 1st July for the October issue section and by 1st August for all subsequent sections.

In undertaking this exercise we are confident that this Buyer's Guide will be welcomed by all readers. To make sure you do not miss out, we recommend you order your copies of Practical Wireless **now.**

M. A. COLWELL—*Editor*

Next month: FIRST AGAIN, this time with TELE-TENNIS. You have probably seen the slot-machine version—see ours in the July issue and make one yourself. Also included are a 4-band portable radio, a wide-band high quality amplifier for audio and radio applications, advance details of new projects. Further details on page 139.

NEWS... NEWS... NEWS...

HOW!

THE womenfolk of the Navajo Indian tribe were sitting round the camp fire one balmy, summer evening. One woman, who was sitting on a deer skin, had a son who weighed 140lb. Another woman sitting on a buffalo skin had a son who weighed 160lb. A third woman, who herself weighed a staggering total of 300lb, was sitting on a hippopotamus skin.

What mathematical theorem does this remind you of and why?
*Answer at foot of page.
The aforementioned was extracted from the April issue of *The Cornish Link*, the official magazine of the Cornish Radio Amateur Club. Club call is G4CRC.

Subscription to the C.R.A.C. is £1·25 per annum. All enquiries should be addressed to the club p.r.o., Bill Locke G3NKE, "Hillside," Kehelland, Camborne, Cornwall (Tel. Camborne 2419). Sheila Locke, G3NKE's xyl, is Editor of the *Cornish Link*.

The C.R.A.C. annual mobile rally will be held on July 21st, 1974 on the campus of the Cornwall Technical College, Pool, Redruth. Prospective exhibitors may obtain further information and stand details from Bill Locke.

Going Back

We have received a letter from Roger Goodman, who wanted some information on the instrument we included in our November 1973 issue (page 667). He says he would like to express his thanks to "Going Back" for the help he received in providing information on his "linesman detector". He received 21 replies and would like to sincerely thank those people who wrote to him, from Adrian Moss, aged 10, to a 71 year-old radio amateur.

*Pythagoras. Because the squaw on the hippopotamus was equal to the sons of the squaws on the other two hides. Hi!

The Source of Sound

A feature at this year's Ideal Home Exhibition was a pavilion which showed, in sound and vision, the development of sound recording from early wax discs. Five room-settings were on view, dating from 1920 to the present. Our picture shows the 1930's setting.

Weekend Course

WHAT now looks massive and dominant in our society, only 50 years ago was tentative and experimental.

The beginnings of radio lie deep in the past; indeed one could look back thousands of years to those persons whose curiosity was aroused by small amber beads becoming attracted after polishing. This was investigated by Gilbert in experiments with "electricity" shown to Queen Elizabeth I. There followed the discoveries of Ampere and Volta, Faraday, Maxwell, Hertz and Marconi, which prepared the world for what was to be one of the great revelations of all time—*the means of communication by radio broadcasting.*

The weekend course will range from the early inventions and inventors of wireless and television to reminiscences of Savoy Hill, while not too technical language will describe Radio and Television studios. The social impact of the growth of broadcasting will be reviewed and its reflection on programming.

The weekend is enlivened with demonstration and illustration, using working exhibits and archive recordings — Marconi — Reith — Nellie Melba, leaning heavily on the tradition of Information — Education — and Entertainment. Antiquities will be on working display, a crystal set of 1920—the pre-broadcasting era and "fireworks" in the form of a replica of Marconi's spark transmitter and receiver. Modern high power equipment will be used for transmission and reception throughout the world, during the weekend, under the callsign GB2HF.

The weekend will begin on Friday 7th June (evening) in an amenable social atmosphere, cultivated in a comfortably furnished guest house and will be led by Mr. Ralph Barrett, C.Eng. MIEE, MIERE.

Further details may be obtained by telephoning 01-203-3381.

SORRY WE ARE LATE!
We apologise for the late appearance of Practical Wireless. The delay has been caused by an industrial dispute in the printing industry.

CAR RADIO DESIGN

RICHARD COLLIN

THE first car radio receivers were essentially mains-type valve receivers with a special power supply. The 12 volt DC battery voltage was 'chopped' by a mechanical vibrator into a rough AC which was applied to a special type of power transformer, followed by considerable smoothing circuits. These receivers were very bulky and produced a large amount of noise from the vibrator. So much, in fact, that in many designs the power supply was separate to allow mounting outside the passenger compartment. These receivers were produced for almost 30 years until the transistor arrived on the scene.

Initially, only one transistor was used in the output stage. This led to a significant simplification of the receiver. Valves were still used in the earlier stages, although they were specially designed to operate with a 12 volt 'HT' rail, the receivers being known as 'hybrid' sets. The more expensive 'hybrid' receivers used a transistor driver stage and two power devices in a push-pull transformer output circuit. Up to 5 watts output could be provided into a 3 ohm loudspeaker.

The fully transistorised car receiver did not appear until high-frequency transistors became available at an economic price, when the car receiver underwent a complete change in design and the efficiency increased considerably. The old valve receivers consumed about 40 watts of power (3·5A at 12V) whilst the present generation of receivers require only 12W (1A at 12V). This reduction of heat output allowed more effective screening and helped to reduce size, the average car radio now measuring 7in x 2in x 4in deep, approximately.

CIRCUITRY

Fig. 1 is an example of the circuit of a modern car radio which, in general, is fairly standard, but there are some special considerations. The RF stages must be high gain and the AGC must be fast acting. The oscillator stages must have very low drift and the whole set must operate successfully over a wide temperature range. In addition, the power supply circuits must effectively filter out the spikes and transients and whistles produced by the car electrical system. Allowance also has to be made for connection to either negative or positive chassis cars.

AERIAL INPUT CIRCUITS

A car radio aerial invariably has a high value of capacitance resulting from the screened feeder that is used to minimise interference pick-up and the input circuits have to accommodate this. A pre-set capacitor (C5, Fig. 1) is provided to balance out the feeder capacitance. This is adjusted once and for all with the receiver finally installed in the car. The normal procedure is to 'trim' for maximum sound output whilst tuned to a weak signal on the high frequency part of the MW band. A similar function is provided by C1 on the LW band.

The tuned circuits (AE, RF and OSC) are provided by a ganged permeability tuner. L2 tunes the aerial circuit and L3 is a loading coil, switched into circuit on LW.

To achieve the high gain necessary in a car receiver a tuned RF stage is used. Transistor Tr1 is a conventional amplifier with AGC applied to the base circuit, via R2/R14, and a tuned circuit, L4, C10/C12 providing coupling to the next stage. L4 is also part of the permeability tuner. This is switched out of circuit on LW. The signal from the RF circuit is fed into the base of Tr2, the mixer oscillator stage.

The oscillator circuit is provided by L6 in conjunction with C16-18 on MW plus C20/L5 on LW. The reason for using C17 and C18 (200pF plus 220pF) instead of just one single capacitor is to provide temperature drift compensation. In the receiver shown C18 is an NTC capacitor with a coefficient of −1500ppm. This compensates for any drift in the value of L6 and maintains an essentially stable oscillator frequency from −20°C to over 50°C.

The IF output is taken from Tr2 collector via IFT1 primary L7. The primary is capacitively coupled via C23 to the secondary L8 which feeds directly into the base of Tr3 the IF amplifier. The amplified IF is applied to the detector diode D4 via IFT2. AGC is developed by D2, D3 and fed back to the RF stage.

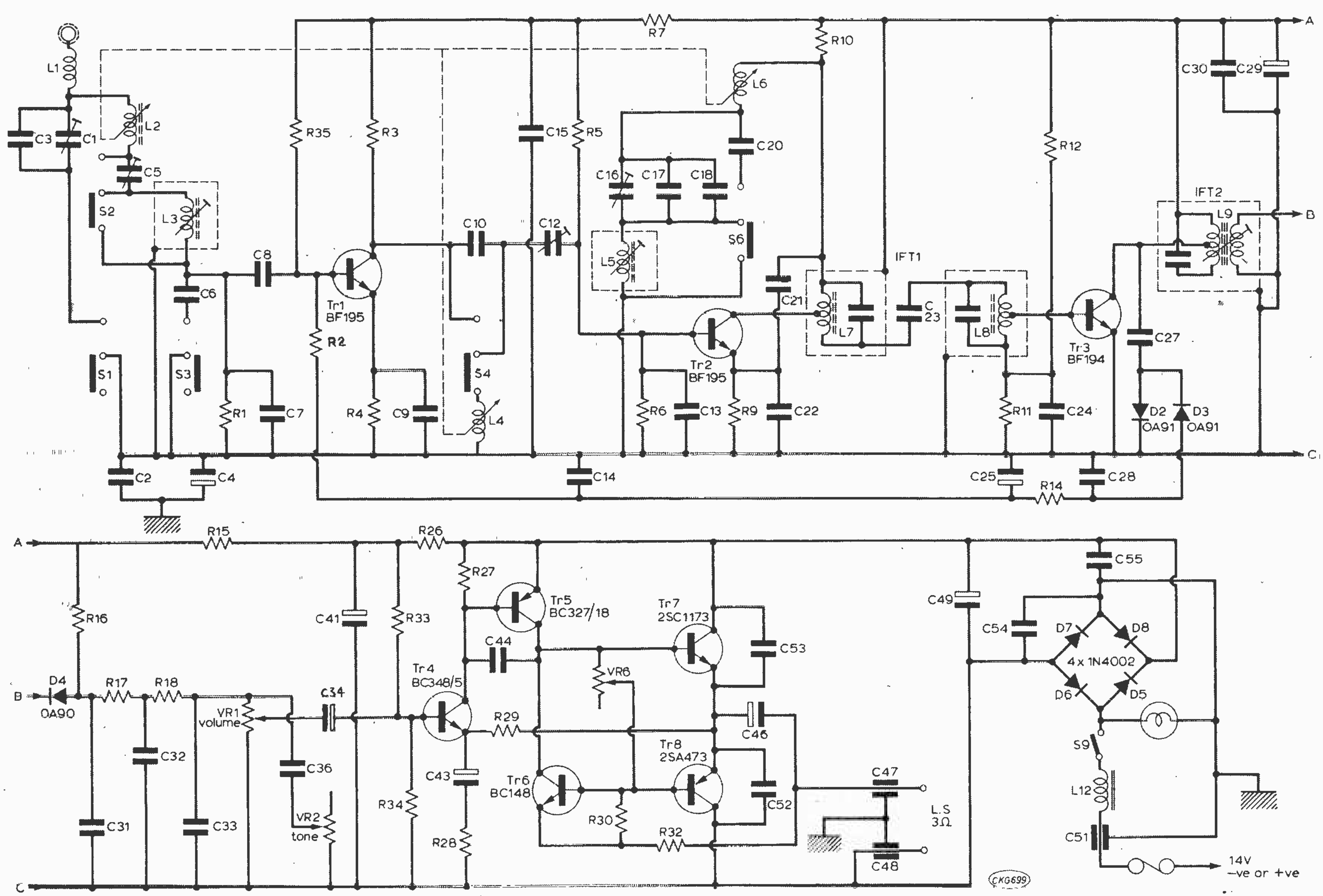


Fig. 1. Circuit diagram of a typical modern car radio. Its operation is described in the text.

Bias is applied to D4 via R16 to improve signal quality at low output levels.

C31, R17, C32, R18 and C33 provide filtering for the signal. VR1 is the volume control and VR2 provides top-cut tone control in conjunction with C36. Transistors Tr4 to Tr8 form a conventional audio amplifier providing 5W output into a 3Ω load with a fully charged battery (14·4V).

Capacitors C53, C52 and the feed-through types C47, C48 and C51 provide RF filtering of the DC supply. LF smoothing is effected by L12 and C49. An interesting feature is the use of separate diodes D5-D8 which form a bridge rectifier, allowing connection to cars with either negative or positive chassis. An important feature of this design is the method by which the RF earth of the radio is DC isolated from chassis by C2 and C4, but connected to the car chassis by either D6 or D7 depending on the battery polarity.

RECENT TRENDS

The advent of low cost, high performance integrated circuits has recently brought further simplification to car receivers. The audio stages have been replaced by a power IC producing 4 watts output from the detector signal at the volume control. More recently complete AM subsystem IC's have appeared and these allow integration of the RF and IF stages so that it is now possible to produce a car radio with just two integrated circuits.

EXPERIMENTAL TWO—IC CAR RADIO

Battery Supply:	12-16V, positive or negative chassis.
Power Output:	3·5W/4Ω or 4W/3Ω.
Tuning Range:	MW 185-577 metres. LW 1000-2000 metres.
Temperature Range:	—20°C to 60°C.
Active Devices:	RCA CA3123E RF-IF—OSC—AGC. SGS TBA810AS Audio

In the following pages a two-IC 4W car radio built by the author is described, the radio having been in use very successfully for over four months. **It must be stressed that anyone wishing to build a similar receiver should ensure that they can obtain the permeability tuner unit before they begin work as these are not readily available to the home constructor.**

A full circuit board layout and circuit description is given but the chassis work is left to the individual as it consists of little more than an aluminium surround with top and bottom plates.

CIRCUIT DESCRIPTION

The circuitry is shown in Figs. 2 and 3. The whip aerial is coupled via an RF choke, L1, into the RF amplifier by a conventional car radio tuned input circuit consisting of L2 and capacitors C3, C4, C5 and R1. C3 is a preset capacitor which is adjusted only after the receiver is finally installed in the car. Its purpose is to balance out the capacitance of the aerial feeder and provide optimum power transfer into the RF stage. On LW, C1 and C2 perform a similar function while a loading coil L3 is also switched into circuit.

The RF stage is gain controlled by a frequency counter AGC circuit which allows control of the AGC response by selection of the coupling capacitor, C19. The output of the RF stage is coupled to the mixer stage by a further tuned circuit L4, C11, C12 and C13. On the LW the circuit is untuned and L4 switched out of circuit.

The oscillator stage is tuned by L5 together with C14, C15 and C16. On LW a further loading coil, L6, is switched into circuit. Because of the temperature range experienced within a car, extra care has to be taken in the design of the oscillator circuit. Temperature stability is provided by using three tuning

★ components list

Resistors

R1	2·2kΩ	R5	150kΩ	R9	100Ω
R2	1·2kΩ	R6	1·2kΩ	R10	1Ω
R3	3·3kΩ	R7	100kΩ	VR1	10kΩ log*
R4	330Ω	R8	27Ω	VR2	22kΩ log*

Resistors ¼ or ½W 10%

* concentric controls, ganged with S5, long bush

Capacitors

C1	390pf ceramic	C21	0·01μF
C2	30/140pf pre-set	C22	0·047μF
C3	,,	C23	180pF ceramic
C4	47pF ceramic	C24	0·047μF
C5	1500pF ,,	C25	0·1μF
C6	0·047μF	C26	470μF 6V
C7	470μF 10V	C27	0·0047μF ceramic
C8	0·1μF	C28	1500pF ,,
C9	10μF 16V	C29	0·1μF
C10	47μF 16V	C30	100μF 16V
C11	390pF ceramic	C31	1000μF 25V
C12	180pF ,,	C32	0·1μF
C13	470pF ,,	C33	1000μF 25V
C14	30/140pF pre-set	C34	1000μF 25V
C15	180pF ceramic*	C35	0·1μF
C16	120pF polystyrene†	C36	1000pF feedthrough
C17	0·015μF	C37	1000pF feedthrough
C18	10μF 16V	C38	1000pF feedthrough
C19	56pF ceramic	C39	100μF 16V
C20	0·0047μF ,,	C40	0·1μF

* temp. coeff.—47ppm † —150ppm

Inductors

L1	6μH RFC	L3	Toko YXNS 6A139BA
L2	Tuner, see note	L6	Toko YXNS 6A140HM
L4	Tuner, see note	L7	see text
L5	Tuner, see note		

IFT1 Toko YHCS/1A/590R
IFT2 Toko YHCS/1A/589R
IFT3 Toko YHCS/111 00/AC2

Semiconductors

D1	OA90	IC1	CA3123E (RCA)
D2/5	50V 1·5A bridge	IC2	TBA810AS (SGS/ATES)

Miscellaneous

S1 to S4 are ganged. In the prototype a 6 pole changeover was used. For a manually tuned set the switch can be a 'push-on push-off' type. With a pushbutton set this switch is operated by the buttons changing from MW to LW automatically, in which case the return spring and lock must be removed from the switch. S5, on/off switch, is part of VR1/2 assembly. LP1, 14V LES bulb and holder. F1, in-line fuseholder and fuse 1·5A.

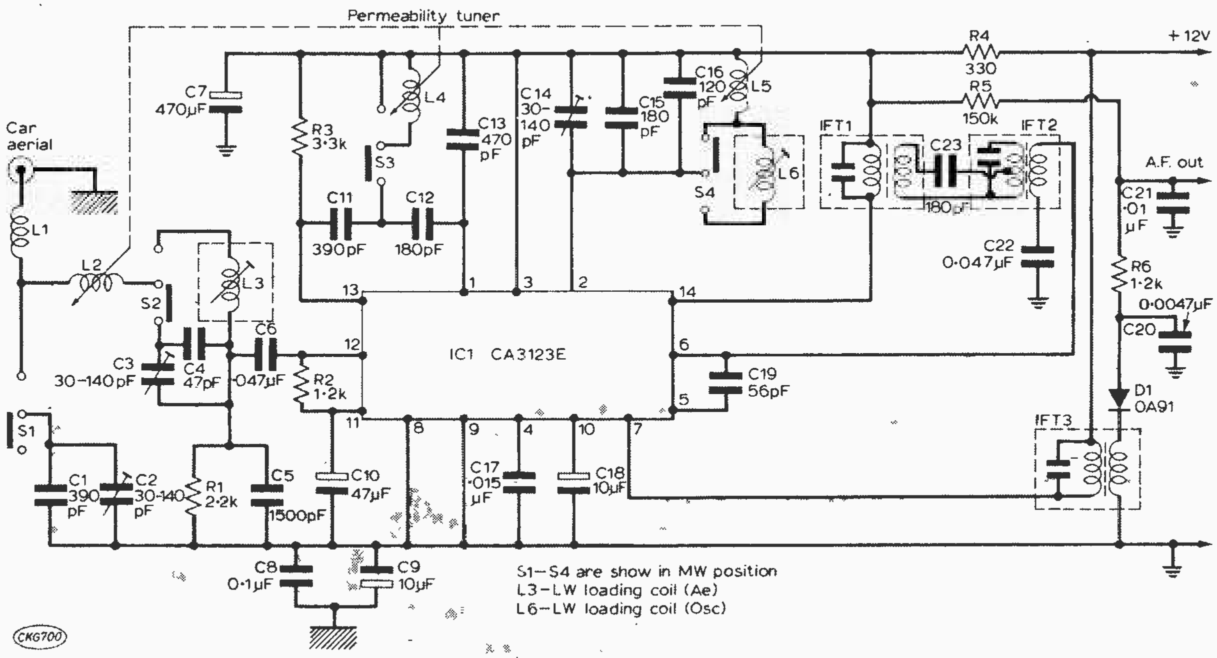
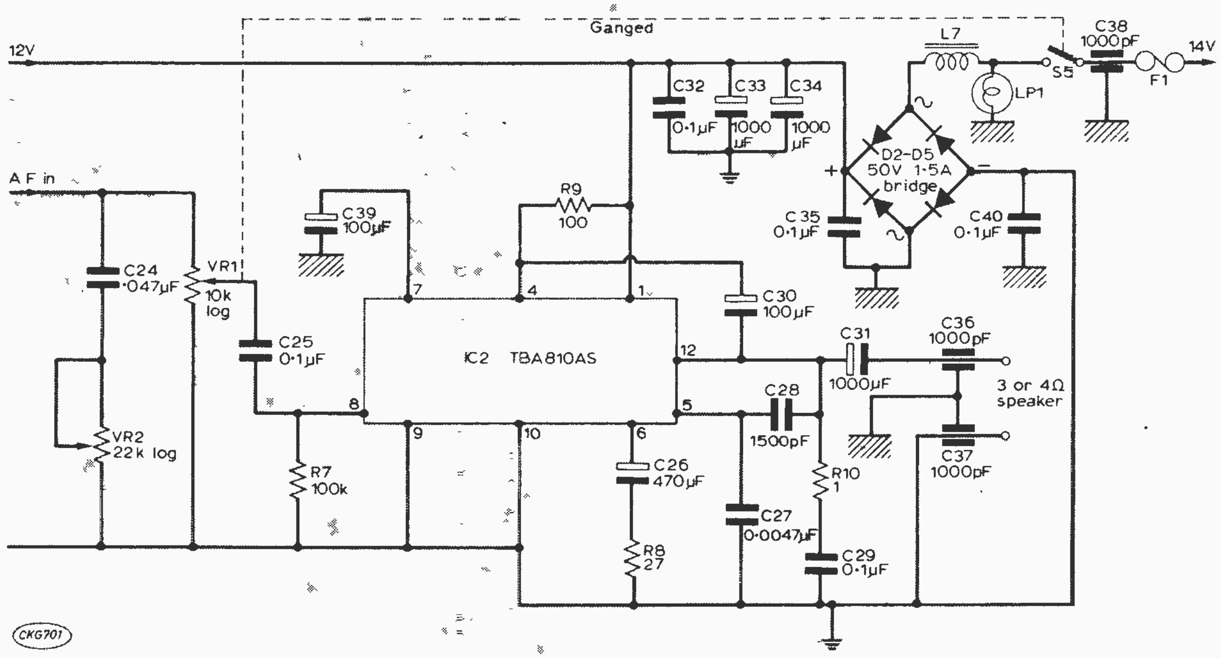


Fig. 2, above, RF section of the experimental car radio with the audio section, Fig. 3, below.

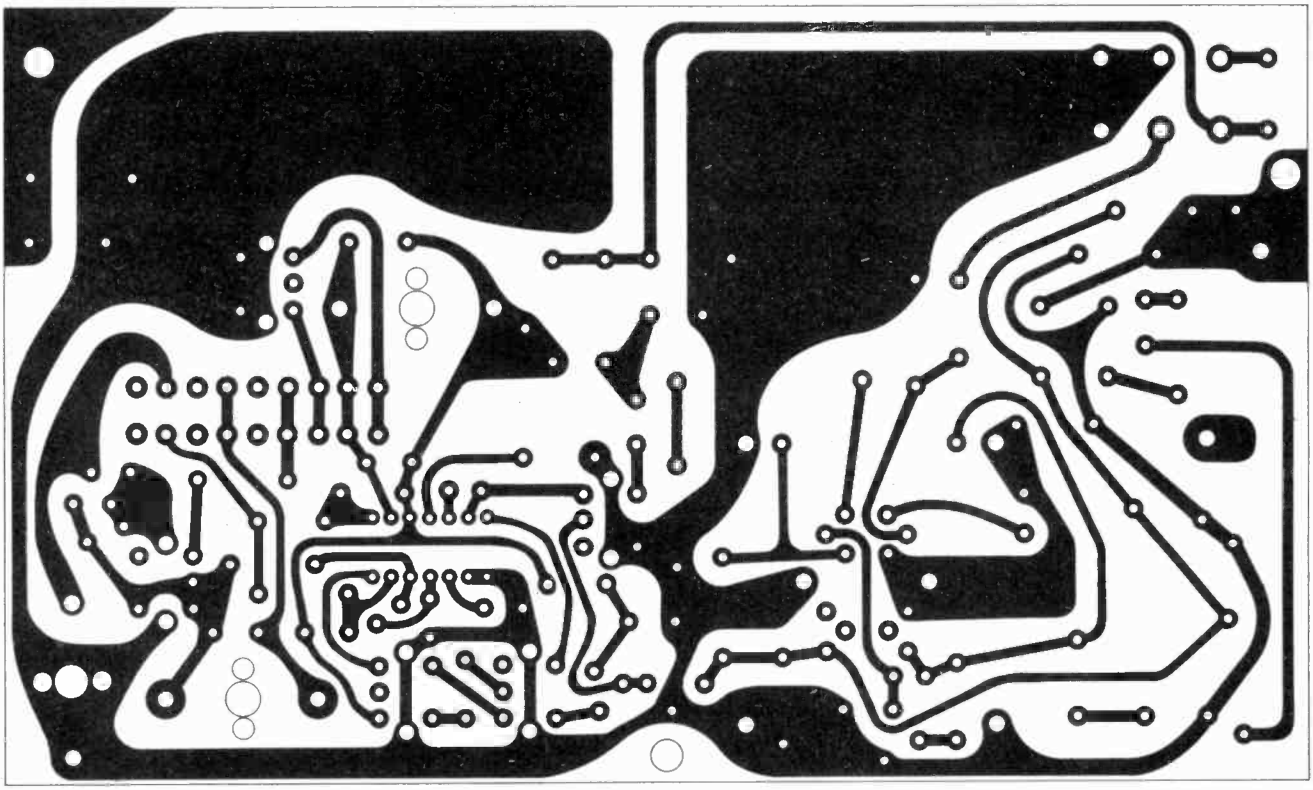


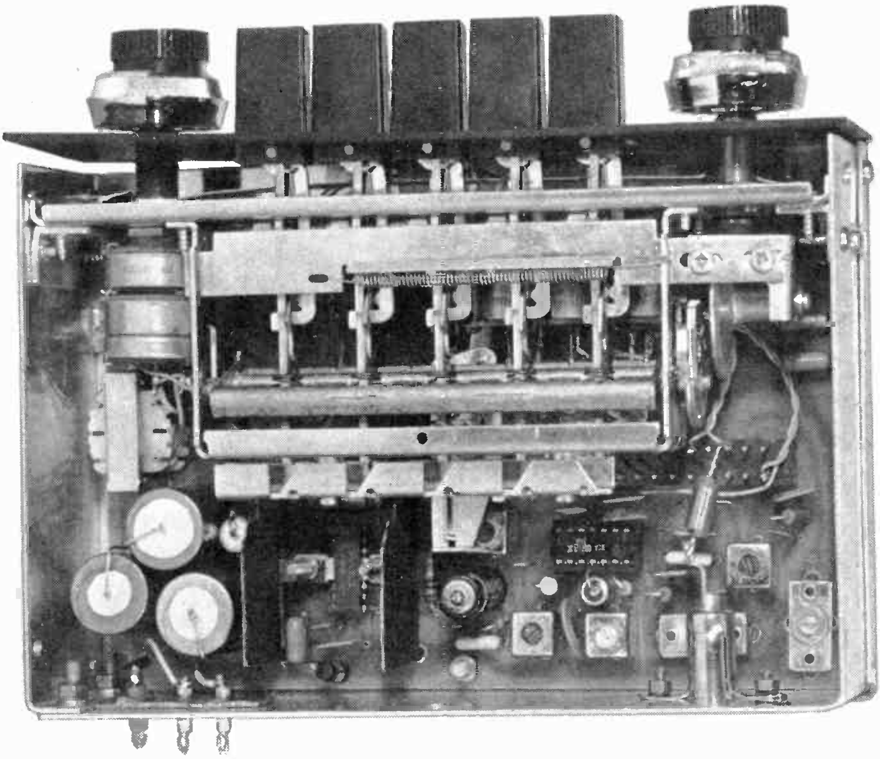
capacitors with specific negative temperature coefficients to compensate for any positive drift in the values of L5 and L6. The three main tuning inductors L2, L4 and L5 are ganged together in a complete permeability tuner which can have push-button facilities and automatic waveband switching.

The IF output (470kHz) is taken from the mixer and coupled to the IF amplifier via a double tuned arrangement IFT1 and IFT2. After amplification the signal is fed to the detector diode via IFT3. The detected audio output is developed across the detector load formed by the volume control VR1. Capacitors C20 and C21 provide filtering in conjunction with R6.

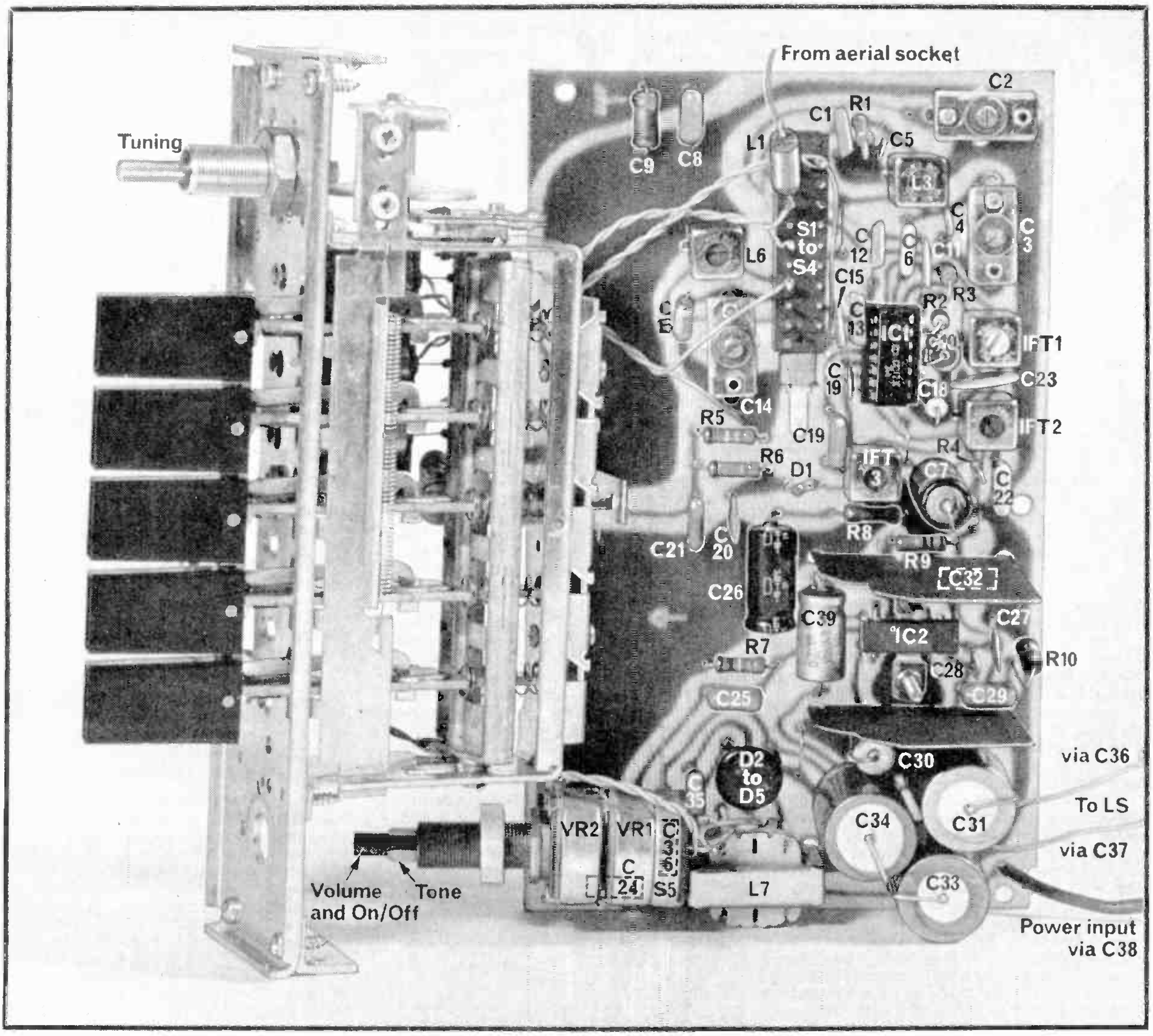
Top-cut tone control is provided by VR2 and C24. The gain of the audio amplifier is set by C26 and R8 which form a potential divider with the feedback resistor in the IC. Capacitors C27 and C28 determine the top frequency roll-off characteristic. A Zobel network (R10, C29) is effectively connected across the loudspeaker load which thus always appears essentially resistive to the output devices in the IC, protecting them from transients that could occur across inductive loads.

