# PRACTICAL WIRELESS

APRIL 1974

25p


## the 'SLIMLINE' 5-Band Receiver


Australia 50c
New Zealand 50c
South Africa 45c
Rhodesia 45c
Nigeria K40
Malaysia $1.80
Sweden Kr 3.50
Malta 22c5
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PLUS:

## 'QUICK-WIPE'

WINDSCREEN WIPER DELAY UNIT

ALSO:

## Guide to the Multi-range Testmeter

# look! electronics really mastered

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**... visual**
**... exciting!**

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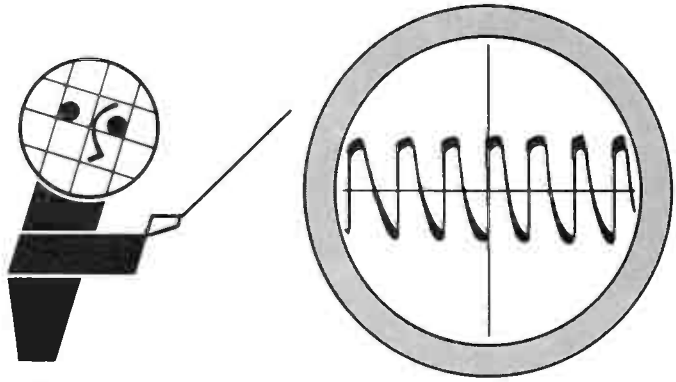
no unnecessary theory
no "maths"



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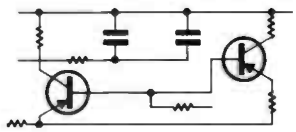
BUILD, SEE AND LEARN
step by step, we take you through all the fundamentals of electronics and show how easily the subject can be mastered. Write for the free brochure now which explains our system.

## 1/ BUILD AN OSCILLOSCOPE

You learn how to build an oscilloscope which remains your property. With it, you will become familiar with all the components used in electronics.

## 2/ READ, DRAW AND UNDERSTAND CIRCUIT DIAGRAMS



as used currently in the various fields of electronics.

## 3/ CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS & SEE HOW THEY WORK, including:

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This new style course will enable anyone to really understand electronics by a modern, practical and visual method—no maths, and a minimum of theory—no previous knowledge required. It will also enable anyone to understand how to test, service and maintain all types of electronic equipment, radio and TV receivers, etc.

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# PRACTICAL WIRELESS

VOL. 49 NO. 12
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APRIL 1974

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



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## NEWS & COMMENT


1142 SAFETY FIRST—Leader article and May preview
1143 NEWS . . . NEWS . . . NEWS . . .
1146 *TELEVISION*—Coming in the April issue
1167 NEXT MONTH IN *PRACTICAL WIRELESS*
1195 ON THE AIR
1195 Broadcast Short Wave—*Malcolm Connah*
1196 Medium Wave—*Charles Molloy*
1196 VHF/FM—*Simon David*


## CONSTRUCTIONAL


1144 THE "QUICKWIPE" variable time sweep windscreen wiper—*P. S. Collins*
1154 EXPERIMENTAL WORKSHOP. Grounded Emitter Amplifiers—*M. J. Hughes, M.A.*
1165 BATTERY CHARGER—AUTOMATIC 12V CAR BATTERY CHARGER—*Richard Collin*
1168 'SLIMLINE' 5-band portable receiver—*F. G. Rayer*
1174 "P.W. CRATA" Cassette Recorder and Tuner Amplifier Part 2—*Richard Collin*


## OTHER FEATURES


1146 TECHNICROSS No. 3—Solution
1147 GUIDE TO MULTI-RANGE TEST METERS—*H. Leeming, G3LLL*
1161 IMPEDANCE MATCHING—*C. Budd*
1180 OSCILLOSCOPE TECHNIQUES Part 2—*Alan C. Ainslie*
1191 SAFETY IN DOMESTIC ELECTRONICS
1192 OFF THE RECORD


## SPECIAL OFFER


1179 *PRACTICAL WIRELESS* TOOL KIT

# HUGE DISCOUNTS

ON LEADING BRAND HI-FI

## ALL R.S.C. PRICES INC VAT

★ FULL LABOUR AND MATERIAL GUARANTEES FOR 12 MONTHS

LOW DEPOSIT TERMS OVER 8 MONTHS

| | List Price | RSC Price |
|---|---|---|
| WHARFEDALE DENTON | £39·93pr | £29·95 |
| WHARFEDALE LINTON | £48·69pr | £35·95 |
| LEAK 150 | £46·82pr | £37·50 |

Prices shown correct at time of going to press 12.2.74

**AKAI GXC 36D** Tape Unit £76·95 (Rec. Price £109·50) Carr. £1
**AKAI 4000DS** Tape Unit £76·95 (Rec. Price £109·50) Carr. £1
**AKAI 1721L** Tape Unit £79·95 (Rec. Price £114·50) Carr. £1
**AKAI GXC46D** Tape Unit £104·75 (Rec. Price £149·50) Carr. £1
**GOLDRING GL72** T/Table & P.U. £29·95 (Rec. Price £37·29) Carr. 75p
with Free Goldring G800 Cartridge worth over £10 fitted to above unit.
**GOLDRING GL75** T/Table & P.U. £34·95 (Rec. Price £47.19) Carr. 85p.
with Free Goldring G800 Cartridge worth over £10 fitted to above unit.
**BSR MP60** T/Table & P.U. £9·95 (Rec. Price £14·95) Carr. 40p

**T/TABLES with MAGNETIC CARTRIDGE/PLINTH & COVER**

**GARRARD SP25** with G850 £16·95 SPECIAL PRICE (Carr. £1)
**MacDonald MP60** with G800 £17·95 SPECIAL PRICE (Carr. £1)
**GARRARD AP76** with G800 £28·95 SPECIAL PRICE (Carr. £1)


## A HIGH FIDELITY 30 + 30W STEREO SYSTEM

AUDIO FIDELITY MODEL 60 AMPLIFIER.
PAIR AUDIO FIDELITY MARQUESS 30 SPKRS.
McDONALD MP60 with G800 Cartridge.
Ready wired on Plinth with Cover.
Cabinet finished in Teak Veneer.
Send S.A.E. for leaflet.

Total Value over £165

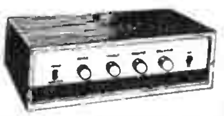
Carr. £3 **£99·95**

## 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

SPECIAL PURCHASE Worth Double **£55** Carr. £[illegible]

## 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 P.U. or Tape/Radio. For loudspeaker output impedances of 3 to 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
Or FACTORY BUILT IN TEAK VENEERED CABINET as illustrated £16·50 or dep. £2·12 and 8 monthly payments £2·12 (Total £19·08).

## HI-FI SPEAKER ENCLOSURES

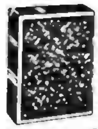
Teak veneer finish. Acoustically lined. Sizes approx. Carr. 45p.per enc

JE8 Size 16" × 11" × 9". Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·50**

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

SE8 For optimum performance with any 8in. Hi-Fi speaker. Size 19 × 10½ × 9in. **£6·50**

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



## AUDIOTRINE HI-FI SPEAKER SYSTEMS

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. **£6·50** Carr. 33p
OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£7·65** Carr. 39p

## AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticised Cone surround. "D" 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.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HF808T | 8" | 10W | £2·98 | HF120D | 12" | 15W | £5·50 |
| HF102D | 10" | 10W | £3·30 | HF126 | 12" | 15W | £6·35 |
| HF120 | 12" | 15W | £4·95 | HF126D | 12" | 15W | £6·85 |

## 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 9½ × 2½ × 5½in. Silver finish facia 10½ × 3½in.
Complete kit, wiring diagrams and instructions. **£7·95** Carr. 40p.
OR FACTORY BUILT £10·95

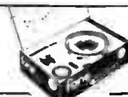
## R.S.C. TA12 MKIII 6·5+6·5 WATT STEREO AMPLIFIER

Fully Transistorised. Solid State. Hi-Fi o/p of 6·5 watts per channel. Designed for optimum performance with any crystal or ceramic Gram. P.U. Cartridge, Radio Tuner, Tape Recorder, etc.
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). Send S.A.E. for leaflet.

## 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 £4·99 **£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 £6·99

## AUDIO FIDELITY FR1 SPEAKER KIT



Response 30Hz–15KHz. Imp. 8–15 ohm 8" Bass Unit, Pressure Tweeter, Cross-over etc. £11each Carr Free
SPECIAL OFFER £14·95 Pair Carr. 45p.

## 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

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

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

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

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

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

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

## 'YORK' HIGH-FIDELITY 3 SPEAKER SYSTEM

COMPLETE KIT

★ Moderate size only 25 × 14 × 10in. approx.
★ Response 30-20,000 c.p.s. Impedance 15 ohms
★ Performance comparable with units costing considerably more **£25** Carr. 75p

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

## R.S.C. TRANSFORMERS, L.F. CHOKES & RECTIFIERS

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

**MIDGET CLAMPED TYPE 2½ × 2½ × 2½in.**

| | |
|---|---|
| 250v., 60mA, 6·3v. 2a | £1·10 |
| 250-0-250v., 60mA 6·3v 2a | £1·16 |

**FULLY SHROUDED UPRIGHT MOUNTING**

| | |
|---|---|
| 250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a. | £1·55 |
| 250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·45 |
| 300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·45 |
| 300-0-300v. 130mA, 6·3v. 4a. c.t., 6·3v. 1a. For Mullard 510 Amplifier | £2·95 |
| 350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·45 |
| 350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·95 |
| 425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a. | £5·45 |
| 425-0-425v. 200mA, 6·3v. 4a., Twice 5v. 3a. | £5·60 |
| 450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a. | £6·00 |

**TOP SHROUDED DROP-THRO' TYPE**

| | |
|---|---|
| 250-0-250v. 70mA, 6·3v. 2a., 0-5-6·3v. 2a. | £1·49 |
| 250-0-250v. 100mA, 6·3v. 3·5a. | £1·71 |
| 250-0-250v. 100mA, 6·3v. 2a., 6·3v. 1a. | £1·75 |
| 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 |
| 300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·45 |
| 300-0-300v. 130mA, 6·3v. 4a., c.t. 6·3v. 1a. Suitable for Mullard 510 Amplifier | £2·85 |
| 350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a. | £2·45 |
| 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, ECL86 to 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.

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

# RSC DISCO SYSTEM


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

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

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

## RSC TDI DISCO CONSOLE

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

## R.S.C. COLUMN SPEAKERS

IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

All types 15 Ohms covered in Rexine and Vynair
TYPE C4100 IS ALSO SUITABLE FOR BASS GUITAR OR ELECTRONIC ORGAN

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

**TYPE C318 50 WATTS** Low feedback characteristic. Fitted three 13" × 8" deep cone high flux speakers with high power voice coils. Size approx. 54" × 14" × 11". Dep. £4·72 & 8 mthly pymts £4·15 (£37·92) Carr. 85p **£32·72**

**TYPE C4100 100 WATTS** Inc. four 12" 50 watt speakers for conservative rating. Extra heavy construction. Size approx. 58 × 16 × 10" Acoustically filled and pressurised. Terms: Dep. £22·00 & 12 mthly. pyts. £4·29 (Total £73·48). Carr. £1·50 **£66·00**

## 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** 18" 100 Watt 14,000 gauss 8/15Ω **£27·50** Dep: £3·50 and 8 mthly payments £3·50 (Total £31·50)

**'POP' 60** 15" 60 Watt 14,000 gauss 8/15Ω **£15·75** Dep. £2 and 8 monthly payments £2 (Total £18)

FOR BASS GUITAR, ELECT. ORGAN, ETC.

**'POP' 50** 12" 50 Watt 13,000 gauss 15Ω **£12·75** Dep £1·71 and 8 monthly payments £1·71 (Total £15·39). PAIR SUITABLE ALL PURPOSES

## 'POP' 55 12" 60W

Gauss 15,000 Imp 8/15 Or Dep £2·45 and 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

## 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**

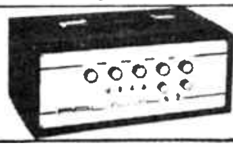
## FANE SPEAKERS 'POP' 25/2 12 in. 25 WATT

Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). Carr. free **£8·75** or Dep. £1·15 and 8 mthly payments £1·15 (Total £10·35).

## GROUP EQUIPMENT PACKAGE OFFERS

| | | |
|---|---|---|
| F.A.L. PHASE 50 MK.III AMPLIFIER<br>PR. FANE POP 25/2 25W L/SPEAKERS<br>Terms: Deposit £17·32 and 12 monthly payments of £3·88 (Total £57·88) | £39·93<br>£17·50<br>£57·43 | PACKAGE PRICE **£51·95** carr. £1·10 |
| F.A.L. PHASE 50 MK.III AMPLIFIER<br>PR. FANE POP 50 L/SPEAKERS<br>Terms: Deposit £20 and 12 monthly payments of £3·90 (Total £66·80) | £39·93<br>£25·50<br>£65·43 | PACKAGE PRICE **£59·99** carr. £1·10 |
| F.A.L. PHASE 50 AMPLIFIER<br>PAIR L12/20 SPKRS (in Cabinets)<br>Terms: Deposit £20·00 and 12 monthly payments £3·90 (Total £66·80) | £39·93<br>£26·30<br>£66·23 | 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 circuit to guard against damage from accidental shorts. 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 **£37·95**
Or deposit £5·95 and 8 monthly payts. of £4·72. Total £43·71

**L12/20** 12" 25 WATT 13,000 lines 15 ohms Dep £4·15 & 8 mthly pymts £1·42 (Total £15·51) **£13·15** Carr. 55p.

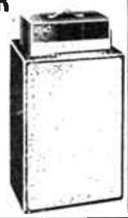
**L12/10** 10-15 Watt veneer finish cabinet 12" unit 8-15 ohm. Size approx. 14" × 14" × 9". Carr. 50p. Dep. £2·25 & 8 mthly pymts £1·04 (Total £10·57) **£8·25**

## 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 £20·00 and 12 monthly payments £3·90 (Total £66·80). Carr. £1·50 UK Mainland
SAE for leaflet
**ONLY £59·95**

## REGENT 50 AMPLIFIER



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

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

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

Credit Terms: Deposit £24·50 & 12 monthly payments of £4·68. (Total £80·66.) Carr. £2·50 **£72·50**

## 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 £4·40 and 8 monthly payments of £3·09 (Total £29·12). **£25·85** Carr. 75p

## R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BMI. An all-dry battery eliminator. Size 5½ × 4½ × 2½in. approx. Completely replaces batteries supplying 1·5v and 90v, to battery radio where A.C. mains 200/250v. 50c/s is available. Carr. 30p. **£4·15**

## 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.

All items subject to availability, Prices correct at 12.2.74 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, 38p 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.
**DERBY** 97 St. Peter's Street. (Closed Wed.). Tel. 41361
**DARLINGTON** 19 Northgate (Closed Wed.). Tel. 68043
**DONCASTER** 3 Queensgate, Waterdale Centre. (Closed Thurs)
**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
**LEEDS** 5-7 County (Mecca) Arcade, Briggate (Closed Wed.). Tel. 28252
**LIVERPOOL** 73 Dale St. (Closed Wed.). Tel. 236 3573
**LONDON** 238 Edgware Road, W.2. (Closed Thurs.). Tel. 723 1629
**MANCHESTER** 60A Oldham Street (Closed Wed.). Tel. 236 2778
**MIDDLESBROUGH** 106 Newport Rd. (Closed Wed.).
**NEWCASTLE UPON TYNE** 24 Newgate Shopping Centre (Closed Wed.). Tel. 21469
**NOTTINGHAM** 19/19A Market Street (Closed Thurs.). Tel. 48068
**PRESTON** 41 Friargate Walk, St. Georges Shoppg Prec
**SHEFFIELD** 13 Exchange Street (Castle Mkt. Blds.
**STOCKPORT** (Closed Thurs.). Tel. 20716
8 Little Underbank (Closed Thurs.). Tel. 480-0777
**SUNDERLAND** 5 Market Sq. (Closed Wed). Tel. 70573

IP **I.L.P. (Electronics) Ltd**

# 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.

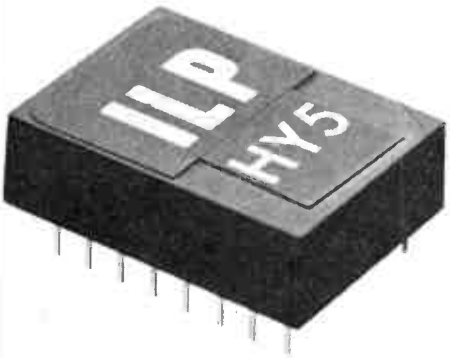
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

| | 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.

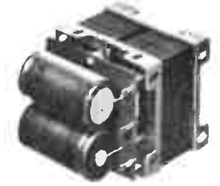
**SPEC.**

**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** 15mA
**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**


CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT

CANTERBURY 63218


Please note we reserve the right to substitute at our discretion updated versions of advertised designs where applicable.

# Henry's

PANEL METERS · TRANSFORMERS · CONTROLS · RELAYS
IRONS · TOOLS · VALVES · POT CORES MOST TYPES OF COMPONENTS
You need a catalogue! 55p post paid complete with Discount Vouchers


UK's LARGEST RANGE OF KITS & GADGETS

## TEST EQUIPMENT

### MULTIMETERS
(carr. etc. 30p)

| | | |
|---|---|---|
| M210 (Case £1·25) | 20K/Volt Slimline | 6·75 |
| TLH33D | 2K/Volt Robust | 7·50 |
| U437 | 10K/Volt Steel case. AC up to 40 KHz | 4·95 |
| U4324 | 20K/Volt with AC current ranges | 8·00 |
| AF105 (Case £1·90) | 50K/Volt | 11·95 |
| U4313 | 20K/Volt AC current. Steel case | 10·50 |
| U4341 | Plus Built in transistor tester | 10·50 |
| Model 500 (Case £1·95) | 30K/Volt | 9·95 |

### OTHER EQUIPMENT

| | | |
|---|---|---|
| SE250B | Pocket Signal Injector | 2·10 carr. 15p |
| SE500 | Pocket Signal Tracer | 1·70 carr. 15p |
| TE15 | Grid Dip meter 440kHz–280mHz | 15·00 carr. 30p |
| TE40 | AC Millivoltmeter 1·2mHz | 19·75 carr. 35p |
| TE65 | 28 Range valve voltmeter | 22·50 carr. 40p |
| TE20D | 120kHz–500mHz RF Generator | 18·95 carr. 40p |
| TE22D | 20Hz–200kHz Audio Generator | 19·95 carr. 40p |
| SE350A | Deluxe Signal Tracer | 12·50 carr. 20p |
| SE400 | Volts/ohms/R-C sub./RF field/RF gen. | 14·75 carr. 20p |

### New Revolutionary Supertester 680R

680R Multi-tester £18·50

| Accessories | |
|---|---|
| Transistor tester | 11·00 |
| Electronic voltmeter | 18·00 |
| Ampclamp | 11·95 |
| Temperature probe | 11·95 |
| Guass meter | 11·95 |
| Signal Injector | 5·95 |
| Phase Sequence | 5·95 |
| EHT Probe | 5·95 |
| Shunts 25/50/100A | 4·50 |

### A SELECTION OF INTERESTING ITEMS

| | | |
|---|---|---|
| C3025 | Compact transistor tester | 6·50 p & p 15p |
| Q4002 | Photoelectric System | £13·70 |
| E1310 | Stereo mag. cart. preamp. | 4·80 p & p 25p |
| Easiphone D1201 | telephone amplifier | 7·50 p & p 25p |
| D1203 | Teleamp. with PU coil | 4·95 p & p 20p |
| LL1 | Door intercomm. and chime | 8·40 p & p 25p |
| 1 Kw Dimmer/controller | | 3·00 p & p 10p |
| 9" Twin spring unit | For | 3·30 p & p 15p |
| 16" Twin spring unit | Reverbs | 6·65 p & p 25p |
| US50 Ultrasonic Switch Transmitter/Receiver | | £12·75 |
| C3041 1-250 MHz | | £4·25 |
| C3043 5CH 1-300 MHz | | £5·75 |
| VHF 105 Aircraft Band Convertor | | 4·50 p & p 15p |
| B2005 4 Ch. mic. mixer | | 4·20 p & p 15p |
| B2004 2 ch. Stereo mixer | | 6·75 p & p 15p |
| PK3 Kit. Etch your own printed circuits | | £1·95 p & p 20p |

### EXCLUSIVE: SPECIAL OFFERS

MW/LW CAR RADIO + or − Earth with speaker and fixings. £6·50 carr./packg. 30p.

8 TRACK CAR STEREO (− Earth) with speakers in Pods & fixings. £12·50 carr/packg. 40p.

Portable Battery Cassette Tape Player £7·25.

Car Lighter Plug and adaptor for all cassette and radio 6/7½/9 volt output (state width) £1·95 each

Rotel Stereophones
RH630 £4·50
RH700 £6·75
RH430 £3·30

Rotel RA310 15+15 watt Stereo Amplifier (List £52·00) £34·52.

Wein W500 Battery/Mains Cassette Recorder £12·75

AKAI GXC40 Stereo cassette recorder. £59·95 carr/packg. 50p.
Pair Akai ADM microphones. £6·95 carr/packg. 20p.

PORTABLE CASSETTE TAPE PLAYER— for car or carry around. £7·25 carr/packg. 20p.

HANIMAX BC808 POCKET CALCULATOR WITH % KEY. £28·95.

HANIMAX BC811M MEMORY VERSION £37·50

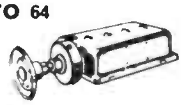
MAINS UNIT for BC808, BC811M £2·85 (state model)

HANIMAX H101 STEREO COMPACT RECORD PLAYER 2 x 7 watts Complete with Speakers (List £54·50) Price £39·95 Plus free pair of stereo phones.

## SPECIAL PURCHASES

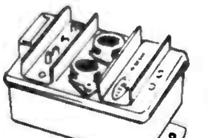
### UHF TV TUNERS CHANNELS 21 TO 64

Brand new transistorised geared tuners for 625 Line Receiver IF output. £2·50. Post 20p.



## EASY TO BUILD KITS BY AMTRON— EVERYTHING SUPPLIED

| Model No. | | |
|---|---|---|
| 310 | Radio control receiver | 2·98 |
| 300 | 4-channel R/C transmitter | 5·95 |
| 345 | Superhet R/C receiver | 5·95 |
| 455 | AM signal generator | 12·33 |
| 65 | Simple transistor tester | 1·40 |
| 115 | 8 watt Amplifier | 3·90 |
| 120 | 12 watt amplifier | 4·70 |
| 125 | Stereo control unit | 5·70 |
| 130 | Mono control unit | 3·60 |
| 605 | Power supply for 115 | 4·55 |
| 610 | Power supply for 120 | 4·55 |
| 615 | Power supply for 2 x 120 | 5·73 |
| 230 | AM/FM aerial amplifier | 2·93 |
| 240 | Auto packing light | 5·90 |
| 275 | Mic. preamplifier | 6·08 |
| 570 | LF generator 10Hz–1mHz | 15·80 |
| 575 | Sq. wave generator 20Hz–20Khz | 14·60 |
| 590 | SWR meter | 12·85 |
| 620 | Ni-CAD Charger 1·2–12v | 6·00 |
| 630 | STAB Power supply 6-12v 0·25-0·1A | 8·15 |
| 690 | DC motor speed Gov. | 2·87 |
| 700 | Electronic Chaffinch | 7·00 |
| 705 | Windscreen wiper timer | 6·60 |
| 760 | Acoustic switch | 10·75 |
| 780 | Metal Detector (electronics only) | 9·65 |
| 790 | Capacitive Burglar alarm | 6·85 |
| 835 | Guitar preamp. | 4·25 |
| 840 | Daisy car alarm | 6·15 |
| 875 | CAP. Discharge ignition for car engine (−Ve Earth) | 13·15 |
| 80 | Scope Calibrator | 2·25 |
| 255 | Level indicator | 6·15 |
| 525 | 120–160mHz VHF timer | 11·30 |
| 715 | Photo cell switch | 7·70 |
| 795 | Electronic continuity tester | 4·30 |
| 860 | Photo timer | 13·25 |
| 871 | Slide projector auto feed control | 7·15 |
| 235 | Acoustic Alarm for driver | 7·60 |
| 465 | Quartz XTAL checker | 8·75 |
| 220 | Signal Injector | 2·30 |
| 390 | VOX | 15·50 |
| 432 | Testakit | 19·30 |
| 670 | Buffer Battery Charger | 6·55 |
| 885 | Capacitive Contact Alarm | 6·25 |
| 850 | Electronic Keyer | 16·75 |
| 820 | Electronic Digital Clock | 58·50 |



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation. Subject to change without notice.

### BUILD THIS TUNER

MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2½" x 3½". All parts £4·85, carr. 15p.

### MULTI-USE & RADIONIC KITS

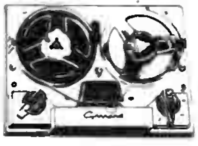
| | | |
|---|---|---|
| 10–1 | 10 Projects | 3·60 |
| 50–1 | 10 Projects | 6·00 |
| 150–1 | 150 Projects | 13·20 |
| Telephone Communicator | | 7·20 |
| X20 | 20 (Elec.) } Projects | 4·95 |
| X40 | 40 (radio) } Projects | 9·45 |

(carr./packing 40p)

**All transistor circuits with hand books**

### BUILD THIS RADIO

Portable MW / LW radio kit using Mullard RF/IF module. Features MW — bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts £7·98 (battery 22p). carr etc. 32p.



### GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9·50 carr. 30p

### TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post. etc. 15p any quantity).

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K. 1 Meg. 45p each.

Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 65p each. (Quantity discounts available)

Complete with knobs.

### MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO
'17' High impedance £2·00
'18' Med. impedance £2·00
R730/E73 2 track mono Record/Erase low imp. 75p pair.
Erase Heads for '17' and '18' 75p
'63' 2 track mono, Hi imp. £1·75
'43' Erase Head for '63' 75p
(Post, etc. 15p any quantity).

### SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER

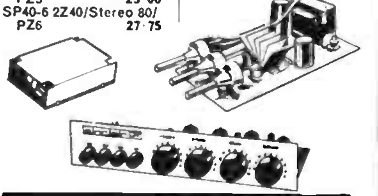
AMPLIFIERS (carr., etc. 20p)

| | |
|---|---|
| 4-300, 0·3 watt 9 volt | 1·75 |
| 104, 1 watt 9 volt | 3·10 |
| 304, 3watt 9 volt | 3·95 |
| 555, 3 watt 12 volt | 4·10 |
| E1208, 5 watt 12 volt | 5·10 |
| 608, 10 watt 24 volt | 4·95 |
| 410, 10 watt 28 volt | 4·95 |
| E1206, 30 watt 45 volt | 9·95 |
| E1210, 2½ + 2½ watts 12 volt | 7·75 |
| RE500, 5 watt IC mains operated Amplifier with controls | 6·30 |
| SAC14, 7 + 7 watt Stereo with controls | 11·75 |
| SAC13, 15 + 15 watt Stereo with controls | 14·95 |
| SP40-5 2Z40/Stereo 80/PZ5 | 25·00 |
| SP40-6 2Z40/Stereo 80/PZ6 | 27·75 |

SP60 2Z60/Stereo 80/PZ8 30·45
Transformer PZ8 3·95)

New SINCLAIR PROJECT 80

| | |
|---|---|
| Stereo Preamp. | 11·95 |
| Audio Filter Unit | 6·95 |
| Z40 15 Watt Amp. | 5·45 |
| Z60 25 Watt Amp. | 6·95 |
| PZ5 Mod. for 1 on 2 Z40 | 4·98 |
| PZ6 Mod. (S Tab) 1 on 2 Z40 | 7·98 |
| PZ8 Mod. (S Tab) 1 on 2 Z60 | 7·98 |
| TRANSFORMER FOR PZ8 | 3·95 |
| Project 605 Kit | 19·95 |
| Project 805 | 26·95 |



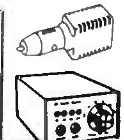
### POWER SUPPLIES FOR EVERY PURPOSE

(All cased unless stated chassis)

| | |
|---|---|
| 470C 6/7½/9 volt 300 MA (Includes Multi-Adaptor for Tape Recorders, etc.) | 2·15 post 20p |
| Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7½v, 9v) | 1·95 ea. post 25p |
| SC202 3/6/7½/9 volt 400mA | 3·35 carr. 30p |
| HC244R Stabilised version | 4·35 carr. 30p |
| P500 9 volt 500mA | 2·90 post 20p |
| P11 24 volt 500mA (chassis) | 2·90 post 20p |
| P15 26/28 volt 1 amp (chassis) | 2·90 post 20p |
| P1080 12v 1 amp (chassis) | 4·50 post 20p |
| P1081 45v 0·9 amp (chassis) | 7·50 post 20p |
| P12 4½–12 volt 0·4–1 amp | 7·15 post 30p |
| SE101A 3/6/9/12 volt 1 amp (Stab.) | 10·30 post 25p |
| RP164 6/7½/9/12 1 amp (Stab.) | 12·95 post 30p |

### FIBRE OPTICS

0·01 Diam. Mono Filament £3·00 per 50 metre reel
0·13 Diam. 64 Fibres Sheathed. £1·00 per metre
SPRAYS 15mm Diam. (Mares Tail Spray £10·50 7mm. Diam. £5·00)



All types offered subject to availability. Prices correct at time of press E & OE. 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.

# Henry's RADIO LIMITED
EDGWARE ROAD, W2

SEE FACING PAGE FOR ADDRESSES

**MANUFACTURERS OF ELECTRONIC AND AMPLIFICATION EQUIPMENT**
**SPECIALISTS IN QUALITY TRANSISTOR EQUIPMENT**
**OPEN 6 DAYS A WEEK. 9.00 a.m.-6.00 p.m.**

# TUAC

**TRANSISTOR UNIVERSAL AMPLIFICATION COMPANY LTD.**
**DEPT. W**
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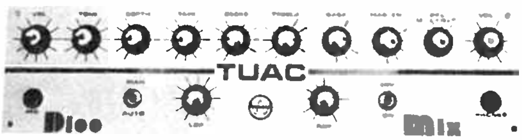
**01-672 3137/9080**

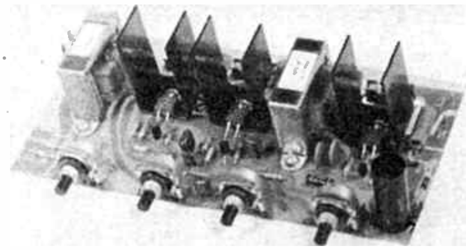



## TUAC DISCOTHEQUE MIXER WITH AUTO FADE

Designed for the discerning D.J. of professional standard. Offering a vast variety of functions. **£25·50**

Controls: Mic Vol, Tone, Over-ride depth, Auto Manual Sw. Tape Vol, L&R Deck Faders. Deck Volume. Treb. & Bass. H. Phon Vol. Selector. Master Vol, on/off sw. Max. output 1V RMS. **PANEL SIZE 18" × 4½" DEPTH 3"**
POWER SUPPLY **£3·50p**

## *NEW!*
## 3 CHANNEL LIGHT MODULATOR



- ★ 1,000 watts per channel
- ★ Operates from ⅛th watt to 100 watts
- ★ Full wave control
- ★ Fully fused and suppressed
- ★ 12 easy connections

**£17·25**

Single channel version **£6·50p**

**ALL PRICES INCLUDE V.A.T. AND POSTAGE AND PACKING**
**ACCESS & BARCLAY CARDS ACCEPTED, JUST SEND US YOUR NUMBER. H.P. ARRANGED THROUGH PAYBONDS**

---

ALL PRICES INCLUDE VAT

**BARGAIN PARCELS** 14lb at £1·60 plus 35p p.p.; 28lb at £3·00 plus 57½p p.p.; 56lb at £4·95 plus £1·37½ p.p. Contain pots, Res. Valves, Diodes Tagboards, Chassis, Valveholders, etc. Good value save £££s. Lucky Dip Service.

**FANTASTIC BARGAIN.** New 6 inch tubes. E450 4/B/16 4VH, medium Persistance, green. Ideal scope tube.

Also 7BP7. All unused as new. Price £1·55 post paid.

**NEW HEAVY COAX CABLE** dia. ¼" 70 ohms approx. 50ft. lengths £1·55, p. & p. 32½p. 100 ft. lengths £2·97, p. & p. 55p.

**AERIALS.** New Condition Whip Type, 4ft. 22p; 11ft. 82½p. all collapsible type. P. & p. 4ft. 10p. 11ft. 15p. New bases on adjustable clamp for the above, 67½p. p. & p. 27½p.

**CRYSTALS AS NEW.** Hc 6u; 5,030; 4,945; 4,875; 4,840; 4,795; 4,580; 4,660; 4,520; 4,510; 2,295 Kc/s. 55p each plus 8p p.p.

**TRANSISTOR BOARDS**—consisting of transistors, diodes and resistors etc. Long leads. Good value 12 for £1.00 (min. order) P. & P. 25p. Quotations for quantity.

**OUR SELECTION OF 6-Ex. Equ. METERS** consisting of 3in., 2½in., 2in. mill amps, volts, amps. Mixed at the bargain price of £2·20 P. & P. 27½p, minimum order of six.

**AERIAL POLES** 4ft high 2" in diameter push-in type as new 75p each p. & p. 25p each minimum four.

**AERIAL MAST POLES** approx. 5ft high 2" dia. Interlocking ends. Minimum order three. New condition, £1·10 each section. Carriage 37½p each section. ¼" 75 ohms Coax in 50ft coils with BNC plugs good condition. Price £1·10 + 32½p p.p.

**AS NEW 500ua PENNY SIZE METERS** complete with jack plug price £1·10 each, p. & p. 10p.

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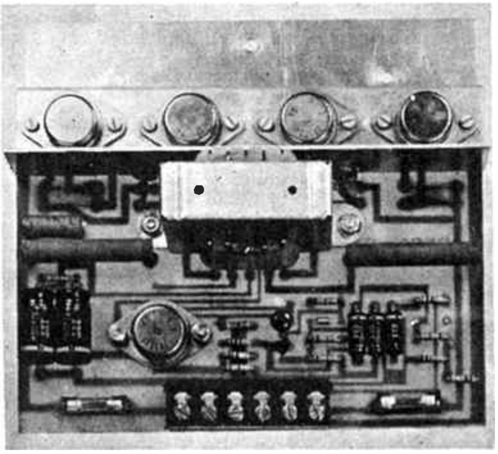

**TP125** illustrated **£15·25**
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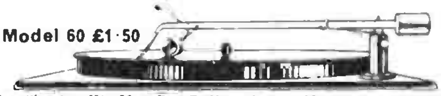

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| 1020 | For model G240 3/32" | 38p |
| 1021 | For model G240 1/8" | 38p |
| 1022 | For model G240 3/16" | 38p |
| 50 | For model X25 3/32" | 38p |
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ELEMENTS
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| C4 | 75 | ⅛th W Resistors mixed preferred values | 0·55 |
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| C6 | 2 | Tuning Gangs, MW/LW VHF | 0·55 |
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| C 8 | 10 | Reed Switches | 0·55 |
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## PLUGS AND SOCKETS
SOCKETS

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| PS 36 DIN | 3 Pin | 0·10 |
| PS 37 DIN | 5 Pin 180° | 0·10 |
| PS 38 DIN | 5 Pin 240° | 0·10 |
| PS 39 | Jack 2·5mm Switched | 0·09 |
| PS 40 | Jack 3·5mm Switched | 0·10 |
| PS 41 | Jack ¼" Switched | 0·17 |
| PS 42 | Jack Stereo Switched | 0·26 |
| PS 43 | Phono Single | 0·06 |
| PS 44 | Phono Double | 0·10 |
| PS 45 | Car Aerial | 0·09 |
| PS 46 | Co-Axial Surface | 0·09 |
| PS 47 | Co-Axial Flush | 0·14 |

## INLINE SOCKETS

| | | |
|---|---|---|
| PS 21 | D.I.N. 2 Pin (Speaker) | 0·13 |
| PS 22 | D.I.N. 3 Pin | 0·17 |
| PS 23 | D.I.N. 5 Pin 180° | 0·17 |
| PS 24 | D.I.N. 5 Pin 240° | 0·17 |
| PS 25 | Jack 2·5mm Plastic | 0·10 |
| PS 26 | Jack 3·5mm Plastic | 0·12 |
| PS 27 | Jack ¼" Plastic | 0·24 |
| PS 28 | Jack ¼" Screened | 0·28 |
| PS 29 | Jack Stereo Plastic | 0·22 |
| PS 30 | Jack Stereo Screened | 0·32 |
| PS 31 | Phono Screened | 0·14 |
| PS 32 | Car Aerial | 0·15 |
| PS 33 | Co-Axial | 0·17 |

## PLUGS

| | | |
|---|---|---|
| PS 1 | D.I.N. 2 Pin (Speaker) | 0·11 |
| PS 2 | D.I.N. 3 Pin | 0·12 |
| PS 3 | D.I.N. 4 Pin | 0·15 |
| PS 4 | D.I.N. 5 Pin 180° | 0·14 |
| PS 5 | D.I.N. 5 Pin 240° | 0·15 |
| PS 6 | D.I.N. 6 Pin | 0·15 |
| PS 7 | S.I.N. 7 Pin | 0·15 |
| PS 8 | Jack 2·5mm Screened | 0·10 |
| PS 9 | Jack 3·5mm Plastic | 0·09 |
| PS 10 | Jack 3·5mm Screened | 0·12 |
| PS 11 | Jack ¼" Plastic | 0·13 |
| PS 12 | Jack ¼" Screened | 0·18 |
| PS 13 | Jack Stereo Screened | 0·29 |
| PS 14 | Phono | 0·06 |
| PS 15 | Car Aerial | 0·15 |
| PS 16 | Co-Axial | 0·10 |

## CABLES

| | | |
|---|---|---|
| CP 1 | Single Lapped Screen | 0·06 |
| CP 2 | Twin Common Screen | 0·08 |
| CP 3 | Stereo Screened | 0·08 |
| CP 4 | Four Core Common Screen | 0·23 |
| CP 5 | Four Core Individually Screened | 0·30 |
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| Type | Amps. | Price | P & P |
|---|---|---|---|
| MT50/½ | ½ | £1·93 | 30p |
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| MT50/2 | 2 | £3·30 | 40p |

## CARTRIDGES
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ACOS GP96-1. 100mV at 1cm/sec £2·65
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TTC J-20 10C Crystal/Hi Output Compatible £1·10
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C60, 32p C90, 41p C120, 52p

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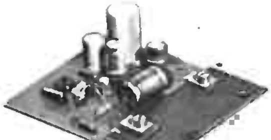
# BI-PAK *QUALITY* COMES TO AUDIO!

## 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 Œ 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

### POWER SUPPLIES

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

### PRE-AMPLIFIERS

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

### TRANSFORMERS

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

### PA 12. PRE-AMPLIFIER SPECIFICATION

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

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

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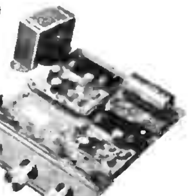
SEMICONDUCTOR ADVERTISEMENTS in

**Practical Wireless**
**Wireless World**
**Radio Constructor**

**ALL PRICES INCLUDE V.A.T.**

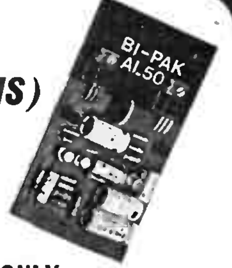
## The STEREO 20

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



**£14·45**

## *50W* pk 25w (RMS)




**0·1% DISTORTION!**
**HI-FI AUDIO AMPLIFIER**

## THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1 KHz.

★ Signal to noise ratio 80dB.

**ONLY £3·58 each**

★ Supply voltage 10–35 Volts.

★ Overall size 63mm 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT TESTED GUARANTEED.

## 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 |

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# TRANSFORMERS

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| Ref. No. | VA (Watts) | Weight lb | oz | Size cm. | £ | P & P p |
|---|---|---|---|---|---|---|
| 07 | 20 | 1 | 8 | 7·0 × 6·0 × 6·0 | 2·32 | 30 |
| 149 | 60 | 3 | 12 | 9·9 × 7·7 × 8·6 | 3·45 | 36 |
| 150 | 100 | 5 | 8 | 9·9 × 8·9 × 8·6 | 3·79 | 52 |
| 151 | 200 | 8 | 0 | 12·1 × 9·3 × 10·2 | 6·45 | 52 |
| 152 | 250 | 13 | 12 | 12·1 × 11·8 × 10·2 | 8·41 | 67 |
| 153 | 350 | 15 | 0 | 14·0 × 10·8 × 11·8 | 11·22 | 82 |
| 154 | 500 | 19 | 8 | 14·0 × 13·4 × 11·8 | 16·25 | - |
| 155 | 750 | 29 | 0 | 17·2 × 14·0 × 14·0 | 22·10 | |
| 156 | 1000 | 38 | 0 | 17·2 × 16·6 × 14·0 | 29·87 | – |
| 158 | 2000 | 60 | 0 | 21·6 × 15·3 × 18·1 | 49·25 | – |

PLEASE NOTE NEW ADDRESS AS BELOW

## AUTO TRANSFORMERS

| Ref. No. | VA (Watts) | Weight lb | oz | Size cm. | Auto Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 113 | 20 | 1 | 0 | 5·8 × 5·1 × 4·5 | 0-115-210-240 | 1·22 | 22 |
| 64 | 75 | 2 | 4 | 7·4 × 6·7 × 6·1 | 0-115-210-240 | 2·40 | 30 |
| 4 | 150 | 3 | 4 | 8·9 × 7·7 × 7·7 | 0-115-200-220-240 | 2·89 | 36 |
| 66 | 300 | 6 | 4 | 9·9 × 9·6 × 8·6 | .. | 5·63 | 52 |
| 67 | 500 | 12 | 8 | 12·1 × 11·2 × 10·2 | .. .. | 8·36 | 67 |
| 84 | 1000 | 19 | 8 | 14·0 × 13·4 × 14·3 | .. .. | 15·19 | 82 |
| 93 | 1500 | 30 | 4 | 14·0 × 15·9 × 14·3 | .. .. | 21·99 | – |
| 95 | 2000 | 32 | 0 | 17·2 × 16·6 × 14·0 | .. .. | 28·70 | • |
| 73 | 3000 | 40 | 0 | 21·6 × 13·4 × 18·1 | .. .. | 39.17 | • |

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

## TRANSFORMERS
PRIMARY 240/250 VOLTS 12 AND OR 24 VOLT RANGE

| Ref. No. | Amps. 12V | Amps. 24V | Weight lb | oz | Size cm. | Secondary Windings | £ | P & P p |
|---|---|---|---|---|---|---|---|---|
| 111 | 0·5 | 0·25 | | 8 | 4·8 × 2·9 × 3·5 | 0·12V at 0·25A × 2 | 1·22 | 22 |
| 213 | 1·0 | 0·5 | 1 | 4 | 6·1 × 5·8 × 4·8 | 0·12V at 0·5A × 2 | 1·44 | 22 |
| 71 | 2 | 1 | 1 | 12 | 7·0 × 6·4 × 6·1 | 0·12V at 1A × 2 | 1·90 | 22 |
| 18 | 4 | 2 | 2 | 12 | 8·3 × 7·7 × 7·0 | 0·12V at 2A × 2 | 2·68 | 30 |
| 70 | 6 | 3 | 3 | 8 | 8·9 × 8·0 × 7·7 | 0·12V at 3A × 2 | 3·20 | 42 |
| 108 | 8 | 4 | 5 | 8 | 9·9 × 8·9 × 8·6 | 0·12V at 4A × 2 | 3·60 | 52 |
| 72 | 10 | 5 | 6 | 4 | 9·9 × 9·6 × 8·6 | 0·12V at 5A × 2 | 4·25 | 52 |
| 116 | 12 | 6 | 6 | 12 | 9·9 × 10·2 × 8·6 | 0·12V at 5A × 2 | 5·10 | 52 |
| 17 | 16 | 0 | 8 | 12 | 12·1 × 9·9 × 10·2 | 0·12V at 8A × 2 | 6·56 | 52 |
| 115 | 20 | 10 | 11 | 8 | 14·0 × 9·6 × 11·8 | 0·12V at 10A × 2 | 8·36 | 67 |
| 187 | 30 | 15 | 15 | 8 | 14·0 × 12·1 × 11·8 | 0·12V at 15A × 2 | 15·40 | 82 |
| 226 | 60 | 30 | 32 | 0 | 17·2 × 15·3 × 14·0 | 0·12V at 30A × 2 | 28·44 | • |

## 30 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 112 | 0·5 | 1 | 4 | 6·1 × 5·8 × 4·8 | 0-12-15-20-24-30V | 1·42 | 22 |
| 79 | 1·0 | 2 | 4 | 7·0 × 6·7 × 6·1 | .. .. | 1·92 | 36 |
| 3 | 2·0 | 3 | 4 | 8·9 × 7·7 × 7·7 | .. .. | 2·90 | 36 |
| 20 | 3·0 | 4 | 8 | 9·9 × 8·3 × 8·6 | .. .. | 3·58 | 42 |
| 21 | 4·0 | 6 | 4 | 9·9 × 9·6 × 8·6 | .. .. | 4·25 | 52 |
| 51 | 5·0 | 6 | 12 | 12·1 × 8·6 × 10·2 | .. .. | 5·30 | 52 |
| 117 | 6·0 | 8 | 0 | 12·1 × 9·3 × 10·2 | .. .. | 6·31 | 52 |
| 88 | 8·0 | 12 | 0 | 12·1 × 11·8 × 10·2 | .. .. | 8·18 | 67 |
| 89 | 19·0 | 13 | 12 | 14·0 × 10·2 × 11·8 | .. .. | 10·33 | 67 |

## 50 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 102 | 0·5 | 1 | 12 | 7·0 × 6·4 × 6·1 | 0-19-25-33-40-50V | 1·90 | 30 |
| 103 | 1·0 | 2 | 12 | 8·3 × 7·4 × 7·0 | .. .. | 2·80 | 36 |
| 104 | 2·0 | 5 | 8 | 9·9 × 8·9 × 8·6 | .. .. | 3·87 | 42 |
| 105 | 3·0 | 6 | 12 | 9·9 × 10·2 × 8·6 | .. .. | 5·26 | 52 |
| 106 | 4·0 | 10 | 0 | 12·1 × 10·5 × 10·2 | .. .. | 6·99 | 52 |
| 107 | 6·0 | 12 | 0 | 14·0 × 10·2 × 11·8 | .. .. | 10·35 | 67 |
| 118 | 8·0 | 18 | 0 | 14·0 × 12·7 × 11·8 | .. .. | 13·51 | 97 |
| 119 | 10·0 | 25 | 0 | 17·2 × 12·7 × 14·0 | .. .. | 16·93 | • |

## 60 VOLT RANGE

| Ref. No. | Amps. | Weight lb | oz | Size cm. | Secondary Taps | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 124 | 0·5 | 2 | 4 | 7·0 × 6·7 × 6·1 | 0-24-30-40-428-69C | 1·93 | 36 |
| 126 | 1·0 | 3 | 4 | 8·9 × 7·7 × 7·7 | .. .. | 2·70 | 36 |
| 127 | 2·0 | 6 | 4 | 9·9 × 9·6 × 8·6 | .. .. | 4·25 | 42 |
| 125 | 3·0 | 8 | 12 | 12·1 × 9·9 × 10·2 | .. .. | 6·46 | 52 |
| 123 | 4·0 | 13 | 12 | 12·1 × 11·8 × 10·2 | .. .. | 8·36 | 67 |
| 40 | 5·0 | 12 | 00 | 14·0 × 10·2 × 11·8 | .. .. | 9·85 | 87 |
| 120 | 6·0 | 15 | 8 | 14·0 × 12·1 × 11·8 | .. .. | 12·14 | 82 |
| 121 | 8·0 | 25 | 00 | 14·0 × 14·7 × 11·8 | .. .. | 13·65 | • |
| 122 | 10·0 | 25 | 0 | 17·2 × 12·7 × 14·0 | .. .. | 20·09 | • |
| 189 | 12·0 | 29 | 00 | 17·2 × 14·0 × 14·0 | .. .. | 22·49 | • |

## MINIATURE TRANSFORMERS WITH SCREENS

| Ref. | MA. | Weight lb | oz | Size cm | VOLTS | £ | P & P p |
|---|---|---|---|---|---|---|---|
| 238 | 200 | | 2 | 2·8×2·6×2·0 | 3-0-3 | 1·31 | 10 |
| 212 | 1A 1A | 1 | 4 | 6·1×5·8×4·8 | 0-6 0-6 | 1·52 | 22 |
| 13 | 100 | | 4 | 3·9×2·6×2·9 | 9-0-9 | 1·12 | 10 |
| 235 | 330,330 | | 4 | 4·8×2·9×3·5 | 0-9, 0-9 | 1·52 | 10 |
| 207 | 500, 500 | 1 | 00 | 6·1×5·4×4·8 | 0-8-9, 0-8-9 | 2·03 | 22 |
| 208 | 1A, 1A | 1 | 12 | 7·0×6·4×6·1 | 0-8-9,0-8-9 | 2·73 | 30 |
| 236 | 200, 200 | | 4 | 4·8×2·9×3·5 | 0-15, 0-15 | 1·52 | 10 |
| 214 | 300, 300 | 1 | 4 | 6·1×5·8×4·8 | 0-20, 0-20 | 1·60 | 22 |
| 221 | 700 (D.C.) | 1 | 8 | 7·0×6·1×6·1 | 20-12-0-12-20 | 1·41 | 30 |
| 206 | 1A, 1A | 2 | 12 | 8·3×7·7×7·0 | 0-15-20, 0-15-20 | 3·08 | 36 |
| 203 | 500, 500 | 2 | 4 | 8·3×7·0×7·0 | 0-15-27, 0-15-27 | 2·82 | 38 |
| 204 | 1A, 1A | 3 | 4 | 8·9×7·7×7·7 | 0-15-27, 0-15-27 | 2·86 | 38 |

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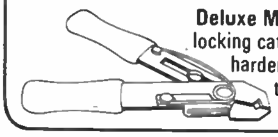

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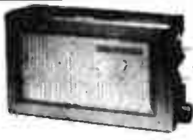

3 Tunable wavebands. M.W. L.W. and Trawler Band. 7 stages. 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size 5½" × 1¼" × 3½" approx. Plans and Parts Price List 15p (Free with parts).

