PRACTICAL WIRELESS

AUGUST 1974

25p

PW DERBY Stereo Headphone Amplifier

&

TWO METRE CONVERTER — HIGH QUALITY SOUND LINKS

ELECTROVALUE

Present

THIS MONTH'S SELECTION OF GUARANTEED-TO-SPECIFICATION COMPONENTS

Everything Brand New ★ Attractive Discounts ★ Free Postage (U.K.)

TRANSISTORS
and semi-conductors of many types from simple diodes to ICS photo-sensitive devices, threshold switches, etc. etc.

MINITRON DIGITAL INDICATORS
3015F Seven segment filament, compatible with standard logic modules. 0–9 and decimal point; 9mm characters in 16 lead DIL (some alphabetical symbols available) **£1·20**
Suitable BCD decoder driver 7447 **£1·15**
3015G showing + or – & 1 & dec. pt. **£1·20**

CAPACITORS
DALY ELECTROLYTIC
in cans, plastic sleeved
1000mF/25V **28p** 1000/50 **41p**
5000/100 **£2·91** 2000/50 **57p**
5000/25V **62p** 5000/50 **£1·18**
2200/100 **£1·56**

POLYESTER TYPE C.280
Radial leads for P.C.B. mounting. Working voltage 250V d.c.
0·01, 0·015, 0·022, 0·033, 0·047 ea. **3p**
0·068, 0·1, 0·15 ea. **4p**
0·22, **5p**; 0·33 **7p**; 0·47 **8p**; 0·68 **11p**; 1·0 **14p**; 1·5 **21p**; 2·2 **24p**

SILVERED MICA
Working voltage 500V d.c.
Values in pFs—2·2 to 820 in 32 stages ea. **6p**
1000, 1500 **7p**; 1800 **8p**; 2200 **13p**; 2700, 3600 **12p**; 4700, 5000 **15p**; 6800 **20p**; 8200, 10,000 **25p**

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0 mF/35V. ea. **14p**
2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V ea. **14p**
4·7/35V, 10/16V, 22/6·3V ea. **18p**
10/25V, 22/16V, 47/6·3V 100/3V ea. **20p**

POLYCARBONATE
Type B42540 Working Voltage—250V
Values in mF:
0·0047, 0·0068; 0·0082; 0·01; 0·012; 0·015 ea. **3p**
0·018; 0·022; 0·027; 0·033; 0·039; 0·047; 0·056
0·068; 0·082; 0·1 ea. **4p**

CERAMIC PLATE
Working voltage 50V. d.c.
In 26 values from 22pf to 6800pF, each, **2p**

POTENTIOMETERS
ROTARY, CARBON TRACK. *Double wipers for good contact and long working life*
P.20 SINGLE linear 100ohms to 4·7megohms, ea. **14p**
P.20 SINGLE log. 4·7Kohms to 2·2megohms, ea. **14p**
JP.20 DUAL GANG lin. 4·7Kohms to 2·2megohms, ea. **48p**
JP.20 DUAL GANG log. 4·7Kohms to 2·2megohms, ea. **48p**
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only ea. **48p**
JP.20 DUAL GANG antilog 10K only **48p**
2A DP mains switch for any of above **14p** extra.
Decades of 10, 22 and 47 only available in ranges above.
Skeleton Carbon Presets Type PR, horizontal or vertical **6p** each.

SLIDER
Linear or log. 4·7K to 1 meg. in all popular values ea. **30p**
Escutcheon plates, black, white or light grey, ea. **10p**
Control knobs, blk/wht/red/yel/grn/blue/dk. grey/lt. grey ea. **7p**

JACKS AND PLUGS
Sockets
2-circuit unswitched S1/SS **12p**
2-circuit /2 break contacts S1/BB **15p**
3-circuit unswitched (Not GPO) S3SSS **17p**
3-circuit with 3 break contacts S3/BBB 20 **20p**
2 circuit with chrome nut and black/white/red/green or grey unswitched S5/SS **16p**
with 2 break contacts S5/BB **20p**
Miniature 3.5mm 2-circuit, (black) 2 br. cont S6/BB **9p**

Plugs
2 circuit screened top entry P1 **24p**
side entry SEP1 **36p**
Line socket mono 231 **40p**
Line socket stereo 244 **45p**
3 circuit unscreened, bl/grey/wh. P4 **46p**
2 circuit, unscreened, bl/whi/red/bl/grn/gry P2 **18p**
3 circuit screen top entry P3 **53p**
side entry SEP3 **55p**
Miniature 3·5mm 2-circuit screened P5 **13p**
Min. 3·5mm 2-circ. unscrnd. various colours P6 **10p**

EV CATALOGUE
2nd printing
(Green and yellow cover)

112 pages, thousands of items; illustrations; diagrams; much useful technical information. The 2nd printing of this catalogue has been updated as much as possible on prices. It costs only 25p post free and includes a refund voucher for 25p for spending when ordering goods list value £5 or more.

INSULATED SCREW TERMINALS
In moulded polypropylene, with nickel plate on brass. With insulating set, washers, tag & nuts. 15A/250V in blk/brwn/red/yel/grn/bl/gry/wh. Type TP.1, ea. **14p**
Suitable plugs Type TP4, 4mm each **7p**
Type TP2, 2mm each **4p**

ZENER DIODES
Full range E24 values: 400mW: 2·7V to 33V, **14p** each; 1W: 6·8V to 82V, **21p** each; 1·5W: 4·7V to 75V, **67p** each. 20W: 7·5V to 75V, **94p** each. Clip to increase 1·5W rating to 3 watts (type 266F), **5p**.

RESISTORS

Code	*Watts*	*Ohms*	*1 to 9*	*10 to 99* (see note below)	*100 up*
C	1/3	4·7–470K	**1·3**	**1·1**	0·9 nett
C	1/2	4·7–10M	**1·3**	**1·1**	0·9 nett
C	3/4	4·7–10M	**1·5**	**1·2**	0·97 nett
C	1	4·7–10M	**3·2**	**2·5**	1·92 nett
MO	1/2	10–1M	**4**	**3·3**	2·3 nett
WW	1	0·22–3·9	**9**	**9**	**8**
WW	3	1–10K	**7**	**7**	**6**
WW	7	1–10K	**9**	**9**	**8**

Codes:
C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

Values: All E12 except C $\frac{1}{3}$W, C $\frac{3}{4}$W, and MO $\frac{1}{2}$W.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Tolerances:
5% except WW 10% ±0·05Ω under 10Ω and MO $\frac{1}{2}$W 2%.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) Prices for 100 up in units of 100 only.

VEROBOARD
Copper clad 0·1 matrix—2·5 x 3·75 ins. **30p**; 3·75 x 3·75 ins.—**30p**; 2·5 x 5 ins.—**30p**; 3·75 x 5 ins.—**33p**.
Copper clad 0·15 in. matrix 2·5 x 3·75 ins.—**20p**; 3·75 x 3·75 ins.—**30p**; 2·5 x 5 ins.—**30p**; 3·75 x 5 ins.—**36p**.
Vero spot face cutter (any matrix) **48p**.
0·040 pins (for 0·1 matrix) per 100—**36p**.
0·052 pins (for 0·15 matrix) per 100—**36p**.

ELECTROLYTICS
Axial Lead

μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

KNOBS
In a great variety of modern types, for ¼" shaft, from plastic to solid aluminium as well as pointer and numbered types.

CONNECTORS
DIN from two way to 7 way plugs and sockets, phono types mains connections, etc. etc. Page 88 in Catalogue 7

BAXANDALL SPEAKER KIT
As designed by P. J. Baxandall and described originally in "Wireless World." Simple to assemble, fantastically good results and a greater money saver. Carries 10 watts RMS, 15 ohms impedance. Size 18in x 12in x 10in. Complete kit, including pack-flat cabinet. **£14·90.**
The size and weight of this product obliges us to charge 70p part cost of carr. in U.K.
Equaliser Assembly. **£2·30.**
Loudspeaker Unit 59RM109, **£2·45.**
Cabinet Kit (to Baxandall design), **£10·45.**
Cross-over choke for additional woofer to above **£1·50.**

This is EV Service

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Available on all items except those shown with NETT PRICES. 10% on orders from £5 to **£14·99**. 15% on orders £15 and over.

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All goods are sold on the understanding that they conform to manufacturers' specifications and satisfaction is guaranteed as such—no rejects, 'seconds' or sub-standard merchandise is offered for sale.

GIRO ACCOUNT—No. 38/671/4002

Prices quoted do not include V.A.T., for which 10% must be added to total nett value of order. Every effort is made to ensure correctness of information and prices at time of going to press. Prices subject to alteration without notice.

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Telephone Egham 3603 Telex 264475 Shop hours 9–5.30 daily: Sat. 9–1 p.m.

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PRACTICAL WIRELESS

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AUGUST 1974

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

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● NEWS & COMMENT

● CONSTRUCTIONAL

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HUGE DISCOUNTS

ON LEADING BRAND HI-FI — **All R.S.C. Prices include VAT**

*Full labour and material guarantees for 12 months
LOW DEPOSIT TERMS OVER 8 MONTHS

	List Price	RSC Price
WHARFEDALE DENTON	£43·09 Pr.	£29·95
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LINEAR 202 AMPLIFIER	£39·93	£24·75
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Prices shown correct at 30th May 1974

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All £1 carr.

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GARRARD SP25 MK IV with G850 Special Price £19·95 (Carr. £1)
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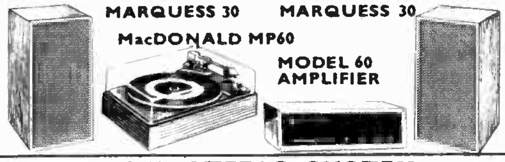

A HI-FI 30 + 30W STEREO SYSTEM

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. Or Deposit £11·48 and 18 fortnightly payments £5·74 (Total £114·80)

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

HI-FI 10 + 10W STEREO SYSTEM

AUDIOTRINE STEREO 20 AMPLIFIER GARRARD TURNTABLE with Sonotone Cartridge wired-on Plinth with cover. PAIR DIPLOMAT 10w SPEAKERS, Teak Veneer finish. Carr. £2

SPECIAL PURCHASE Worth Double **£55**

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

JE8 Size 16" × 11" × 9". Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·95**

SE10 For outstanding results with 10in. Hi-Fi spkr. Size 25½ × 16 × 9in. Ported **£6·95**

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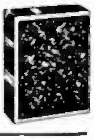
SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter 25½ × 16 × 9in. **£7·95**



RSC G66 MkII 6+6 WATT high quality STEREO AMPLIFIER

Controls: Bass, Treble, Vol. and Bal. 10 Transistors plus Diodes. Output rating I.H.F.M. Frequency range 20-20,000 c.p.s. Bass Control ± 12db. Treble Control ± 13db. Selector switch for Crystal P.U. or Tape/Radio. For speaker output impedances of 3 — 15 ohms. For standard 200-250v. A.C. mains operation. Attractive Black and Silver finished metal fascia plate and matching control knobs. COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and COMPREHENSIVE WIRING DIAGRAMS & INSTRUCTIONS **£12·75** Carr. 40p
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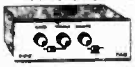
Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£7·45** Carr. 45p
OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£7·95** Carr. 50p

R.S.C. TA6 6 Watt HI-FI AMPLIFIER



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 × 3½in. Complete kit, wiring diagrams and instructions. **£7·95** Carr. 40p. FACTORY BUILT **£10·95**

AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticised Cone surround. "D" or "T" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 8–15 ohms. PLEASE STATE CHOICE.
Exceptional performance at low cost.

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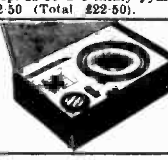
R.S.C. TA12 MKIII 6·5+6·5 WATT STEREO AMPLIFIER

Fully Transistorised. Hi-Fi o/p of 6·5 watts per channel. Optimum performance with any crystal or ceramic P.U. Cartridge, Radio Tuner, Tape Rec. etc. Input Sel. Switch, Bass, Treble, Vol. & Bal. Controls. 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).

FANE 807T HIGH FIDELITY SPEAKER

A full range 8in. 10 watt unit for excellent sound quality, in suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25 Hz to 15 KHz. Gauss 10,000. Impedance 3 or 8-15 Ω.
PLEASE STATE IMPEDANCE REQUIRED List £4·50 **£3·99**
MODEL 803T 8" 15w. with parasitic Tweeter. Response 25 Hz to 15 KHz. Gauss 13,000 Imp 3 or 8–15Ω. **£5·50** List £6·50

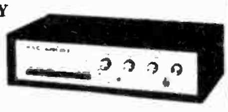
AUDIO FIDELITY FR1 SPEAKER KIT



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.
£11 each. Carr. Free. SPECIAL OFFER **£14·99** Pair Carr. 50p

R.S.C. MkIII SUPER 30 HIGH FIDELITY STEREO AMPLIFIER

BUILD AN AMPLIFIER WORTH APPROXIMATELY DOUBLE THE KIT PRICE INCLUDING CABINET
Only high grade components by leading manufacturers



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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. **£22·95**

R.S.C. STEREO FM III TUNER. in cabinet Visually matches Super 30 Mk. III **£37·95**

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 **£25·95** Carr. 75p
Consists of (1) 12in. 15w 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 £4·71 and 8 monthly payments £3·12 (Total £29·67)

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FULLY GUARANTEED. Impregnated and Interleaved where necessary. Primaries 200-250v. 50c/s. Screened

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350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a.	£1·81
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
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350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·85

FILAMENT or TRANSISTOR POWER PACK Types 6·3v. 1·5a. 55p; 6·3v. 2a. 60p; 6·3v. 3a. 85p; 6·3v. 6a. £1·45; 12v. 1a. 61p; 12v. 3a. or 24v. 1·5a £1·50; 0·9-18v 1½a £1·25; 0-12-25-42v 2a £1·95.

CHARGER TRANSFORMERS 0-9-15v. 1½a. £1·10, 2½a. £1·25; 3a. £1·40; 5a. £1·60; 6a. £1·85; 8a. £2·20

AUTO (Step UP/step DOWN) TRANSFORMERS 0-110/120v. 200-230-250v. 50-80 watts £1·25, 150 watts, £2·10 250 watts £3·00; 500 watts £6·40

OUTPUT TRANSFORMERS

Push-Pull 8 watts EL84 to 3 Ω or 15 Ω	95p
Push-Pull 10 watts 6V6, 3-5-8-15 Ω	£1·55
Push-Pull EL84 to 3 or 15 Ω 10-12 watts	£1·50
Push-Pull Ultra Linear for Mullard 510, etc.	£2·45
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω	£2·20
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15 Ω	£3·65

SELENIUM RECTIFIERS
F. W. (Bridged)
All 6/12v. D.C. output. Max. A.C. input 18v.
1a, 28p. 2a, 39p. 3a, 55p. 4a, 72p. 6a, 88p.

L.F. CHOKES
150mA, 7-10H, 250 Ω 77p; 100mA, 10H, 200 Ω 66p; 80mA, 10H, 350 Ω 55p; 60mA, 10H, 400 Ω 28p.

RSC 100watt DISCO SYSTEM

AT FANTASTIC LOW PRICES!

Units listed below
(a) DISCOMASTER TWIN T/TABLE CONSOLE with integral 100W amp.
(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"
(a) (b) (c) & (d) Carr. £3·00 **£149·95**
Deposit £19·95 & 19 fortnightly payments of £7·87 (Total £169·48).

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. £7·98 and 18 fortnightly pymts. £3·99 (Total £79·80) **£69·95** Carr. £1·50

DISCOMASTER TWIN TURNTABLE POWER CONSOLE

Garrard SP25 or McDonald MP60 turntables. Sonotone or Acos cartridges with diamond styli. Facilities as TDI Console but with built-in 100 watt Power Amplifier, complete with lid. Or Deposit £11·48 and 18 fortnightly payments £5·74 Carr. £2·50 (Total £114·80) **£99·95**

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" x 8" 20 watt speakers. Terms: Dep. £2·95 and 8 m'thly payments £2·51 (Total £23·03) Carr. 65p. **£19·95**

TYPE C8/70 70 WATTS. Fitted three 12" 25 watt Highly sensitive high flux speakers with high power voice coils. Size approx. 54" × 14" × 11". Dep. £9·95 & 8 mthly pymts. £4·31 (Total £44·43) Carr. 85p **£39·95**

FANE ULTRA HIGH POWER LOUDSPEAKERS

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, 14,000 gauss, 8/15Ω	15" 60 Watt, 14,000 gauss, 8/15Ω	12" 50 Watt, 13,000 gauss, 15Ω
£29.70	£16·95	£12·99
Dep: £3·80 and 8 mthly payments £3 80 (Total £34·20)	Dep. £2·17 and 8 monthly payments £2·17 (Total £19·53)	Dep £1·95 and 8 monthly payments £1·71 (Total £15·63)

FOR BASS GUITAR, ELECT. ORGAN, ETC. PAIR SUITABLE ALL PURPOSES

NEW 'POP' 55 12" 60W

Gauss 15,000 Imp 8/15Ω Or Dep £2·45 & 8 monthly payments £2 (Total £18·45) **£15·95** Carr. Free

ALL RSC PRICES INCLUDE VAT

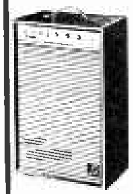
INTEREST CHARGES REFUNDED on Credit Purchases settled in 3 months

FANE CRESCENDO SPEAKERS

Full range available at ALL BRANCHES

FANE SPEAKERS 'POP' 25/2 12 in. 30 WATT

Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). Carr. free **£8·99** CREDIT TERMS (PAIRS ONLY) Dep. £2·80 & 8 mthly pymts. £2·30 (Total £21·20).



MINSTREL 8W GUITAR AMP.

Incorporating Tremolo and 13" × 8" or 10" Speaker. Output 8 watts R.M.S. Continuous. 3 Jack Inputs for Microphone and Instrument. Mains Neon Controls: Volume, Tone, Tremolo Speed Tremolo Intensity.
Terms: Deposit £3·95 and 8 monthly payments £2·39 (Total £23·07). Carr. free **£19·95**

GROUP EQUIPMENT PACKAGE OFFERS

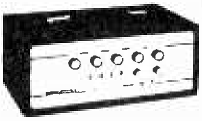
F.A.L. PHASE 50 MK. III AMPLIFIER £39·93
PR. FANE POP 25/2 30W L/SPEAKERS £17·98
£57·91
Terms: Deposit £6·77 and 8 monthly payments of £6·77 (Total £60·93)
PACKAGE PRICE **£52·95** carr. £1·10

F.A.L. PHASE 50 MK.III AMPLIFIER £39·93
PR. FANE POP 50 L/SPEAKERS £25·98
£65·91
Terms: Deposit £10·05 and 18 fortnightly payments of £3·33 (Total £69·99)
PACKAGE PRICE **£59·99** carr. £1·10

F.A.L. PHASE 50 AMPLIFIER £39·93
PAIR L12/20 SPKRS (in Cabinets) £25·90
£65·83
Terms: Deposit £10·05 and 18 fortnightly payments £3·33 (Total £69·99)
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**

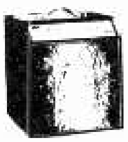


HIGH QUALITY LOUDSPEAKER UNITS

ALL TWO TONE REXINE AND VYNAIR FINISH
L125 50 WATT Fitted pair of 12" 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Carr. £1·50 **£39·95**
Or deposit £7·95 and 8 monthly payts. of £4·72. Total £45·71

L12/20 12" 25 WATT 13,000 lines 15 ohms Terms for Pairs. Dep £3·32 & 8 mthly pymts £3·32 (Total £29·88) **£12·95** Carr. 55p.

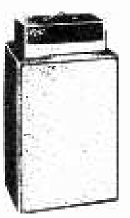
L12/10 10-15 Watt Veneered cabinet 12" unit 8-15 ohm. Approx. 14" × 14" × 9". Carr. 65p. Terms for Pairs. Dep. £2·05 & 8 mthly pymts £2·05 (Total £18·45). **£7·95**



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** SPECIAL PRICE for limited period



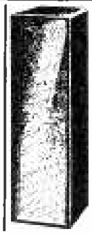
REGENT 50X AMPLIFIER

A powerful high quality unit for lead, rhythm, guitar, vocalists, gram, radio, tape. Peak Output rating. Not for Bass Guitar.
★ Two extra heavy duty 12in. speakers.
★ 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. Credit Terms: Deposit £7·98. & 18 fortnightly payments of £3·99 (Total £79·80). Carr. £2·50. **£69·95**
REGENT 50B for Bass Guitar and general purposes. Or Dep. £9·18 & 18 fortnightly payments £4·59. (Total £91·80). Carr. £2·50 **£79·95**

GP30 AMPLIFIER

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.
Terms: Deposit £3·58 and 8 monthly payments of £3·58 (Total £32·22). **£27·95** Carr. 75p



C4/100 HEAVY DUTY COLUMN SPEAKERS

Suitable for Public Address or Vocal and Instrumental Groups. Fitted four 12" 50 watt speakers. Robust attractive Vynide covered cabinet 58" × 16" × 10" approx.
SPECIAL PRICE Carr £1·50 **£59·95**
Or Dep. £20 and 12 mthly pymts £3·90 (Total £66·80).

NOW SEVEN NEW BRANCHES BOLTON, COVENTRY DONCASTER, STOCKPORT SUNDERLAND, PRESTON and NOTTINGHAM

NEW LARGER PREMISES AT HULL, DARLINGTON, NEWCASTLE & DERBY

RSC HI-FI CENTRES LTD.

Barclaycard and Access accepted

All items subject to availability. Prices correct at 30.5.74 E. & O.E.

MAIL ORDERS & EXPORT ENQUIRIES TO:— AUDIO HOUSE, HENCONNER LANE, LEEDS, 13. Tel: Pudsey (09735) 77631.
TERMS C.W.O. or C.O.D. No C.O.D. under £1. POSTAGE 28p EXTRA UNDER £2. 33p EXTRA OVER £2 OR AS QUOTED. TRADE SUPPLIED. S.A.E. PLEASE WITH ENQUIRIES.
SUPPLIERS TO GOVT. DEPTS. H.M. FORCES. EDUCATION AUTHORITIES & HOSPITALS, Etc.
MAIL ORDERS MUST NOT BE SENT TO SHOPS

R.S.C. BRANCHES OPERATE A 5-DAY WEEK
OPEN ALL DAY SATURDAY

BRADFORD 10 North Parade (Closed Wed.). Tel. 25349
BOLTON 23 Deansgate. (Closed Wed.). Tel. 33512
BIRMINGHAM 30/31 Great Western Arcade. Tel. 021-236 1279 (Closed Wed.).
COVENTRY 17 Shelton Square, The Precinct. Tel. 25983
DERBY 97 St. Peter's Street. (Closed Wed.). Tel. 41364
DARLINGTON 19 Northgate (Closed Wed.). Tel. 68043
DONCASTER 3 Queensgate, Waterdale Centre. (Closed Thurs). Tel. 63069
EDINBURGH 101 Lothian Rd. (Closed Wed.). Tel. 229 9501
GLASGOW 326 Argyle St. (Closed Tues.). Tel. 248 4158
HULL 7 Whitefriargate (Closed Thurs.). Tel. 20505
LEICESTER 32 High Street (Closed Thurs.). Tel. 56420
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LONDON 238 Edgware Road, W.2. (Closed Thurs.). Tel. 723 1629
MANCHESTER 60A Oldham Street (Closed Wed.). Tel. 236 2778
MIDDLESBROUGH 106 Newport Road (Closed Wed.). Tel. 47096
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NOTTINGHAM 19/19A Market Street
PRESTON 41 Friargate Walk, St. Georges Shopping Prec. Tel. 51979 (Closed Thurs.). Tel. 48068
SHEFFIELD 13 Exchange Street (Castle Mkt. Bldg.)
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PE SCORPIO Mk 2 ignition system kit new from ELECTRO SPARES

* 6 OR 12 VOLT
* + VE AND - VE GROUND

Here's the new, improved version of the original PE Scorpio Electronic Ignition System—with a big plus over all the other kits—the PE Scorpio Kit is designed for *both* positive and negative ground automotive electrical systems. Not just+ve ground. Nor just—ve ground. But both! So if you change cars, you can be almost certain that you can change over your PE Scorpio Mk. 2 as well. Containing all the components you need, this Electro Spares PE Scorpio Mk. 2 Kit is simply built, using our easy-to-follow instructions. Each component is a branded unit by a reputable manufacturer and carries the manufacturer's guarantee. Ready drilled for fast assembly. Quickly fitted to any car.
When your PE Scorpio Mk. 2 is installed, you instantly benefit from all these PE Scorpio Mk. 2 advantages.

★ Easier starting from cold ★ Firing even with wet or oiled-up plugs ★ Smoother running at high speed
★ Fuel saving ★ More power from your engine
★ Longer spark plug life ★ No more contact-breaker burn

Electro Spares prices:
De luxe Kit only £11.50 inc. VAT and p & p.
Ready Made Unit £14.75 inc. VAT and p & p.
State 6V or 12V system.
Send SAE now for details and free list.

FM VARICAP STEREO TUNER

As featured in the May 1973 issue of 'Practical Electronics'. Superb Hi-Fi tuner Kit now available from Electro Spares. Including cabinet and all components – pre-set Mullard modules for R.F. and I.F. circuits. Motorola I.C. Phase Lock Loop Decoder for perfect stereo reception. No alignment needed. Guaranteed first time results – or send it back, and we'll return it in perfect order (for a nominal handling charge). Electro Spares price **only £28.50 inc. VAT and p & p.**

'GEMINI' STEREO AMPLIFIER

A superb unit with a guaranteed output of 30 watts RMS per channel into 8 ohms. Full power THD is a mere 0.02%, and frequency response is —3 dB from 20 Hz to 100 kHz into 8 or 15 ohms. Electro Spares have already sold 100s and 100s of these Kits. Get yours now! Depending on your choice of certain components, the price can vary from **£50 to £60 inc. VAT and p & p.**

★ All components as specified by original authors, and sold separately if you wish.
★ Full constructional data book with specification graphs, fault finding guides, etc. 55p plus 4p postage.
★ Price List only. Please send S.A.E. (preferably 9 x 4 minimum) for full details.

ELECTRO SPARES

The Component Centre of the North
288 ECCLESALL RD., SHEFFIELD S11 8PE (C)
Tel: Sheffield (0742) 668888

THE FOLLOWING ITEMS ARE NEW. TUNING COILS S.W. type size 4¼ x 2¼ 3 for **85p. HEAD & MIKE SETS** for use with 19 Set low res, M.C. type, Hand mike, adjustable headband with ear pads **£2. DIODES 100 PIV** at 3 amps wire ended 4 for **60p. C.R.T.** type 7BP7A 7" flat face. 6·3 heater, Blue/Yell phosfor, okay for slow scan T.V. with base connections **£2. BLOWER MOTORS** for use on 6 to 28v DC double ended type size overhaul 6 x 3½", outlets 1½ x 1½" boxed **£2·55. TRIMMERS** Air spaced ceramic base 20pf 10 for **65p.** 100 for **£4·40. METER UNIT X** pionter ind for use with 115Rx as dual 115 Ua movements **£1·79. CONTROL UNIT** with valves 6BA6, 6AS6, 12AU7, pot core 1½ x ½" ·1uf 1% conds, relay etc **£1·15. SILICON DIODES** Ferranti type ZS78 800 PIV 750 Ma 15 for **£1·10. INSULATED TERMINALS** slim style will take 4mm plug in Red, Blk, Blue, Gr, Yell, Wht, Grey, Brown 4 for **60p. COAX CABLE** grey sheath 75 ohm ¼" dia 15 meters for **£1·20. COAXIAL LEADS BNC UHF, N** type etc list on request.
THE FOLLOWING ARE EX EQUIPMENT. EXTRACTOR FANS 8" dia with grill 115v 50c/s 3000 RPM 2 phase motor heavy duty unit **£3·90. SCOPE EHT CONDS** ·5uf 1 Kv, ·25uf 1·5 Kv., ·/uf 2·5 Kv all **25p** ea. **DIODES** type ZR22 200 PIV 8 amps 4 for **75p. CRT** type VCR138 3·5" dia, green screen, supplied with base, mu met shield & front mount req 1 to 2Kv EHT ideal for scope use with base conn. **£4·40. WAVEMETER ASS.** absorbtion type range 420 to 460 Mc/s approx with Det, with dial & knob not cal in freq 11 x 2½" **£2. METERS** 270° scale 1 Ma FSD scale 0 to 20 with 100-0-100 Ua in same case size 3½ x 3½ **£3·38. HIGH VOLTAGE DIVIDER** for use with scope ratio 10 & 100.1 up to 20Kv Wk **£3·20. VIDICON C.C.T.V.** camera tubes E.E. type P862 with data sheet 6·3 95 Ma heater grade A & B **£9·50 A. £6·50 B. CRYSTAL OVEN** with 12 type Hc6/u holders can be removed. **76p. PLUGS & SKS** Belling Lee type with cable cover & clamp 25 way **55p,** 18 way **35p,** 8 way **25p,** 4 way **20p.**

Above prices include Postage & V.A.T. S.A.E. for list or inquiry.

A. H. SUPPLIES

57 MAIN ROAD, SHEFFIELD S9 5HL. Tel: 444278 (0742)

ERSIN Multicore 5 CORE SOLDER

for fast, easy reliable soldering

Ersin Multicore Solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.

EASY-TO-USE DISPENSERS

Size 5 Savbit alloy 18 swg, **30p** (illustrated).
Size 19A 60/40 alloy 18 swg, **30p**
Size 15 60/40 alloy 22 swg, **34p**

IDEAL FOR HOME CONSTRUCTORS

Size 1 cartons in 40/60, 60/40 and Savbit alloys in 7 gauges **46p**

Size 12 Reel for Service Engineers and Electricians. 18 swg Savbit alloy **£1·46**

BIB WIRE STRIPPER AND CUTTER

Deluxe Model 9 Automatic opening spring, locking catch, plastic-covered handles. Case hardened and precision ground. Adjusts to most wire sizes. Cuts and strips flex, splits plastic twin flex. **75p**

Prices shown are recommended retail, excluding V.A.T.
From Electrical and Hardware Shops. If unobtainable, send 10p p&p direct to **Bib Hi-Fi Accessories Limited, Hemel Hempstead, Herts HP2 7EP**

RECORD PLAYBACK HEADS (TRUVOX)
Individual prices of these are:
2 track record playback heads 50p each.
4 track record playback heads 72p each.
Erase heads are also available separately—
2 track 33p—4 track 55p.

NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. 8p each, 10 for 60p Plastic pushrod suitable for operating. 6p each, 10 for 54p.

1 R.P.M. MOTOR+GEAR BOX
Made by the famous Chamberlain & Hookham Ltd. These could be made to drive clock or similar. Really robust reliable unit. Price £1·10 each.

AUTO—ELECTRICAL CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £6·35 plus 25p post and insurance.

MAINS TRANSISTOR POWER PACK
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1·10, plus 20p postage.

MINIATURE WAFER SWITCHES

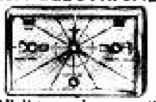
2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 25p each.

MULTI-SPEED MOTOR.

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 97p plus 23p postage and insurance.

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. 8p each. 10 for 73p. Ditto as above but for printed circuit 6p each 10 for 63p. Sub Miniature Slide Switch. DPDT 19mm (¾in approx.) between fixing centres. 20p each or 10 for £1·90. SP Change over spring return 250v 1 amp. 11p.

15A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you awake — switch on lights to ward off intruders — have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2·15 + 20p p. & p. or with glass front, chrome bezel, 83p extra.

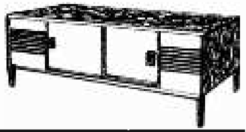
BALANCED ARMATURE UNIT
500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, 37p each.

12 VOLT 1½ AMP. POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mF smoothing. Price £2·20 plus 20p post & packing. Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15 amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 63p post.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1·10 each or £12 per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

STEREO RADIO CABINET

Long, Low and Modern. Teak veneered with sliding front and tapered legs. Speaker spaces each end. Size approx. 4ft. 2in × 13in × 15in. Probably cost over £20 to make. Our Price £8·10 each.

THIS MONTH'S SNIP
ULTRA MODERN RECORD CHANGER.

Famous BSR deck with stereo cartridge. £6·95 + £1·00 post.

HORSTMANN 24-HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:—

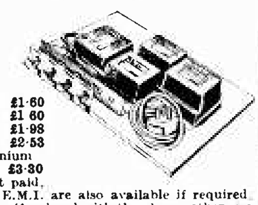
Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated. Size 3in. × 3in. × 2in. deep. Price £3·85 as illustrated but less case.

PORTABLE RADIO CASE DE-LUXE

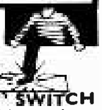
A similar size to the above but a more expensive design. Used with the Good Companion de-luxe model. £2·20 plus 50p post and insurance.

KETTLE ELEMENTS
Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1⅛in (approx.) suitable for Swan and other similar models—1⅝in (approx.) suitable for G.E.C., Hotpoint, etc. All quick boil 2¼kW elements at 240V, Price £1·88.

MULLARD UNILEX STEREO SYSTEM

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this:—

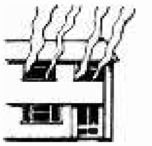
1 Unilex Amplifier	Ref. EP.9000	£1·60
1 Unilex Amplifier	Ref. EP.9000	£1·60
1 Unilex Pre-Amp	Ref. EP.9001	£1·98
1 Unilex Power Unit	Ref. EP.9002	£2·53
1 Control panel kit with spun aluminium faced knobs		£3·30

Or the complete outfit—£11·30 post paid.
Pair of 15 ohm speakers made by E.M.I. are also available if required price £3·30 the pair. No extra postage if ordered with the above, otherwise add 25p.

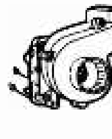
SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc.
24in × 18in £1·69
13in × 9in £1·21

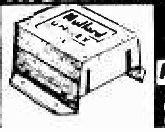
HORSTMANN "TIME AND SET" SWITCH

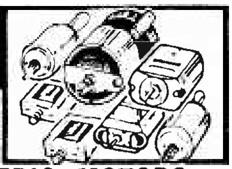
(A 30 amp Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing.
Two models 15 amp £1·98, 30 amp £2·58. P. & P. 25p each

SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection against these killers.
Saga uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately. In a neat case measuring approx. 5" × 3½" × 2½", it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. £6·99 plus 30p post.

OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS, NOW AVAILABLE. PRICE 30p POST PAID.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4¼" × 4¼" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc., etc. A real bargain at £2·05.

UNILEX MULLARD 4 WATT HI-FI AMPLIFIER FOR ONLY £1·60

Sensational "once in a lifetime offer" because Mullard over-produced — definitely not repeatable once our stocks (now over half sold) are cleared. Hi-Fi 4 transistor amplifier complete in case ready to use. Batt., car or mains operated—freq. range 50hz-15Khz—distortion better than .2%. Comes complete with guarantee and data FREE to purchasers. Great handbook published by Mullard "tells all you need to know" to build your own stereo. Complete Unilex Stereo System £11·30, pair of speakers for same £3.80.

ONLY £1 FOR 7 ELECTRIC MOTORS

7 powerful battery motors as used in racing cars and power models. Output and types vary to make them suitable for hundreds of different projects—tools, toys, models, etc. All brand new reversible and for 10 to 12v. Bats., wiring diagrams included. Post and VAT 30p.
FREE Details of how to make miniature power station.

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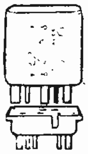
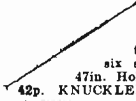
For aerials, etc. The following types are in stock Dia. ⅜", 4" long 15p, 5" long 18p. Dia. 5/16", 5" long 20p, 6" long 25p, 8" long 30p. Dia. 3/8", 4" long 20p, 5" long 25p, 6" long 30p. 8" long 40p: Dia. ½", 6" long 35p; Ferrite Slab 3" long x ¾" x 1/8th"—20p

MINIATURE SEALED RELAY

American made. Our Ref. No. REL A1. Measures only ⅞" wide × 1" thick and 1" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms. and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 33p including base.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw 42p. KNUCKLED MODEL FOR F.M. 55p

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Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. £3·30 plus 20p post and insurance.

MIDGET TWO GANGS
Tuning condenser as fitted to many Japanese and Hong Kong radios—probably 200pf each section with ¼" spindle with terminal-less trimmers. Price 38p. With trimmers 50p.

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For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3 Price 99p each, 10 for £9.

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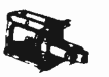
Model 2 — small but powerful 1in. pull— approx size 1¼ × 1¼ × 1¼in. 66p. Model 4001/—⅝in. pull. Size 2¼ × 2 × 14in. 83p. Model TT1—1½in. pull. Size 3 × 2¼ × 2in £1·98 plus 20p post and insurance

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Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20, twin stethoset instead of earpiece 83p extra—post and ins. 20p.

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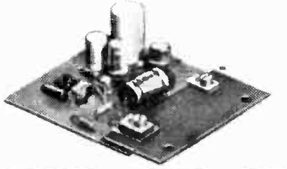
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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" × 2½" × 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

PRE-AMPLIFIERS

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

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

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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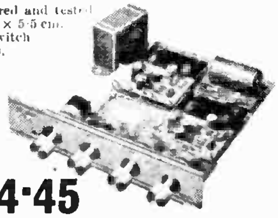
The STEREO 20

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.