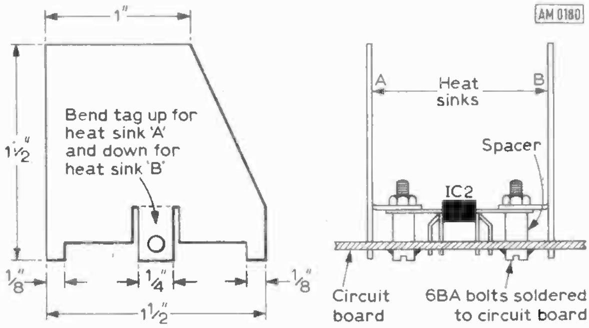
Capacitor C31 is sufficiently large to provide a lower bass limit of −3dB at 40Hz. Capacitors C36, C37 and C38 are ceramic feedthrough types used to further suppress RF interference by decoupling





At the top is shown the full size layout of the PCB. The photograph above shows the PCB and the tuner unit. The photograph at the top of the next page is of the PCB with component locations. The copper areas below are showing through the board.





Heatsinks used with IC2.

the loudspeaker lines and the power input. The main smoothing is provided by the 1·5mH choke L7 and C32, C33, C34 and C35. These components greatly attenuate interference produced by charging and ignition circuits. Diodes D2-D5 form a bridge rectifier and provide automatic polarity correction, regardless of which battery pole is connected to the radio case. The earth rail is isolated from the chassis at DC by capacitors C8, C9, which have negligible impedance at RF so that the circuit is effectively earthed to the case.

Basically any three coil ganged permeability coil assembly designed for transistor car radio can be utilized. The type used by the author was an S. Bird type AW160. Probably the easiest way of obtaining a tuner is to order this as a replacement part via a radio dealer or car radio service agent. Either a push-button unit or coil pack only can be used. In the latter case it will be necessary to rig up some form of drive cord and scale pointer.

THE IGNITION CHOKE

Any small choke with an inductance of between 1·5 and 4mH will suffice. The winding should be less than 0·5Ω and able to carry approximately 1A DC. The author wound his own using a miniature transformer core found in the junk box, the winding being 100 turns 18swg enamelled copper wire.

The Toko IFT's are obtainable from Ambit International, 37 High Street, Brentwood, Essex as well as the TBA810AS which costs £1·50 inc. The CA3123E costs £1·98 inc. from Electronic Component Supplies, Thames Avenue, Windsor, Berks.

IN-CAR ENTERTAINMENT

COLIN RICHES

In-car entertainment or ICE as it is popularly referred to, is a booming business and it does not matter whether you drive an 'old banger' or a gleaming Jensen, music on the move adds pleasure to your leisure.

In this article, I have chosen a selection of ICE units currently available. In some cases, I have quoted manufacturers' recommended prices, but if readers scout around, they will find some very efficient ICE items at quite reasonable discount prices.

Should readers require any additional information, they should write to the manufacturers concerned.

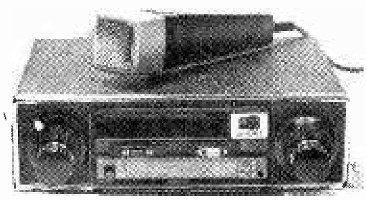
PHILIPS The RN712 plays stereo cassettes. It receives stereo radio programmes and long/medium waves. It records in mono from either radio or microphone and it costs £177·50. One can console oneself over the price however, by working out how much a separate tape recorder, stereo tape player, stereo tuner-amplifier and m.w./l.w. receiver would cost if they were purchased individually.

The RN712 must, without doubt, be classified as one of the most sophisticated in-car units on the market and it has a list of features as intriguing as Aladdin's cave.

Reception of f.m. signals is generally difficult in cars because the multiplex signal is extremely sensitive to interference. Philips have introduced an "I.A.C." circuit to overcome this problem.

The Interference Absorbtion Circuit (I.A.C.) operates on f.m., radio record and mono microphone functions. For the technical, it cuts off the interfering pulses on the audio signal by keeping constant the instantaneous value of this signal from the point just prior to the pulse becoming active until after it has passed on. Operation is limited to 50% of signal time as this cuts distortion which may occur from the absorbtion of too many interference pulses.

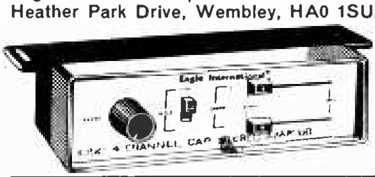
This unit will be featured in a Special Product Report in a future issue. Philips Ltd., Century House, Shaftesbury Avenue, London, WC2H 8AS.



AIWA The Aiwa TP-1042 stereo cassette player starts playing when a cassette is inserted and switches off, ejecting the cassette when the tape ends. The amplifier employs all silicon transistors and controls are provided for balance, tone, volume, fast forward wind and fast rewind. Johnsons of Hendon Ltd., Radlett Road, Colney Street, St. Albans, Herts., AL2 2EA.

EAGLE A very useful item from Eagle International is the FF.21 4-channel car stereo adaptor. It converts and synthesises an existing car stereo system with the addition of two extra loudspeakers. Any 8-track tape player, cassette player or f.m. multiplex receiver can be used with this unit, allowing 4-channel stereo to be enjoyed in the car.

The FF.21 we tested proved to be very effective. After making a few simple connections, the switch on the unit is turned to the '2 ch' position and the two front slider volume controls are set at maximum. The car stereo is then switched on with its controls set as usual. The 'rear speaker' control on the FF.21 is then turned anti-clockwise and the switch set to the '4 ch' position. The rear speaker control is then slowly turned clockwise and the full 4-channel effect is obtained. Eagle International, Precision Centre, Heather Park Drive, Wembley, HA0 1SU.



PYE Model 2253 is an **auto-reverse** cassette car player. Automatic track switching at the end of the tape is achieved by reversal of the tape running direction. Insertion of a cassette automatically switches on the unit and an illuminated indicator shows the direction of the tape travel. This unit can be fitted to cars of either polarity—a protection diode being fitted to prevent 'blowing up the works'.

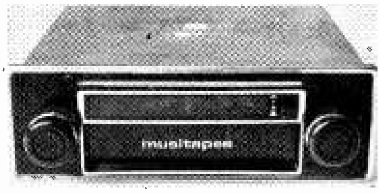
When we tested the 2253 with the 'wick' turned right up, the current drawn was 1A. Wow and flutter is quoted as less than 0·3% and frequency response as 40Hz to 10kHz. Output power is 3·5W per channel.

Normal fast wind and rewind facilities are provided and we found a C60 cassette rewound in 64 seconds.

We have had this unit in constant use over the last few months and it has performed without any troubles whatsoever. It is very thoughtfully designed and has excellent tonal quality. Recommended retail price, inclusive of VAT is £44·21. Pye Limited, P.O. Box 49, Cambridge.

MUSITAPES Model 8159 is an 8-track stereo cartridge player with a long and medium wave receiver. The control on the left is for on/off, volume and track change with a separate tone control. The knob on the right controls radio tuning and channel balance.

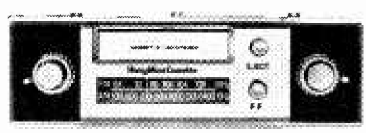
Output power is quoted as 10W and frequency response 30–10,000Hz. Speaker impedance is 4–8 ohms. Recommended retail price is £58 plus VAT. Musitapes (Wholesale) Limited, 402 Edgware Road, London, W2 1ED.



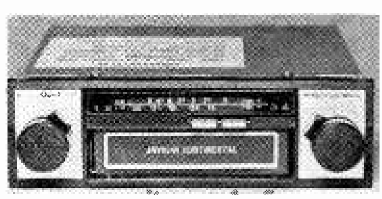
SANYO The FT 8006E is an 8-track stereo cartridge player combined with a m.w./l.w. and f.m. receiver. It has rotary on/off, volume, tone, tuning and balance controls and push-button waveband selection and track change. Output power is 6W per channel and frequency response is quoted as 30–10,000Hz. Operation is on 12V negative earth vehicles only. Recommended retail price, including VAT is £64·75. Sanyo Marubeni UK Limited, Bushey Mill Lane, Watford, Herts.

HARRY MOSS Apart from marketing a good range of in-car equipment, this firm also supplies a 12V d.c. unit, operated from the mains and including speakers, that can be used to work car-type 8-track players and radios in the home.

One of their receivers which caught my eye was the 344 stereo cassette player and a.m./f.m. receiver. Output is 7W per channel and the circuit includes 2 i.c.'s, 28 transistors and 10 diodes. A fast-forward button for tape is provided and there is an indicator light to show when the radio is receiving a stereo programme. Harry Moss (London) Limited, 424 Kingston Road, London, SW20 8LJ.



JAVELIN The Javelin Continental PU612A is a m.w./l.w. receiver and an 8-track stereo tape player. It's a very neat looking unit which performs very well. The controls are easy to operate and an illuminated indicator shows which track the tape is playing at any given time. Output is 5W per channel and the price, excluding VAT is £67. Javelin Electronics Limited, 137–149 Goswell Road, London, EC1V 7EY.

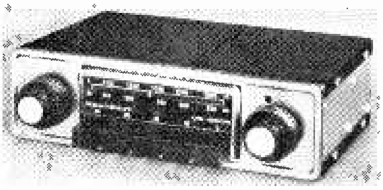


HEATHKIT The CR9502 comes from the famous Heathkit stable and covers long and medium waves. Output power is 4·5W and a special circuit allows the unit to be connected to both positive and negative earth vehicles without re-wiring or changing any components.

The circuit embodies two integrated circuits and sensitivity is quoted as 8μV on medium waves and 30μV on long waves.

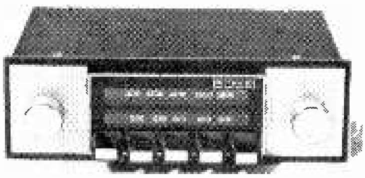
This kit comes complete with fully comprehensive and lavishly illustrated instruction manual and costs £19·80.

We will be including a Special Product Report on this receiver kit in a future issue. Heath (Gloucester) Limited, Gloucester, GL2 6EE.

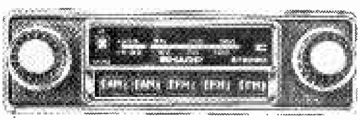


R & TV COMPONENTS The 'Tourist' comes in kit form at £6·60. It has 2·5W output and an i.c. output stage. It also employs a pre-assembled 3-stage i.f. module. We built up one of these kits from the instructions supplied and found it to work very efficiently. The ability to solder on a printed circuit board however is essential and we would not recommend the absolute beginner to tackle this one.

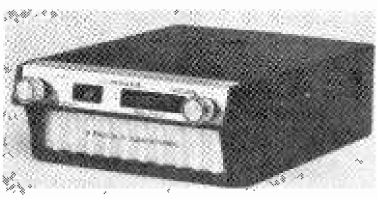
Radio & TV Components Ltd., 21 High Street, Acton, London, W3 6NG.



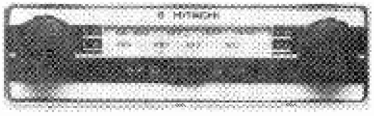
SHARP This stereo radio is designated AR/953. It employs a.g.c. and a.f.c. in the circuit and covers f.m. and medium waves. Output power is 5W per channel and recommended retail price £49·95 including VAT. Sharp Electronics (UK) Ltd., 48 Derby St., Manchester, M8 8HN.



PIONEER This Pioneer TP222 is a mini-sized 8-track stereo cartridge player designed to be fitted under the dashboard. The circuit employs 4 i.c.'s and 1 diode. Output is 3·5W per channel and frequency response is said to be 40Hz to 10kHz, wow and flutter less than 0·3% and S/N ratio more than 45dB. Price is £31·46 plus VAT and speakers are extra. Autocar Electrical Equipment Co. Ltd., 1 Chantry Road Industrial Estate, Kempston, Bedford.



HITACHI The WM702 retails at £17·90 (VAT paid) and covers l.w. and m.w. Output is 3W and speaker impedance 8 ohms. The circuit includes 7 transistors and 2 diodes. Supply voltage is 6/12V either positive or negative earth. This radio comes complete with brackets and mounting screws. Hitachi Sales (UK) Ltd., New Century House, Coronation Road, Park Royal, London, NW10 7QN.



BOSCH I have chosen the Blaupunkt ACR 845 from an excellent range of in-car equipment ranging in price from £30 to £300. This unit is an 8-track stereo cartridge player which plays back on 2 (stereo) or 4 (quadraphonic) channels.

Front panel controls include a tape 'head tuner' which compensates for discrepancies in track position between tapes, and slider controls for front and rear volume. The ACR 845 comes complete with fitting kit and four speakers and costs £83·50 including VAT. Bosch Limited, Rhodes Way, Watford, WD2 4LB.

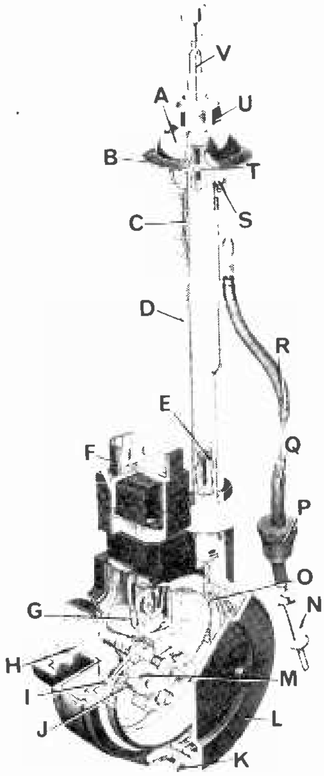
RADIOMOBILE The 308 CSR is a long/medium wave radio and stereo cassette player. The cassette ejects automatically at the end of play and within 10 seconds if the unit is switched off with cassette in position. Coming complete with two speakers, and fixing kit, recommended price is £67·95 inc. VAT. Radiomobile Ltd., North Circular Road, London, N.W.2.

GRUNDIG This is the WK 2503 medium/long wave receiver in presentation pack which includes fitting kit, speaker and baffle and suppression components. Output is said to be 5/7W, and circuit has tuned r.f. stage and 3-stage a.g.c. A socket is supplied for tape recorder connection. Price is £39·85. Grundig Ltd., Newlands Park, London, S.E.26.

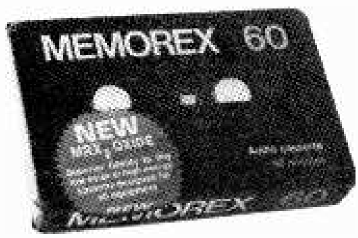
PHILIPS have introduced a range of electric car radio aerials. They are compact, lightweight and corrosion resistant. There are three models: the Standard, Automatic and De-luxe Automatic and the prices, including VAT, are £13·50, £15·50 and £18 respectively.

An important feature of these aerials is the use of a small efficient motor claimed to give superior lift capability with a power consumption of only 600mA. A 12-month guarantee is also included and this covers free aerial replacement.

On the picture, (A) is brass/chromed dome, (B) plastic seal, (C) injected plastic insulation, (D) metal screening tube, (E) sprung slides ensuring good contact between rods, (F) plug-in relay operates AE from radio on/off switch, (G) limit switch cuts motor at end of rod travel, (H) motor, (I) water-resistant compartment, (J) nylon gears, (K) drain hole, (L) nylon casing, (M) ball bearing clutch, (N) sprung leaves ensure tight fit, (O) tooth drive cable, (P) grommet, (Q) correct capacity cable, (R) screening, (S) earthing bar, (T) serrated edge gives good contact with car, (U) mounting nut, (V) stainless steel rods.



MEMOREX The tape used to test some of the cassette machines in this article was the new Memorex MRX2 Oxide. It is claimed to have a distinct 2dB advantage over many competitive brands especially at high frequencies. It comes in C30, C45, C60 C90 and C120 sizes.



understanding DISTORTION

PART 1

A. FOORD

THE gain of an amplifier is usually stated as a single number, either as a ratio or in decibels. Although this is adequate for most practical purposes it does imply perfect linearity, or no distortion. In an ideal amplifier, where V is the input, A is the gain, and V_{out} is the output:—

$$V_{out} = AV$$

However, since practical amplifiers are not linear the input/output transfer characteristics will always be curved. The standard form usually assumed for this non-linear function is:—

$$V_{out} = A_1V + A_2V^2 + A_3V^3 + \dots A_nV^n$$

If we consider only two terms for this expansion and allow V to become the instantaneous voltage of a sinewave, we have:—

$$V_{out} = A_1V \sin \omega t + A_2V^2 \sin^2 \omega t$$

The second term may be expanded so that the result becomes:—

$$V_{out} = A_1V \sin \omega t + \frac{A_2}{2} \times V^2 (1 - \cos 2\omega t)$$

The output from the amplifier now contains an unwanted second harmonic whose amplitude depends on the square of the input level and the co-efficient A_2. This means that if the input level is doubled we produce four times the amount of second harmonic distortion which is one reason why distortion increases rapidly with signal level. Similarly the third term in the original series will produce distortion with a strong third harmonic content.

Fig. 1 shows a typical transfer characteristic for an amplifier, with the resulting output signal. If the transfer characteristic for an amplifier is known then the distortion can be calculated by a graphical method. However, this approach is only feasible for a considerably non-linear transfer characteristic and in practice harmonic distortion has to be measured by electronic methods.

This simplified explanation shows what happens when a single frequency is amplified by an amplifier. In a practical system two or more signals are applied simultaneously to any amplifier. If this contains a non-linear element then mixing occurs. This produces not only fundamentals and harmonics of the signals, but also the sum and difference frequencies of the signals themselves and their harmonics. These sum and difference frequency components are called intermodulation products. For audio applications intermodulation measurements are probably more valuable than harmonic distortion measurements, although both are normally quoted.

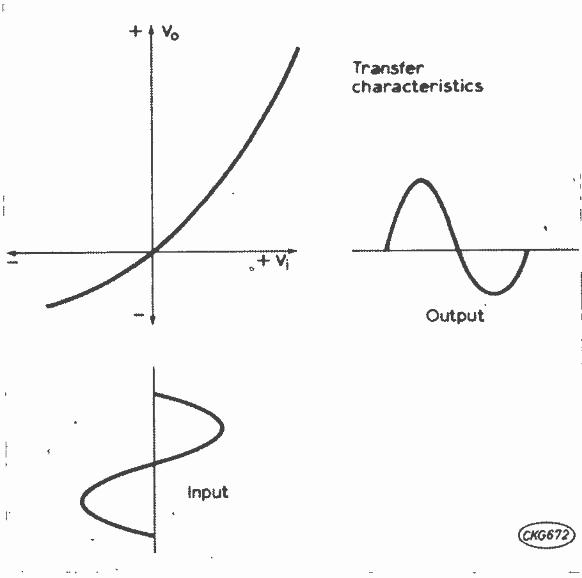


Fig. 1: The generation of distortion by amplifier non-linearity.

Effects of Non-linearity

Since audio amplifiers are used for the transmission of music and speech any distortion causes a loss in quality. In music all harmonics up to and including the 6th will "harmonise" with the fundamental, while higher order harmonics may become disagreeable. In general, intermodulation distortion is more noticeable since the products are not harmonically related to the original signals. Although harmonic and intermodulation distortion must in theory be related through the shape of the transfer characteristic, there is no direct and convenient relationship in practice.

Measurement of Non-linearity

Rather than try to measure small deviations in the linearity of the amplifier transfer characteristics it is much simpler, and more sensitive, to measure the effects of non-linearity. Naturally the effects to measure are harmonic distortion using a single signal, and intermodulation distortion using two signals. In spectrum analysis the amplitude of each component is measured individually. This demands elaborate

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BC109c	16p	BFX87	30p	OA70	12p	TIP31B	75p	2N1304	25p	2N3905	22p
BC147	12p	BFX88	30p	OA81	10p	TIP32B	85p	2N1305	25p	2N4058	12p
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test equipment but gives detailed information on the distortion mechanisms for design work. The other standard measurement methods give no indication of the relative amplitudes of the various components, and are therefore more suitable for routine testing.

Causes of Non-linearity

There are many causes of non-linearity, and include:—

1 The inherent curvature of the amplifier transfer characteristics.
2 Mismatch between halves of push-pull stages, which causes an excessive even harmonic distortion for class A and AB stages.
3 Cross-over distortion in class B push-pull stages, which may produce an increase in percentage distortion as the signal amplitude is reduced.

Spectrum Analysis

In spectrum analysis the amplitude of each individual frequency component of a waveform is measured separately, and these components can be summed to calculate a total harmonic distortion factor if required. This instrument is called a spectrum (or wave) analyser or a frequency selective voltmeter. It can be designed on two different principles, but is essentially a narrow band filter which can be tuned over any part of the audio band. It can be used to measure harmonic distortion as shown in Fig. 2.

The bandwidth of the filter is very narrow, perhaps 3Hz, so that it is possible to measure the amplitude of any selected harmonic without measuring an unwanted harmonic or the fundamental. If for example the fundamental were 1V and the amplifier output had a 2nd harmonic content of 0·01%, then the analyser has to measure a 0·1mV signal at 2kHz without reading the 1V fundamental. This 80dB dynamic range illustrates the complexity, and hence cost, of this technique.

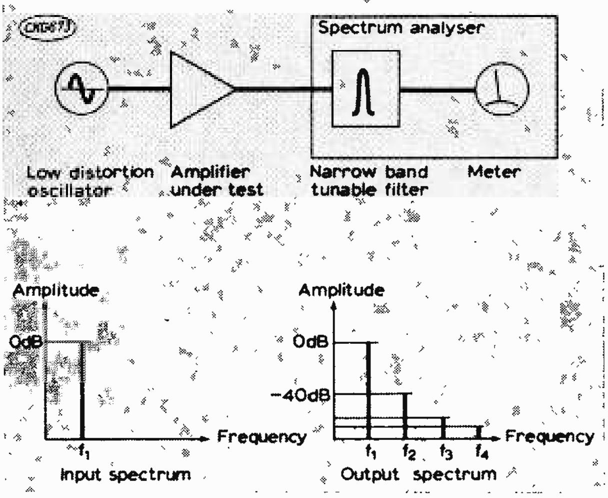

Fig. 2: Harmonic distortion measurement by spectrum analysis.

A low distortion input signal is applied to the amplifier under test, and the spectrum analyser is used to measure the amplitudes of the fundamental and each harmonic in turn. This measurement can be made either in absolute terms, or as shown in the figure, in relative terms. If a single figure is required for total harmonic distortion the terms can be summed on an RMS basis. Then total harmonic distortion D% is given by:—

$$D = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2}}{V_1} \times 100\%$$

For example, if:

$V_1 = 1V$ (Fundamental)
$V_2 = 0\cdot1mV$ (2nd Harmonic)
$V_3 = 0\cdot3mV$ (3rd Harmonic)
$V_4 = 0\cdot1mV$ (4th Harmonic)

Then:—

$$D = \frac{\sqrt{0\cdot1^2 + 0\cdot3^2 + 0\cdot1^2}}{1000} \times 100\% = 0\cdot033\%$$

A similar arrangement can be used to measure intermodulation products, as shown in Fig. 3. To simulate actual operating conditions the two frequencies and their relative levels can be varied, producing an infinite variety of test conditions! In instrumentations applications these values would be chosen to represent particular test requirements, but for audio applications two standard methods may be used.

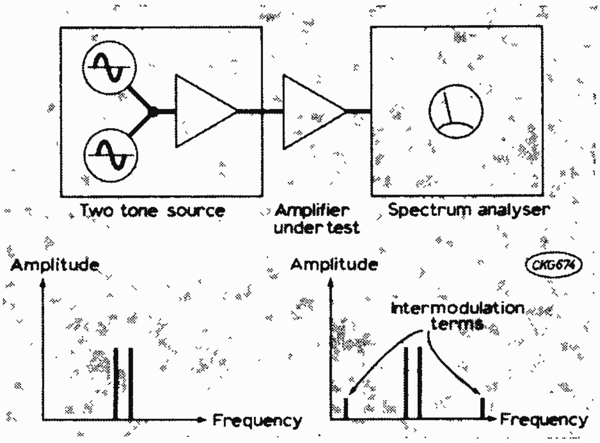

Fig. 3: Intermodulation measurement by spectrum analysis.

One advantage of two frequency intermodulation distortion measurements is that the test signals need not have a low HARMONIC distortion content if suitable frequencies are used. For example if signals of 1·1kHz and 900Hz are used, then possible intermodulation terms are:—

A+B	=1100+ 900=2kHz
A−B	=1100− 900=200Hz
A+2B	=1100+1800=2·9kHz
A−2B	=1100−1800=700Hz
etc	etc

The harmonic distortion terms inherent in the two sources will be

2A	2·2kHz	and	2B	1·8kHz
3A	3·3kHz		3B	2·7kHz
4A	4·4kHz		4B	3·6kHz
etc				etc

These harmonic distortion terms are well separated from the intermodulation terms, allowing them to be distinguished on the spectrum analyser.

Distortion Factor Meter

If a plot of total harmonic distortion against frequency is required for several different amplifier power levels then it is laborious to use a spectrum analyser and calculate the results. The distortion factor meter is designed to make such measurements quickly and simply, but cannot indicate the individual distortion components. The basic block diagram is shown in Fig. 4.

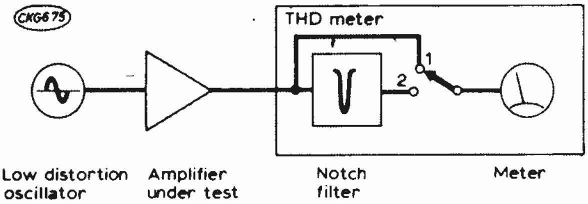

Fig. 4: Total harmonic distortion measurement.

The fundamental is eliminated by a narrow band rejection filter and the total harmonic content of the residue measured. The narrow band filter may be a bridged or parallel T or a Wein bridge and can be tuned over the audio band. When the switch is in position 1 the fundamental plus distortion is measured, while in position 2 the distortion only is measured. Then the THD is given by:

$$\mathrm{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \ldots}}{\sqrt{V_1^2 + V_2^2 + V_3^2 + V_4^2 + \ldots}} \times 100\%$$

In normal audio equipment the distortion is low (less than 1%) and this expression approximates to the previous equation:

$$\mathrm{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \ldots}}{V_1} \times 100\%$$

This assumes that the final detector and meter measures a true RMS value. In practice such meters are expensive, and either an average or pseudo-RMS reading meter may be used. A pseudo-RMS reading meter uses diodes or other non-linear elements to give a reading which is approximately correct for waveforms with a high harmonic content such as a squarewave or noise. When an average reading meter is used the difference between this and the correct RMS reading is less than 1 part in 100 even for distortions of up to 14% and may be ignored. However true RMS reading meters are important for some other applications.

CCIF Intermodulation Measurement

As previously discussed the main advantage of the two frequency methods of intermodulation measurement is that a very low distortion source may not be required. There are methods to CCIF (Comite Consultatif International Telephonique) and SMPTE (Society of Motion Picture and Television Engineers) standards. The two methods may give widely differing results and it is revealing to use them both in performance measurements. For the CCIF measurement the test signal consists of two sinewaves of equal amplitude but close together in frequency. The basic block diagram is shown in Fig. 5.

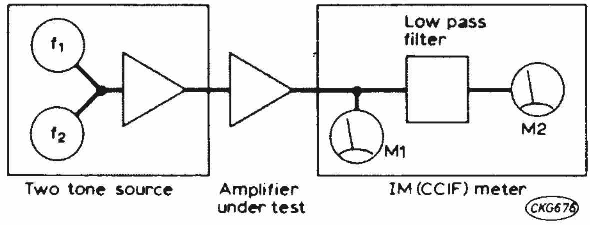

Fig. 5: Intermodulation distortion measurement (CCIF standards).

Two frequencies (perhaps 1·1kHz and 900Hz) are summed and applied to the amplifier under test. The low pass filter removes all the odd order intermodulation products, $(2f_1 - f_2)$, $(3f_1 - 2f_2)$, etc, and the sum components, $(f_1 + f_2)$, $(2f_1 + f_2)$, etc. The even order intermodulation products, $(f_1 - f_2)$, $2(f_1 - f_2)$, $3(f_1 - f_2)$, etc, are indicated on a peak reading meter M2. This is compared with the peak reading on M1 for the input signal and the IM distortion calculated:—

$$\mathrm{IM\ (CCIF)} = \frac{M2}{M1} \times 100\%$$

Although this technique only indicates an intermodulation distortion figure obtained by measuring certain even order components it is still useful for routine testing.

SMPTE Intermodulation Measurement

In the SMPTE method two tones widely separated in frequency are used, with the amplitude of the low frequency f_1 being four times that of the high frequency f_2. Typical frequencies would be 1kHz and 10kHz. When this two tone signal is amplified by a non-linear system the intermodulation will produce sidebands symmetrically spaced about f_2. For example, $(f_2 \pm f_1)$, $(f_2 \pm 2f_1)$, etc. The basic block diagram is shown in Fig. 6.

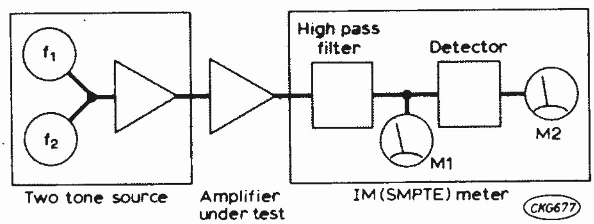

Fig. 6: Intermodulation distortion measurement (SMPTE standards).