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

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

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

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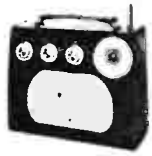

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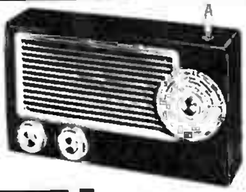

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 ×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

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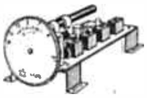

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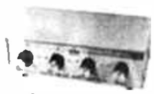

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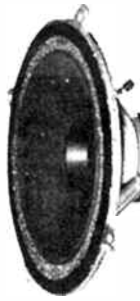

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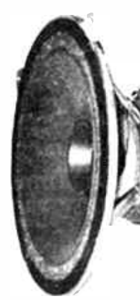

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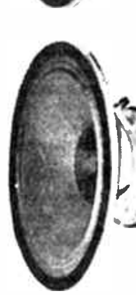

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PHOTOMULTIPLIER type 931 A £3·25 ea. P & P 25p.

**ROTARY SWITCH PACK—6** brand new switches (1 ceramic; 2 off 4pole 2 way etc.). 50p P & P 20p.

**COMPONENT PACK** consisting of 5 pots, various, brand new: 250 resistors ¼ and ½ watt, many high stabs, etc. Fine value at 50p, P. & P. 17p.
**P.C.B. PACKS** S & D. Quantity 2 sq ft—no tiny pieces. 50p plus P. & P. 20p.
**FIBRE GLASS** as above £1 plus P. & P. 20p.
Ferric Chloride Resistance Pen FREE (whilst stock lasts) on all purchases of our £1 Fibre Glass pack.
5 CRYSTALS 70 to 90kHz. Our choice. 25p, P. & P. 15p.
**5 MOVING COIL METERS.** Various. £2, P. & P. 37p.
**CAPACITOR PACK**—50 Brand new components, only 50p, P. & P. 17p.
**POTS**—10 different values. Brand new. 50p, P. & P. 17p.
**TRIMMER PACK.** 2 Twin 50/200pF ceramic 2 Twin 10/60pF ceramic; 2 min. strip with 4 preset 5/20pF on each; 3 air spaced preset 30/100pF on ceramic base. ALL BRAND NEW. 25p the lot, P. & P. 10p.
**FLAT FACED 4" TWIN BEAM TUBE** type CV2193. Green trace. Brand new £4 each, P. & P. 37p.
**LIGHT EMITTING DIODES** (Red) from Hewlett-Packard. Brand New. 38p each. Holder 1p each. Information 5p.
**PHOTOCELL** equ. OCP71, 13p each.
**PHOTO RESISTOR** type Clare 703. Two for 50p.
**MODERN TELEPHONES** type 706. Two-tone grey. £3·75 each. Two-tone green £3·75 each. Black £2·75 each. P & P 25p ea.
Also **TOPAZ YELLOW** £4·50 each, P. & P. 25p.
Ideal **EXTENSION TELEPHONES** with standard GPO type dial, bell and lead coding. £1·75 each P. & P. 25p.

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**WHEN COMPLETE THE UNIT CAN BE FITTED TO YOUR CAR IN ONLY 15 MINUTES USING THE STANDARD COIL AND CONTACT BREAKER POINTS: TO GIVE YOU:—**

Instant all weather starting, Up to 20% fuel saving, Longer battery life, Higher top speed, Faster acceleration, Spark plugs last about five time longer, Misfire due to contact breaker, bounce electronically eliminated, Purer exhaust emission resulting in less air pollution, Contact breaker burn *eliminated*.

Suitable for all petrol engines up to 8 *cylinders*

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Unit for Motor Cycles with twin coils and twin C.B. Points £19·80
(prices include VAT and post & packing)
(NOT AVAILABLE IN KIT FORM)

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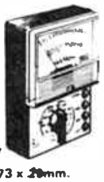
**114 PARK FARM ROAD**
**BIRMINGHAM B43 7QH**

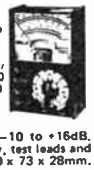
# LASKYS

**INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).**

## 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 £2.95** P&P 15p

## AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 28mm.
**OUR PRICE £3.50** P&P 15p

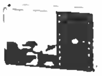
## MODEL C1092 MULTIMETER

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

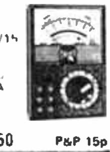
## MODEL U437 MULTIMETER

10,000opv. A first class, instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistance 300 ohms/3/30/300k/3 Meg. ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.
**OUR PRICE £4.95** P&P25p

## MODEL TH12

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

## U4323 MULTIMETER

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

## MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC 0/6/30/120/600/1200V AC. 0/30uA. 6mA/60mA/300mA 600mA. 0/8k/80k/800k/8 Meg ohms –20 to +63dB.
**OUR PRICE £7.50** P&P 15p

**ALL PRICES EXCLUDE VAT**

Also see following pages

## HIOKI Model 720X VOM

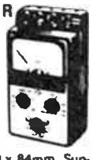
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.
**OUR PRICE £5.97** P&P 20p

## 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 20p

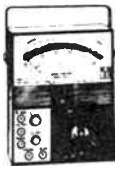
## TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. –20 to +81 5dB
**OUR PRICE £8.50** P&P 17p

## U435 MULTIMETER

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

## U4312 MULTIMETER

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

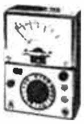
## KAMODEN 360 MULTIMETER

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 £13.95** P&P 25p

## U91 Clamp VOLT AMMETER

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

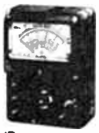
## MODEL 500

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 £10.95** Carr. paid
Leather case for above £1.75

## HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistance. 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

## KAMODEN HM7208 FET VOM

Input impedence 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
**OUR PRICE £14.95** 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 £17.50** P&P 25p

## TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps–1.2MHz. –40 to +50dB supplied complete with leads and instructions.
**OUR PRICE £17.50** P&P 25p

## 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

## U4317 MULTIMETER

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

## Model 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 resistance 0–20/200k/2/20 Meg. ohms. DC current:– 10/250uA/2.5/25/250 mA/10A. AC current:–0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.
**OUR PRICE £15.00** P&P 40p

## TE65 VALVE VOLTMETER

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

## C15 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 at 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 C116 Double Beam OSCILLOSCOPE

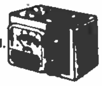
5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.
**OUR PRICE £87.00**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

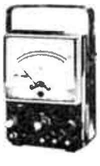
## LB4 TRANSISTOR TESTER

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

## U4341 Multimeter & Transistor Tester

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

## LB3 TRANSISTOR TESTER

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

## KAMODEN HM350 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 £12.50** 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 £15.95** P&P 25p

## TE16A TRANSISTORISED SIGNAL GENERATOR

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

## MODEL TE20 RF SIGNAL GENERATOR

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

## ARF 300 AF/RF SIGNAL GENERATOR

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

## AT201 Decade ATTENUATOR

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

## MCA220 Automatic Voltage Stabiliser

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

## PS100B Regulated POWER SUPPLY UNIT

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

## PS200 Regulated POWER SUPPLY UNIT

Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.
**OUR PRICE £19.95** P&P25p

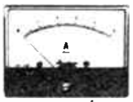
# SEW CLEAR PLASTIC PANEL METERS

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

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

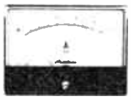
*Items with asterisk are Moving Iron type, all others are Moving Coil

## CLEAR PLASTIC MODEL S0640
Size: 85 x 64mm



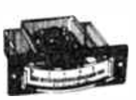
| | | | |
|---|---|---|---|
| 50uA | £3.35 | 20V DC | £3.20 |
| 100uA | £3.30 | 50V DC | £3.20 |
| 200uA | £3.30 | 300V DC | £3.20 |
| 500uA | £3.25 | 15V AC | £3.30 |
| 50-0-50uA | £3.35 | 300V AC | £3.30 |
| 100-0-100uA | £3.30 | VU Meter | £3.45 |
| 1mA | £3.20 | | |
| 5mA | £3.20 | | |
| 10mA | £3.20 | | |
| 50mA | £3.20 | | |
| 100mA | £3.20 | | |
| 500mA | £3.20 | | |
| 1A DC | £3.20 | | |
| 5A DC | £3.20 | | |
| 10A DC | £3.20 | | |
| 5V DC | £3.20 | | |

## CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



| | | | |
|---|---|---|---|
| 50uA | £4.55 | 300V AC | £4.00 |
| 100uA | £4.35 | VU Meter | £4.75 |
| 500uA | £4.10 | | |
| 50-0-50uA | £4.35 | | |
| 100-0-100uA | £4.30 | | |
| 1mA | £3.95 | | |
| 1A DC | £3.95 | | |
| 5A DC | £3.95 | | |
| 20V DC | £3.95 | | |
| 50V DC | £3.95 | | |
| 300V DC | £3.95 | | |

## EDGWISE MODEL PE70
Size: 90 x 34mm



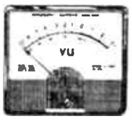
| | |
|---|---|
| 50uA | £4.15 |
| 100uA | £3.95 |
| 200uA | £3.75 |
| 500uA | £3.60 |
| 50-0-50uA | £3.96 |
| 100-0-100uA | £3.85 |
| 1mA | £3.50 |
| 300V AC | £3.50 |
| VU Meter | £4.25 |

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

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

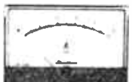
| | | | |
|---|---|---|---|
| 50uA | £7.60 | 300V DC | £6.55 |
| 100uA | £7.05 | 500mA/5A DC | £7.70 |
| 50-0-50uA | £7.05 | 5V/50V DC | £7.70 |
| 1A DC | £6.55 | 5V/15V DC | £7.70 |
| 5A DC | £6.55 | 1A/15A DC | £7.70 |
| 5V DC | £6.55 | | |
| 10V DC | £6.55 | | |
| 15V DC | £6.55 | | |
| 20V DC | £6.56 | | |
| 50V DC | £6.55 | | |

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



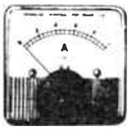
| | | | |
|---|---|---|---|
| 50uA | £4.85 | 300V DC | £4.30 |
| 100uA | £4.70 | 15V AC | £4.35 |
| 200uA | £4.45 | 300V AC | £4.35 |
| 500uA | £4.30 | S Meter 1mA | £4.30 |
| 50-0-50uA | £4.70 | VU Meter | £5.00 |
| 100-0-100uA | £4.45 | 1A AC | * £4.30 |
| 500-0-500uA | £4.30 | 5A AC | * £4.30 |
| 1mA | £4.30 | 10A AC | * £4.30 |
| 1-0-1mA | £4.30 | 20A AC | * £4.30 |
| 5mA | £4.30 | 30A AC | * £4.30 |
| 10mA | £4.30 | | |
| 50mA | £4.30 | | |
| 100mA | £4.30 | | |
| 500mA | £4.30 | | |
| 1A DC | £4.30 | | |
| 5A DC | £4.30 | | |
| 15A DC | £4.30 | | |
| 30A DC | £4.35 | | |
| 10V DC | £4.30 | | |
| 20V DC | £4.30 | | |
| 50V DC | £4.30 | | |
| 150V DC | £4.30 | | |

## CLEAR PLASTIC MODEL S0830
Size: 110 x 83mm



| | | | |
|---|---|---|---|
| 50uA | £3.75 | 10V DC | £3.40 |
| 100uA | £3.70 | 20V DC | £3.40 |
| 200uA | £3.65 | 50V DC | £3.40 |
| 500uA | £3.45 | 300V DC | £3.40 |
| 50-0-50uA | £3.75 | 15V AC | £3.65 |
| 100-0-100uA | £3.70 | 300V AC | £3.65 |
| 1mA | £3.40 | VU Meter | £3.85 |
| 5mA | £3.40 | | |
| 10mA | £3.40 | | |
| 50mA | £3.40 | | |
| 100mA | £3.40 | | |
| 500mA | £3.40 | | |
| 1A DC | £3.40 | | |
| 5A DC | £3.40 | | |
| 10A DC | £3.40 | | |
| 5V DC | £3.40 | | |

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

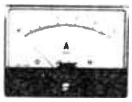


| | | | |
|---|---|---|---|
| 50uA | £3.00 | 300V AC | £2.70 |
| 100uA | £2.85 | S Meter 1mA | £2.75 |
| 200uA | £2.75 | VU Meter | £3.00 |
| 500uA | £2.70 | 1A AC | * £2.65 |
| 50-0-50uA | £2.90 | 5A AC | * £2.65 |
| 100-0-100uA | £2.75 | 10A AC | * £2.65 |
| 500-0-500uA | £2.65 | 20A AC | * £2.65 |
| 1mA | £2.65 | 30A AC | * £2.65 |
| 5mA | £2.65 | | |
| 10mA | £2.65 | | |
| 50mA | £2.65 | | |
| 100mA | £2.65 | | |
| 500mA | £2.65 | | |
| 1A DC | £2.65 | | |
| 5A DC | £2.65 | | |
| 10V DC | £2.65 | | |
| 20V DC | £2.65 | | |
| 50V DC | £2.65 | | |
| 300V DC | £2.65 | | |
| 15V AC | £2.70 | | |

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

| | | | |
|---|---|---|---|
| 50uA | £2.80 | 15V DC | £2.50 |
| 100uA | £2.70 | 20V DC | £2.50 |
| 200uA | £2.65 | 50V DC | £2.50 |
| 500uA | £2.60 | 100V DC | £2.50 |
| 50-0-50uA | £2.75 | 150V DC | £2.50 |
| 100-0-100uA | £2.65 | 300V DC | £2.50 |
| 500-0-500uA | £2.50 | 500V DC | £2.50 |
| 1mA | £2.50 | 750V DC | £2.50 |
| 1-0-1mA | £2.50 | 15V AC | £2.55 |
| 2mA | £2.50 | 50V AC | £2.55 |
| 5mA | £2.50 | 150V AC | £2.55 |
| 10mA | £2.50 | 300V AC | £2.55 |
| 20mA | £2.50 | 500V AC | £2.55 |
| 50mA | £2.50 | S Meter 1mA | £2.55 |
| 100mA | £2.50 | VU Meter | £2.90 |
| 150mA | £2.50 | | |
| 200mA | £2.50 | | |
| 300mA | £2.50 | | |
| 500mA | £2.50 | | |
| 750mA | £2.50 | | |
| 1A DC | £2.50 | | |
| 2A DC | £2.50 | | |
| 5A DC | £2.50 | | |
| 10A DC | £2.50 | | |
| 15A DC | £2.50 | | |
| 20A DC | £2.50 | | |
| 3V DC | £2.50 | | |
| 10V DC | £2.50 | | |

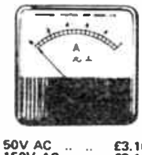
## CLEAR PLASTIC MODEL S0460
Size: 59 x 46mm



| | | | |
|---|---|---|---|
| 50uA | £3.10 | 10V DC | £2.85 |
| 100uA | £3.05 | 50V DC | £2.85 |
| 200uA | £3.00 | 300V DC | £2.85 |
| 500uA | £2.80 | 15V AC | £3.00 |
| 50-0-50uA | £3.10 | 300V AC | £3.00 |
| 100-0-100uA | £3.05 | VU Meter | £3.20 |
| 1mA | £2.85 | | |
| 5mA | £2.85 | | |
| 10mA | £2.85 | | |
| 50mA | £2.85 | | |
| 100mA | £2.85 | | |
| 500mA | £2.85 | | |
| 1A DC | £2.85 | | |
| 5A DC | £2.85 | | |
| 10A DC | £2.85 | | |
| 5V DC | £2.85 | | |

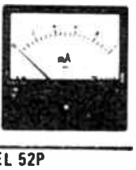
POSTAGE & PACKING 15p

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



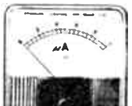
| | | | |
|---|---|---|---|
| 50uA | £4.10 | 50V AC | £3.10 |
| 100uA | £3.45 | 150V AC | £3.10 |
| 200uA | £3.35 | 300V AC | £3.10 |
| 500uA | £3.05 | 500V AC | £3.10 |
| 50-0-50uA | £3.45 | S Meter 1mA | £3.15 |
| 100-0-100uA | £3.40 | VU Meter | £4.10 |
| 500-0-500uA | £2.85 | 1A AC | * £2.85 |
| 1mA | £2.85 | 5A AC | * £2.85 |
| 5mA | £2.85 | 10A AC | * £2.85 |
| 10mA | £2.85 | 20A AC | * £2.85 |
| 50mA | £2.85 | 30A AC | * £2.85 |
| 100mA | £2.85 | 50mA AC | * £2.85 |
| 500mA | £2.85 | 100mA AC | * £2.85 |
| 1A DC | £2.85 | 200mA AC | * £2.85 |
| 5A DC | £2.85 | 500mA AC | * £2.85 |
| 10A DC | £2.85 | | |
| 15A DC | £2.85 | | |
| 20A DC | £2.85 | | |
| 30A DC | £3.10 | | |
| 50A DC | £3.20 | | |
| 5V DC | £2.65 | | |
| 10V DC | £2.85 | | |
| 20V DC | £2.85 | | |
| 50V DC | £2.85 | | |
| 150V DC | £2.85 | | |
| 300V DC | £2.85 | | |
| 15V AC | £3.10 | | |

## BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm



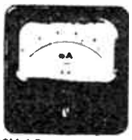
| | |
|---|---|
| 50uA | £3.85 |
| 100uA | £3.75 |
| 500uA | £3.35 |
| 50-0-50uA | £3.75 |
| 100-0-100uA | £3.65 |
| 1mA | £3.00 |
| 1A DC | £3.30 |
| 5A DC | £3.30 |
| 20V DC | £3.30 |
| 50V DC | £3.30 |
| 300V DC | £3.30 |
| 300V AC | £3.30 |
| VU Meter | £4.05 |

## CLEAR PLASTIC MODEL 52P
Size: 60 x 60mm



| | | | |
|---|---|---|---|
| 50uA | £3.85 | S Meter 1mA | £2.85 |
| 100uA | £3.30 | VU Meter | £3.95 |
| 500uA | £2.90 | 1A AC | * £2.75 |
| 50-0-50uA | £3.35 | 5A AC | * £2.75 |
| 100-0-100uA | £3.25 | 10A AC | * £2.75 |
| 1mA | £2.75 | 20A AC | * £2.75 |
| 5mA | £2.75 | 30A AC | * £2.75 |
| 10mA | £2.75 | | |
| 50mA | £2.75 | | |
| 100mA | £2.75 | | |
| 500mA | £2.75 | | |
| 1A DC | £2.75 | | |
| 5A DC | £2.75 | | |
| 10V DC | £2.75 | | |
| 20V DC | £2.75 | | |
| 50V DC | £2.75 | | |
| 300V DC | £2.75 | | |
| 15V AC | £2.85 | | |
| 300V AC | £2.85 | | |

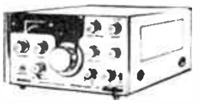
## BAKELITE MODEL 65
Size: 80 x 80mm



| | | | |
|---|---|---|---|
| 25uA | £5.05 | 30V AC | * £2.85 |
| 50uA | £3.90 | 50V AC | * £2.85 |
| 100uA | £3.30 | 150V AC | * £2.85 |
| 500uA | £3.00 | 300V AC | * £2.85 |
| 50-0-50uA | £3.35 | 500V AC | * £2.85 |
| 100-0-100uA | £3.30 | VU Meter | £4.00 |
| 500-0-500uA | £2.85 | 1A AC | * £2.85 |
| 1mA | £2.85 | 5A AC | * £2.85 |
| 1-0-1mA | £2.85 | 10A AC | * £2.85 |
| 5mA | £2.85 | 20A AC | * £2.85 |
| 10mA | £2.85 | 30A AC | * £2.85 |
| 50mA | £2.85 | 50A AC | * £2.85 |
| 100mA | £2.85 | 500mA AC | £2.85 |
| 500mA | £2.85 | 50mV DC | £3.20 |
| 1A DC | £2.85 | 100mV DC | £3.20 |
| 2A DC | £2.85 | | |
| 5A DC | £2.85 | | |
| 15A DC | £2.85 | | |
| 30A DC | £2.85 | | |
| 50A DC | £2.85 | | |
| 5V DC | £2.85 | | |
| 10V DC | £2.85 | | |
| 20V DC | £2.85 | | |
| 50V DC | £2.85 | | |
| 150V DC | £2.85 | | |
| 300V DC | £2.85 | | |

# SUPER VALUE TOP QUALITY TRIO equipment

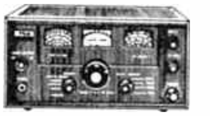
## TRIO JR599 RECEIVER



Nine wave-bands covering 1.8–29.7 MHz, 144–146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. Variable AF and RF controls. 4–16 ohm output and jack for phones. Power requirement 100/240V AC, 12/14V DC. Size: 270 x 140 x 310mm.

**Our Price £132.50** CARR. PAID

## TRIO 9R59DS RECEIVER



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

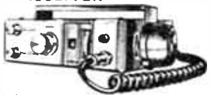
**Our Price £42.50** CARR. PAID

## TRIO TR2200 TRANSCEIVER

Fully transistorised portable VHF transceiver Will transmit and receive on six channels between 144–146MHz. 1 watt transmitter. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.

**OUR PRICE £79.50** Carr.paid

## BELTEK W5400 CAR TRANSCEIVER



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

**OUR PRICE £75.00** P&P 50p

## WALKIE TALKIES

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

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

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

P&P 50p per pair

NB. Licence required for use in UK

## KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

**OUR PRICE £5.25** P&P 50p

## POWER RHEOSTATS

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

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

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

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

**ALL PRICES EXCLUDE VAT**

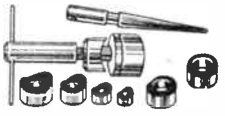
Also see previous page

## AUTO TRANSFORMERS

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

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

## CP110 CHASSIS PUNCH SET



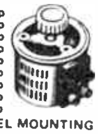
Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories.

**OUR PRICE £3.00** P&P 40p

## YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

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

MODEL S260 BENCH MOUNTING



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

MODEL S260B PANEL MOUNTING

| | | |
|---|---|---|
| 1A | £10.00 | 30p |
| 2.5A | £12.00 | 35p |

## BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0–180 degrees. Blank scales 1–5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft

**OUR PRICE £1.62** P&P 15p

## 2 TRANSISTOR RADIO KIT

No Soldering required. All connections made with spring clips. Kit includes all parts and wire including ear-piece. Will receive all normal broadcasts on Medium Wave 535–1605kHz. Operates from standard 9V battery or Solar Cell included.

**OUR PRICE £1.30** P&P 30p

## SWR METER Model SWR3

Handy SWR meter for transmitter 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 25p

# LASKYS

**INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).**

## LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

**OUR PRICE £1.97** P&P 30p

## TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC) Frequency response 200–4,000Hz.

**OUR PRICE £2.25** P&P 30p

## DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms 20–12,000Hz. Complete with lead and plug.

**OUR PRICE £2.25** P&P 30p

## TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz Complete with cable and stereo jack plug.

**OUR PRICE £2.60** P&P 30p

## SH80V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz Complete with 10ft. coiled lead and jack plug

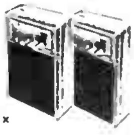
**OUR PRICE £4.97** P&P 30p

## BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms Microphone impedence 200 ohms

**OUR PRICE £5.95** P&P 30p

## SPECIAL BARGAIN!! PHONIC 10 Two Way Speakers



Matched pair of compact book-shelf speakers of unique design incorporating a 2" high frequency unit & 6" woofer. 8 ohms impedence. Size: 348 x 228 x 110mm.

**OUR PRICE £8.85** Pair P&P 50p

## SPECIAL BARGAIN !! STEREOSOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS. 16 watts peak. Complete with Din lead.

**OUR PRICE £12.95** P&P 50p

## AUDIOTRONIC CRITERION SPEAKERS

High quality three way speaker system offering a performance better than more expensive units. Teak finished with dark fronts. Frequency response: 40Hz–20kHz. 8 ohms impedence. Maximum power 20 watts. Size: 476 x 232 x 232mm.

**OUR PRICE £27.50 Pr.** P&P £1

## JOSTY KIT — HIGH QUALITY CONSTRUCTION KITS

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

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

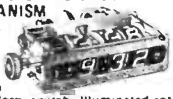
Post and Packing 15p per kit.

| | |
|---|---|
| AE1 100mW output stage | £1.65 |
| AE2 Pre-amplifier | £1.26 |
| AE3 Diode receiver | £2.00 |
| AE4 Flasher | £1.09 |
| AE5 Astable multi-vibrator | £1.05 |
| AE6 Monostable multi-vibrator | £1.02 |
| AE7 RC generator | £1.06 |
| AE8 Bass filter | 99p |
| AE9 Treble filter | 99p |
| AE10 CCIR filter | 99p |
| AF20 Mono amplifier | £4.80 |
| AF25 Mixer | £3.60 |
| AF30 Mono pre-amplifier | £2.61 |
| AF35 Emitter amplifier | £2.27 |
| AF80 0.5W mic. amplifier | £4.22 |
| AF305 Intercom | £9.52 |
| AF310 Mono amplifier | £5.91 |
| AT5 Automatic light control | £2.58 |
| AT25 Window wiper robot | £5.82 |
| AT30 Photo cell switch unit | £5.70 |
| AT50 400W triac light dimmer/speed control | £4.80 |
| AT56 2,200W triac light dimmer/speed control | £6.90 |
| AT60 1 channel light control | £7.80 |
| AT65 3 channel light control | £14.55 |
| GP304 Circuit board | £4.94 |
| GP310 Stereo pre-amplifier for use with 2 x AF310 | £21.27 |
| GP312 Circuit board | £11.45 |
| GU330 Tremolo unit | £7.50 |
| HF61 Diode detector | £3.32 |
| HF65 FM transmitter | £2.70 |
| HF75 FM receiver | £2.87 |
| HF310 FM tuner | £15.81 |
| HF325 Deluxe FM tuner | £24.12 |
| HF330 Decoder (HF310/325) | £9.96 |
| HF380 lw/vhf aerial amplifier | £4.94 |
| HF395 broadband aerial amp. | £1.77 |
| LF380 Quadraphonic device | £11.36 |
| M160 Multi-vibrator | £1.71 |
| M191 VU Meter | £4.55 |
| M192 Stereo balance meter | £4.97 |
| M1302 Transistor tester | £8.45 |
| NT10 Stabilised power supply 100mA, 9V | £6.15 |
| NT300 Stabilised p. supply | £12.51 |
| NT305 Voltage converter | £4.50 |
| NT315 Power supply 240V AC to4,5/15V DC, 500mA | £9.57 |

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

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

## DT55G DIGITAL CLOCK MECHANISM



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

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## SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems. 25 Watts. 4–8 ohms. 40Hz–18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts.