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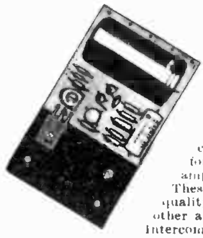
- Load—3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm × 105mm × 13mm

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	± 15bB 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

ONLY £13·15

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

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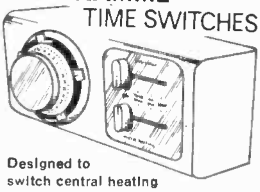

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★ Noise—80dB
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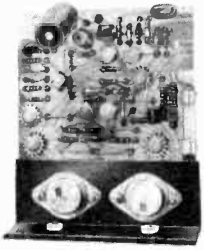
120 watt module complete with built-in supply—extra heavy duty £19·75 Carr. 60p



THE SA100 MODULE

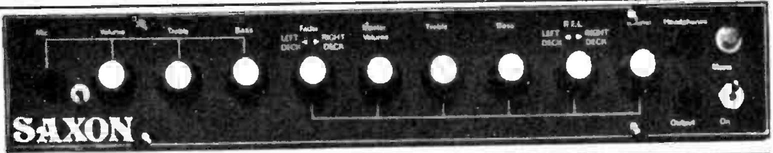
POWER SUPPLIES

UNSTABILISED			
PU45	Suits 2 SA35 or 1 SA50	£4·90	Carriage 30p
PU70	Suits 2 SA50 or 2 SA100	£7·75	Carriage 40p
STABILISED			
PS45	Suits 2 SA35 or 2 SA50	£3·50	Carriage free
MT45	Transformer for above	£3·50	Carriage 30p
PS70	Suits 2 SA100	£4·90	Carriage free
MT70	Transformer for above	£4·90	Carriage 40p

N.B. PS70 is not suitable for the SA50

Mk II STEREO DISCO MIXER £19·75
Carr. 30p

This well tried unit mixes two decks, handles any ceramic cartridge, and features mic over-ride plus separate full range bass and treble controls on both mic and deck inputs. Ample headphone power is available for P.F.L. May be used for mono and is mains operated. Fitted with sturdy screening case. Controls: Mic vol, bass, treble. Left/Right fade, deck volume, bass, treble, h/phone select, vol. Mains. Size 17½in × 3in × 4in deep.



DISCO MODULE £8·00 Carr. 20p

Thousands sold of this extremely popular mono version. A mic input may be fitted using the VA30 (see below). Low consumption from a 9V battery. Features the same high standards of reproduction as the Stereo version. Controls: H/phone select, vol. Left deck vol, Right deck vol, bass, treble, master vol. Size 12¾in × 3in × 2in deep.

3-CHANNEL SOUND-LITE £22·50 Carr. 30p

Only SAXON can supply such incredible value for money. This unit features 3kW power handling, full-wave control, bass, middle, treble AND master controls. Twin loudspeaker jacks for "through" connections. It may be used free standing or will panel mount next to either of the above. Also features unique CUT-BACK circuitry for extra wide range response. Size 12in × 3in × 2¼in deep. Professional standards at a price you can afford!

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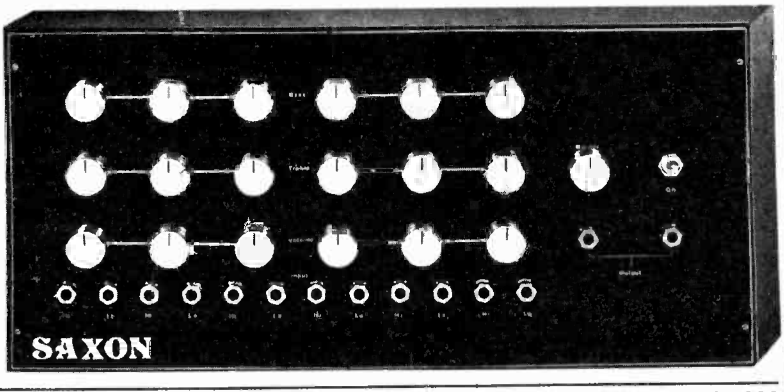
Featuring multiples of our VA30 module, the M4HL and M6HL fulfil the requirements of all clubs, groups, etc. where a high quality mixer is required. Each channel has one high and one low impedance input, plus volume, treble and bass controls. Input impedances may, if required, be easily changed. The M4HL has four channels, and one output, and the M6HL six channels (12 inputs) and a master control and two outputs. Either unit may be used free-standing or panel mounted. These mixers will feed all types of amplifier. Recommended for their versatility and high performance, and excellent value for money.

VA30 CHANNEL MODULE **£3·50** Carr. free

This is the basic channel module in the above mixers and may also be used for extra inputs on either the mono or stereo mixers. Fitted with volume, bass and treble controls, requires just a jack and supply (9–100V)



SAXON CSE 100 COMPLETE AMPLIFIER
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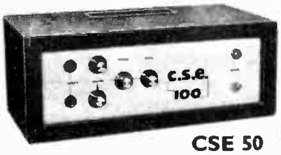
100W of speech and music—Two separately controlled inputs. Wide range bass and treble controls. Sturdy and attractive vynide case. Twin outputs. Ideal for groups, discos, etc. Fully tested and guaranteed. 50W version identical in appearance.



CSE 50
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Four individually controlled FET input stages plus wide range bass and treble controls. 120W of speech and music output from twin loudspeaker sockets. Sturdy case, and an attractive facia make this excellent value for money. Hundreds in use by groups, discos, clubs, etc.
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SAXON 50
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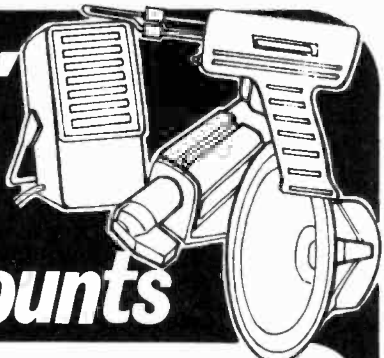

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EMI 3½" 3 or 8 ohm C/Mag .. 1·00
Cone Tweeter 8 or 15 ohm, 10 watt .. .. .. 2·40
Cone Tweeter 8 ohm, 3 watt 1·45
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12 x 12 x 6 with 8" 8" x 5" or 6½" and 3½" cut out .. .. 2·45
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DM160 Dynamic omni-dir. ball metal .. .. .. 3·85
UD130 50K/600 ohm, uni-dir ball me al .. .. .. 5·75
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SK 1 Kit (15 watt iron 2 spare Bib etc.) .. 3·30
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240v input 6, 7·5 or 9 300mA 2·75
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	1–5	6–10	11–20
C60	35p	33p	30p
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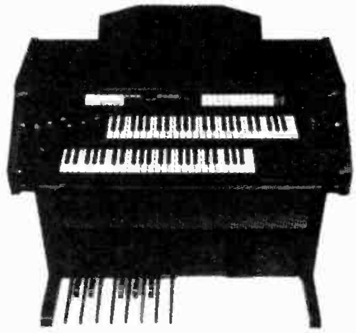

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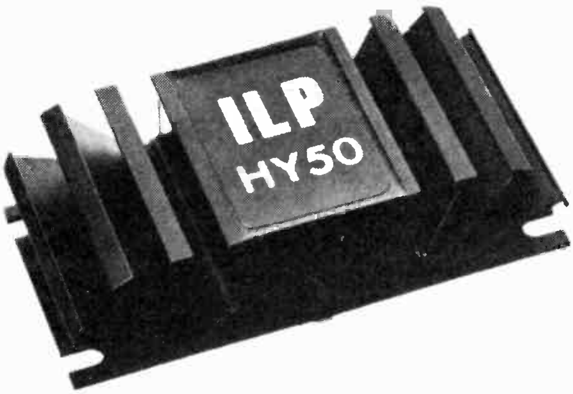
SECOND GENERATION 25 WATT HYBRID



A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices. We have now finally reduced the modular amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split line) power supply. The HY50 takes medium power modules to their logical conclusion by incorporating with it a heatsink, which is designed in special high conductivity alloy, sufficient for normal audio use without additional chassis sinking. All this without significantly increasing the size of the module comparable in size to a packet of 'King-size' cigarettes.

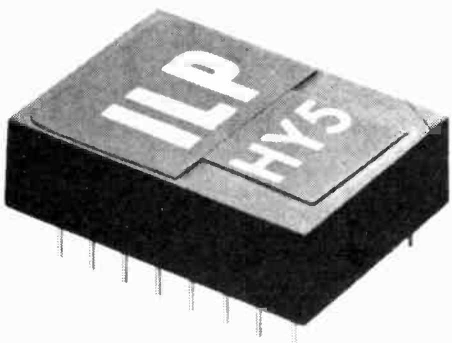
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

	SPEC.
OUTPUT POWER:	25 watts RMS, 50 watts peak music power
LOAD IMPEDANCE:	4·16Ω into 8Ω
INPUT SENSITIVITY:	Odb (0·775 volts RMS)
INPUT IMPEDANCE:	47KΩ
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25 watts typically 0·05
SIGNAL/NOISE RATIO:	better than 75db
FREQUENCY RESPONSE:	10Hz-50KHz ± 1db
SUPPLY VOLTAGE:	± 25 volts
SIZE:	105 x 50 x 25 mm

Price £5·80 mono, £11·60 stereo

Price inclusive of VAT & P & P

NEW HY5 PRE-AMPLIFIER



Unchallenged for two tears, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.
Like the HY50, the new HY5 has no external components & has been redesigned to run off a split power-line with improvements in signal/noise, overload, capability & reduced distortion. The output has been increased to match the power module (Odb), and to share the same power supply.
Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.
When combined with the HY50 & power supply only potentiometers are required to complete a simple mono amplifier with input & output facilities expected to be found on Hi-Fi amplifiers.
The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.

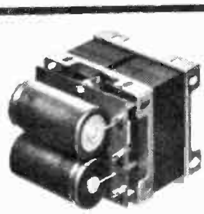
SPEC.

INPUTS
Magnetic Pick-up 3mV (within 1db RIAA curve)
Ceramic Pick-up up to 3mV
Microphone 10mV
Tuner 250mV
Auxiliary 3-100mV
Input impedance 47kΩ 1kHz

OUTPUTS
Tape 100mV.
Main output, Odb (0·775volts)

ACTIVE TONE CONTROLS
Treble ± 12db at 10kHz
Bass ± 12db at 100Hz
OVERLOAD CAPABILITY (equalization stage) 40db on most sensitive input
OUTPUT NOISE LEVEL (below 10mV magnetic input) 68db
DISTORTION 0·05% at 1kHz
SUPPLY VOLTAGE ± 16-25 volts
SUPPLY CURRENT 5mA
Price £4·85 mono, £9·70 stereo
Price inclusive of VAT & P & P

POWER SUPPLY PSU50



The new PSU50 has a low profile look being only 2½ inches high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25 volts
INPUT VOLTAGE 210-240 volts
SIZE L. 70, D. 90, H. 60 mm

Price £5·23
Price inclusive of VAT & P & P

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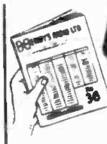

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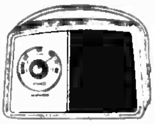

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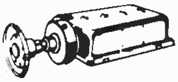

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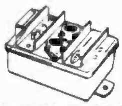

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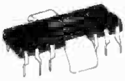

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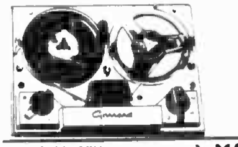

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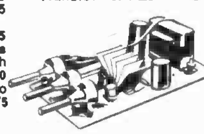

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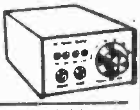

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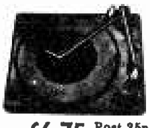

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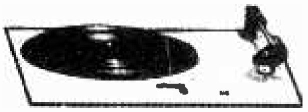

R.C.S. DISCO DECK SINGLE RECORD PLAYER
Fitted with auto stop. Acos stereo/mono cartridge. Baseplate. Size 11in × 8¾in. Turntable. Size 7in diameter. A/C mains. 220/250V motor has a separate winding 14 volt to power a small amplifier. 3 speeds plays all size records. **£5·50** Post 25p

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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
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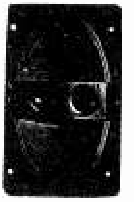

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¼	CF	22-2M2	1	0·75	0·60	0·55	3·9×10·5
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¼	MF	10-2M7	2	1·54	1·32	1·1	3x7
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8·0μF	40V	6½p	220μF	6·4V	6½p
10μF	16V	6½p	220μF	10V	6½p
10μF	25V	6½p	220μF	16V	8p
10μF	63V	6½p	220μF	63V	21p
15μF	16V	6½p	330μF	16V	12p
15μF	63V	6½p	330μF	63V	25p
16μF	40V	6½p	470μF	6·4V	9p
22μF	25V	6½p	470μF	40V	20p
22μF	63V	6½p	680μF	16V	15p
32μF	10V	6½p	680μF	40V	25p
33μF	16V	6½p	1000μF	16V	20p
33μF	40V	6½p	1000μF	25V	25p
32μF	63V	6½p	1500μF	6·4	15p
47μF	10V	6½p	1500μF	16V	25p
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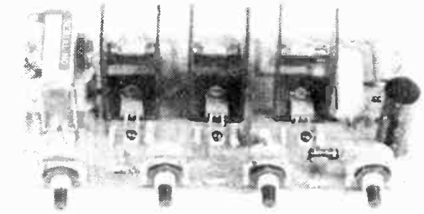

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EF80	**10p**	PCL82	**15p**	U191	**20p**
EBF89	**15p**	PCL84	**15p**	6BW7	**12p**
ECC81	**12p**	PCL85	**20p**	6F23	**15p**
ECC82	**12p**	PL36	**17p**	30F5	**12p**
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Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	£	P & P p
07	20	1	8	7·0 x 6·0 x 6·0	2·55	30
149	60	3	12	9·9 x 7·7 x 8·6	3·79	36
150	100	5	8	9·9 x 8·9 x 8·6	4·17	52
151	200	8	0	12·1 x 9·3 x 10·2	7·09	52
152	250	13	12	12·1 x 11·8 x 10·2	9·25	67
153	350	15	0	14·0 x 10·8 x 11·8	12·32	82
154	500	19	8	14·0 x 13·4 x 11·8	17·87	–
155	750	29	0	17·2 x 14·0 x 14·0	24·31	
156	1000	38	0	17·2 x 16·6 x 14·0	29·87	–
158	2000	60	0	21·6 x 15·3 x 18·1	49·25	–

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	£	P & P p
113	20	1	0	5·8 x 5·1 x 4·5	0-115-210-240	1·34	22
64	75	2	4	7·4 x 6·7 x 6·1	0-115-210-240	2·64	30
4	150	3	4	8·9 x 7·7 x 7·7	0-115-200-220-240	3·18	36
66	300	6	4	9·9 x 9·6 x 8·6	"	6·19	52
67	500	12	8	12·1 x 11·2 x 10·2	" "	9·20	67
84	1000	19	8	14·0 x 13·4 x 14·3	" "	16·71	82
93	1500	30	4	14·0 x 15·9 x 14·3	" "	24·19	–
95	2000	32	0	17·2 x 16·6 x 14·0	" "	31·57	•
73	3000	40	0	21·6 x 13·4 x 18·1	" "	39·17	•

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115V 500W enclosed transformer, with mains lead and two 115V outlet sockets. £9·49. P & P 67p. 20 Watt version £2·02 P & P27p

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Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	£	P & P p
111	0·5	0·25		8	4·8 x 2·9 x 3·5	0·12V at 0·25A x 2	1·34	22
213	1·0	0·5	1	4	6·1 x 5·8 x 4·8	0·12V at 0·5A x 2	1·58	22
71	2	1	1	12	7·0 x 6·4 x 6·1	0·12V at 1A x 2	2·09	22
18	4	2	2	12	8·3 x 7·7 x 7·0	0·12V at 2A x 2	2·95	30
70	6	3	3	8	8·9 x 8·0 x 7·7	0·12V at 3A x 2	3·52	42
108	8	4	5	8	9·9 x 8·9 x 8·6	0·12V at 4A x 2	3·96	52
72	10	5	6	4	9·9 x 9·6 x 8·6	0·12V at 5A x 2	4·67	52
116	12	6	6	12	9·9 x 10·2 x 8·6	0·12V at 5A x 2	5·61	52
17	16	8	8	12	12·1 x 9·9 x 10·2	0·12V at 8A x 2	7·22	52
115	20	10	11	8	14·0 x 9·6 x 11·8	0·12V at 10A x 2	9·20	67
187	30	15	15	8	14·0 x 12·1 x 11·8	0·12V at 15A x 2	16·94	82
226	60	30	32	0	17·2 x 15·3 x 14·0	0·12V at 30A x 2	31·28	•

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P p
112	0·5	1	4	6·1 x 5·8 x 4·8	0-12-15-20-24-30V	1·56	22
79	1·0	2	4	7·0 x 6·7 x 6·1	" "	2·11	36
3	2·0	3	4	8·9 x 7·7 x 7·7	" "	3·18	36
20	3·0	4	8	9·9 x 8·3 x 8·6	" "	3·96	42
21	4·0	6	4	9·9 x 9·6 x 8·6	" "	4·67	52
51	5·0	6	12	12·1 x 8·6 x 10·2	" "	5·83	52
117	6·0	8	0	12·1 x 9·3 x 10·2	" "	6·94	52
88	8·0	12	0	12·1 x 11·8 x 10·2	" "	9·00	67
89	10·0	13	12	14·0 x 10·2 x 11·8	" "	11·36	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P p
102	0·5	1	12	7·0 x 6·4 x 6·1	0-19-25-33-40-50V	2·09	30
103	1·0	2	12	8·3 x 7·4 x 7·0	" "	3·08	36
104	2·0	5	8	9·9 x 8·9 x 8·6	" "	4·26	42
105	3·0	6	12	9·9 x 10·2 x 8·6	" "	5·79	52
106	4·0	10	0	12·1 x 10·5 x 10·2	" "	7·69	52
107	6·0	12	0	14·0 x 10·2 x 11·8	" "	11·38	67
118	8·0	18	0	14·0 x 12·7 x 11·8	" "	12·40	97
119	10·0	25	0	17·2 x 12·7 x 14·0	" "	18·62	•

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	£	P & P p
124	0·5	2	4	7·0 x 6·7 x 6·1	0-24-30-40-48-60	2·12	36
126	1·0	3	4	8·9 x 7·7 x 7·7	" "	2·97	36
127	2·0	6	4	9·9 x 9·6 x 8·6	" "	4·67	42
125	3·0	8	12	12·1 x 9·9 x 10·2	" "	7·11	52
123	4·0	13	12	12·1 x 11·8 x 10·2	" "	9·20	67
40	5·0	12	00	14·0 x 10·2 x 11·8	" "	10 83	87
120	6·0	15	8	14·0 x 12·1 x 11·8	" "	13·35	82
121	8·0	25	00	14·0 x 14·7 x 11·8	" "	15·01	•
122	10·0	25	0	17·2 x 12·7 x 14·0	" "	22·10	•
189	12·0	29	00	17·2 x 14·0 x 14·0	" "	24·74	•

MINIATURE TRANSFORMERS WITH SCREENS

Ref.	MA.	Weight		Size cm	VOLTS	£	P & P p
238	200		2	2·8x2·6x2·0	3-0-3	1·44	10
212	1A 1A	1	4	6·1x5·8x4·8	0-6 0-6	1·67	22
13	100		4	3·9x2·6x2·9	9-0-9	1·23	10
235	330,330		4	4·8x2·9x3·5	0-9, 0-9	1·67	10
207	500, 500	1	00	6·1x5·4x4·8	0-8-9, 0-8-9	2·23	22
208	1A, 1A	1	12	7·0x6·4x6·1	0-8-9,0-8-9	3·00	30
236	200, 200		4	4·8x2·9x3·5	0-15, 0-15	1·67	10
214	300, 300	1	4	6·1x5·8x4·8	0-20, 0-20	1·76	22
221	700 (D.C.)	1	8	7·0x6·1x6·1	20-12-0-12-20	1·55	30
206	1A, 1A	2	12	8·3x7·7x7·0	0-15-20, 0-15-20	4·05	36
203	500, 500	2	4	8·3x7·0x7·0	0-15-27, 0-15-27	3·10	38
204	1A, 1A	3	4	8·9x7·7x7·7	0-15-27, 0-15-27	3·15	38

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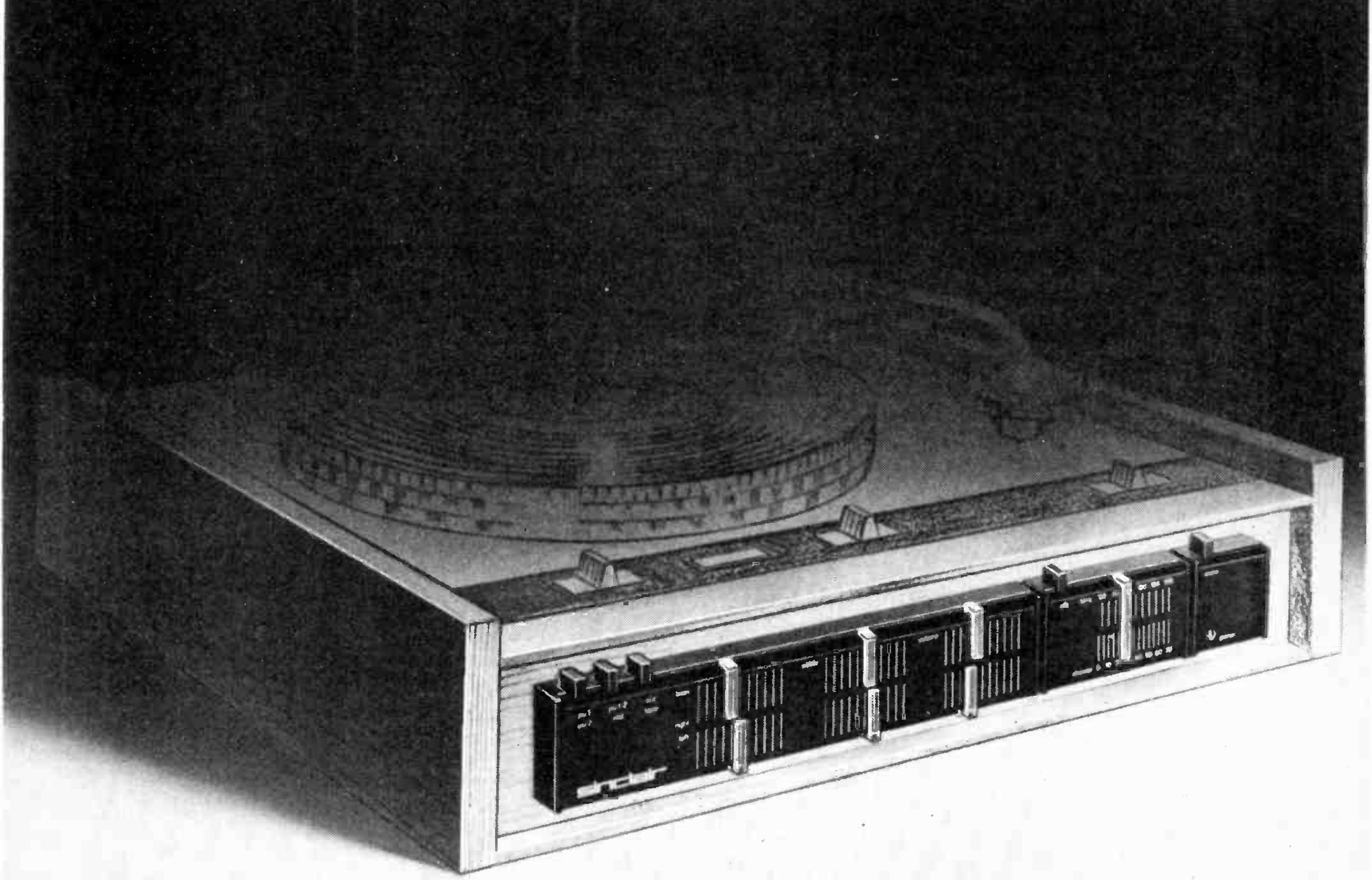
Project 80

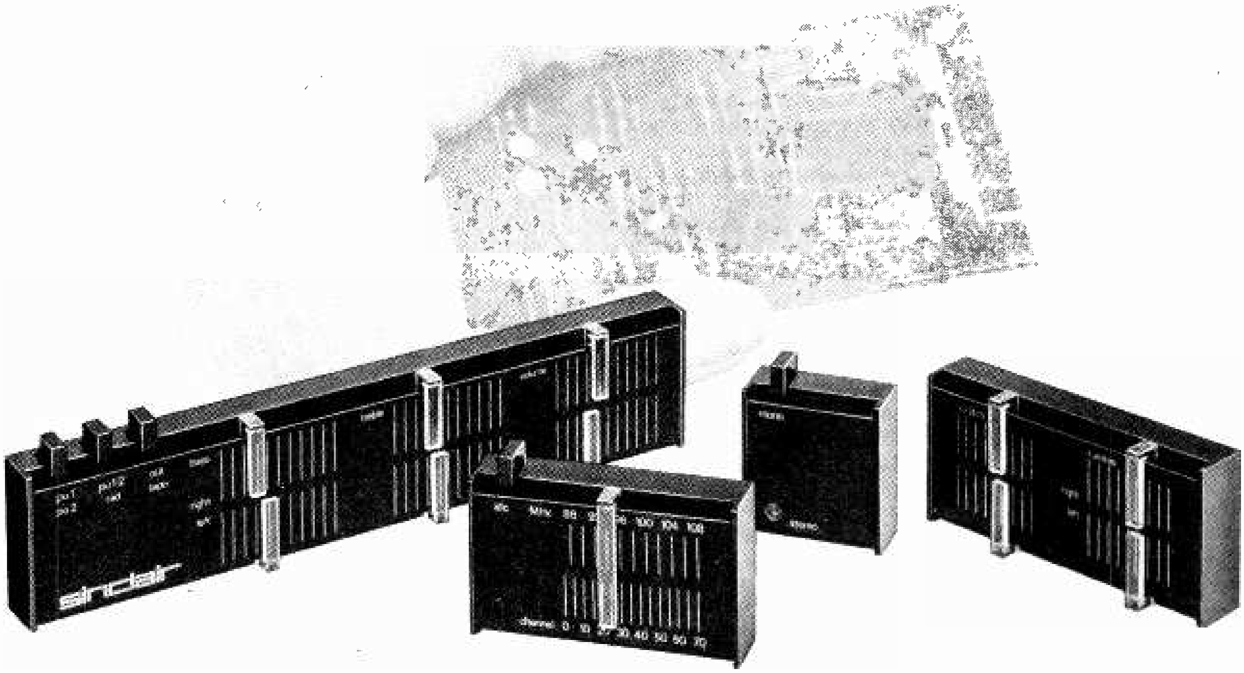
a brilliant new concept in modular hi·fi



Project 80 is going to be the ultimate in modular hi-fi construction for a very long time to come. It combines the qualities most demanded of any modern domestic system – good circuitry, reliability and fine performance – with other features to be found nowhere else in the world. For example, *compactness* – Project 80 control units are $\frac{3}{4}$" deep × 2" high, and each one is completely self-contained. *Elegance* – all of Sinclair's design leadership has been concentrated on producing designs of outstanding functional elegance unsurpassed for styling and simplicity. *Flexibility* – the size and styling of Project 80 modules makes them the most versatile units ever. Combine them how you will, where you will, the Project 80 System of your choice gives you the best.

sinclair

Sinclair Project 80



technically the world's most advanced

Project 80 gives you choice from a range of 9 different modules for combining in a variety of ways to suit your requirements. The Stereo 80 is a versatile pre-amp control unit designed to meet all domestic hi-fi requirements including tape monitoring, high sensitivity magnetic cartridge input, and of course, individual slide controls on each channel for precise output matching. By separating the F.M. tuner and stereo decoder, useful economies can be effected where stereo radio reception is not needed. Two power amplifiers – Z.40 (18 watts RMS continuous into 4 ohms using 35V) and Z.60 (25 watts RMS continuous into 8 ohms using 50V) are available with choice of 3 different power supply units. The PZ.8 with its virtually indestructible circuitry is particularly recommended. For the final word in system building, the Active Filter Unit puts the finishing touch of quality to what are easily the world's most technically advanced hi-fi modules. Any further units likely to be added to Project 80 range will be compatible with those already available.

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.

sinclair

Sinclair Radionics Ltd
London Rd., St. Ives
Huntingdon PE17 4HJ
Telephone
St. Ives (0480) 64646

Stereo 80 Control Unit 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 350mV Radio 100mV; 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 tape radio and P U Sliders on each channel for volume bass treble RRP (add £1 19 VAT.) **£11.95**

Project 80 FM Tuner Size – 85 50 · 20mm (3½ · 2 · ¾ins) Tuning range Dual varicap – 87·5 to 108MHz Detector – I C balanced coincidence One I C. equal to 26 transistors Distortion – 0 2% at 1KHz for 30% modulation 4 pole ceramic filter in I.F. section Aerial impedance – 75 Ω or 240 300 Ω Sensitivity – 5 microvolts for 30dB S/N ratio Output – 300mV for 30% modulation Power requirements – 25 to 35 volts (RRP add £1 19 VAT) **£11.95**

Project 80 Stereo Decoder Size – 47 · 50 · 20mm (1⅞ · 2 · ¾ins) One 19 transistor I.C. Channel separation greater than 30dB Power requirements – 25V Output 150mV per channel RRP (add 74p VAT) **£7.45**

Active Filter Unit Separate controls on each channel Size – 108 50 · 20mm (4¼ 2 · ¾ins) Voltage gain – minus 0 2dB Frequency response – 40Hz to 22KHz controls minimum Distortion – at 1KHz – 0 03% using 30V supply H F cut off (scratch) – 22 KHz to 5 5KHz, 12dB/oct slope L.F. cut off (rumble) – 28dB at 20Hz 9dB/oct slope RRP (add 69p VAT) **£6.95**

Z.40 Power Amplifier Size – 55 80 · 20mm (2⅛ · 3⅛ ¾ins) 9 transistors Input sensitivity – 100mV Output 18 watts RMS continuous into 4 Ω (35V) Frequency response – 30Hz-100KHz ± 3dB S/N ratio – 64dB Distortion – at 10 watts into 8 Ω less than 0 1% Power requirements – 12 to 35 volts, built in protection against overload RRP. (add 54p VAT) **£5.40**

Z.60 Power Amplifier Size – 55 98 · 15mm (2⅛ · 3¾ · ¾ins) 12 transistors Input sensitivity – 100-250mV Output – 25 watts RMS continuous into 8 Ω (50V) Distortion – typically 0·03% Frequency response – 15Hz to more than 200KHz ± 3dB S/N ratio – better than 70dB Built-in protection against transient overload and short circuiting Load impedance – 4 Ω min safe on open circuit RRP (add 69p V.AT) **£6.95**

Power Supply Units PZ.8 Stabilised Re-entrant current limiting makes damage from overload or even direct shorting impossible Normal working voltage (adjustable) 50V RRP £7·98 - 79p VAT Without mains transformer PZ.6 35V stabilised RRP £7·98 – 79p V.A.T PZ.5 30V unstabilised R.RP £4·98 - 49p VAT

To Sinclair Radionics Ltd. St. Ives Huntingdon PE17 4HJ

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PW 8

SURPRISE!

PROBABLY one of the most interesting features about our activities is that there is always a chance of the unexpected happening. It may be an unusual DX contact, or a circuit design that behaves in a different manner than expected. It could be that someone comes up with a new integrated circuit that can replace a mass of discrete circuitry. The element of surprise always helps to make a magazine interesting; readers are incredibly thirsty for such information because it is born out of curiosity (see last month's leader). Whilst curiosity is the expectation, you may describe surprise as "unexpectation"—if there was such a word.

At the same time, to preserve the value of surprise, one must exercise some degree of secrecy until it is reasonably sensible to release the full details. However, we often find ourselves caught between these two positions when we have to judge how much we can tell you in advance and how much to leave until the last minute.

For this reason, little information was released about Tele-Tennis, much to the disappointment of our competitors and those who have a commercial interest, and little was released about the "PW Super Separates" that are being started in this issue. So far, we can tell you that the "PW Derby" is a high quality amplifier designed specially for us and described by the co-designer of the "Gemini" amplifier. What follows in future articles in this series must remain secret until the time is right to let readers know.

However, we can tell you that these designs are of a very high standard. For those readers who have a good domestic set-up already, we can probably help you to fill the gaps. If you are looking for a second set-up for the bedroom or spare room, then stay tuned to P.W. every month.

The great advantage of the "P.W. Super Separates" is their flexibility; you don't have to spend a lot of money to build a complete integrated unit, that seems to go on endlessly for about a year. Take your choice and we shall try to publish all the required details of each project.

What better to start with than a stereo headphone amplifier, rapidly becoming the accepted way of personal listening, where the 20 or 30 watt amplifier is more expensive and often too much for personal listening. For information on future projects watch our advance notices each month.

Before packing my bags for a fortnight's holiday, there is just one more point. We understand that some readers are having difficulty in obtaining P.W. and that the Tele-Tennis game has created a rapid demand as soon as it appears. If there are none left on display in your newsagents shop, ask the assistant if they have any more. The chances are that there may be some in the stockroom. Better still, why not place a regular order or take out a subscription and be sure of it.

M. A. COLWELL—*Editor.*

The September issue brings you to the second in the "P.W. Super Separates"—the P.W. Epsom Short Wave Receiver, designed to provide wide coverage of both amateur and broadcast transmissions; a very useful practical article on the use of field transistors; an add-on "squelch" for suppressing noise in audio systems; and of course part 3 of "Tele-Tennis".

Further details on page 327

(All advanced details are subject to the current industrial situation)

NEWS...

BBC and quadraphony

THE BBC has been working for some time on the possible applications of quadraphony to broadcasting. A number of four channel recordings have been made using different production techniques and several transmission systems have been examined. Unfortunately, no system has yet been devised which would enable quadraphonic material to be broadcast from a single v.h.f. transmitter while at the same time providing fully satisfactory reception to listeners using monophonic or stereophonic receivers.

The results obtained with some quadraphonic recordings are impressive, and there is considerable public interest in this development. To enable those who were interested to hear a number of recent BBC quadraphonic recordings, there was an experimental broadcast from 12.05 am to 1 am on the early morning of Saturday, 6 July. Two groups of stereo transmitters were used, Radio 2 carrying the left and right front signals, with Radio 3 carrying the left and right rear signals. To take full advantage of the quadraphonic transmission, listeners required two complete stereophonic receivers, one tuned to Radio 2, feeding the 'front' loudspeakers; a second stereo receiver tuned to Radio 3 connected to the 'rear' speakers.

The special programme included a variety of different musical items as well as some drama and outside broadcast material. The BBC would be grateful for reports from listeners who were able to hear this experimental broadcast.

It must be emphasised that there is no possibility of a regular quadraphonic service on the basis of two separate transmitter networks, but the BBC will continue its investigations into the possibility of a system to provide quadraphonic programmes from a single transmitter, without degrading the results obtained by those with mono or stereo receivers.

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

Interface 74

TEXAS Instruments recently held a very interesting seminar called 'Interface 74'.

Several excellent lecturers spoke on new bipolar IC's and their applications and a very interesting talk on new opto-electronic products by Martin Abbott followed.

An ultrasonic remote-controlled-colour TV was demonstrated by Clive Hoggar, Product Marketing Manager (Consumer IC's) and this was followed by a talk on power transistors presented by John Thorogood and Bryan Norris, Texas Instruments' Applications Manager.

The "star of the day" was Pauline Hamill, Product Marketing Manager for Small Discrete Products. She gave a most interesting lecture (despite a dodgy radio mike!) on Timtor transistors to over 300 male delegates who sat in awed silence. At the end of her talk, Pauline received a great round of applause. (think what courage you would need fellas, to lecture to over 300 women!) Well done Pauline!

Millis Miller, in a lilting Texan accent told the delegates all about the various applications of optoelectronics and this was followed by a talk describing new MOS products.

The day's lectures finished with a question and answer session chaired by Richard Mann, the "mann" who very ably organised and produced the seminar. Richard is the Market Communications Manager of Texas Ltd.

All the delegates were presented with a very comprehensive Data Pack.

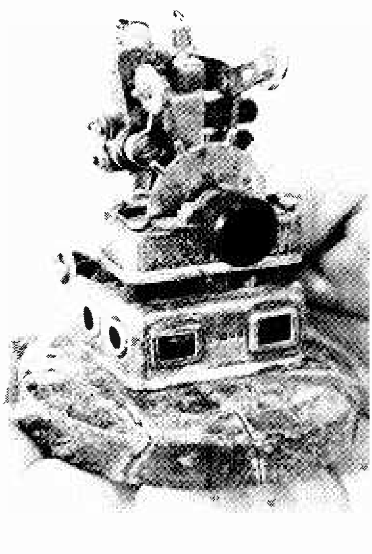
Texas hold these seminars every year and they're jolly good value for money, so if you want details of future presentations, contact T. I. Limited at Manton Lane Bedford (0234-67466).

Preston rally

ON 18th August Preston Amateur Radio Society are holding their mobile rally at Deepdale Primary School, St. Stephen's Rd., Preston.