In the measurement the low frequency tone f_1 is removed by a high pass filter, leaving an amplitude modulated waveform at a carrier frequency of f_2 which is detected and indicated on M2. The intermodulation distortion is given by the conventional expression for modulation depth.

$$\mathrm{IM\ (SMPTE)} = \frac{\text{sidebands level}}{\text{carrier level}} = \frac{M2}{M1} \times 100\%$$

Practical Information

When measurements are made on an amplifier using the techniques discussed it is found that there is no simple rule for comparing the different results, and each technique has its own advantages and disadvantages. Most published amplifier specifications

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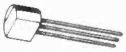

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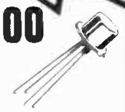

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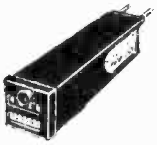

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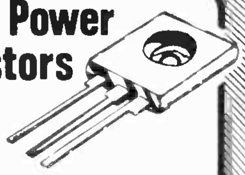

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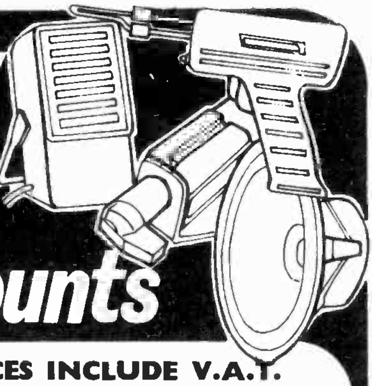

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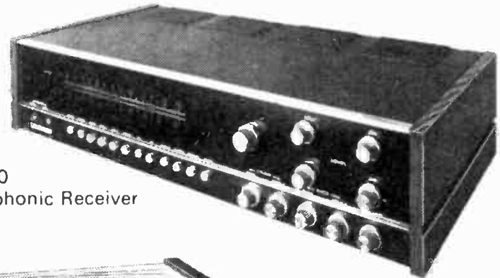

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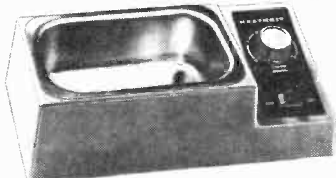

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give the total harmonic distortion curves for various power levels, but intermodulation methods are valuable for very low distortion levels (less than 0·25%). In general for intermodulation measurements the peak to peak input voltage should be the same as for simple harmonic distortion measurements, and all the frequencies involved should be within the pass band of the amplifier under the test.

Naturally the test signals should be combined in a way which does not introduce any intermodulation, the virtual earth summing amplifier is ideal, and the measuring instrumentation itself should be above reproach from a distortion and noise viewpoint.

Basic Causes and Cures

In a class B push-pull amplifier one output transistor conducts for one half of the cycle, and the other transistor conducts for the other half of the cycle. This gives an improved efficiency over a class A amplifier and is extensively used in audio power stages. However, due to the 0·6V base to emitter potential required for each transistor there is a region of input voltage around 0V where the output voltage is very small.

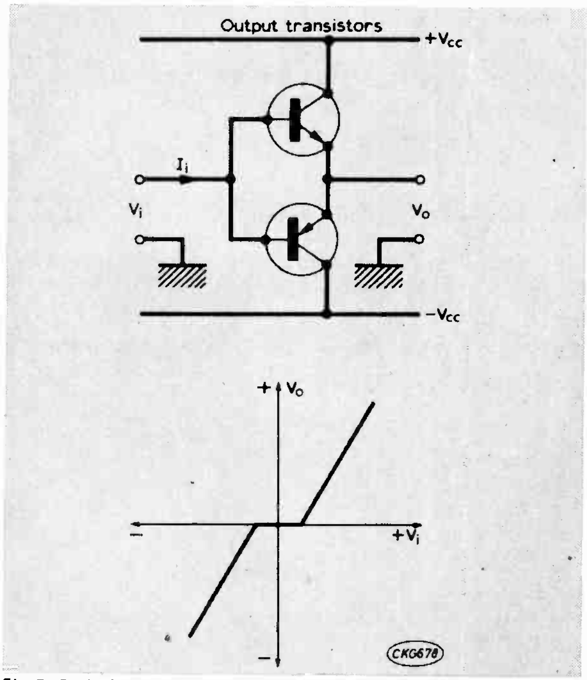

Fig. 7 : Distortion production in complementary class B emitter follower power amplifier output stage.

As shown in Fig. 7 this produces considerable crossover distortion and a reduction of gain in this region. The main problem in audio power amplifier design is the reduction of crossover distortion without degrading the thermal stability of the output stage, and many articles have been written on this aspect. The simplest remedy is to enclose the class B output stage within a negative feedback loop to reduce this distortion, as shown in Fig. 8.

The loop gain "forces" the input voltage of the output stage so that this non-linear transition is as rapid as possible. This arrangement has several disadvantages. Firstly, the amount of feedback needed is considerable and, secondly, the distortion has a high harmonic content so that the frequency

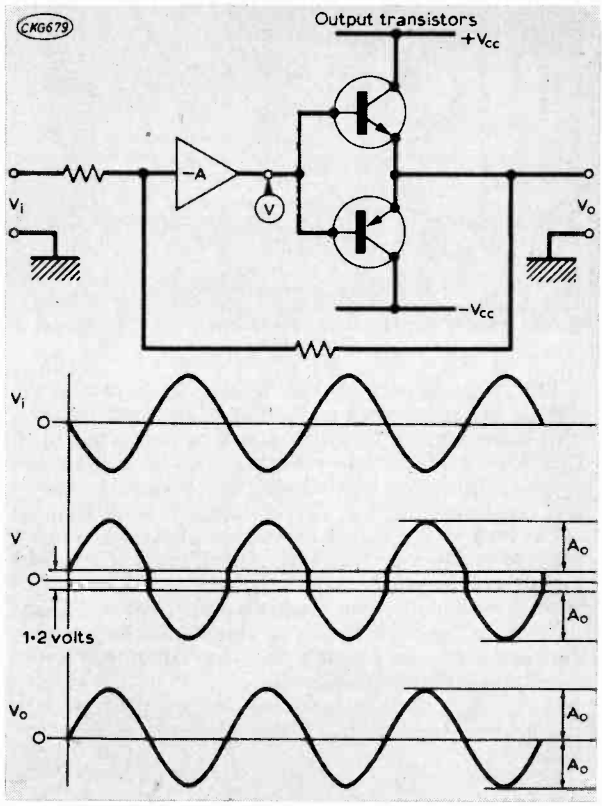

Fig. 8 : Reduction of distortion of output stage by overall negative feedback.

response around the loop has to be maintained far outside the audio band. If an amplifier had 2% distortion without feedback, and its gain were reduced by 26dB, we would now expect the distortion to be reduced to 0·1%.

For a conservatively designed system this would be correct in practice, and at low levels. However at high signal levels the slope of the input/output gain characteristics will change. It can be shown that although the 2nd harmonic distortion may be reduced, the 3rd and higher order distortions may be INCREASED by the feedback around the loop. The net result might be that the amplifier might actually need 35dB of feedback to reduce the THD to 0·1%. Clearly, it is important to reduce the distortion to an absolute minimum BEFORE applying overall feedback.

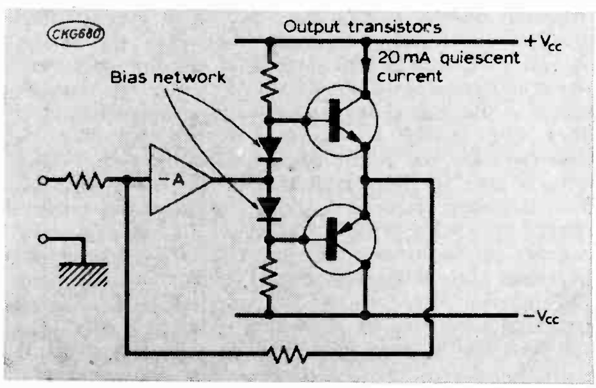

Fig. 9 : Distortion reduction in class B output stage by means of a small quiescent current.

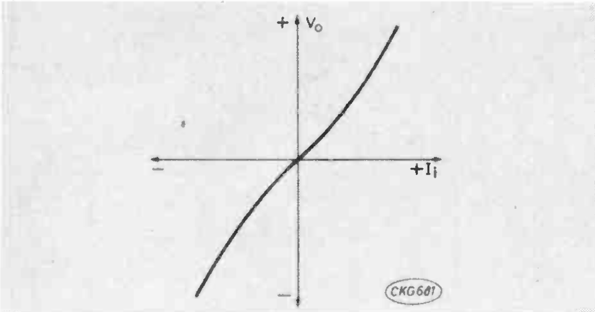

Fig. 10: A plot of output voltage against input current for the output stage of Fig. 7.

The basic circuit of Fig. 8 can be improved by biasing the transistors so that each conducts slightly even when there is no input signal, as shown in Fig. 9. This is very effective in reducing crossover distortion but may introduce the danger of thermal runaway. One treatment has the driver stage directly coupled to the load at low signal levels, but allows the output stage to conduct only at high signal levels. This gives a high efficiency but needs a special driver transformer. Another proposal adds a non-linear resistance network in the base circuit of complementary output transistors to compensate for the non-linear input impedance at low signal levels.

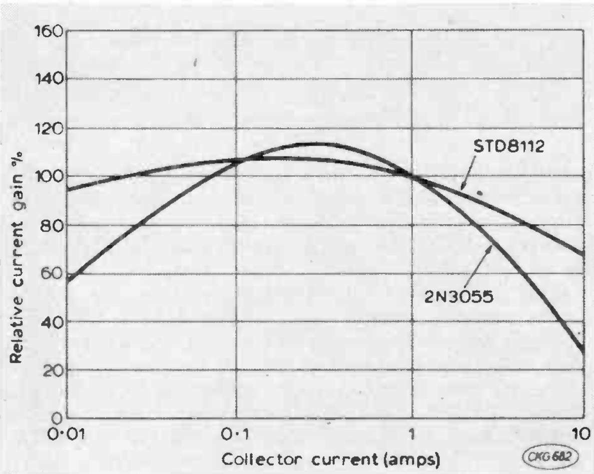

Fig. 11: The beta dropout characteristics for two transistor types.

However since a transistor is essentially a current operated device, the output voltage of Fig. 7 more closely reproduces the input CURRENT, as shown in Fig. 10. There is still a residual non-linearity near the crossover due to the decrease in β at low current levels in the output transistors, and also non-linearity over the whole transfer characteristics due to changes over the whole region. The popular 2N3055 type is poor in this respect, with the triple diffused planar power transistor giving an improved performance at a price. This is illustrated in Fig. 11.

Since the input impedance of the output transistors becomes high when the input voltage is near zero, the current drive must be supplied from a high impedance source. At each zero crossing the transistor drive can more readily step the necessary 1·2V. If suitable precautions are observed then thermal stability is not impaired.

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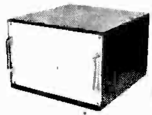

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AD161/2	72p	OC71	20p	1N4001	6p
BC107	10p	TIS43	28p	1N4002	6½p
BC108	10p	2N1711	24p	1N4003	7p
BC109	10p	2N2219	25p	1N4004	7½p
BC147	10p	2N2646	45p	1N4005	8p
BC148	10p	2N2905	33p	1N4006	8½p
BC149	12p	2N2907	25p	1N4007	9p
BC168	13p	2N2926O	10p	WO05	30p
BC169C	12p	2N2926Y	10p	WO4	33p
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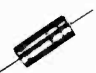
Axial lead electrolytic



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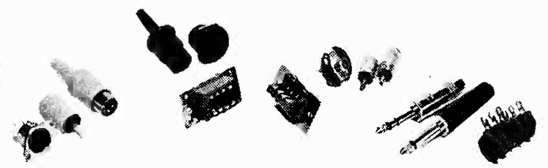
1·5	63	6p	68	16	6p			
2·2	63	6p	68	63	10p			
3·3	63	6p	100	4	6p			
4·7	63	6p	100	10	6p	470	6·3	6p
6·8	40	6p	100	25	6p	470	10	10p
6·8	63	6p	100	40	6p	470	25	12p
10	25	6p	100	63	12p	470	40	18p
10	63	6p	150	6·3	6p	680	6·3	10p
15	16	6p	150	16	6p	680	16	12p
15	40	6p	150	25	6p	680	25	18p
15	63	6p	150	40	10p	680	40	22p
22	10	6p	150	63	12p	1000	4	10p
22	25	6p	220	4	6p	1000	10	12p
22	63	6p	220	10	6p	1000	16	18p
33	6·3	6p	220	16	6p	1000	25	22p
33	16	6p	220	25	10p	1500	6·3	12p
33	40	6p	220	40	12p	1500	10	18p
47	4	6p	220	63	18p	1500	16	22p
47	10	6p	330	4	6p	2200	6·3	18p
47	25	6p	330	10	8p	2200	10	22p
47	40	6p	330	16	10p	3300	6·3	22p
47	63	6p	330	63	22p	4700	4	22p

PLUGS AND SOCKETS



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Plug screened **12p**
Chassis socket **4p**

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Plastic **13p**
Screened **21p**

Std. ¼" stereo plug
Plastic **18p**
Screened **30p**
Open mono socket ¼" **10p**; Moulded mono socket ¼" with 2 break contacts **14p**; Moulded stereo socket ¼" with 3 break contacts **18p**; 3·5mm. plug plastic **9p**; screened **15p**; open socket **8p**.

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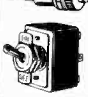

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Carbon Film ¼W 5% 11 Ω to 910k	E12 & E24	1p
Carbon Film 1W 5% 10 Ω to 10M	E12	3½p
Metal Oxide ½W 2% 10 Ω to 1M	E12 & E24	4p
Wirewound 2½W 10% 0·22ohms to 0·47ohms	E12	12p
Wirewound 2½W 5% 1ohm to 270ohms	E12	12p

E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades
E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades

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station SEPARATOR

N. GRAHAM

WITH the onslaught of local radio stations, BBC and IBA, to the medium wave band some form of frequency separation may be required in some areas. The writer decided to make something more compatible with the living room than the now famous PW frame aerial. Consequently it was decided to try a ferrite rod aerial as a possible solution. Of course, if the radio is a transistor one then it will almost certainly have an internal ferrite rod aerial so the set can be rotated to eliminate unwanted stations.

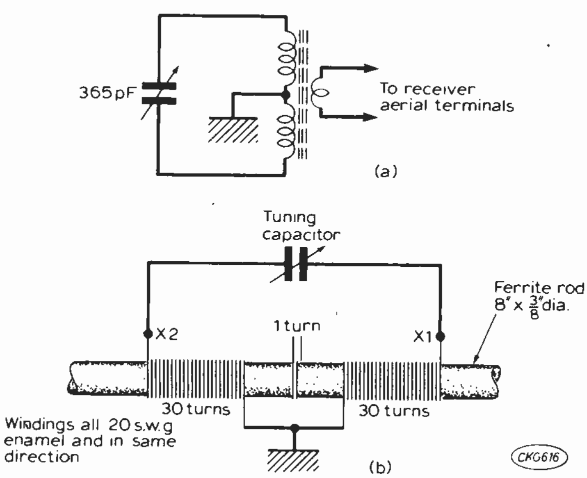


Fig. 1(a): Prototype circuit for medium waves only. (b) shows construction of circuit using a ferrite rod.

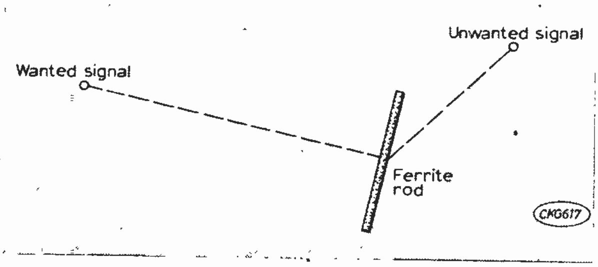


Fig. 2: The ferrite rod aerial has a broad maximum pick-up at right angles to its axis and a very sharp minimum off each end.

Results proved exciting and the circuit shown in Fig. 1a was effective in separating stations having only a small front-to-back angle, Fig. 2. It occurred to the writer to add another winding to the rod to cover the long wave band, Fig. 3. Going a step further another coil was added for the short wave bands, Fig. 4, according to the table. When fixing this coil on the rod tune to the highest frequency and slide the coil along the rod for maximum signal.

At this point thoughts turned to the possibility of switching the coils and producing an aerial tuning unit (ATU). The tuning capacitor can be changed for a two-gang capacitor and connected as in Fig. 5, using an external aerial.

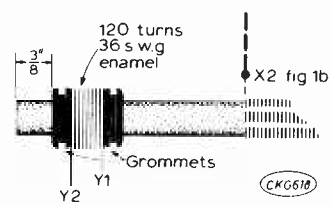


Fig. 3: Construction of the long wave coil on one end of the ferrite rod.

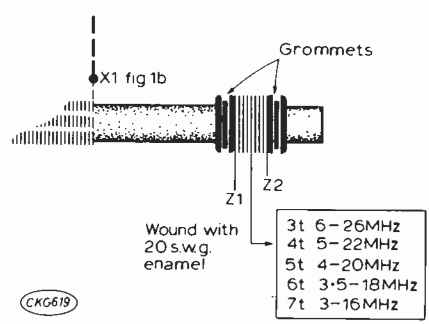


Fig. 4: The short wave coil at the other end of the rod, the number of turns depending upon the tuning range required.

Construction

Construction is simple, as shown in Fig. 1b and Figs. 3/4, the rod being mounted in a plastic or wooden case. The case must not be of metal, which would screen the rod aerial. First make the single turn link at the centre of the rod, holding it down with polystyrene cement or plastic insulating tape.

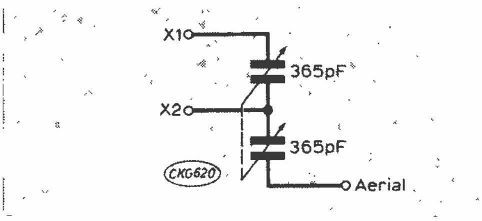


Fig. 5: When an external aerial is used the single tuning capacitor is replaced by a two-gang unit.

Next wind on the two 30-turn coils either side of the link and join their inner ends together and take them to earth. The outer end of each coil can be held with cement or under a grommet chosen to be a good fit on the rod. Do not be tempted to use more than one turn for the link. It may increase the signal transfer but will reduce selectivity. Add the short wave and long wave coils if these are required, Fig. 6.

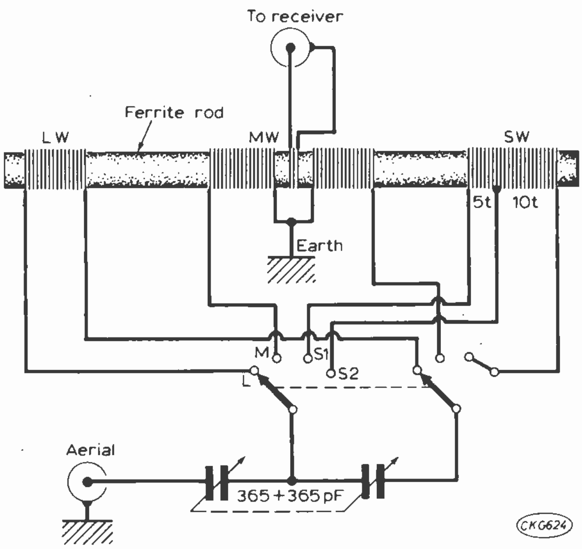
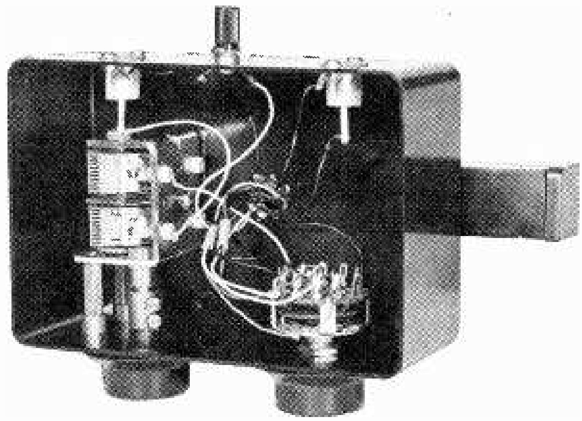


Fig. 6: The complete circuit as finally adopted. Complete short wave coverage is obtained with one tapped coil and range switch.

In use

If the receiver has an S-meter peak the wanted signal and then rotate the rod to eliminate the unwanted signal at the same time keeping the circuit tuned using the unit's tuning capacitor. A point will be found where the wanted signal level is acceptable, consistent with minimum unwanted signal. If the receiver has a manual RF gain control keep the gain as low as possible to prevent the signal operating the automatic gain control which would tend to negate any adjustments made.



*The tuning unit is contained in a **plastic** box, the ferrite rod being mounted in the square **plastic** tube which swivels on top of the box.*

It was found necessary to use a reduction drive on the tuning capacitor as the point at which an unwanted signal could be eliminated was quite critical. ■

PW TECHNICROSS PUZZLE No. 4 Solution

1 A	■	2 L	■	3 R	4 E	S	5 O	N	6 A	N	7 C	E
8 N	A	I	F	■	D	■	R	■	S	■	A	■
O	■	S	■	9 B	A	N	D	W	I	D	T	H
10 D	A	T	E	■	M	■	E	■	D	■	S	■
E	■	E	■	11 U	■	12 F	R	E	E	■	■	13 R
14 L	I	N	E	S	■	R	■	■	15 S	16 I	N	E
O	■	E	■	17 E	S	A	K	18 I	■	M	■	C
19 A	I	R	20 S	■	■	M	■	21 A	P	P	L	E
D	■	■	22 H	O	23 M	E	■	N	■	U	■	P
■	24 S	■	R	■	A	■	25 H	■	26 F	L	A	T
27 R	A	D	I	O	G	R	A	M	■	S	■	I
■	G	■	L	■	I	■	L	■	28 H	E	R	O
29 C	O	L	L	E	C	T	O	R	■	S	■	N

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SOUND TO LIGHT CONVE

Peter Richards

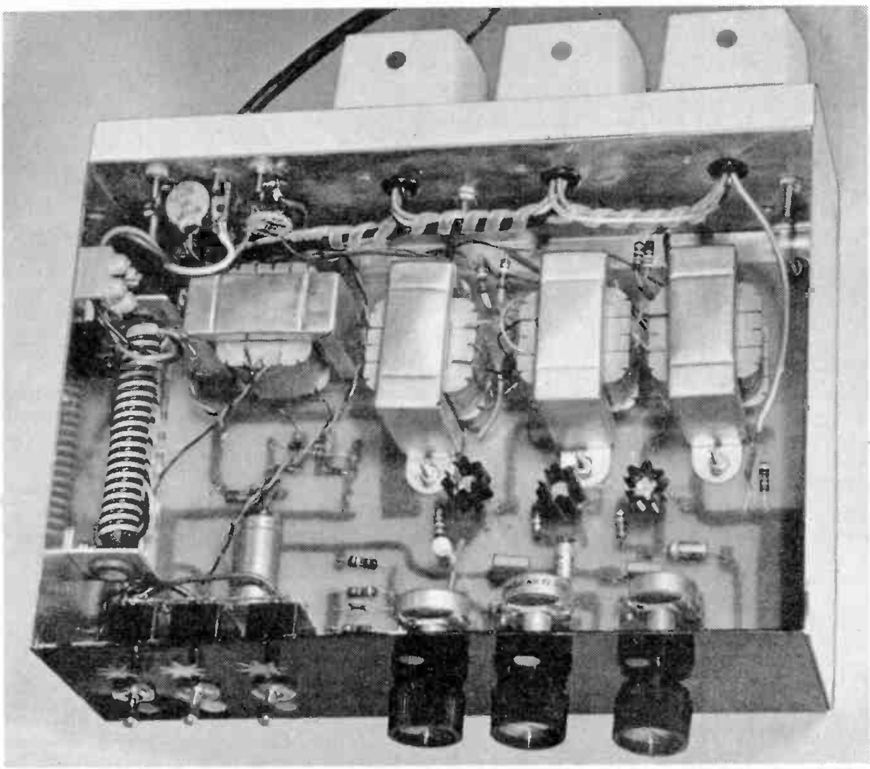
for the disc

TO-DAY, many young electronics enthusiasts are involved with discos of one sort or another. For most of these some sort of light show is required. The unit described here will flash, in time with the music, three independent lamps, (or sets of lamps) up to 250 watts per channel. One lamp responds to bass, one to middle, and the other to treble. Also provided is a facility to turn any of the lamps on full, or off completely. The channels are identified as follows—Red for bass, Green for middle and Blue for treble.

AF CIRCUITRY

The audio input is applied to the filter network which divides it into treble, middle and bass. The signal levels in the three channels are controlled by VR1, VR2 and VR3 respectively. A master control is not required as the filter network, being entirely passive, cannot be overloaded. Each filter is based on simple tone control networks which favour the appropriate frequency range. The separation of treble, middle and bass is not complete, but is sufficient for this application.

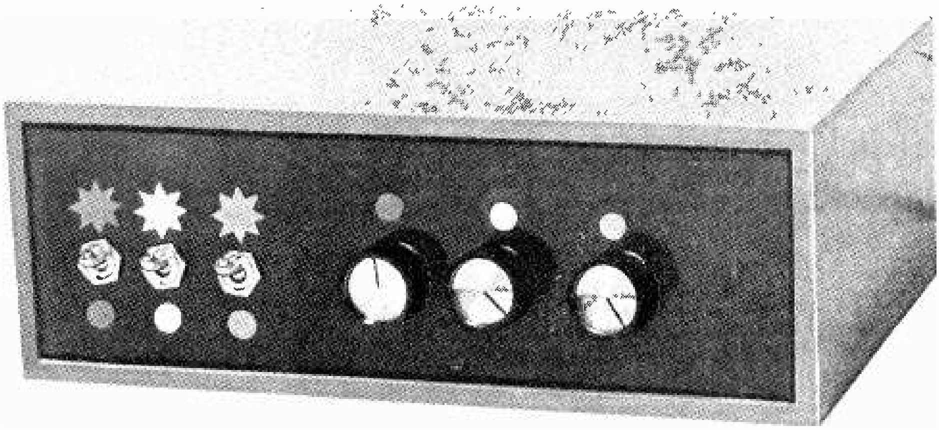
The following description applies to the Blue channel, the others are similar. The separated signal is passed through capacitor C8 to the base of Tr1. This transistor is biased by R4 and normally draws about 100mA, so a small heatsink is required. The 6·3V winding of T2 forms the collector load, whilst the 240V winding goes to the SCR. **Note this carefully.** The change in collector current induces a large voltage across the mains winding and this is used to trigger the SCR.



This view shows the component layout. The SCRs shown here are in TO66 packages and are not widely available. A stud-mounted version is specified in the components list.

RTER

otheque



The power supply for the transistors comes from T1 via a standard rectifier arrangement. and gives about 18V DC on load.

SCR OPERATION

Without wishing to go too deeply into the theory of silicon controlled rectifiers (SCRs), some explanation of their operation may be helpful here. Normally an SCR will block current from both directions. However, when triggered by a positive voltage on the gate it conducts like a diode until the current through it is reduced to zero. With 50Hz AC mains the current reaches zero one hundred times every second, so there is no problem in turning the SCR off.

To trigger the SCR a current above a certain level has to flow through the gate and also, in this circuit, through R5, D5 and T2. If R5 is too small, the leakage through the SCR from the cathode will trigger the device and the lamp will glow. The value of R5 is therefore chosen so that this just fails to happen. This value depends entirely on the individual SCR and was found to lie between 47kΩ and 180kΩ for one batch tested, averaging about 150kΩ.

In most cases use of a preferred value resistor will be satisfactory. Occasionally it may be necessary to use the next higher value and connect a second resistor of 1MΩ in parallel to achieve the desired effect. If R5 is too large, the Blue channel will be insensitive.

When an audio signal appears at the secondary of T2 it will be superimposed on the mains frequency voltage applied to the gate of SCR1. At some stage the two voltages will add and the resultant increase in gate current will trigger the SCR. Having fired, it will remain in conduction until the end of that mains half-cycle. The abruptness of the switching is smoothed out by the thermal delay of the lamp filament and so the overall effect is flashing in time with the music.

MAINS WIRING

The mains input is via a three core lead as a good earth is essential both for safety and for interference suppression reasons. The output is via three 13A sockets. The earth of these must be connected to the mains input earth.

When any of the switches is in the Bypass position full power is applied to the lamp in question. With all three switches in the Bypass position the transformer T1 is switched off, thus removing the power supply from the transistors. If double pole switches are used, the poles should be connected in parallel.

To avoid shorts, hum loops, etc., the input circuit is not earthed except via R1 and C2, the static drain and spike suppression components. When connected to an amplifier the earth follows through from the amplifier.