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Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 6" x 6". Weather and shock protected.

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## RECORD DECKS P&P 50p

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| C114 Mini | £3.95 |
| C129 Mono | £5.50 |
| C137 | £7.00 |
| 510/TPD | £12.55 |
| 610 | £11.35 |
| 610/TPD | £16.65 |
| 710 | £22.70 |
| 810 | £28.30 |
| MP60 | £8.90 |
| MP60/ADC K8 | £11.50 |
| MP60/TPD | £14.20 |
| HT70 | £12.50 |
| HT70/ADC K7E | £15.95 |
| HT70/TPD | £17.80 |
| **CONNOISSEUR** | |
| BD1 Kit | £10.20 |
| BD1 Chassis | £12.50 |
| BD2/SAU2/Chassis | £25.50 |
| BD2/SAU2/Plinth/Cover | £32.25 |
| **GARRARD** | |
| 1025T Stereo | £4.95 |
| 2025TC Less cartridge | £6.35 |
| 2025TC/KS40A | £6.95 |
| SP25 Mk3 | £9.25 |
| SP25 Mk3/G800 | £10.95 |
| SP25 Mk4 | £10.90 |
| SP25 Mk4/M75–6 | £13.90 |
| 86SB | £20.00 |
| SL65B | £11.15 |
| SL72B | £17.75 |
| SL95B | £28.00 |
| **GOLDRING** | |
| G101 Mk2/P/C | £22.50 |
| GL72 | £25.45 |
| GL72P | £33.75 |
| GL75 | £32.20 |
| GL75P | £41.65 |
| GL78 | £34.60 |
| GL78/P/C | £56.25 |
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## RECORD DECK PACKAGES P&P 75p

| | |
|---|---|
| **BSR McDONALD** | |
| 210/SC7M | £7.95 |
| C129 | £9.50 |
| MP60/G800 | £19.50 |
| MP60/TPD/ADC K8 | £16.80 |
| MP60/M44–7 | £17.50 |
| HT70/TPD/ADC K7E | £21.25 |
| 610/TPD/ADC K8 | £19.25 |
| **GARRARD** | |
| 2025TC/9TA-HC/D | £11.35 |
| SP25 Mk3/G800 | £18.15 |
| SP25 Mk3/M44E | £18.25 |
| SP25 Mk3/M44–7 | £17.80 |
| SP25 Mk3/M55E | £18.80 |
| SP25 Mk3 Module/M75–6 | £19.45 |
| SP25 Mk4/G800 | £19.95 |
| SP25 Mk4/AMC50E (M55E) | £21.30 |
| AP76/G800 | £26.75 |
| AP76/G800E | £28.95 |
| AP76/M44–7 | £27.50 |
| AP76/M44E | £28.00 |
| AP76/M55E | £28.60 |
| AP76/M75ED | £35.20 |
| AP76/M75EJ | £31.20 |
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| GL75/G800 | £40.90 |
| GL75/G800E | £43.35 |
| GL78/G800 | £45.65 |
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| G101/P/C/G800 | £23.70 |
| **RANK DOMUS** | |
| BD2000 | £43.60 |
| BA4000 | £53.95 |
| BD6000 | £67.50 |
| **WHARFEDALE** | |
| Linton W30 Teak | £23.90 |
| Linton W30 White | £25.10 |

## AUDIOTRONIC LOW NOISE CASSETTES

| TYPE | 5 | 10 | 25 |
|---|---|---|---|
| C60 | £1.27 | £3.00 | £7.08 |
| C90 | £2.24 | £4.25 | £10.00 |
| C120 | £2.73 | £5.17 | £12.24 |

## AUDIOTRONIC CrO2 CASSETTES

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

## AUDIOTRONIC 8 TRACK CARTRIDGES

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

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

## EMI LOUDSPEAKERS

Model 350 13 x 8" with single tweeter/crossover 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

**OUR PRICE £7.25** each P&P 37p

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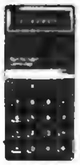
## SINCLAIR CAMBRIDGE CALCULATOR



To build yourself. Complete kit of parts with step by step instructions to build a full specification pocket sized calculator.

**OUR PRICE £24.95** P&P free

ALSO AVAILABLE READY BUILT
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Recommended Price £49.00

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## SINCLAIR Project 80 Modules

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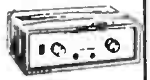
|---|---|
| Z40 Power Amplifier | £5.45 |
| Z60 Power Amplifier | £6.95 |
| Stereo 80 Pre-Amplifier | £11.95 |
| Active Filter Unit | £6.95 |
| Project 805 | £26.95 |
| PZ5 Power Supply | £4.98 |
| PZ6 Power Supply | £7.98 |
| PZ8 Power Supply | £7.98 |
| Transformer for PZ8 | £4.05 |

## SINCLAIR Project 80 Packages

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

POST & PACKING 35p each.

## AUDIOTRONIC AHA101 Stereo Headphone Amplifier



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

**OUR PRICE £8.50** P&P 20p

## 1021 Stereo Listening Station

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

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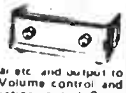
## MP7 MIXER-PREAMPLIFIER

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

**OUR PRICE £8.97** P&P 20p

## EA41 REVERBERATION AMPLIFIER



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

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## Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

**OUR PRICE £9.65** P&P 30p

Stereo multiplex adapter £4.97 extra.

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# The Sinclair Cambridge... no other calculator is so powerful and so compact.

# Complete kit – £24·95! (PLUS VAT)

**The Cambridge – new from Sinclair**
The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle the most complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5·50 !

**Truly pocket-sized**
With all its calculating capability, the Cambridge still measures just $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$. That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of life before replacement.

**Easy to assemble**
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

**Total cost? Just £27·45!**
The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32·95 – so you're saving £5·50 ! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.


**Features of the Sinclair Cambridge**

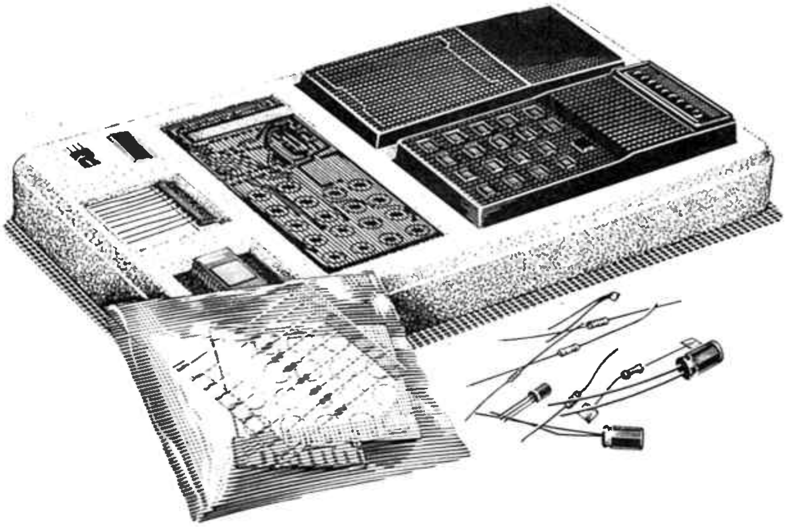
- * Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$, weight $3\frac{1}{2}$ oz.
- * Standard keyboard. All you need for complex calculations.
- * Clear-last-entry feature.
- * Fully-floating decimal point.
- * Algebraic logic.
- * Four operators (+, —, x, ÷), with constant on all four.
- * Constant acts as last entry in a calculation.
- * Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £30.
- * Calculates to 8 significant digits, with exponent range from $10^{-20}$ to $10^{79}$.
- * Clear, bright 8-digit display.
- * Operates for weeks on four U16-type batteries. (MN 2400 recommended.)

# A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge.
Assembly time is about 3 hours.

Contents:

1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



**This valuable book – free!**
If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.

How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations.

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Sinclair Radionics Ltd, London Road,
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**Why only Sinclair can make you this offer**
The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.
And *you* benefit!

**Take advantage of this money-back, no-risks offer today**
The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

**Price in kit form: £24·95 + £2·50 VAT. (Total: £27·45)**
**Price fully built: £29·95 + £3·00 VAT. (Total: £32·95)**

PW 4/74

To: Sinclair Radionics Ltd, London Road,
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Please send me

☐ a Sinclair Cambridge calculator kit at £24·95 + £2·50 VAT (Total: £27·45)

☐ a Sinclair Cambridge calculator ready built at £29·95 + £3·00 VAT (Total: £32·95)

*I enclose cheque for £ , made out to Sinclair Radionics Ltd, and crossed.

*Please debit my *Barclaycard/Access account. Account number ____________

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*Delete as required.

PLEASE PRINT

# SAFETY FIRST

TO encourage safety in the mere *presence* of electrical, electronic, radio or television apparatus, let alone during their operation, is not only laudable but vital. Hence the British Electrotechnical Approvals Board for Household Equipment (now affectionately BEAB) is extending the BEAB Approval Scheme to include audio and radio products including record players, radios, radiograms, mains/battery portable receivers with (curiously) "continuously rated audio outputs up to 6 + 6 watts stereo or 10 watts mono". Manufactured equipment that is licensed to bear the BEAB approval marking has to be first subjected to some detailed and stringent tests at the BSI laboratory.

The specification for the tests, detailed in BS 415: 1972 (with amendments), highlights for the more casual of the manufacturers, and probably some of the amateur constructor fraternity, areas of potential risk in mains driven equipment that all too often are taken for granted. There are, of course, extreme cases like the ladies' dangling necklace test and the test which inserts artificial fingers into apertures almost in determination to find live contact.

Generally the scheme is an excellent one. In most British equipment, that is designed and manufactured by responsible people, it is unlikely that no thought will be given to hazards such as shock, fire risk, ionised radiation, implosion and the like.

What has been needed is some form of yardstick by which a known hazard can be measured. Let us not be carried away by any thought that this standard is for manufacturers only. There are frequent cases where more strict attention to detail is needed by everyone who has mains driven appliances or electronic equipment.

We have only one serious complaint: that is the use of graphical symbols to indicate the nature of the supply (a.c. or d.c.) and to indicate live terminals. To the uninitiated layman, technical symbols mean nothing and he will not be inclined to buy BS3939 to find out before operating his new purchase.

Elsewhere in this issue we have highlighted only a few of the points in BS415 that we feel the general public need to know about. It is stressed that the detailed specification is designed to cover most contingencies of normal operation; we recommend manufacturers, suppliers and users to refer to this for more information.

M. A. COLWELL—*Editor.*

**The May issue of Practical Wireless will include a special pull-out feature to make a handy booklet "Guide to Long Distance Reception of Radio and TV", (useful for locals, too!). Also appearing will be constructional projects: the medium wave "Mini-Pop" (goes in a jacket pocket); an audio booster and power supply to enable you to hear cassette recordings in the car; a trace doubler to enable you to convert a single-beam oscilloscope for four displays. We shall also be giving first details of a super new project that we know will appeal to sports fans all over the world. Don't miss out—order your copy regularly NOW.**

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

**Further details on page 1167**

# NEWS...

## Export sales of British made Dolby

IN a recent statement Phoenix Videosonic Ltd., of Braintree, Essex, Europe's only manufacturer of Dolby Noise Reduction Units announced significant export sales to Europe, North America and Japan.

A Videosonic spokesman stated: "Videosonic leads the world in the technical specification of its equipment: in the PD4 we have introduced a new high level Dolby 'B' circuit providing a unique range of over 95dB between noise and 0·1% distortion. At this time the PD4 represents the ultimate way to take the PSSST! out of tape.

To further extend our lead in the World Hi-Fi market, the PD2b has been introduced as the world's first battery operated Dolby Unit, allowing 'field' use in the most rigorous conditions. The integral microphone pre-amplifier makes this an ideal unit for reporter or similar usage.

World recognition of Videosonic technical manufacturing competence has been most encouraging, and we can only take pride in our immediate penetration of the Japanese market in the face of very strong local competition. We are advised that our range of Dolby products will be displayed and demonstrated in the top 850 Hi-Fi Retail Shops in Japan, and that local response to date has been very positive. Our first shipment to Japan leaves this week.

## Portable Fluorescent Lamp (March P.W.)

WILL readers please note, that the transformer specified is now no longer available. An improved transformer is available from Messrs G. F. Milward at 77p plus 20p p & p. This includes full modification details and uses fewer components. A 21 in. 13W tube is available at 50p + 20p p & p, and it is claimed that this tube gives a greater light output than the 15W tube. S.A.E. to G. F. Milward for further details.

# NEWS... NEWS... NEWS...

## Bargains galore

IF you are in the "Ally Pally" area on March 24th, pay a visit to the Collector's Bazaar which is being held in the Palm Court.

This is a five-bazaar event which includes militaria, vintage post cards, vintage toys, transport relics and, of most interest to our readers, vintage records, horn gramophones, phonographs and probably some items of vintage radio equipment.

*Practical Wireless* visited one of these bazaars held at St. Johns Wood a few months ago, and it was there that Colin Riches purchased an Edison "Gem" phonograph to be featured in a future "Going Back."

If any readers want to find out the details of hiring a stall at the bazaar (£3·50 for the day) contact the organiser John Carter, Smewins, Shottesbrooke, nr. Maidenhead, Berks, SL6 3SR (Tel. Shurlock Row 539).

Otherwise, put on your cycle clips and pedal along to Alexandra Palace, Wood Green, London N.22, on March 24th. They'll let you in at 1 p.m. but be sure to have your entrance fee of 30p at the ready.

## R and TV Components Ltd.

IN their March advertisement, the price of postage and packing for the "Stereo 21" should have read £1·60. Apologies to R and TV Ltd.

## Public Address Exhibition

Readers who have an interest in outdoor activities, such as rallies, will be planning events for the coming season. To get up to date on public address installations, it would be worthwhile to visit Sound '74, the international exhibition of the Association of Public Address Engineers. A lecture programme will be held concurrently on p.a. design, building acoustics, microphones, and the financial side of public address work from the practical point of view.

The A.P.A.E. has received more stand space bookings than previously, but there are still a few left for those who wish to come in at a late stage, including suppliers of disco equipment.

Admission is free to all interested persons: tradesmen, manufacturers, buyers, and users of public address and allied equipment in the entertainments business. Tickets can be obtained from exhibitors or from the A.P.A.E. Secretariat, 6 Conduit Street, London W1R 9TG.

The scope of activities covered is extended to include audio-visual effects.

Overseas readers will be interested to learn that the A.P.A.E. are exhibiting in Hall 9A at the Hanover Fair from 25th April to 3rd May 1974 and at the I.C.E.T.I.A. exhibition at Melbourne, Australia from 7th to 11th October

*Practical Wireless* will be on show at the Hanover Fair.

## Hi-Fidelity 74

HI-FIDELITY 74 is a rival exhibition to the Sonex show. It will be run at the same time and held at the Heathrow Hotel, Bath Road. It's the idea of Malcolm Blockley who is the Hi-Fi Division Sales Manager of Pyser-Britex Ltd.—the sole UK distributor of Marantz, Teledyne and Kensonic equipment.

The organiser states that this show has been arranged because many manufacturers are fed-up with trying to demonstrate their products in small, cramped hotel bedrooms.

Hi-Fidelity 74 will run from March 27th to 31st inclusive but the first two days will be for the trade and press only.

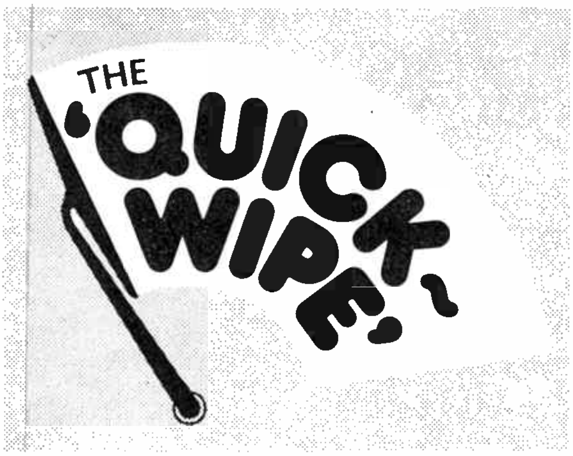
## Blast them out!

IN order to reduce the effects of interference from an East German station at night, the BBC has increased the transmitting power of the Radio 4 Moorside Edge transmitter to 300kW.

## UK wavebands and frequencies

THE BBC Engineering Department have issued a useful data sheet which shows the frequencies and wavebands allocated to broadcasting in the United Kingdom. Below we give the details from that sheet:

| Band | | Frequencies | Service |
|---|---|---|---|
| Low frequency (l.f.) (long waves) | | 160–255kHz (1875–1176m) | a.m. radio |
| Medium frequency (m.f.) (medium waves) | | 525–1605kHz (571–187m) | a.m. radio |
| High frequency (h.f.) (short waves) | | 3950–4000kHz (75-m band)<br>5950–6200kHz (49-m band)<br>7100–7300kHz (41-m band)<br>9500–9775kHz (31-m band)<br>11700–11975kHz (25-m band)<br>15100–15450kHz (19-m band)<br>17700–17900kHz (16-m band)<br>21450–21750kHz (13-m band)<br>25600–26100kHz (11-m band) | a.m. radio |
| Band I | (v.h.f.) | 41–68MHz (channels 1 to 5) | 405-line television |
| Band II | (v.h.f.) | 88–97·6MHz | f.m. radio |
| Band III | (v.h.f.) | 174–216MHz (channels 6 to 13) | 405-line television |
| Band IV | (u.h.f.) | 470–582MHz (channels 21 to 34) | 625-line television |
| Band V | (u.h.f.) | 614–854MHz (channels 39 to 68) | 625-line television |
| Band VI | (s.h.f.) | 11700–12500MHz (11·7–12·5GHz) | Not yet in use for broadcasting |

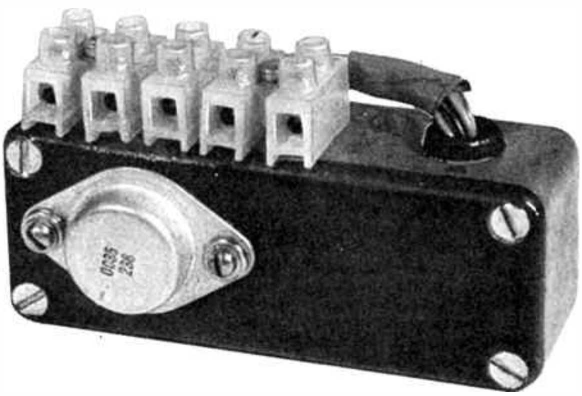



# A VARIABLE TIME SWEEP WINDSCREEN WIPER

P. S. COLLINS

IMAGINE the situation: you are driving your car in drizzly rain, you put on the windscreen wiper. One sweep is sufficient, so you switch it off. Five, ten or fifteen seconds later the windscreen needs another wipe, so you switch on the wiper again for another single stroke. This could go on for some time and tends to be wearisome.

The circuit here described saves this tiresome routine and allows you to relax in the automation of a variable time-sweep wiper. Although the circuit is designed for wiper motors with automatic parking facility, there is some information at the end of the article which will be helpful to those who have wiper motors without this facility.



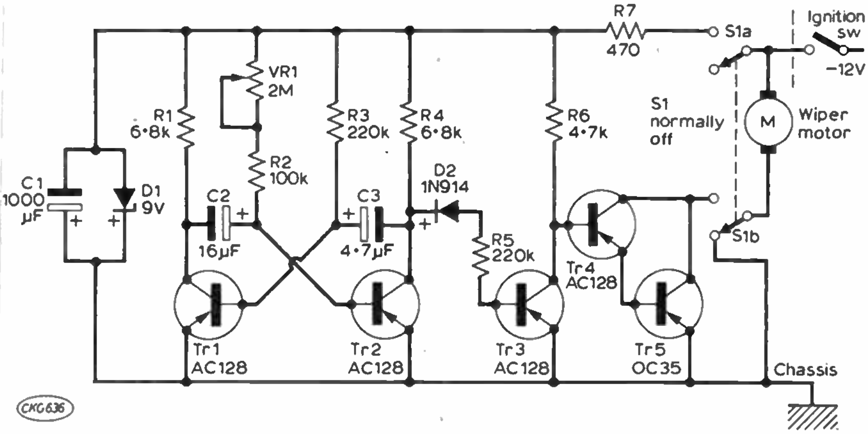
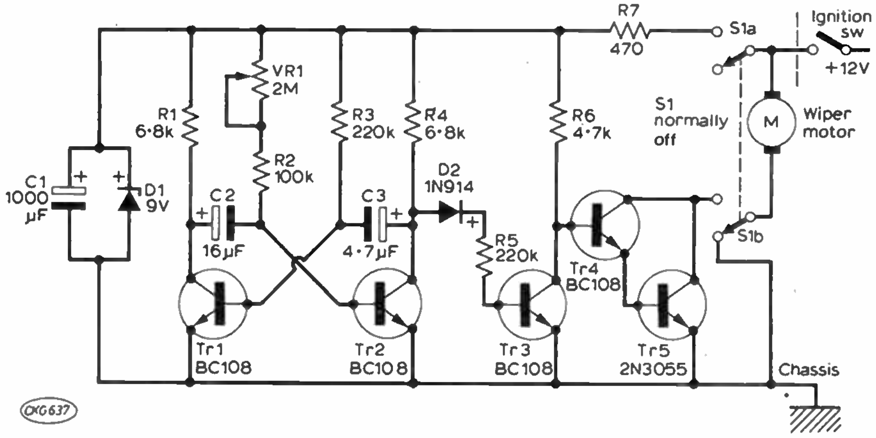



*Fig. 1. Circuit of the Quickwipe for a vehicle with a* **POSITIVE** *earth system. It is essential to be quite sure which side of the battery is connected to chassis.*

*Fig. 2. In this circuit for a* **NEGATIVE** *earth system, different transistors are used and capacitors and diodes are reversed compared to those in Fig. 1.*



Figures 1 and 2 are the circuits for positive and negative earthed vehicles; the difference lies only with the active components and reverse connection of the polarised ones. The circuit action remains the same. Tr1 and Tr2 form a multivibrator generating a pulse of fixed length with a variable repetition rate. VR1 allows this rate to be varied between approximately 3 and 30 seconds. Tr3, 4 and 5 form a pulse amplifier to drive the wiper motor.

The fixed pulse length is $\frac{3}{4}$ second which is sufficient time to drive the motor long enough for its internal switches to take over the drive and thus return it to the park position. Switch S1 is centre off. One switch, S1b, switches for continuous operation, earth being directly applied to the motor.

In the other position, S1a, applies 12 volts to the circuit and S1b connects the motor as the load for the pulse amplifier. The vehicle wiper switch may now be regarded as redundant, or left in the circuit, as desired.

## CONSTRUCTION

The whole unit can be comfortably housed in a die-cast box measuring $3\frac{1}{2} \times 1\frac{3}{8} \times 1\frac{1}{8}$ in. Figure 3 shows the printed circuit board. Tr5 is mounted on the lid with insulating washer and bushes. All leads from the circuit board and Tr5 are connected to a five-way terminal strip fixed to the side of the box. This enables easy connection to the vehicle's wiring, as shown in Fig. 4.

Confirm the chassis polarity of the vehicle before constructing the unit, then use Fig. 1 OR Fig. 2 as appropriate.