Marconi Exhibition at Science Museum

INCLUDED in the Science Museum, London, exhibition commemorating the centenary of Guglielmo Marconi is a case of personalia like this silver table lighter made in the form of a disc discharger used in the Marconi Company's early long range transmitters. A number of these lighters were made for presentation to delegates attending a conference arranged by the Company in 1912.



(Science Museum photo).

Lee Products

LEE PRODUCTS (GB) are marketing a range of Aiko home entertainment and ICE products under an agreement with the Japanese manufacturer.

Aiko products are added to the existing Elizabethan, Elpico and Dulci brand names.

The 14 Aiko products range from portable cassette tape recorders to a stereo casette deck operating with the Dolby system and priced at £135 including VAT.

The announcement of the Aiko range coincides with Lee Products move to their new premises at Dallas House, Aintree Road, Perivale, Middlesex.

Sinclair price drop

EUROPE's largest manufacturer of pocket calculators, Sinclair, has cut the retail price of its "Cambridge" model to £24·95 plus VAT.

Mr. R. Helmer, Sinclair's marketing manager stated recently that the firm's motive for making the price reduction is to open up a vast new market potential which recent research shows exists around the £20 mark.

The firm state that they are able to bear the price cut because of the scale already achieved on the production of the Cambridge. More than 200,000 units have been sold since its introduction last August.

Mr. Helmer said that 17,000 of the 25,000 units manufactured every month were required for export.

The Cambridge is still available in kit form at £14·95 plus VAT.

Our Front Cover

THE Zero 100 SB automatic single player featured on our cover this month was kindly loaned by Garrard Engineering. The Zero 100 was first introduced in 1971 and has established an excellent reputation, especially for its tangential tracking arm. This unique arm, with its pivoted head is claimed to economically reduce tracking error and harmonic distortion to virtually zero.

The Zero 100 SB retains the refinements included in the earlier decks but has the added advantage of belt drive and an automatic record counter to help monitor stylus wear.

Recommended retail price of the unit, fitted with a Shure M93E cartridge is £69·72. Further information may be obtained from *Garrard Engineering Ltd., Newcastle Street, Swindon, Wiltshire.*

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

L. CASE G8BJQ

two metre converter

A COMMON procedure used to obtain reception of signals in the 2m Amateur band is to employ a crystal-controlled converter the output of which is coupled to the aerial input of a standard short wave communications receiver, which is utilised as a tunable IF strip.

Commercial converters are, in the main, quite expensive and in some cases can cost nearly as much as the listener's main receiver. The converter to be described can be built at less than half the cost of its commercial counterpart but, unfortunately, many constructors have a great deal of difficulty, if not in the actual constructional work involved, then in the alignment of the various stages of the converter.

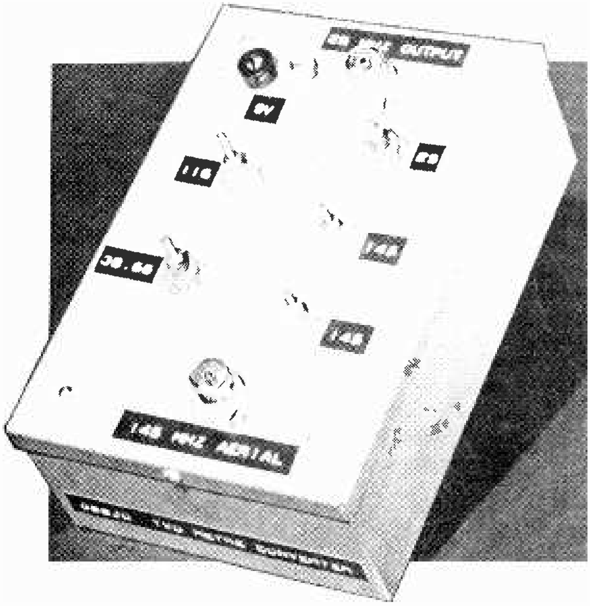
Perhaps the biggest problem in attempting to construct a published design is the duplication of the low inductance coils and persuading them to resonate at the desired frequencies. The problem is made doubly difficult, if not impossible, by the lack of the appropriate test equipment.

On first inspection of the various component catalogues and coil data available no coils are specifically manufactured for frequencies higher than approximately 80 MHz. The types available nearest to our requirements are the Denco Range 7 coils, intended initially for valve usage to cover a frequency range extending up to 78 MHz. Comparatively large parallel capacitance is used to achieve this coverage and simple calculations reveal that, using much smaller values of parallel capacitance, coverage to at least 150 MHz was possible. With this fact in mind the present design was evolved.

THE CIRCUIT

The circuit of the complete converter is shown in Fig. 1. The RF stage Tr1 employs an AF139 in the common-base mode with untuned input from the aerial and a double-tuned bandpass arrangement at the output to feed the mixer, top capacitance coupling being provided by means of C4. Extra gain could have been achieved by employing the same transistor in the common-emitter configuration, but this would have required some form of neutralisation so in the interests of simplicity this was not thought to be desirable. The circuit used has been found, in practice, to provide ample gain and has at no time showed any signs of instability when using such diverse aerials as random lengths of wire and multi-element Yagi arrays.

The crystal oscillator stage Tr3 employs an AF115 as does the common-base frequency multiplier Tr4. The frequency of oscillation is controlled by the quartz crystal X1, C10 providing the necessary feedback capacitance to maintain oscillation. The circuit will not oscillate unless the tuned circuit L4/C9 is resonant near to the frequency of the crystal, which in this case is 38·666 MHz, adjustment of the tuned circuit being achieved by means of the core in L4. The 38·666 MHz output is then link coupled to the tripler stage Tr4, the output of which is tuned to 116 MHz and link coupled via L5 to the gate circuit of the 2N3819 FET mixer Tr2.



The amplified RF signal at 145±1 MHz is then mixed with the oscillator output frequency at 116 MHz. The difference frequency 29±1 MHz is then extracted from the FET drain circuit and fed via L3, which is tuned to 29 MHz by C7, to the main receiver aerial socket. With the converter oscillator frequency operating below signal frequencies, the direction of tuning on the main receiver will be maintained. This means that when tuning from 28 MHz up to 30 MHz on the main receiver, the converter is tuning from 144 MHz to 146 MHz.

CONSTRUCTION

The converter is housed in a readily available aluminium box with lid measuring 6×4×2in allowing ample room for the coils and other components. Most of the wiring and small components are accommodated on a $5\frac{1}{2}\times3\frac{1}{2}$in piece of single sided copper clad board Fig. 2 which has the advantage that components and screens can be soldered directly to it, enabling short earth returns to be made.

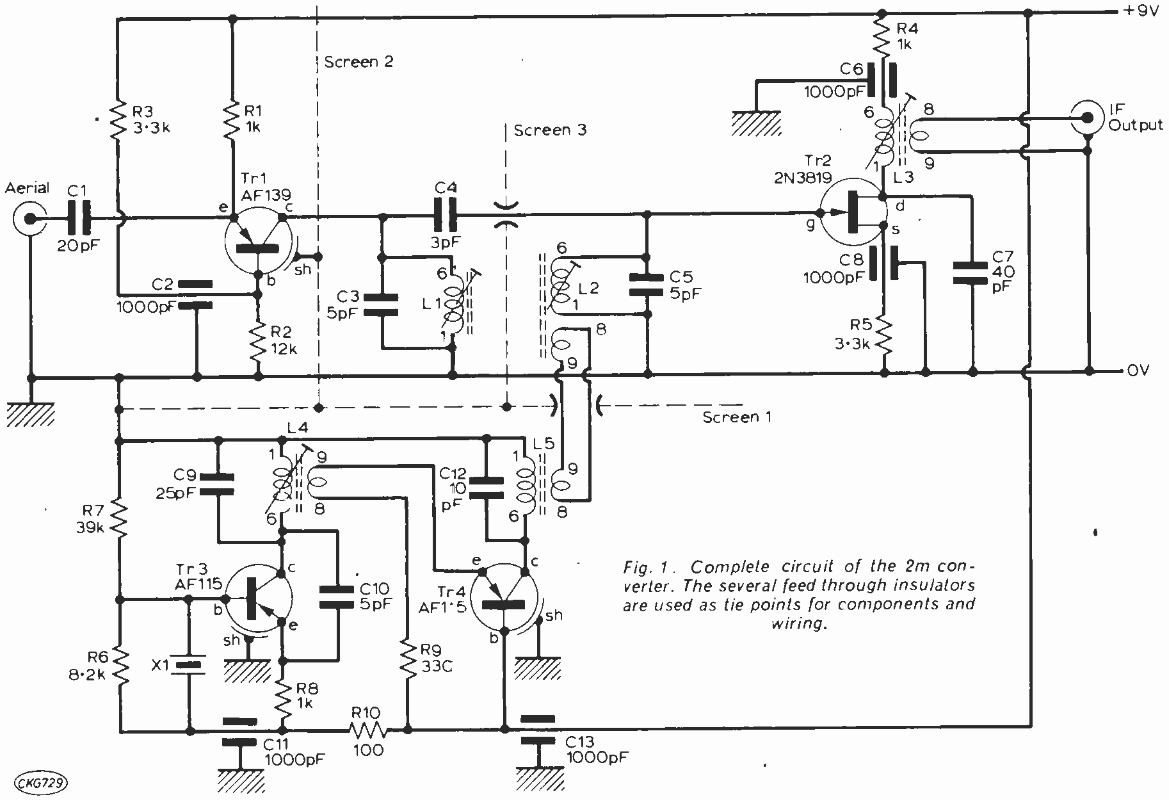


Fig. 1. Complete circuit of the 2m converter. The several feed through insulators are used as tie points for components and wiring.

★ components list

Resistors

R1	1kΩ	R6	8·2kΩ
R2	12kΩ	R7	39kΩ
R3	3·3kΩ	R8	1kΩ
R4	1kΩ	R9	330Ω
R5	3·3kΩ	R10	100Ω

All resistors ¼ or ½W 10%

Capacitors

C1	20pF TC	C8	1000pF FT
C2	1000pF FT	C9	25pF TC
C3	5pF TC	C10	5pF TC
C4	3pF TC	C11	1000pF FT
C5	5pF TC	C12	10pF TC
C6	1000pF FT	C13	1000pF FT
C7	40pF TC		

TC Tubular Ceramic   FT Feedthrough

Semiconductors

Tr1 AF139   Tr3/4 AF115
Tr2 2N3819

Inductors

L1/2/5/ Range 7 Red
L3/4 Range 5 Blue

All Denco miniature dual-purpose (valve type) coils. Cores must be specifically requested for the Range 7 coils.

Miscellaneous

Aluminium box 6 x 4 x 2in (Type AB13). Copper-clad board 5½ x 3½in. Coaxial sockets (2). Battery plugs/sockets (2). Crystal 38·666MHz HC6U or HC18U (Senator Crystals, 36 Valleyfield Rd., London, SW16 2HR).

The copper clad board is mounted on ⅜in spacers, one at each corner, and the five Denco coils are mounted on the aluminium box lid. This means that although ¼in fixing holes are needed in the lid, ½in holes are required in the board so as to clear the main form of the coils. This method of construction, in effect, lowers the coil pins enabling shorter coil connections to be made, which is a distinct advantage at the frequencies involved. The two coaxial sockets and the battery sockets are also mounted on the box lid, holes being suitably provided in the copper board to take their connections.

The copper board should be cut and drilled Fig. 3, making sure that holes have been provided for all the coils, the feedthrough capacitors and the aerial, IF output and battery leads plus of course the holes for the 6BA fixing nuts and bolts. This board can then be used as a template for drilling the box lid. The feedthrough capacitors can now be soldered or bolted into position cutting off just enough of the pins on the non-copper side of the board so that they do not make contact with the underside of the box lid when it is in position.

At this point R10 must be soldered into position between the projecting pins of C11 and C13 on the non-copper side of the board. The aerial, IF output and battery sockets can now be fixed in position on the box lid and the copper board mounted on its spacers ready for wiring the remainder of the components.

Short direct wiring must be used and special care taken when soldering to the coil pins. The polystyrene formers used for the coils will melt if subjected to excessive heat and it is perhaps a good idea to use a heat sink on the coil pins, as well as on all the transistor leads, when soldering.

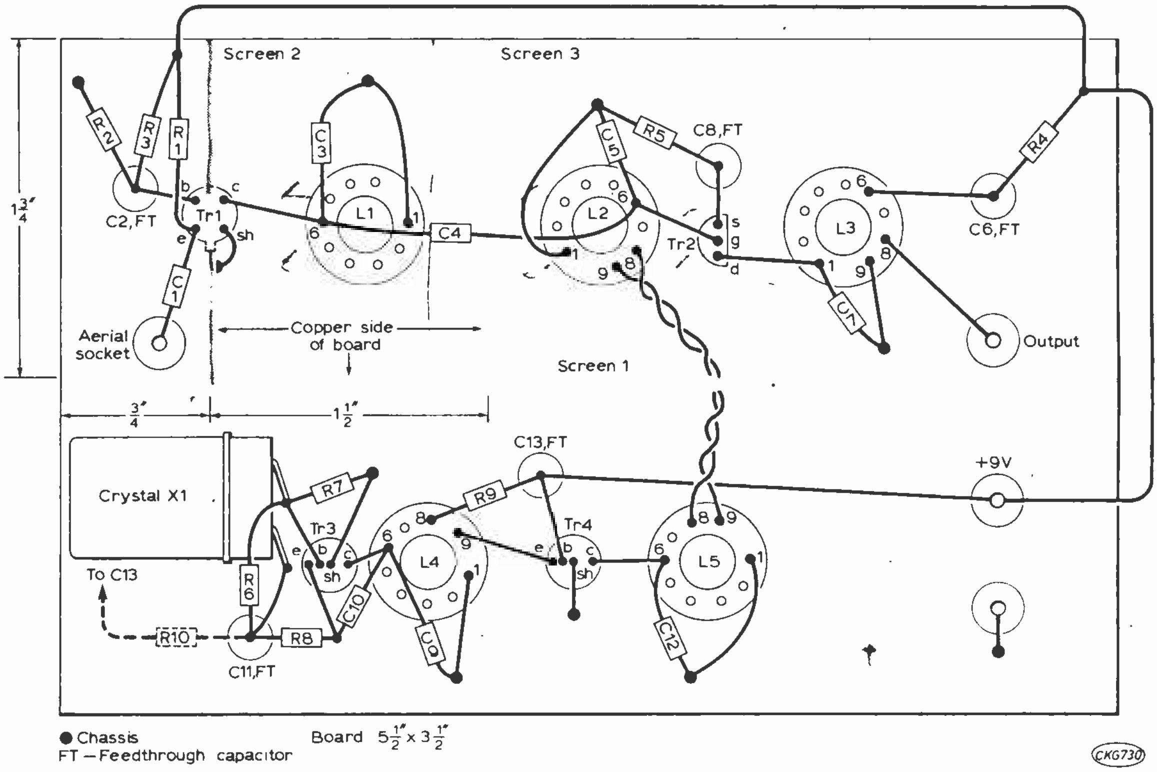
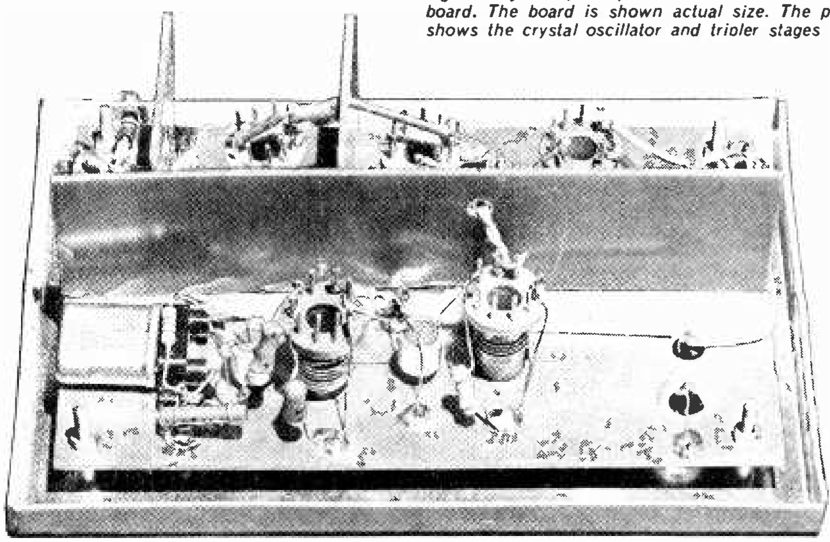


Fig. 2: Layout of components and screens on the copper-clad board. The board is shown actual size. The photograph below shows the crystal oscillator and trioler stages of the converter.



The crystal used in the original converter was of the HC6U type and the necessary crystal holder was glued in position on the copper board.

A wire ended crystal of the HC18U type could also be used, no holder then being required.

ALIGNMENT

Before any 2m signals can be heard with the converter the crystal oscillator stage Tr3 must be operating. Adjustment of L4 core will make the oscillator work. This can be checked by connecting a meter in series with one of the battery leads and adjusting L4 for a peak in current, indicating that the oscillator is functioning correctly The battery supply should be switched on and off several times to ensure that the oscillator works every time. If the oscillator fails to restart at any time, tune L4 very slightly to the high frequency side of the current peak, i.e. anticlockwise about half a turn. Adjustment of L5 core should now produce another similar but smaller increase in current when tuned to 116 MHz.

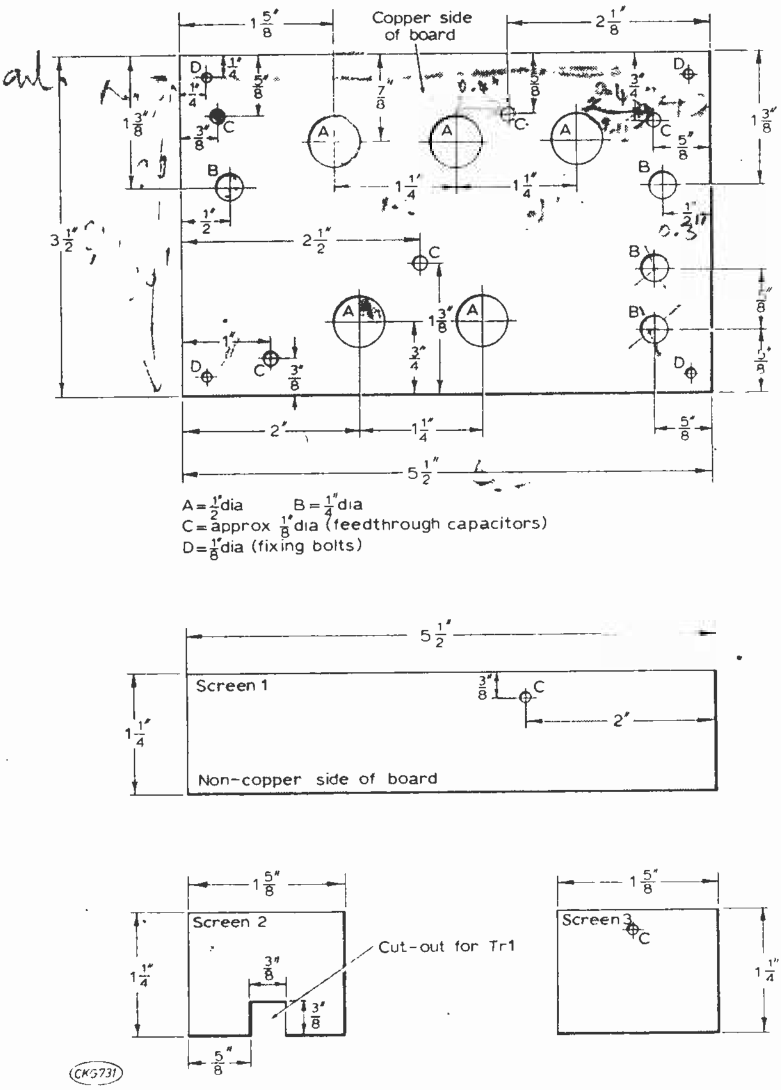
Operation of the oscillator on any frequency other than 38·666 MHz and thus the multiplier on 116 MHz, was found to be impossible with the values of parallel capacitance used. In order to align the remaining tuned circuits the converter should now be coupled to the main receiver by means of a short length of coaxial cable and the receiver tuned to 29MHz. A suitable 2m aerial should be plugged into the converter aerial socket. The IF output coil L3 and the two 145 MHz tuned circuits L1 and L2 should be peaked by means of their respective cores for maximum noise from the loudspeaker or headphones. The coils should now be very close to their correct settings and any strong signals on the 2m band should be heard if the main receiver is tuned from 28 to 30MHz. The coils can then be finally adjusted on these incoming signals.

As a guide when setting the coil cores the length of brass studding projecting from the top of coils L2, L4 and L5 when correctly aligned was 0·4in, L1 was 0·3in, and L3 was 0·2in. When final alignment has been completed the cores can be locked in position with 6BA nuts.

AERIALS

Although a simple dipole or halo type of aerial will provide satisfactory reception of signals from local or near local stations, the increase in range obtained by using a multi-element Yagi aerial far outweighs its cost and is a very worthwhile acquisition. Dimensions for a simple half-wave dipole suitable for initial tests are given in Fig. 4.

The choice of output frequency of the converter was purely a personal one and 28 to 30 MHz used because an Amateur-bands-only receiver was in



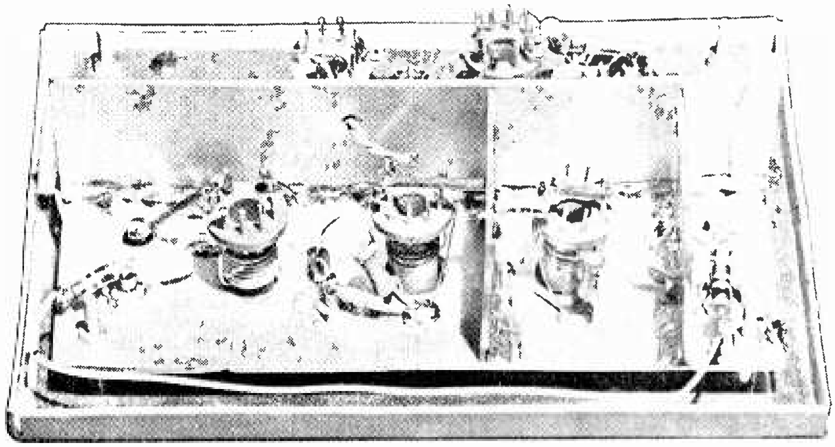


Fig. 3: Top left, gives all the drilling information required to prepare the board for wiring. The screens are soldered directly to the main board as are many of the component earth returns. The photograph emphasises the simplicity of the design. This view is of the RF tuned circuits and the IF output coil L3 at extreme left.

use. It is realised that not all general coverage receivers provide adequate performance at such high frequencies, often lacking in sensitivity, image frequency rejection and bandspreading facilities. In such cases a lower tunable IF is desirable, the most popular seeming to be 4 to 6 MHz. For this lower IF the crystal must be changed to 46·666 MHz, C9 to 18pF, C12 to 6·8pF, C7 to 35pF and L3 to a Range 3 Blue coil.

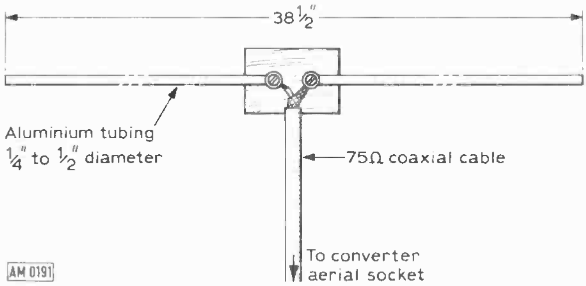


Fig. 4: This simple dipole will do for initial tests of the converter but a beam aerial will greatly improve results.

Although the converter is fully screened, if the lower IF is used trouble may be experienced with signals breaking through at the tunable IF frequencies, especially if the main receiver is not fully screened. The shortest practicable length of coupling coax should be used in these cases and if this is unsuccessful the metal case of the converter should be bonded to the main receiver case by a short metal strap. ■

PW TECHNICROSS PUZZLE No. 5 Solution

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

I.C. OF THE MONTH

Number 46 LM381N DUAL LOW NOISE AMPLIFIER

THE National Semiconductor LM381N device contains two similar low noise preamplifiers in a single integrated circuit. It has a wide range of uses in entertainment equipment, such as amplifying the signals from stereo tape recorder heads or cartridges. It is an ideal device for amplifying low level signals in low noise applications. The amplifiers are completely independent and each provides a gain, without feedback, of about 112dB; a voltage gain of 160,000.

The device provides a channel separation of 60dB whilst the internal power supply decoupling and regulator circuits provide 120dB rejection of signals on the power supply line, such as mains hum. Although many attempts have been made to use suitable operational amplifiers for low noise audio applications, the availability of the new LM381N designed specifically for these applications makes it possible to obtain lower noise levels, better rejection of signals on the power supply lines, wider bandwidth, with fewer external components.

A specially selected ultra-low noise version of the LM381N is available under the coding LM381AN. It is used in critical applications requiring the lowest possible noise levels, such as hydrophone amplifiers, studio sound equipment, scientific instrumentation etc. The LM381AN is naturally somewhat more expensive than the more commonly used LM381N.

The LM381N operates from a single power supply in the range 9V to 40V. The typical supply current is 10mA. The device contains internal circuits which protect it from damage if the output is accidentally shorted limiting the output current to about 12mA. The maximum output voltage swing which can be obtained from the LM381N is only 2V less than the power supply voltage used. The total harmonic distortion is typically 0·1%.

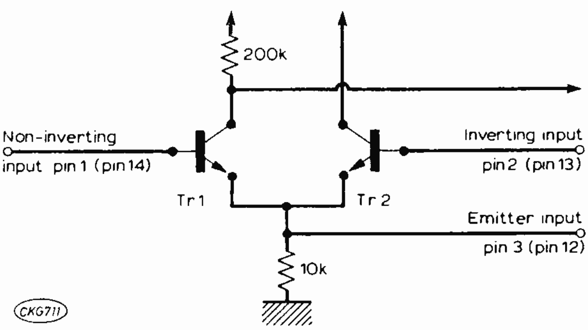


Fig. 1: The internal input circuit of the LM381N.

Input

The basic circuit of the input stage of one of the amplifiers in the device is shown in Fig. 1. In the circuits and text the pin numbers of the **second** amplifier will be shown in brackets. The optimum noise performance is obtained with 'single ended operation'. In this case Tr2 is biased OFF and feedback is taken to the common emitter of pin 3 (pin 12). Noise figures with single ended operation are typically 1dB with 50kΩ input impedance, 1·3dB with 10kΩ and 1·6dB with 5kΩ input over the frequency bandwidth 10Hz to 10kHz.

When the extra noise contributed by Tr2 can be tolerated, the feedback may be taken to the inverting input of pin 2 (pin 13). The impedance at the base of Tr2 is about one hundred times higher than that at the emitter; smaller capacitors and larger resistors can therefore be employed when the feedback in tone and equalization circuits is returned to the base. However, in this 'differential' configuration the noise is increased by a factor of $\sqrt{2}$. The input impedance is of the order of 100kΩ whilst the output impedance is 150Ω.

Bandwidth

The amplifiers each contain an internal frequency compensating capacitor which results in a gain-bandwidth product of about 15MHz. This is the frequency at which the gain falls to unity. This compensation is adequate to preserve stability at a

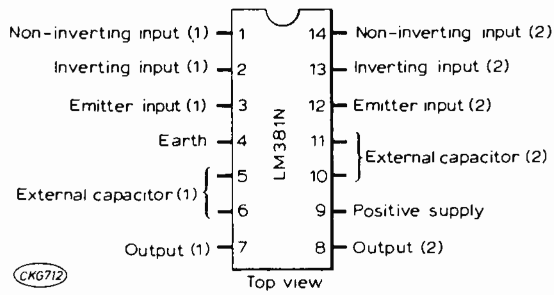


Fig. 2: The connections of the LM381N. The connections to the two internal amplifiers are distinguished by the numbers in brackets.

closed loop gain of 10. A suitable external capacitor may be placed in parallel with the internal capacitor connecting between pins 5 and 6 (pins 10 and 11), Fig. 2. This reduces the amplifier bandwidth and thus removes most of the high frequency noise.

Applications

Tape Playback Preamplifier using the LM381N is shown in Fig. 3. Tape playback amplifiers must contain frequency compensation circuits so that the overall record-replay operation shall produce a level frequency response. The capacitor C1 provides an amount of negative feedback which increases with rising frequency. The gain therefore decreases with rising frequency, the circuit being designed to have a response complying with the NAB standard for a tape speed of $3^3{}_4$ i.p.s.

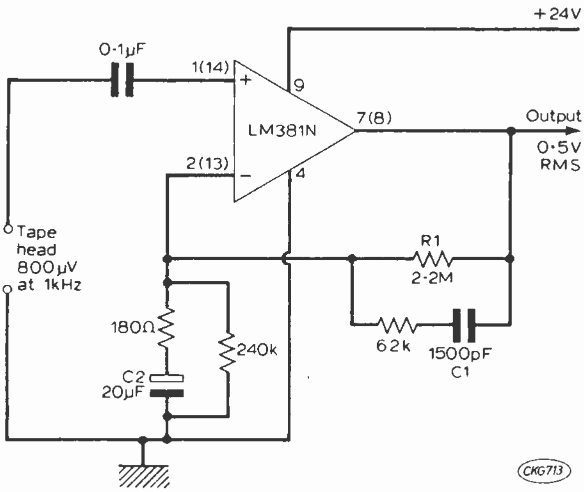


Fig. 3: A typical tape playback preamplifier.

The circuit will convert an output of 800μV from a playback head into a 0·5V RMS signal at the preamplifier output at a frequency of 1kHz, a voltage gain of 56dB. This circuit requires about five seconds before it can be used after the power has been supplied since C2 takes time to charge through R1.

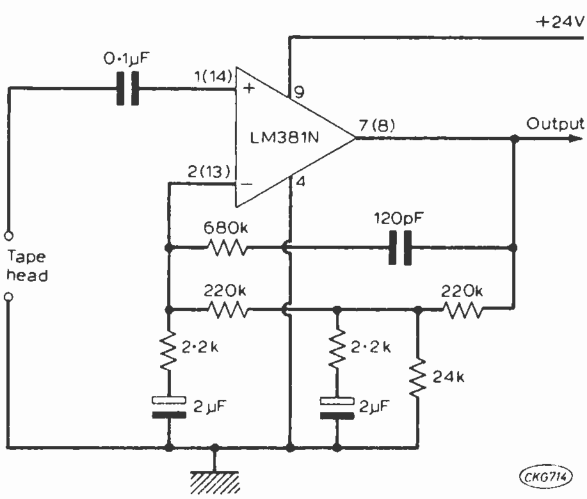


Fig. 4: A fast turn-on tape playback amplifier.

The circuit of Fig. 4, is slightly more complex than Fig. 3 but it has the advantage that it can be used immediately the power is applied. It has been designed to have a similar performance to that of the Fig: 3 circuit. The 120dB rejection of signals on the power supply line has been preserved in this circuit.

Tape Record Preamplifier used to feed tape recording heads must also be tailored to produce the correct response. Consider the case where a microphone producing a peak output signal of 10mV is required to drive a tape recording head which requires 30μA of audio drive current. This requirement can be met by the circuit of Fig. 5. A single ended input circuit is used for optimum noise performance.

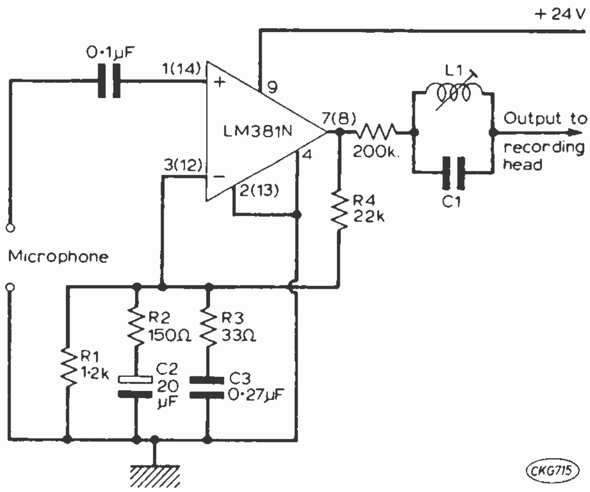


Fig. 5: A preamplifier for driving a tape recording head.

The values of the inductance L1 and of the capacitor C1 should be chosen to suit the particular recording head used. The feedback network R1 to R4, C2 and C3 provides the required frequency response.

Magnetic Pick-ups provide outputs which are typically in the range 3·5mV to 8mV at a velocity of 5cm/second; high quality recordings use velocities of this order. The output is proportional to the velocity.

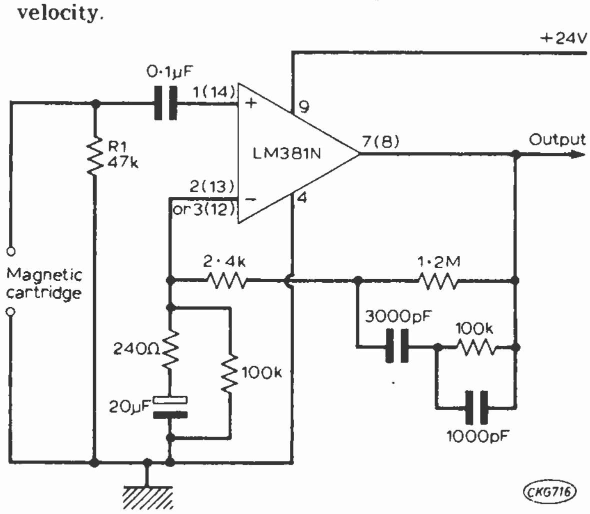


Fig. 6: A preamplifier for use with a magnetic cartridge in a record player.

A typical preamplifier for use with a magnetic pick-up is shown in Fig. 6. It provides the required response which falls with increasing frequency and has been designed for use with a cartridge of 0·5mV/cm/sec sensitivity. The circuit will drive a power amplifier which reaches the overload level when a signal of 5V RMS is applied to its input. The resistor R1 provides the load to a standard cartridge with the normal RIAA characteristics.

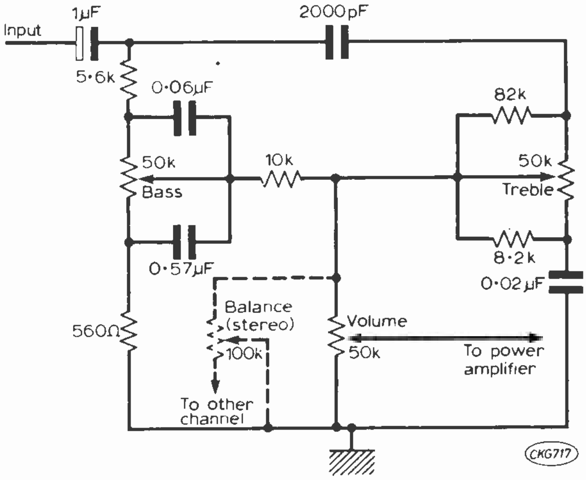


Fig. 7: A tone control circuit suitable for use between the output of the Fig. 6 circuit and the input of a power amplifier.

Tone controls. In many circuits two preamplifiers are employed, one before and one after the tone control circuits, in order to compensate for the insertion loss in the tone control network. However, when the LM381N is used as a preamplifier, only a single preamplifier stage is required owing to the high gain and high maximum output voltage provided by this device. A simple tone control circuit with bass and treble boost and cut facilities is shown in Fig. 7 which can, for example, be placed directly between the output of the record player amplifier of Fig. 6 and a power amplifier.

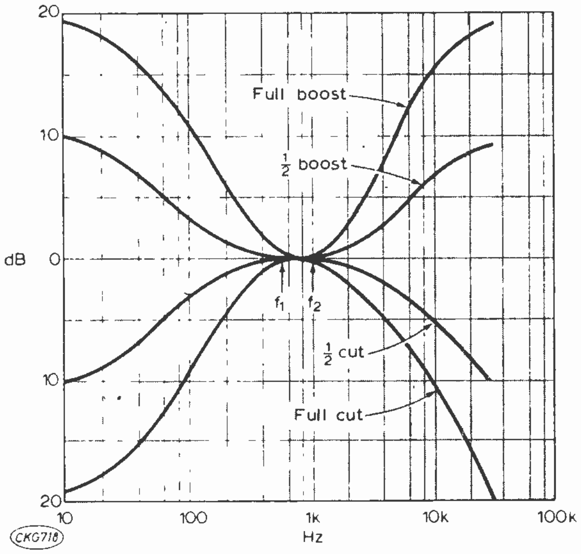


Fig. 8: The characteristics of the tone control circuit of Fig. 7.