INTERFERENCE SUPPRESSION

In the switching circuit used here the SCRs are firing at random points during the AC mains cycle. The resulting voltage transients can cause considerable interference to nearby radio and TV reception

★ components list

Resistors

R1 4·7MΩ	R6 5·6kΩ	R11 1kΩ
R2 10Ω 2W	R7 22kΩ	R12 22kΩ
R3 47kΩ	R8 See text	R13 See text
R4 22kΩ	R9 3·9kΩ	All ½W 10% carbon except R2
R5 See text	R10 47kΩ	
VR1 100kΩ log	VR2 10kΩ log	VR3 100kΩ log

Capacitors

C1	1000μF	25V	C8	4μF 25V
C2	47pF		C9	0·1μF
C3	0·047μF	250VAC	C10	0·047μF
C4	0·047μF	250VAC	C11	4μF 25V
C5	0·1μF	250VAC	C12	0·047μF
C6	0·033μF		C13	10μF 25V
C7	0·047μF			

Semiconductors

Tr1—Tr3 BFY52
D1—D4 1N4002
D5—D7 OA81
SCR1—SCR3 CRS 3/40AF

Miscellaneous

T1 240V: 12V 1A, T2–T4 240V: 6V 2A Both types from RSC (Hi-Fi Centres) Ltd.; S1–S3 SPCO 250V 3A; SK1–SK3; L1 see text; Heatsinks for Tr1-3

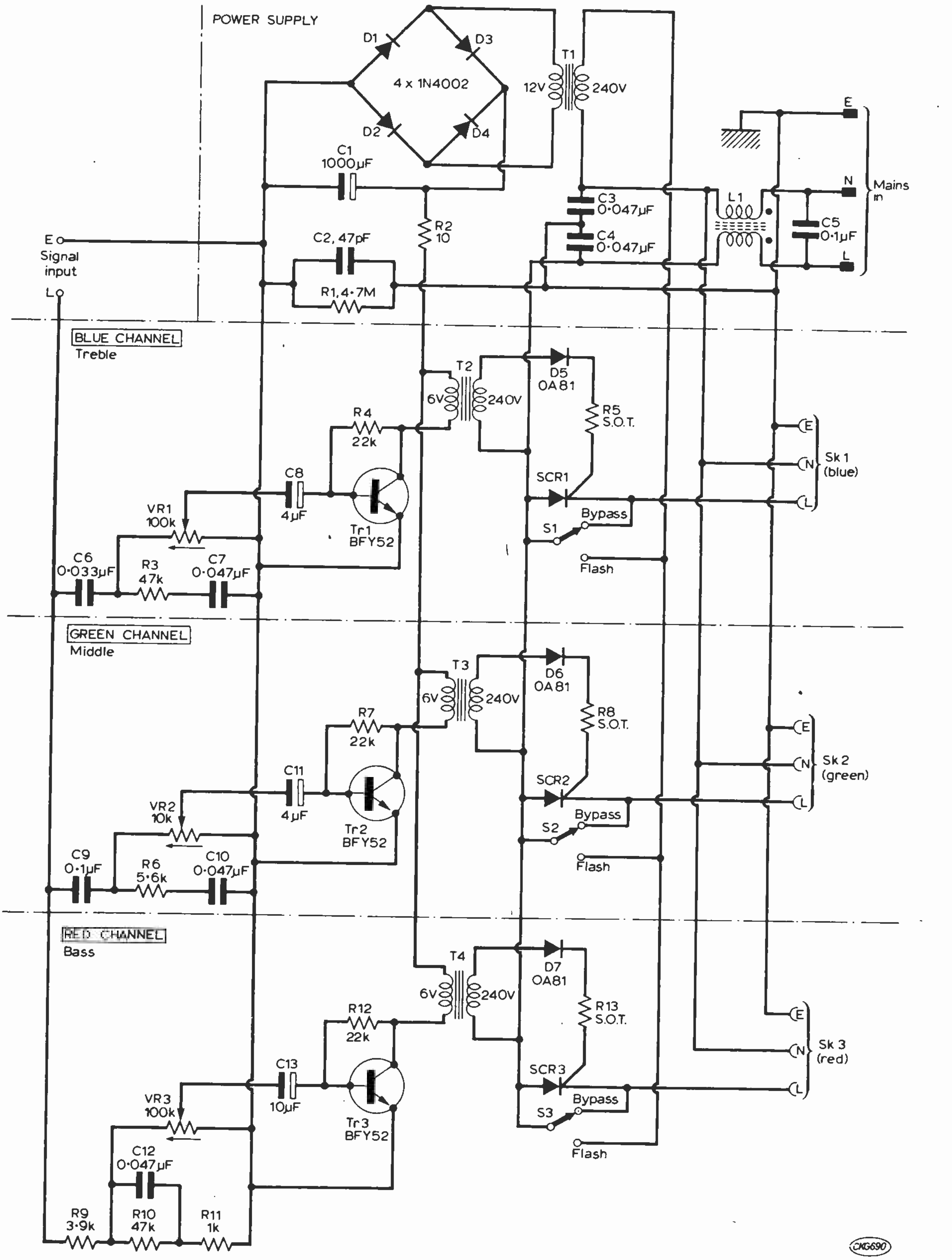


Fig. 1: Circuit diagram of the converter. The mains input should be via a suitably fused plug.

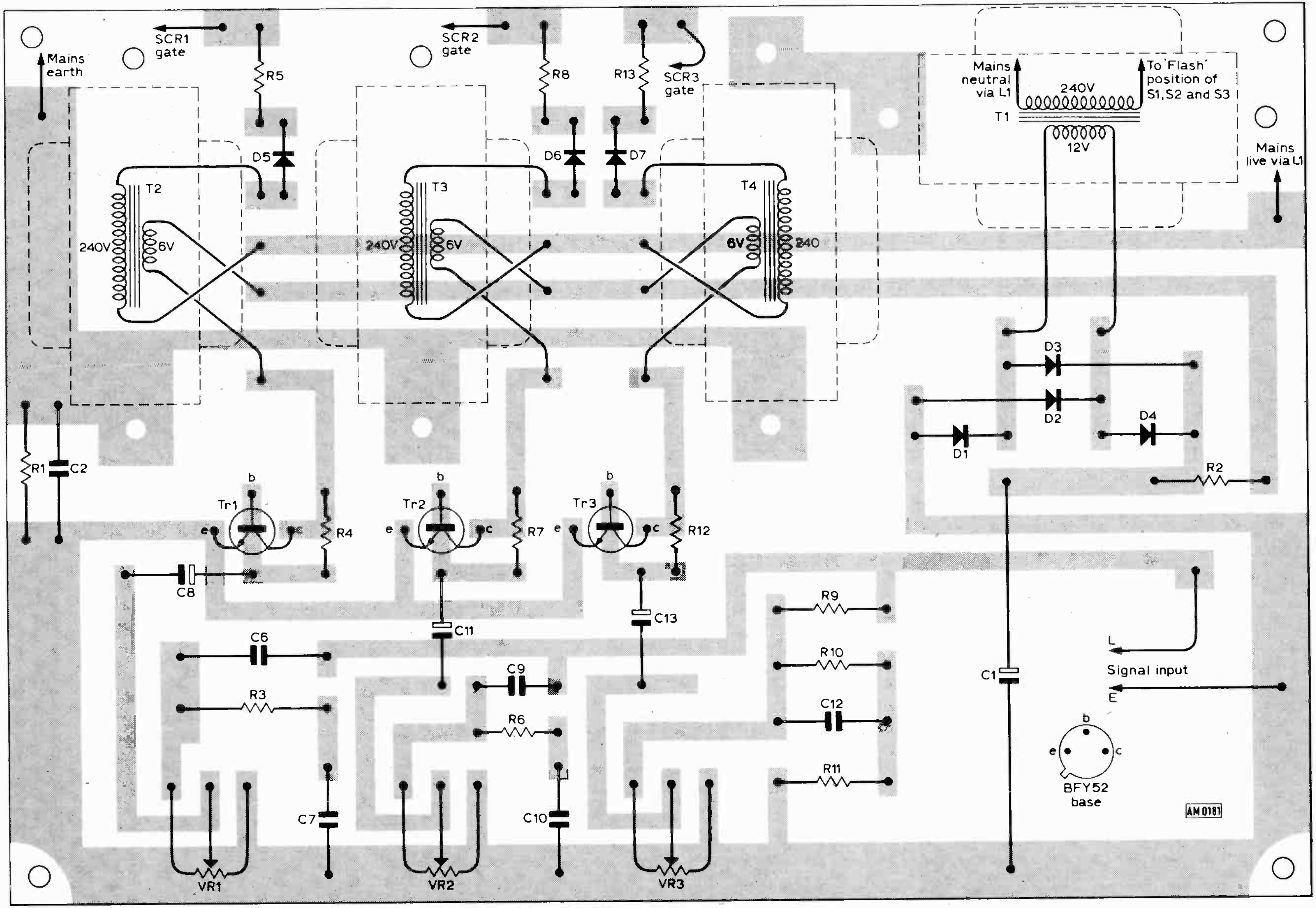
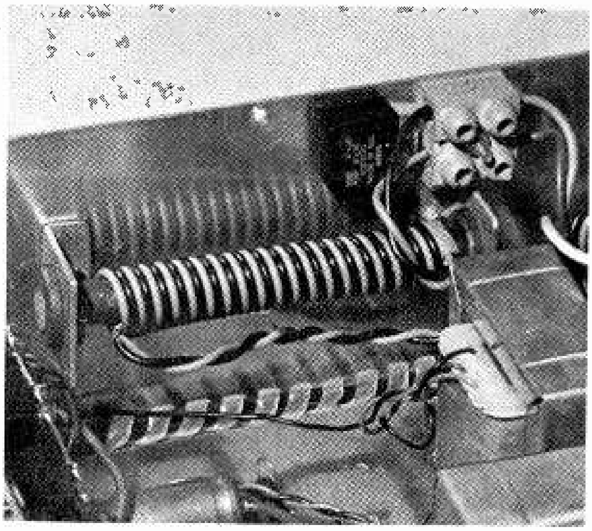


Fig. 2: Full size layout of the printed circuit board seen from the copper side with skeleton view of components.



Choke L1 is mounted on the left-hand end of the box using grommets and aluminium-angle feet.

and even to audio amplifiers. It is therefore essential to incorporate some form of suppression, which in this unit comprises C3, C4, C5 and L1, a bifilar-wound ferrite cored choke. Winding data for L1 is given later in the article.

As load currents are increased it becomes more and more difficult to obtain adequate suppression whilst keeping the filter circuits simple and inexpensive. The limit of 250W per channel is set for this reason.

The length of leads between the unit and the lamps also has quite an effect on the interference problem. These leads should be kept as short as possible—preferably not much over a couple of yards.

CONSTRUCTION

In the interests of reliability the unit was built on a printed circuit board housed in a 10×7×3in. aluminium box. The PCB should be mounted on spacers giving adequate clearance between the metal box and the printed tracks carrying mains potential.

The SCRs and switches are mounted on the box, the potentiometers are mounted on the circuit board. The three 13A sockets are fixed to a length of plywood which is bolted to the back of the box and provides a safety cover over the SCR anode studs. The ply must be recessed to clear the studs, otherwise leakage may occur via the wood with consequent risk of shock.

All four transformers are small enough to bolt direct to the PCB, though this should preferably be of fibre-glass to take their weight safely.

Exact drilling details are not given for the PCB because the layout may have to be changed slightly to allow for variation in component size, especially C1. However, plenty of room is available on the board.

The SCRs are mounted using insulating kits and silicone grease. The anode leads are soldered to a busbar joining solder tags which are placed on the bolts holding the SCRs.

The mains wiring must be done very carefully, using wire of adequate gauge. The mains filter choke L1 is wound on a ⅜in. diameter ferrite rod 4in. long. Each winding is 20 turns of 14/0·0076in. or 16/0·2mm pvc insulated wire, requiring a length of about 36in. including flying leads. The two windings are put on together so that the turns of one are between the turns of the other. Capacitor C4 must be mounted as close as possible to the SCR anodes.

When construction is complete the values for R5, R8 and R13 can be determined by test. It is suggested that Veropins are fitted to the circuit board in these positions, and the resistors soldered across them. In this way it is easier to experiment with different values.

Presets are unsuitable for R5, R8 and R13. Because of the voltages involved, small sparks from slider to track cause pitting. It is in order to use a preset initially to determine R5 etc., but it should be replaced by a fixed resistor afterwards.

Any channel may be omitted if desired. No other modifications are needed if this is done. Just omit the appropriate parts.

Finally a sleeve of ¼in. ply was made to go round the box and fixed to it by four self-tapping screws, which also secure the four rubber feet.

OPERATION

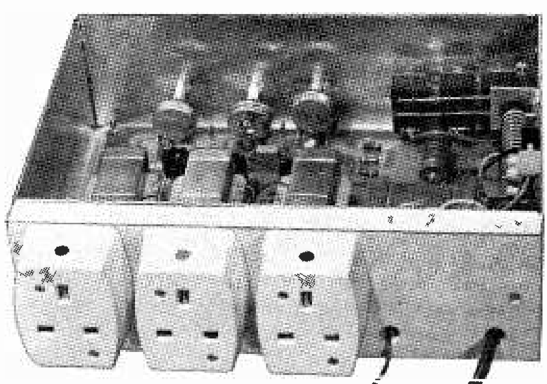
Turn all three controls to minimum, and all three switches to Bypass. Connect to amplifier and mains. Plug in 3 lamps, each should come on as it is plugged in. Set each switch to Flash, the appropriate lamp should then go out. With all three switches in the Flash position, play a record and advance each control until the corresponding lamp just flashes. Overloading spoils the effect.

The input to the unit comes from across one of the speakers. For good operation 2VAC or more is needed, but negligible power is taken. This represents slightly over 1W and should present no problem in any disco. Adjustments to volume, tone, etc. on the amplifier will probably mean that the controls for the lights need readjusting.

A domestic sound system operating at normal listening levels will probably not provide adequate drive for this unit.

The lights should be wired to a standard 13 amp plug, fitted with a 3 amp fuse, in the conventional way. All metal parts must be earthed.

Any lamps may be used but banks consisting of many low wattage bulbs, as opposed to 250 watt spotlights, flash better. The effect is improved by colours. ■



Input and output connections are at the rear. The live SCR studs are protected by the socket mounting block.

TAKE 20

DAVID ANDREWS

No. 60
LIGHT CONTROLLED OSCILLATOR

A series of simple transistor projects, using not more than twenty components.

THIS is a very simple project that employs a voltage controlled oscillator. Admittedly not a very sophisticated oscillator nor any guarantee of a well definable law relating voltage to frequency but the principle is so simple that it may prove an interesting sound source to electronic music experimenters. This application uses the output voltage from a photo-resistive cell/resistor combination (PCC1 and VR1) to control the frequency of the signal.

Circuit

Tr1 and Tr2 are the active members of a fairly conventional free-running multivibrator; C2 and C3 form the timing element for one half of the cycle but the usual timing resistor from the base of Tr2 has been replaced by a resistor and Tr3, Fig. 1. Tr3 acts as an emitter follower and sets the potential at the top end of R2. It is this potential that governs the rate at which the voltage at the base of Tr2 rises, controlling the time of the other half of the multivibrator's cycle. The higher the potential at the top end of R2 the higher the frequency of the oscillator. This potential MUST, however, be greater than 600mV otherwise no oscillation will occur. This potential is controlled via the base of Tr3; any input voltage in the range of 1·2V to 4·5V on the base of this transistor will effect frequency control.

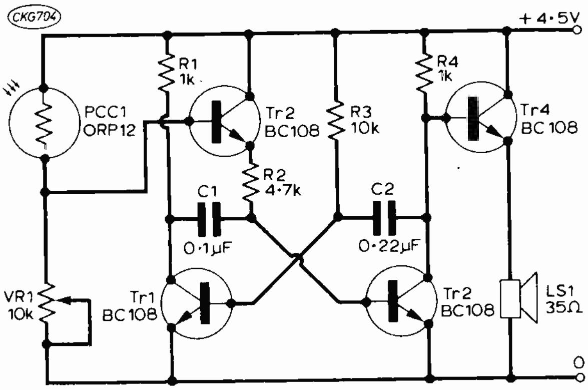


Fig. 1: Circuit of light controlled oscillator.

The lower portion of this range gives an exponential relationship between voltage and frequency but the law tends to linearise at the top end. In this application the control voltage is taken from the junction of PCC1 and VR1; the potentiometer being used to set the input to respond to any range of ambient lighting. Any shadow falling on the cell will reduce the frequency. This could be caused by persons passing the detector or, with care, the hands could be used to control the shading and thus produce a "Theremin" type of music.

Alternative Inputs

There is no reason why other sources of input voltage should not be used provided that they fall in the correct range and comes from a source impedance not greater than 100kΩ. Note that only one half of the multivibrator's waveform is controlled hence it is not possible to maintain unity mark/space ratio. This could be effected, together with a wider range of frequency sweep, if the Tr3/R2 combination was repeated on the other side of the astable. The same voltage source could be used to drive both halves or, alternatively, two independent non-interacting voltage sources could be used for different effects.

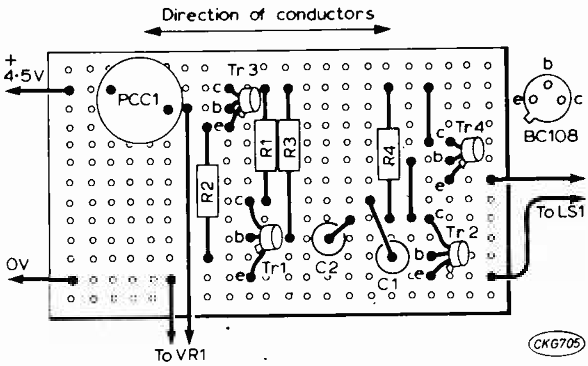


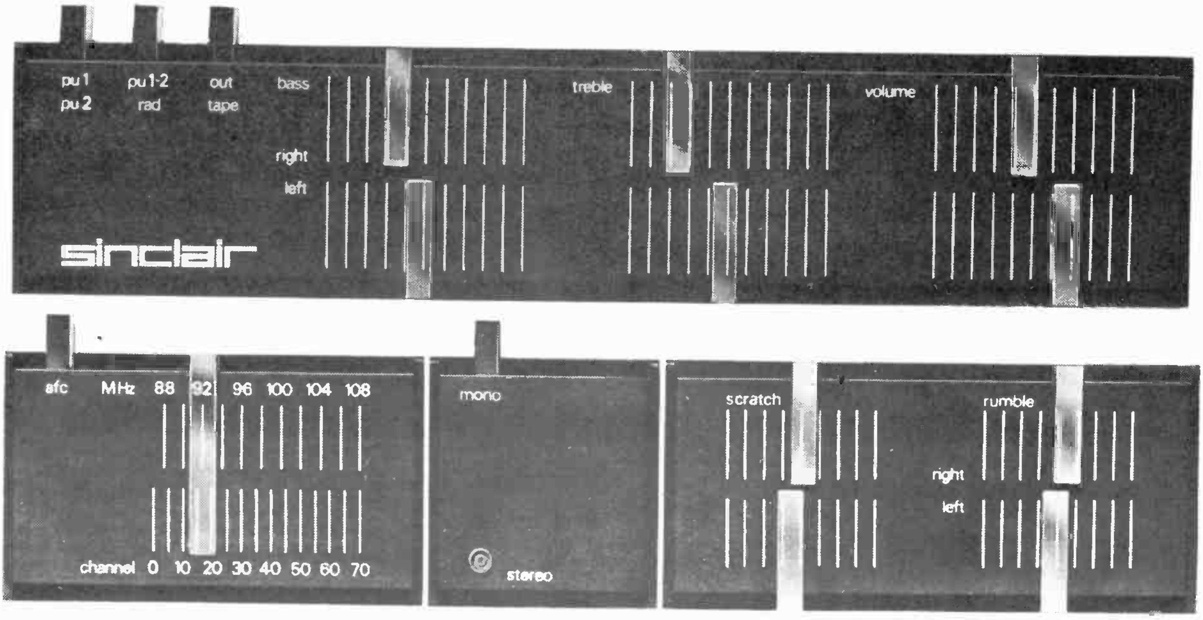
Fig. 2: Author's layout of circuit shown in Fig. 1.

A suitable layout of the unit on veroboard is shown in Fig. 2. VR1 could be mounted at the left end of the board provided the copper rails were broken to prevent short circuits. Finally, the board could be fitted in a box with a suitable aperture for the light to reach the photo cell, together with the battery.

★ components list

R1	1kΩ ¼W	PCC1	ORP12
R2	4·7kΩ	Tr1	BC108
R3	10kΩ	Tr2	BC108
R4	1kΩ	Tr3	BC108
C1	0·1µF	Tr4	BC108
C2	0·22µF	LS1	35 ohm (min)
VR1	10kΩ pot.		

Sinclair Project 80
exciting



only ¾" deep x 2" high

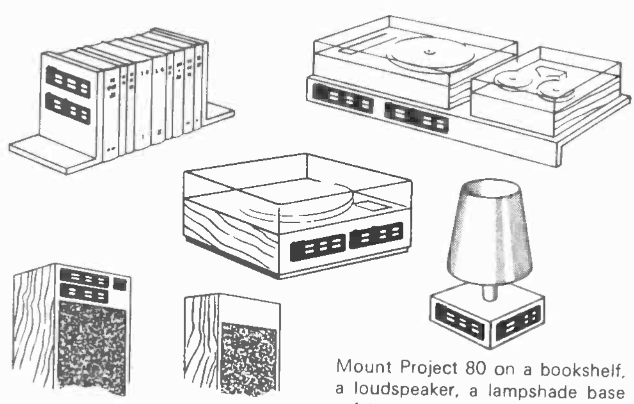
Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5·45 +54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10·43 +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 × Z.40s, Stereo 80; PZ.6	£30·83 +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 × Z.60s, Stereo 80; PZ.8	£33·83 +£3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14·93 +£1.49 V.A.T.

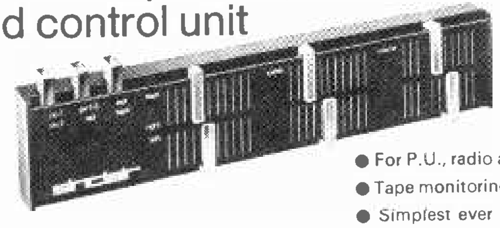
Project 80 FM tuner, decoder, and A.F.U. may be added as required



Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base a false wall with two Q.16 loudspeakers . . . almost anywhere.

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



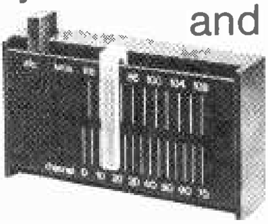
- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm (10¼ × 2 × ¾ins)
Finish – Black with white indicators and transparent sliders
Inputs – Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV
Radio 300mV; Tape 30mV
Signal/noise ratio – 60dB
Frequency range – 20Hz to 15KHz ± 1dB. 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape radio and P.U. Sliders for volume, bass (+ 12dB to – 14dB at 100Hz) treble (+ 11dB to – 12dB at 10KHz)

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER
Size – 85 × 50 × 20mm (3½ × 2 × ¾ins)
Tuning range – 87·5 to 108 MHz
Detector – I.C. balanced coincidence for good A.M. rejection
One I.C. equal to 26 transistors
Distortion – 0·2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Output – 300 mV for 30% modulation
Power requirements – 23 to 33 volts

R.R.P. £11.95 +£1·19 V.A.T.

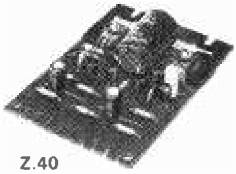
DECODER
Size – 47 × 50 × 20mm (1⅞ × 2 × ¾ins)
One 19 transistor I.C.

R.R.P. £7.45 +0·74 V.A.T.

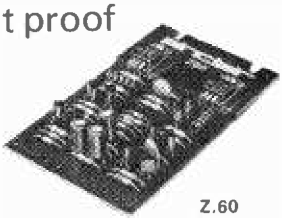
Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge.

Z.40 & Z.60 power amplifiers totally short-circuit proof



Z.40



Z.60

Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS
Size – 55 × 80 × 20mm (2⅛ × 3⅛ × ¾ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
Signal/noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0.1%
Power requirements – 12 to 35 volts

Z.60 TECHNICAL SPECIFICATIONS
Size – 55 × 98 × 15mm (2⅛ × 3⅞ × ¾ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz + 1dB
Signal/noise ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min. max. safe on open circuit

Z.40 R.R.P. **£5.45** + 0·54 V.A.T. **Z.60** R.R.P. **£6.95** + 0·69p V.A.T.

Project 80 active filter unit

Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.

TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz controls minimum
Distortion – at 1 KHz – 0·03% using 30V supply
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct slope

- For scratch and rumble control
- Transistorised active circuitry

R.R.P. £6.95 +0·69 V.A.T.

Power supply units

PZ.8

Stabilised. Re-entrant current limiting makes damage from overload or even direct shorting impossible. Normal working voltage (adjustable) 45V.

R.R.P. £7·98 + 0·79p V.A.T.
Without mains transformer

PZ.5 30V unstabilised
R.R.P. £4·98 + 0·49p V.A.T.

PZ.6 35V, stabilised
R.R.P. £7·98 + 0·79p V.A.T.

To SINCLAIR RADIONICS LTD. ST. IVES, HUNTINGDON PE17 4HJ

Please send post paid ______

for which I enclose Cash/Cheque for £ ______ including V.A.T.

Name ______

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Telephone St. Ives (0480) 64646

EXPERIMENTAL WORKSHOP

M. J. HUGHES M.A.

LEARNING BY PRACTICAL PROJECT STEPS

PART 8—POTENTIAL DIVIDER BIASING & GROUNDED BASE AMPLIFIERS

ONE often wishes to have a fairly simple grounded emitter amplifier stage that gives reasonably well defined gain and at the same time will work with transistors having a fairly wide spread of h_{FE}. The feedback bias method of controlling the working point of the output is one technique but the quiescent output voltage (typically mid-rail) is still dependent on the h_{FE} of the device in question. It was shown last month, that we can define the gain of a stage very accurately by using two transistors and associated negative feedback, but sometimes this is too sophisticated a circuit for simple applications.

A very commonly used method of biasing is to use the *potential divide* method; this has the advantage of being less dependent on h_{FE} and at the same time allows us to tailor the signal gain of the stage by using negative feedback. It is not as predictable a circuit as the two transistor version we saw previously but nevertheless is frequently used by designers.

Biasing

The basic potential divide biasing method is shown in Fig. 59. R1 and R2 between them set the bias but R4 is also a very important component because it helps stabilise the quiescent output voltage. Let's see how this is done. To arrive at component values we must first decide what we need as a quiescent output and what current we want to flow in the collector circuit of the transistor (Tr1). As a rule of thumb one should aim for a collector current that is at least ten times higher than the current that needs to be drawn from this circuit to power another stage. At the moment we have not given ourselves any specification in that direction so it need not bother us too much. If we specify a mid-rail output of 4·5V and a collector current of about 0·1mA the value of R3 has to be $\frac{4\cdot5}{0\cdot1}$ kΩ. In practice we have made it 39kΩ so the voltage at A (provided we do everything else right) will be slightly higher than mid-rail but this is no hardship!

We must now turn our attention to how we generate the necessary base current to control 0·1mA of collector current; this is where R1, R2 and R4 come in. Base current is that which flows between points B and C. This is going to be part of the current flowing down R1 and will go through the base emitter junction to add to any collector current already flowing through R4. We now rely very much on the fact that we can predict, fairly accurately, that there will always be a potential difference of 600mV between points B and C (this is the forward voltage drop across a silicon *pn* junction); also we hope that the transistor we use will have a fairly high h_{FE} so that when the base current adds to the collector current through R4 it will make insignificant contribution to voltage changes at point C. Provided h_{FE} is 200 or more the increase in current through R4 caused by this will be less than 0·5%.

In practice we usually try to select a value for R4 that will give us a quiescent potential at C of about 1V. Assuming our original quiescent collector current is *all* that flows through it (i.e. ignoring base current) its value works out at $\frac{1}{0\cdot1}$ kΩ to 10kΩ. We can now say that the potential at B will be 600mV more positive than the 1V at C (i.e. +1·6V). It is now a simple matter to calculate the values for R1 and R2 provided that we set ourselves the criterion that the total current flowing down the chain of R1 with R2 should be four or five times our desired base current. If we say 5 times I_b flows down R1 then only 4 times I_b will flow down R2 (because one unit of I_b is extracted at point B to feed the transistor's base emitter circuit). If we assume h_{FE} to be approximately 200 we can expect a base current requirement of $\frac{I_C}{h_{FE}} = \frac{0\cdot1}{200} = 0\cdot0005$mA (don't worry about whether the h_{FE} is exactly this in practice for the moment).

Having assumed this we can now work out the theoretical values for R1 and R2. We know that the potential at B is +1·6V hence if five times I_b flows through R1 the resistor should have a value of $\frac{9-1\cdot6}{5\times0\cdot0005}$ kΩ = approx. 3,000kΩ (or to a near aproxi-

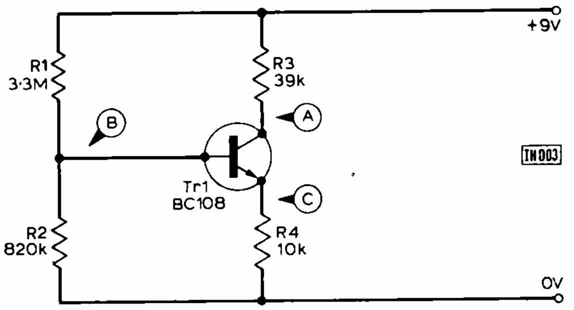


Fig. 59: The values of the bias resistors, R1 and R2, are usually chosen to set point A at a mid-rail voltage.

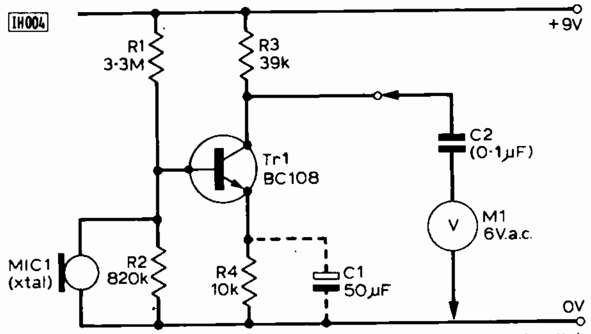


Fig. 61: The small current injected into the base/emitter circuit by the microphone produces an amplified signal at Tr1's collector. Negative feedback has to be suppressed by capacitor C1. Some a.c. multimeters might incorporate the d.c. blocking capacitor C2.

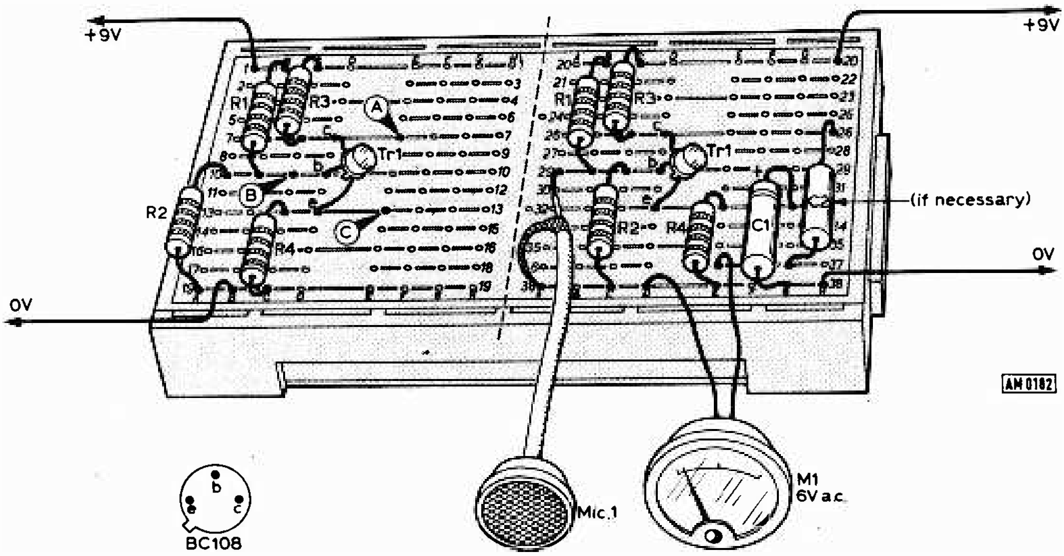


Fig. 60: Layout for Fig. 59.

Fig. 62: Layout for Fig. 61.

mation 3·3MΩ). The voltage drop across R2 is 1·6V and it has four times I_b flowing through it so its value works out as $\frac{1 \cdot 6}{4 \times 0 \cdot 0005}$ kΩ = 800kΩ (we have rounded it *up* to 820kΩ to match the rounding *up* of R1).

Make up this circuit and using a 20,000Ω per volt meter, measure the potentials at A, B and C and see how near we are to our predicted requirements.

Within reasonable limits the quiescent output level is controlled by the potential at C and the forward voltage drop across the base emitter junction.