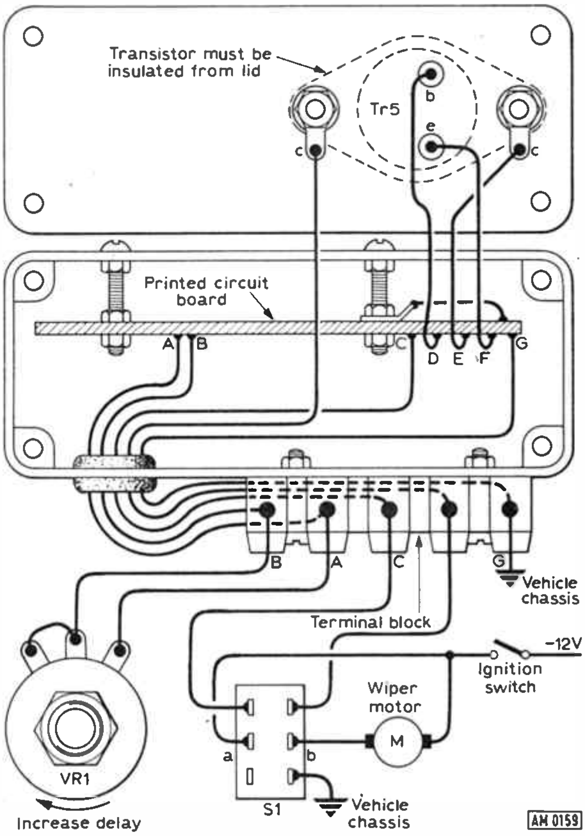
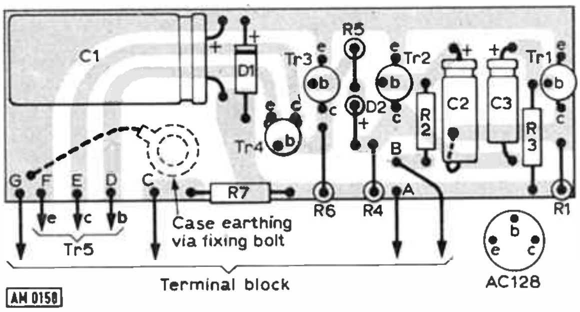
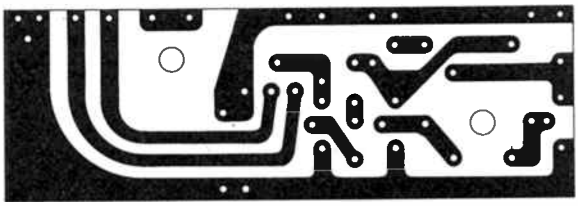
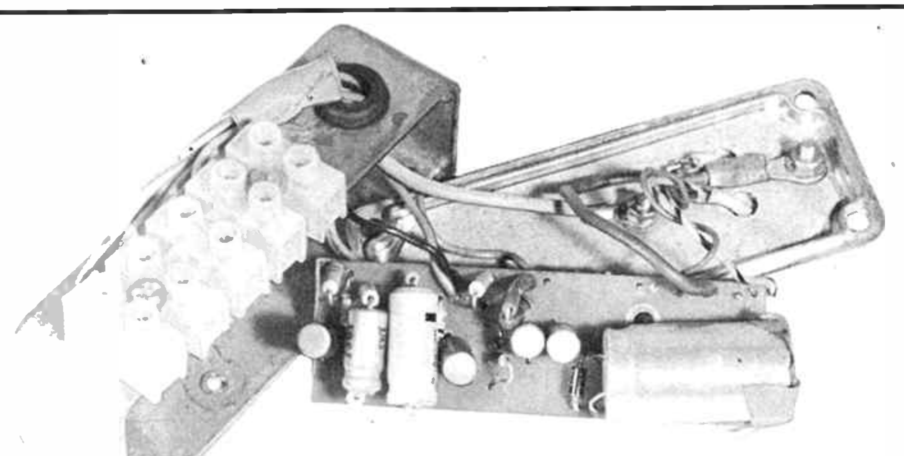



Fig. 3, left, shows PCB actual size and component layout for POSITIVE earth unit. Fig. 4, above, illustrates external wiring of Quickwipe.





Box lid, with output transistor, removed to show PCB which is normally bolted into box, as in Fig. 4.

## ★ components list

**Resistors**

| | | | |
|---|---|---|---|
| R1 | 6·8kΩ | R5 | 220kΩ |
| R2 | 100kΩ | R6 | 4·7kΩ |
| R3 | 220kΩ | R7 | 470Ω |
| R4 | 6·8kΩ | VR1 | 2MΩ linear |

Resistors 10% ¼W except R7 ½W

**Capacitors**
C1 1000μF 25V C2 16μF 16V C3 4·7μF 16V

**Semiconductors**
D1 9V zener 400mW D2 1N914

**Positive Earth** Tr1—4 AC128 Tr5 OC35

**Negative Earth** Tr1—4 BC108 Tr5 2N3055

**Miscellaneous**
S1, Double pole—double throw switch, centre off. Diecast box (RS Comps.—"Box 992"). Printed circuit board. Insulation kit for Tr5. Five way terminal block.

**NOTE:** It may be possible to arrange the fixed pulse length to correspond with the time taken for the wipers to travel one complete sweep, in the case of wipers without the self-park facility. This could be achieved by altering the values of R3 and C3.

These points are offered only as helpful guides. The author has conducted no tests in this regard and cannot therefore give any facts regarding accuracy or success. ■

# PW TECHNICROSS PUZZLE No. 3 Solution

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

# GUIDE TO multi-range test meters

H. LEEMING G3LLL

IT does not seem many years since test meters were so expensive that, in the radio and TV trade, at least, one was shared between several engineers, the losers having to make do with wet fingers and neon screwdrivers! Test meters are now relatively cheap so that no enthusiast or handyman can really afford to be without one; whether it be for attending to the Hi-Fi system, fixing the car, or even sorting out a fault on the front door bell. Despite their simplicity in operation these meters can deceive the unwary and so it is hoped that a little basic theory will be of practical assistance.

The multi-range test meter commonly contains ranges such as AC and DC voltage, DC current and at least one resistance range. Other functions may be included on the more elaborate instruments but all use the basic meter movement plus the switching of various internal components in or out of circuit.

## The DC Voltmeter

The meter movement fitted to most modern test instruments needs a current of something in the range of 1 to 1/100 of a milliamp to move a pointer across the full extent of the scale. The theoretical circuit of the basic meter movement is shown in Fig. 1. The "internal resistance" is not an actual resistor, but is the resistance of the coil of wire in the meter movement. From Ohm's Law, (voltage = current × resistance) this 1mA meter movement shown will require a voltage of 0·1 volt for full scale deflection, (1/1,000 × 100/1 = 0·1 volt). This basic meter could therefore be used to measure voltages of up to 0·1 volt or currents of up to 1 milliamp—not very useful!

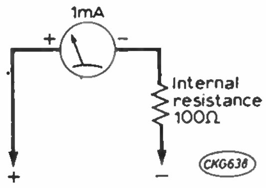



*Fig. 1: Representation of meter movement must include resistance of moving coil.*

The meter movement is basically a current operated device, but it can be made to read various quantities. A little thought will show that a 1mA meter movement will read full scale if 1 volt is applied to it through a series resistance which, including internal resistance, totals 1,000 ohms. From Ohm's Law, 1 volt across 1,000 ohms causes a current of 1mA to pass. A voltmeter using a 1mA meter movement is said to have a sensitivity of 1000 ohms per volt.

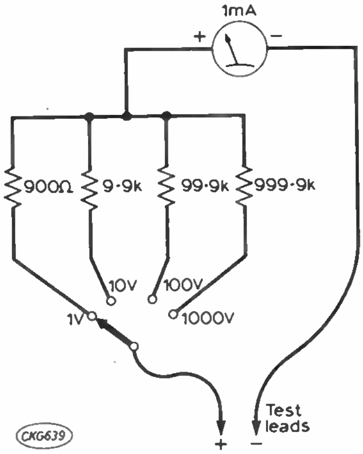



*Fig. 2: Series resistors for voltmeter allow for coil resistance. Only of importance on lower ranges.*

Fig. 2 shows the meter wired to read four ranges of voltage and it will be seen that the total resistance of the meter is 1,000 ohms for every volt of the range in question. For this reason it is referred to as 1,000 OPV and this would usually be marked on the meter scale.

Such a meter does have its disadvantages and its relatively low resistance can greatly affect circuit voltages as will be shown. In Fig. 3a two 1 ohm resistors are connected across the supply and the voltage between X and Y is measured. If the meter is switched to the 1 volt range it has a total resistance of 1,000 ohms (remember 1,000 OPV) this resistance being shunted across R2. As the meter resistance is very high, compared to R1 and R2, its effect is negligible and the reading is given accurately as 0·5 volts. If, however, the meter is transferred to the circuit in Fig. 3b and another reading is taken the resulting accuracy is quite different. Once again, the reading should be 0·5 volts, but note what happens when the meter is connected across R2. R2 is shunted by the meter's resistance of 1,000 ohms and the resistance of the bottom half of the circuit drops to around 900 ohms. The voltage divides itself according to the ratio of the resistors and the meter reads just below 0·1 volts.

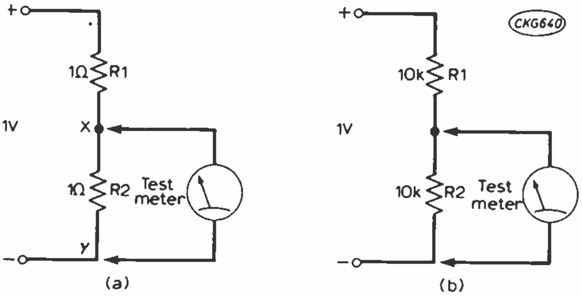



*Fig. 3 (a) and (b): to demonstrate effect of meter resistance on high and low resistance circuits.*

The meter is not really wrong, it simply reads the voltage that is present when it is connected. Using the same meter a more accurate reading could be taken by switching to the 10 volt range when the test meter's resistance would rise to 10,000 ohms; the meter's resistance in parallel with R2 would then total 5,000 ohms and whilst the voltage reading would still be low at 0·33 instead of 0·5, it would be a little more realistic. Could we take the same argument further and switch to the 100 volt range with a meter resistance totalling 100,000 ohms, and obtain an accurate result? Unfortunately, no, since when the meter was switched to this range the pointer would move so little that we would not be able to take an accurate reading from it.

If we want a more accurate reading in a high resistance circuit the answer is a more sensitive meter movement that will allow us to insert larger values of voltage multiplier resistors. If for instance, we substitute a meter with a 50 micro-amp movement, (0·05mA), we will obtain a sensitivity of 20,000 OPV. Using circuit Fig. 3b we would then obtain, on the 1 volt range, a reading that was almost correct, (20,000 ohms being shunted across R2), or by switching to the 10 volt range using this higher sensitivity meter we would obtain a reading that was accurate to within all normal requirements.

As has been illustrated, the DC voltmeter can only read the voltage which is present when it is connected. It cannot guess at the voltage which appears when it is disconnected. When using a voltmeter one should get into the habit of comparing the resistance of the range being used with the resistance of the circuit being measured.

In many cases when operating in a high resistance circuit a more accurate reading will be obtained if a higher voltage range is used. If in doubt a reading should be taken on two adjacent ranges of the test meter. With any good quality instrument these readings should be about the same, but if they are not it implies that the meter is loading the circuit on the lower voltage range.

## Valved or Transistorised Voltmeters

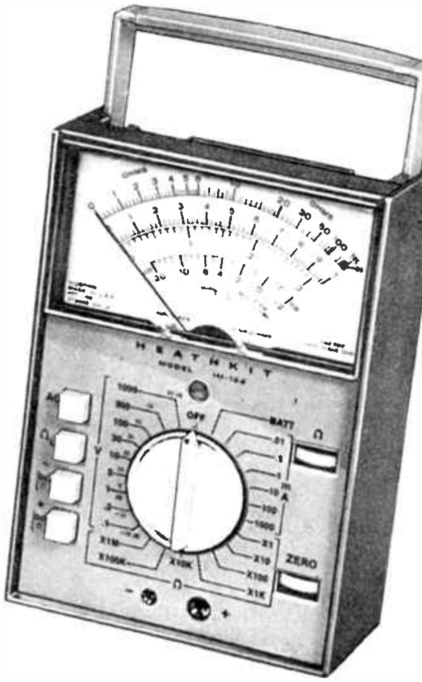
To obtain higher sensitivities using normal techniques requires very expensive and delicate meter movements. It is not common practice, therefore, to make multi-range test meters with a sensitivity of much over 50,000 OPV. In some circumstances an even higher sensitivity is required, so that test meters of as high a sensitivity as this would be of little use at measuring, say, 0·1 volts in a circuit with resistance of several megohms. To enable higher sensitivities to be obtained, the valve and then the transistorised voltmeter were introduced. In these devices amplification is used so that an input resistance of 10 megohms or more is presented, even on the lowest voltage ranges. Such instruments are essential if tests are to be made in some high impedance transistorised circuits where very small voltages are present.

## Frequency Response

Most test meters are basically intended for making tests at the mains frequency and their accuracy often falls off at frequencies in the audio range. One should check the frequency response of a test meter before relying upon it to check audio or bias frequency voltages. In the latter case it should be remembered that high frequency bias voltages can damage the rectifier in some test meters, and also that even if the meter's frequency response is adequate that its loading (possibly only a few hundred OPV) can, in many circuits, much reduce any voltage present. If it is desired to accurately measure voltages at high audio or radio frequencies the valve or transistorised voltmeter is again essential.

## The AC Voltmeter

The AC ranges of multi-range test meter function in very much the same way as the DC ranges except that a rectifier is incorporated to enable the basic DC meter movement to function, see Fig. 4. As with the DC voltage section of the meter, the amount of loading on the circuit being tested is indicated by the sensitivity in ohms-per-volt. Rectifiers have a tendency to be non-linear at low current




*The Heathkit IM-104 mu timeter, a modern design providing 53 ranges on four scales. Frequency response up to 50kHz on AC voltage ranges. Input resistance of 10 MΩ on DC voltage ranges.*
*(Courtesy Heath (Glos.) Ltd.)*

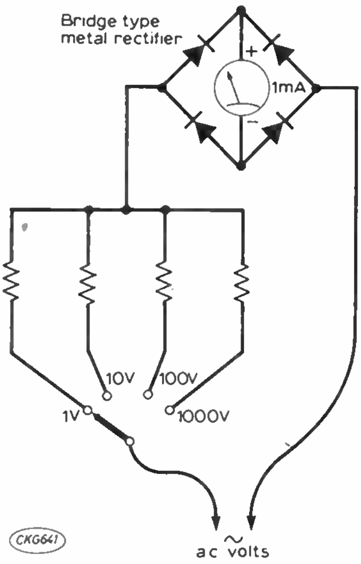



*Fig. 4: Incorporation of meter bridge rectifier on AC voltage ranges.*

levels and so, in the interest of accuracy, it is common to reduce the sensitivity of the test meter when switched to the AC ranges. The popular Avo Model 8, for instance, has a sensitivity of 20,000 OPV on the DC ranges but only 1,000 OPV on the AC ranges.

## The Direct Current Ranges

The basic DC meter movement, as we have seen, will reach full scale when a small current is passed through it. The example shown in Fig. 1 needed 1mA for full scale deflection. If it is desired to measure a larger current, some of the current must be by-passed. The circuit with various resistors which are known as "shunts" is shown in Fig. 5. The value of shunt resistor R3, for instance, is calculated so that when the test meter is measuring 1A, 999 milliamps go via R3 and 1mA passes through the meter.

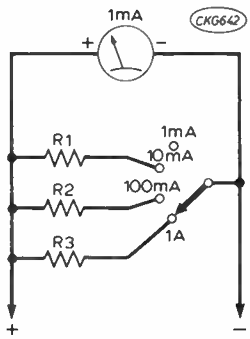



*Fig. 5: Switchable shunts to increase current range of basic meter.*

It is important to note that when measuring current, some voltage is required to operate the meter, as was shown earlier, when dealing with the DC voltmeter. In this case 0·1 volts will be dropped across the meter terminals. In most cases when making measurements, as in Fig. 6a, this small voltage drop will make negligible difference, being small in relation to the voltages in the circuit. If we try to make a test as shown in Fig. 6b however,

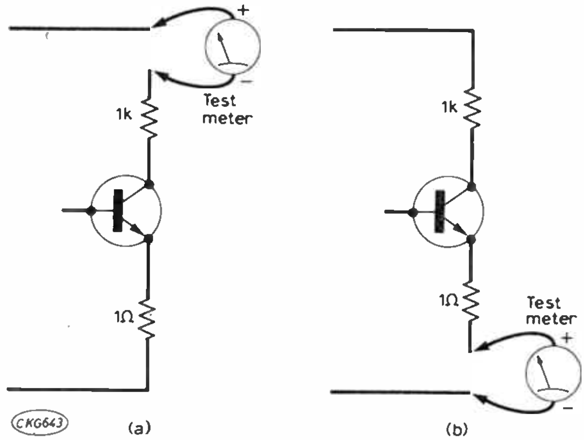


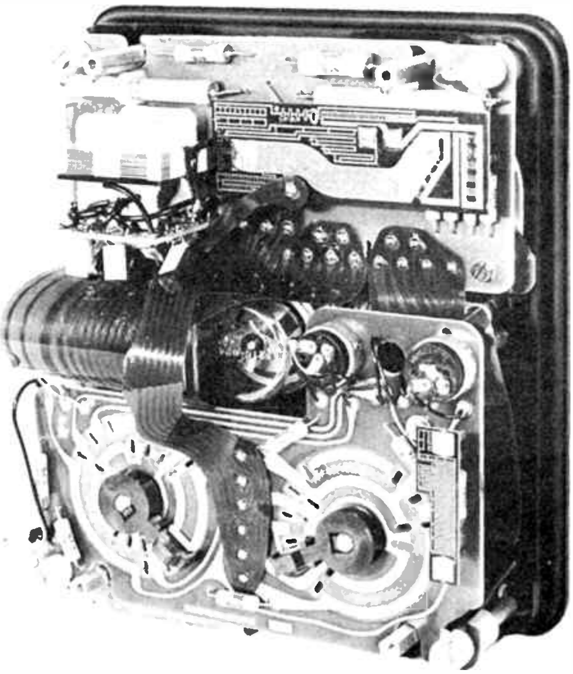

*Fig. 6 (a) Correct and (b) incorrect method of inserting meter in transistor circuit.*

this is not the case. Here the effect of adding the meter in series with the circuit is to considerably increase the value of the emitter resistor. Increasing this effective value would mean that the current which flowed with the test meter connected would be much less than the current which normally flowed in the circuit.

When checking current flow in low impedance circuits, it is better to measure the voltage across a known resistor and then to calculate the current.

## The Resistance Ranges

Figure 7 shows a basic method of resistance measurement. If the test prods are touched together R2 can be adjusted until the meter reads full scale, the current being provided by the battery. As we have seen a 1mA meter when used as a voltmeter



*An excellent view of the latest AVO Model 8. It uses printed circuit techniques for shunts and switchboards.* (Courtesy AVO Ltd. Dover) has a sensitivity of 1,000 OPV and here, if the battery is exactly 1·5V, R1 plus R2, plus internal resistance must equal 1,500 ohms, when R2 is set to provide full scale deflection with the test prods touching. If now, instead of touching the test prods together, we connect them to a resistor being tested, of 1,500 ohms, the meter will then read half-scale as an external resistor of the same value as the built-in resistance has been added to the circuit. The centre of the scale would be marked 1,500 ohms and with suitable calibration resistors of between, say, 50 and 50,000 ohms, resistors could be checked using this set-up, with reasonable accuracy.

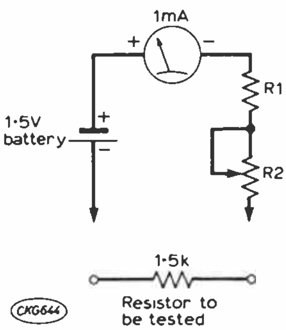



*Fig. 7: Basic circuit for measuring resistance.*

To divide the range by 10 we can shunt the meter as was done on the current ranges so that the sensitivity of the circuit becomes 100 OPV, enabling R1 and R2 to be reduced to 1/10 of their previous value. Alternatively, we can multiply the range by 10 by fitting a 15V battery and increasing R1 and R2 tenfold. In this way we obtain a meter with a centre scale range of 150, 1,500 and 15,000 ohms on three ranges enabling resistors from below 10 to above 500,000 ohms to be checked with good accuracy.


*A large, clear scale with an anti-parallax mirror is the highlight of the latest AVO.*

## Use of Ohms Range

From the above discussion it will be seen that a current is passed through the component to be tested and that a voltage is also applied across it. In most cases this will do no harm, but it is wise to be aware that voltages of up to 25 or so are possible on the high resistance ranges and that currents in the order of 100mA or more may be found on the low ohms ranges of some test meters. When checking circuits where there is the slightest risk of damage being caused, it is wise to avoid using the highest or lowest ohms range on the test meter and to concentrate tests on the range which applies low voltage and low current. If magnetic devices, such as tape heads, are tested, note that they will be magnetised by the meter current. These tests should not be made, therefore, unless a defluxer is available to remove the residual magnetism.

It should be noted that no checks of resistance can be made unless the circuit which is being tested,

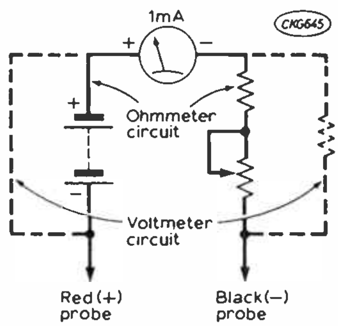



*Fig. 8: Illustration of reverse polarity of probes in an ohmmeter circuit.*

is completely dead. All voltage sources should therefore be disconnected before tests take place, as, quite apart from giving the wrong results, severe damage can be caused to the test meter and equipment if resistance tests are attempted on live circuits. Devices such as transistors, diodes and electrolytic capacitors are inherently polarity sensitive so the polarity of the voltage output of the test meter should be noted whilst making tests on these devices. As will be seen from Fig. 8 using normal circuit arrangements the polarity of the test prods is normally **opposite** on the ohms range to that marked on the meter for the voltage and current ranges.

## Decibels

Many test meters have a scale marked in decibels marked in + and − values over a total of 15dB's or so. It must be clearly understood that the decibel is **not** an absolute value, such as the ohm or volt, but, as will be seen from the shape of the dB scale, is a logarithmically based system of comparison. Whilst many test meters are calibrated so that 0dB = 0·775V this is just an abitrary figure. In practical use, such as measuring the frequency response of an amplifier, the signal level is adjusted so that the output when measured with the test meter set to a suitable range, reads 0dB. If the input frequency is then varied the output variation, and hence the frequency response of the equipment being tested, can be read off directly in decibels.

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| ECC82 | 0·48 |
| ECC83 | 0·45 |
| ECC84 | 0·55 |
| ECC85 | 0·58 |
| ECC88 | 0·75 |
| ECC189 | 0·71 |
| ECF80 | 0·56 |
| ECF82 | 0·78 |
| ECF86 | 0·71 |
| ECH81 | 1·00 |
| ECH83 | 1·00 |
| ECH84 | 0·78 |
| ECL80 | 0·53 |
| ECL82 | 0·61 |
| ECL83 | 0·68 |
| ECL86 | 0·63 |

| | |
|---|---|
| EF80 | 0·46 |
| EF83 | 1·03 |
| EF85 | 0·43 |
| EF86 | 0·90 |
| EF89 | 0·81 |
| EF91 | 1·30 |
| EF92 | 1·40 |
| EF95 | 1·35 |
| EF183 | 0·60 |
| EF184 | 0·60 |
| EH90 | 0·56 |
| EL34 | 0·95 |
| EL36 | 1·05 |
| EL81 | 0·90 |
| EL84 | 0·47 |
| EL85 | 0·55 |
| EL86 | 0·95 |
| EL95 | 0·70 |
| EL91 | 1·81 |
| ELL80 | 1·30 |
| EM84 | 1·18 |
| EM87 | 1·18 |
| EY51 | 0·88 |
| EY86/87 | 0·42 |
| EY88 | 0·64 |
| EZ80 | 0·51 |
| EZ81 | 0·40 |
| GY501 | 0·90 |
| GZ34 | 0·78 |

| | |
|---|---|
| PC86 | 0·75 |
| PC88 | 0·75 |
| PC97 | 0·45 |
| PC900 | 0·56 |
| PCC84 | 0·52 |
| PCC88 | 0·80 |
| PCC89 | 0·65 |
| PCC189 | 0·65 |
| PCF80 | 0·51 |
| PCF82 | 1·80 |
| PCF86 | 0·65 |
| PCF200 | 0·85 |
| PCF201 | 0·87 |
| PCF801 | 0·65 |
| PCF802 | 0·71 |
| PCF806 | 0·66 |
| PCH200 | 0·88 |
| PCL82 | 0·54 |
| PCL83 | 0·66 |
| PCL84 | 0·59 |
| PCL85 | 0·63 |
| PCL86 | 0·63 |
| PCL805/85 | 0·63 |
| PD500 | 1·55 |
| PFL200 | 0·80 |
| PL36 | 0·88 |
| PL81 | 0·75 |
| PL81A | 0·88 |
| PL82 | 0·50 |
| PL83 | 0·96 |

| | |
|---|---|
| PL84 | 0·66 |
| PL504 | 0·88 |
| PL508 | 1·05 |
| PL509 | 1·55 |
| PL802 | 0·96 |
| PY33 | 0·66 |
| PY81/800 | 0·50 |
| PY82 | 0·55 |
| PY88 | 0·60 |
| PY500A | 1·05 |
| PY800 | 0·50 |
| PY801 | 0·50 |
| U26 | 1·00 |
| U191 | 1·00 |
| U193 | 0·50 |
| UABC80 | 0·90 |
| UBC81 | 0·70 |
| UBF89 | 0·60 |
| UCC85 | 0·60 |
| UCH81 | 1·00 |
| UCL82 | 0·70 |
| UCL83 | 0·70 |
| UF89 | 0·80 |
| UL84 | 0·95 |
| UY85 | 0·50 |
| 6/30L2/ECC804 | 1·00 |
| 6F23/EF812 | 1·05 |
| 30C1/PCF80 | 0·51 |