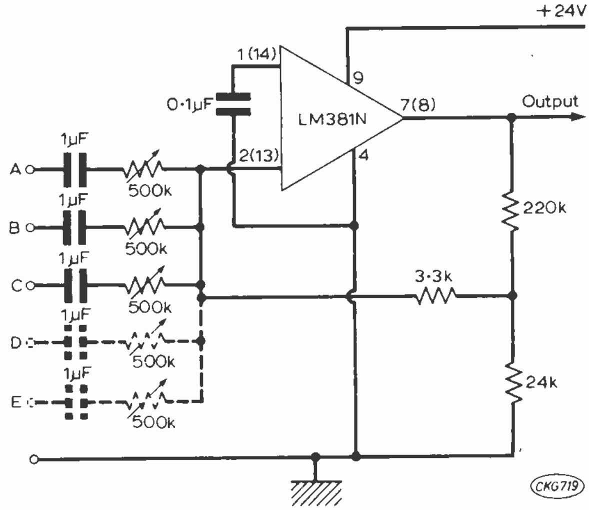


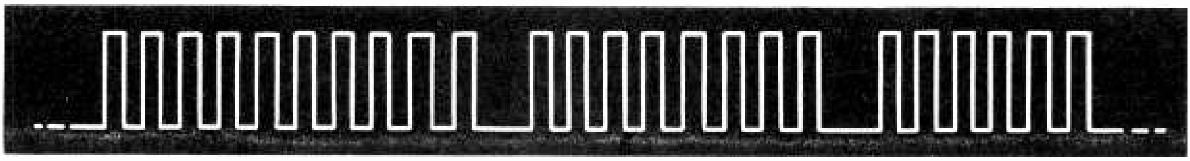
Fig. 9: An audio mixer circuit. Further inputs can be added, if required as indicated by the components shown in dotted lines.

The characteristics of the tone control circuits of Fig. 7 are shown in Fig. 8. It can be seen that a maximum boost or cut of about 20dB is available on both treble and bass.

Audio Mixer is the final example of the versatility of the LM381N, Fig. 9 designed for use with 600Ω dynamic microphone providing output level of 10mV. The circuit provides an output signal of 5V and can be used over a dynamic range of 80dB. A number of input signals (A to E) can be selected or combined with any other input signal.

The LM381N and AN are available from Athena Semiconductor Ltd., 140 High St., Egham, Surrey.

HIGH QUALITY SOUND LINKS



VIVIAN CAPEL

THE quality of the signals dispatched from the BBC studios for broadcast over the VHF frequency-modulation network is of a very high standard indeed. Development of domestic tuners and amplifiers over recent years has been such as to enable justice to be done to the high standard of received signals. Hi-fi radio enthusiasts will readily confirm the excellent results that can be obtained, yet sometimes with a note of reservation. It is often found that broadcasts originating in an area remote from the regional transmitter are of a lower standard than those coming from the local studio. So listeners in the South cannot expect as good results from a live broadcast at the Edinburgh Festival as from London's Festival Hall.

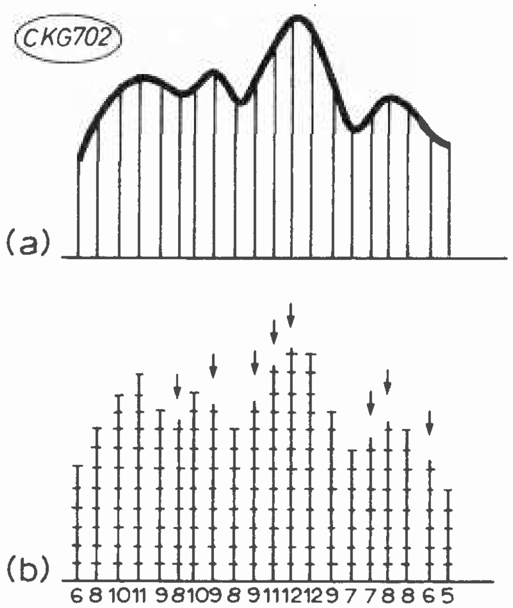


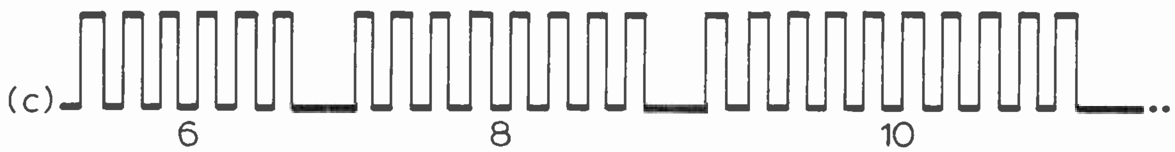
Fig. 1 : (a) Typical audio analogue signal with instantaneous sampling intervals shown. (b) Quantisation, where each sample is assigned a digital value according to the number of units (bits). Arrows indicate samples where level is between two bits. (c) First three samples represented by train of pulses.

The reason for this is the links that are used to convey the signals from the studio or concert hall to the various transmitters. Owing to the limited range of VHF transmitters these must be sited within the locality they serve, hence the inescapable need for long studio links, often of several hundred miles. Many things can happen to a signal on a journey of that length, the higher frequencies can be lost, there can be phase differences due to varying transit times of different frequencies, any non-linearity will produce harmonic and intermodulation distortion, and of course noise can be picked up from numerous sources, thus imposing a restriction on the dynamic range which can be allowed. Furthermore reactive elements can give rise to 'ringing', the spurious oscillation produced by transients in the signal.

NEW LINKS

All this will be a thing of the past as the new pulse-code-modulation (PCM) links are installed between studios and transmitters all over the country. The South East is already so equipped and the links are being extended Westward and Northward, so that within two or three years the same standard of quality will be transmitted irrespective of the area of origin. By means of PCM, signals can be sent over great distances without any loss of information and with zero noise and distortion. This like the perpetual-motion machine may seem to be a science-fiction dream, but it really does work. Like a lot of 'new' ideas, it is not new at all, having been invented in 1938, but the complex circuitry required, had to wait until IC's were developed before it could become a practical proposition.

In order to understand how it works we must first consider the nature of the normal audio signal such as the output of a microphone. It takes the form of a constantly varying voltage which in fact is comparable or analogous to the varying pressures of the sound-wave producing it. For this reason it is termed an **analogue** signal, and, because it consists of a wide range of frequencies and amplitude levels, it needs equipment capable of handling such ranges without modification of the signal in order to process it. Therein lie the difficulties.



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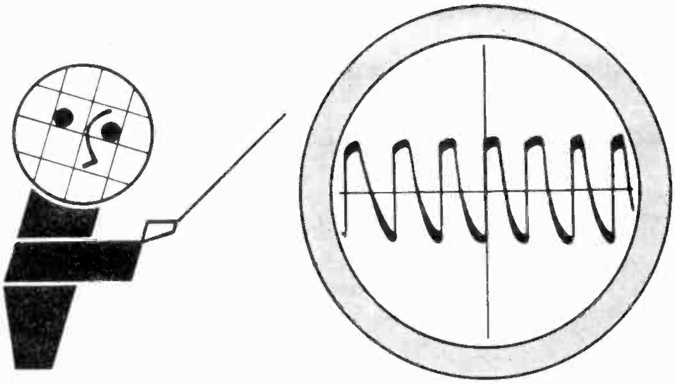

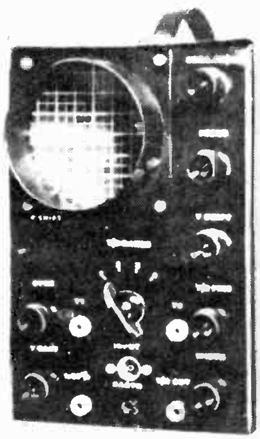

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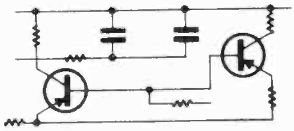

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QUANTISATION

If we take a typical audio signal, and sample the level at regular intervals we will get the result as shown in Fig. 1. Each sample represents the instantaneous level of the audio signal at the moment of sampling, and this level can be expressed by a certain number of electrical pulses. The individual samples are known as **words,** and the pulses making up each sample as **bits.** The conversion of the analogue signal into pulses is termed **quantisation** because it is quantitively expressed as a certain number of bits. As the signal is now a series of digits or numbers it is described as **digital**. This information can be later decoded and used to construct a wave identical to the original.

The quality of the result depends on two main factors. First, the number of samples or words that are taken in a given time. Any alteration of the waveshape that occurred between two successive samples would be lost. Such an event would occur if the sampling rate was lower than the highest frequency contained in the signal. In practice it has been found that the sampling rate must be at least twice as high as the highest frequency to be sent. BBC FM broadcasts transmit frequencies up to 15kHz, and so the sampling rate is a little higher than twice this at 32kHz.

The other factor is the number of bits contained in each sample. If the amplitude of the original wave is to be accurately represented, the maximum number of levels definable must be large. Should the analogue wave amplitude fall between two specified levels, it will be assigned the value of the lower one and be reproduced at that level in the decoding process. Thus the wave shape will not be identical to that of the original and harmonic distortion will be added. This type of distortion arising during quantisation is the only type of distortion than can arise. Once the signal is encoded no further distortion can appear in the transmission. Thus it is always a known quantity and does not depend on outside variables.

BBC PCM

The BBC system uses a large number of sampling levels, actually 8191 different amplitudes, and so quantisation distortion is kept to a very low level. It is in fact 1 part in 8191, maximum, which is 0·0122%, far better than the domestic equipment used to reproduce it.

As described here though, the system has one major snag. With a sampling frequency of 32kHz, and each sample can contain up to 8000 bits, the resulting frequency will be 262MHz! This is completely unrealistic, and no link would have the bandwidth to accommodate anything like such a frequency, especially for a single audio channel.

Many readers who have followed thus far, will, by now, have cast their eyes down the following paragraphs with some apprehension and perhaps disgust. Practical men are often allergic to maths, and so the tendency may be to finish about here and turn over to the constructional features. However, don't be put off by what may appear to be a formidable array of figures. It's much easier than it looks, and actually it is very interesting to see the rather ingenious way by which the bandwidth problem has been solved. On the other hand, mathematical types, will probably have solved it already.

BINARY CODE

The solution lies in the use of the binary code by which large numbers can be represented by a small number of digits of only two factors, 0 and 1. To start with, most readers will know that when a number is multiplied by itself (squared), it is said to be raised to the second power and written n^2; when so multiplied twice (n^3) it is raised to the third power, and so on The table lists 13 values, the twelve powers of 2, and also 1. When all these are added the result is 8191 and it is a fact that any number between 1 and 8191 can be obtained by taking one or more of these numbers and adding them. None need be used more than once.

To illustrate the point consider a couple of examples. The number 3417 can be obtained by adding:—$2^{11}=2048$; $2^{10}=1024$; $2^8=256$; $2^6=64$; $2^4=16$; $2^3=8$ and 1. Agreed? Well, that wasn't too bad, so we will try another one, this time let's choose a nice round number, 5000. This is made up of: $2^{12}=4096$: $2^9=512$; $2^8=256$; $2^7=128$ and $2^3=8$.

In these examples we only listed the values actually used and ignored the others. However, to enable us to get the sequence right we must list all 13 even if it means assigning a zero value to the unused ones by multiplying by 0.

Going back to our first example then, the sequence is: $2^{12}\times0$; $2^{11}\times1$; $2^{10}\times1$; $2^9\times0$; $2^8\times1$; $2^7\times0$; $2^6\times1$; $2^5\times0$; $2^4\times1$; $2^3\times1$; $2^2\times0$; $2^1\times0$; 1×1.

The second example gives us: $2^{12}\times1$; $2^{11}\times0$; $2^{10}\times0$; $2^9\times1$; $2^8\times1$; $2^7\times1$; $2^6\times0$; $2^5\times0$; $2^4\times0$; $2^3\times1$; $2^2\times0$: $2^1\times0$; 1×0.

Then, if both sending and receiving equipment 'understand' that they refer to a consecutive series of powers of 2, each sample of up to 8191 amplitude levels can be accurately represented by thirteen digits of either 0 or 1. In our examples the series would be 3417=0110101011001 and 5000=1001110001000. In the transmission, 1 is represented by a pulse and the 0 by a space.

BINARY TABLE

1	1	1
2	2^1	2
3	2^2	4
4	2^3	8
5	2^4	16
6	2^5	32
7	2^6	64
8	2^7	128
9	2^8	256
10	2^9	512
11	2^{10}	1024
12	2^{11}	2048
13	2^{12}	4096

This table shows the 13 binary bits, 1 and the 12 powers of 2. Any number between 1 and 8191 can be obtained by adding specified bits. Use or omission of a bit is indicated by 1 or 0 expressed electrically by pulse or space.

Thus there is a dramatic saving in bandwidth; now the frequency will be 13 binary bits × 32000 (the sampling frequency) or just over 400kHz. It may be thought that this is still rather high for an audio link that handles just the same programme as a 15kHz analogue link. This, of course, is true, but if we consider the advantages the extra bandwidth is well worth it.

Take noise, for example. Radio amateurs know from experience that when conditions are poor and noise levels high, that the morse code is far more intelligible than speech. Morse is, of course, a digital signal being composed of a series of pulses and spaces similar to our PCM. A feature of both is that the pulses are all of the same amplitude, irrespective of whether the modulated audio signal in the case of PCM, is of high or low level. Low audio signals cannot then get lost in a high noise-level, so this in turn enables a higher dynamic range (ratio of high to low-level signals) to be sent. As the receiving equipment responds only to the pulses, noise originating in the link has no effect at all, so it is, in fact, noiseless. Only if the noise approached the level of the pulses would it have an effect but this would be extremely unlikely.

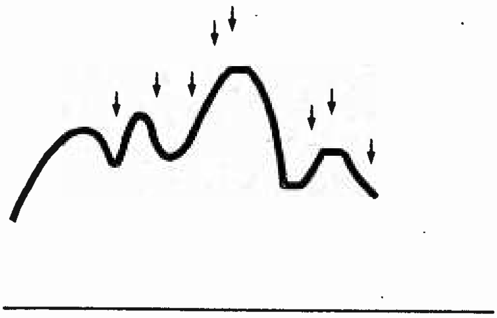

Fig. 2: Quantisation distortion. Wave-form of Fig. 1 distorted because number of bits (12) is insufficient to accurately represent amplitude levels as indicated by arrows in Fig. 1.

PULSE SHAPE

Pulse-shape is of minor importance as long as the receiver recognises it as a pulse and counts it; harmonic distortion therefore will likewise not affect the signal and there can be no loss of information contained within the modulation, so the audio frequency response cannot be modified. Hence there is zero distortion over the link. It can be seen then that high bandwidth requirement is more than compensated for by the virtually ideal transmission characteristics.

The BBC links combine 13 PCM channels into one having an overall bandwidth of 5·5MHz, the same as for a single television channel, which enables the links and associated equipment to be standardised with that of the television service. The 13 channels can be used for separate mono programmes or six stereo with one spare.

NOISE

Although the signal becomes unaffected by noise once it is encoded, noise in the analogue or encoder circuits will be encoded along with the audio signal. The noise is stated to be −69dB weighted, which is of a very low order, much less than could be picked up on a long analogue studio link. The possibility of error in the signal has been provided for. Each sample, as we have seen, consists of thirteen pulses or spaces. If, due to an error in the encoder or elsewhere, there is a discrepancy, the decoder will recognise the error and hold the value at the last error-free sample until the next such one arrives.

RESULTS

For high-quality results the sampling rate and bit quantity used by the BBC is necessary, but good results are possible with more modest parameters. Some private telephone systems which carry speech only use an 8kHz sampling rate to give a 4kHz upper frequency response and 7 binary bits. An interesting feature of some of these systems is the polarity reversal of alternate pulses. Thus two pulses form a complete cycle and thus halve the bandwidth requirement.

A demonstration at the Sonex 1973 exhibition gave a direct comparison, with recorded piano music, of results obtained with different bit quantities. When using 12 bits, results were indistinguishable from the 13. At 11, results were still very good but there was a barely perceptible trace of distortion, while at 10 it was more easily detected. From 9 down it became progressively worse. The quantisation distortion has a rather unusual sound which can best be described as a 'crumbling' effect. It should be noted that each binary digit reduction corresponds to a halving of the actual sampling levels, and a doubling of the distortion.

It should be emphasised too, that PCM applies only between studios and transmitters, the broadcast signal being in the normal analogue form irrespective of the type of link used. Digital broadcasting is possible but existing receivers would be rendered obsolete unless both forms existed together, since compatibility is always a major consideration when contemplating any change in a broadcasting system. Furthermore, with the present congestion of the radio bands, the extra bandwidth, although technically easy to achieve, would be impractical. ■

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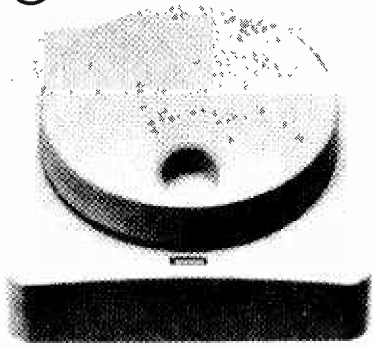

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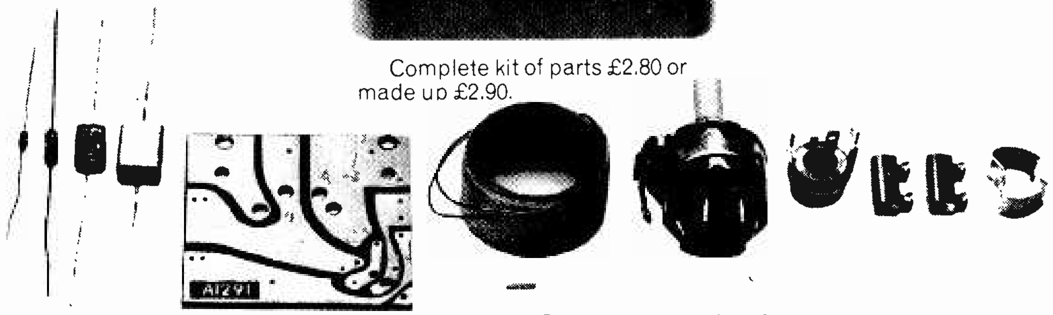

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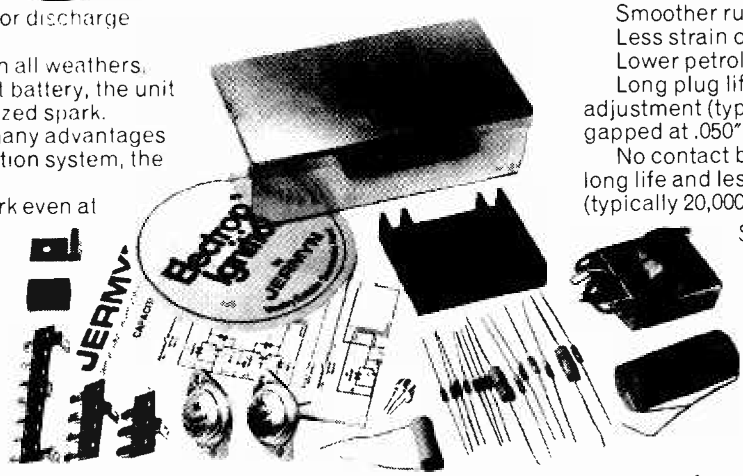

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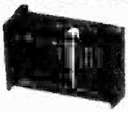

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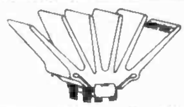

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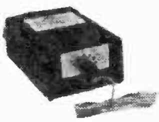

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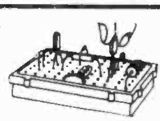

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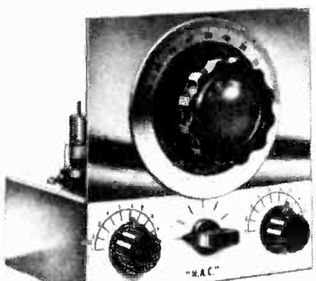

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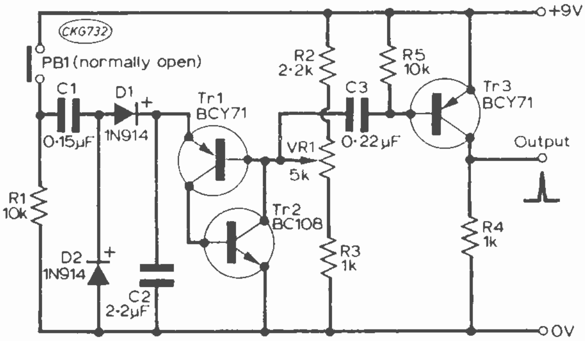
Repeated pressing of PB1 will build up the potential on C2 until it exceeds the level set at the base of Tr1 which is preset by VR1. When this happens Tr1 and Tr2 go rapidly into conduction, aided by regenerative feedback, and C2 is discharged giving rise to a negative going signal at the collector of Tr2. This is fed to the PNP transistor (Tr3) and generates a 9V spike with a reasonably low source impedance.



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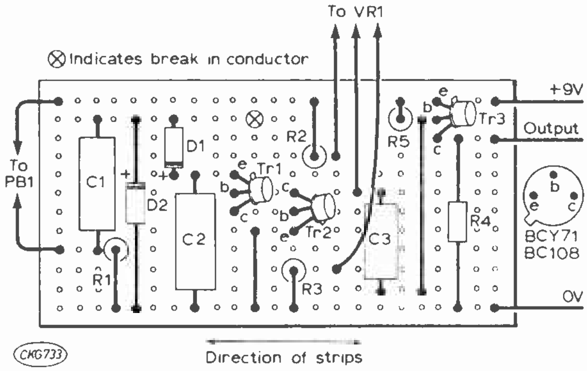


Circuit arranged on Veroboard, VR1 and pushbutton being mounted externally.

The divide ratio is given by the number of times PB1 has to be pressed before C2 is discharged by the transistors and with the values given in this circuit is adjustable, by means of VR1, between about 3 and 20. If the repetition rate of button pressing is low there is bound to be some charge lost from C2 due to its own and transistor leakage. However, the prototype worked quite reliably at a rate of approximately one press per second. It is, however, anticipated that this circuit would interface with an electronic source of signal operating at a low audio frequency and this problem is then not likely to arise.

★ components list

R1 10kΩ ¼W
R2 2·2kΩ ¼W
R3 1kΩ ¼W
R4 1kΩ ¼W
R5 10kΩ ¼W
VR1 5kΩ linear pot.
C1 0·15µF
C3 0·22µF
C2 2·2µF low leakage polycarbonate
D1/D2 1N914
Tr1 BCY71 (general purpose pnp silicon)
Tr2 BC108
Tr3 BCY71
PB1 Normally open push button

P.W. ELECTRONIC COMPONENTS BUYERS' GUIDE
Special supplement in the October issue giving details of components commonly available, followed by additional sections in succeeding issues. More details on page 116 of the June issue.

WIRELESS TELEGRAPHY ACT
Readers and advertisers are reminded of the requirements laid down by the Wireless Telegraphy Act. It is an offence in the U.K. to install or operate wireless telegraphy apparatus except under the provisions of the Act and, except in the case of broadcast sound-only receivers, a licence must be obtained.
Included within the provisions of the Act are any apparatus transmitting deliberate signals for any purpose such as "walkie-talkies", radio-controlled models or servos and some types of metal detectors. Apparatus radiating interference signals are subject to controls which also come under the administration of the same Ministry. If you require full information, please write to *Waterloo, Bridge House, Waterloo Rd., SE1 8UA.*

P.W. TOOL KIT OFFER
Demand for the above tool kit far exceeded expectations and we have had to look for alternative supplies. We apologise to all those readers who have been kept waiting. By the time this issue appears we expect to have cleared the arrears of orders.

EXPERIMENTAL WORKSHOP

M. J. HUGHES M.A.

LEARNING BY PRACTICAL PROJECT STEPS

PART 10—LOUDSPEAKER DRIVERS

IN ANY audio system there comes a time when it is necessary to use electronic signals to drive a loudspeaker. This part of the series will describe several alternative ways this can be done but we shall limit ourselves to considering only low powers in the experimental projects mentioned. The reason for this is solely to keep construction simple and to ensure that only low cost components need be used. Having said that let us hasten to add that the principles to be described are also applicable to the highest of power amplifiers, however, there are usually special protection circuits in these cases which tend to complicate the issue—and in many instances the protection circuitry can be more complex than the amplifier itself.

In one or two previous projects we have driven loudspeakers without saying too much about the method we have adopted; now is the time to fill the omission.

In an amplifier we have to provide several logical stages of amplification some of which we have already covered; basically these can be summarised as, (a) an input pre-amplifier which helps compensate for the impedance of the signal source, (b) a stage which will tailor the frequency response or provide a degree of tone control and (c) a stage that increases the level of signal voltage; this latter stage often brings the signal level up to the maximum needed for the application but usually the output impedance of such a stage is fairly high and certainly cannot be used to pass sufficient current through the low impedance of a loudspeaker speech coil—which can be anything in the range of from 3 to 70 ohms. The prime objective of a power stage is to take the output from the voltage amplifier and match this to the low impedance of the loudspeaker's coil; at the same time a degree of voltage amplification might also be applied.

The loudness of a loudspeaker is proportional to the amount of electrical power one can dissipate within the speech coil of the loudspeaker. If one knows the impedance of the loudspeaker the power can be quite simply calculated in terms of either the voltages developed across the speech coil or the current flowing through it. These, of course, are a.c. quantities because we are dealing with signals as opposed to bias currents—in some instances (as we shall see) we have to take account of the latter. If we assume that all the current flowing through the coil is a.c. and comprises signal current the power dissipation can be stated as

$$I^2 \times Z \text{ or } \frac{V^2}{Z}$$

where I is the current through the coil and V is the voltage developed across it (these can be peak or r.m.s. values depending on whether we are dealing with r.m.s. or peak power). Z is the loudspeaker's impedance. It is simpler to take the second equation for most purposes and we can see from it that for a given signal voltage we get most power dissipation for the smallest loudspeaker impedance; however we must ensure that the voltage source is not "current limiting" i.e. it must come from a very low source impedance.

For maximum power coupling the source impedance should equal the loudspeaker's impedance. Assuming ideal impedance matching ;if we have a signal amplified to 1V r.m.s and apply this to a 35Ω loudspeaker the output power will be

$$\frac{1 \times 1}{35}$$

which is just under 30mW; reducing the speaker impedance to 3Ω would, theoretically, give about 300mW of power but the current requirement would be up by a factor of about ten.

It would be better to double the voltage of the signal to get higher power, because there is a square law relationship between the two, and one does not have to provide a very low source impedance—this is always difficult and provides other problems with power supplies etc. For highest powers it is obviously desirable to have as high a signal voltage as possible together with a low impedance output. To obtain 50W into a 15Ω loudspeaker would require signal voltages in the order of 27·5V r.m.s. To obtain this high signal level it is necessary to have power rail voltages in excess of 50V. It is thus impossible to get really high powers unless one is prepared to operate with reasonably high voltages as well as low loudspeaker impedances.

Throughout this series we have operated, in the main, with a 9V supply rail and a 35Ω loudspeaker. Assuming we made preamplifiers with ideal mid rail biasing the peak signal voltages we could obtain would be 4·5V which corresponds to about 3·2V r.m.s. Given these parameters the maximum powers we could produce would not exceed 300mW r.m.s.

Summing up, we need to get as high a current with as high a voltage as possible across the speech coil and the experiments that follow show various attempts at getting to this end by different methods —each method has its pros and cons which we shall discuss.

Fig. 71 shows an obvious way of driving a loudspeaker and is an extension of the grounded emitter amplifier—covered in previous parts. Strictly speaking we should consider the loudspeaker as having an impedance a.c. signal but in practice this is very close to its d.c. resistance; inductance is low and hence inductive reactance at low frequencies is fairly small. If one considers LS1 of Fig. 71 as being a 35Ω resistor we can select a value for R1 which will give us a mid rail bias at the collector of Tr1.

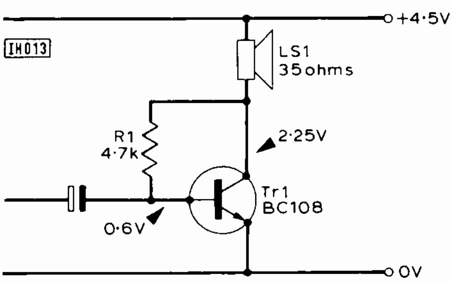


Fig. 71: For the collector potential to be mid rail Ic Ω 65mA and hence R1 must be about 5kΩ. Quiescent power dissipation in Tr1 is about 150mW. Input impedance is low.

Before doing this we have to consider the maximum current rating of the transistor with reference to the maximum current that might flow through LS1 when the transistor is fully conducting. Imagine that the supply voltage was our usual 9V and that Tr1 was fully conducting; the potential at the collector would be a fraction of a volt (the saturation voltage) and the current flowing would be nearly

$$\frac{9}{35} = \text{approx } 250\text{mA}.$$

This is more than twice the current rating for the transistor hence if a.c. input signals were of sufficient amplitude we might drive the transistor into saturation and burn it out at the same time. By reducing the supply rail to 4·5V we would only just be exceeding Ic(max) for the BC108 even if we applied this maximum input signal. Due to saturation voltages and forward drops in the preceding circuits it would be unlikely that the collector current would exceed the maximum rating of 100mA. We have thus deduced that with this particular transistor the maximum supply voltage in this application is 4·5V for safety. R1 is calculated in the same way as in a previous part to give a mid rail collector voltage so that signals can give peak positive and negative going excursions of 2·25V.

Wire up the circuit of Fig. 71 and measure the quiescent voltages but also take special note of the quiescent current being drawn in the absence of input signal. It is comparatively high and causes power to be dissipated in the transistor and the speech coil of the loudspeaker to no useful effect. This is a feature of this type of amplifier which comes into the general class of Type A circuits. The maximum r.m.s. power output for a 2·25V peak signal would be approximately 70mW and this compares with nearly 150mW of static dissipation caused by the quiescent current. Not very efficient!

In theory the maximum efficiency of a Class A amplifier is 50 per cent and this is its main drawback; it means that transistors get unduly hot, a lot of current is drawn from the supply under quiescent conditions and, in the case of portable equipment, one would suffer from rapid battery exhaustion. Some Hi-Fi purists will claim—probably correctly—that the class A circuit will provide the best fidelity of signal reproduction because the transistor is operating as a "more or less" linear amplifier, i.e. the current through the loudspeaker is directly proportional to the signal current and there is no way that distortion can creep in. This, of course, is not strictly true—particularly in a simple circuit such as this one because, for a start, h_{FE} for a transistor varies with collector current and thus the true linearity (assumed) is not realisable in practice without considerably more complexity. Nevertheless this is a very simple way of providing an audio low power output in simple applications—in particular those that will be subjected to intermittent use.

An example is shown in Fig. 72 where the output from a simple oscillator is used to drive a loudspeaker as a morse practice oscillator. When constructing this unit observe that LS1 *must* be 35Ω and the supply should not exceed 4·5V.

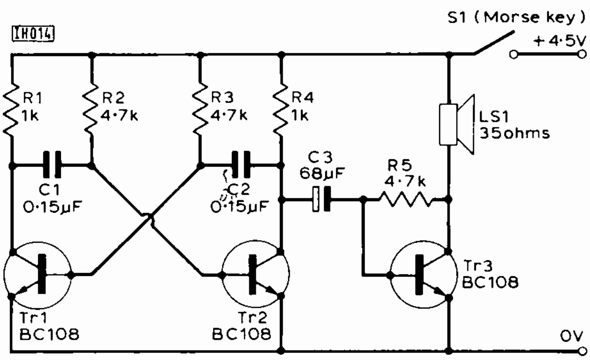


Fig. 72: Using the simple class A power stage in a morse practice oscillator circuit. As the signal voltage is high C3 could be omitted and R5 is then connected directly between Tr2's collector and Tr3's base.

Because we have signals as high as 4·5V at the collector of Tr2 it is not necessary to have C3 in circuit because the signal will be driving Tr3 from one extreme of conduction to the other and the sophistication of mid rail biasing is not necessary hence the circuit can be simplified by taking R5 from the collector of Tr2 direct to the base of Tr3.

To obtain a higher output power we need to increase the supply voltage and reduce the loudspeaker's impedance. If this is done we have to use a transistor with a higher current and power dissipation rating; at the same time we illustrate, in Fig. 74, how we can use the simple expedient of making the power stage from an emitter follower (the input signal is so high that we do not need any form of voltage amplification). To provide sufficient

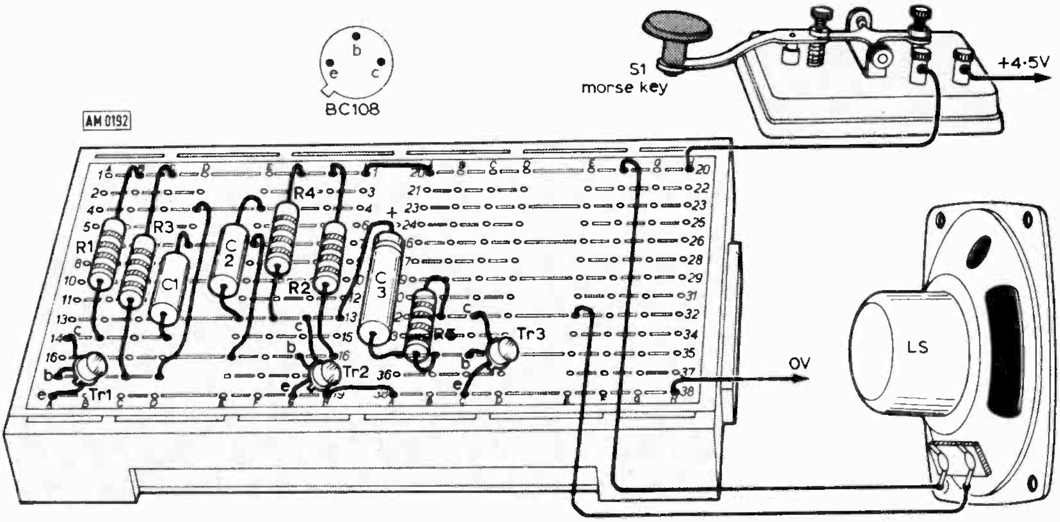


Fig. 73: Layout for Fig. 72

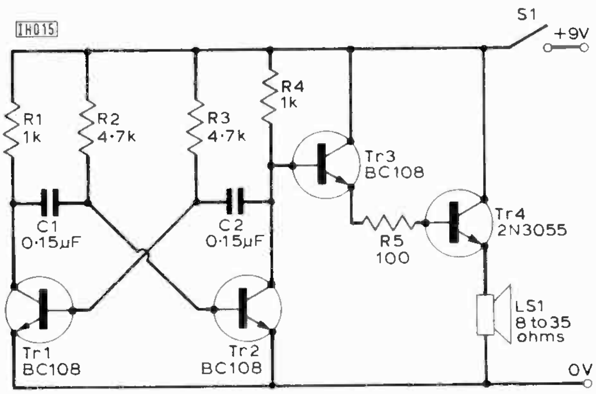


Fig. 74: Using a power transistor and an emitter follower driver enables us to use a lower resistance load (giving more power) and at the same time we can increase the supply voltage for more power.

signal base current into Tr4 without loading the output of the multivibrator we have inserted Tr3 making, in effect, a super alpha pair. This type of output is ideal if we are not worried about mid rail biasing in the output stage.

The base of Tr3 could have been connected directly to the collector of a conventional grounded emitter amplifier and the mid rail voltage would automatically have been reflected in the quiescent potential at Tr4's emitter—if one allows for base/emitter forward drops. The only problem with that would be that there is a high standing quiescent current flowing through the speech coil of the loudspeaker giving rise to heating and also the cone would be displaced preferentially in one direction.

To be continued

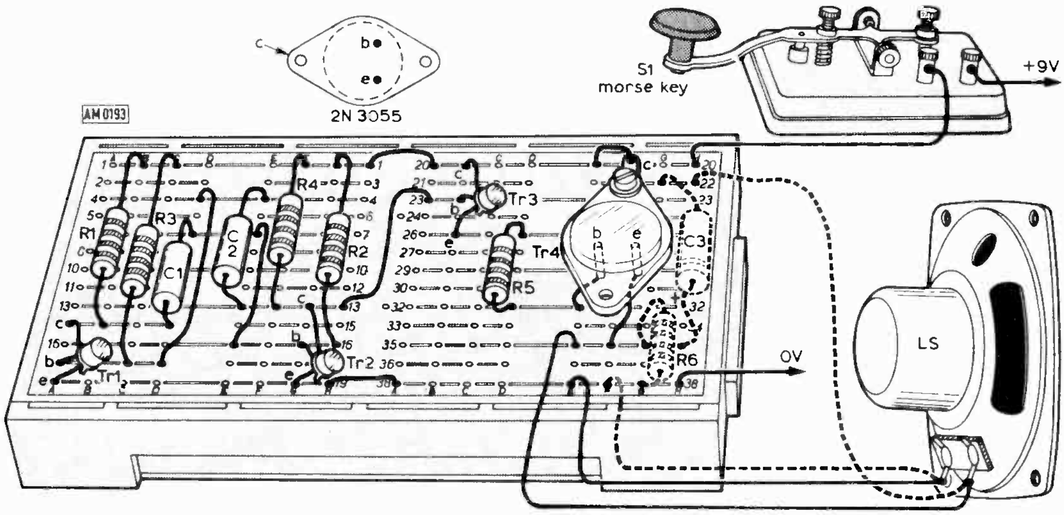


Fig. 75: Layout for Fig 74

HOTLINES ON RECENT DEVELOPMENTS

NO TICK GIVEN HERE

CMOS circuits intended to form a two-chip digital watch system have recently gone into quantity production at Intel. A total average power consumption of only 15μW means that the watch will operate for more than a year from one mercury cell.