The transistor works, to some extent, like an emitter follower; i.e. provided there is sufficient h_{FE} in the first place (and we have sufficient *total* current flowing through R1 and R2) the transistor will draw the necessary amount of base current to keep the potential at C 600mV more negative than that at B. If we ensure we have several times the predicted base current flowing through the potential divide resistors then small variations in actual base current drawn will not significantly affect the potential at B. It would, obviously, be better to reduce the values of R1 and R2 to ensure that the standing current was very much higher than I_b but this is undesirable for some applications. For example if we wish to use a crystal microphone or cartridge as a source of signal for amplification these two resistors act as if they were both connected in parallel across the source and thus reduce the input impedance of the amplifier with the predictable drop in low frequency response from a high impedance capacitative source.

Why not use a crystal microphone (in the same manner as last month) and measure the a.c. voltage changes at the collector of Tr1—use the circuit and layout for Fig. 61.

At first leave out the capacitor C1 and try the "hum and whistle" test. You will probably see very little signal. The reason for this is that not much of the extra current, supplied by the microphone, is being used to modulate the collector current. The reason is that as soon as you try to inject more current into the base, the potential at the emitter rises to combat it (negative feedback). This negates the effect of the extra base current—in so doing it shows that we have a nice stable biasing system! However this is not particularly desirable when it comes to amplifying a signal so we have to do something about it. As our applied signal is a.c. by nature it will flow through a capacitor so we connect a high value capacitor between the emitter of Tr1 and ground. Any a.c. signal applied to the base will cause maximum a.c. base current to flow and this produces maximum modulation of the quiescent collector current.

Connect C1 into the circuit and try your test again; you should now get a much larger response at the

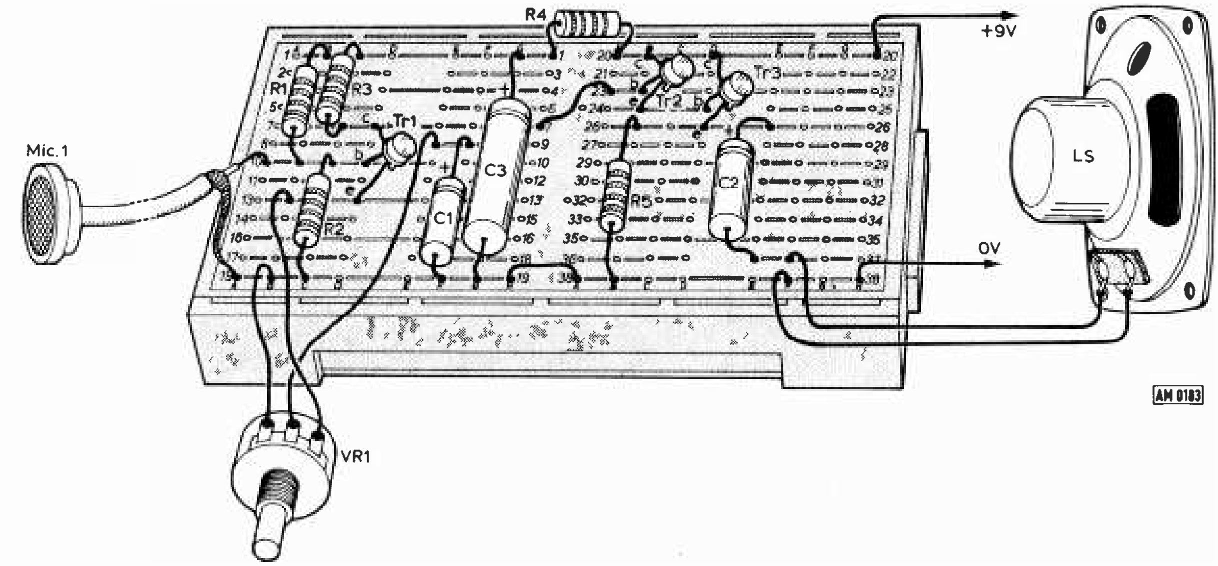


Fig. 64: Layout for Fig. 63.

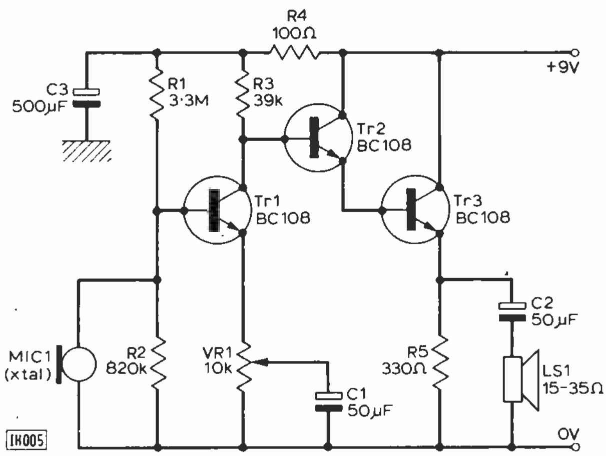


Fig. 63: A simple microphone amplifier (for use as an intercom or baby alarm) using a potential divider biased stage. Volume is controlled by VR1.

collector. We still have negative feedback to d.c. (thus stabilising the bias) but, provided C1 is of high enough a value, we have removed all negative feedback to a.c. We call C1 an emitter by-pass or decoupling capacitor. We obviously get more amplification by including C1 but at the expense of frequency response.

Because we are drawing maximum current from the a.c. source we can say that the input impedance of our amplifier is much less when we reduce the negative feedback; this means that although the amplification at high frequencies increases dramatically it is severely reduced at low frequencies. Usually one has to compromise with the amount of emitter decoupling as shown in Fig. 63. This circuit allows you to apply more or less of the effect of C1 by adjustment of VR1. With the extra power stage you can experiment and hear the difference between high gain and poor frequency response or low gain with better response. Some circuits use the technique of adjustable feedback to control volume, in which case you trade volume for quality.

(TO BE CONTINUED)

See also the Leader article on page 116.

CQ! CQ! CQ! CQ! CQ!

EXCHANGE

...R209 in perfect working order, exchange for other communication receiver (eg AR88, HRO, CR70A, etc), or sell.—P. J. Kay, 85 Northway, Maghull, Liverpool.

ISSUES WANTED

...Practical Wireless Sept., Oct., Nov., and Dec. 1971.—R. Vye, 97 Grange Drive. Melton Mowbray, Leicestershire LR13 1EZ.

...Practical Television for March, April and May 1954 on "Simplex TV".—P, Loxdale, 3 Elm Lane, Redland, Bristol.

...Practical Wireless January/February 1973 with details of the W. Cameron 10 + 10W amplifier.—Lawrence French, 181 Thomas Street, Kitty, E.C. Dem., Guyana, S.A.

...Series of Practical Wireless required: Vol. 42 Nos. 1, 2, 3, 4, 9, 10. Vol. 43 Nos. 2, 3, 4, 7, 8, 9, 10, 11, 12. Vol. 44 Nos. 1, 2, 3, 4, 5, 6, 7, 8.—Cyril Moriarty, Railway View, Athlone, Eire.

...Practical Wireless October/November 1964 and April and November 1965.— P. J. Bowyer, 204 Bournemouth Park Road, Southend-on-Sea, Essex SS2 5LU.

...Issues of P.W. from May '71—Aug. '71 inclusive.—E. J. Houghton, 42 Southampton Hill, Titchfield, Fareham, Hants.

...January 1973 P.W. required.—M. A. Fairman, 40 St. Mary's Gardens, Trowbridge, Wilts. BA14 7PQ.

...April 1973 issue of Practical Wireless.—P. J. Arden, 1 Hallam Grange Rise, Fulwood, Sheffield S10 4BE.

...December 1969 issue of Practical Television.—L. J. Symes, Titchborne Farm, Redlynch, Salisbury, Wilts.

...P. Wireless January and March 1972. July, September, October, December 1971. Also Volume 46.—B. G. J. Simeon, 5 Penlu Court, Tuckingmill, Camborne, Cornwall.

...Telefunken 'Partener 101', LW/MW/VHF Transistor Radio. Borrow or purchase circuit diagram or any info.—B. Pendry, 3 Rugby Street, Belfast BT7 1PX.

...wanted AR88D Manual to buy or will exchange vintage components.—C. E. Clark, 91 Craven Road, Brighton, Sussex.

CASSETTE RECORDER AND TUNER AMPLIFIER

PART 4 RICHARD COLLIN

ASSEMBLY AND WIRING

Having constructed the chassis and power supply and made up the five main boards, final assembly can commence. The boards are mounted on to the chassis skeleton frame in the positions shown in the photographs. It is important when bolting the boards into place to make sure that they are totally isolated from the metalwork—transistor mounting bushes make neat insulators for this application. The power amplifier board should be mounted before the heatsink clearance holes in the rear panel are drilled. These holes can then be accurately marked out. It is important that the transistor leads are not strained when the heat sink plate is bolted to the rear panel. A smear of silicone grease should be applied between the plate and the panel to ensure good thermal contact.

Once all boards, switches, potentiometers and sockets are mounted, wiring may commence. Be sure to follow the wiring diagrams exactly. Take particular notice of the screened lead connections. The screen is not often connected at both ends as this would cause earth loops. This applies especially to the wiring to the input sockets. To ensure that earth loops are not created by the connection of external apparatus (e.g. gramophone deck or tape recorder) most screens are not connected at the sockets.

Each of the +34V and OV leads from the PCB's should be taken direct to the tags of 5C3. The negative tag is then earthed to an adjacent chassis-mounted solder tag. This is important so that the power supply and signal earth paths are clearly defined. For the same reason, all screened cables must have an overall insulating sheath.

Failure to follow the wiring routes shown could result in serious hum and instability problems. Any stereo system has critical earth return paths, because any length of wire has a finite resistance. It is possible to generate voltages across this resistance which will be added to the intended input signals. The phase and magnitude of these unwanted voltages can be such that oscillations occur which may be at very high frequencies and therefore inaudible. They can however cause distortion and also lead to failure of transistors. In addition high hum levels can be generated.

INITIAL TESTS

Having completed all construction and wiring, a further very thorough check of all connections, electrolytic capacitor polarities and component positioning should be made.

Once everything has been checked out, the loudspeakers should be connected, the Volume control set at minimum, the Bass, Balance and Treble set mid-way. Before connecting the mains supply, the

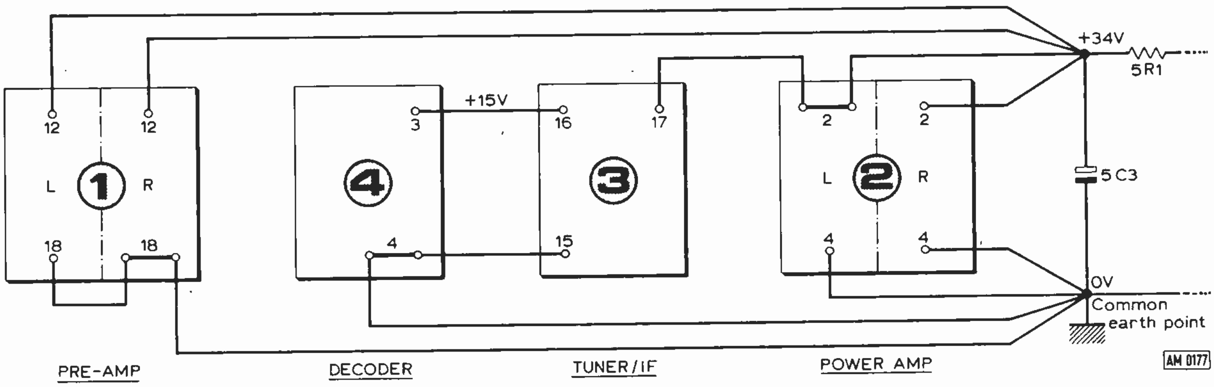
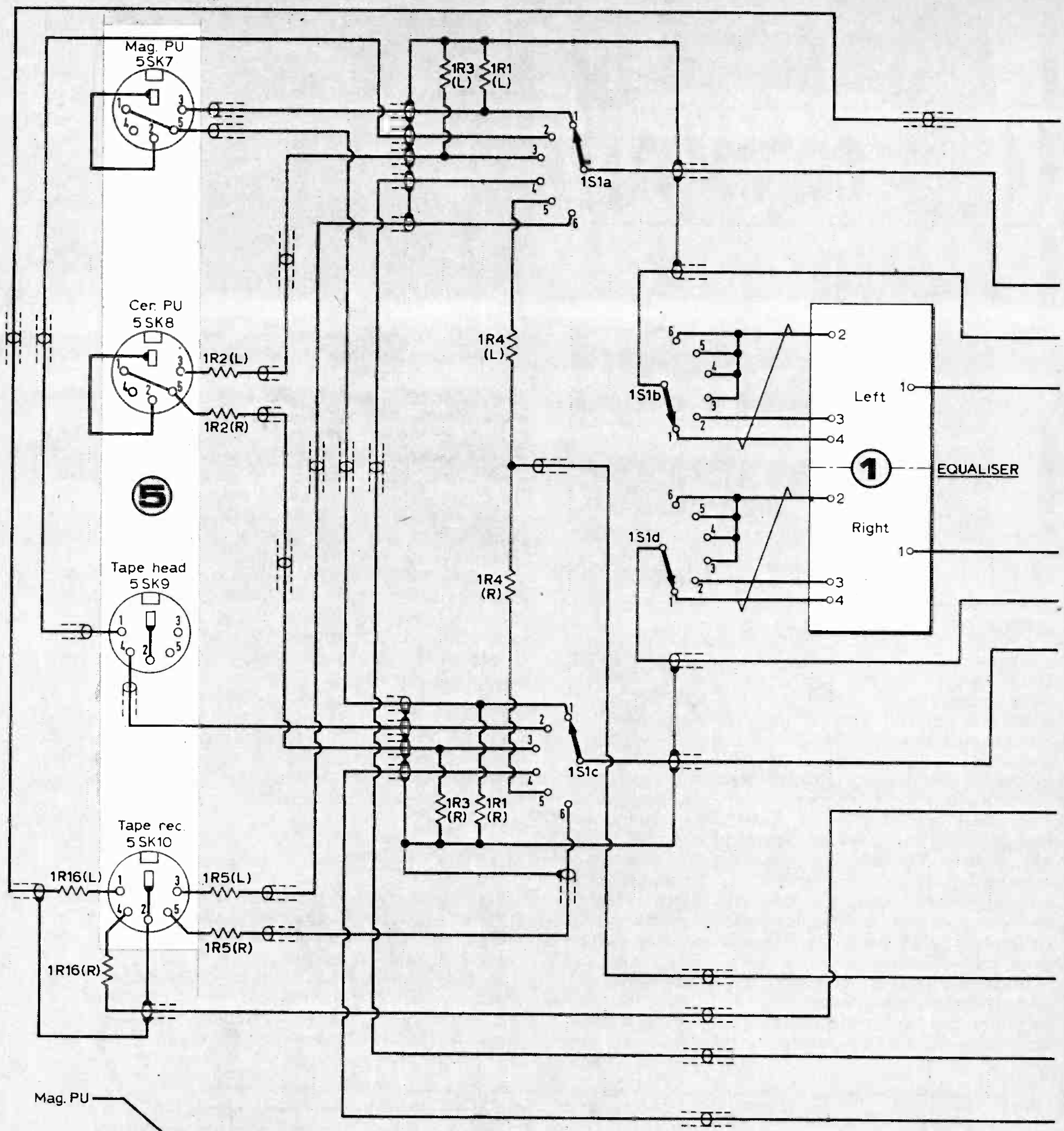
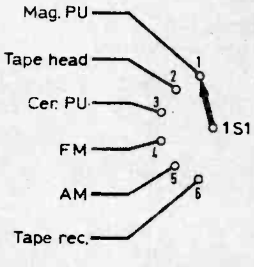


Fig. 20: Wiring diagram of power distribution to PCBs.





Key to Mode switch positions

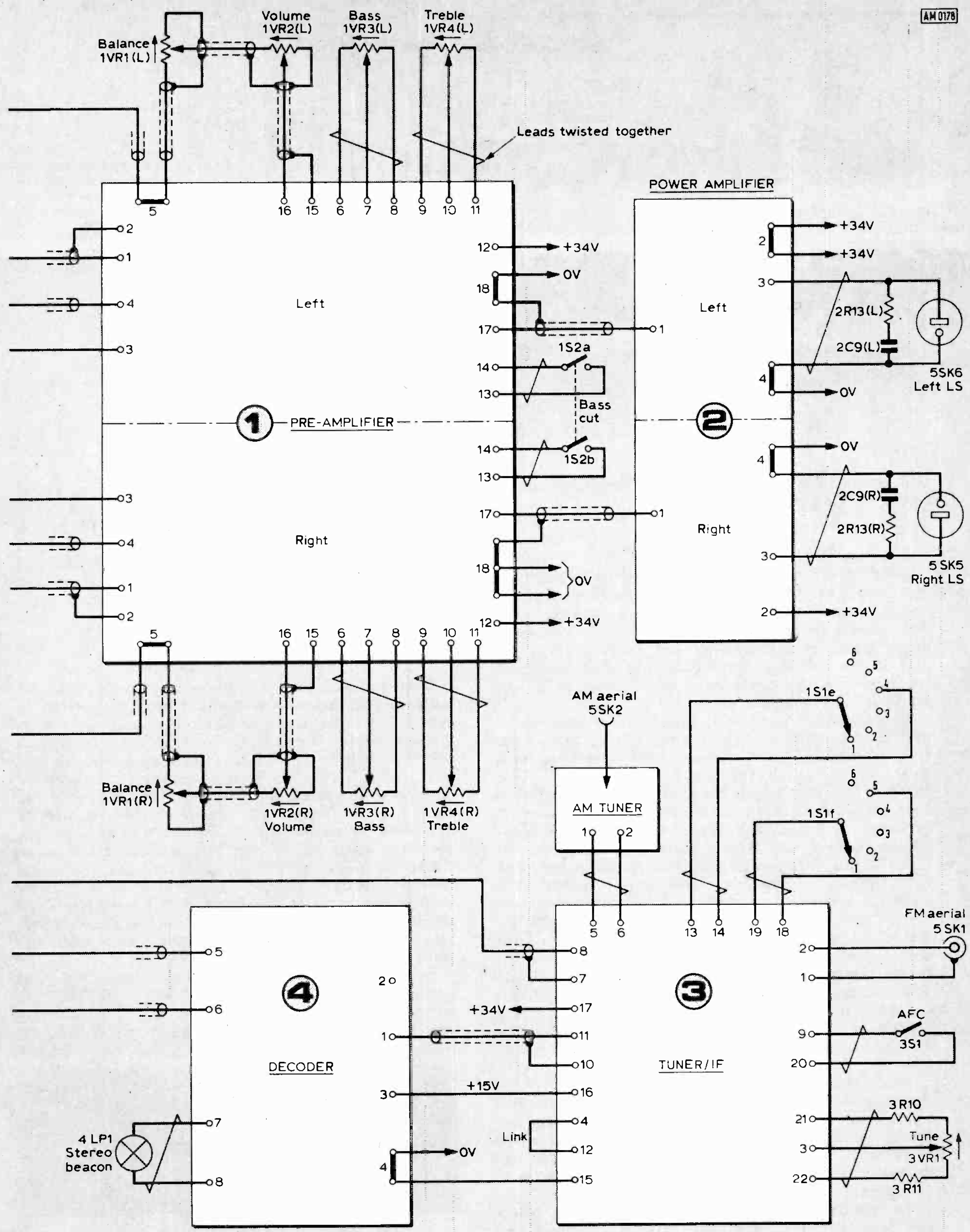
Notes:

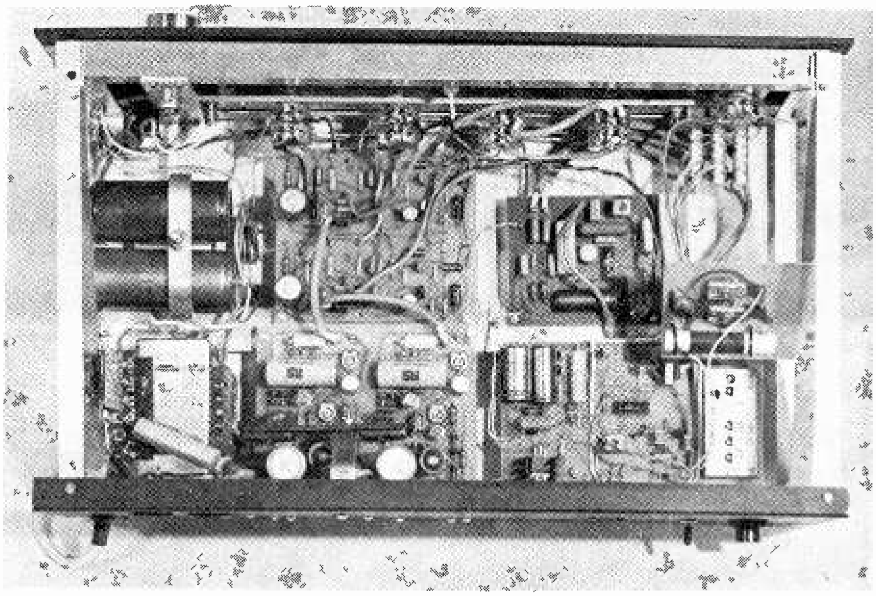
1.....The braids of screened cables must be connected only at the points shown. They are earthed only via the Pre-amplifier.

2.....Arrows on potentiometers indicate clockwise movement of wiper.

3.....Prefixes to component references indicate unit circuit diagram on which components appear. (e.g. 3VR1 is shown on Tuner and IF section.)

Fig. 21: Overall wiring diagram, excluding power and earthing (see Fig. 20). Screened wire must be used where shown. The Balance, Volume, Bass and Treble potentiometers for the Right and Left channels are each ganged.


AM 0178
Volume
1VR2(L)
Bass
1VR3(L)
Treble
1VR4(L)
Balance
1VR1(L)
Leads twisted together
POWER AMPLIFIER
+34V
0V
Left
1S2a
Bass
cut
1S2b
PRE-AMPLIFIER
Right
2R13(L)
2C9(L)
5SK6
Left LS
2C9(R)
2R13(R)
5 SK5
Right LS
Balance
1VR1(R)
1VR2(R)
Volume
1VR3(R)
Bass
1VR4(R)
Treble
AM aerial
5SK2
AM TUNER
1S1e
1S1f
FM aerial
5 SK1
AFC
3S1
DECODER
TUNER/IF
+15V
Link
4 LP1
Stereo
beacon
3 R10
Tune
3 VR1
3 R11



Top view of CRATA showing unit positions with Power Supply at the left. The Pre-Amplifier and Decoder are at the top, Power Amplifier and Tuner/IF at the bottom.
The Equaliser board, which is not shown in this photograph, should be mounted near the input selector switch.

two preset resistors on each power amplifier should be set as follows:

VR1—midway
VR2—fully anti-clockwise

Connect the mains supply and switch on—a faint hiss thould then be audible in each speaker. Measure the HT supply across the smoothing capacitor 5C3. This should be approximately 34V. If the voltage is much lower, then switch off and recheck all wiring and boards for short circuits—check also the power transistors which could have been damaged during lead forming or soldering.

If the voltage is correct, connect a meter (preferably a valve-voltmeter) to the emitter of Tr4 on the left power amplifier. Adjust VR1 (left) so that this voltage is half the HT voltage i.e. 17V. Next the bias for the output stage should be set. This is best carried out using an oscilloscope and sinewave generator. Connect the 'scope' across the left hand speaker socket and feed a 1kHz sine wave into the input of the left power amplifier. Feed in only sufficient signal to produce a low output volume. The output waveform is certain to exhibit crossover distortion (see Fig. 22). Adjust VR2 (left) until the distortion just disappears. If an oscilloscope and signal generator are not available, the bias may be set with a milliammeter. Disconnect one end of R12 and connect the meter (100mA fsd) in series with this resistor. Adjust VR2 (left) so that the current flowing is 10mA. Reconnect R12 and then repeat the entire setting up procedure on the right hand power amplifier.

Next, using a high impedance voltmeter, check the operation of Tr1/2 in the preamplifiers. Measure the voltage on Tr2 collector—it should be about 5V. If the voltage is much different, change the value of R7 until the voltage is correct. Reducing R7 will increase the voltage and vice versa. Check both channels.

To test the preamplifiers and socket wiring, select the Magnetic P.U., Ceramic P.U., Tape head and Tape recorder replay positions in turn, feeding the associated sockets with their respective input signals.

Having ensured that each input is working, select whichever is the most convenient to use and make a more thorough check on the amplifier performance. Check that the Tone controls behave as expected, check the Bass Cut switch (if fitted) and also the action of the Balance control. If a signal generator and oscilloscope are available the operation may, of course, be checked in greater detail.

TUNER ALIGNMENT

Once satisfied that the audio stages are functioning correctly, select AM Radio. Check that +15V is present at the emitter of 3Tr2. If a selector switch is fitted select the first position. Adjust the appropriate trimming capacitor associated with the ferrite aerial until the desired station is received. Orientate the board for maximum volume, with the complete receiver in the plane in which it will be operating when finally installed. Lock the board into position. Then adjust the trimmer capacitor associated with L2 on the aerial board for maximum volume. Readjust the two trimmers until no further improvement can be obtained. With the multi-station version repeat the procedure for each selector switch position, being careful not to disturb those trimmers already adjusted.

Next select FM Radio. Without a signal, a high background noise is to be expected. Connect an aerial (FM dipole), switch off the AFC and rotate the Tuning control until a station is located. (If using preselected tuning, select any push button

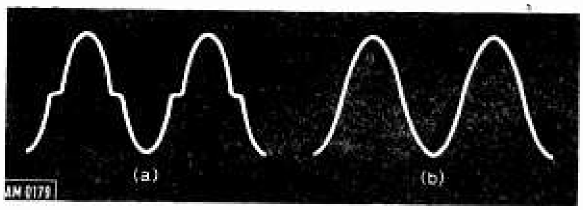


Fig. 22: Output waveform of sine wave
(a) With crossover distortion.
(b) With VR2 adjusted for correct bias on output transistors.

and adjust the appropriate preset resistor, having first set the fine tune potentiometer to mid-way). As soon as a signal is located, adjust the core of 3L4 (the FM IF coil) for maximum volume, using an insulated trimming tool. Then select several other stations and recheck the IF coil setting.

DECODER ADJUSTMENT

Tune to a station broadcasting in stereo. Adjust the decoder oscillator coil L1, again using a proper tool, until the Stereo indicator lamp lights—as it does so the decoder should automatically switch into the stereo mode, making the previous monaural sound image appear to spread out. Continue turning the core until the lamp goes out again and the decoder switches back to mono. The correct tuning point is mid-way between the point where the lamp lights and the point where it goes out again.

Now turn the Tuning until off tune. The lamp should extinguish and the audio become louder and severely distorted. Switch on the AFC—the station should instantly come on tune again and the lamp relight. Switch off the AFC and tune back through the correct point until a distorted signal is again received. Switching on the AFC should again bring the receiver on tune. Finally check that the Stereo lamp does not come on when tuned to a station broadcasting in mono.

To prevent the decoder being triggered by noise or by the 23kHz tone on Radio 4, capacitor 3C20 was added across the audio output of the FM tuner. Too high a capacitance at this point will degrade stereo separation with some samples of the decoder IC. The value fitted should therefore be the minimum consistent with correct operation, i.e. lamp On for stereo and Off for mono broadcasts.

Having completed the alignment, it only remains to check the Tape recorder output. This may be accomplished with an oscilloscope, or a tape recorder set to 'record'. This should respond to the programme being received. The Volume and Tone controls on the equipment will not affect the tape record output.

The equipment is now fully aligned and fully operational. It only remains to mount CRATA into its case.

★ Voltage analysis

Meter 10kΩ/Vdc—negative lead to OV rail, all readings in volts

H.T. Supply at 5C3 34V

Pre Amplifier (each channel)

	e	b	c
Tr1 BC149	*	*	2
Tr2 BC148	*	2	4
Tr3 BC149	0	*	5

Power Amplifier (each channel)

	e	b	c
Tr1 BC158	17	16	*
Tr2 BC148	17	17·5	18
Tr3 2N6288	0	*	17
Tr4 2N6288	17	18	34
Tr5 2N6111	17	17	0

Tuner & IF

(a) AM Radio selected

	in	out
IC1 ZN414	1	1·5

	e	b	c
Tr1 BC113	0	0·6	0·75
Tr2 2N6288	15	16	34

(b) FM Radio selected

IC2	Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CA3089E	Reading	2	2	2	0	0	5	5	5	5	5	12	0	2	0	5	0

NOTE—The reading on pin 7 (AFC output) varies with tuning.

Decoder FM Radio selected—tuned to stereo broadcast

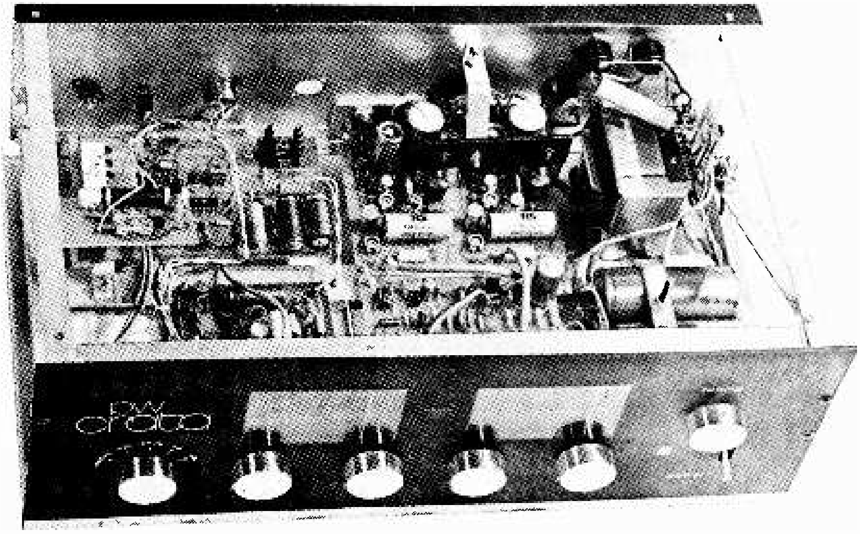
IC1	Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CA3090Q	Reading	2	2	0	0	0	6	1	1	10	10	15	0	0	3	5	5

	e	b	c
Tr1 BC158	15	14·5	15

* Indicates very low reading due to circuit loading by meter.

FAULT FINDING

To help with any problems encountered during testing, or with any future service requirements, all transistor and IC terminal voltages are given in the table. ■



The Power Amplifier heatsink arrangements are visible here. The small pcb on the mains transformer tagboard carries the rectifier assembly.