| | |
|---|---|
| 30C15/PCF800 | 1·05 |
| 30C17 | 1·00 |
| 30C18/PCF805 | 0·90 |
| 30F5/PF818 | 1·10 |
| 30FL1/PCE800 | 0·75 |
| 30FL2 | 0·75 |
| 30FL12 | 1·05 |
| 30FL14 | 0·85 |
| 30L1/PCC84 | 0·52 |
| 30L15/PCC805 | 1·05 |
| 30L17 | 0·90 |
| 30P4MR | 1·30 |
| 30P12/PC801 | 1·05 |
| 30P19/PC802 | 1·00 |
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| DF91 | 0·30 |
| DF96 | 0·50 |
| DK91 | 0·45 |
| DK92 | 0·70 |
| DK96 | 0·60 |
| DL92 | 0·40 |
| DL94 | 0·48 |
| DL96 | 0·55 |
| DY86/7 | 0·36 |
| DY802 | 0·37 |
| EABC80 | 0·38 |
| EAF42 | 0·75 |
| EB91 | 0·22 |
| EBC33 | 1·00 |
| EBC41 | 0·75 |
| EBC81 | 0·33 |
| EBF80 | 0·40 |
| EBF83 | 0·40 |
| EBF89 | 0·32 |
| EBL31 | 1·50 |
| ECC81 | 0·40 |
| ECC82 | 0·33 |
| ECC83 | 0·33 |
| ECC84 | 0·30 |
| ECC85 | 0·40 |
| ECC88 | 0·40 |
| ECH35 | 1·25 |
| ECH42 | 1·00 |
| ECH81 | 0·30 |
| ECH83 | 0·45 |
| ECL80 | 0·55 |
| ECL82 | 0·35 |
| ECL83 | 0·70 |
| ECL86 | 0·40 |
| ECLL800 | 3·20 |
| EF37A | 1·20 |
| EF39 | 1·20 |

| | |
|---|---|
| EF80 | 0·25 |
| EF85 | 0·35 |
| EF86 | 0·30 |
| EF89 | 0·28 |
| EF91 | 0·37 |
| EF92 | 0·50 |
| EF95 | 0·40 |
| EF98 | 0·75 |
| EF183 | 0·30 |
| EF184 | 0·35 |
| EL32 | 0·60 |
| EL33 | 1·75 |
| EL34 | 0·50 |
| EL36 | 0·50 |
| EL37 | 2·50 |
| EL41 | 0·90 |
| EL42 | 0·90 |
| EL84 | 0·28 |
| EL95 | 0·40 |
| ELL80 | 1·00 |
| EM80 | 0·45 |
| EM81 | 0·60 |
| EM84 | 0·35 |
| EM85 | 1·00 |
| EY51 | 0·40 |
| EY86 | 0·40 |
| EZ40 | 0·75 |
| EZ41 | 0·75 |
| EZ80 | 0·28 |
| EZ81 | 0·29 |
| GY501 | 0·80 |
| GZ30 | 0·45 |
| GZ32 | 0·50 |
| GZ34 | 0·65 |
| GZ37 | 1·25 |
| HN309 | 1·50 |
| KT61 | 1·75 |
| KT66 | 2·50 |
| KT81 (7C5) | 1·30 |
| KT81 | 1·75 |
| KT88 | 2·90 |
| KTW61 | 1·00 |
| MU14 | 1·00 |
| N78 | 2·75 |

| | |
|---|---|
| PC86 | 0·60 |
| PC88 | 0·60 |
| PC97 | 0·50 |
| PC900 | 0·48 |
| PCC84 | 0·40 |
| PCC88 | 0·55 |
| PCC89 | 0·50 |
| PCC189 | 0·60 |
| PCF80 | 0·30 |
| PCF82 | 0·35 |
| PCF86 | 0·60 |
| PCF801 | 0·50 |
| PCF802 | 0·50 |
| PCF805 | 0·90 |
| PCF806 | 0·75 |
| PCF808 | 0·90 |
| PCL82 | 0·35 |
| PCL83 | 0·66 |
| PCL84 | 0·45 |
| PCL85 | 0·50 |
| PCL86 | 0·45 |
| PCL805/85 | 0·50 |
| PD500 | 1·80 |
| PEN45 | 0·75 |
| PL36 | 0·55 |
| PL81 | 0·50 |
| PL82 | 0·45 |
| PL83 | 0·45 |
| PL84 | 0·40 |
| PL500 | 0·75 |
| PL504 | 0·75 |
| PL508 | 0·90 |
| PL509 | 1·55 |
| PL802 | 0·95 |
| PX4 | 3·50 |
| PX25 | 3·50 |
| PY33 | 0·63 |
| PY81 | 0·30 |
| PY82 | 0·35 |
| PY83 | 0·38 |
| PY88 | 0·40 |
| PY500 | 1·00 |
| PY81/800 | 0·50 |
| PY801 | 0·50 |

| | |
|---|---|
| SP41 | 3·00 |
| SP61 | 0·75 |
| T41 | 1·00 |
| U14 | 1·00 |
| U25 | 0·85 |
| U26 | 0·85 |
| U191 | 0·75 |
| UABC80 | 0·40 |
| UAF42 | 0·75 |
| UBC41 | 0·75 |
| UBC81 | 0·45 |
| UBF80 | 0·40 |
| UBF89 | 0·40 |
| UCC85 | 0·45 |
| UCH42 | 0·75 |
| UCH81 | 0·40 |
| UCL82 | 0·35 |
| UCL83 | 0·70 |
| UF41 | 0·75 |
| UF89 | 0·40 |
| UL41 | 0·85 |
| UL84 | 0·43 |
| UY41 | 0·48 |
| UY85 | 0·40 |
| VR105-30 | 0·40 |
| VR150-30 | 0·40 |
| OA2 | 0·40 |
| OB2 | 0·40 |
| 1R5 | 0·45 |
| 1S5 | 0·30 |
| 1T4 | 0·30 |
| 3S4 | 0·40 |
| 3V4 | 0·70 |
| 5R4GY | 0·80 |
| 5U4G | 0·40 |
| 5V4G | 0·50 |
| 5Y3GT | 0·45 |
| 5Z4G | 0·45 |
| 6/30L2 | 0·90 |
| 6AK5 | 0·40 |
| 6AM5 | 0·90 |
| 6AQ5 | 0·45 |
| 6AS7G | 0·85 |
| 6AT6 | 0·45 |
| 6AU6 | 0·30 |
| 6BA6 | 0·28 |
| 6BE6 | 0·35 |
| 6BH6 | 0·75 |
| 6BJ6 | 0·55 |
| 6BQ7A | 0·55 |
| 6BR7 | 1·00 |
| 6BS7 | 1·35 |
| 6BW6 | 0·90 |
| 6BW7 | 0·90 |
| 6C4 | 0·35 |
| 6CD6G | 1·30 |
| 6CH6 | 1·40 |
| 6CW4 | 1·00 |
| 6F23 | 1·05 |
| 6F25 | 1·00 |
| 6F28 | 0·70 |
| 6J5M | 0·65 |
| 6J5G | 0·45 |

| | |
|---|---|
| 6J6 | 0·30 |
| 6J7M | 0·45 |
| 6J7G | 0·40 |
| 6K6GT | 0·75 |
| 6K7M | 0·45 |
| 6K7G | 0·30 |
| 6K8M | 0·70 |
| 6K8G | 0·45 |
| 6K25 | 0·75 |
| 6L6G | 0·55 |
| 6Q7M | 0·50 |
| 6Q7G | 0·50 |
| 6SL7GT | 0·48 |
| 6SN7GT | 0·48 |
| 6SQ7GT | 0·50 |
| 6U5G | 0·75 |
| 6V6G | 0·40 |
| 6V6GT | 0·45 |
| 6X4 | 0·40 |
| 6X5G | 0·40 |
| 6X5GT | 0·45 |
| 7B6 | 0·75 |
| 7B7 | 0·70 |
| 7C5 | 1·30 |
| 7C6 | 0·75 |
| 7H7 | 0·70 |
| 7R7 | 0·75 |
| 7S7 | 2·25 |
| 7Y4 | 0·75 |
| 12AT6 | 0·40 |
| 12AT7 | 0·40 |
| 12AU6 | 0·45 |
| 12AU7 | 0·33 |
| 12AX7 | 0·33 |
| 12BA6 | 0·45 |
| 12BE6 | 0·50 |
| 30C1 | 0·30 |
| 30C15 | 1·05 |
| 30C17 | 1·10 |
| 30C18 | 0·90 |
| 30F5 | 1·10 |
| 30FL1 | 0·80 |
| 30FL2 | 0·75 |
| 30FL14 | 0·90 |
| 30L15 | 1·05 |
| 30L17 | 0·95 |
| 30P4MR | 1·30 |
| 30P12 | 1·05 |
| 30P19 | 1·00 |
| 30PL1 | 0·95 |
| 30PL13 | 1·20 |
| 30PL14 | 1·25 |
| 35W4 | 0·50 |
| 35Z4GT | 0·70 |
| 50CD6G | 1·20 |
| 807 | 0·50 |
| 813 ITT | £13 |
| 813 USSR | £5·75 |
| 866A | 1·00 |

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| | |
|---|---|
| AA119 | 0·7 |
| AAZ13 | 0.10 |
| AAZ15 | 0·10 |
| AC107 | 0·35 |
| AC126 | 0·25 |
| AC127 | 0·25 |
| AC128 | 0·20 |
| AC176 | 0·25 |
| AC187 | 0·20 |
| AC188 | 0·20 |
| ACY21 | 0·22 |
| ACY39 | 0·65 |
| AD140 | 0·50 |
| AD149 | 0·50 |
| AD161 | 0·39 |
| AD162 | 0·39 |
| AF115 | 0·25 |
| AF116 | 0·25 |
| AF117 | 0·20 |
| AF186 | 0·40 |
| AF239 | 0·44 |
| ASY27 | 0·30 |
| ASY28 | 0·25 |
| BA102 | 0·25 |
| BA115 | 0·10 |
| BC107 | 0·12 |
| BC108 | 0·12 |
| BC109 | 0·12 |
| BC113 | 0·16 |
| BC117 | 0·21 |
| BC143 | 0·30 |
| BC147 | 0·12 |
| BC148 | 0·10 |
| BC169C | 0·14 |
| BC182 | 0·12 |
| BC182L | 0·12 |
| BC184L | 0·13 |
| BCY32 | 1·20 |
| BCY33 | 0·38 |
| BCY34 | 0·45 |
| BCY70 | 0·15 |
| BCY71 | 0·20 |
| BCY72 | 0·15 |
| BCZ11 | 0·65 |
| BD121 | 1·00 |
| BD124 | 0·80 |
| BD131 | 0·45 |

| | |
|---|---|
| BD132 | 0·50 |
| BF115 | 0·22 |
| BF167 | 0·25 |
| BF173 | 0·28 |
| BF179 | 0·33 |
| BF180 | 0·35 |
| BF181 | 0·35 |
| BF194 | 0·13 |
| BF195 | 0·13 |
| BF197 | 0·15 |
| BF200 | 0·32 |
| BFS61 | 0·25 |
| BFS98 | 0·25 |
| BFX29 | 0·28 |
| BFX88 | 0·22 |
| BFY50 | 0·20 |
| BFY51 | 0·20 |
| BFY52 | 0·20 |
| BFW10 | 0·61 |
| BY100 | 0·15 |
| BY126 | 0·14 |
| BY127 | 0·15 |
| BZX61 series | 0·20 |
| BZY88 series | 0·10 |
| CRS1-05 | 0·30 |
| CRS1-40 | 0·45 |
| CRS3-05 | 0·40 |
| CRS3-40 | 0·55 |
| MJE340 | 0·50 |
| MJE370 | 0·68 |
| MJE520 | 0·65 |
| MJE2955 | 1·10 |
| MJE3055 | 0·75 |
| MPF102 | 0·40 |
| MPF103 | 0·36 |
| MPF104 | 0·35 |
| MPF105 | 0·46 |
| NKT404 | 0·60 |
| OA5 | 0·60 |
| OA10 | 0·40 |
| OA79 | 0·10 |
| OA81 | 0·10 |
| OA91 | 0·7 |
| OA200 | 0·08 |
| OA202 | 0·10 |

| | |
|---|---|
| OC16 | 1·00 |
| OC20 | 2·00 |
| OC23 | 1·25 |
| OC25 | 0·40 |
| OC28 | 0·70 |
| OC35 | 0·55 |
| OC36 | 0·65 |
| OC42 | 0·40 |
| OC44 | 0·18 |
| OC45 | 0·18 |
| OC71 | 0·15 |
| OC72 | 0·25 |
| OC76 | 0·30 |
| OC77 | 0·55 |
| OC81 | 0·28 |
| OC81D | 0·28 |
| OC81Z | 0·45 |
| OC83 | 0·25 |
| OC140 | 0·65 |
| OC170 | 0·25 |
| OC171 | 0·30 |
| OC200 | 0·55 |
| OC201 | 0·80 |
| OC202 | 0·90 |
| OC203 | 0·55 |
| OCP71 | 1·00 |
| ORP12 | 0·55 |
| ORP60 | 0·45 |
| T1005 | 0·20 |
| TIC44 | 0·29 |
| TIC226D | 1·50 |
| TIL209 | 0·25 |
| TIS43 | 0·26 |
| ZTX107 | 0·12 |
| ZTX108 | 0·10 |
| ZTX300 | 0·14 |
| ZTX301 | 0·14 |
| ZTX302 | 0·20 |
| ZTX304 | 0·24 |

| | |
|---|---|
| ZTX500 | 0·15 |
| ZTX501 | 0·15 |
| ZTX503 | 0·16 |
| ZTX531 | 0·25 |
| ZTX550 | 0·18 |
| 1N914 | 0·06 |
| 1N4001 | 0·6 |
| 1N4002 | 0·7 |
| 1N4003 | 0·8 |
| 1N4004 | 0·8 |
| 1N4005 | 0·10 |
| 1N4006 | 0·12 |
| 1N4007 | 0·12 |
| 1N4009 | 0·06 |
| 1N4148 | 0·06 |
| 1S921 | 0·07 |
| 1S2033 | 0·20 |
| 1S2051A | 0·10 |
| 1S2100A | 0·20 |
| 1S3010 | 0·25 |
| 2N696 | 0·15 |
| 2N697 | 0·15 |
| 2N706 | 0·10 |
| 2N706A | 0·12 |
| 2N1131 | 0·25 |
| 2N1132 | 0·25 |
| 2N1302 | 0·18 |
| 2N1303 | 0·18 |
| 2N1304 | 0·22 |
| 2N1305 | 0·22 |
| 2N1306 | 0·28 |
| 2N1307 | 0·28 |
| 2N1308 | 0·28 |
| 2N1309 | 0·30 |
| 2N1613 | 0·20 |
| 2N1614 | 0·45 |
| 2N2147 | 0·75 |
| 2N2160 | 1·00 |
| 2N2369A | 0·16 |

| | |
|---|---|
| 2N2646 | 0·50 |
| 2N2904 | 0·20 |
| 2N2904A | 0·25 |
| 2N2905 | 0·32 |
| 2N2905A | 0·25 |
| 2N2906 | 0·20 |
| 2N2926 | 0·10 |
| 2N3053 | 0·20 |
| 2N3055 | 0·60 |
| 2N3525 | 0·80 |
| 2N3614 | 0·59 |
| 2N3615 | 0·65 |
| 2N3702 | 0·11 |
| 2N3703 | 0·12 |
| 2N3704 | 0·14 |
| 2N3705 | 0·12 |
| 2N3706 | 0·10 |
| 2N3707 | 0·13 |
| 2N3708 | 0·07 |
| 2N3709 | 0·10 |
| 2N3710 | 0·11 |
| 2N3711 | 0·11 |
| 2N3819 | 0·35 |
| 2N3820 | 0·50 |
| 2N3823 | 0·50 |
| 2N3903 | 0·15 |
| 2N3904 | 0·20 |
| 2N3905 | 0·25 |
| 2N3906 | 0·16 |
| 2N4056 | 0·15 |
| 2N4059 | 0·10 |
| 2N4060 | 0·13 |
| 2N4061 | 0·13 |
| 2N4062 | 0·14 |
| 3N141 | 0·81 |
| 40360 | 0·40 |
| 40361 | 0·45 |
| 40362 | 0·40 |
| 40430 | 0·85 |

| | |
|---|---|
| SN7400 | 0·20 |
| SN7401 | 0·20 |
| SN7402 | 0·20 |
| SN7403 | 0·20 |
| SN7404 | 0·20 |
| SN7405 | 0·20 |
| SN7406 | 0·40 |
| SN7407 | 0·40 |
| SN7408 | 0·25 |
| SN7409 | 0·33 |
| SN7410 | 0·20 |
| SN7411 | 0·23 |
| SN7412 | 0·28 |
| SN7413 | 0·30 |
| SN7416 | 0·30 |
| SN7417 | 0·30 |
| SN7420 | 0·20 |
| SN7422 | 0·28 |
| SN7423 | 0·40 |

| | |
|---|---|
| SN7425 | 0·37 |
| SN7427 | 0·37 |
| SN7428 | 0·43 |
| SN7430 | 0·20 |
| SN7432 | 0·37 |
| SN7433 | 0·43 |
| SN7437 | 0·43 |
| SN7438 | 0·43 |
| SN7440 | 0·20 |
| SN7441AN | 0·85 |
| SN7442 | 0·85 |
| SN7450 | 0·20 |
| SN7451 | 0·20 |
| SN7453 | 0·20 |
| SN7454 | 0·20 |
| SN7460 | 0·20 |
| SN7470 | 0·33 |
| SN7472 | 0·38 |

| | |
|---|---|
| SN7473 | 0·44 |
| SN7474 | 0·48 |
| SN7475 | 0·59 |
| SN7476 | 0·45 |
| SN7480 | 0·80 |
| SN7482 | 0·87 |
| SN7483 | 1·20 |
| SN7484 | 1·00 |
| SN7486 | 0·50 |
| SN7490 | 0·75 |
| SN7491AN | 1·10 |
| SN7492 | 0·75 |
| SN7493 | 0·75 |
| SN7494 | 0·85 |
| SN7495 | 0·85 |
| SN7496 | 1·00 |
| SN7497 | 4·32 |
| SN74100 | 2·16 |

| | |
|---|---|
| SN74107 | 0·51 |
| SN74110 | 0·57 |
| SN74111 | 0·86 |
| SN74118 | 1·00 |
| SN74119 | 1·92 |
| SN74121 | 0·57 |
| SN74122 | 0·80 |
| SN74123 | 1·44 |
| SN74141 | 1·00 |
| SN74145 | 1·44 |
| SN74150 | 2·30 |
| SN74151 | 1·15 |
| SN74154 | 2·30 |
| SN74155 | 1·15 |
| SN74156 | 1·15 |

| | |
|---|---|
| SN74157 | 1·09 |
| SN74170 | 2·88 |
| SN74174 | 1·80 |
| SN74175 | 1·29 |
| SN74176 | 1·44 |
| SN74190 | 2·30 |
| SN74191 | 2·30 |
| SN74192 | 2·30 |
| SN74193 | 2·30 |
| SN74194 | 1·72 |
| SN74195 | 1·44 |
| SN74196 | 1·58 |
| SN74197 | 1·58 |
| SN74198 | 3·16 |
| SN74199 | 2·88 |

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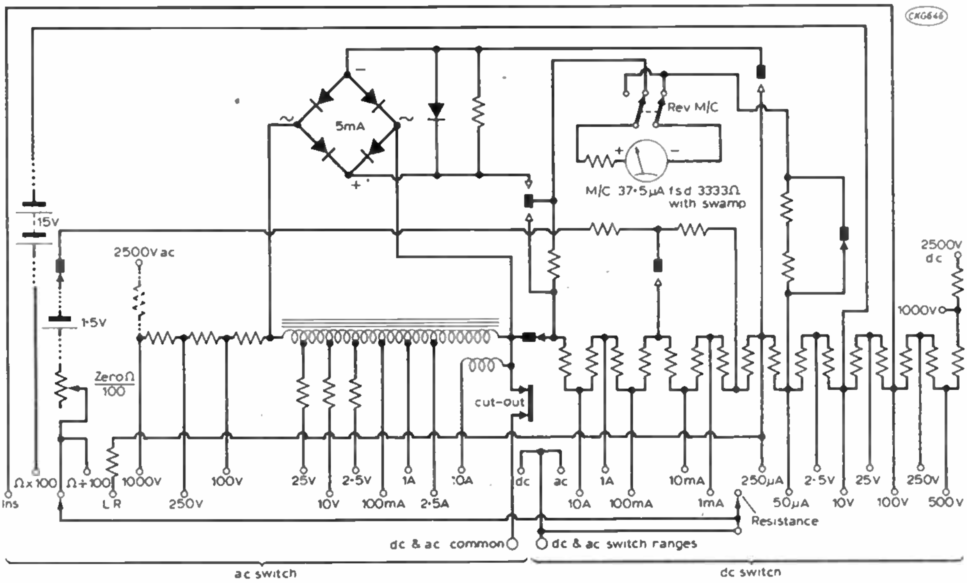



*Fig. 9: Basic circuit of the Model 8 Avometer Mk II to show the complexity of a modern multi-meter* (Courtesy AVO Ltd Dover)

To be really useful in making this kind of test the response of the test meter and the output of the audio generator must be flat with frequency, otherwise one is liable to end up in the position of the wheel-tapper who condemned 100 wheels only to find he had a cracked hammer! Remember, it costs next to nothing to print a decibel scale on a meter but it costs pounds to incorporate the response and accuracy needed to make it really meaningful for even simple audio frequency response measurements.

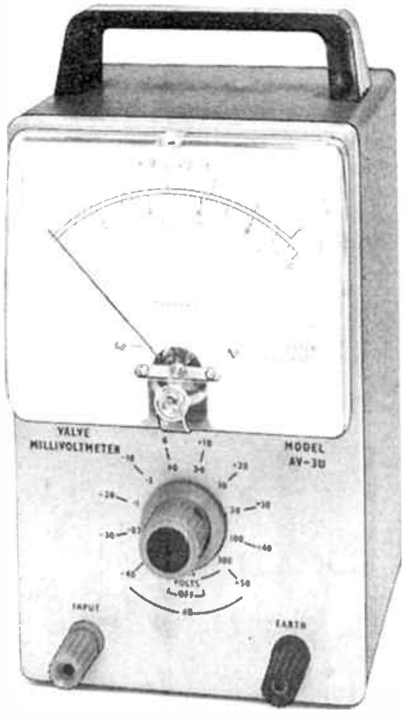
## Precautions in use

Multirange test meters are precision instruments which can easily be damaged by over-loading. Whilst many meters have built-in automatic protection, these circuits only give a limited protection; they do not cater for gross overloads. A moments carelessness can leave an instrument which is beyond economical repair. To avoid disasters follow the makers' instructions, together with the following suggestions:—

1. Always leave the instrument switched to a high voltage range when not in use. Never on a current or ohms range.
2. Never connect meter to any live circuit when switched to ohms.
3. Be extra careful to avoid short circuits when using the current ranges.
4. When measuring unknown voltages or currents switch to the highest range first, and only change over to a lower range if less than, say, one third of full scale deflection is registered.

## Buying a meter

There is a host of small test meters available, many of which should be more than adequate for the average hobbyist. Aim to get a meter which has a sensitivity of 10,000 OPV or more on the DC ranges and which has a scale which is clear to read. A resistance range coverage of from, say, 1 ohm to 2 megohms, will fill most needs. AC current ranges are not really of any great importance, as




*This valve millivoltmeter, type AV-3U, is mains operated and has a sensitivity of 10mV f.s.d. on the lowest range and 300V RMS on top range.* (Courtesy Heath (Glos.) Ltd.)

current can always be calculated from resistance and voltage measurements, but a few DC current ranges will be found useful.

When comparing meters it can be advantageous to take along a battery and a few known values of resistors. There is nothing like a practical test to prove whether readings are plain and straightforward or confused and ambiguous. The cost?—£15 will buy a meter which is likely to be more than good enough but look around and testers costing well under £10, which are by no means cheap and nasty, can be found. ■

# EXPERIMENTAL WORKSHOP

M. J. HUGHES M.A.

## LEARNING BY PRACTICAL PROJECT STEPS

# PART 6—GROUNDED EMITTER AMPLIFIERS

LAST month's emitter followers were all types of current amplifiers. In every case the output voltage was the same, or slightly less than the input voltage. Many applications require voltage amplification—e.g. raising the output level of a microphone to an extent that when current amplification is applied the resultant signal could drive a loudspeaker. The grounded emitter amplifier will provide a reasonable degree of voltage *and* current amplification and is, perhaps, the most used type of amplifier stage in the whole of electronics. Because both voltage *and* current is amplified we call the grounded emitter stage a *power amplifier* but not necessarily in the sense that you can expect several watts of useful output; specialised power stages are better equipped for the latter purpose and these will be covered later in the series.

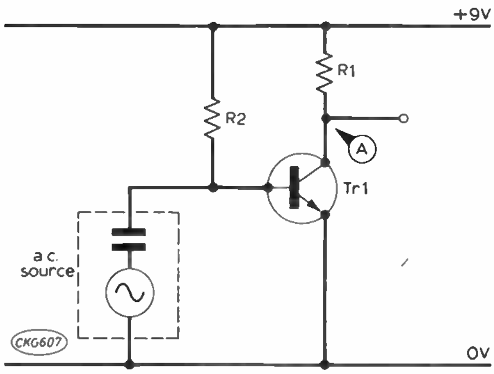



*Fig. 42: It is difficult to predict a value for R2 to set the potential at A to mid-rail unless the $h_{FE}$ for Tr1 is accurately known.*

Referring to Fig. 42, we know that we can make the voltage at point A go to +9V by ensuring that the transistor is cut off (i.e. by passing zero base current) and conversely we can make it fall to zero volts by passing a certain amount of base current through R2. By knowing an accurate value of $h_{FE}$ for the transistor we could calculate a value for R2 that will cause just sufficient collector current to flow that the voltage drop across R1 will be 4·5V. Theoretically we could hold the voltage at A exactly mid-way between the two supply rails. At the same time we could connect a source of voltage through a capacitor to the base of the same transistor and (assuming the source voltage was zero at the time) this would not affect our *bias* condition. However, as soon as we begin to generate a voltage from the source this would cause current to be added or subtracted from the bias current (depending on the polarity of the a.c. signal) and would cause the voltage at A to rise and fall in exact relation—except for the 180° change of phase. Having point A biased "mid rail" allows maximum peak swings of voltage without the transistor clipping (going totally out of conduction) or bottoming (going into saturated conduction) unsymmetrically. In the ideal amplifier the voltage seen at A should faithfully represent that from the source.