The oscillator/divider chip is intended for use with a 32kHz crystal and is capable of an accuracy of better than 1 minute per year. The other chip contains the decoder/driver circuitry and is offered in two versions. One of these provides the facility of being able to switch the display to show minutes and seconds. The hours display is then blanked. To help you time intervals of a few seconds, both versions of the output chip cause the colon separating the hours and minutes to flash at 1Hz.

GROWING

Developments in liquid crystal displays continue apace. A French company has recently exhibited a 5000-point matrix display giving a text of 96 characters and, even more intriguing, a simple animated picture display twelve inches square.

At the IEA exhibition in London, an Austrian firm was showing a seven-segment display some 6 inches high.

MORE SCOPE OR LESS?

Whilst television CRTs have got a lot shorter over the years, those used in oscilloscopes have stayed much the same length, mainly as a result of the good deflection linearity required. Now Philips have developed a new type of CRT which has a diverging lens in the form of a domed mesh between the deflection plates and the screen. The tube length for a given size of display is considerably reduced as a result.

ELECTRIFYING

News from the USSR that scientists at the Latvian Academy of Sciences have discovered a method of rotating non-metallic objects by passing them through an intense electric field. This effect, similar to that of a magnetic field upon ferromagnetic materials, has been demonstrated using wood, mica and plastics components. Suggested practical applications include alignment of parts on a conveyor belt or in other assembly systems.

SOMETHING'S MOVING

Small enough to be held in the palm of the hand, Mullard's new X-band (3cm.) Doppler transmitter-receiver modules may well find application in future vehicle collision alarms.

Greatly enhanced signal-to-noise ratio has been achieved by using separate cavities for the transmitter oscillator and receiver detector, both coupled to a single integral antenna.

When used in an intruder detection system, the module can pick out a man moving at a range of 50 feet. Just the thing to protect your priceless art treasures!

SUNPOWER

In the United States, a Senate investigation has been set up to consider Federal support for a programme of solar energy development. Giving evidence to the investigating committee, RCA Research director Paul H. Rappaport forecast that economical solar energy systems could be in widespread use in the U.S. within five years.

A planned extension to the RCA Building in New York will use solar energy to help run its heating and air-conditioning system.

FACE TO FACE

A spin-off resulting from the recently introduced local government changes is a new video-telephone system developed by Rediffusion Industrial Services.

The idea was that members of the public wanting to make an enquiry or complaint should not have to travel long distances to one of the new regional government offices in order to see an officer specialising in a particular field. Instead they would go to their local office where an automatically operated console would give them "across-the-desk" contact with the regional office via video-phone. Also included is a document scanner large enough to show household goods or package foods which may be the subject of complaint.

Already, one large company has expressed interest in the system as a means of providing conference facilities for its senior managers.

It would appear that the system has great potential for saving time and fuel by reducing the need for travel.

MULTIPLEX

More news from British Rail on improved communications, this time aboard Inter-City expresses.

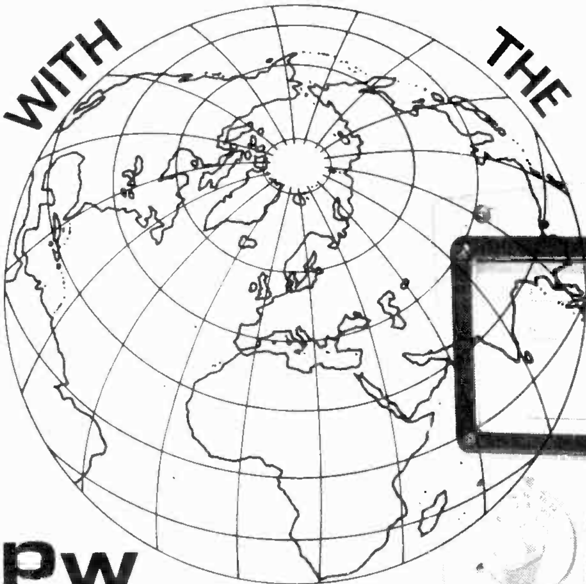
Equipment being fitted will provide three channels—guard to passenger, guard to driver and an audio message playback system which is controlled by distance travelled along the track. All this information is distributed through the train on only two wires, which are also used to control the train lighting.

Rather special measures have been taken to protect the audio equipment from spikes on the train wiring. These spikes can reach 7kV!

Novus

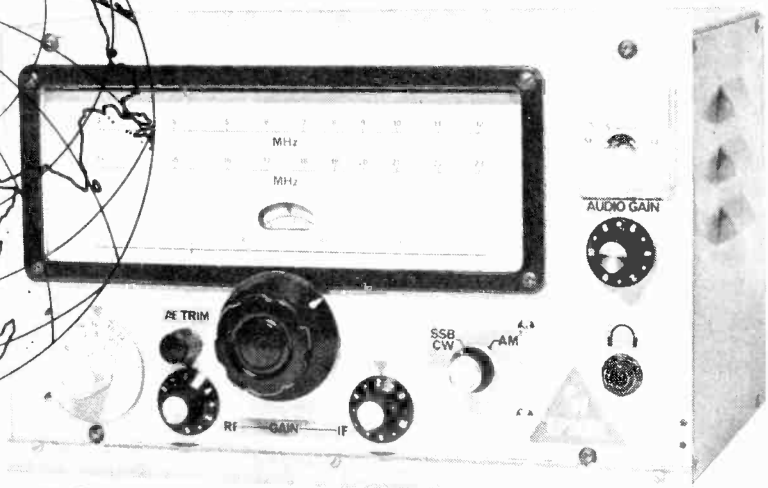
Listen clearly!

WITH



THE

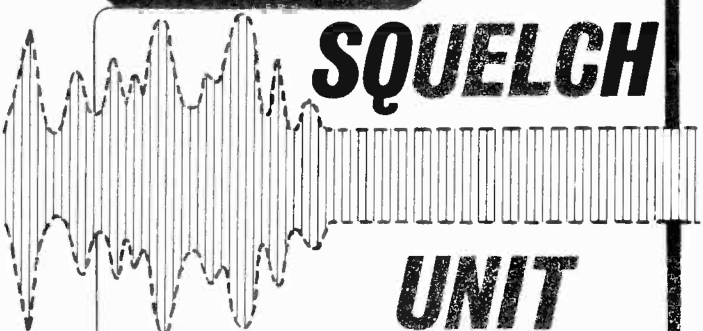
IN NEXT MONTH'S PRACTICAL WIRELESS



PW EPSOM GENERAL COVERAGE SHORT WAVE RECEIVER

Do you get annoyed at interference apparent on some short wave stations? Do you find the same station twice, once where it should be on the dial and again where it shouldn't? These problems are frequently generated in the receiver itself. Listen to the bands as they really are, on the 'Epsom' receiver. Alignment is simplicity itself—no expensive test gear needed. One range calibration method sets up whole spectrum 2·5 to 23MHz. Copies AM, CW and SSB signals with automatic sideband switching. Its special features can be built into your own receiver.

add-on AUDIO SQUELCH UNIT



Audio squelch circuits are frequently found in radiotelephones, cutting out objectionable noise in the absence of a signal. This simple one-IC unit can be fitted to a public address, intercom or other audio system where a high background noise level presents a problem.

ALL ABOUT FET's

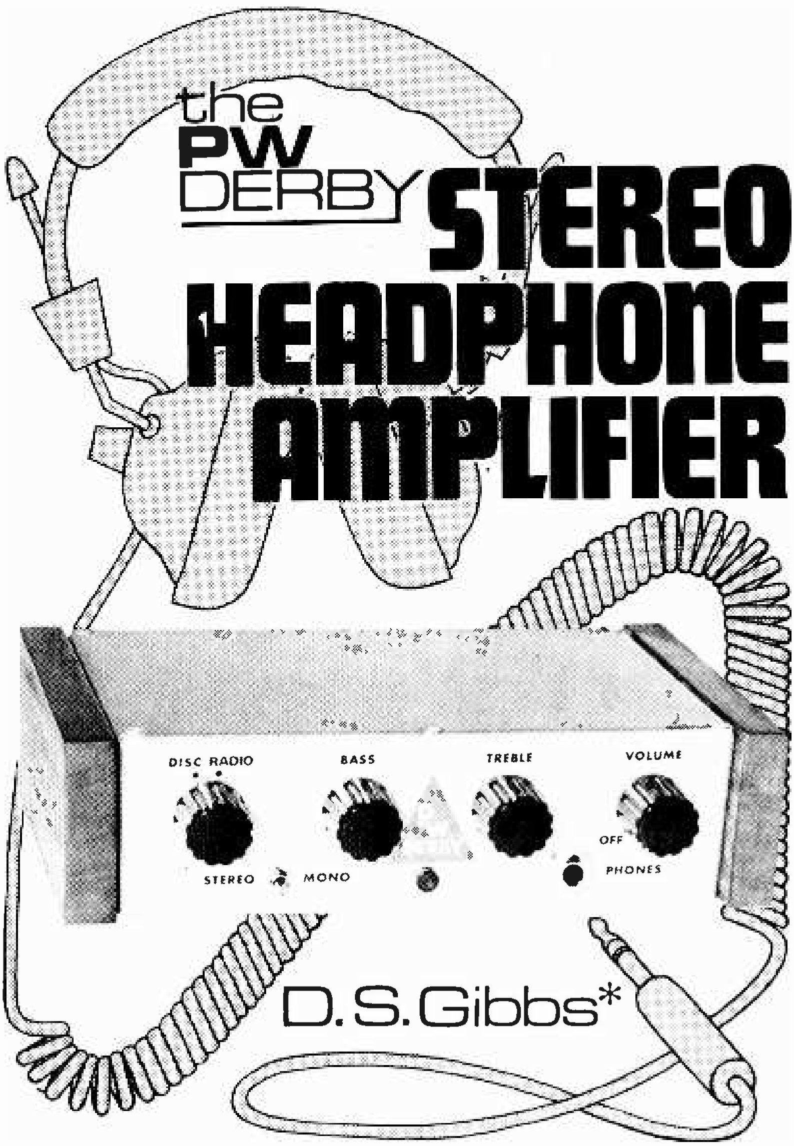
Field-effect transistors are quite common nowadays in D-I-Y electronic projects but what do you really know about them? We eliminate the mystery and show how they work and describe their advantages. Many practical circuit applications complete a useful guide to FET's.

MANY OTHER CONSTRUCTIONAL ARTICLES, SPECIAL FEATURES AND REGULAR COLUMNS ON SALE IN AUGUST

The above details are subject to the national industrial situation at the time of going to press.

the PW DERBY STEREO HEADPHONE AMPLIFIER

D. S. Gibbs*



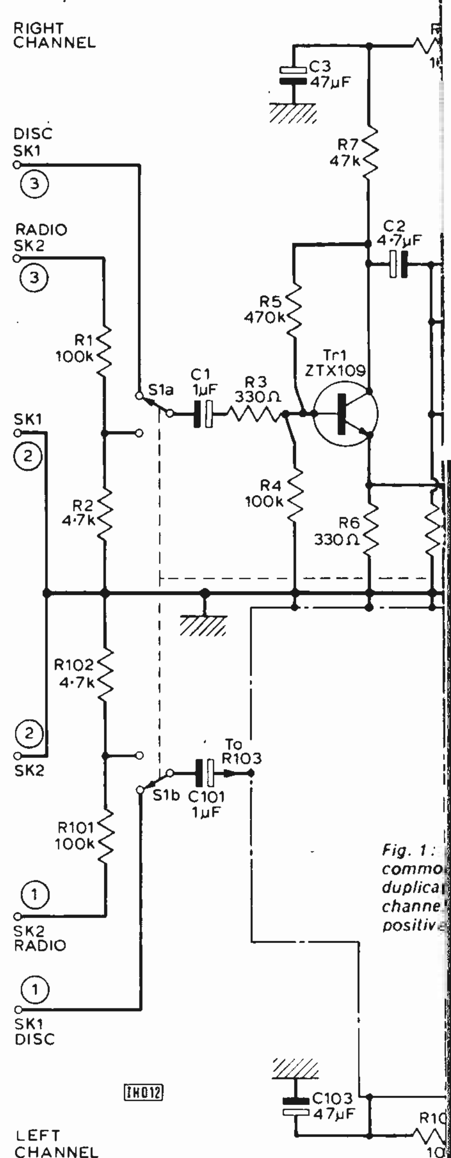


Fig. 1: commo duplica channe positive

MANY hi-fi enthusiasts tend to dismiss headphones out of hand, probably through memories of the strangulated reproduction of the Services surplus 'cans'. In contrast, modern stereo headphones are capable of giving a startlingly clear and well defined stereo image, with a quality of reproduction exceeding that of the best loudspeakers. By isolating the listener from his environment they give a sense of detachment, enabling one to devote one's entire attention to the music. For the same reason they are excellent for studying languages or for those whose musical tastes differ from those of their family.

Headphones are ideal for those just starting to acquire a hi-fi system as they minimize the expenditure required. Later, when it is desired to expand the system, it is only necessary to add a pair of amplifier modules, a power supply and a pair of

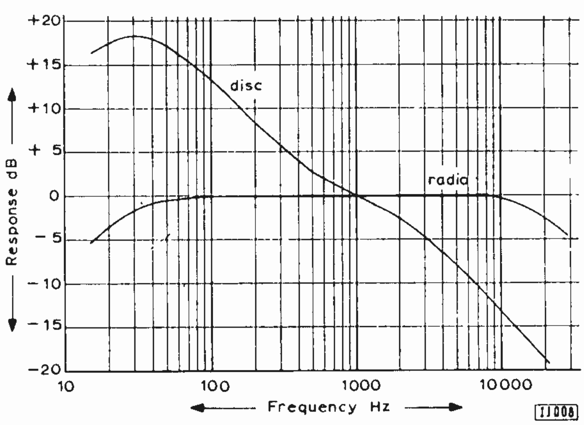
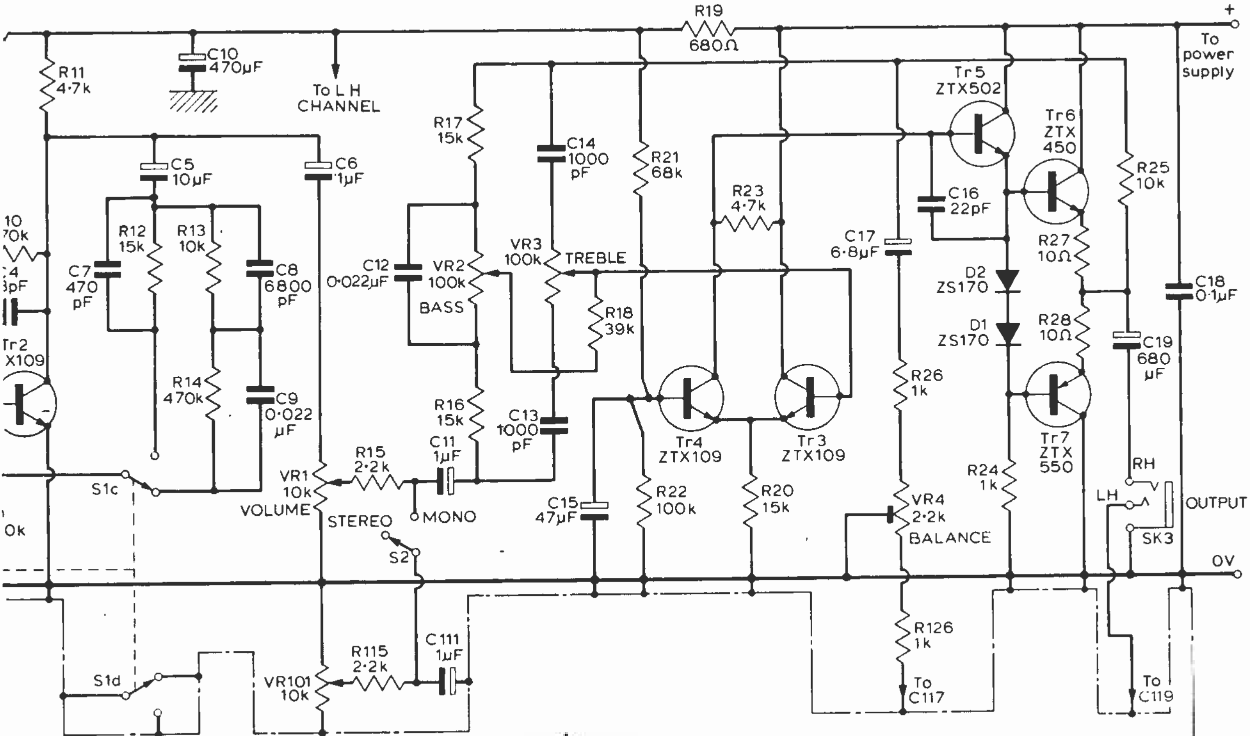


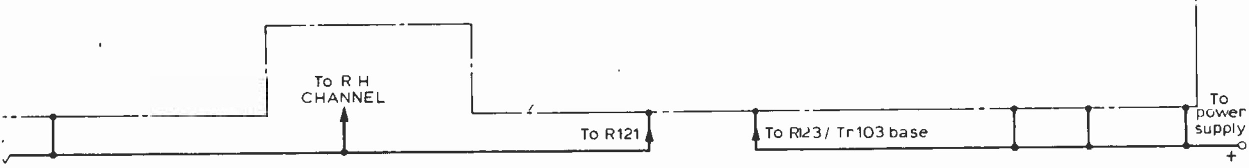
Fig. 3: Response curves of the amplifier for record or radio.

* *Ferranti Ltd.*



put and right channel circuits together with components. The right channel circuit is f within the dotted lines to form the left **Note:**—*Tr5 should be pnp with emitter to* upply.

PW SUPER SEPARATES



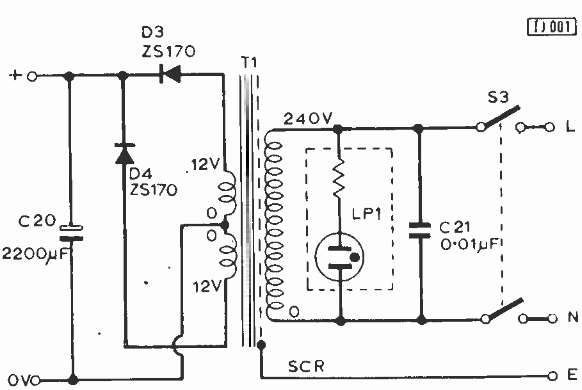


Fig. 2: Circuit of the power supply section of the 'Derby'.

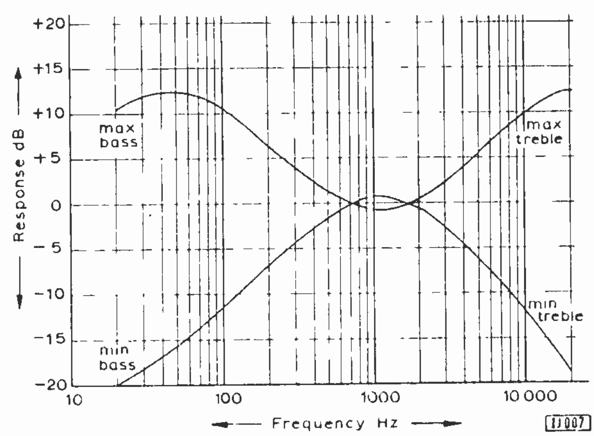


Fig. 4: The effects of the tone controls are shown in these curves.

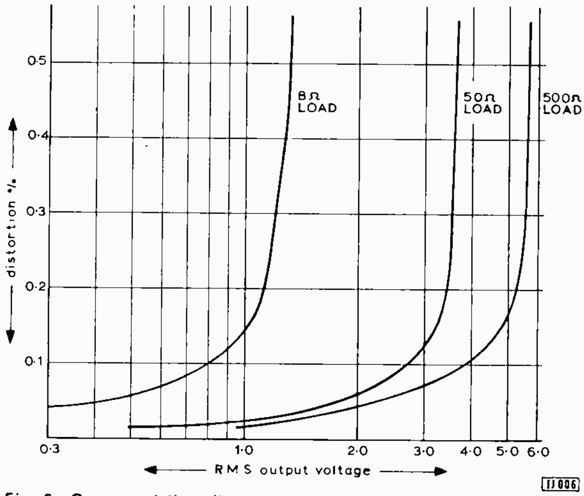


Fig. 5: Curves relating distortion with output voltage and load impedance.

loudspeakers as the headphones amplifier serve as a preamplifier. The circuit described here gives a standard of perfomance equal to a good hi-fi amplifier and it can be used with any make of headphones provided the impedance is greater than 8 ohms. The circuit is designed to give an output level of at least 1 volt into any impedance and this will be sufficient to generate a sound pressure level of 90dB or more with most types of stereo headphones.

CIRCUIT

The circuit diagram of the amplifier is shown in Figs. 1 & 2. The input stage comprising Tr1 and Tr2 is conventional and provides a 5mV input with RIAA equalisation for magnetic cartridges and a 100mV input with a flat frequency response for radio etc. Other inputs can be added by the constructor if desired. The response curves of the radio and disc inputs are shown in Fig. 3.

The output stage, comprising Tr3-Tr7, follows the same general lines as a normal hi-fi power amplifier but has been designed for a very much lower power level. The tone control is of the Baxendall type and is incorporated into the feedback loop of the amplifier. The response curves of the tone control are shown in Fig. 4. The output stage thus serves as both a power amplifier and a tone control stage.

The balance control operates by varying the feedback and hence the gain of the output stage and for this reason it cannot reduce the signal level to zero. It does however provide a variation of ±9dB between channels. This is entirely adequate for use with headphones as the headphones themselves are usually well matched. The variation of distortion with output level is shown in Fig. 5.

CONSTRUCTION

The prototype was constructed in a $7\frac{1}{4} \times 4\frac{1}{2} \times 2$in. diecast box which was decorated with a coat of silver paint and a pair of wooden ends, to give a domestically acceptable appearance. However, any suitable case can be used, provided that the same layout is adhered to. A duplicate of the prototype has been constructed in a record player plinth on a small aluminium chassis. Drilling details for the diecast

★ components list

Resistors

R1 R101 100kΩ	R11 R111 4·7kΩ	R21 R121 68kΩ
R2 R102 4·7kΩ	R12 R112 15kΩ	R22 R122 100kΩ
R3 R103 330Ω	R13 R113 10kΩ	R23 R123 4·7kΩ
R4 R104 100kΩ	R14 R114 470kΩ	R24 R124 1kΩ
R5 R105 470kΩ	R15 R115 2·2kΩ	R25 R125 10kΩ
R6 R106 330Ω	R16 R116 15kΩ	R26 R126 1kΩ
R7 R107 47kΩ	R17 R117 15kΩ	R27 R127 10Ω
R8 R108 10kΩ	R18 R118 39kΩ	R28 R128 10Ω
R9 R109 220kΩ	R19 680Ω	R29 R129 } Fig. 10
R10 R110 470kΩ	R20 R120 15kΩ	R30 R130 } Fig. 10

All ¼W or ½W 5% carbon film
LH channel numbers have 100 prefix

VR1 VR101	10kΩ log dual gang with DPST switch
VR2 VR102	100kΩ linear dual gang
VR3 VR103	100kΩ linear dual gang
VR4	2·2kΩ skeleton preset pot

If a fully variable balance control is desired VR4 should be made a 2·2 or 2·5kΩ pot (linear law) and mounted on the front panel

Capacitors

C1 C101 1μF 35V TB	C12 C112 0·022μF 160V P
C2 C102 4·7μF 35V TB	C13 C113 1000pF 125V Poly
C3 C103 47μF 25V Elec	C14 C114 1000pF 125V Poly
C4 C104 33pF 125V Poly	C15 C115 47μF 10V Elec
C5 C105 10μF 25V Elec	C16 C116 22pF 125V Poly
C6 C106 1μF 35V TB	C17 C117 6·8μF 40V Elec
C7 C107 470pF125V Poly	C18 C118 0·1μF 250V P
C8 C108 6800pF 160V P	C19 C119 680μF 16V Elec
C9 C109 0·022μF 160V P	C20 2200μF 25V Elec
C10 470μF 25V Elec	C21 0·01μF 750V D
C11/111 11μF 35V TB	

TB—Tantalum bead Elec—Electrolytic
Poly—Polystyrene P—Polyester D—Disc ceramic

Semiconductors

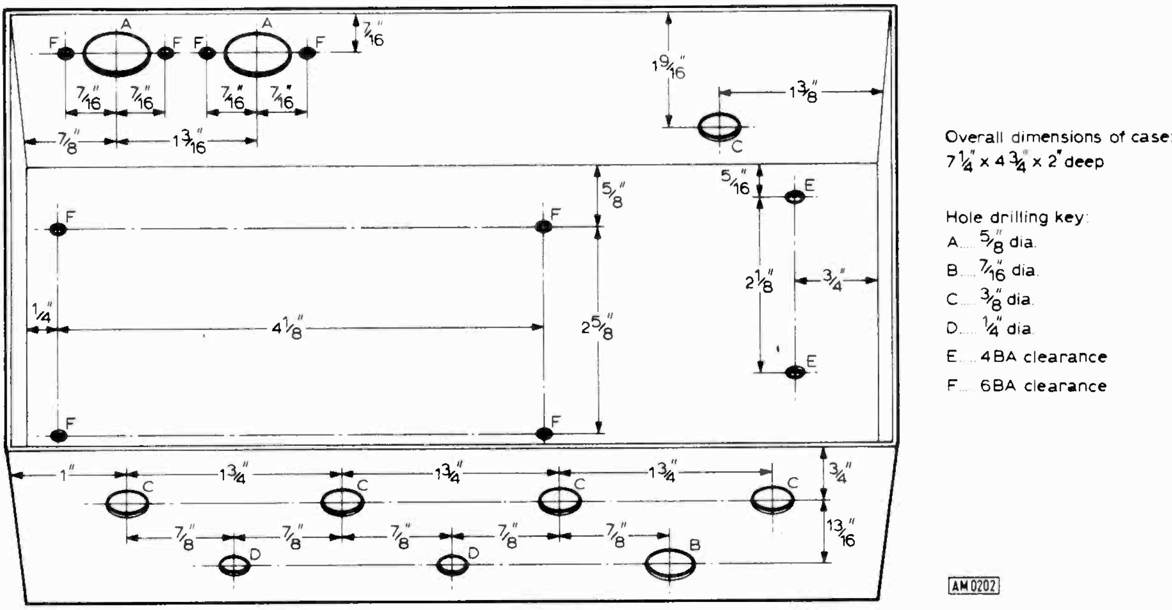
	Recommended	Alternatives
Tr1 Tr101	ZTX109	ZTX108B/C, ZTX382, ZTX383, ZTX384
Tr2 Tr102	ZTX109	as above
Tr3 Tr103	ZTX109	as above
Tr4 Tr104	ZTX109	as above
Tr5 Tr105	ZTX502	ZTX550, BFS97, ZTX537/538, ZTX212
Tr6 Tr106	ZTX450	ZTX337/338, BFS60
Tr7 Tr107	ZTX550	ZTX537/538, BFS97
D1 D101	ZS170	ZS270 or any ZS170/270 series
D2 D102	ZS170	as above
D3	ZS170	as above
D4	ZS170	as above

Miscellaneous

S1, 4 pole 3 way rotary switch. S2, Single pole toggle switch. LP1, Miniature neon indicator lamp. SK1/2, 5 pin DIN sockets (2). SK3, Stereo jack socket. T1, Mains transformer 12V+12V 6VA (RS Components Ref. Min. Tr. 12V). Knobs (4). Diecast box Eddystone 6827P.

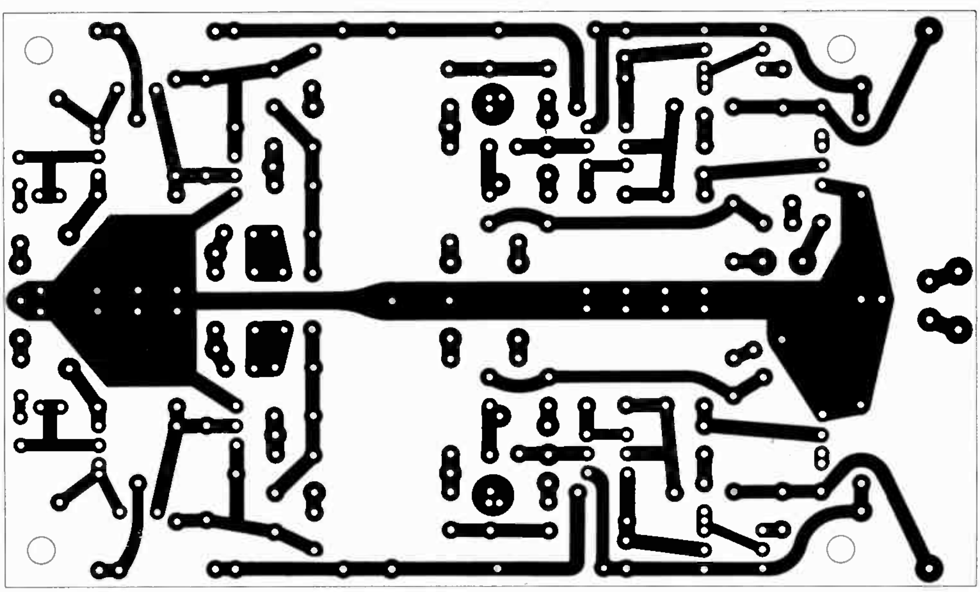
Davian Electronics, PO Box 38, Oldham, Lancs, OL2 6XJ can supply PCB at £1·85, kit of semiconductors at £3·10 or both for £4·75, all inclusive of VAT and P/P.

OUTPUT	1·3V into 8 ohms 4V into 50 ohms 6V into 500 ohms	This is sufficient to generate a sound pressure level of over 90dB with most headphones
DISTORTION	0·14% with 8 ohm load 0·02% with 50, 500 ohm load	1V output at 1kHz
TONE CONTROLS	Bass ± 12dB at 50Hz Treble ± 12dB at 15kHz	
DYNAMIC RANGE (Input)	25dB referred to 1V output	
SIGNAL/NOISE RATIO	Disc 67dB unweighted 20Hz to 20kHz 80dB weighted, 30 phon curve Radio 69dB unweighted 72dB weighted	referred to 1V output
BALANCE CONTROL	±9dB variation between channels	
FREQUENCY RESPONSE	Disc within 1dB of RIAA curve 20Hz to 20kHz Radio −3dB at 20Hz and 22kHz	



AM0202

Fig 6 above, gives drilling information for the diecast box while in Fig. 7 below, the printed circuit board is shown actual size.



AM 0203

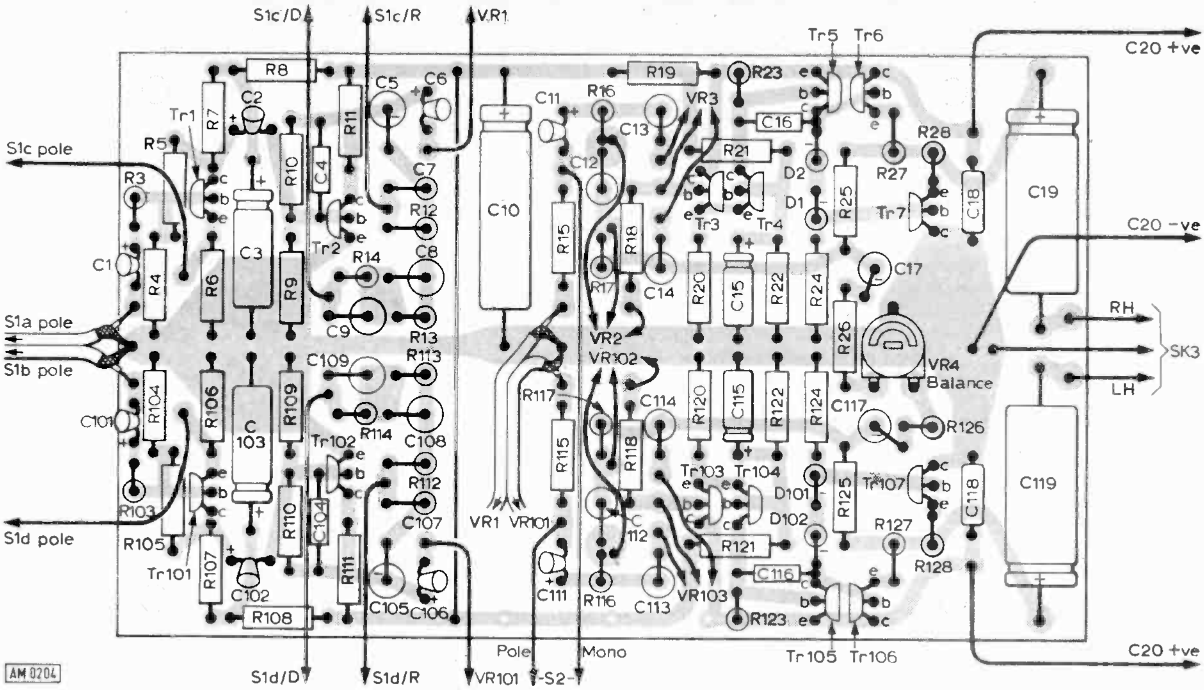
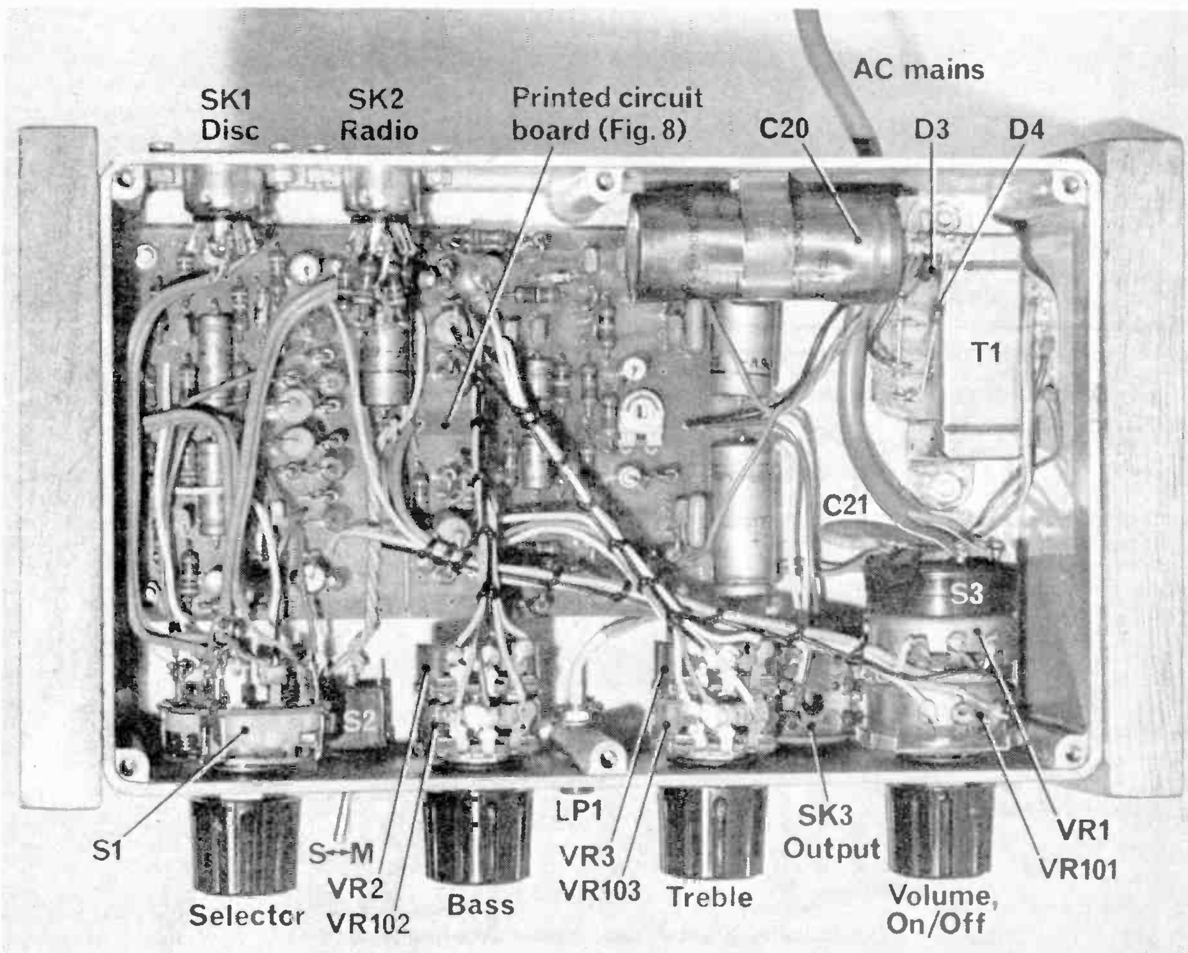


Fig. 8: Layout of components on the PCB and details of the associated wiring. The photograph shows the location of the components mounted on the box.