Oscilloscope techniques

PART 4 ALAN AINSLIE

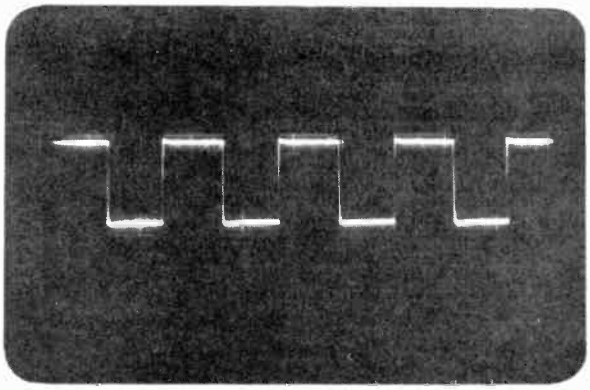
If the switching waveform is not a pure square wave it will tend to blur the trace on the CHOP mode, but on ALT switching takes place during flyback and is of no consequence, unless it is very bad. Beam blanking is often employed to render switching transients unseen and to produce a clearer trace.

When using a dual trace plug-in there are difficulties with timebase triggering, but these will be dealt with later.

Often the dual trace unit has a polarity reversal switch for each beam to reverse the direction of deflection. Also the ALT/CHOP switch besides having positions for CH1 only and CH2 only has a sum position. The deflection in this position is the sum of the signals, or if one channel is inverted, the difference. Hence the dual trace unit can be used as a differential amplifier. However, results are not generally as good as a proper differential plug-in.

The differential plug-in usually has two inputs, one being inverted. A mode switch enables the operator to add the two signals and so anything common to both inputs at the same level is rejected. The degree of rejection is termed the "common mode rejection". Elaborate facilities are provided to optimise the CMR at all attenuator settings and frequencies.

Differential amplifiers are used to investigate balanced signals, investigate phase changes and in the analysis of distortion, as well as for precise balancing methods. The average amateur laboratory can usually manage with a dual trace unit and a bit of common sense.

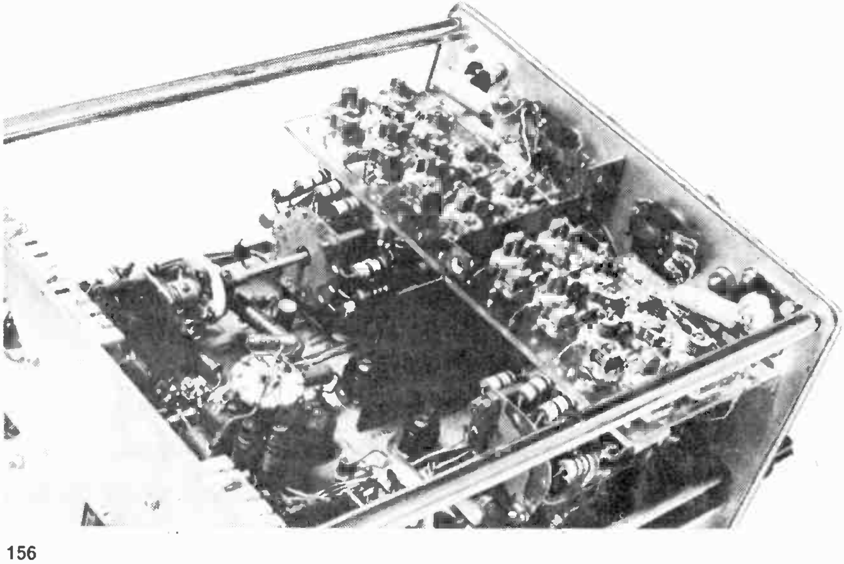


A 180kHz beam switching waveform. The overshoot and lack of blanking during the switching transients cause the overall trace to lack definition.

PROBES

As mentioned earlier the input impedance of a typical scope is perhaps 1MΩ in parallel with 25pF. When a screened input lead is connected the capacitance would be well over 100pF. At 100pF and 500MHz this is an impedance of a little less than 32 ohms!

Probes have been developed to reduce this capacity to as little as 1 or 2pF. The simplest types are the passive attenuator probes, Fig. 9 shows the arrangement. The resistors Rp and Ry are the divider, for a 10:1 probe with Ry (the input resistance) of 1MΩ



The inside of a double beam plug-in. The attenuator switches and the associated trimmer capacitors can be clearly seen. Because of the high input impedances screening between the channels is necessary and can be seen between the two attenuators.

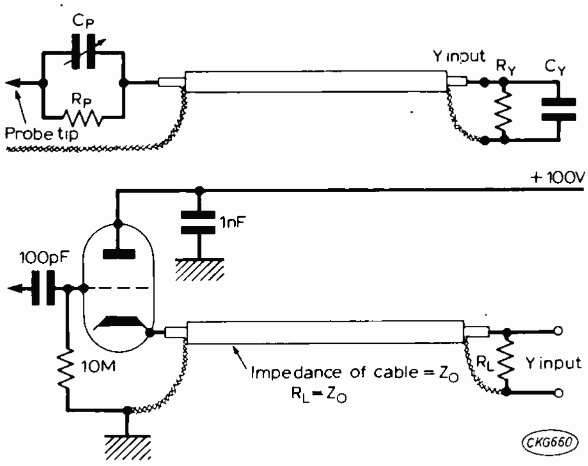


Fig. 9. Two simple probe circuits.

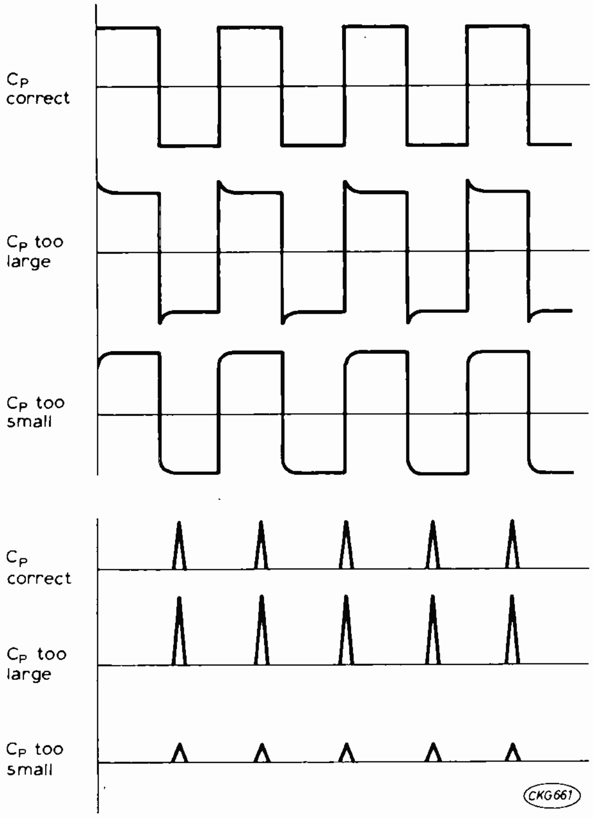


Fig. 10. Effect on square wave of various values of Cp.

then Rp would be 9MΩ. Cp and Cy (input capacity) plus the cable capacity form the capacitive divider. Cp is adjusted on a 1kHz square wave to give a good response. Then:—

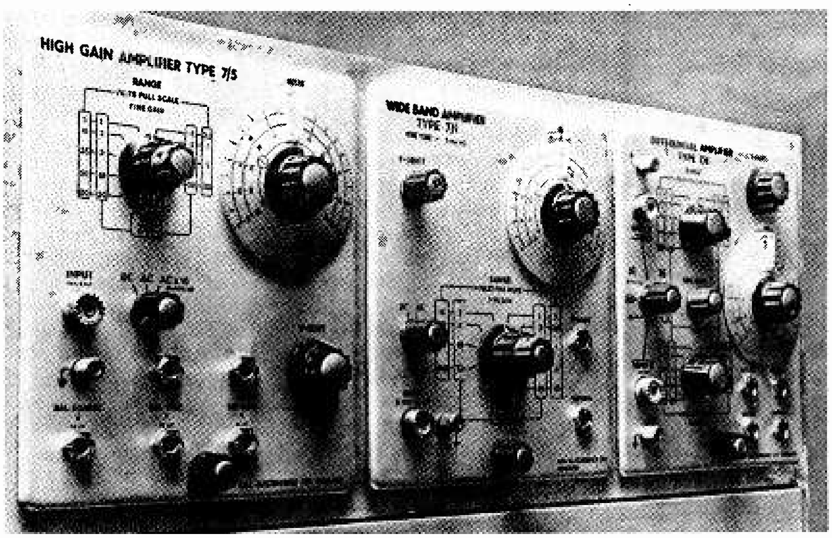
$$Rp \times Cp = Ry \times Cy + \text{Cable Capacity}$$

The capacity seen at the probe tip is therefore much less than the capacitance at the scope input and even with several feet of coax a 10:1 probe gives a capacitance of only about 12pF. Higher ratios are available giving even less capacity and are invaluable for serious work.

A passive probe has to be matched to the scope by adjustment of Cp the series trimmer, which is adjusted to give a good display on a 1kHz square wave as shown in Fig. 10. The effect of slight maladjustment may be thought to be negligible, but Fig. 10 also shows the display of a brief pulse. It can be seen that in order to keep the amplitude calibration accurate at all frequencies the probe must be carefully adjusted.

The second approach, also shown in Fig. 9, is to take the input cathode follower right up to the circuit under test. The capacitance is reduced to only a few pF and there is only a small attenuation (output = 0·85 × input; sometimes reduced to 0·5 for ease of calculations). However the input signal range is limited and attenuators have to be added to the front of the probe. One other major snag is that power has to be fed to the probe along the signal cable. The resistor RL is to terminate the cable and prevent reflections.

The cathode follower probe is most useful but tends to be expensive and easily damaged by overvoltage at the input. These two facts alone mean that most amateurs stick to passive probes which virtually never wear out, cannot be blown up, unless you try very hard, and are reasonably priced.



Three amplifiers designed for the EMI WM16 oscilloscope. The wideband unit fully utilises the full main frame bandwidth having a rise time of 5ns. The high gain amplifier has a rise time slightly worse than the wideband unit but has provision for providing 5mV/cm sensitivity at 25MHz bandwidth. The differential unit has a bandwidth of 25MHz and a common mode rejection of 50dB when correctly set up.

CALIBRATION

The calibration of the Y deflection system does not usually present a very great problem, the main difficulty being in the adoption of a standard against which the scope is to be set. Usually this standard will be the lab voltmeter if it is known to be correct within a per cent or so and is reliable.

Valve scopes should be run for an hour or more, then the power supply voltages checked and adjusted. After a further hour or so the calibration can be started. In order for non-linearity not to affect the results, signals are applied to give about 75% max. deflection. For example, with the attenuator set to the 5V/cm position (Y shift range 25V) a DC signal of 20V would be used.

The first step is to set the input levels to the main frame amplifier. First a meter is connected between the two balanced inputs and the Y shift adjusted to give zero voltage between them. The drive amplifier balance control (centreing) is then adjusted to centre the trace (timebase free running) on the central graticule line. Then the voltage difference (produced by Y shift control) to deflect, say, 2cm is noted. The gain preset (main frame) is adjusted to bring the sensitivity to the value quoted in the manual (usually 0·1 to 0·5V for 1cm deflection).

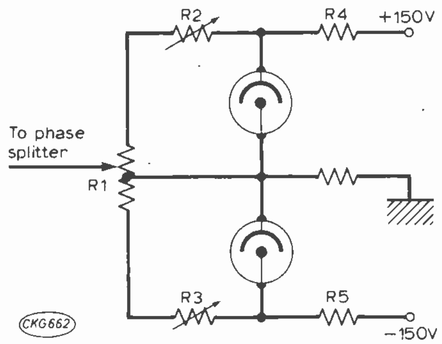


Fig. 11. Circuit for calibrating Y deflection system.

The attention can now be turned to the plug-ins. The first step here is to calibrate the Y shift if necessary. The calibrated shift is set to 0V and the trace centred by the Y shift. A DC input is applied and the calibrated shift adjusted to again centre the trace. The reading on the dial is noted and compared with the applied voltage. Fig. 11 shows the general arrangement of the calibrated shift. The mechanical centre (0V) of the calibrated shift R1 is set so that the resistance between slider and centre tap is zero when the scale indicates 0V. R2 is used to calibrate the negative half of the rotation and R3 is used to calibrate the positive half of the rotation.

When the calibration shift has been set the fine gain control (if fitted) is turned to maximum and the preset gain (usually the phase splitter cathode resistor) is adjusted for the required volts/cm from a DC input producing three-quarters of full deflection. The calibration can be checked by noting the rotation of the calibrated shift for a certain deflection both in a positive and negative direction. It should be noted that the calibrated shift once set is accurate regardless of the settings of the preset gains or the main frame gain.

To be continued

ON THE AIR

BROADCAST BANDS

SHORT WAVE DX
by MALCOLM CONNAH

WITH such a large number of reports this time I think I should start straight away with the contribution from **Ian L. Wadman** of Didcot in Berkshire. Ian has a new Trio 9R-59DS and a 70 foot end-foot antenna. Some concentration on 60 metres produced the following excellent results:

4770 ELWA, Liberia in English at 0615.
4832 Radio Capital, Costa Rica, Spanish at 0405.
4860 R. Maracaibo, Venezuela, Spanish at 0420.
4882 R. Commercial, Dominican Rep., music at 0530.
4900 R. Juventud, Venezuela, Spanish at 0355.
4940 R. Yarucuy, Venezuela, Spanish at 0345.
4970 R. Rumbos, Caracas in Spanish at 0455.
5030 R. Continente, Venezuela, S/off at 0500.
5035 Bangui, Cent. Afr. Rep. with music at 0545.
5050 R. Tirana, Home Service at 0340.

The **Rev. W. John Mckae** of Birkenhead has built the 3 Band SW receiver described in the December issue. This combined with a 45 foot indoor aerial and ATU produced the following:

5995 VOA, noted in English at 2130.
6045 Hilversum, Holland, English at 1045.
6065 Radio Sweden in English at 1600.
6120 Vatican Radio noted in English at 2100.
7260 Monte Carlo, S/off in English at 0845.
7310 Radio Vilnius, Lithuania S/off at 2300.
7345 R. Prague noted in English at 2200.
11815 WYFR noted in English at 2240.
15185 R. Finland in English at 1830.
21520 Radio Switzerland noted in English at 2125.

Linford Fevrier sends in our first report from the West Indies; St. Lucia to be precise; using a Pye valve domestic receiver and 100 foot long wire to hear:

6010 R. Sweden in English at 2114.
6090 R. Luxembourg in English at 0210.
9570 Swiss B.S. in English at 0905.
9635 R. Nacional de Colombia, Spanish at 1539.
11775 WINB, Red Lion, USA in English at 2130.
11855 Broadcasting Service of Saudi Arabia at 1855.
11880 Voice of Turkey in English at 2213.
11895 R. Senegal in French at 2225.
11935 R. Portugal in English at 0208.
15190 La Voix de la Revolution Congolaise at 2010.

Matthew Phillips of Halstead in Essex is only 12 years of age but this Domestic receiver is 37 years old; using a metal bed frame as an aerial the combination produced the following log:

5995 R. Australia in English at 0900.
6180 BBC, Cyprus relay at 1730.
7210 Red Cross Radio in English at 1730.
7245 Austrian Radio noted at 1030.
9005 R. Tehran, Iran at 2000.
9520 ORTF, Paris noted at 1415.
9525 AIR, Delhi in English at 2230.
9570 R. Australia noted at 1500.
9670 Adventist World Radio at 0930.
11710 Radio Kiev, USSR noted at 1930.
11730 R. Tashkent, USSR noted at 1400.
11765 R. Australia in English at 0645.
11770 BBC, Ascension Island relay at 1700.
11815 NHK, Japan in English at 0800.
11850 R. Norway in English at 0815.
11900 RSA, South Africa noted at 1900.
11970 Radio Tunis in English at 0900.
17825 RSA, South Africa noted at 1600.

Robin Hookham of Stretford, Manchester certainly managed to hook'em when he used his Codar Multiband-6 and 40 foot end-fed antenna to record:

4970 R. Rumbos in Spanish at 2345.
4980 Ecos del Torbes in Spanish at 0026.
5920 R. Kiev, Ukraine noted at 1950.
5940 R. Vilnius with Mailbag show at 0047.
6130 R. Norway with id. in English at 1900.
9545 R. Ghana, 'Africa Worldwide' at 2125.
9670 IBRA Radio with religious pgr. at 2015.
11720 R. Nacional de Brazil, English at 2312.
11805 R. Globo in Portuguese at 2008.
11860 R. Canada Int., SW Club at 2148.
11880 Voice of Turkey in English at 2203.
15130 WYFR with news at 1905.
15300 HCJB, Quito, Ecuador 'DX Partyline' at 1944.
15410 UN Radio noted at 1921.

Please remember to correct all times to GMT when sending in reports and also remember the new address.

MEDIUM WAVE DX
by CHARLES MOLLOY

HAROLD Emblem (Mirfield Yorkshire) has been listening to the Middle East on the medium waves with his Eddystone 730 communications receiver and MW loop antenna. He reports hearing Riyadh, Saudi Arabia on 587kHz; Cairo on 710kHz; Baghdad 760kHz; Tartar, Syria 782kHz; Quazvin, Iran 841kHz; Damman, Saudi Arabia 885kHz; Izmir, Turkey 926kHz; Diyabakir, Turkey 1061kHz; Sharjah, United Arab Emirates 1535kHz. Harold also reports hearing CSB81 at Santa Maria, Azores on 1570kHz at 2336hrs GMT. Stations in the Middle and Near East can be logged during the evening and after 2300hrs GMT, the time when a number of Europeans sign-off for the night. A sensitive and selective receiver together with a medium wave loop antenna is essential for this type of DXing though a few of the stronger outlets can be heard with simpler equipment. Try for Kuwait on 539kHz; Batra, Egypt on 620kHz; El Beida, Libya on 1124kHz; Tripoli, Libya on 1250kHz and Kuwait on 1345kHz.

Brendon Rooney (Glencar, Co. Sligo in Eire) has sent in an excellent log of North American reception. Using a Trio 9R59DS, a Heathkit GR78 transistor communications receiver and a medium wave loop with balanced differential amplifier, he reports hearing CBN St John's in Newfoundland on 640kHz; WOR New York City on 710kHz; WABC also in NYC on 770kHz; WCCO Minneapolis on 830kHz; WHDH Boston on 850kHz; CJON St John's on 930kHz; CBM Montreal 940kHz; CHNS Halifax, Nova Scotia on 960kHz; CBA Moncton, New Brunswick 1070kHz; WBAL Baltimore on 1090kHz; WNEW New York City on 1130kHz; WOWO Fort Wayne, Indiana 1090kHz. Although these stations were heard between 2300hrs and 0200hrs during December it is possible to hear North America on the medium waves in the UK at any time of year provided there is a path of darkness between transmitter and receiver. In June stations can be logged during the hour before sunrise. North Americans broadcast on 'channels' which are multiples of 10kHz and they are easy to identify as they use their callsigns frequently (prefix C for Canada and W or K for the US.) followed by the name of the city or town where the studios are located.

Julian Allan (Hadleigh, Suffolk) has been trying the medium waves with his Audiosonic transistor portable with internal ferrite rod aerial. He reports hearing London Broadcasting on 719kHz (417m); American Forces Network (AFN) Frankfurt on 872kHz (344m); BBC Radio Medway 1034kHz (290m); AFN Munich 1106kHz (271m); Radio Sweden 1178kHz (254·5m) in English at 2245hrs GMT; Radio Tirana, Albania 1394kHz (215·2m); Trans World Radio, Monte Carlo 1466kHz (204·6m). On the long waves Julian has heard Mainflingen, West Germany on 151kHz (1986m); Allouis, France 164kHz (1829m); Luxembourg 236kHz (1271m). Others to look for on the long waves are the Voice of America, Munich 171kHz (1734m); Azilal, Morocco 209kHz (1435m) in Arabic; Tipaza, Algeria 251kHz (1195m) normally in French but in English at 1900hrs GMT; Lahti, Finland 254kHz (1181m).

Brian Murray (Edinburgh) has been busy again with his Astrad transistor portable coupled to an old 405-line TV aerial. His log includes CSB2 Lisbon, Portugal on 1034kHz at 0020hrs; Radio Portugal 1061kHz in English at 2300hrs; Radio Denmark also on 1061kHz at 2300hrs; BBC Radio Derby on 1115kHz at 2240hrs and BBC Radio Manchester 1457kHz at 1800hrs, all times being in GMT.

VHF/FM DXING

by SIMON DAVID

LAST month I reported on the strange events in January. My Correspondent **E. W. Earnshaw** is now on his way around the world as a seagoing Radio Officer. The reported Turkish station, Radio Ankara news, has been verified by an official at the Turkish Embassy who heard the tape recording made in Newcastle. Other recordings made were of f.m. broadcasts from Russian and Polish origin followed by a Spanish station. I hope this will not deter others reporting more modest DXing achievements.

Openings of a less dramatic nature in February enabled **Roy Patrick** of Derby to pick up Hessischer Rundfunk, Frankfurt on 99MHz. He received a very quick QSL card from them.

George E. Sykes is only 50 feet above sea level at Bolton-le-Sands, Lancashire but has a clear view all round. On his AR2000, with an Aerialite 264 and Stolle rotator 15 feet above his garage, he has received local radio stations from Blackburn, Merseyside, Carlisle and Sheffield. He wonders if going upstairs means better results! An unidentified station was picked up on 102MHz, but best reception comes from local mobiles. Kirk O'Shotts, Blaenplwyf and Divis have also been picked up.

Colin Chatfield of Camborne, Cornwall has a home made 5-element Yagi feeding a P.W. design preamp and Heathkit FM4-TU tuner. He has received Radio Eirean in English and Gaelic, Radio 4 from Wenvoe and Haverfordwest, BBC radio from North Hessary Tor and ORTF from Brest 97·7MHz.

Finally, anyone in the home counties who heard a foreign station, probably East European, between 97·7 and 98MHz (above LBC) on 23rd March, please let me know. Reception on my receiver was not good enough to identify it.

Please state the date, frequency and country of origin in all reports; also your receiver and aerial type would be useful.

Station information

Among the latest information to hand are the following: Perth, BBC Radios 1/2,3 and Radio Scotland are now on 89·0, 91·2, 93·4MHz respectively; Campbeltown BBC services are similarly changed to 88·6, 90·8, 93·0MHz respectively. Listeners with preset push-button receivers will need to alter the tuning of the appropriate channels in these areas.

The IBA station BRMB Radio started broadcasting official programmes on 94·8MHz from Lichfield. VHF transmissions are said to be better here than the alternative medium wave transmissions. The aerial is directional, mounted on the 1,000ft television mast, and beamed towards Birmingham centre. Polarisation is circular to help car radio and portable radio reception.

Piccadilly Radio (IBA) went on the air on 2nd April in the Manchester Area. The transmitter situated at Saddleworth broadcasts on 97·0MHz using a circular polarised directional aerial. The next to follow will be Swansea Sound from Kilvey Hill on 95·1MHz using an omni-directional circular polarised aerial.

Full details of IBA independent radio broadcasts on v.h.f. and medium wave can be obtained by sending a stamped addressed envelope to the *Engineering Information Service, Independent Broadcasting Authority, 70 Brompton Road, London SW3 1EY*, or *Crawley Court, Winchester, Hampshire SO21 2QA*.

BBC local radio information can be obtained from *Engineering Information Dept., BBC Broadcasting House, London W1A 1AA.*

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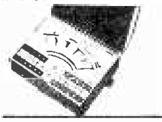

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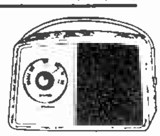

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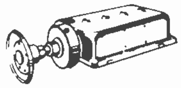

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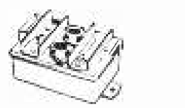

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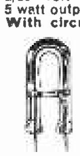

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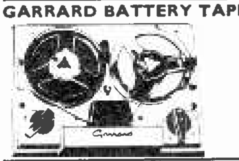

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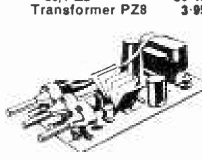

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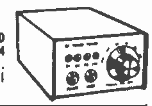

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ON THE AIR

by Eric Dowdeswell G4AR

FIRST, the bad news! Dave Gibson G3JDG, your conductor around the amateur bands for so long, reports that for personal reasons he is no longer able to produce the monthly page. Dave's reports under the heading of 'The Amateur Bands' began in October 1964 and the following month became part of the feature 'On the Short Waves'.

We owe a lot to Dave for keeping us up-to-date on amateur affairs over the years. His humorous, free-and-easy style of writing will be missed. Good luck in the future Dave and thanks a lot, keep in touch.

And now, more bad news! This page is being taken over by yours truly who will endeavour to give you at least as good a service as did JDG. How well I shall succeed remains to be seen. A lot depends upon the number and quality of the reports received so start them rolling to my QTH given below.

Reporting

A few pointers which will help all round:- letters short, reports accurate and to the point and preferably on a separate sheet of paper and above all, legible! Call signs, in particular, should be in clear block letters but I hope I have enough experience to be able to spot the odd boo-boo. I don't want to hear about those routine QSO's heard on 20m made by fellows using 400W of SSB and a multielement beam. But do tell me all about that unusual callsign, that newly activated country or exotic expedition plus the DX that is really DX when related to the band/power/distance involved.

Reports of QRP work may prove of interest as they may encourage others to try a little less power and more ingenuity and operating know-how to achieve the results they do with high power.

Break for a commercial! As ST2AR in Khartoum, Sudan from 1953 to 67 I worked nearly 300 countries, using homemade equipment and mostly wire aerials, but not one of these QSO's held the same thrill for me as did the QSO I had a couple of years ago with W1BB on Top Band with a genuine 10W input. In recent times G3XAP has worked all continents with 9W input on this band and now threatens to repeat the performance with 5W, which leaves me gasping! He does have the slippery slope of the sunspot cycle to slide down so others ought to try and emulate him while the going is good. The glow of self-satisfaction attending success has to felt to be appreciated!

GB Operations

With the proliferation of GB prefixes for use at just about any event that a club secretary cares to dream up their novelty value has decreased to zero. However, there are a couple of calls around that rise about this modern day mediocrity. In the centenary year of the birth of Marconi, GB2MT was operated from Bayswater, London from April 25 to 28 on 15, 20 and 80m SSB. The QTH was the house in which Marconi and his mother lived in 1896/7.

Another event associated with the centenary and taking place over the weekend of June 7/9 is a House Party at Stratford-Upon-Avon where guests will face a programme of films, talks and demonstrations to illustrate the progress of radio communications. GB2HF will be on the air to demonstrate how it is done. QSL's and reports to Ralph Barrett G2FQS (QTHR) or the Bureau, for both stations.

By the time this appears in print you may have heard GB2MT already on April 7 when it was located at the top of the GPO building in St. Martins-le-Grand in London from where Marconi made the first official demonstration of wireless in this country to a second station on the Embankment just half a mile away. QSL as above.

Deadlines

The deadline for your reports each month is a rather flexible feast since the date, from month to month, when the magazine "goes to bed" can vary by as much as seven days. Aim at the middle of the month but remember that every effort will be made to squeeze in material received after this time. Incidentally, I often wonder if the brief listing of future events is really of any interest. I have a sneaking feeling that anyone with sufficient enthusiasm will have already acquainted himself with the full details from other sources.

Starting off with a nil balance of readers' reports and an aversion to nicking anything from the other scribes the reports on the band conditions must wait until next month. Suffice to say that the sunspot number is dropping more or less as predicted so take the hint and keep an eye on the lower frequency bands for your reports. Cheers for now.

BROADCAST BANDS

Short Wave Reports by 15th of the month to Malcolm Connah, 27 Lismore Road, Highworth, Swindon, Wiltshire, SN6 7HU.

Medium Wave Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

VHF/FM Reports to Simon David, c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.