In practice the method of obtaining this mid-rail bias shown in Fig. 42 is not very satisfactory because the $h_{FE}$ for the transistor must be accurately known and this can vary widely from one device to another (even though they may be of the same type number).

## Base current

A simple way of compensating for this device variation is to use the potential at A as the voltage source for providing the base current—shown in Fig. 43. If the potential at A is too high the base current will be increased, hence the collector potential falls; conversely if A tends to be too low the base current decreases and the potential at A is forced to rise. By careful selection of component values this feedback bias circuit caters well for quite wide variations in the gains of transistors. It is not perfect by any means but is an improved way of getting a mid rail voltage reliably. You can make up the circuit of Fig. 43 on T Dec and try different BC108 devices. The voltage you measure should not fall outside the range of +3·5 to +5·5V. For those interested it is quite easy to arrive at the component values. First of all assume that the collector load is to be 1kΩ. For the potential at A to be +4·5V (assuming a 9V supply) the drop of 4·5V across R1 will be caused by a collector current of

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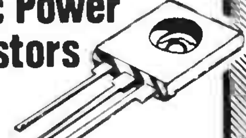

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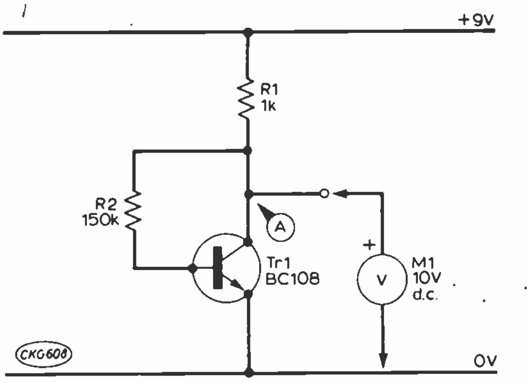



*Fig. 43: Using the potential at A as the driving source for base current helps compensate for variations in $h_{FE}$.*

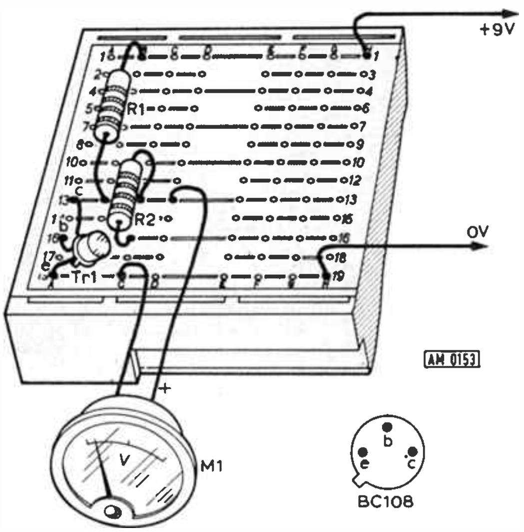



*Fig. 44: Component layout for Fig. 43.*

4·5mA. If we expect an $h_{FE}$ of around 200 for the BC108 this means that the base current needed to cause 4·5mA collector current is 4·5/200 = 0·0225mA. The value of R2, to give this current is calculated from the potential difference across it (potential at A minus the 0·6V base emitter drop) divided by the base current 3·9/0·0225kΩ = 170kΩ. The small base current drawn will theoretically modify our original assumption of the potential at A but is so small that it can be ignored. Strictly speaking we should have shown R2 as having a value of 170kΩ but because of other experiments to follow we have made it 150kΩ. The effect of this is to cause the quiescent voltage to be slightly less than mid-rail—but near enough for the experiment.

A crystal microphone is a very easily obtainable source of a.c. voltage that is of a capacitive nature and this can be connected straight across the base of Tr1 and ground of our circuit without affecting the bias conditions (see Fig. 45). Note that we have split the value of our original R2 between two resistors (R2 and R3) in series. Initially leave out the capacitor C1 and connect a meter set to a low a.c. range through a capacitor to point A. Most modern test meters have this capacitor built into them if you use the input socket marked "Output". The capacitor is there so that the meter only responds to a.c. components on top of the d.c. quiescent voltage at A. Whistle loudly into the microphone and you should see a slight movement of the meter (probably 1V maximum).

Remember, though, that the output from the microphone is unlikely to be greater than a few tens of millivolts. Clearly there is some form of voltage amplification. If you think about it, though, the a.c. fluctuations at A are being fed back, out of phase, to the base through resistors R2 and R3. This will negate the input signal and the overall gain of the amplifier is going to be considerably impaired. We can, however prevent the a.c. component of the feedback signal reaching the base by connecting a capacitor from the junction of R2 and R3 to ground. Do this while whistling into the microphone and you should see at least a two to one improvement in amplification. We call C1 a decoupling capacitor and it should be of a high enough capacitance to shunt even the lowest frequencies to ground.

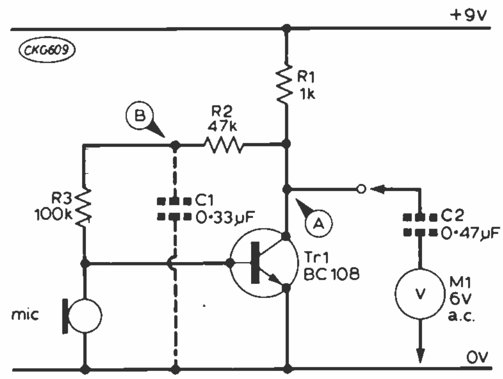



*Fig. 45: A signal from a crystal microphone can be superimposed on the bias current but the components have to be slightly modified. Use a meter with an "Output" connection switched to a.c. or alternatively insert C2 when using an a.c. voltmeter.*

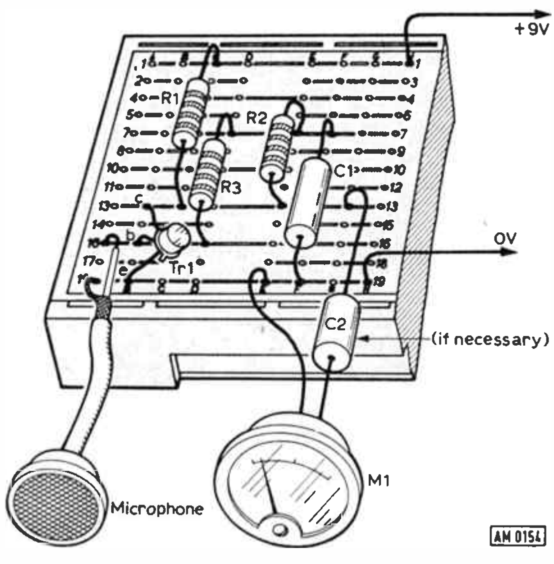



*Fig. 46: Component layout for Fig. 45.*

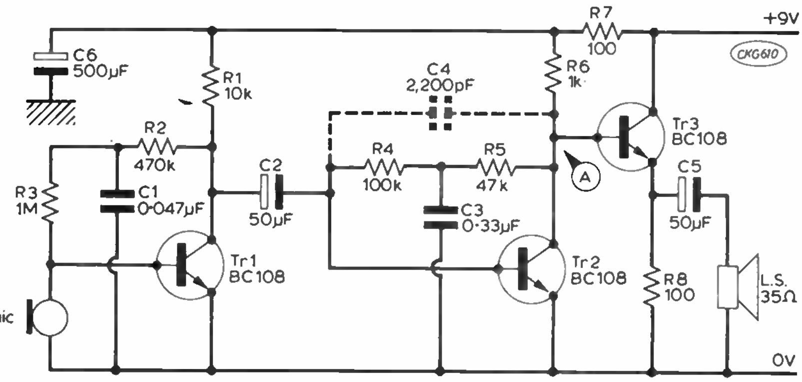
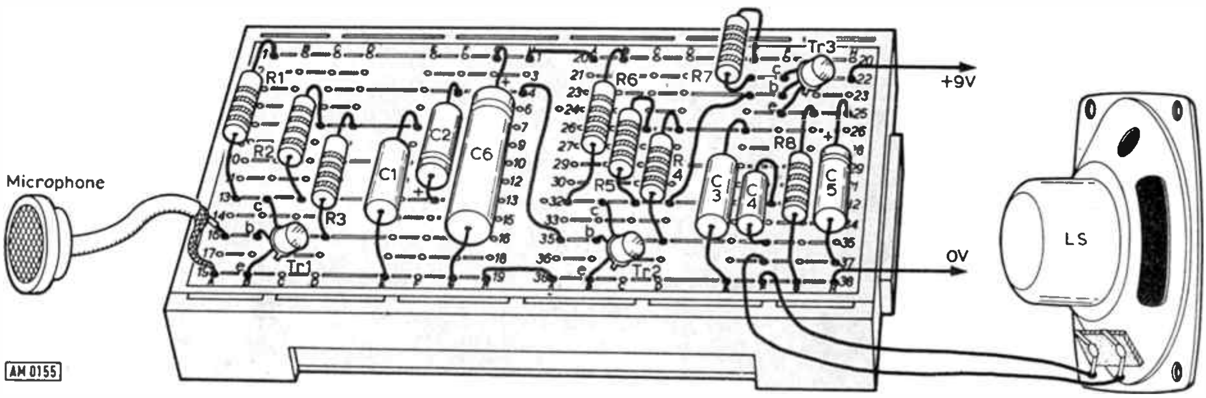



*Fig. 47: A basic amplifier capable of driving a small loudspeaker from a crystal microphone and suitable for an intercom or baby alarm.*

*Fig. 48: Component layout for Fig. 47.*




The output current from a crystal microphone is very small—because of its high impedance—particularly at low frequencies but there must be quite a reasonable current generated between collector and emitter of the transistor to give rise to the voltage swings we can see at point A. Thus the transistor can be seen to give both current and voltage amplification. The component values in Fig. 45 are not really ideal for coupling from a crystal microphone because we require a fair amount of a.c. base current from the source, and as mentioned earlier, there is not much of this available at low frequencies. The low frequency response of this amplifier would therefore be pretty poor. We can, however, use exactly the same approach to make a stage that needs only one tenth of the input current by increasing all our resistance values by factors of ten (the first stage of Fig. 47. The output from the collector of Tr1 is now coupled as an a.c. signal source to the base of Tr2 which, excluding C4, is identical to the stage we have just described. Before connecting C4 or Tr3 measure the a.c. signal at point A exactly as before; you should see a really high voltage swing (getting on for three or four volts) and more than that, you can get a useful reading for ordinary speech a few inches away from the microphone.

The circuit is clearly providing more voltage gain and has a more useful response at the lower frequency of the human voice. Obviously by increasing the gain at low frequencies we must be overdoing it at high frequencies therefore we insert capacitor C4 which is used, deliberately, to feedback signal from the collector of Tr2 to its base. Because it has a low value it will provide more negative feedback at high frequencies than at low frequencies and hence helps to linearise the frequency response of the two stage amplifier. Use the "whistle and speech" test to see that the amplitude for the whistle is reduced but the level for normal speech has not been appreciably affected. Because we now have a useful voltage swing at A for speech we can use a current amplifier (an emitter follower) to give sufficient current at that voltage to drive a loudspeaker. This is provided by Tr3.

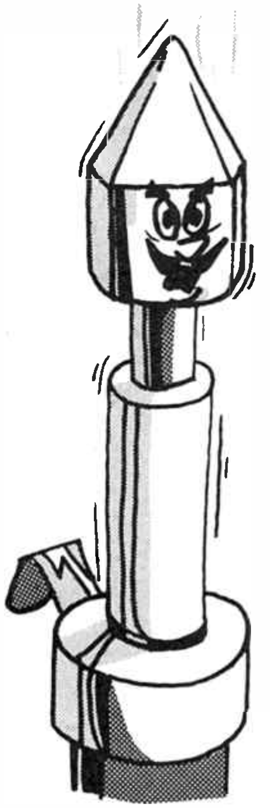
Note that it is necessary to decouple the power rail between the output stage and the amplifiers by means of R7 and C6. Without these components the current drawn by the output transistor could cause voltage variations on the line which are then seen as a form of signal by the preceding stages and amplified. This leads to instability and the whole circuit would oscillate wildly.

The amplifier of Fig. 47 does not have a particularly good frequency response but is quite adequate for intercom or baby alarm applications. No volume control is provided and in some circumstances you might encounter accoustic feedback (howl-round). This can be prevented by keeping the microphone and the loudspeaker well apart.

A problem with the circuits we have covered, so far, is that the voltage gain is very much dependent on the $h_{FE}$ of the transistor in question. There are other circuits which—at the expense of a little gain—enable us to get what there is under reasonably accurate control.

*To be continued*

# The Hot-Head



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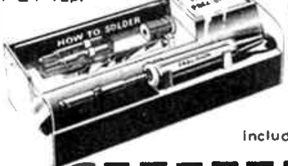


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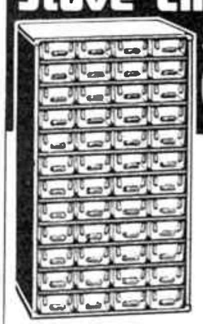

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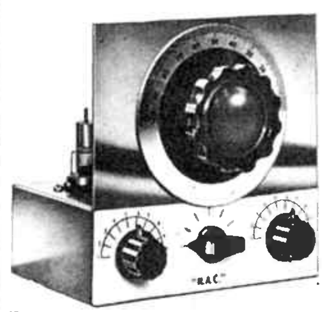


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# IMPEDANCE MATCHING?

## THE WHYS AND WHEREFORES

C. BUDD

THE concepts of input impedance and output impedance are not really difficult to understand although there is no single rule to cover every situation. What is correct practice depends almost entirely on the individual design requirements.

The most important rule of impedance matching is derived from the maximum power transfer theorem.

### The maximum power transfer theorem

If a signal source with a purely resistive output source is required to drive a purely resistive load, maximum power will be transferred from source to load when the load resistance is equal to the output impedance of the source. It should be noted that the theorem assumes that the input and output impedances to be purely resistive, which will rarely be the case in practice, and that to deliver maximum power to the load is the sole requirement.

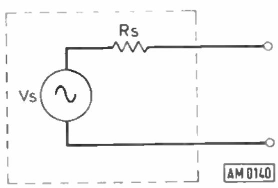
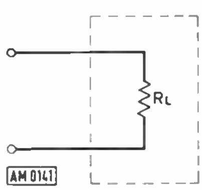



*Fig. 1: Equivalent circuit of signal source with resistive output impedance.*

*Fig. 2: Equivalent circuit of resistive load.*



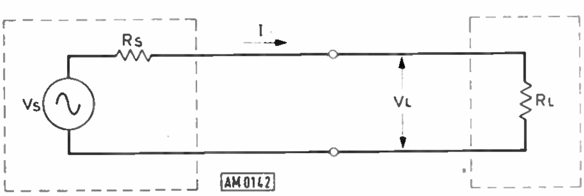




***Fig. 3: Equivalent circuit of the source of Fig. 1 driving the load of Fig. 2.***

Assuming that our signal source may be represented by an a.c. voltage source in series with a resistance (Fig. 1) and that our load may be represented by a pure resistance (Fig. 2), we can combine the two (Fig. 3) and write some pertinent equations as follows.

Calling the power delivered to the load P

$$V_L = \frac{V_S R_L}{R_L + R_S} \text{ by potential divider action}$$

and $I = \dfrac{V_S}{R_L + R_S}$ where I is the a.c. current flowing

$$P = IV_L$$

$$\therefore P = \frac{V_S^2 R_L}{(R_L + R_S)^2}$$

where $V_L$ = load voltage, $V_S$ = source voltage, $R_L$ = load resistance, and $R_S$ = source resistance.

Given the source voltage and the source and load resistances we can, with this formula, calculate the power delivered to the load. But we can do more than that. If we assume arbitrary values for $V_S$ and $R_S$ we can plot a graph of $R_L$ against P. The curve obtained will be similar to that in Fig. 4. From the graph it may be seen that the power transferred is at maximum at approximately the point where $R_L$ equals $R_S$. It may be shown that P reaches a maximum when $R_L$ is exactly equal to $R_S$.

Maximum power transfer between source and load occurs when the source resistance is equal to the load resistance.

### Other considerations

In practice, however, it is not as straightforward as this because maximum power transfer may not be our only concern. Consider the simple audio output stage shown in Fig. 5. The purpose if T1 is to match the speaker impedance to the output impedance presented by the transistor.

From the maximum power transfer theorem, one could reasonably assume the the "correct" load resistance would be the output resistance of the transistor, but this is not so. In this case maximum efficiency (i.e. power transfer from amplifier to load) is not our main concern.

Of greater importance is the maximum power that the stage will deliver without distortion due to bottoming (the transistor being turned off by the input signal) or saturation. In fact the load resistance into which the stage will deliver the maximum power without distortion, known as the optimum load, is equal to the supply voltage divided by the quiescent collector current and has nothing to do with the actual output resistance of the stage.

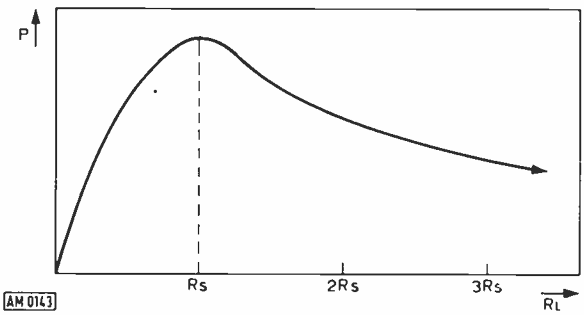



*Fig. 4: Sketch graph showing that the power delivered to the load is at a maximum when $R_L = R_S$.*

In a practical case the optimum load will generally be higher than the output resistance for an audio power amplifier, and this is the reason that commercial audio power amplifiers, intended to drive load impedances of 3, 8 or 16 ohms, often have output impedances of a fraction of an ohm.

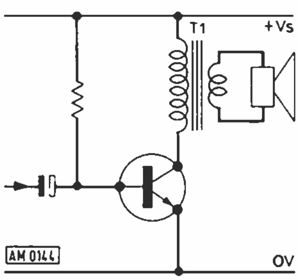



*Fig. 5: Simple audio output stage.*

### Reactive components

An input or output impedance will have reactive components as well as a resistive one. If possible, the reactive element of the source impedance should be cancelled by those of the load impedance. In other words, a source with an equivalent series capacitance should "see" a load with an equivalent series inductance, the reactance being equal, but opposite, to that of the source capacitance.

In this way, the source capacitance and the load inductance form a series-tuned circuit which, ideally, has zero dynamic impedance (zero resistance). Any net reactance in the source-load circuit is undesirable since it reduces the maximum power that can be delivered to the load by the source. Such "reactance balancing" is only possible at a single frequency and in a system of large relative bandwidth (e.g. an audio preamplifier) it is of no use.

At r.f. however, the relative bandwidth will generally be much less and it is usually easy to make the reactive elements of source and load cancel out in the frequency band in use. As an example, one of the functions of the aerial tuning unit in a transmitting system is to cancel out the reactive elements of the aerial impedance.

### Equal load and source resistance

Now let us consider another situation in which it would be better to deviate from the rule of making the load resistance equal to the source resistance because maximum power transfer is not our only concern. Fig. 6 shows the equivalent circuit diagram of a typical crystal microphone or ceramic pick-up. The output impedance of such a device consists of a fairly large resistance (typically a few megohms) in series with a small capacitance of perhaps two or three hundred picofarads. If the capacitive element was absent, the transducer drives a pre-amp with an input resistance equal to $R_S$ and all would be well.

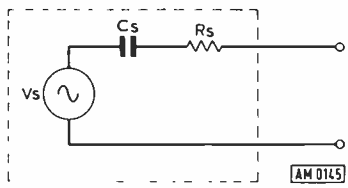



*Fig. 6: Equivalent circuit of typical crystal microphone or ceramic pick-up.*

However, at the lower audio frequencies, the reactance of $C_s$ in a practical transducer becomes large enough to be significant in comparison to $R_s$ and attenuation of the bass frequencies would result if the input impedance of the pre-amp were equal to $R_s$.

Since an inductance in series with the transducer would only cancel the capacitance at a single frequency and would, in any case be ridiculously large, the simplest solution to the problem is to make the input impedance of the pre-amp very large compared to $R_s$. The reactance of $C_s$ at bass frequencies would then be insignificant compared to the total resistance in circuit and no significant attenuation of the bass frequencies would occur.

### High impedance input

The circuit diagram of a crystal microphone driving a pre-amp with an ample input resistance of 10MΩ is shown in Fig. 7. One could reasonably think, from the maximum power transfer theorem, that the large ratio between the resistive component of the source impedance and the load resistance would result in a large loss of available power.

This is the case, but it may be shown that the power gain of a common source f.e.t. stage (and that of a common cathode valve stage) is proportional to the value of the resistor (R1 in Fig. 7) shunting the input, which is roughly equal to the

—continued on page 1166

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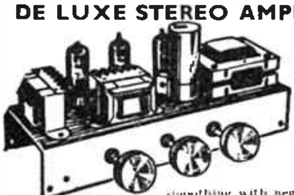

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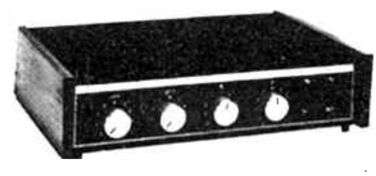

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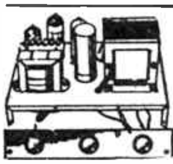
*Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.*



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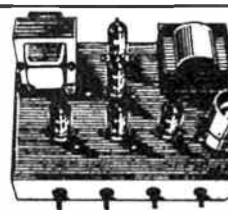

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# AUTOMATIC 12V CAR BATTERY CHARGER

**Richard Collin**

THIS simple automatic battery charger was originally designed for use with the very popular battery operated fluorescent lamp described in the December issue of *Practical Wireless*. Its purpose was to keep the battery in a fully charged state, restoring energy used when mains power is available.

The circuit is of course suitable for charging any 12 volt car battery at a maximum rate of 2·25A. When the battery reaches full charge (13·5 volts) a "crowbar" circuit operates and shuts off the charge current. Interruption of the mains supply restores the crowbar to its off state.

## *Circuit description*

The circuit diagram is shown in Fig. 1. A mains isolation transformer with a 30V centre-tapped secondary winding feeds a full-wave thyristor circuit to provide the charging current. The thyristors are triggered by the d.c. potential applied to the gate electrodes via diodes D1 and D2 and the associated smoothing capacitor C1.

Resistors R1, R2 and R3 limit the gate current together with the indicator lamp LP2. Resistor R1 and lamp LP2 also limit the current through the crowbar thyristor CSR3 when it is 'on'. Resistors R4 and R5 are connected in parallel. They limit the charge current to 2·25A to protect the transformer, CSR1 and CSR2. Diode D3 is included to stop current flowing back from the fully charged battery into the crowbar circuit once it has triggered.

The crowbar trigger potential is set by the 6·8V zener diode D4 in the gate circuit of CSR3. By using the potentiometer across the circuit output it is possible to adjust the voltage of the output to a predetermined level at which the crowbar circuit 'fires'. The crowbar thyristor 'shorts' the main gates to earth and stops them from receiving gate pulses, so stopping conduction.

## ★ components list

| | |
|---|---|
| R1 | 68Ω 5W wirewound resistor |
| R2, R3 | 270Ω ¼W |
| R4, R5 | 1Ω 10W wirewound |
| R6 | 1·2kΩ ¼W |
| R7 | 330Ω ¼W |
| VR1 | 2·2k potentiometer (miniature preset) |
| C1 | 640μF 25V |
| LP1 | Mains neon indicator |
| LP2 | 6·3V 0·2A lamp |
| S1 | Single pole, single throw toggle |
| FS1 | 3A fuse |
| T1 | Mains transformer, secondary 30V centre tapped, 3A |
| CSR1 | 2N3228 TO-66 or any 50V 5A thyristor, and mounting hardware |
| CSR2 | 2N3228 TO-66 or any 50V 5A thyristor, and mounting hardware |
| CSR3 | TIC44 |
| D1 | 1N4001 |
| D2 | 1N4001 |
| D3 | 1N1612R or any 50V 5A stud type (stud is anode) and mounting hardware |
| D4 | 6·8V 1 watt zener diode |

Lamp holder (m.e.s.), connecting wire, mains lead, fuseholder, nuts, bolts, etc. Heatsinks (see Fig. 3.)