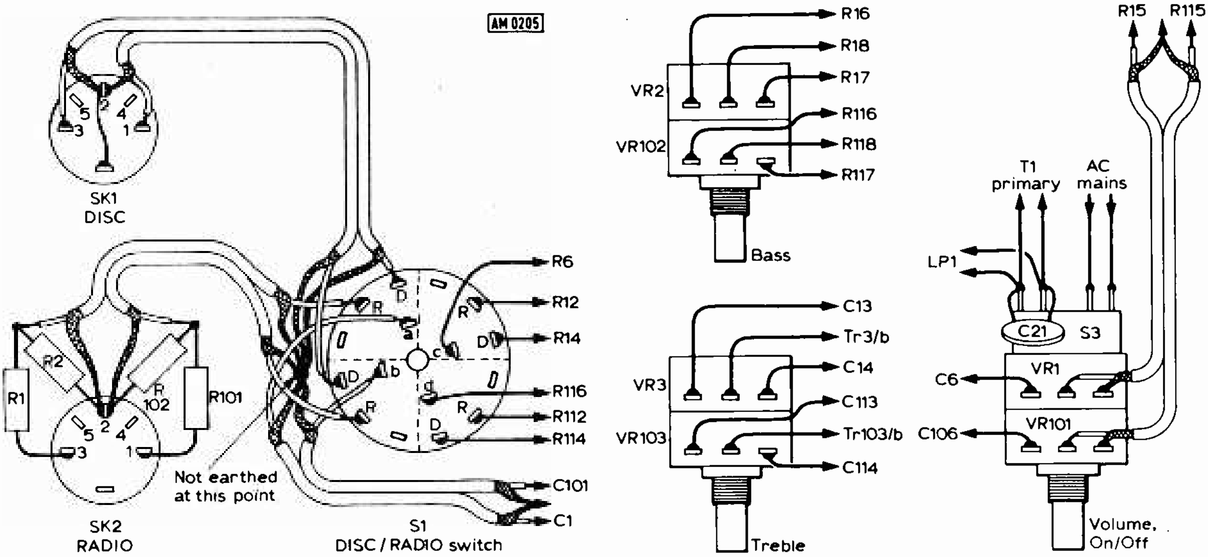


Fig. 9: Detailed information on the connections to the input sockets and various controls.

box are given in Fig. 6, and after drilling the box should be painted as desired. If wooden ends are required the ends of the box should be left unpainted.

Most of the small components are mounted on a single fibreglass printed circuit board, Fig. 7, measuring 5×3in. There is not a great deal of room to spare and miniature components should be used throughout. The first step is to assemble all the components on the board as shown in Fig. 8, and then to solder all wires for the external connections. Twin screened wire should be used at the input and between the volume control and R15/R115, but ordinary thin connecting wire is satisfactory elsewhere. All leads should be as short and direct as possible.

Mount the stereo/mono switch S2, the pilot lamp and the output jack socket SK3 on the front panel of the case and then mount the mains transformer inside. The assembled printed circuit board can now be fixed in place on ¼in. spacers and wired up to S2 and SK3. Then mount the three potentiometers and the selector switch and wire up as shown in Fig. 9. Finally mount the two DIN input sockets and C20 and complete the wiring. The two rectifier diodes D3 and D4 are wired directly between the transformer and the positive tag of C20. It may be necessary to cut short the negative tag of C20, or bend it down, to avoid shorting against the transformer. After assembly the wooden ends can be fixed in place with contact adhesive.

The specified selector switch has three 'ways', so an extra input can be added if desired. All that is necessary is to provide an extra DIN input socket and wire it as for the Radio input. If a sensitivity differing from 100mV is required R1 and R2 can be altered appropriately.

HEADPHONES

Headphones specifications tend to be rather confusing, as they are often specified as "suitable for 4/16 ohm amplifiers" when the impedance of the phones themselves is usually much higher than 4 ohms. Most commercial hi-fi amplifiers feed the phones output through a high value series resistor,

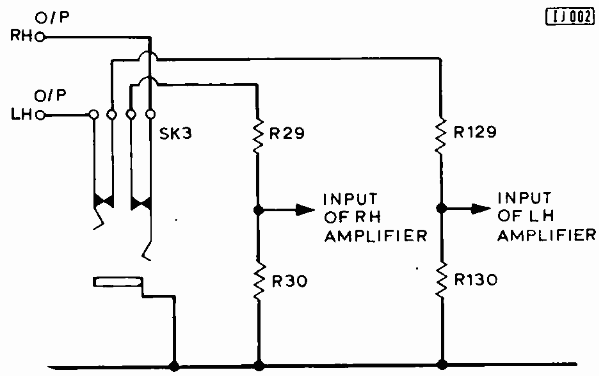


Fig. 10: Attenuator circuit for use when 'Derby' is employed to drive power amplifiers. Take values of resistors from table below.

AMPLIFIER SENSITIVITY	R29 R129	R30 R130
50mV	1kΩ	47Ω
100mV	1kΩ	100Ω
200mV	1kΩ	220Ω
500mV	1kΩ	1kΩ
1V	0	1kΩ

to reduce the signal level to an acceptable level. This unit feeds the headphones direct and has a very low output impedance, giving good electrical damping. If the reader is in any doubt about the correct impedance of his headphones the best course it to measure the DC resistance with an ohmmeter. The impedance is not likely to be less than this figure.

USE AS A PREAMPLIFIER

As stated earlier, this circuit will make a very satisfactory preamplifier. The output of 1V is rather too high for most power amplifier modules, so it will be necessary to interpose an attenuator between the unit and the power amplifier. Suitable values for various amplifier sensitivities are given in Fig. 10. If the attenuator resistors are connected via a switched jack socket then the amplifiers will be automatically muted when the headphones are plugged in. ■

THE POPULAR NEW ELECTRONIC GAME

TELE-TENNIS

PLAYED ON THE TELEVISION SCREEN

PART 2

M. J. HUGHES MA

Physical Features

Apart from the modulator itself, layout of the game is not critical; nevertheless constructors are strongly advised to use printed circuit boards due to the large number of integrated circuits. Mechanical construction of the prototype was kept as simple as possible. In many respects the single plane layout adopted proved to be ideal, allowing easy access to all the preset controls. Another advantage of the planar construction is that you can build the unit in stages without having to keep it inside its case—this is useful for carrying out tests and checking each board as you go along.

Six circuit boards are used, each secured to a sub-frame made of lengths of aluminium bar or extrusion; when completed this subframe is lowered inside a case. The only extra connections then required are to the front panel controls and the output points. The case was made from bent aluminium sheet carefully glued at the corners with an epoxy resin. The sloping front panel is hinged.

The six boards are designated A to F and these are laid out on the sub frame as shown in Fig. 7. The mains transformer is bolted on to an aluminium plate shaped to screw under the longer struts of the subframe. When making the subframe ensure that you allow sufficient clearance between the aluminium struts so that there can be no chance of short circuits between them and the pcb tracks. (About $\frac{3}{8}$in. clearance is allowed between the longer edges of each board and the copper to prevent such short circuits.)

Apart from Board F each printed circuit has overall dimensions of $3\frac{3}{4}$in. x $5\frac{1}{2}$in. Board F has a length of 3in. but it has the mains transformer alongside it. The overall length of your subframe should take into account the dimensions of the transformer used if different to that in the prototype. By making this subframe first you can get the system partly functioning at each stage. Make sure that there is at least one inch clearance between the underside of the circuit boards and the lowest points on the subframe. This is to prevent the modulator screening box,

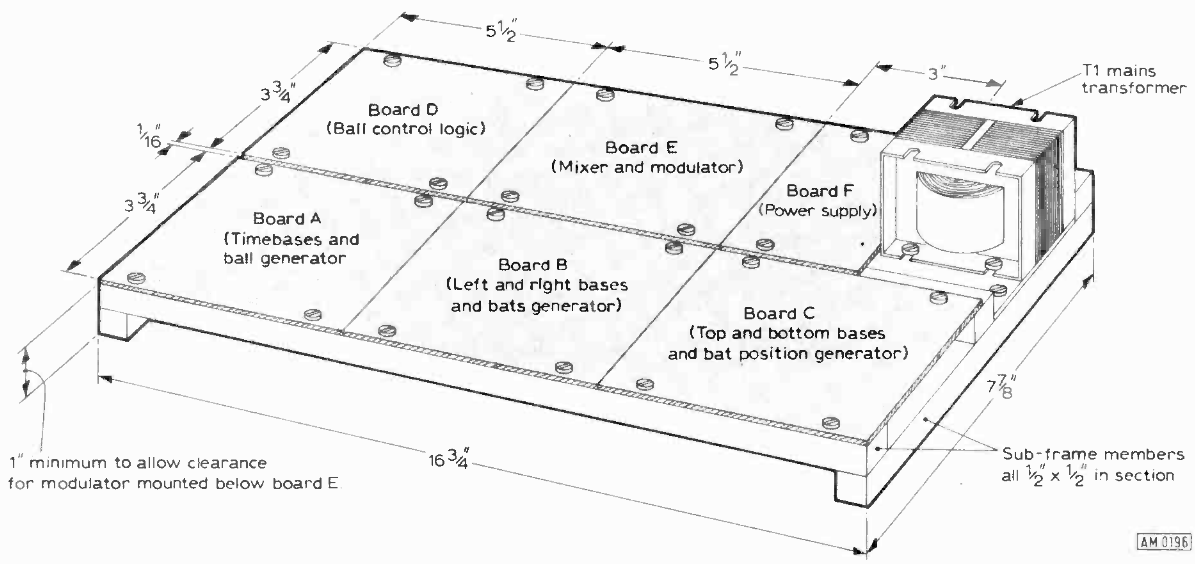


Fig. 7: Layout of printed circuit boards and mains transformer on the subframe. In the prototype this was made from aluminium bar but any material of similar size may be used.

which is live, touching the bottom of the Tele Tennis final enclosure.

This month we shall describe the operation and construction of boards E and F. If these are built first it is then possible to monitor the signals from other boards on your own television set—this obviates the need for an oscilloscope (although if you have one it would be most useful for setting up purposes!).

Power Supplies

Three power rails are needed; a stabilised +5V for the logic circuits, +12V (nominal) for the Ball control ramp generators and +12V (nominal) for the modulator. We have separated the latter two 12V supplies with heavy decoupling to prevent hum on the RF carrier and to prevent the ball control ramps altering the supply level to the modulator. Apart from this heavy smoothing and decoupling it is not necessary to stabilise the 12V rails.

The circuit for the power supply board is shown in Fig. 8. The stable 5V rail is provided by a TO-3 encapsulated voltage regulator 7805. Other similar devices could be used but some are prone to high frequency oscillation which could present problems. A 1000μF capacitor on board A provides LF decoupling, while 0·1's at various points on other boards reduce the chances of noise spiking from the TTL. The smoothing capacitors for the two 12V rails are located on boards D and E respectively.

Layout is pretty straightforward but it is essential to heat-sink the voltage regulator with a piece of shaped aluminium sandwiched between the IC and the board. This heatsink can be live and there is thus no

★ PCB functions

Board	Function
A	Time bases, Sync mixer, Ball generator, Ball vertical change control
B	Left and Right Base generators, Bat width generators, Bat output
C	Top and Bottom Base generators, Bat height and position generators
D	Ball control ramp generators, Ball control logic, Service and Ball Boy control, Ball blanking
E	Video mixer, Video blanking, Sync/Video mixer, UHF Modulator
F	Power supply

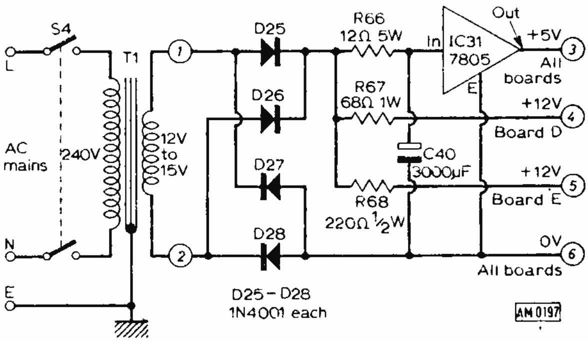
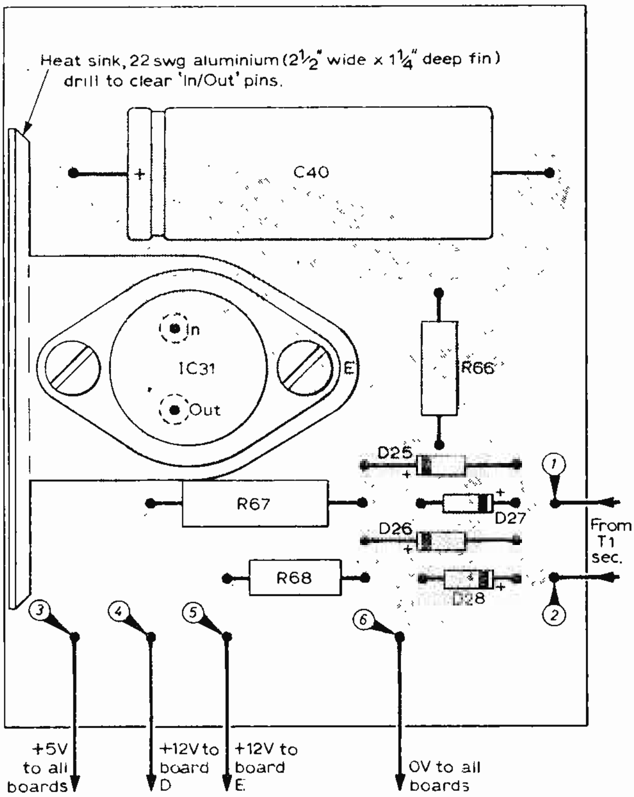


Fig. 8: Power supply circuit diagram. Smoothing capacitors for the +15V rails are mounted on Boards D and E.



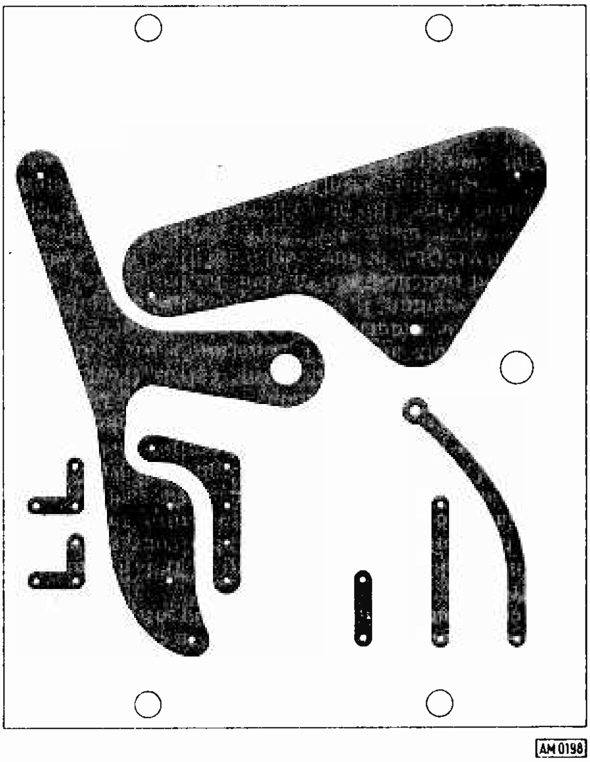


Fig. 9: Actual size layout of Board F and location of components.

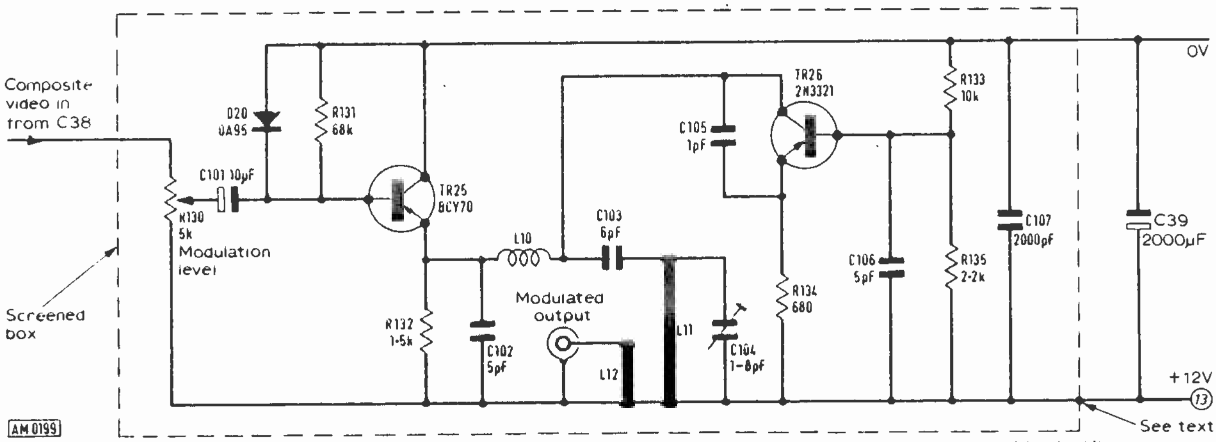


Fig. 10: Circuit diagram of the UHF modulator. Component references within the shaded area are those used by the kit suppliers and should not be confused with references in the rest of the project.

need for insulating mountings. Mount board F and the transformer on to the subframe and check that the correct voltages are present. Do not worry if the 12V rails are reading high (probably around 15V) because they are off load.

Modulator

The next step is to assemble the modulator. The circuit is shown in Fig. 10 and we are indebted to Crofton Electronics for permission to publish it here. Provided the kit's instructions are carefully followed **in every detail** there are no major problems to be expected. Remember, though, to take care with the ceramic feedthrough capacitors and ensure that the strip inductors L11 and L12 are precisely cut and positioned. Mark and drill or cut holes in the uniform copper area of the Mixer/Modulator board so that the modulator will rest flush against the square copper land. Bolt the modulator case firmly into position under the board by means of the potentiometer bush, so that the control spindle and input and output connections all protrude through the plain side of the board.

Using a large soldering iron you should, eventually, run a fillet of solder between the tinned modulator case and the copper land to give extra mounting support. Before doing this, however, it is as well to test the modulator. Connect temporary leads between the +12V and 0V pins of the modulator board and the corresponding points on board F and fit the 2000μF smoothing capacitor (C39) on board E. Set the tuning trimmer of the modulator and the modulation potentiometer to mid positions and connect the output socket of the modulator to the aerial socket of a 625 line standard television set via a short length of coaxial cable. Switch on the power and there should immediately be some indication on the television screen that something has happened—maybe the screen will brighten up or blacken off.

Check that the supply voltage is now about +12V and try adjusting the tuning of the television set. In the absence of any modulating signal there will be no picture as such, but it should be quite obvious that there is a carrier present as you tune through the range. By turning up the modulation control (turning **anticlockwise**) and touching the input pin with a finger you might be able to display a faint hum bar. At this stage it is sufficient to know that there is a carrier. You can now progress with the rest of board E.

Video mixer

The circuit for the mixer stages is shown in Fig. 11. Diodes D17 and D23 in conjunction with R61 form a diode OR gate which assembles all the waveforms that define portions of the final picture. We call this stage the Video Mixer. The combined output of this stage is fed to the blanking circuit where the mixed

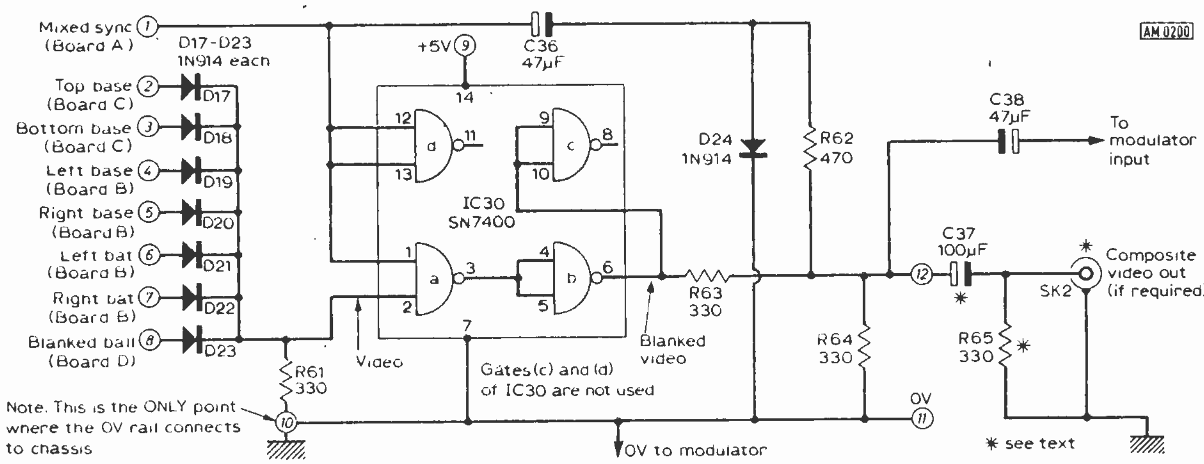
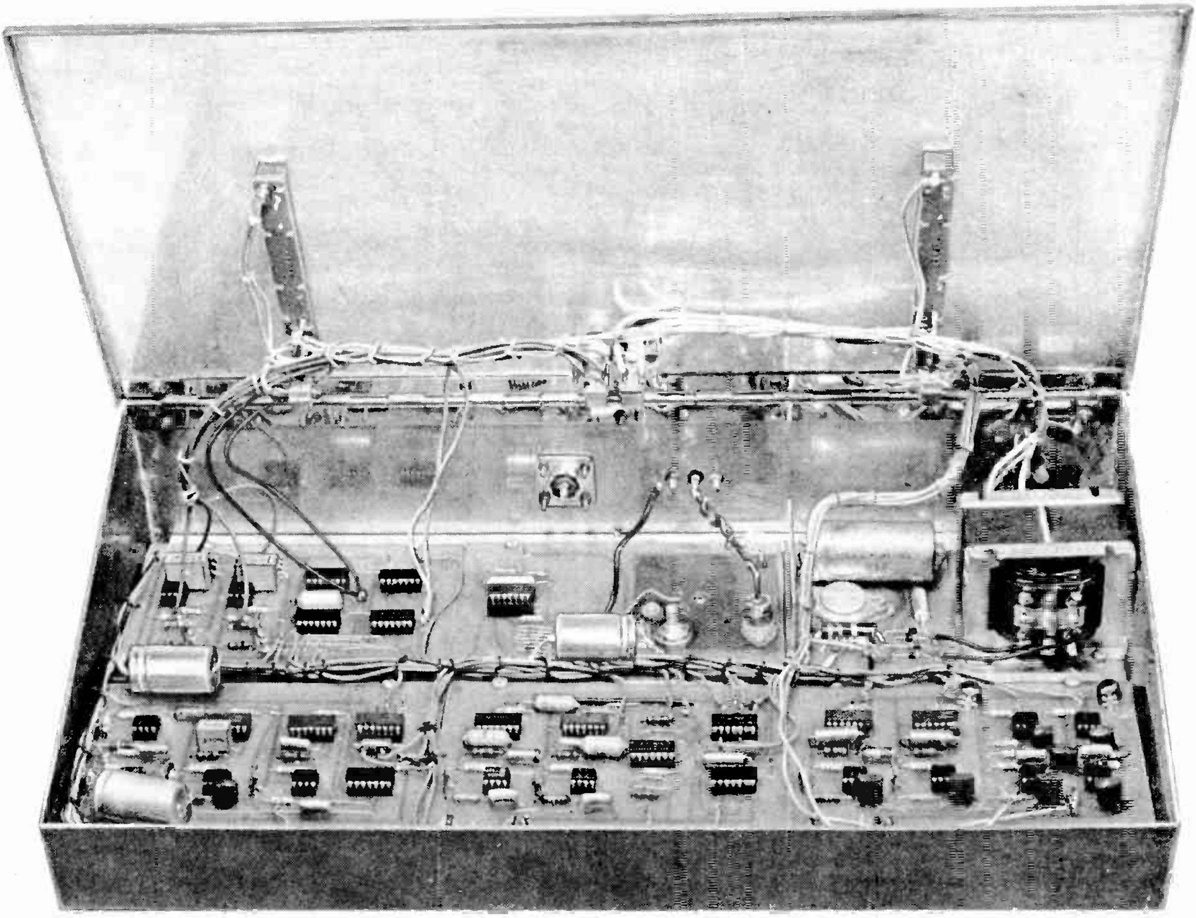


Fig. 11: Circuit diagram of Board E, including Video Mixer, Blanking and Sync/Video Mixer.



Interior view of the prototype Tele-Tennis unit. The composite video output socket is not connected up.

sync (from board A) is ANDED with it by IC30a. This has the function of ensuring that no video signal is present during periods when we shall be adding the field and line sync pulses.

The next stage is to combine synchronisation pulses with blanked video. R62, R63 and R64 form an additive mixer for the two signal sources, whilst D24 clamps the tops of the sync pulses to ground. Therefore, whenever a sync pulse occurs this is added to the video in a negative going direction. The ratios of the resistors in this stage are important to ensure the correct proportions of video and sync.

Two outputs are provided from this point. The composite video signal can be taken straight to a monitor if required, however we expect that most constructors would not possess such an instrument, and in that case C37 and R65 can be omitted. The alternative is to feed the composite signal to the modulator input via C38. Make sure that you connect this capacitor with the correct polarity because the case of the modulator is connected to the **positive** rail.

Throughout this project we recommend that you use dual-in-line sockets for all the integrated circuits. Apart from allowing you to replace suspect devices you will protect the guarantee given by most reputable suppliers. Do **NOT** connect any of the power lines to the subframe as chassis grounds. There is only one connection to chassis and this is made on final assembly into the case.

★ components list

BOARD 'E'

Resistors—all $\frac{1}{8}$ or $\frac{1}{4}$W
R61 330Ω R62 470Ω R63 330Ω
R64 330Ω R65 330Ω

Capacitors—all 25V electrolytics
C36 47µF C37 100µF C38 47µF
C39 2000µF

Semiconductors
D17–D24 1N914 IC30 SN7400

Miscellaneous
PCB; DIL14 IC socket; 14 wiring pins; Modulator kit from Crofton Electronics, 15/17 Cambridge Road, Kingston-upon-Thames, Surrey KT1 3NG, price £7·30 including p.p. and VAT.

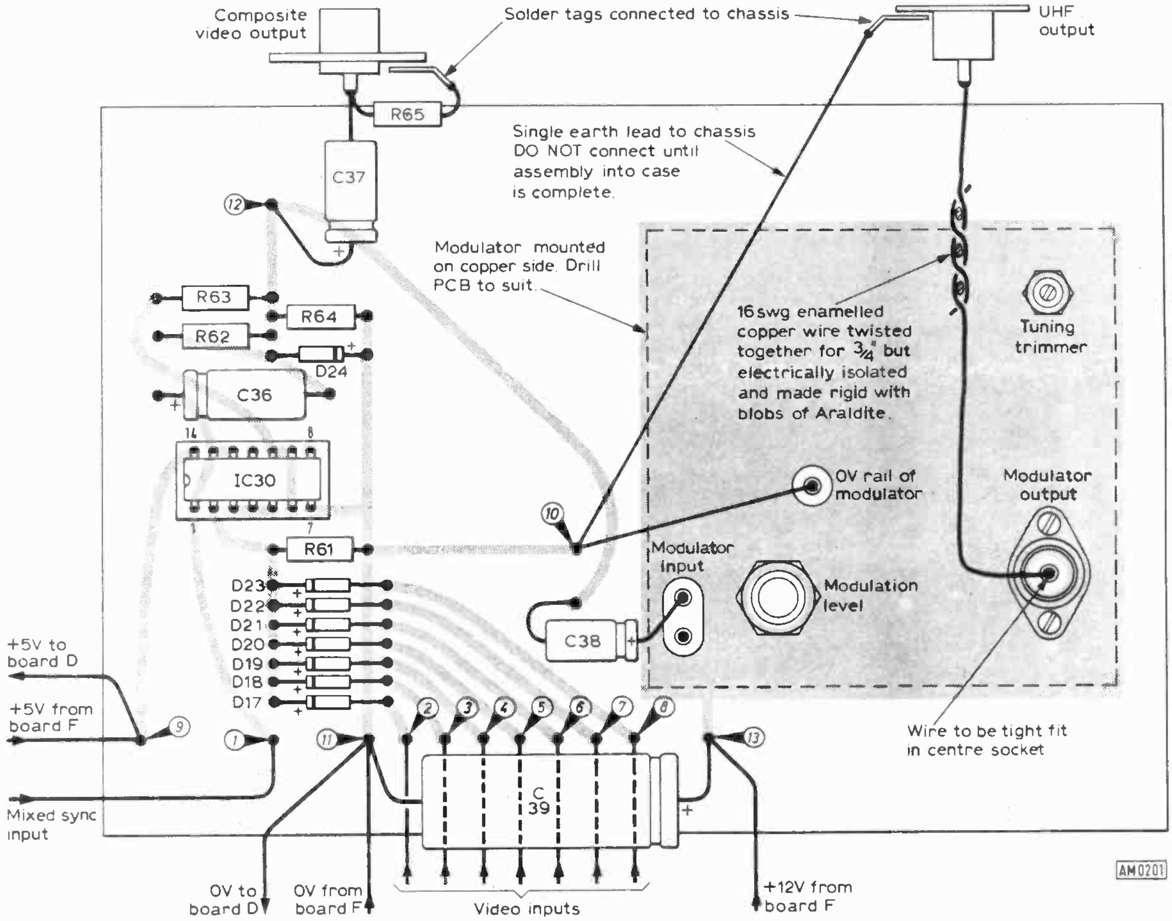
BOARD 'F'

Resistors
R66 12Ω 5W R67 68Ω 1W
R68 220Ω $\frac{1}{4}$W

Capacitor
C40 3000µF 25V electrolytic

Semiconductors
D25–D28 1N4001 IC31 7805 regulator

Miscellaneous
T1 Pri: 240V, Sec: 12–15V $\frac{1}{2}$A; PCB; 6 wiring pins; material for heat-sink, transformer mount and subframe.



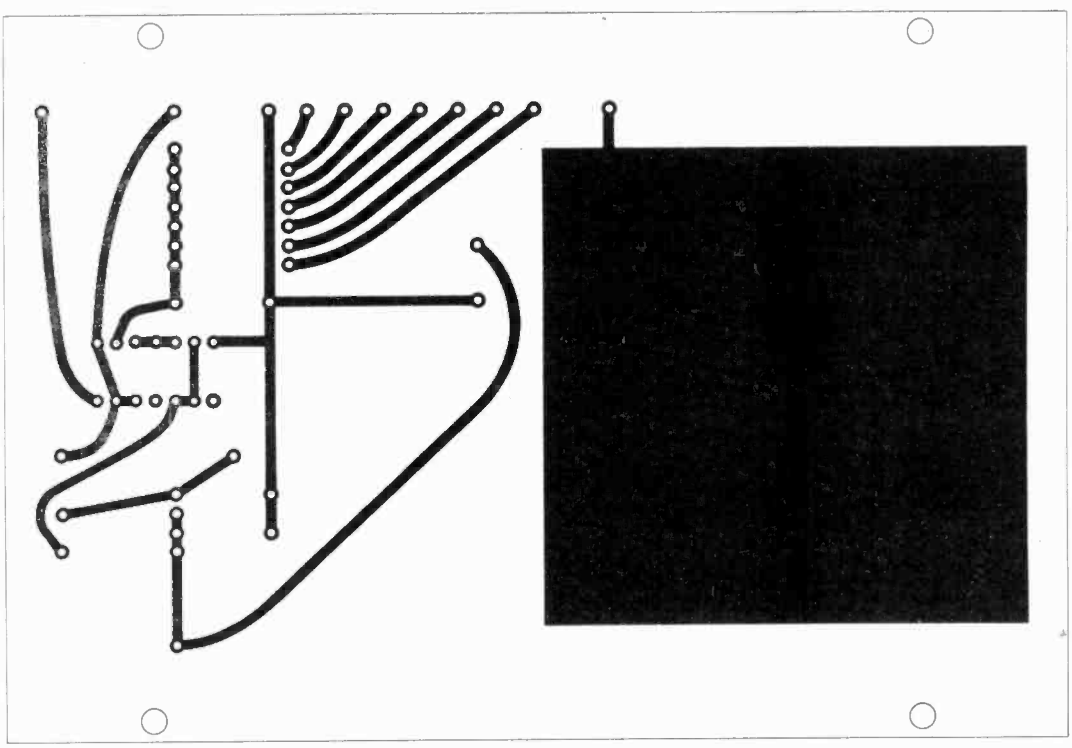
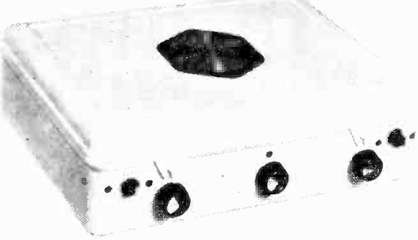


Fig. 12: Actual size layout of Board E and location of components.

—*continued on page 346*



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- ★ 7 Transistor Loudspeaker Radio MW/LW.
- ★ 5 Transistor Short Wave Radio.
- ★ Electronic Metronome.
- ★ Electronic Noise Generator
- ★ Batteryless Crystal Radio.
- ★ One Transistor Radio.
- ★ 2 Transistor Regenerative Radio.
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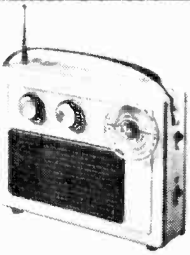

Nine Transistors, 9 Tuneable wavebands as Roamer Ten Built in ferrite rod aerial for MW/LW. Retractable chrome-plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9½" × 7" × 2½" approx. Parts Price List and Plans 30p (Free with parts).

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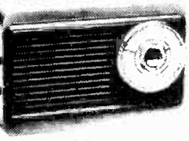

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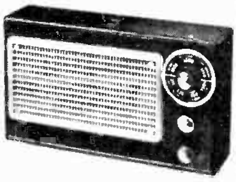

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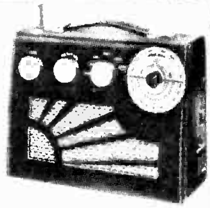

10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers. 9 Tunable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Latest 4" 2 watt ferrite magnet loudspeaker.

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).

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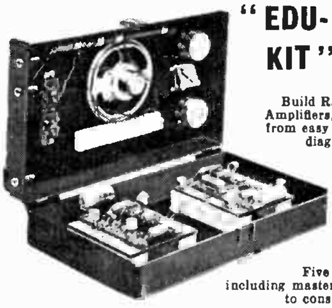

Five units including master unit to construct.

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.
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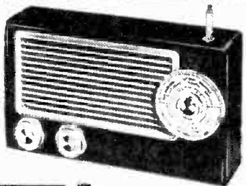

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Oscilloscope techniques

PART 6 ALAN AINSLIE

POWER SUPPLIES

It is not intended in this section to go into all aspects of power supply theory as it is very involved and all manner of supplies are used in oscilloscopes. However we can take a general look at power supplies and some of the problems encountered.

VALVE HEATERS

Valve heaters are usually wired in parallel, in groups of perhaps 5 or 6A maximum. Because of considerations of heater-cathode voltages some of the heater lines may be at certain potentials, e.g. 0V, +100V or −150V etc. Perhaps the most obvious case of this is in the case of the CRT heater which must be at −1 or −2kV. The bright up bistable is usually at EHT potential as would be the EHT series regulator if fitted. All these heaters would be run from one transformer winding and strapped to the negative EHT supply.

We shall shortly look at RF EHT generators which provide an output that is usually doubled or tripled to provide the 10 or 12kV needed on a high voltage tube. If the tripler uses valves then the heaters are usually run from a winding on the EHT transformer. A failure of the EHT generator will therefore cause these valves not to light.

In order to prevent hum and drift the input valves to the Y amplifier are sometimes fed from a stabilised HT line in series. One open circuit heater will therefore cause the whole lot to go out. One further difficulty is that heater cathode shorts can put a few valves out without affecting the others, giving rise to very misleading faults. However this practice of series valves is limited to only a few valves in very complex oscilloscopes and is not usually found in fairly simple ones.

Also supplied from a heater line is the graticule illumination, if fitted. This usually consists of a pair of small 6·3V, 0·1A bulbs in parallel, fed from a 6·3V line by a 100ohm pot. This enables the illumination to be changed to suit the display intensity.

HT SUPPLIES

The HT requirements of a small AC coupled scope may be quite modest and if no accurate calibration is intended the power supply can follow normal radio practice, i.e. a full wave rectifier and simple smoothing. Both metal and valve rectifiers are used but care should be taken when replacing a valve with a couple of BY127's, as is often done for economy in the event of a failure having occurred. In general it is very bad practice as the HT comes on straight away and decoupling capacitors can short circuit through overvoltage and electrolytics can blow up making a mess when they do so and that can be dangerous so always replace a valve with a valve, or provide a thermal switch to put the HT on after 30 seconds or so.

This is the method incorporated in several large oscilloscopes where valve rectifiers would waste too much power. A small thermal switch puts 6·3V on to a relay after 30 seconds or so. The relay flips over and connects the HT windings to their rectifiers as well as providing a "holding" current for the relay and taking the supply off the terminal switch which cools down. If there is a small power break the relay loses its holding current and the HT cannot be reconnected until the thermal switch has heated up again. This protection can be extended to switch off the HT in the event of a plug-in unit being removed and another inserted, HT taking another 30 seconds to come on.