AMATEUR BANDS

Logs covering any amateur band/s in band/alphabetical order by the middle of the month to **Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.**

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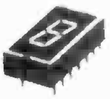

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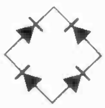

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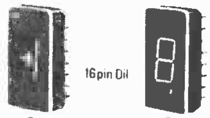

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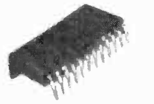

just imagine, one MOS LSI I.C. eliminating 15 MSI I.C.s and numerous other components. Either

12 or 24 hour. 4 or 6 digit
50 or 60Hz operation
leading zero supression
single voltage supply
similar to DIGITRONIC in P.W. March 1973.
Only £7·99

With 4 LED's £16·59
With 6 LED's £20·75

CHROMASONIC electronics

RESISTORS

Rating	Type	Tolerance		Range	Price Each
¼/½ watt	Carbon Film	±5%	E12 Series	5Ω to 330KΩ	1½p
½ watt	Metal Oxide Film	±2%	E12 Series	10Ω to 1MΩ	4½p
½ watt	"Cermet" Thick Film	±2%	E12 Series	56Ω to 150KΩ	8p
½ watt	Carbon Film	±5%	E24 Series	10Ω to 10MΩ	1½p
½ watt	Carbon Composition	±0 5Ω	(2·2Ω) 2·7Ω: 3 3Ω: 3·9Ω: 4·7Ω:		4½p
1 watt	Carbon Composition	±10%	(5 6Ω) 6·8Ω: 8·2Ω		5½p
1 watt	Carbon Film	±5%	E12 Series	10Ω to 10MΩ	3p
2 watt	Carbon Film	±5%	E12 Series	10Ω to 10MΩ	6p
2½ watt	Wire Wound	±10%	E12 Series	0 22Ω to 0·47Ω	10p
2½ watt	Wire Wound	±5%	E12 Series	1Ω to 270Ω	10p
5 watt	Wire Wound	±5%	~ E12 Series	0·5Ω to 8·2KΩ	10p
10 watt	Wire Wound			0·5Ω to 6·8KΩ	11p
10 watt	Wire Wound	±5%	10KΩ: 15KΩ 20KΩ:	25KΩ	17p
15 watt	Wire Wound			10Ω to 6·8KΩ	13½p

TRANSISTORS and DIODES

AC107 16p
AC126 13p
AC127 13p
AC128 13p
AC176 15p
AC187 22p
AC187K 20p
AC188 22p
AC188K 25p
ACY19 25p
ACY20 22p
AD140 49p
AD149 49p
AD161 38p
AD162 38p
AD161/2pr 75p
AF114 17p
AF115 17p
AF116 17p
AF117 17p
AF118 92p
AF124 33p
AF125 27p
AF126 27p
AF127 27p
AF139 35p
AF172 25p
AF179 71½p
AF239 41p

ASY26 33p
BC107 11p
BC108 11p
BC109 11p
BC114 15½p
BC117 22p
BC147 10p
BC148 10p
BC149 10p
BC157 13p
BC158 12p
BC159 14p
BC168B 11p
BC169 12p
BC171 20p
BC172 17½p
BC174B 35p
BC177 22p
BC178 22p
BC179 24p
BC182L 11p
BC183L 12p
BC184L 12p
BC187 27½p
BC212L 12p
BC213L 13p
BC214L 11p
BC268 15p
BC327 26½p
BC328 24½p

BCY70 17p
BCY72 17p
BCZ10 28p
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BD131 55p
BD132 66p
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BD135 42p
BD136 44p
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BD138 55p
BD139 61p
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BD203 £1·55
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BF167 24p
BF173 24p
BF177 28p
BF178 29p
BF179 33p
BF180 33p

BF181 33p
BF184 28p
BF185 25p
BF194 15p
BF195 17p
BF196 16p
BF197 16p
BF200 32p
BF200 27½p
BF244B 27p
BF262 25p
BF263 25p
BF272 £1·21
BF390 37p
BFS28 £1·01
BFW10 66p
BFW11 67p
BFW87 38p
BFX29 43p
BFX30 37½p
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MJE3055 92p
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MPF105 45p
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2N1893 52½p
2N2160 £1·54
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2N2646 55p
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2N3054 51p
2N3055 52p
2N3391A 29p
2N3566 18p
2N3638 20p
2N3702 13p
2N3703 12p
2N3704 13p
2N3705 12½p
2N3706 14p
2N3707 12p
2N3708 10p
2N3709 10p
2N3710 11p
2N3711 11p
2N3711 £1·82
2N3772 £2·75

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2N3773 £2·20
2N3819 28p
2N3823 99p
2N3903 16½p
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2N3905 23p
2N3906 25p
2N4058 13½p
2N4289 19p
2N4441 87p
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2N4443 £1·45
2N4444 £2·09
2N4871 60p
2N5129 16½p
2N5172 11p
2N5459 69p

2N5777 47p
2N6076 16½p
3N140 £1·01
3N141 89p
3N152 £1·01
3N153 89p
40360 51p
40361 50p
40362 50p
40408 55p
40430 £1·39
40432 £2·17
40673 55p
AA119 10p
AA120 10p
AA129 10p
AAZ13 11p
BA100 10p
BA102 27½p
BA110 45p
BA111 55p
BA112 99p
BA114 9p

BA115 19p
BA116 9p
BA128 11p
BA129 23p
BA143U 75p
BA143V 67p
BA144 20p
BA145 22p
BA148 22p
BA154 20p
BA155 15½p
BA156 16½p
BA182 26½p
BA220 7p
BA221 7p
BA222 7½p
BAV10 11p
BAW62 10p
BAX13 9p
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BAY38 41p
BB105 42p
BB141 99p

CAPACITORS

MULLARD C333, 629 and 630 series—Ceramic Plate. E12 series from 1·8pF to 0·002μF. **5½p.**

CERAMIC DISC—LOW VOLTAGE—0·01μF, 0·022μF, 0·047μF, **5½p**; 0·1μF, 0·22μF, **6½p.**

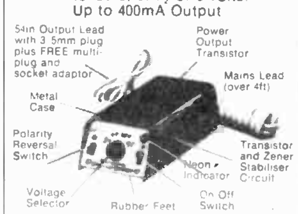
POLYSTYRENE (160V)—From 10pF to 0·01μF in multiples of 10pF; 15pF, 22pF; 33pF; 47pF and 68pF, **4½p.**

MYLAR PLATE (100V)—1000 PF, 2000pF, 5000pF, **2½p**, 0·01μF, 0·02μF, 0·04μF, 0·05μF, **3½p**; 0·068μF, 0·1μF, **5p**; 0·2μF, **6½p.**

MULLARD C280 (250V POLYESTER)—0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, **3½p**; 0·068μF, **4p**; 0·1μF, 0·15μF, **4½p**; 0·22μF, **5½p**; 0·33μF, **7p**; 0·47μF, **9p**; 0·68μF, **12p**; 1·0μF, **14½p**; 1·5μF, **22p**; 2·2μF, **26½p.**

new stabilised POWER PACK/CONVERTER

Switched 3, 6, 7½ or 9 volts.
Up to 400mA Output



Our Price £4·99 + P. & P. 16p.

Unstabilised Version of above ..	£2·99
Other Eliminators (unstabilised)*	
6 volts at up to 50mA	£1·65
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P. & P. on all models 16p

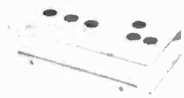
ZENERS

All 5% tolerance

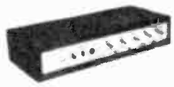
BZY88, 400mW, 3·3V to 33V	11p
1ZS, 1W, 3·3V to 100V	18p
BZX70, 2·5W, 7·5V to 75V	27p

VAT INVOICES ON REQUEST

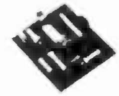
UNLESS SHOWN OTHERWISE P&P ON U.K. ORDERS IS 10p. OVERSEAS ORDERS AT COST



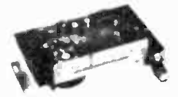
Mullard LP1186
Varactor diode tuned F.M. tuning heart £4·15, as described in P.E. May 1973. LP1185 matching I.F. strip £4·85.



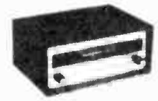
THE TEXAN
20 + 20 Watt integrated Stereo Amplifier Kit. Superb state-of-the-art design by engineers of Texas Instruments. £31·35 + P. & P. 49p.



SGS EA1000
3 watt amplifier module. Price including handbook and FREE heatsink. Our price £2·49. Quantity discounts.



A1005S
F.M. tuner chassis, fully transistorised 9 Volt positive earth operation.
Our Price £8·20.



A1018
F.M. tuner, similar to A1005S but in oiled walnut cabinet, etc.
Our Price £11·39.

A1005MS
Multiplex Stereo Decoder, fully built and aligned, to match A1005S.
Our Price £6·60.

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Audio I.C. Leaflet No. 12. FREE (only with I.C.'s—10p separately.

Pre-Amplifiers
Dual. MC1303L £1·89
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Amplifiers
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2 watt, LM380 £1·40
3 watt, SL414 £1·76
5 watt, TBA800 £1·59
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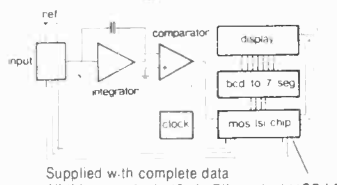
15 watt, BHA0002 £3·95
35 watt driver NE540L £1·32

NEW SL414 pin for pin = SL403D 3 watt £1·76

3½ decade DVM



- Maximum Display + or − 1 999V
- Minimum Display + or − 1mV
- Can be scaled up to read 1 999V
- Automatic Polarity Detection
- Dual Ramp Integration
- Automatic Overange Indication
- Up to 50 readings per second
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Supplied with complete data
All this on a single 16 pin DIL packed MOS LSI Integrated Circuit
A State-of-the-Art Digital Voltmeter I.C. **for only £7·79**

Coil-less Phase-Locked Loop I.C. Stereo Decoder

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Our Price £3.05

MC1312 decodes CBS. SQ. Free leaflet No. 11 gives full circuit and details.
Our Price £6·49

QUADRISONICS

Inc. all parts for decoder, inc. Veroboard, V.A.T., P. & P. (Leaflet alone 10p.)

Linears

	8pin Dip	TO99	14pin Dil
709	34p	40p	35p
710	35p	40p	39p
711		45p	39p
723		96p	95p
741	42p	45p	43p
747			92p
748	42p	45p	43p

CA3046	95p	MVR5V(L0005)	£1·65
CA3075	£1·65	MVR12V(L005)	£1·65
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LM301	£1·05	NE561B	£4·92
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MFC6040	£1·10	[illegible]	[illegible]

the component people

Dept.1.
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MULLARD block filter LP1175 as used with TAD100 now only £1·49

R.F. CHOKES, 0·1μH to 19mH. For full details ask for List No. 5. P.&P. 5p

DENCO COILS

Transistor Range: Series 1T to 5T inclusive Blue, Yellow, Red and White all **44p** each.
I.F. Transformers: IFT13, 14, 16 and 17, 55p each; IFT 15, 76p; IFT18, 73p.

Dual Purpose Range: Series 1 to 7 inc. Blue, Yellow, Red and White. 44p each.
1 to 5 Green. List No. 5 gives full details.
Ferrite Aerials: Medium and Long—state 300pF or 500pF tuning. 87p each

Tuning Gangs

Type C804
5pF 71p 50pF 77p
10pF 71p 60pF 83p
15pF 71p 75pF 83p
20pF 77p 100pF 85p
25pF 71p

Type 0
365pF 83p
365 + 365pF 99p

Type 00
208 + 176pF with screen and trimmers 99p

P & P all types 10p

NEW FERRANTI RANGE

ZN414
The Radio I.C. in a TO18 can. Supplied with our data leaflet No. 10. Giving circuits and component information. (Leaflet alone 10p.)
Our Price £1.32

BFS59	15p	ZTX302	17p	ZTX450	17p	ZS121	10p	ZS272	18p
BFS60	20p	ZTX303	14p	ZTX451	17p	ZS122	13p	ZS274	19p
BFS61	20p	ZTX304	21p	ZTX500	12p	ZS123	16p	ZS276	26p
BFS96	15p	ZTX310	9p	ZTX501	13p	ZS124	18p	ZS278	37p
BFS97	23p	ZTX311	10p	ZTX502	17p	ZS140	25p		
BFS98	20p	ZTX312	10p	ZTX503	14p	ZS141	43p	KSO30A	
		ZTX313	11p	ZTX504	43p	ZS142	33p	Zener	
ZTX107	10p	ZTX314	13p	ZTX510	17p	ZS170	10p	Series	
ZTX108	10p	ZTX320	31p	ZTX530	21p	ZS171	13p	as	
ZTX109	15p	ZTX330	15p	ZTX531	22p	ZS172	16p	BZY88	
ZTX212	14p	ZTX331	16p	ZTX550	17p	ZS174	17p	Series	
ZTX213	14p	ZTX341	22p	ZTX551	17p	ZS176	23p	11p	
ZTX214	15p	ZTX382	13p			ZS178	38p	each.	
ZTX300	12p	ZTX383	15p	DIODES		ZS270	11p		
ZTX301	13p	ZTX384	18p	ZS120	8p	ZS271	16p		

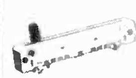
ELECTROLYTICS

μF	4V	6·3V	10V	16V	25V	40V	63V	100V	160V	450V
1							6½p		8½p	15p
1·5							6½p			
2·2							6½p		8½p	
3·3							6½p			
4·7							6½p		8½p	17p (4μF)
6·8						6½p	6½p	8½p		
8										21p
10					6½p		6½p	8½p		
15				6½p		6½p	6½p			24p (16μF)
22			6½p		6½p		6½p	11p		
33		6½p		6½p		6½p				33p (32μF)
47	6½p		6½p	6½p	6½p	6½p	8p			25p (50μF) (350V)
68		6½p		6½p			11p			
100	6½p		6½p		6½p	8p	14p	25p		
150		6½p		6½p	8p	11p.	14p			
220	6½p		6½p	8p	11p	14p	19p	31p		
330	6½p		8p	11p			25p	44p		
470		8p	11p		14p	20p	26p	47p		
680		10p		14p	20p	25p		59p		
1000	13p		14p	19p	22p	25p	44p	79p		
1500		18p	19p	25p						
2200		18p	24p		39p	44p	79p	149p		
3300		26p								
4700	25p			44p	68p	79p	149p	252p		
6800				75p						

Potentiometers

5kΩ 250kΩ
10kΩ 500kΩ
25kΩ 1MΩ
50kΩ 2MΩ
100kΩ

Log or lin less switch (and 1kΩ lin) 13p
Log or lin with switch 26p
Dual less switch 44p
Dual with switch 10kΩ, 100kΩ and 1MΩ, log only 57p



10kΩ, 25kΩ, 50kΩ, 100kΩ — Single 40p, Dual 60p

New Silver and Black Knob 16½p

Presets

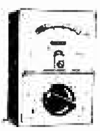
Vertical or Horizontal
0·1 watt 6½p 0·25 watt 7½p
100Ω 1kΩ 10kΩ 100kΩ 1MΩ
250Ω 2·5kΩ 25kΩ 250kΩ 2·5MΩ
500Ω 5kΩ 50kΩ 500kΩ 5MΩ
Cermet Type to 1MΩ only **41p**

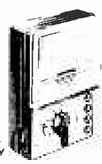
VDR's & Thermistors

A15B	98p	GL23	£1·21
CZ1	16½p	R53	£1·49
CZ4	18p	R54	£1·61
CZ13A	18p	VA1005	16p
CZ19	18p	VA1026	16p
E298CD A258	13p	VA1033	16p
E298ED A258	13p	VA1034	16p
E298ED A260	13p	VA1039	16p
E298ED A262	13p	VA1040	16p
E298ED A265	13p	VA1053	16p
E298ED P268	13p	VA1055S	16p
E298ZZ 05	13p	VA1056S	16p
E298ZZ 06	13p	VA1066S	17p
E299DD P336	14p	VA1067S	19p
E299DD P338	14p	VA1077	19p
E299DD P342	14P	VA1098	21p
E299DD P348	14p	VA1104	31p
GL16	£1·21	VA1107	29p

Other types obtainable upon application

LASKYS

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multi meter. Ranges: – 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/ 100mA. Resistence. 0/150k ohms. Decibels. –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £2.95 P&P 15p

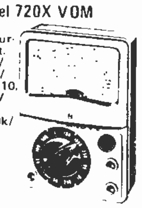
AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/ 300/1200V AC, (2500 opv). 0-6/30/ 300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm
OUR PRICE £3.50 P&P 15p

MODEL C1092 MULTIMETER

Features 5,000 opv jewel movement and a good selection of range functions. Edgwise ohms adjustment. Ranges. – 0–3/15/150/ 300/1,200V AC (2,500 opv). 0–6/30/300/600 V DC (5,000 opv). DC current 0 300uA/ 300mA. Resistence: R x 10, R x 1,000. –10 to +16dB Complete with battery, test leads and data booklet Size: 120 x 73 x 28mm
OUR PRICE £3.75 P&P 35p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/ 50/150/1000V DC. 0/10/ 50/250/1000V AC. 0/ 50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.
OUR PRICE £5.95 P&P 15p

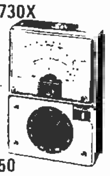
HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/ 5/25/100/500/ 1000V DC. 0/10. 50/250/1000V AC. 0–50uA/ 250mA. 0–20k/ 2 Megohms.
OUR PRICE £5.97 P&P 20p

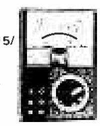
MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 6 3/12/30/120/ 600V DC. 3/30/ 120, 600V DC 50/600µA 60· 600mA. 10/100K 1 Meg/10 Meg Ohm. 20 to 46 dB.
OUR PRICE £6.97 P&P 15p

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/ 500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/ 0.5/5/50/500mA DC. Resistance: 5/ 50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.00 P&P 20p

MODEL HIOKI 730X

30,000 opv. Overload protection. 3 30 60 300 600 1200V DC, 12 60 120 600 1200V AC. 60 µA 30mA 300mA 2K 200K 2 Meg Ohm 10 to 63 dB.
OUR PRICE £7.50 P&P 15p

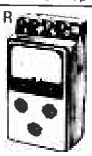
MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/ 60/300/1200V DC 0/6/30/120/600/ 1200V AC. 0/30uA/ 6mA/60mA/300mA/ 600mA. 0/8k/80k/ 800k/8 Meg ohms. –20 to +63dB.
OUR PRICE £7:50 P&P 15p

U4324 MULTIMETER

High sensitivity, over load protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/ 60/120/600/1200V DC. 3/6/15/60/150/ 300/600/900V AC. Current: 0.06/0.6/ 6/60/600mA/3A DC. 0.3/3/30/300mA/ 3A AC. Resistence 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £8.00 P&P 20p

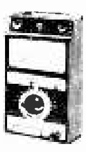
TMK MODEL TW50K

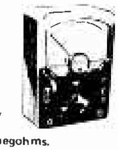
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/ 0.25/1.25/2.5/5/10/ 25/50/125/250/ 500/1000. AC Volts 1.5/3/5/10/25/50/ 125/250/500/ 1000. DC current 25/50uA/2.5/5/25/ 50/250/500mA/5/ 10A. Resistence: 10k/100k/1 Meg/ 10 Meg ohms. –20 to +81.5dB.
OUR PRICE £8.50 P&P 17p

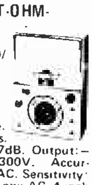
U435 MULTIMETER

20,000opv. Overload protected. Ranges. 75mV/2.5/10/25/ 100/250/500/1000V DC. 2.5/10/25/100/ 250/500/1000V AC. Current: 50uA/1/5/ 25/100mA/0.5/2.5A DC. 5/25/100mA/ 0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 20p

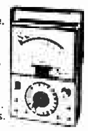
U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £10.50 P&P 20p

U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/ 60/150/300/600/ 900V DC & 75mV. 0/0.3/1.5/7.5/30/ 60/150/300/600/ 900V AC. 0/300uA/ 1.5/6/15/150/60/ 600mA/1/1.5/6A DC. 0/1.5/6/15/ 60/150/600mA/ 1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £9.75 P&P 25p

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/ 100/250/500/ 1000V DC. 0/2.5/10/25/100/ 250/500/1000V AC. 0/50uA/5/50/ 500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Carr. paid
Leather case for above £1.75

HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges. 0–0.3/0.6/ 1.5/3/6/12/30/60/150/ 300/600/1,200V DC. 0–3/6/15/30/60/120/ 300/600/1,200V AC. Current: 0–30/60uA/ 1.5/3/15/30/150/300 mA/6/12A. Resistence. 0–3/300k/3/30Mohms. Decibels. –10 to +17dB. Output:– 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC 4 inch meter. Built in protection. Size 57 x 102 x 153mm
OUR PRICE £11.95 P&P 40p

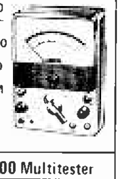
HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/ 12/30/60/120/300/ 600/1200V DC. 1.5/3/6/12/30/60/150/ 300/600/1200V AC. 15/30uA/3/6/30/60/ 150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.
OUR PRICE £14.95 P&P20p

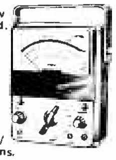
Model HT100B4 MULTIMETER

Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/ 1 /50/250/500/1,000 Volts DC. 2.5/10/50/ 250/1,000 Volts AC. DC resistence: 0–20/ 200k/2/20 Meg ohms. DC current.– 10/250uA/2.5/25/250 mA/10A. AC current:–0–10A. –20 to +62dB: Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
OUR PRICE £15.00 P&P 40p

MODEL AS.1000 VOM

100,000 opv. Mirror scale. Built-in meter protection 0 3 12 60 120 300 600 1200V DC. 0 6 30 120 300 600V AC. 0 10µA 6 60 300mA. 12 Amp 0 2K 200K 2M 200 Meg Ohm 20 to 17 dB
OUR PRICE £17.50 P&P 20p.

KAMODEN HM720B FET VOM

Input impedence 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/ 1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £21.00 P&P 30p

KAMODEN 72,200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3 3/30/120/600/ 1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/ 1.2mA/120mA/ 600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/ 2 Meg/200 Megohms.
OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/ 0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/ 500/1000V AC. Current: 50uA/0.5/ 1/5/10/50/250mA/1/5A DC. 0.25/ 0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/ 30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £15.00 P&P 20p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length. 165mm. 0/300/750uA/ 1.5/3/7.5/15/ 30/75/150/300/ 750mA/1.5/3/ 7.5A DC. 0/3/ 7.5/15/30/75/ 150/300/750mA/ 1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/ 30/75/150/300/750V DC. 0/750mV/ 1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
OUR PRICE £49.00 P&P 50p

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/ 0.03/0.1/0.3/ 1/3/11/30/100/ 300V RMS. 5cps–1.2MHz. –40 to +50dB

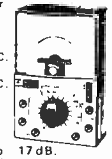
supplied complete with leads and instructions.
OUR PRICE £17.50 P&P 25p

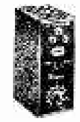
TE65 VALVE VOLTMETER

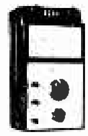
28 ranges. DC volts 1.5–1500V. AC volts 1 5–1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.
OUR PRICE £17.50 P&P 30p
Additional probes available: RF £2.12, HV £2.50

LB3 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.
OUR PRICE £3.95 P&P 20p

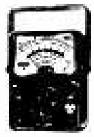
MODEL AF.105 VOM

50,000 opv Mirror scale. Meter protection. 0 3 3/12 60 120 300 600 1200V DC. 0 6 30 120 300/600 1200V DC. 0 30µA/6 60 300 mA 12 Amp 0 10K 1m/10m 100 Meg Ohms. 20 to 17 dB.
OUR PRICE £12.50 P&P 20p.

LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/ 30/60/150/300/900V DC. 1.5/7.5/30/150/ 300/750V AC. Current: 0.06/0.6/ 6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/ 0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £10.50 P&P 20p

KAMODEN HMG500 insulation resistance tester

Range 0–1,000 Megohms, 500V. Battery operated. Wide range clear meter 4"x 4¾". Complete with deluxe carrying case, batteries and instructions.
OUR PRICE £19.95 P&P 30p

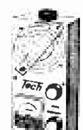
S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/ 0.6/3/12/30/120/ 600V DC. 0/6/30/ 120/600V AC. 0/12/600uA/12/ 300mA/6/12A DC 0/10k/1 Meg/ 100 Meg. –20 to +50dB. 0.01–0.2 MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £15.95 P&P 25p

CI5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.
OUR PRICE £39.00 Carr. paid

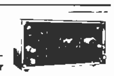
RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.
OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.
OUR PRICE £19.95 P&P 20p

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.
OUR PRICE £4.25 P&P 25p

AT201 Decade ATTENUATOR

Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.
OUR PRICE £12.50 P&P 37p

Also see following pages

ALL PRICES EXCLUDE VAT

LASKYS

HIGH QUALITY CONSTRUCTION KITS

JOSTY KIT

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£4.80
AF25 Mixer	£3.60
AF30 Mono pre amplifier	£2.61
AF35 Emitter amplifier	£2.27
AF80 0.5W mic. amplifier	£4.22
AF305 Intercom	£9.52
AF310 Mono amplifier	£5.91
AT5 Automatic light control	£2.58
AT25 Window wiper robot	£5.82
AT30 Photo cell switch unit	£5.70
AT50 400W triac light dimmer/speed control	£4.80
AT56 2,200W triac light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
GP304 Circuit board	£4.94
GP310 Stereo pre amplifier for use with 2 x AF310	£21.27
GP312 Circuit board	£11.45
GU330 Tremolo unit	£7.50
HF61 Diode detector	£3.32
HF65 FM transmitter	£2.70
HF75 FM receiver	£2.87
HF310 FM tuner	£15.81
HF325 Deluxe FM tuner	£24.12
HF330 Decoder (HF310/325)	£9.96
HF380 lw/vhf aerial amplifier	£4.94
HF395 broadband aerial amp.	£1.77
LF380 Quadraphonic device	£11.36
M160 Multi-vibrator	£1.71
M191 VU Meter	£4.55
M192 Stereo balance meter	£4.97
M1302 Transistor tester	£8.45
NT10 Stabilised power supply 100mA, 9V	£6.15
NT300 Stabilised p. supply	£12.51
NT305 Voltage converter	£4.50
NT315 Power supply 240V AC to 4.5/15V DC, 500mA	£9.57

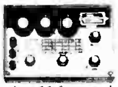
Amateur Electronics by Josty Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10.

OUR PRICE £3.30 (No VAT) P&P 25p plus VAT.

AE1 100mW output stage	£1.50
AE2 Pre-amplifier	£1.15
AE3 Diode receiver	£1.82
AE4 Flasher	99p
AE5 Astable multi-vibrator	95p
AE6 Monostable multi-vibrator	93p
AE7 RC generator	97p
AE8 Bass filter	90p
AE9 Treble filter	90p
AE10 CCIR filter	90p

Also see previous page

TRANSISTORISED L.C.R. A.C BR/8 MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Resistance 6 ranges 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7⅞" x 5" x 2" **OUR PRICE £25.00** P&P 25p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads. **OUR PRICE £8.97** P&P 25p

MODEL TE20 RF SIGNAL GENERATOR

Six bands. 120kHz—260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements 105—125V, 220—240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc. **OUR PRICE £17.50** P&P 40p

TE-200 RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions. Size 140mm x 215mm x 170mm **OUR PRICE £17.50** P&P 30p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/ Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads. **OUR PRICE £29.95** P&P 50p

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave 19—100,000 Hz Square Wave Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm. Operation 220/240v. A.C. **OUR PRICE £19.95** P&P 37p

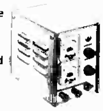
MCA220 Automatic Voltage Stabiliser

Input 88—125V AC or 176—250V AC. Output 120V AC or 240V AC. 200V/A rating. P&P 50p **OUR PRICE £11.97**

PS1008 Regulated POWER SUPPLY UNIT

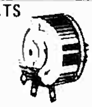
Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm. **OUR PRICE £11.97** P&P 25p

PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5—20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm. **OUR PRICE £19.95** P&P 25p

POWER RHEOSTATS



High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/250/500/1000/2500 Ohms **£1.15** P&P 10p

50 WATT 10/25/50/100/250/500/1000/2500/5000 Ohms. **£1.62** P&P 10p

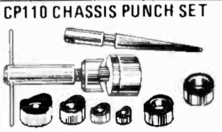
100 WATT 1/5/10/25/50/100/250/500/1000/2500 Ohms **£2.34** P&P 15p

AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

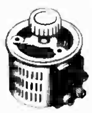
80 WATTS	£2.75	P&P 18p
150 WATTS	£3.50	P&P 18p
300 WATTS	£4.50	P&P 23p
500 WATTS	£6.95	P&P 33p
1000 WATTS	£9.50	P&P 38p
1500 WATTS	£12.50	P&P 43p
2250 WATTS	£20.95	P&P 50p
5000 WATTS	£44.95	P&P £1

CP110 CHASSIS PUNCH SET



Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories. **OUR PRICE £3.00** P&P 40p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS



Excellent quality at low cost. Input: 230V 50/60Hz. Output 0—260V.

MODEL S260 BENCH MOUNTING

		P&P
1A	£10.50	30p
2.5A	£12.00	35p
5A	£17.50	37p
8A	£30.35	50p
10A	£33.75	75p
12A	£29.50	75p
20A	£85.00	125p
25A	£95.00	130p
40A	£120.00	150p

MODEL S260B PANEL MOUNTING

1A	£10.00	30p
2.5A	£12.00	35p

240° Wide Angle 1mA METERS

MW 1—6 60x60mm **£6.50** P&P 15p

MW 1—8 80x80mm **£6.90** P&P 15p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0—180 degrees. Blank scales 1—5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft **OUR PRICE £1.62** P&P 15p

WALKIE TALKIES

SKYFON 100mW **OUR PRICE £24.95 per pair**

P302 Two Channel 300mW **OUR PRICE £52.50 per pair**

P1003 Three Channel 1 Watt **OUR PRICE £71.25 per pair**

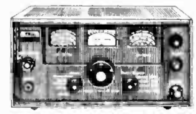
P&P 50p per pair

NB. Licence required for use in UK

RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380—7000Hz. Size app. 6" x 6". Weather and shock protected. **OUR PRICE £4.97** P&P 30p

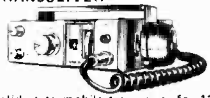
TRIO 9R59DS RECEIVER



Four bands covering 550kHz to 30 MHz continuous and electrical band-spread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB—CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

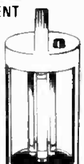
Our Price £42.50 CARR. PAID

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 150 x 70 x 220mm. **OUR PRICE £75.00** P&P 50p

HITACHI FLUORESCENT LANTERN L1901



A portable battery operated lantern ideal for home, motoring, camping etc. Approx 10" tall. Provides brilliant light from 9 1.5v batteries (not supplied) **OUR PRICE £7.90** P&P 25p

DT55G DIGITAL CLOCK MECHANISM

Features 24 hour alarm setting, on/off and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V—3 Amp. **OUR PRICE £5.95** P&P 30p

KE630 3 Station INTERCOM

Master and two sub stations. Can be used on desk or wall mounted. Complete with cable and batteries **OUR PRICE £5.25** P&P 50p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20—20,000Hz. Complete with 6' lead and plug. **OUR PRICE £1.97** P&P 30p

TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200—4,000Hz. **OUR PRICE £2.25** P&P 30p

OH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20—12,000Hz. Complete with lead and plug. **OUR PRICE £2.50** P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz—18kHz. Complete with cable and stereo jack plug. **OUR PRICE £2.60** P&P 30p

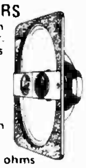
SH8DV MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz—18kHz. Complete with 10ft. coiled lead and jack plug. **OUR PRICE £4.97** P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms. **OUR PRICE £5.95** P&P 30p

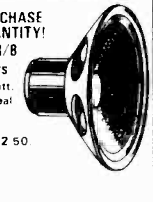
EMI LOUDSPEAKERS



Model 350 13 x 8" with single tweeter/crossover. 20—20,000Hz. 15 watts RMS. Available 8 or 15 ohms. **OUR PRICE £7.50** each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55—13,000Hz. 8 watts RMS. Available 8 or 15 ohms **OUR PRICE £3.62** each P&P 25p

SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers

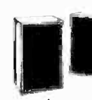


8 ohms 30 watt. Heavy duty, ideal for Hi Fi P.A. Group. OUR PRICE £12.50 P&P 50p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead. **OUR PRICE £12.95** P&P 50p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS



High quality 2 way speaker systems. 25 Watts. 4—8 ohms. 40Hz—18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts. **OUR PRICE £26.95** PR. P&P £1

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm. 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88—108MHz. Ready built, ready for use. Fantastic value for money. **OUR PRICE £5.95** P&P 20p

Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88—108MHz. Powered by 9V battery. **OUR PRICE £13.50** P&P 30p Stereo multiplex adapter £5.95 extra.

ALL PRICES EXCLUDE VAT

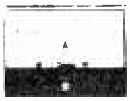
SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

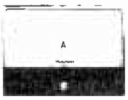
*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



50uA	£3 80		
100uA	£3 75		
200uA	£3 70		
500uA	£3 65		
50-0-50uA	£3 75		
100-0-100uA	£3 70		
1mA	£3 65		
5mA	£3.65		
10mA	£3.65		
50mA	£3.65	10V DC	£3 65
100mA	£3.65	20V DC	£3 65
500mA	£3 65	50V DC	£3 65
1A DC	£3.65	300V DC	£3 65
5A DC	£3.65	15V AC	£3 75
10A DC	£3.65	300V AC	£3 75
5V DC	£3.65	VU Meter	£3 90

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

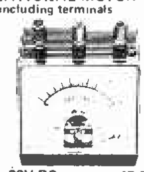


50uA	£4 60		
100uA	£4 50		
500uA	£4 30		
50-0-50uA	£4 50		
100-0-100uA	£4 45		
1mA	£4 30		
1A DC	£4 30		
5A DC	£4 30		
20V DC	£4 30	150V AC	£4 45
50V DC	£4 30	300V AC	£4 45
300V DC	£4.30	VU Meter	£4 90

EDGWISE MODEL PE70
Size: 90 x 34mm

50uA	£4.15
100uA	£4 10
200uA	£4 05
500uA	£3 90
50-0-50uA	£4 10
100-0-100uA	£4 05
1mA	£3 85
300V AC	£3 95
VU Meter	£4 30

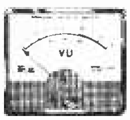
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals



A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

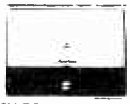
50uA	£8 50		
100uA	£7 90		
50-0-50uA	£7 90		
1mA	£7.60	20V DC	£7 60
1-0-1mA	£7.60	50V DC	£7 60
1A DC	£7 60	300V DC	£7 60
5A DC	£7 60	500mA/5A DC	£8.60
5V DC	£7.60	5V/50V DC	£8.60
10V DC	£7 60	5V/15V DC	£8 60
15V DC	£7 60	1/5A DC	£8.60
		1A/15A DC	£8 60

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm



50uA	£5 45		
100uA	£5 40		
200uA	£5.35		
500uA	£5 25		
50-0-50uA	£5.40		
100-0-100uA	£5 35		
500-0-500uA	£5.20		
1mA	£5 20		
1-0-1mA	£5 20		
5mA	£5.20		
10mA	£5.20		
50mA	£5 20		
100mA	£5 20	300V DC	£5 20
500mA	£5 20	15V AC	£5 30
1A DC	£5.20	300V AC	£5 30
5A DC	£5.20	S Meter 1mA	£5 20
15A DC	£5 20	VU Meter	£5 55
30A DC	£5.40	1A AC	* £5 20
10V DC	£5.20	5A AC	* £5 20
20V DC	£5 20	10A AC	* £5 20
50V DC	£5.20	20A AC	* £5 20
150V DC	£5.20	30A AC	* £5 20

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



50uA	£4 30		
100uA	£4 25		
200uA	£4 20		
500uA	£4 15		
50-0-50uA	£4 25		
100-0-100uA	£4 20		
1mA	£4 10		
5mA	£4 10		
10mA	£4 10		
50mA	£4 10	10V DC	£4 10
100mA	£4 10	20V DC	£4 10
500mA	£4 10	50V DC	£4 10
1A DC	£4 10	300V DC	£4 10
5A DC	£4 10	15V AC	£4 20
10A DC	£4 10	300V AC	£4 20
5V DC	£4 10	VU Meter	£4 40

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm

50uA	£3 20		
100uA	£3 15		
200uA	£3 10		
500uA	£3 00		
50-0-50uA	£3 15		
100-0-100uA	£3 10		
500-0-500uA	£2 95		
1mA	£2 95		
5mA	£2 95		
10mA	£2 95		
50mA	£2 95		
100mA	£2 95		
500mA	£2 95	300V AC	£3 05
1A DC	£2 95	S Meter 1mA	£2 95
5A DC	£2 95	VU Meter	£3 40
10V DC	£2 95	1A AC	* £2 95
20V DC	£2 95	5A AC	* £2 95
50V DC	£2 95	10A AC	* £2 95
300V DC	£2 95	20A AC	* £2 95
15V AC	£3 05	30A AC	* £2 95

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm

50uA	£3 10		
100uA	£3 05		
200uA	£3 00		
500uA	£2 85		
50-0-50uA	£3 05		
100-0-100uA	£3 00		
500-0-500uA	£2 80		
1mA	£2 80		
1-0-1mA	£2 80		
2mA	£2 80		
5mA	£2 80		
10mA	£2 80		
20mA	£2 80		
50mA	£2 80	20V DC	£2 80
100mA	£2 80	50V DC	£2 80
150mA	£2 80	100V DC	£2 80
200mA	£2 80	150V DC	£2 80
300mA	£2 80	300V DC	£2 85
500mA	£2 80	500V DC	£2 85
750mA	£2 80	750V DC	£2 90
1A DC	£2 80	15V AC	£2 90
2A DC	£2 80	50V AC	£2 90
5A DC	£2 80	150V AC	£2 90
10A DC	£2.80	300V AC	£2 90
3V DC	£2 80	500V AC	£3 00
10V DC	£2 80	S Meter 1mA	£2 80
15V DC	£2 80	VU Meter	£3.20

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm

50uA	£3 50		
100uA	£3 45		
200uA	£3 40		
500uA	£3 35		
50-0-50uA	£3 45		
100-0-100uA	£3 40		
1mA	£3 30		
5mA	£3 30		
10mA	£3 30		
50mA	£3 30	10V DC	£3 30
100mA	£3 30	20V DC	£3.30
500mA	£3 30	50V DC	£3 30
1A DC	£3 30	300V DC	£3 30
5A DC	£3'30	15V AC	£3 45
10A DC	£3 30	300V AC	£3 45
5V DC	£3 30	VU Meter	£3 65

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

50uA	£3 95		
100uA	£3 85		
200uA	£3 80		
500uA	£3 75		
50-0-50uA	£3 85		
100-0-100uA	£3 80		
500-0-500uA	£3 70		
1mA	£3 70		
1-0-1mA	£3.70		
5mA	£3 70		
10mA	£3 70	300V DC	£3 70
50mA	£3 70	15V AC	£3 80
100mA	£3 70	50V AC	£3 80
500mA	£3 70	150V AC	£3 80
1A DC	£3 70	300V AC	£3 90
5A DC	£3 70	500V AC	£3 80
10A DC	£3 70	S Meter 1mA	£4 10
15A DC	£3 70	VU Meter	£3 70
20A DC	£3 80	1A AC	* £3 70
30A DC	£3 85	5A AC	* £3.70
50A DC	£4.05	10A AC	* £3 70
5V DC	£3 70	20A AC	* £3 70
10V DC	£3 70	30A AC	* £3 70
15V DC	£3.70	50mA AC	* £3 70
20V DC	£3 70	100mA AC	* £3 70
50V DC	£3 70	200mA AC	* £3.70
150V DC	£3 70	500mA AC	* £3.70

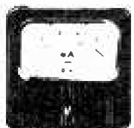
BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£4 50
100uA	£4 45
500uA	£4 20
50-0-50uA	£4 45
100-0-100uA	£4 40
1mA	£4 20
1A DC	£4 20
5A DC	£4 20
20V DC	£4 20
50V DC	£4 20
300V DC	£4 20
300V AC	£4 30
VU Meter	£4 70

CLEAR PLASTIC MODEL MR 52P
Size 60 x 60mm

50uA	£3 70		
100uA	£3 50		
500uA	£3 35		
50-0-50uA	£3 50		
100-0-100uA	£3 45		
1mA	£3 30		
5mA	£3 30		
10mA	£3 30		
50mA	£3 30		
100mA	£3 30		
500mA	£3 30		
1A DC	£3 30		
5A DC	£3.30	S Meter 1mA	£3 30
10V DC	£3 30	VU Meter	£3 80
20V DC	£3 30	1A AC	* £3.30
50V DC	£3 30	5A AC	* £3.30
300V DC	£3 30	10A AC	* £3 30
15V AC	£3 40	20A AC	* £3.30
300V AC	£3 40	30A AC	* £3.30

BAKELITE MODEL MR 65 Size: 80 x 80mm



25uA	£5 25		
50uA	£4 00		
100uA	£3 95		
500uA	£3 65		
50-0-50uA	£3 95		
100-0-100uA	£3 90		
500-0-500uA	£3 60		
1mA	£3.60		
1-0-1mA	£3 60		
5mA	£3 60		
10mA	£3 60		
50mA	£3 60	300V DC	£3 60
100mA	£3 60	30V AC	* £3 60
500mA	£3 60	50V AC	* £3 60
1A DC	£3 60	150V AC	* £3.60
2A DC	£3 60	300V AC	* £3 60
5A DC	£3 60	500V AC	* £3 60
10A DC	£3 60	VU Meter	£4.10
15A DC	£3 60	1A AC	* £3 60
30A DC	£3 60	5A AC	* £3.60
50A DC	£3 80	10A AC	* £3 60
5V DC	£3 60	20A AC	* £3 60
10V DC	£3 60	30A AC	* £3.60
15V DC	£3.60	50A AC	* £3.60
20V DC	£3.60	500mA AC	* £3.60
50V DC	£3.60	50mV DC	£3.75
150V DC	£3 60	100mV DC	£3 75

SINCLAIR Project 80 Modules

Z40 Power Amplifier	£5.45
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Stereo 80 Pre-Amplifier	£11.95
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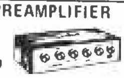
PZ8 Power Supply	£7.98
Transformer for PZ8	£4.05

SINCLAIR Project 80 Packages

2 x Z40/Stereo 80/PZ5	£25.00
2 x Z40/Stereo 80/PZ6	£27.75
2 x Z60/Stereo 80/PZ8	£30.45

POST & PACKING 35p each.

MP7 MIXER-PREAMPLIFIER



5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

ALL PRICES EXCLUDE VAT

1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1 57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

AUDIOTRONIC CrO2 CASSETTES

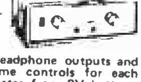
TYPE	5	10	25
CR60	£3.92	£7.72	£19.12
CR90	£5.32	£10.46	£25.22

AUDIOTRONIC 8 TRACK CARTRIDGES

TYPE	Each	5	10
40M	85p	£4.00	£7.50
80M	£1.15	£5.40	£10.25

P&P Cassettes 3p, Cartridges 5p each OVER 10 of either POST FREE!

AUDIOTRONIC AHA101 Stereo Headphone Amplifier



All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 20p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beau-walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 20p

EUROPE'S LEADING HI-FI RETAILERS

We've the world's finest high fidelity equipment for you to choose from, and expert staff who will be pleased to help and advise on your particular requirements. Amplifiers, tuners and receivers – record decks, tape and cassette equipment, loudspeakers, complete stereo systems, quadraphonic units and systems, in-car equipment, television – the choice is yours from our extensive stocks, and you'll find that Laskys prices are the most competitive anywhere in the country.

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34 LISLE ST. WC2	01-437 9155
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193 EDGWARE RD. W2	01-723 6211
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382 EDGWARE RD. W2	01-723 4194
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152/3 FLEET ST. EC4	01-353 2833

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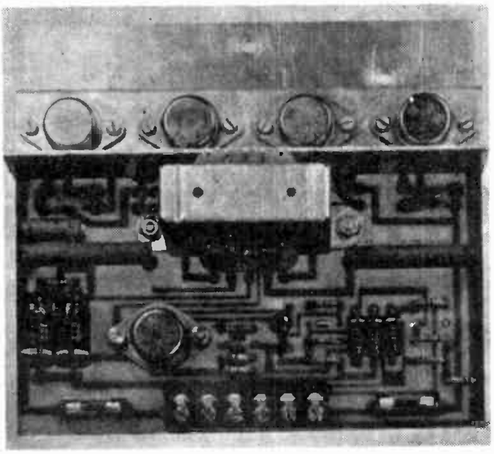

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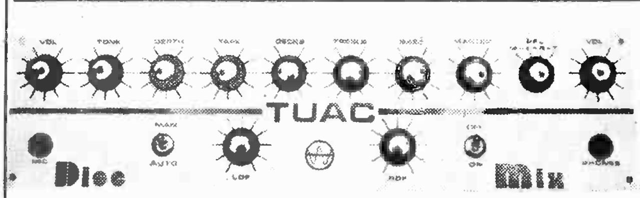

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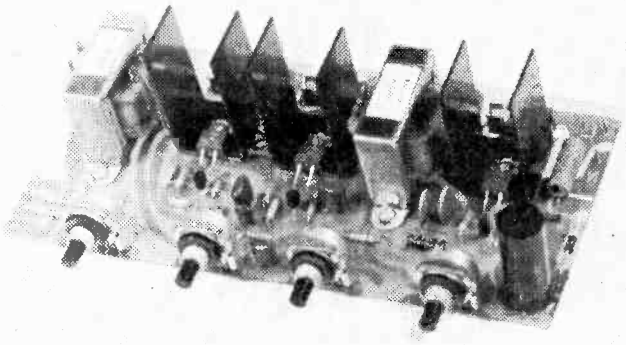

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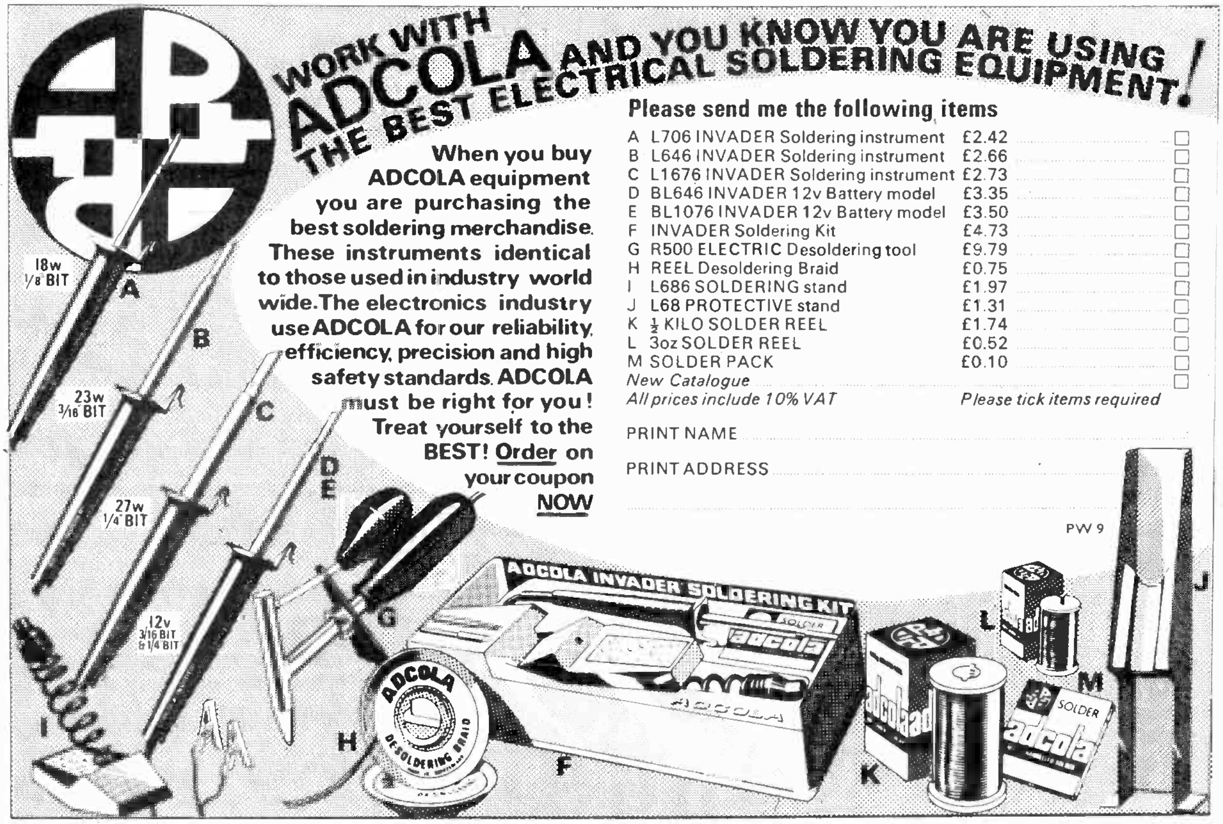

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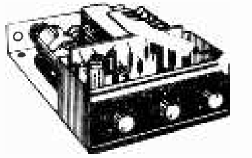

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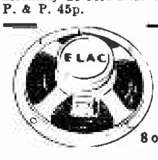

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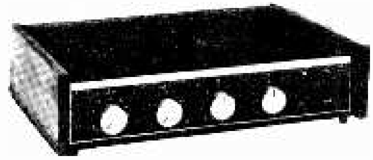

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A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise, level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification; Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1M Ω. Full power bandwidth: ±3dB 12-15,000 Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1.0 amp. Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

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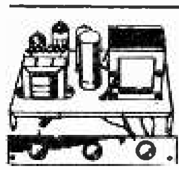

3-VALVE AUDIO AMPLIFIER HA34 MK II.
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £6·00. P. & P. 45p.
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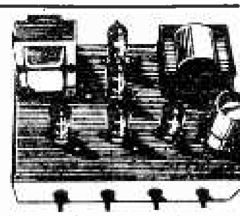
10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 15p + SAE (Free with parts)' **All parts sold separately.** ONLY £9·00 P. & P. 60p. Also available ready built and tested £13·00 P. & P. 70p.

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NELSON-JONES FM TUNER KIT

VARICAP TUNING

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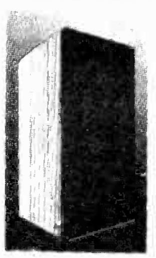

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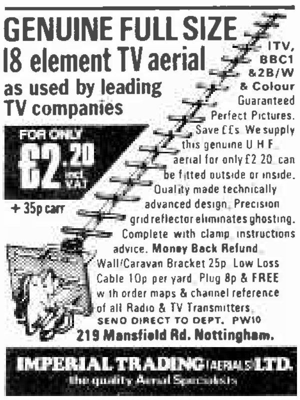

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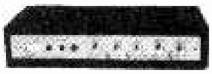

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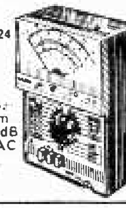

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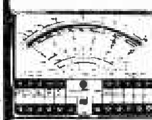

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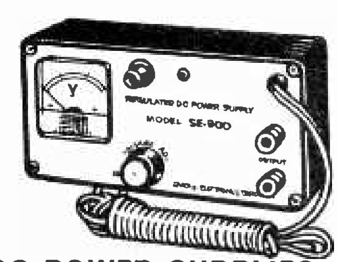

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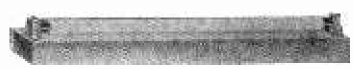

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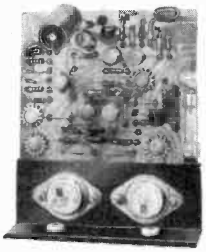
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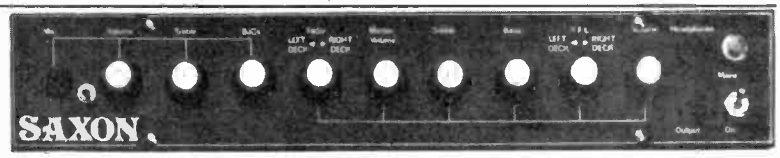

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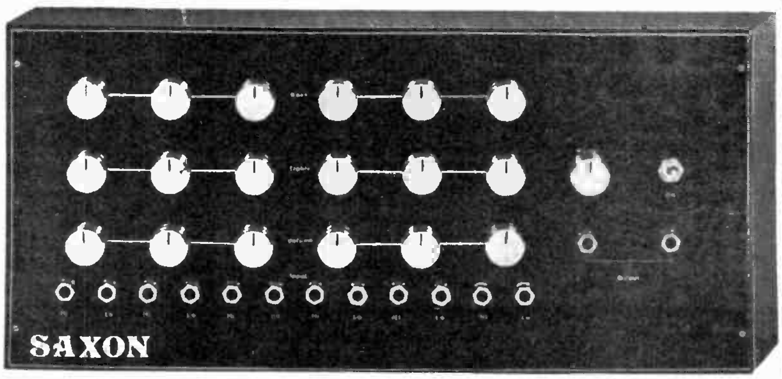

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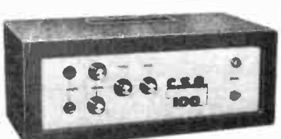

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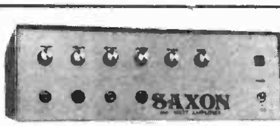

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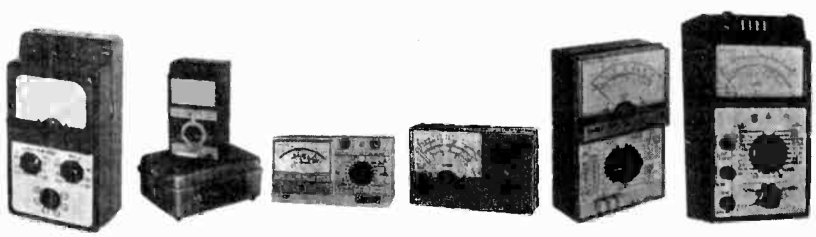

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AC127	12p	BC148	11p	MJE520	52p	ZTX108	12p	2N3703/4	12p	OA90/1	6p
AC128	12p	BC149	11p	OC26	35p	ZTX109	12p	2N3705/6	10p	OA200/1	6p
AC176	14p	BC182	11p	OC28	40p	ZTX300	14p	2N3707	10p	PL4001	7p
AC187	12p	BC183	11p	OC35	40p	ZTX301	14p	2N3708/9	7p	PL4004	9p
AC188	12p	BC184	11p	OC41	35p	ZTX302	18p	2N3819	25p	PL4007	12p
ACY17	21p	BC212	11p	OC42	38p	2N1131	20p	2N3903/4	15p	1N914	5p
ACY19	22p	BC213	11p	OC44	12p	2N1132	20p	2N3905/6	17p	1N4001/2	6p
ACY20	20p	BC214	11p	OC45	12p	2N1301/2	20p	40360	40p	1N4003/4	7p
ACY21	16p	BCY70	15p	OC70	12p	2N1303/4	24p	40361	45p	1N4005	7p
ACY22	16p	BCY71	20p	OC71	12p	2N1305/6	24p	40486	72p	1N4006/7	8p
AD140	40p	BCY72	15p	OC72	12p	2N1307	26p	40528	70p	1N4148	5p
AD145	40p	BD131	45p	OC74	22p	2N1671B	99p				
AD161	30p	BD132	45p	OC81	12p	2N1990	45p				
AD162	30p	BF194	15p	OC82	15p	2N2217	23p				
AF114/5	14p	BF195	15p	OC83N	20p	2N2218A	20p				
AF116/7	14p	BF196	16p	OC201	60p	2N2906	15p				
AF118	40p	BFY50	20p	OC202	80p	2N2907	18p				
BC107	10p	BFY51	20p	OCP71	95p	2N2926	9p				
BC108	10p	BFY52	20p	TIP29	43p	2N2053	20p				

DIODES

AA120	10p
AA129	10p
BA116	15p
BY100	15p
OA9	9p

ZENER BZY88
400mW
3·3V–33V
10p each

DIGITAL IC'S 74 SERIES

7400	17p	7426	28p	7472	28p	74111	85p
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7403	18p	7430	18p	7475	55p	74141	95p
7404	18p	7432	37p	7476	37p	74180	£1·42
7405	18p	7433	43p	7480	69p	74182	£1·42
7406	39p	7437	43p	7481	£1·10	74193	£2·28
7407	39p	7438	43p	7482	86p	74194	£1·65
7408	21p	7440	18p	7483	£1·10	74196	£1·45
7409	24p	7441	75p	7484	95p		
7410	18p	7442	15p	7485	£1·87		
7411	22p	7443	£1·20	7486	38p		
7412	28p	7444	£1·20	7490	69p		
7413	28p	7447	£1·30	7491	99p		
7414	60p	7448	£1·18	7492	69p		
7416	35p	7450	18p	7493	69p		
7417	35p	7451	18p	7494	80p		
7420	18p	7453	17p	7495	80p		
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7423	38p	7460	18p	74104	60p		
7425	38p	7470	28p	74105	59p		

LINEAR IC'S

709C	35p
723C	90p
741C	38p
748C	45p
CA3046	95p
CA3075	£1·65
CA3090	£4·25
LM300	£1·70
LM304	£1·70
MC1303	£1·30
MC1304	£1·60
MFC4000	45p
TBA800	£1·35
ZN414	£1·15

BRIDGE RECTIFIERS

BO25/10	18p
B1/05	25p
B1/10	25p
B1/20	28p
B1/60	30p
B2/05	35p
B2/20	45p
B2/60	50p
B2/100	55p
B4/800	£1·00
BY122	55p
BY164	34p
WO1	30p
WO6	35p

TGS (Gas and Smoke Detector) .. .. £1·85

DIL SOCKETS
8, 14, 16 pin .. 15p each

POLYESTER CAPACITORS. Axial lead type.
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 0·0068μF, **2½p**; 0·01μF, 0·015μF, 0·022μF, **3p**; 0·047μF, 0·068μF, 0·1μF, 0·15μF, **4p**; 0·22μF, **7p**; 0·33μF, **10p**; 0·47μF, **13p**;
160V: 0·1μF, 0·15μF, **4p**; 0·22μF, **5p**; 0·33μF, **6p**; 0·47μF, **7p**; 0·68μF, **10p**; 1μF, **13p**.
Radial lead P.C. type:
250V: 0·01μF, 0·015μF, 0·022μF, **3p**; 0·033μF, 0·047μF, 0·068μF, **3½p**; 0·1μF, **4p**; 0·15μF, **4p**; 0·22μF, 0·33μF, **5p**; 0·47μF, **7p**; 0·68μF, **10p**; 1·0μF, **11p**.

ELECTROLYTIC CAPACITORS. Miniature axial lead type.
63V: 1μF, 1·5μF, 2·2μF, 3·3μF, 4μF, 4·7μF, 6·8μF, 10μF, 15μF, 22μF, 47μF, 68μF, **6p each**
40V: 100μF, **6p**; 150μF 25V, **6p**; 25V: 220μF, **11p**; 470μF, **13p**; 1,000μF, **24p**.
16V: 1000μF, 1500μF, **16p**; 10V: 2200μF, **18p**.

CERAMIC CAPACITORS
50V d.c. Plaquette body 25mm leads.
Range: 22pF–10,000pF. Price **2p** each.
0·015μF, 0·022μF, 0·033μF, 0·047μF **3p**.

MYLAR FILM CAPACITORS
100V: 0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, 0·04μF, 0·05μF, **3p**.
100V: 0·1μF, 0·2μF, 50V: 0·47μF **6p**.

POTENTIOMETERS Carbon Track
0·25W, log and linear values.

1kΩ—2MΩ Single gang	12p
5KΩ—2MΩ s/gang w/switch	24p
2kΩ—2MΩ Dual gang	37p

PRESET POTENTIOMETERS

0·25W 1kΩ—1MΩ Hor. and Vert.	6p
0·1W 100Ω—220kΩ Vert. only	4p

SLIDER POTENTIOMETERS
0·25 W log and linear values

10kΩ—100kΩ Single gang	40p
10kΩ—100kΩ Dual gang	55p

KNOBS
To fit ¼" shaft unless specified.

Black Pointer type	6p
Slim Silvered	10p
Black 1" with chrome rim	15p
Slider Pot knob (Black)	10p
Slider Pot knob (Silvered)	10p

THYRISTORS

CRS 1/10	100V 1A	30p
CRS 1/20	200V 1A	35p
CRS 1/40	400V 1A	45p
CRS 1/60	600V 1A	55p
CRS 3/10	100V 3A	40p
CRS 3/40	400V 3A	55p
CRS 3/60	600V 3A	65p

RESISTORS

	Tol.	Range	Values	1–9	10–99
¼W	5%	2·2R–10M	E12	1p	0·8p
½W	5%	2·2R–10M	E12	1p	0·8p
1W	5%	2·2R–10M	E12	2p	1·5p
4W	10%	1–10 ohm	E12	6p	—

ALUMINIUM BOXES

AB7	2¼"	5¼"	1½"	40p
AB8	4"	4"	1½"	40p
AB9	4"	2¼"	1½"	40p
AB10	4"	5¼"	1½"	45p

SWITCHES

Toggle SPST	18p
DPDT	22p
Slide ½A sub. min.	10p
Slide 1A	14p
Push Button 6 pole changeover	35p
Wafer 1/12, 2/6, 3/4, 4/3 way	24p each

VEROBOARDS

PITCH	0·1	0·15	0·15 plain
2½ x 3¾"	22p	16p	12p
2½ x 5"	24p	24p	12p
3¾ x 3¾"	24p	24p	—
3¾ x 5"	28p	27p	21p
2½ x 17"	80p	60p	45p
3¾ x 17"	105p	84p	63p
5 x 17"	141p	—	89p
Pkt. of 50 pins			20p
Spot face cutter			42p
Pin insertion tool			52p

JACK PLUGS (CHROME)

Standard Screened	12p
Stereo Screened	30p
2·5mm Screened	8p
3·5mm Screened	10p

SOCKETS

Standard	12p
Stereo	15p
2·5mm	7p
3·5mm	7p

DIN PLUGS, SOCKETS AND COUPLERS
Pins: 2, 3, 4, 5 (180°, 240°), 6, 7
PLUGS: **12p**, SOCKETS: **8p**, COUPLERS: **10p**

PHONO PLUGS, SOCKETS & COUPLERS
Assorted Coloured Plugs: **5p**, **COUPLERS: 8p**
SOCKETS Single: **5p**, Double: **7p**. Triple: **10p**

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As featured by Practical Wireless 1972

Now built and used by thousands of satisfied customers. Features slim design overall size in cabinet 15¼" x 2¾" x 6¾". 6-IC's, 10 transistors, stabilisers Gardners low field transformer. Fibre Glass PC Panel, complete chassis work. Now available built and tested as well as in kit form. HIGH QUALITY & STABILITY ARE PREDOMINATE FEATURES — DEVELOPED BY TEXAS ENGINEERS FOR PERFORMANCE, RELIABILITY AND EASE OF CONSTRUCTION. FACILITIES. On/off switch indicator, headphones socket, separate treble, bass, volume and balance controls, scratch and rumble filters, mono/stereo switch, input selector: Mag. P.U., Radio Tuner, Aux. Can be altered for Mic., Tape, Tape-head, etc. Constructional details Ref. No. 21 30p. Distributed by Henry's throughout UK. FREE—Teak cabinet with complete kit.

Kit price **£28·50** (+ VAT + 50p carr/packing) or built and tested **£35·00** (+ VAT + 50p carr/packing) as illustrated.

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800 80 watt mixer/amp	£45·00
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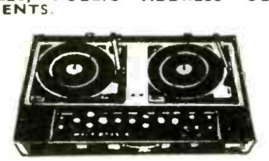

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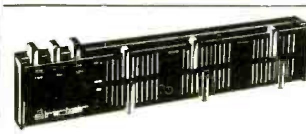

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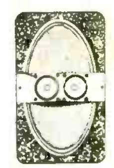

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B200	8"	15 watt		£8·50
B139/2	13" x 8"	30 watt LF		£13·75
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