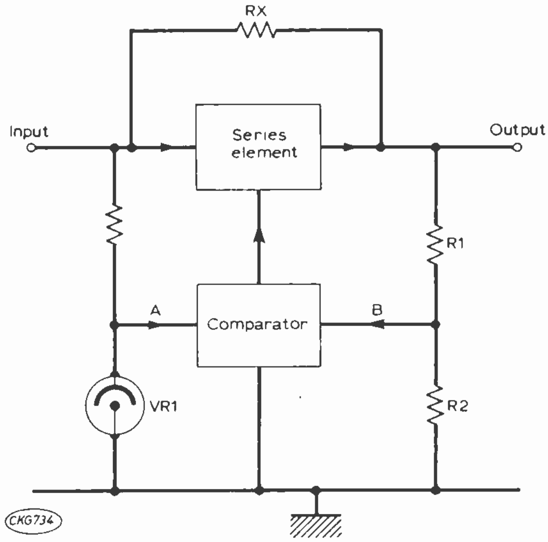

Fig. 1. Circuit requirements for a series stabilised HT line.

If some valve heaters are run from the HT line then there is also a delay while these warm up. In general this type of scope takes about 5 minutes to switch on and sort itself out, but the advantage of circuit protection is well worth the operating delay.

In most oscilloscopes some or all of the HT lines are stabilised. Because the HT load is predictable (except under fault conditions) the series stabiliser can be arranged to stabilise with little loss of power.

Fig. 1 shows the general arrangement of this type of stabiliser. R_x can be made such that the power dissipation in the stabiliser valve is kept to a reasonble level, whilst maintaining adequate stabilisation. The comparator, usually a long-tailed pair, senses the difference in potential between the points A and B and drives the series element so as to correct the difference. The ratio R1/R2 sets the output voltage and R1 is usually made preset so that the HT rail can be accurately set to its prescribed value.

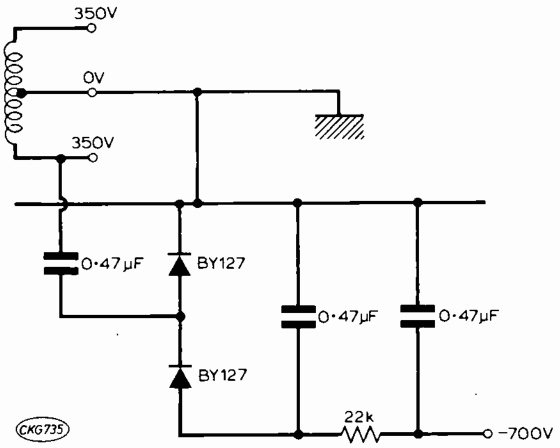

Fig. 2. Method of obtaining EHT for a small CRT using a standard mains transformer.

The circuit also has a hum reducing action in that no hum exists at point A (set by VR1) and so the comparator "makes sure" that no hum exists at point B. Hum can be injected into the comparator as well to give virtually perfect DC (ripple less than 25mV) with a ripple input of several volts. The series element is usually a power pentode or triode. If the current demand is large several valves may be placed in parallel to meet the current requirements.

If more than one HT line is required to be stabilised it is usual to make a very good job of stabilising one of the lightly loaded lines and to use this to stabilise all higher voltage lines. A typical oscilloscope would usually have HT rails at −150, +150, +400V to cover the requirements of the Y amplifier and timebase.

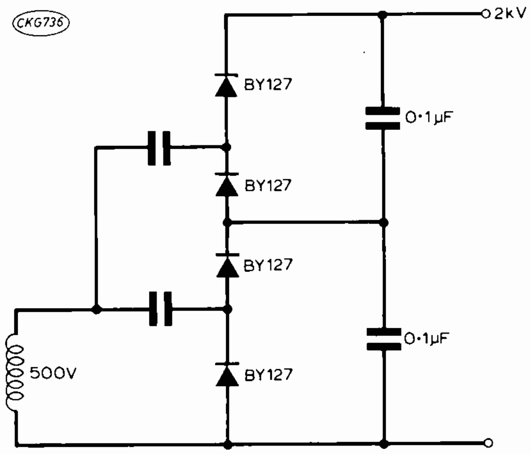

Fig. 3. Development of the voltage multiplier to produce 2kV.

EHT can be derived from one winding of the mains transformer at full voltage (say 1·5kV) and rectified and smoothed. If the oscilloscope is calibrated then the EHT must be regulated and a small series pentode is generally used for this purpose. The provision of a 1·5kV winding on a mains transformer is difficult and expensive (also lethal if you happen to get hold of it!) and so many scopes use voltage multiplication from a low voltage winding, followed by a series regulator if necessary.

Fig. 2 shows how 700V can be obtained from the 350-0-350 mains transformer of a small oscilloscope and Fig. 3 shows how the idea is extended to give 2kV from 500V. The Solartron D1400 used this principle to produce nearly 1·5kV from a 140V transformer winding.

These methods of deriving HT from a mains transformer are satisfactory up to a few kV but when 8 or 10kV is needed RF supplies are usually employed. These have the advantage that the supply can be self stabilising, can supply all the EHT supplies, operates at a high frequency and so does not need bulky smoothing capacitors and is fairly harmless in the event of accidents. Fig. 4 shows a block diagram of a typical form of this type of generator. The oscillator is self-oscillating by virtue of positive feedback from the transformer (a small winding feeding the output valve grid). The comparator provides an error signal to maintain the potential at point A as it should be, obviating any changes in the cathode supply. The PDA supply tends also to be stabilised but not so well, but is in any case not so important.

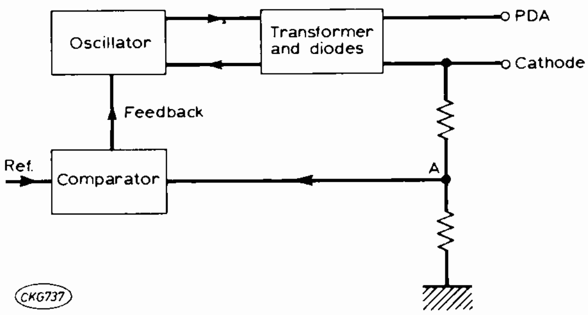

Fig. 4. Block diagram of RF generator producing 8 to 10kV.

The oscillator is tuned by a capacitor across the anode transformer winding and normally runs at 25 to 30kHz. The transformer is usually a ferrite toroid for high efficiency with the windings on polythene bobbins. As we have already mentioned, there are also windings for the voltage multiplier valve heaters if fitted. The whole EHT unit is usually isolated in a small compartment and the supply leads decoupled to prevent RF appearing everywhere. It is advisable to keep dust and damp out of this compartment and vulnerable points are usually given a coat of shellac during manufacture. Any damp might cause tracking which can cause a surprising amount of damage. In damp environments it is perhaps useful to place a small bag of silica gel in the compartment to keep the area as dry as possible.

When setting the EHT voltage with the "SET EHT PRESET" it is as well not to go over the voltage prescribed as this overruns the output valves, overruns the multiplier heaters and puts a strain on the insulation and the CRT. Any repairs in the EHT unit must

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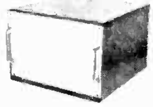

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6·8	40	6p	100	25	6p	470	10	10p
6·8	63	6p	100	40	6p	470	25	12p
10	25	6p	100	63	12p	470	40	18p
10	63	6p	150	6·3	6p	680	6·3	10p
15	16	6p	150	16	6p	680	16	12p
15	40	6p	150	25	6p	680	25	18p
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22	10	6p	150	63	12p	1000	4	10p
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22	63	6p	220	10	6p	1000	16	18p
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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	6p	2200	10	22p
47	40	6p	330	16	10p	3300	6·3	22p
47	63	6p	330	63	22p	4700	4	22p

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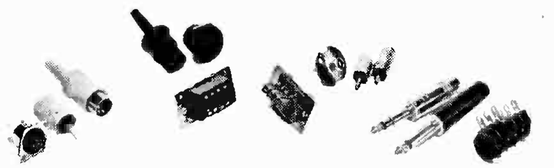

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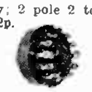

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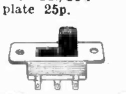

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be done with neat, round soldered joints to prevent corona discharge which produces ozone which destroys the insulators. It is also important to replace all screening and earth braidings. Spark gaps are often provided, especially in equipment with transistors, to break down when excess voltages occur, preventing damage to other parts of the circuit and they should be kept free of dirt otherwise they will flash over for no apparent reason.

The EHT generator is usually supplied from the highest available voltage rail in the oscilloscope and the supply line is very well decoupled. The current taken is usually only about 50 or 60mA and so represents a light load on the line.

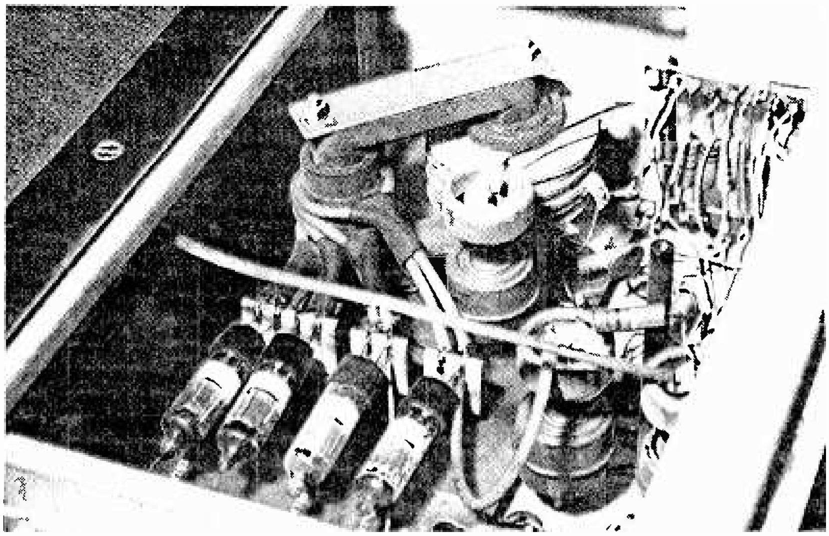
Taking into account the overall power requirements of a complete oscilloscope the mains transformer is physically rather large (weight perhaps 10 or 15lb) and tends to produce a large magnetic field. In order to guard against this field and external magnetic fields the CRT is enclosed in a Mumetal shield which acts as a magnetic screen. The excellent screening properties of Mumetal make it possible to mount the transformer fairly near to the tube without ill effects. When removing a CRT it is important not to bend the Mumetal as it loses its properties if bent and replacement shields are expensive. The Mumetal is also earthed to prevent external electric fields penetrating the tube and causing deflection.

The internal layout of the oscilloscope is to a great extent governed by thermal considerations. For example the X and Y output stages and the power supply regulator valves are situated so that they can lose their heat easily. Small signal stages can be tucked away in any odd corners without coming to much harm. Power valves are always operated vertically for maximum reliability as the grids may sag when used horizontally. This should be borne in mind if the scope is run on its side for long periods during calibration etc.

Signal leads also play a part in dictating the layout in that signal-carrying leads are kept as short as possible to reduce capacitance and stray pick-up. When undertaking any modifications on oscilloscopes it is important to bear the above facts in mind as regards positioning of any extra stages or wiring.

GENERAL MAINTENANCE

Apart from recalibration, say every 6 months, or if obviously needed, an oscilloscope needs additional care and attention. The heat generated causes dirt and dust to stick and if a fan is fitted this makes matters worse. When used in a dusty environment it is as well to keep the oscilloscope covered with a plastic sheet to keep out unnecessary dust. However when the scope is in use there is little that can be done because to obstruct the dust is to obstruct the airflow necessary to maintain a safe working temperature.



The EHT section of an oscilloscope, the rectifier valves heaters being fed from individual windings on the transformer.

The author used to think that a scope could not be cleaned and pampered too much but is now a bit wiser! When cleaning out dust with a small brush connections become dislodged and dust gets into switches and controls. So it is best to keep the number of "spring cleans" to as few as are really necessary and to allow a bit of time for fault finding afterwards. But do not be put off—the result of a clean scope is a more reliable scope that is much easier to work on when it does break down.

For general chassis cleaning a brush round with a 1" paint brush is usually adequate unless the dirt is greasy when the chassis may be rubbed down with a

COOLING

Large oscilloscopes usually have a fan at the back to keep the scope cool and the field from the fan motor is such that a piece of Mumetal is often needed around the motor. This should always be replaced when servicing of the motor is completed. The danger of an excessive rise in internal temperature is so great in some scopes that a thermal cut-out is incorporated to switch off the HT, but leave the fan running if the temperature should become too high. Clogged air filters can cause this to happen and it should not be ignored because all manner of awkward faults can be brought on by excessive temperatures.

rag soaked in acetone or carbon tetrachloride. It is important not to disturb any preset pots or trimmers, especially in the distributed amplifier and attenuator and in the timebase. The EHT generator whether RF or from the mains should be kept clean as the dust builds up quickly in this area and also can do the most damage. Oil from leaking EHT capacitors also aggravates the situation but a cloth soaked in acetone will probably clear up the mess.

CONTROLS

Controls quite naturally come in for a lot of hard wear and pots and switches tend to become erratic. A gentle squirt of "SERVISOL" aerosol will sort out most problems. It is important not to spray too much as it can make rather a mess. Beware of the cheaper brands, they dissolve plastic switch parts in a flash, leaving a gooey mess in place of the switch! When potentiometers become noisy or erratic in operation a gentle squirt of "SERVISOL" on the track will probably effect a lasting cure. Some spurious effects can be traced to the spindle bearing and a gentle squirt here may well help, but it is important not to get the fluid on to the front panel as it can make rather a mess and dissolve some types of lettering.

Input sockets (especially the UHF83) sometimes need tightening to ensure reliable contact but it is necessary to be careful not to cause too great a deformation especially with the BNC sockets which are quite fragile. Oscilloscopes equipped with plug-in units often need a little lubrication on their runners and it is advisable to keep the rear connector clean otherwise erratic operation will result. One point often overlooked is that power valves (regulator, X and Y outputs and EHT generator) when they are greasy suffer a much higher running temperature due to lack of cooling. It is a good idea to keep all valves clean and polished and to give the base a tiny squirt of "SERVISOL" before replacing the valve. Several oscilloscopes place the EHT generator valves in screening cans (to prevent radiation) and if these fill up with dust, as often happens, the valve tends to run scorching hot with the possibility of early failure.

SERVICING

With regard to the electronics there is little that can be done in the way of maintenance on a regular basis, it being necessary to wait for faults to occur before they can be rectified. Fortunately the majority of oscilloscopes are constructed to be as reliable as possible for the price and consequently the fault rate is low. Most faults can be found with a multimeter and a signal source applied to the scope. When found the faults usually turn out to be due to faulty valves, faulty rectifiers, open circuit or "high" resistors or short circuited capacitors. When making replacements it is important to keep to a high standard of workmanship and to use good quality components of adequate rating.

COMPONENT REPLACEMENT

A word is perhaps of use here concerning the AC qualities of resistors. The reactances of resistors becomes important at high frequencies in critical circuits, such as the Y amplifier and timebase. The standard carbon rod type of resistor, usually 10% tolerance at best, is perhaps one of the best types with regard to its AC performance. Its inductance is zero and the capacitance is usually less than 1pF. Metal film resistors are also as good in this respect and are available in a wide range of ratings and with tolerances as close as 0·5% if necessary. Other types of carbon resistor although of high reliability may have quite significant inductance and also fairly high self-capacitance. Wirewound resistors are absolutely useless in such applications and should only be used where they are well decoupled and their reactance of no consequence.

In general it is best to replace any components by identical types, which can be ordered from the scope manufacturer if necessary. Replacement component tolerances should be better or the same as the item they replace. Servicing of oscilloscopes, particularly by their owner, rarely creates any problems as the circuits are well defined in their operation and the layout in the majority of cases is intended to aid servicing.

To be continued

TELE-TENNIS

—continued from page 338

The reason for making an issue over grounding is that the Crofton modulator has inverted supply rails, i.e. its case is at +12V, whereas we shall ultimately be making our system ground OV. **Do not under any circumstances** let the case of the modulator come into contact with other metal work or you will put a dead short across the power supply. It is best to cover all exposed metal work of the modulator's case with a couple of layers of PVC tape.

When Board E is complete it can be screwed to the subframe alongside the power supply board and the supply leads wired in. Apply power and check that a carrier is present by watching the television screen. If you have a signal generator (you can make a simple one from a standard multivibrator circuit) giving outputs of up to 5V you can inject a 15·625kHz signal into the mixed sync input. Turn up the brightness of the television set and you should—if the set is in tune—see a dark band running down the left hand side of the screen. Adjust the tuning for maximum signal—it is easier to adjust the set rather than the modulator—and then see the effect of varying the modulation level. Alternatively injecting a 50Hz square wave into the same point should produce a dark horizontal band running across the screen. The signal generator will need fine adjustment to obtain precise field or line lock. A square wave having a frequency between 50Hz and a few hundred kilohertz connected to the inputs of diodes D17 to D23 should cause a random array of white dots to appear on the face of the television set. Further tests must wait until we have produced a correctly generated set of field and line sync pulses. This we shall do next month when we describe the circuitry and construction of boards A and B.

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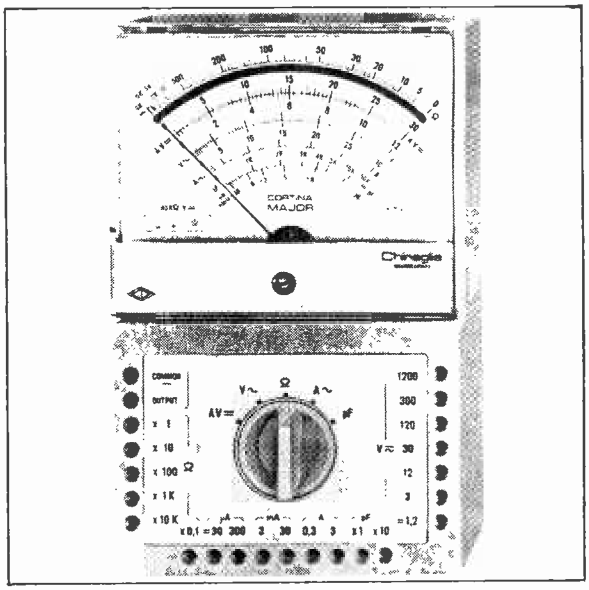
SPECIAL PRODUCT REPORT

CORTINA-MAJOR MULTIMETER

IF you are a conscientious constructor, you would not be able to get very far without getting frustrated by the need for a multi-range meter. It is almost as essential as a speedometer to a motorist. Without one, how can you locate fault conditions, or check component values.

Practical Wireless recently published an article on this subject, illustrating examples of well known types. When looking around to buy a multimeter what should you look for? Well this will depend to some extent on the usage expected of it. There are meters renowned for robustness and the ability to withstand fairly rough handling. There are those that have a high sensitivity, or an extended voltage range, or built-in capacitance meter. Good ones are not cheap to buy, but this does not mean that cheap ones are not worth having.

There has been a recent introduction of some Italian instruments into the U.K. which are certainly worth looking into for several reasons. These are made by Chinaglia Dino and are being distributed in this country by Chinaglia (UK) Ltd*. There are several types, each having its own performance/cost parameters; we have selected as being a very useful all-rounder, the "Cortina Major" which costs £22·27 or, if you want the Universal Signal injector with it, will cost £27, plus VAT in each case. There are lower priced meters in the range that are also worth looking into, but with more modest performance.



MANUFACTURER'S SPECIFICATION

Sensitivity	A.C. & D.C., 40kΩ/V
Accuracy	D.C. ± 2·5% Ohms ± 2%
Bandwidth	20Hz to 10kHz
Dimensions	156 x 100 x 40mm
Weight	650 grammes
Power requirements	Internal, 2 x 1·5V HP7 or similar) 1 x 22·5 (B 122 or similar) for resistance. External, 220-240V 50Hz for capacitance and frequency only.

RANGES

Volts D.C.	Volts A.C.	Current D.C.	Current A.C.
0-420mV	0-3V	0-30μA	0-3·0mA
0-1·2V	0-12V	0-300μA	0-30mA
0-3·0V	0-30V	0-3mA	0-0·3A
0-12V	0-120V	0-30mA	0-3·0A
0-30V	0-300V	0-0·3A	
0-120V	0-1,200V	0-3·0A	
0-300V			
0-1,200V			

Resistance Ω	Power dB
0-2kΩ	−10 to +11
0-20kΩ	+ 2 to +23
0-200kΩ	+10 to +31
0-2MΩ	+22 to +43
0-20MΩ	+30 to +51
0-200MΩ	+42 to +63

Frequency Hz	Capacitance μF
0-50Hz	0-0·05μF
0-500Hz	0-0·5μF
0-5kHz	

Ballistic Capacitance
Extends ranges up to one Farad.

Universal Signal Injector

Frequencies	500kHz modulated at 1kHz
Harmonic content	Usable up to 500MHz
Output	20V peak-to-peak
Isolation	Probe will withstand 500V d.c. at circuit under test
Power requirements	25mA from internal battery

PERFORMANCE

The quoted performance figures are tabulated here and straight away, readers will notice the sensitivity of 40kΩ/volt. This is adequate for transistor and i.c. circuitry and brings the meter into possible applications even with high impedance work without serious shunting errors in the readings indicated. When used as a voltmeter across any a.c. or d.c. load, the internal resistance of the instrument will often have some effect on the reading accuracy. The higher the sensitivity in terms of kilohms per volt, the less will be that error.

The Major will handle a.c. and d.c. voltage and current measurements. The a.c. current facility is particularly interesting; although not required very often, it can be a nuisance if you are using a meter that does not have this facility, as is the case with some earlier models from other makers. The main problem with this range is that its accuracy really depends upon the frequency of the current being measured because of the reactance effects of the meter coil. For inductive loads, it can be a little misleading unless the frequency is taken into account. In the absence of any other figures of measurement than the claimed accuracy of ± 2·5 per cent for a.c. ranges, we assume this to apply within the quoted bandwidth.

RANGES

The d.c. current ranges are very useful for transistor circuits, being based on a common scale of 0 to 30 with

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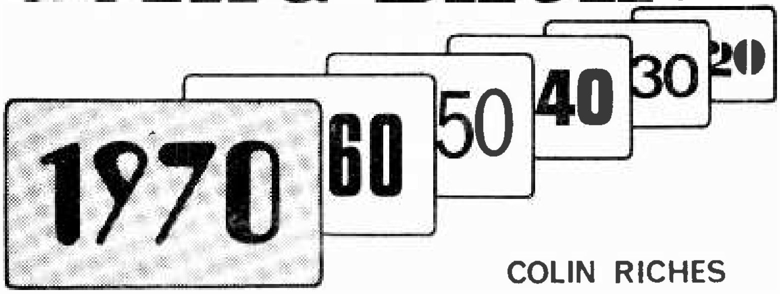


COLIN RICHES

THIRTY-FIVE years ago this year the Zenith Trans-Oceanic was born.

Over the years new knowledge and improved technology have gone into successive improved versions. The latest—the Trans-Oceanic Royal D-7000Y — is equipped to tune to 11 wave bands. (1) a.m., 540-166MHz, (2) f.m., 88-108MHz, (3) l.w., 150-400kHz, (4) s.w., 1·6-3·5MHz, (5) 3·5-90MHz, (6) 9·4-10·1MHz, (7) 11·4-12·33MHz, (8) 14·6-15·8MHz, (9) 17·1-18·5MHz, (10) 20·6-22·4MHz and (11) 161-164MHz.

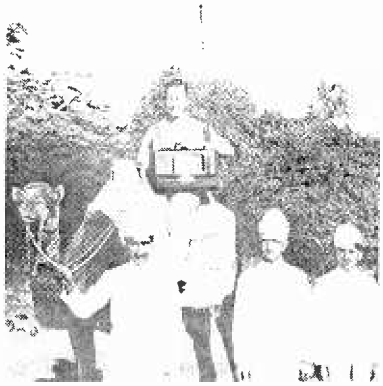
It is designed and treated to operate in extreme climatic conditions, and incorporates r.f. gain control, b.f.o., vernier tuning and battery level meter, illuminated dial and chart panel, telescopic aerial and personal earphone. Navigational benefits include a time zone indicator, logging scale and azimuth compass. A swivel base platform can be supplied to aid directional tuning. It operates on 9 standard U2 type batteries but also has a built-in a.c. power supply for either 115V or 230V a.c.

The Trans Oceanic theory was developed into practice in 1939, when Commander E. F. McDonald (Zenith's late founder-president), having asked the company's engineering department to produce a shortwave battery operated radio, found that he could sit in his Canadian fishing lodge and pick up both the weather forecast from Ohio and broadcasts from London.

After a combination broadcast and shortwave receiver with broad bandspread for easier tuning had been produced, McDonald took one to Northern Canada and sent another to Commander Donald B. McMillan in the Arctic. McMillan tested it on Baffin Island, and then further north on Ellesmere and Greenland. Finding it fully satisfactory, he radioed McDonald to express his approval.

When some further 20 experimental models had been tested and subsequent modifications

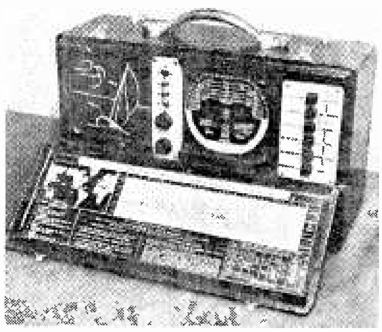
Experimental S.W. transmission with singing Eskimos (1925). Zenith's founder-president Commander McDonald is standing on the right.



An early "mobile" Trans-Oceanic

adapted, the set went into production several months before the Zenith factory was converted for the war effort in 1941. At that stage 100,000 Trans-Oceanic radios were on the order books, and though many of these were never completed, several thousand had been by the time the US entered the war. Members of the allied forces were frequently comforted throughout the duration of the war by broadcasts from their native countries, the radio set often being their only link with home.

About his Trans-Oceanic radio, a British army officer wrote,



First multiband receiver made in 1941

"During the whole war, it was either with me or close behind with my luggage. Besides being under enemy fire, it has stood in the open in blistering heat and sandstorms, likewise in monsoon rain and snow. I have watched it dropped into cargo holds by coolies and have sympathised with it after suffering a kick by a donkey. In spite of such treatment, there has been no occasion during its ten years life that the set has failed to work."

Since introduction in 1941, a number of major improvements have taken place. Announced to yachtsmen in 1951, as a "king-size

—continued on page 350

SPECIAL PRODUCT REPORT—*continued from page 348*

appropriate range multiplication factors. The 30μA range enables low leakage currents to be detected, whilst the 3 amp range is useful for average thyristor d.c. load measurement.

The voltage ranges are divided into two scales— 0 to 12 and 0 to 30 with appropriate multipliers. The advantage of using two scales is to maintain average meter indications between a half and full scale deflection, usually recommended for most measurements on load, without having to interpolate at the low end of the scale. The 1,200V ranges will cope with most applications except e.h.t. for cathode ray tubes; the optional extra probe will extend this range to 30kV d.c., sufficient for most oscilloscope or television c.r.t.s., for an additional £7·27 plus VAT.

The resistance ranges are from 0 to 2kΩ (useful readings) on a 20kΩ scale, up to 0 to 20MΩ (useful readings) on a 200MΩ scale. This will cater for a very wide range of measurements from 1 ohm to 20MΩ d.c. but does not, as is usual, mean that "cold insulation" tests on capacitors or wiring will necessarily give reliable results.

Two 1·5V batteries have to be fitted to give the low resistance ranges and one 22·5V battery for the high resistance ranges.

Decibel measurements are based on the standard 0dB= lmW in 600 ohms, or 0·775V a.c., using the a.c. voltage circuit for measurements ranging from -10 to $+63$dB.

Using an interpolation scale in the instructions an indication of frequency is possible based on the use of the capacitance circuit and, in the case of the X100 range, it depends on an external accurate 4,700pF capacitor being applied. Both the frequency and capacitance ranges require this instrument to be connected to an accurate 50Hz mains supply of 220 to 240V for which a lead is provided. The meter uses a resistance measurement circuit to determine reactance, and hence interprets the result as a direct capacitance reading up to a maximum 0·5μF. For most purposes the 10,000μF "ballistic capacitance" range is likely to be the maximum required, and this is achieved by interpolation of the d.c. AV scale using the chart given in the instructions.

The optional extra U.S.I. (Universal Signal Injector) is virtually a square wave signal generator using two transistors and mounted inside a "pen" type tube with a 1·5V battery. It provides a 1kHz "pulse" waveform from a blocking oscillator suitable for signal tracing and fault finding procedures in a wide range of radio, audio and TV equipment. The probe is claimed to withstand, on test, 500V d.c. and provide 20V peak-to-peak output.

In the event of repairs being needed, the manufacturers have appointed Coates-Clarke (Services) Ltd., of 110a St. Margarets Road, Hanwell, London W.7. to carry out this service.

*Chinaglia (UK) Ltd., 19 Mulberry Walk, London SW3 6DZ

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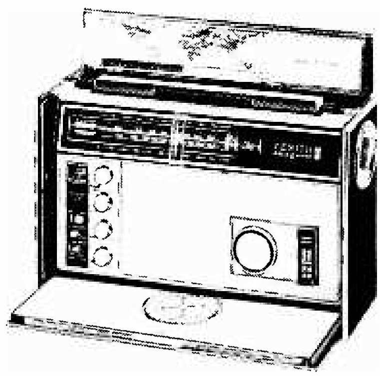
aspirin for the headaches of amateur sailors" and "the world's newest aid to navigation," the new Trans-Oceanic had had added to it two new continuous tuning bands that covered the entire 38 to 150 metre band, (2 to 8MHz).

In 1954 another new version of the Trans-Oceanic was introduced and included a ferrite rod aerial which, in conjunction with new circuits, was said to "treble the range" for standard broadcast reception. Other additions included a horizontal slide-rule type tuning dial. Push-button band selection and a reel-away take-up on the power control. Inside the set's cover were located a series of flip charts, a world-wide time map and listings for all major short-wave stations.

McDonald's next challenge to his company engineers was to develop a transistorised Trans-Oceanic portable radio that would "equal or better the performance" of the valved version. Compactness was his stipulation to the engineers. Whether for yachts or expeditions, it was paramount that weight and bulk size was kept to a minimum but without the sacrifice of performance. There was not to be room for a teaspoon of sugar, or the engineers "would get it back." After three years of research and development Zenith announced "the world's first all-transistor band-spread short wave portable radio" in 1957.



The 1974 version of the Trans-Oceanic. Recommended retail price is £247·50 inc. VAT.

Components and circuitry were built into a case measuring $10\frac{1}{4} \times 12\frac{1}{2} \times 4\frac{7}{8}$in representing a major achievement in miniaturisation and space efficiency. It included a new rotary band switch and associated circuits for electrical band-spread tuning which occupied a fraction of the space required in valved short wave sets. The band selector switch rotated a "rolling pin" dial scale so that only one tuning band was visible at a time.

"The ultimate in personal radios" was announced in 1962—this was a 9-band Trans-Oceanic, the Royal 3000. This transistorised receiver combined superlative performance and virtually "drift-free" tuning of the f.m. broadcast band with new sensitivity on short wave, long wave and standard broadcast bands. It was similar to the previous model but less the 13 metre band and plus the f.m. broadcast band (88 to 108MHz).

August 1964 saw the one millionth Trans-Oceanic portable radio roll off the Zenith production line.

In 1968 the Trans-Oceanic was again altered quite significantly with the addition of the wave bands. The Royal 7000, as the new model was called, featured 11 bands and incorporated a v.h.f. fixed crystal U.S. "weather" band at 162·55MHz. The set was tuned to the weather position to hear up-to-the-minute weather reports. The second band addition was short wave (a division of the earlier 2-9MHz spread), making a total of seven short wave bands, long wave, f.m. a.m. and weather band. Other improvements in the Royal 7000 included a b.f.o. and manual r.f. gain controls.

In 1971, the Royal 7000 was further refined with replaceable crystals for the weather band, enabling the listener to receive weather stations assigned to frequencies other than the common 162·55MHz (U.S.), in 1972 the Royal D-7000Y was improved again with the addition of the adjustable weather band and minor cabinet changes. The 1974 version is shown in our picture.

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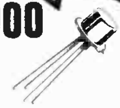

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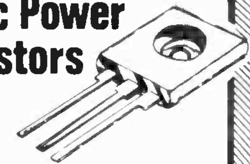

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ON THE AIR

BROADCAST BANDS

SHORT WAVE DX
by MALCOLM CONNAH

A 'Radio Australia Listeners' Club Group' has been formed by **George Hewlett** of 22 Park Hill Road, Torquay, Devon and **Miriam Bryant** of 2 Broad Street, St. Columb, Cornwall. The club is not only for members of the official Listeners' Club but for anyone interested in listening to Radio Australia.

Although the club will mainly serve the South West of England the founders are prepared to answer any queries about the reception of Radio Australia. They would appreciate a stamped addressed envelope with any query requiring an answer.

Readers' Logs

The first two logs this month come from the husband and wife team of **Douglas** and **Rita Malpus** from Cumberland. Douglas uses a 5 valve domestic receiver and a 25 foot end-fed antenna, which is often used at an alternative address in Scotland. Rita uses a Ferguson-Caravelle Transportable with a 120 feet long-wire and ATU. The results achieved were as follows.

Douglas Malpus
6205 R. North Sea International at 1900.
9670 IBRA Radio noted at 2100.
11775 R. Nacional D'Espana at 1715.
15185 R. Finland noted at 1820.
15295 ORTF, Paris, France at 1110.
15305 SBC, Berne, Switzerland at 1100.
15415 R. Kuwait noted at 1850.
15440 WYFR, USA noted at 2230.
17770 Radio Sweden at 1400.
17885 HCJB, Quito, Ecuador at 2130.

Rita M. Malpus
9525 AIR, General Overseas Service at 2020.
9535 SBC, Berne, Switzerland at 2200.
9650 Deutsche Welle, Cologne at 2145.
9690 R. Bucharest, Rumania at 1315.
9833 R. Budapest, Hungary noted at 2230.
9750 R. Vilnius, Lithuania at 2230.
11810 V. of Turkey, Ankara noted at 2230.
15185 R. Finland noted at 2030.

Christopher L. Hodgson of Sunderland used his Codar MultiBand 6 with a 50 foot end-fed, 9 metre inverted vee and an ATU to hear:
9455 Radio Pyongyang noted at 2015.
9540 Radio Australia, S/on at 1800.
9695 Trans World Radio, Monte Carlo at 0820.
11720 R. Nacional, Brazilia at 2315.
11905 UN Radio, Greenville at 2205.
15084 R. Tehran, Iran in Farsi at 1030.
15310 BBC, Far East Relay (Malaysia) at 1530.
15410 UN Radio, Greenville at 1625.
15570 Radio Pakistan, S/on at 1530.
17820 Radio Canada Int. in Czech. at 1715.
17885 BBC, Cyprus relay at 1155.
21685 Radio Kuwait, S/off in Arabic at 1505.

William F. Kitching of Telford in Shropshire has a Grundig Satellit 2000 receiver and using only the telescopic aerial he heard the following:
3980 VOA, Munich noted at 2100.
3985 SBC, Berne, Switzerland at 0700.
6015 ORTF, Paris, France noted at 0515.
11730 Radio Nederland, Bonaire relay at 0630.
15012 Voice of Vietnam at 1800.
15195 R. Afghanistan noted at 1130.
17855 NHK, Radio Japan at 0900.
21535 RSA, South Africa noted at 1500.
21655 R. Norway (Sundays) at 1400.
21740 VOA, Greenville at 1700.
25790 RSA, South Africa noted at 1330.

Albert E. Ord of South Shields again used his Trio 9R59DS with a Joystick antenna and Hamgear preselector the log for this month including:
3905 AIR, India in English at 2330.
4955 R. Nacional, Colombia in Spanish at 0530.
5990 HCJB, Quito, Ecuador in English at 0645.
9410 R. Pyongyang in English at 2140.
9570 R. Australia noted at 0800.
9620 S.O.D.R.E., Uruguay in Spanish at 2200.
11775 R. Bucharest in English at 0430.
11780 R. New Zealand heard at 0730.
11825 V. of Free China, Taiwan, English at 1930.
15415 R. Kuwait, Pop Music at 1945.
17755 HCJB, Quito, Ecuador in English at 1900.
21540 R. Ghana heard in English at 1500.

Trevor Bland of Lea, near Gainsborough in Lincolnshire, used his Telton TF-182 to log the following:
5960 R. Canada Int. in English at 1030.
6030 AFRTS, Washington in English at 0130.
6040 VOA, Washington in English at 1935.
7280 R. Moscow in English at 2025.
9022 R. Tehran, Iran in English at 2005.
9585 R. Finland in English at 2030.
9625 R. Canada Int. in English at 2400.
11815 TWR, Bonaire relay in English at 0100.
15385 R. Nacional, Brazil in English at 2015.
15430 AFRTS, Washington in English at 1730.
17880 HCJB, Quito, Ecuador in English at 2015.

ON THE AIR

MEDIUM WAVE BROADCASTS

by CHARLES MOLLOY

NICHOLAS Taylor who lives at Sunbury-on-Thames does his medium wave DXing with an Ultra 4175 receiver and a medium wave loop antenna. Local radio stations logged include IBA London on 719kHz; BBC Radio Blackburn on 854kHz; Solent on 998kHz; Medway on 1034kHz; Leeds on 1106kHz; Derby on 1115kHz; London on 1457kHz; Brighton on 1484kHz; Nottingham on 1520kHz; Bristol on 1546kHz. Nicholas has been hunting-out the stations on the American Forces Network in West Germany and he reports hearing AFN Frankfurt on 872kHz; Berlin on 935kHz; Munich on 1106kHz; Stuttgart on 1142kHz; Heidelberg on 1304kHz; Augsburg on 1394kHz and low power relays on 611kHz and 1502kHz. Karlsruhe on 1034kHz is another outlet to look for. The Armed Forces Radio and Television Service (AFRTS) operates in many countries other than Germany. Stations heard occasionally in the UK are Keflavik, Iceland on 1484kHz; Lajes, Azores on 1500kHz; Kenitra, Morocco also on 1484kHz and Athens, Greece on 1594kHz.

Kevin Peel (Hornchurch, Essex) has been busy with his Astrad receiver and 100ft outdoor aerial. He reports hearing BBC Radio Derby on 1115kHz; AFN Munich on 1106kHz; AFN Stuttgart 1142kHz and the 1000kW station at Cluj in Romania on 1151kHz. During the summer months Cluj along with Lugof on 755kHz carry a multi-lingual programme for tourists at 2230hrs GMT with programmes of Romanian music and announcements in English, French and German. Both stations will verify a correct reception report with a QSL card.

Brendon McNamee reports again from Portrush in N. Ireland. With his Sharp BZ-23 receiver and whip antenna he has logged BBC Radio Derby 1115kHz at 2338hrs; Manx Radio, Isle of Man on 1295kHz at 1655hrs; Radio Sweden 1178kHz with its international service at 0020hrs.

Our regular reporter **Brian Murray** (Edinburgh) has been concentrating on the local radio networks. With his Astrad VEF 204 receiver connected to an externally mounted TV aerial he has heard IBA Birmingham on 1151kHz with close down at 0105hrs; IBA Manchester also on 1151kHz testing at 0130hrs; BBC local radio stations at Carlisle on 755kHz at 1415hrs; Blackburn on 854kHz at 1410hrs; Sheffield on 1034kHz at 0100hrs; Medway 1034kHz at 2245hrs; Leeds 1106kHz at 2350hrs; Derby 1115kHz at 2240hrs; Bristol 1546kHz at 2258hrs and Leicester 1594kHz at 2255hrs. Brian also reports hearing two stations from the Iberian peninsula. From Spain, Radio Centro, Madrid on 1385kHz at 0155hrs and from Portugal CSB2, Radio Club Portugues in Lisbon on 1034kHz at 0020hrs. Externally mounted TV aerials often give good results as a medium wave antenna. Try connecting both the inner and the outer of the co-axial down lead to the aerial socket of the MW receiver. The outer (shield) will make a good vertical aerial in localities free from electrical interference.

Radio Algeria can be heard on 251kHz (1195m) on the long waves in English between 1900hrs and 1930hrs GMT every evening. The signal, which comes from a 750kW transmitter at Tipaza, is heard well in the UK. The station asks for reception reports which should be sent to Radio Algeria, 21 Boulevard des Martyrs, Algiers, Algeria.

VHF/FM DXING

by SIMON DAVID

IF we could forecast, with a useful degree of accuracy, likely openings for f.m. DXing then one could assume that we would be able to tune in together and all obtain near perfect results. It is easy to assume this, but the facts are different. What one DXer may pick up at one instant may be very different from the fortunes of another 100 miles or more away. It is sometimes forgotten that some British local radio stations may be as far away as some of the continentals, for example, North France and North England are approximately the same distance from Bristol or Oxford.

Here is a useful idea that could be helpful to f.m. DXers. For 50p you can buy the new large British Rail timetable. Now why should this be of any value to DXing? Well, included with it are two large double-sided maps—one of Gt. Britain and the other of Europe as far east as the Black Sea. These are clearly marked with the main towns and railways and make a very clear f.m. DXers map. (These maps are worth the 50p alone in my opinion.) If you cannot get one then any other flat map of Europe will do. ("Global" maps tend to distort distance lines.)

Now use a large pair of compasses, or the cotton-and-pencil technique, to draw concentric circles about the centre point representing your home town. These circles can be drawn to the scale of the map to represent distances of 25, 50, 75, 100 etc. miles from your home. Next go over the map thoroughly and pick out all the known f.m. transmitting stations and draw a box around the place name to help it to stand out. When you have received any of these stations on your f.m. radio receiver, you can fill in the box with a light coloured pencil.

If your aerial is installed in a fixed position, determine as accurately as possible the compass point or transmitter towards which it is directed. Draw a straight line on the map through your home town representing this aerial direction and continue that line as far as possible across the map. You now have a quick reference chart to locate any station that comes in within a reasonable distance of that aerial line. If you want a reference for marking f.m. transmitters on the map you can either do it the hard way by going through all the radio station details in the World Radio and TV Handbook or use the f.m. station list that I mentioned last month.

My thanks to all readers who have written to me including **Bob Bonsall** of Buxton, **F. Walshe** of Southport who has picked up the Isle of Man, R.T.E., Lille and several northern local stations using a Stolle rotator. **Geoffrey Tyrell** writes from Aylesbury who (I am delighted to learn) has come back to P.W. after four years in the wilderness. He makes some observations about stations that he can pick up with only a single dipole arrangement and a Hacker Hunter portable radio. These include BRMB, LBC, Capital, BBC Radio London, Medway, Birmingham, Oxford and Stoke.

ON THE AIR

by Eric Dowdeswell G4AR

HURRAH! First past the post to drop a report into my lap was **Stanley Sharred** (Birmingham) who is no newcomer to this page. To refresh your memories he has a CR100 with a horizontal centre-fed aerial, feeding an aerial tuning unit I am glad to note! An ATU will produce more extra 'S' points on the meter than anything else! The 60ft legs of Stan's aerial are in a Vee configuration so the aerial becomes quite a useful beam at the higher frequencies. His Morse is obviously pretty good so it's high time he went off to get his RAE, providing he doesn't neglect his reports of course!

Dave Patrick (Carlisle) at 15 is a regular reader of PW and honoured this page with his first-ever report. His set-up of an R1475 plus two 150ft wires 25ft up should pull in most signals. Try combining the aerials Dave, with an ATU, as does Stanley, above. Switch in one or the other or both. If they can be arranged more or less at right angles good all-round coverage can be obtained. I suppose many readers of this page wouldn't mind being able to get just one 150 footer hanging on the aerial socket!

John Porter (Baslow, Derbys.) wrote an extremely short note with his list of goodies, but very welcome, nevertheless. All I can say about John is that he uses the 9R59DS and 33ft of aerial which is obviously a good combination in the right hands. Incidentally, I am sending out some log sheets which I have run off to those who kindly report in to this feature, hoping that they will jot down for me any worthwhile DX that they hear, at the time they hear it. I know only too well what a bore it is to copy out logs especially some time after the event when interest has waned. A sheet of carbon paper slipped in the log is also a good way of saving time if a copy is wanted. As I point out on the log sheets, it is the rare country or prefix or QRP stations that I would like to know about.

It seems that BV2A on Taiwan (Formosa of old) now has the OK from the authorities to operate and is active on 14218 SSB and 14025 CW. QSL's have been forthcoming from BV land in the past but this ought to make it very much easier now. You might like to get excited over OJ0MA who is expected on from Market Reef with SSB on 14 and 21MHz. The number of these DX-peditions that do eventually get on the air seems to be quite small compared to the number of rumours that one hears and I long ago learnt to wait until the pileup hits the headphones before letting the blood pressure rise at the thought of a 'new one' for the log!

I expect to hear from some of you on the Royal Signals Amateur Radio Society expedition to the British Honduras spot of English Cay, active mid-June as VP1B probably. QSL's to the Society's headquarters station G4RS.

Don't despair of conditions on the HF bands—the information-crammed 160m DX Bulletin of Stew Perry W1BB reckons that things have not been so good last season on our 'DC' band possibly due to too many sunspots around! They would indeed come in useful on the higher frequencies. In spite of all this, however, Stew still lists many prefixes worked on 160m that would grace any 20m log. How about 4S7, VP2, VP8, ZP9, PJ8, ZP1 etc? 'Worked All Continents' is always an exciting achievement, even on the HF bands, but W5RTQ almost did it in one evening on 160m! Only missed out on Africa.

Log Extracts

S. Sharred:—160m GC5BGV **GD4BEG G13YFY** GM6CH OE5ANL OH1SJ VE2DN **VP2EEL W1HGT** (599) **WB8APH 80m** 7X2AH 9K2DC HC8GI HI8EJH OA4OS ZL2BCG ZL4KF **40m** 3D6AW G4AKQ/7Q7 JY3ZH M1C OH2BGM/OH0 T12SW VK2WC VP9AO ZP5AR **ZS6ME 20m** CR4BS WA2ZDF/CP1 KL7BJW KM6DZ OA3XI PJ2CW PJ9JR VE6RP VK7PR VK8OM VP2AB VP2MW VP2VBH VP8LP VR1AC ZL4AD 4S7PB 5X5NK 6Y5ED 8P6EX **15m CR7EK FM7WG HK3CTJ** JH3GET KG4FX SV0MEE (Crete) TJ1EZ **TU2DV**.

D. Patrick:—80m CR4BS EP2VJ OY1M 9H4L **40m** CR6CD JW8IL **20m** CP1DN CR4BS PJ9DI 9Y4MA.

J. Porter:—15m 9G1AR 9W1BX **20m** CP1QCC CP3BY EL5C HK3BET JA0CRL PJ9EE T12CF ZB2CJ CR4LA

S. Sharred again:—**160m KZ5AA VE1MX VP2LPJ** (St. Lucia) **80m** CP1EU EP2VJ (0200) HZ1AB (0200) KV4FZ (2300) VP8NP (0030) ZS6DW (0330) **40m** JY3ZH (Amman 0400) KV4FZ (0130) **LU8AHW** (2330) TR8DG (2130) **20m** HM1AQ (1330) KH6BB (1000) KS6UA (1600) FL8BH (1900) PJ9EE (2130) TA2SC (1530) VE8RCS (0900) YB1AY (1730) ZL1AXT (1030) 5U7HA (1730) **15m** A51PN (1230) CX8BZ (2030) **EL2KS** (1230) FG0BAR (1800-QSL to F6CXL) **KZ5CZN** (2130) VP2SQ (1800-St. Vincent) **VP2VBU** (1300-Tortola)

CW stations in bold, remainder SSB.

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.

The Pye Book of Audio
Published by Pye Limited, Cambridge. Produced by Daily Mirror Books, 79 Camden Road, NW1 9NT
124 pages, 12 x 8½in. Price 95p.

WHEN I first heard about the Pye Book of Audio, I thought "Oh no, another advertising gimmick," but how wrong I was.

This book is a profusely illustrated guide to audio in general and is aimed at the beginner and possibly first-time buyer rather than the man with all the gear already installed in his Hi-Fi den.

The contents are divided into thirteen chapters and there is a foreword written by Benny Green the musician. Chapter 1, The Original Sound, by Tom Stephenson describes what goes on at the recording studio and explains how a record is made.

Chapter 2, written by John Borwick delves into the whys and wherefores of pickups, and illustrates how sound is reproduced from tape or record.

Clement Brown, in Chapter 3 writes on pickups and motors and John Gilbert in Chapter 4 expounds on tuners and amplifiers. Chapter 5 is written by Michael Mayer of the BBC's Engineering Information Department. It's entitled The Broadcast Signal and the title really speaks for itself. Chapter 6, by Pat Hawker is called Commercial Radio and includes a useful question and answer section.

Chapter 8 is on tape recorders for the home and car. Chapter 9 on purchase and care of records and tapes and Chapter 10 describes the ins and outs of 4-channel sound. Chapter 11 helps the reader decide which system to use and how to get value-for-money and Chapter 12 explains how your audio unit is manufactured.

The final chapter helps you decide where to place your audio set-up in your home, and the end of the book contains a useful little glossary of audio terms.

There's only one strange thing in this work that I spotted and that is where a beautiful colour picture of a vintage Thorens phonograph is shown. There is a disc on the turntable but the caption tells us that the machine had a cabinet with facilities for storing the playing cylinders—strange!

Well, Messrs Pye, you are to be congratulated on producing a very well written, well illustrated book which I know will be of great interest and help to many people who are thinking about or are just entering the world of audio.

With the price of 95p, this book just cannot go wrong and I thoroughly recommend it. Excellent value.—**Colin Riches**

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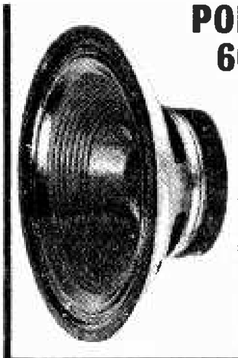

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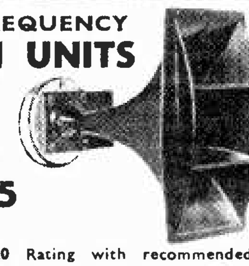
POP '25/2'	12"	30 Watt	£8·99
	2" Voice Coil		inc. VAT
POP '50'	12"	50 Watt	£12·99
	2" Voice Coil		inc. VAT
POP '60'	15"	60 Watt	£16·95
	2" Voice Coil		inc. VAT
POP '100'	18"	100 Watt	£29·70
	3" Voice Coil		inc. VAT

HIGH FREQUENCY

HORN UNITS



MODEL 910

Rating 25 to 50 watts according to filter capacity

£15·95 inc. VAT

MODEL 920 Rating with recommended filter 100 watts **£39·95** inc. VAT

Distributors to Wholesale and Retail Traders—**LINEAR PRODUCTS LTD., ELECTRON WORKS, ARMLEY, LEEDS.**
Manufacturers enquiries to—**FANE ACOUSTICS LTD., 286 BRADFORD ROAD BATLEY, YORKS**
Prices shown correct at May 14, 1974

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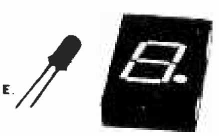

Red + data. 1/8" pin source **LED's 17p!** **Til 209** and clip **22p**
BIG ⅕" panel clip and **RED LED 28p. GREEN** and clip **59p.**
INFRA RED LED £1. IC photo amp **44p** and amp/switch **85p.**

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.**

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KIT: All parts and case. National chip. 4 digit **£20.** 6 x **£23.**
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With data INTEGRATED CIRCUITS 741: 8 pin **29p**, to 99 and 14 pin **27p**, 748 **33p**, 709 **21p**, 710 **35p**, 723 **59p**, 555 timer **79p.** ZN414 rx. **£1·10**, 703 rf if **28p**, mc 1310 and led **£2·76**, mc 1339 **£1·20**, TAD 100 and if **£2**
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AUDIO AMPS: mic 4000 **50p**; 1 and 2W **£1·19**; 3W **£1·29**

74N TTL low prices

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DIL SOCKETS: Professional/gold P. Pins hi or lo Profile 8, 14, 16 Pin **13p.**
2N3055 33p four £1. BC107, BC108, BC109 all 9p each.
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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.
FLUORESCENT LIGHTS. 8W 13" 12 VOLT **£2·59.**

Trampus electronics

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P. & P. 10p CWO.
58/60 GROVE RD., WINDSOR, BERKS.

FERRIC CHLORIDE
Anhydrous to Mil-spec in 1lb sealed packs. 1lb **55p** (20p); 3lb **£1·32** (30p); 10lb **£3·85** (60p).

VERSATILE POWER UNIT
Contains mains transformer, 2A thermal cut-out and bridge rect. Will give 1·7–10·5V output with 2 extra capacitors. Brand new, only **83p** (20p). Also available in a toy garage with press switch, lamp, etc. (Used for 'Hot Wheels'). Only **£1·65** (30p).

AMPLIFIER UNIT
In fully screened case 5½ x 5 x 3½" 2 GET116 on heat sink, 2 zeners, 3 pot cores, 4 small transformers, 1% R's, C's, etc. **70p** (30p).

3W CASED AMPLIFIER
Polished wooden cabinet 14 x 13 x 9", containing a sensitive (20μV) 4 valve amplifier with tone & volume controls. Gives 3 watts output to the 7 x 4" 3Ω speaker. Also a non-standard tape deck. Supplied in good working condition with circuit. Standard mains operation. **£3·50** (£1). Suitable cassette **£1·10** (30p). Spare head **33p.** Tape (ex-computer) **75p** (20p). Amplifier chassis only, complete and tested (2 × ECC83, EL84, EZ80) + speaker **£2·50** (40p).

7lb BARGAIN PARCELS
Hundreds of new components—resistors, capacitors, pots, switches, + PC boards with transistors & diodes, also crystals and loads of odds and ends. Amazing value **£1·82** (40p).

Scopes in stock for callers, ring for details. SAE List. All prices include VAT. Carriage in brackets, small parts 5p.

DEKATRON UNITS
Contain 2 CV2271 dekatrons, 2 4-digit resettable counters, 2 sealed relays, 2 × ECC81, R's, C's, etc. Only **£1·70** (30p).

COMPUTER PANELS
3lbs asstd **£1·10** (30p); 7lb **£2·20** (40p); 56lb **£12** (£2). 12 high quality panels with IC's, power transistors, trimpots etc. **£2·20** (30p), 100 **£13** (£1). Panel with 7 2k trimpots **33p** (10p). Pack containing 50 14pin DIL IC's, inc. 7400, 04, 10, 20, 30 7474 etc, also MC types **£2·20** (20p).

COMPONENT PACKS
500 asstd resistors **£1·10** (20p), 2500 **£4** (50p) 10000 **£13** (£1), 100000 **£80** + carr. 150 poly, ceramic, mica caps **66p** (10p).

NEW COMPONENTS
400V 5A SCR **66p**, 200V **44p**, OC71 **9p**, 14 for **£1·10**, OC81D **8p**, 100/**£5·50**, 741C TO99 **35p**, 2N3055 **38p**, ·05/500V discs 100/**£1·65**, 1000pF disc **£1·65**/100 80+80+20μF 350V **10p**, 10/**83p** (30p). 8uF 2500V **£2·20** (50p), 4 pole 8-way Yaxley switches **33p** (8p), 2 pin DIN plug **10p**, 5 pin 180° **11p**, 3·5mm plug **8p**, phono **5p**, 7 pin DIN plug **11p**, 6 pin DIN plug **11p**, speaker cable **5p**/metre 4 core individually screened **20p**/metre.

Transformers, mains PRI, SEC 16-0-16V @ 1½A+9V tap **£1·65** (30p); 360V @ 375 mA, 260V @ 75mA, 6·3V @ 1A, 6·3V @ 4A **£2·20** (65p). P.O. 4 Digit Counters 2500Ω 50V **55p** (12p) 2μF 600V block paper **33p** (10p) G150/2 Thyratrons ex-equip **33p.** 6 x 4" 4Ω New Speakers **£1·10pr** (20p). Hewlett-Packard 100MHz counter/timer 524D **£66**+carr.

GREENWELD ELECTRONICS (PW4)

51 SHIRLEY PARK ROAD, SOUTHAMPTON

New wholesale/retail shop and mail order dept. Other retail shops at 21 Deptford Bdy, SE8 & 38 Lower Addiscombe Rd, Croydon.

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PUSH BUTTON CAR RADIO KIT

The Tourist II

NO SOLDERING REQUIRED!

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly.
Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.
Technical specification:
(1) **Output** 4 watts R.M.S. output. 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″ wide, 2″ high and $4\frac{5}{16}$″ deep approx

Car Radio Kit £7.70 + 55p post. & pack.

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

Car Aerial Recommended – fully retractable and locking
£1.35 post paid

STEREO 21

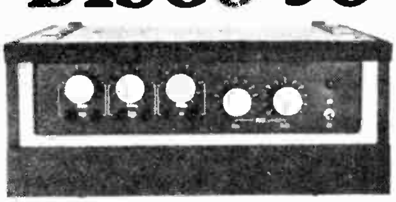
QUALITY SOUND(*) FOR LESS THAN £19·00

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. $15\frac{1}{2}$″ × 8″ × 4″. Complete deck and cover in closed position approx. $15\frac{1}{2}$″ × 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 * 4 Electrically Mixed Inputs *3 Individual Mixing controls. *Separate bass and treble controls common to all 4 inputs *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.
INPUT SENSITIVITIES
—Input—1.) Crystal mic. guitar or moving coil mic, 2. and 10 mV. (selector switch for desired sensitivity.—Inputs—2), 3), 4, Medium output equipment—ceramic cartridge, tuner, tape recorder, organs etc.
– all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. $12\frac{1}{2}$ ins × 6 ins × $3\frac{1}{2}$ ins
£15.00 + 60p. post & pack

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: $19\frac{1}{4} \times 10\frac{1}{2} \times 8$ins. 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. $13\frac{3}{4}'' \times 9'' \times 3\frac{3}{4}''$
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. $17\frac{1}{2}'' \times 10\frac{3}{4}'' \times 6''$ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter. 10 watts handling

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. $31'' \times 13'' \times 11\frac{1}{2}''$. Finished in teak veneer. Drive units approx. $13\frac{1}{2}'' \times 8\frac{1}{4}''$ with $3\frac{1}{4}''$ 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.

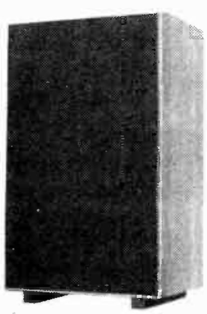
PRICES: SYSTEM 2

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 **List Price £86.00**

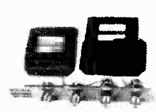


A professional standard five way speaker system with enclosure giving top quality performance
Enclosure Dimensions
approx. (3ft. × 2ft. × 1ft.).
Drive Units
Hand built – 15″ diameter bass with 3″ voice coil, – two 5″ diameter Mid Range units, – two $3\frac{1}{2}''$ HF. units, plus matching crossover 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 $3\frac{1}{4}''$ 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(*)

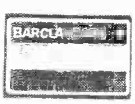
For the man who wants to design his own stereo — here's your chance to start with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic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

£7·64 + 55p. p & p

8 TRACK 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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INVERTER TRANSFORMERS 13/15 WATT (CIRCUIT INCLUDED)	70p
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LAMPHOLDERS (LONG LEAD)	30p PAIR
(SHORT LEAD)	20p PAIR
WHITE ENAMEL CASE, 18" or 21"	70p
TUBE, 18"-15 WATT or 21"-13 WATT	45p

(NOTE:- TUBE ONLY SUPPLIED IF CASE ORDERED, TO PREVENT POSTAL DAMAGE)

13 WATT FITTING READY BUILT AND TESTED—INCLUDING TUBE £3·75

POST/PACKING **20p** PER ORDER

ALL GOODS PLUS 10% V.A.T.

SILICON P.N.P.

Type	Voltage	Frequency	Price
BCY 71	45	200 MHz	12p
BFS 92	100	70 MHz	20p
BFS 95	40	70 MHz	17p
BFX 12	25	210 MHz	10p
2N 2906	60	200 MHz	15p
2N 3702	40	100 MHz	11p
2N 3703	50	100 MHz	12p

SILICON N.P.N.

Type	Voltage	Frequency	Price
BC 108	30	150 MHz	15p
BC 109	30	150 MHz	15p
BF 179	225	125 MHz	40p
BF 180	30	625 MHz	25p
BFW 58	80	80 MHz	15p
BFX 43	30	500 MHz	20p
BFX 86	40	50 MHz	17p
BFY 53	30	50 MHz	10p
2N 607	60	40 MHz	12p
2N 709	15	900 MHz	30p
2N 718	60	60 MHz	12p
2N 753	25	250 MHz	12p
2N 744	20	300 MHz	12p
2N 1613	75	50 MHz	17p
2N 2220	60	250 MHz	15p

SILICON N.P.N.

Type	Voltage	Frequency	Price
2N 3035	60	100 MHz	17p
2N 3707	30		12p
2N 5179	20	900 MHz	40p

GERMANIUM P.N.P.

Type	Voltage	Frequency	Price
ACY 44	50	1 MHz	10p
ADY 26	80	75 watts	£1
AF 124	20	75 MHz	20p
AFY 19	32	350 MHz	20p
ASY 32	25	5 MHz	10p
ASZ 21	15	450 MHz	20p
GET 113	32		10p
GET 120	32	2 watts	10p
OC 123	50	1 MHz	10p
OCP 70	Light-sensitive		20p
2N 1307	30	10 MHz	15p
2N 1309	30	15 MHz	15p
2N 448	60	150 watts	£1

HIGH FREQUENCY, POWER

Type	Voltage	Frequency	Price
BFR 64	40	1,200 MHz	£1
BLY 80A	35	650 MHz	£5
BLY 93A	60	500 MHz	£5
BLY 218	36	1,200 MHz	£2
2N 709	15	800 MHz	15p

MICROWAVE DEVICES

CL 8300	Gunn effect oscillator	9·4 GHz	£40
CL 8370	ditto	9·5 GHz	£10
CL 8380	ditto	10·5 GHz	£10
CL 8390	ditto	11·5 GHz	£10
CL 8430	ditto	9·35 GHz	£40
CL 8450	ditto	9·35 GHz	£40
CL 8470	ditto	9·35 GHz	£40
BXY 27	Varacter Diode. "S" Band. Cut-off	70 GHz	£1
BXY 28	Varacter Diode. Cut-off	100 GHz	£1
BXY 32	Frequency Multiplier. "X" Band	150 GHz	£1
BXY 35A/C	ditto	25 GHz	£1
BXY 36C/D	ditto	75 GHz	£1
BXY 37C/D	ditto	100 GHz	£1
BXY 38C/E	ditto	120 GHz	£1
BXY 39C/D	ditto	150 GHz	£1
BXY 40D/E	ditto	160 GHz	£1
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£1 100 ¼-½ WATT RESISTORS, 100 CERAMIC CAPACITORS, 100 DIODES — POSTAGE 23p — PACK No. 1

£1 1 VERO-BOARD CUTTER, 5 2½ in. x 1 in. x ·15 BOARDS, 50 SQ. INS. "ODD PIECES" VERO — POSTAGE 23p — PACK No. 3

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£1 100 RESISTORS, 100 CAPACITORS (ASSORTED TYPES) — POSTAGE 23p — PACK No. 8

SUPERSOUND 13 HI-FI MONO AMPLIFIER

A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 3dB. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. **PRICE £12·00**. P. & P. 50p.

DE LUXE STEREO AMPLIFIER

A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:- 2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built & tested to a high standard.

PRICE £10·40. P.&P. 50p.

LOUDSPEAKER BARGAINS

5in 3 ohm £1·25. P. & P. 15p 7 × 4in 3 ohm £1·40 P. & P. 20p. 10 × 6in 3 or 15 ohm £3·10. P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet £1·70, P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm £3·50 P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network £4·65. P. & P. 30p.
EMI CERAMIC MAGNET HEAVY DUTY TWEETER. approx. 3½in. Av. 3 or 8 or 15 ohms. £1·25 plus 20p p. & p. BRAND NEW. 12in 15w H/D Speakers, 3, 8 or 15 ohm. (state which). Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £9·90. Guitar models: 25w £9·90. 35w £11·00. P. & P. 45p each.

PRICES INCLUDE VAT

SPECIAL OFFER !

HI-FI LOUDSPEAKER SYSTEMS

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16" high x 10½" wide x 6" deep. Fitted with E.M.I. Ceramic Magnet 13" x 8" bass unit, two H.F. tweeter units and crossover. Maximum power handling 10 watts. Available 3 or 8 or 15 ohms impedance.

OUR PRICE £9.25 Carr. 75p

Cabinet Available Separately £4·95, Carr. 65p.
Also available in 8 ohms with EMI 13" x 8" bass speaker with parasitic tweeter £7·15, Carr. 75p.

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.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £5·00. P. & P. 45p.

SPECIAL BARGAIN OFFER!
Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge.
Brand new. ONLY £8·00 + p. & p. 60p.

BATTERY OPERATED MEGA CIRCUIT TESTER

made by Evershed and Vignoles Ltd., Measures from 0·1 ohm to 200,000 ohms in 2 switched ranges. Used but in perfect condition. Complete with test probes, Leather carrying case and 4½ volt standard battery. Only £7·00 + 40p p & p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

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 1MΩ. 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.

AMPLIFIER KIT	£11·55	P. & P. 25p
(Magnetic input components 33p extra)		
POWER PACK KIT	£3·50	P. & P. 35p
CABINET	£3·50	P. & P. 35p

(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £25·10. Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

SPECIAL OFFER

LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance. £3.70. P. & P. 35p.

Open 9.30–5.30 Monday to Friday. 9.30–5 Saturday
Closed Wednesday.
A few minutes from South Wimbledon Tube Station.

HARVERSON SURPLUS CO. LTD.

(Dept. P.W.) 170 HIGH ST., MERTON, LONDON, S.W.19 Tel.: 01-540 3985

SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

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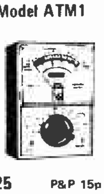
and make no mistake

LASKYS SUMMER SALE AN EXTRA 10% OFF ALL THESE PRICES DURING JULY

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. Resistance: 0/150k ohms. Decibels: —10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

OUR PRICE £3.25 P&P 15p

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgewise 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 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 30p

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.

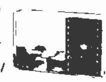
OUR PRICE £5.97 P&P 30p

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 30p.

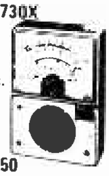
U4323 MULTIMETER



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: x 10. x 100. x 1,000. x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.00 P&P 30p

MODEL HIOKI 730X



30,000 opv. Overload protection. 6/30/60/300/600/ 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 30p.

U4324 MULTIMETER

High sensitivity, overload 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. Resistance: 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 30p

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 30p

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 50p

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 30p

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

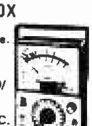
MODEL 500

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

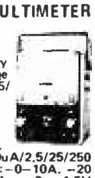
HIOKI MODEL 700X



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&P 30p

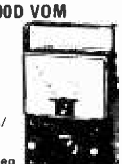
Model HT100B4 MULTIMETER



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 £17.50 P&P 40p

MODEL AS.100D 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 17dB

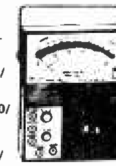
OUR PRICE £17.50 P&P 30p.

KAMODEN TT35 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.

OUR PRICE £17.50 P & P 40p

KAMODEN 360 MULTIMETER



High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/ 2.5/10/50/250/ 1000V DC. 5/10/ 50/250/1000V AC. Current: 0.01mA/0.5/5/50/ 500mA/10A. Resistance: 0.1/ 1/10/100 ohms/ 1/10/100k ohms/ 10/100M ohms. Decibels —20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.

OUR PRICE £17.50 P & P 40p

TMK 100K LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/ 10/50/250/1000V AC. 3/10/50/250/ 500/1000V DC. current 10/100uA/10/ 10/100/500mA/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: —10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/ 250/500/1000V DC. 0/2.5/10/50/250/ 500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/ 5 Meg/50 Meg. Decibels: —20 to +62dB.

OUR PRICE £19.95 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 40p

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

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 50p

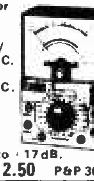
Additional probes available: RF £2.12, HV £2.50

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 + 17dB.

OUR PRICE £12.50 P&P 30p.

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: 0.08/ 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 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.

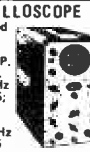
OUR PRICE £19.95 P&P 25p

KAMODEN HMG500 insulation resistance tester

Range 0—1,000 Megohms, 500V. Battery operated. Wide range clear meter 4"x4¾". Complete with deluxe carrying case, batteries and instructions.

OUR PRICE £19.95 P&P 30p

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.

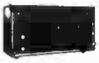
OUR PRICE £19.95 P&P 30p

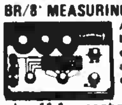
Also see following pages

ALL PRICES EXCLUDE VAT

SWR METER Model SWR3
Handy SWR meter for transmitter or antenna alignment, with built-in field strength meter. Accuracy 5%, Impedance 52" Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 30p

AT201 Decade ATTENUATOR

Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedance 600 ohms. Input power maximum 30dBm. Size: 180 x 50 x 88mm.
OUR PRICE £12.50 P&P 50p

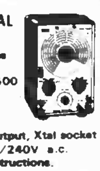
TRANSISTORISED L.C.R. A.C. BR/8' MEASURING BRIDGE

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 microamp meter indication. Size 7½" x 6" x 2" **OUR PRICE £25.00** P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR
6 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 30p

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 50p

TE-20D 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 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR
Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedance 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £24.95 P&P 50p

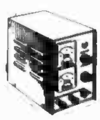
ARF 300 AF/RF SIGNAL GENERATOR
All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

OUR PRICE £37.50 P&P 50p

Also see previous page

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 50p

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 50p

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 10/25/50/100/500/1000/2500 ohms. **£1.15** P&P 10p

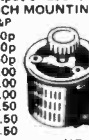
50 WATT 10/50/100/250/500/1500/5000 ohms. **£1.62** P&P 10p

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

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	50p
2.5A	£12.00	50p
5A	£17.50	50p
8A	£30.35	£1.00
10A	£33.75	£1.00
12A	£35.40	£1.00
20A	£85.00	£1.50
25A	£95.00	£1.50
40A	£120.00	£1.50



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1A	£10.00	50p
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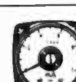
MW 1–6 60x60mm
£6.50 P&P 15p

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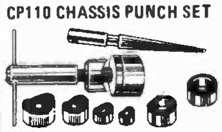
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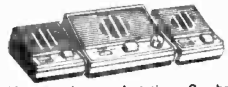
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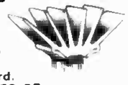
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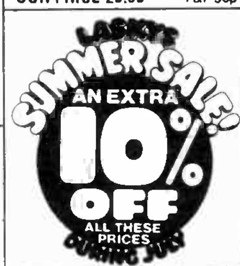

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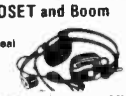
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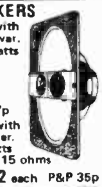
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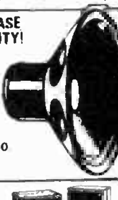
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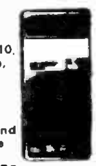
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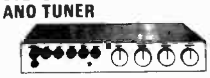
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Amplifier output 8 watts per channel RMS. Distortion less than 0·06%. Silicon transistors. Two pick-up plus radio and tape inputs, tape output and scratch filter. Excellent Value.
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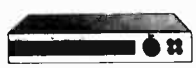
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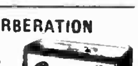
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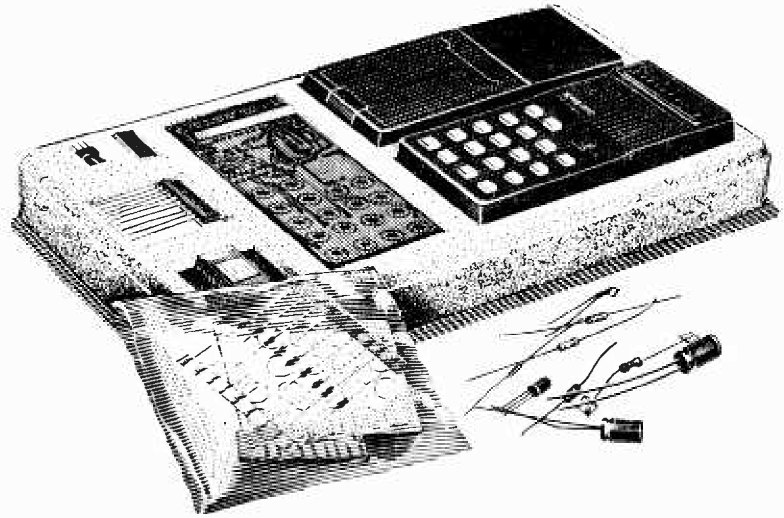

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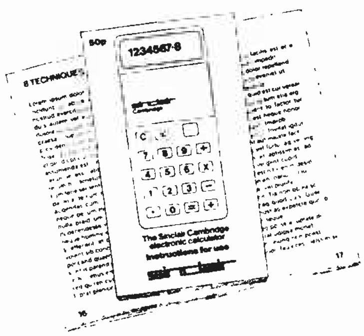

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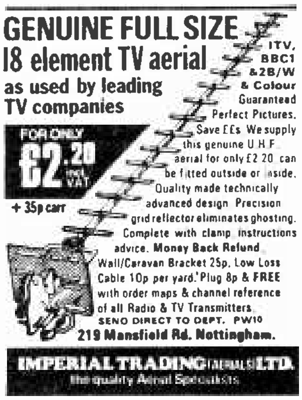

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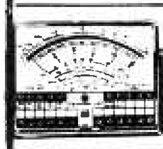

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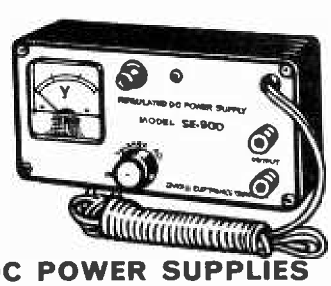

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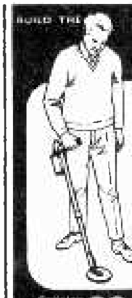

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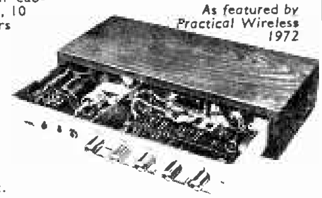

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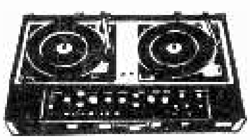

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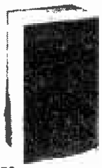

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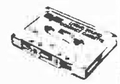

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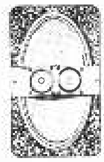

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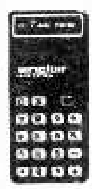

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