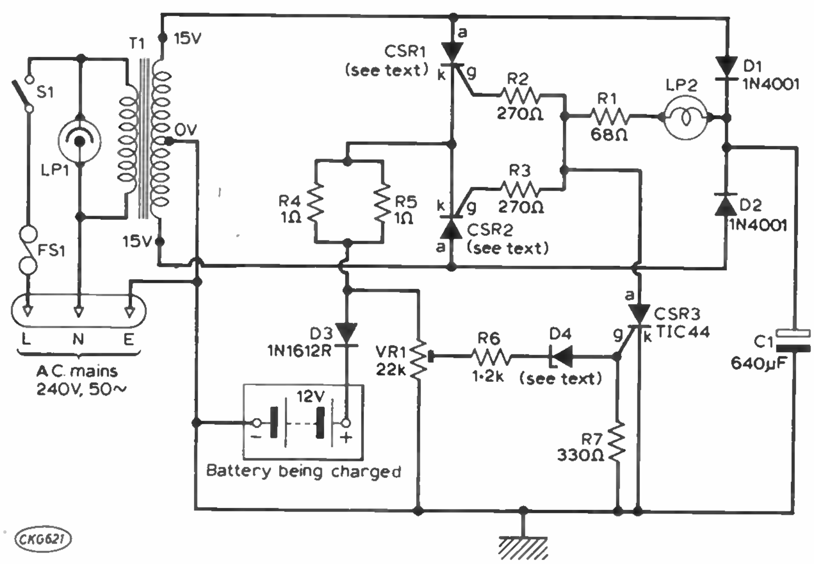


*Fig. 1: Schematic circuit of the automatic battery charger.*

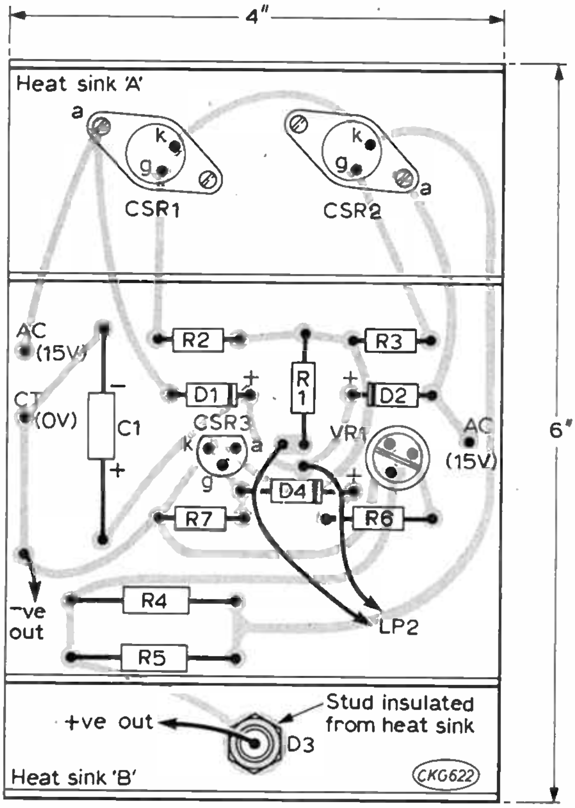


*Fig. 2: Printed circuit board and component layout.*

The circuit board layout is shown in Fig. 2. All components should be mounted onto the board and soldered up. Ensure that electrolytic C1 is connected correctly and check also the polarity of the thyristor and diode connections. The main thyristors, CSR1 and CSR2 and diode D3 must be mounted with insulators on their respective heatsinks. A smear of silicon grease should be applied to each side of the mica washers to ensure good thermal contact. Resistors R4 and R5 should be spaced clear of the board as they will run quite warm.

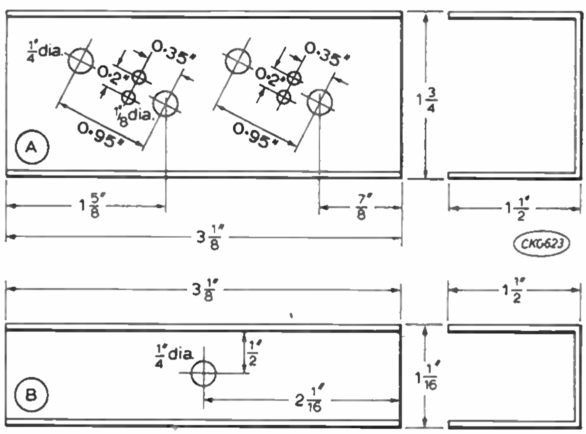


*Fig. 3: Heat sink details, in 16 s.w.g. aluminium.*

When the board is complete and all wires to the transformer are connected make a final wiring check. Then set VR1 fully anticlockwise, and switch on the mains. Measure the voltage across C1; it should be approximately 20V.

Then connect a fully charged 12V battery (about 13·4V off load) across the output terminals. Advance VR1 slowly until the crowbar circuit just operates (lamp LP2 comes 'on'). The voltage measured between earth and R4, R5 and D3 junction should then be about 14V. Do not move the setting of VR1 again—sealing with a dab of glue is a good safeguard. Switch off the unit and disconnect the battery.

Connect a discharged battery to the unit and switch on. If an ammeter is available check the charge rate—about 2·25A. Alternatively measure the voltage across R4, R5; this should be about 1·1V. The crowbar circuit should not operate until the battery is fully charged and reaches 13·4V. Once operated the crowbar cannot be reset unless the mains supply is interrupted.

During power cuts this will be "automatically' accomplished. ■

**IMPEDANCE MATCHING**—*continued from page 1162*

input impedance of the stage. Thus, a high input impedance makes for higher power gain and, hence, greater output power from the stage as well as improving the bass response, as it does in this particular application.

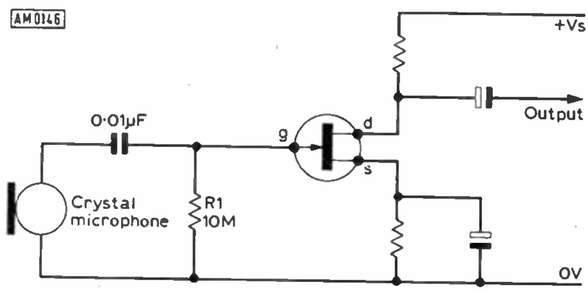


*Fig. 7: A crystal microphone driving an audio preamp with a high input impedance.*

## Power fall-off

There are many such situations in which maximum transfer of power from source to load is not our only concern and load resistance should not be made equal to source output resistance. But the basic principles should be borne in mind. The maximum possible power will be delivered to the load when the input resistance of the load is equal to the output resistance of the source and any reactive components in the source impedance should be cancelled out by equal but opposite reactive elements in the load impedance.

In many practical cases exact equality of source and load resistances is not easy to achieve. It may be seen from Fig. 1 that the power transfer falls off more rapidly with decreasing load resistance than it does with increasing load resistance. Therefore, if it is necessary for a mismatch to occur, it is clearly much better to make the load resistance greater than the source resistance. ■

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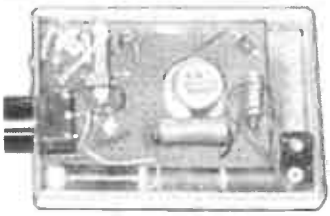

**This is the miniature radio you can hold in one fist. Brings in the popular radio stations on the medium waves. Construction details provided—it's easy to make!**

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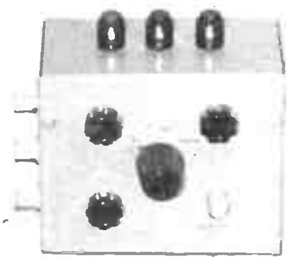

**In conjunction with our current series, aimed to help you get the best out of oscilloscopes, this simple i.c. add-on unit can convert a single beam oscilloscope to double-beam. With twin units, a double-beam oscilloscope can be converted to show four waveforms simultaneously.**

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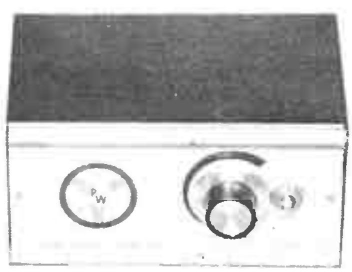

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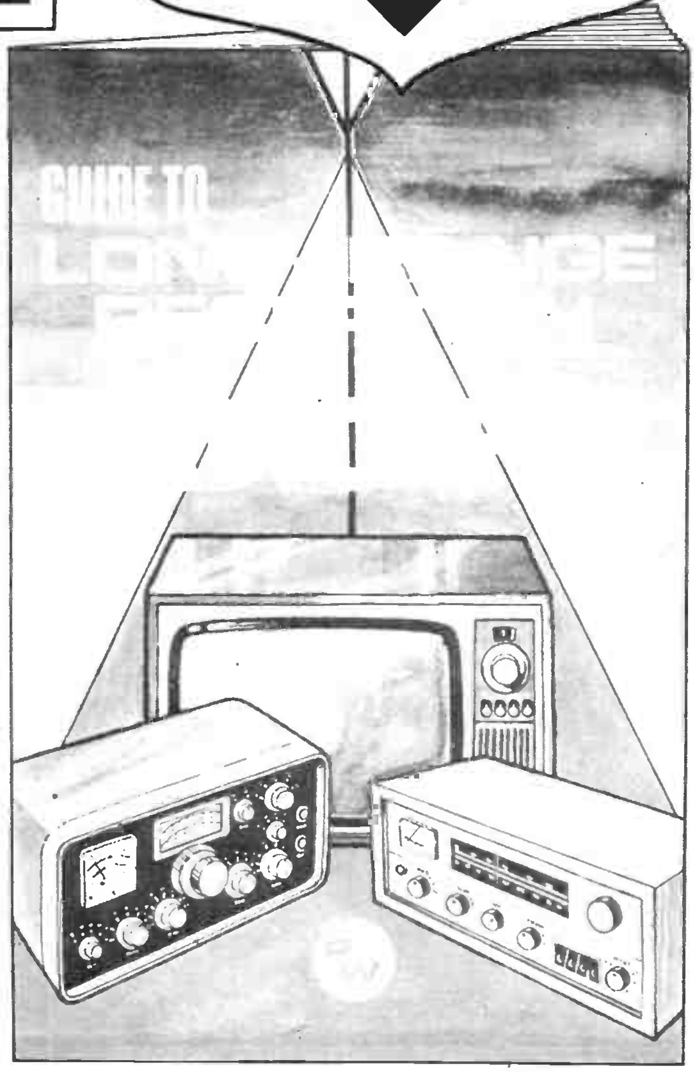

The reception of stations far away is a fascinating hobby. When it can be done on a domestic receiver it becomes even more exciting. Read how radio signals are propagated over thousands of miles, how to choose a short wave receiver, how to select a suitable aerial and how to get FM stereo and TV pictures from the Continent.

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# THE 'SLIMLINE' 5-Band

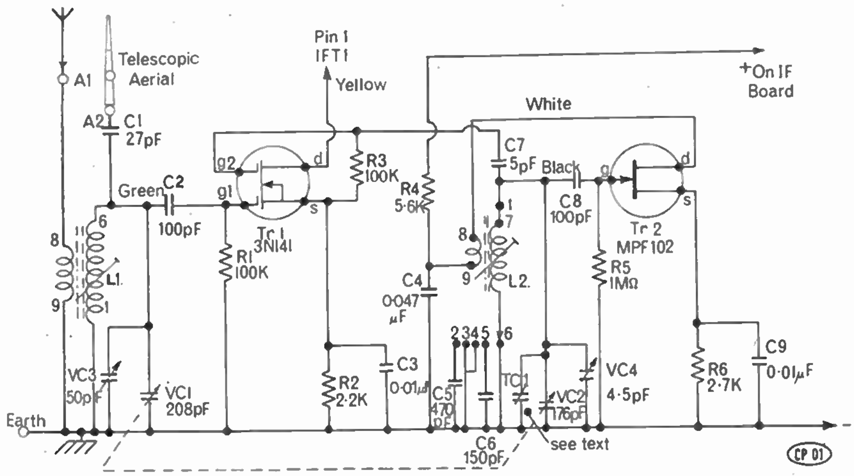



*Fig. 1. First part of the circuit of the Slimline receiver. This contains the mixer stage Tr1 and the oscillator Tr2. Padders C5 and C6 are automatically connected into circuit when the appropriate coil L2 is inserted.*

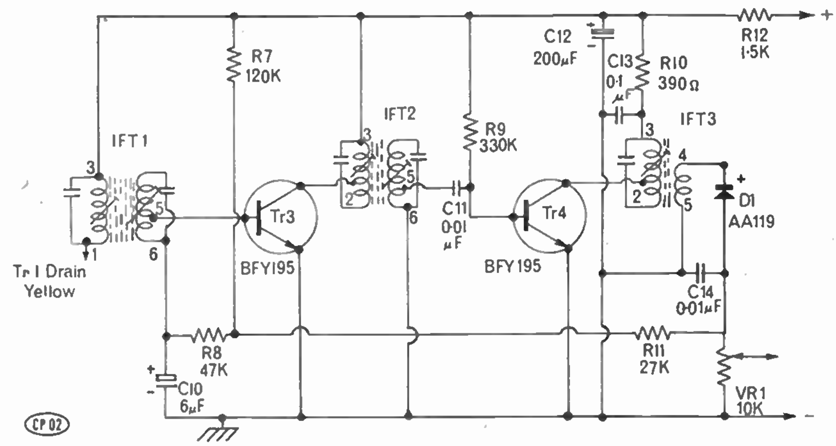



*Fig. 2. The output from the mixer stage feeds into the first IF transformer IFT1 and amplified by Tr3 and Tr4. The capacitors across the windings are part of the IFT assemblies.*

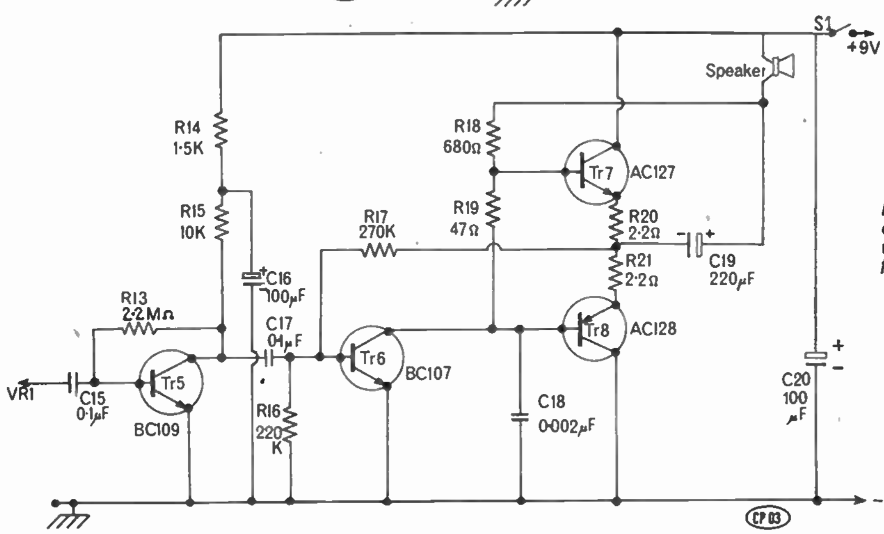



*Fig. 3. The audio signal from the detector diode D1 in Fig. 2 is fed via the volume control to Tr5 and further amplified by Tr6, 7 and 8 and thence to the speaker.*

# Portable Receiver

THIS portable receiver is in a 7×5in. case only 1in. deep, though to these dimensions must be added those of the Trimmer, Fine Tuning and Volume/On-Off controls at one end, and the Band-setting dial on the front. These do not however increase the size very much. The receiver may be operated with its own telescopic rod aerial, with an improved aerial such as a few yards of thin insulated flexible wire or with a conventional aerial.

The coverage of the five bands is approximately as follows:—

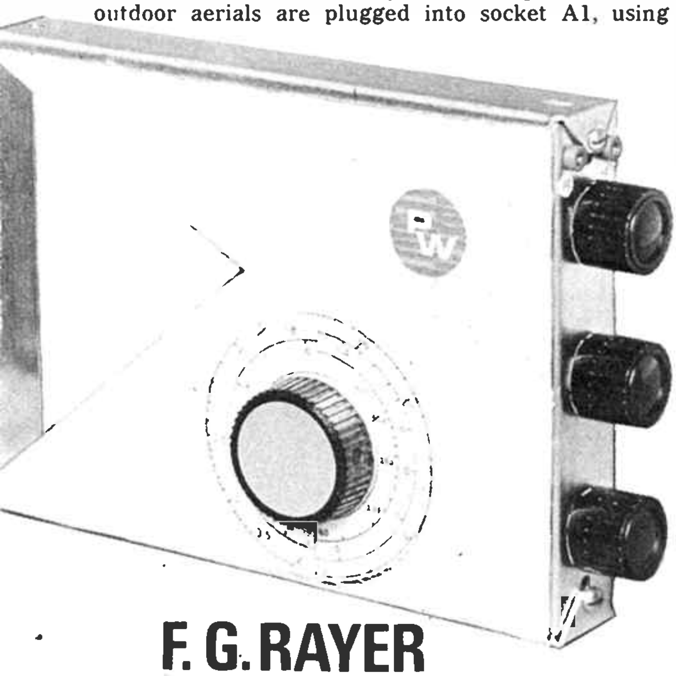
| | | |
|---|---|---|
| Band | 1 | 160—350kHz |
| ,, | 2 | 580—1500kHz |
| ,, | 3 | 1·75—4·0MHz |
| ,, | 4 | 5·9—11·5MHz |
| ,, | 5 | 13—27MHz |

The receiver thus has a wide general utility, tuning medium and long waves, if required, in addition to the most popular short wave bands.

Eight transistors and one diode are employed and the receiver is wired and assembled in separate units. A dual-gate 3N141 mixer is used with an MPF102 FET oscillator, followed by two BFY195's and AA119 diode for IF amplification, demodulation and AGC. The audio section has a BC109 pre-amplifier and BC107 driving an AC127 and AC128 complementary output stage, which provides adequate power for the internal speaker.

## CIRCUIT DETAILS

The telescopic aerial, or a short wire aerial, is connected to socket A2 Fig. 1, but longer indoor or outdoor aerials are plugged into socket A1, using the primary coupling winding of the aerial coil L1. This circuit is tuned by VC1 and the panel trimmer VC3 is provided so that this can be peaked for maximum efficiency with any aerial. Signals are taken to gate 1 of Tr1 and gate 2 is coupled by C7 to the oscillator Tr2. The oscillator coil L2 is tuned by the second section of the ganged capacitor VC1/VC2. VC4 is a bandspread tuning control to allow easy tuning on the short wave bands.




F. G. RAYER

L1 and L2 are plug-in coils so there is no need to obtain coils for those bands which are not required. Band 1 is for long wave coverage and may not be wanted in some areas. The extreme high frequency end of this band is not used (above about 350kHz) as instability arises when this stage is tuned near the intermediate frequency, as would be expected.

Band 2 is for medium wave coverage while Band 3 includes shipping and other transmissions, as well as the 160m and 80m amateur bands. Most general short wave broadcasts come in Band 4 and also Band 5.

Capacitors C5 and C6 in Fig. 1 are padders and the correct value is brought into circuit for each coil when it is inserted, by wiring to the appropriate socket pins. TC1 is an integral trimmer on VC2. If VC1/2 is a type without trimmers a separate 30pF or similar small pre-set must be connected here.

Fig. 2 is the circuit of the IF amplifier. IFT1 and IFT2 are double tuned and IFT3 single tuned and these, with the two BFY195's, result in good selectivity and gain. The demodulator diode D1 provides audio signals for the volume control VR1, and automatic gain control bias for the first IF stage. Current for the IF stages is taken from the 9V supply, through R12, the mixer drain circuit being supplied through the primary of IFT1. The on-off switch S1 is incorporated with the volume control VR1.

The circuit of the audio stages is shown in Fig. 3. Tr5 is a low level high gain amplifier with output to the driver Tr6 which drives the NPN/PNP pair Tr7 and Tr8, R17 providing stabilisation of the DC operating conditions. The circuit is intended for an 18 ohm speaker but it will be found that good results are obtained with a 25 ohm or 35 ohm unit.

## CONSTRUCTION

Both sides of the mixer/oscillator board are shown in Fig. 4. Plain perforated Veroboard is most suitable, with 0·15in matrix. The resistors and capacitors are inserted as shown and the board turned over and leads soldered underneath. In most places the wire ends of the components are long enough to reach other points. Soldered joints should be small and leads kept near the board, with sleeving on leads which may touch each other. The tag MC is later secured with a 6BA or 8BA bolt, to hold the board clear of the panel and to form a negative or earth return.

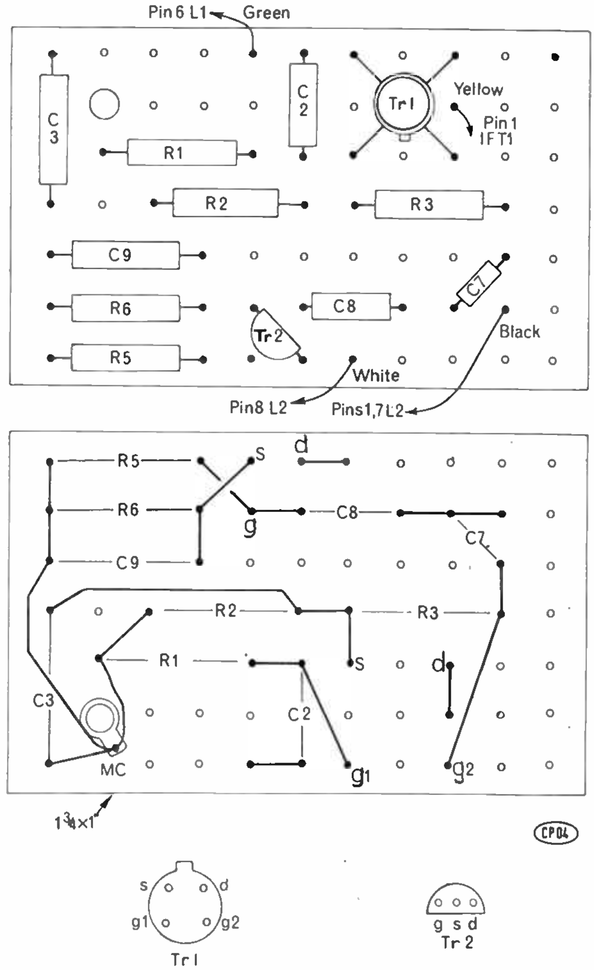



*Fig. 4. Layout of the mixer/oscillator board. Veroboard pins can be used where necessary, if component leads are too short.*

**Important.** An insulated gate transistor of the 3N141 type has an extremely high gate internal resistance and it can be destroyed by the static charge of metal or plastic tools, or by touching its leads with the fingers. Despite this, there is virtually no danger to the transistor if it is installed correctly and once R1, R2 and R3 are connected to it, these protect the gate circuits from static charges.

Leave Tr1 until other wiring on this board is finished. Tr1, as supplied, should have a thin spring or loop which short circuits its four leads, to protect it. This is not removed until the transistor is soldered in place. If it has to be unsoldered for any reason, a length of thin, clean wire should be wound round the four leads, under the transistor, before this is done. Spread the leads with a matchstick so that they come through the holes shown in Fig. 4, bend over the wires from R1, R2 and R3, and solder them to the transistor leads.

It is convenient to use colour coded leads for the external connections. These may be green from C2 for VC1 and pin 6 of L1, yellow for the drain circuit, white from Tr2 drain to pin 8 of L2 and black for VC2 and pins 1 and 7 of the holder for L2.

The IF board is shown in Fig. 5. Holes for the IFT pins and screening can tags should be drilled first. The pins are identified by their spacing, and should be arranged as in Fig. 5. A very small round file may be useful in adjusting the positions of holes, if drilling is not quite correct, so that the IFTs fit without strain on their pins. Holes should also be drilled so that the cores can be reached. Two small tags are secured with the bolts MC, which also fix two angle brackets in place. These brackets allow the board to be fixed to the receiver panel.

Note the polarity of C10, C12 and D1. Proceed with the wiring as for the mixer-oscillator board, with insulated sleeving where required. The wire ends of R12 and C14 can be left projecting, so that other connections can be soldered on later.

The AF amplifier board is built in a similar manner, components being positioned as in Fig. 6. As it is rather difficult to see the transistor lead positions when these are in place, short pieces of coloured sleeving may be put on these wires first, to identify them—green for emitter, blue for base and orange for collector.

Capacitors C16 and C20 are arranged vertically. Bolts secure the tags MC and small brackets, as with the IF board. If necessary, these brackets can be cut from a small spare section of flanged universal

## ★ components list

**Resistors**

| | | | | | |
|---|---|---|---|---|---|
| R1 | 100kΩ | R8 | 47kΩ | R15 | 10kΩ |
| R2 | 2·2kΩ | R9 | 330kΩ | R16 | 220kΩ |
| R3 | 100kΩ | R10 | 390Ω | R17 | 270kΩ |
| R4 | 5·6kΩ | R11 | 27kΩ | R18 | 680Ω |
| R5 | 1MΩ | R12 | 1·5kΩ | R19 | 47Ω |
| R6 | 2·7kΩ | R13 | 2·2MΩ | R20 | 2·2Ω |
| R7 | 120kΩ | R14 | 1·5kΩ | R21 | 2·2Ω |

All resistors 5% ¼ watt
VR1 10kΩ log. pot. with switch S1

**Capacitors**

| | | | | | |
|---|---|---|---|---|---|
| C1 | 27pF | C8 | 100pF | C15 | 0·1μF |
| C2 | 100pF | C9 | 0·01μF | C16 | 100μF 10V |
| C3 | 0·01μF | C10 | 6μF 4V | C17 | 0·1μF |
| C4 | 0·047μF | C11 | 0·01μF | C18 | 0·002μF |
| C5 | 470pF | C12 | 200μF 10V | C19 | 220μF 6·4V |
| C6 | 150pF | C13 | 0·1μF | C20 | 100μF 10V |
| C7 | 5pF | C14 | 0·01μF | | |

VC1/2 208—176pF gang (Jackson 00)
VC3 50pF (Jackson C804)
VC4 4·5pF (Jackson C804)
TC1 30pF trimmer, see text

**Semiconductors**

| | | | | | |
|---|---|---|---|---|---|
| Tr1 | 3N141 | Tr4 | BFY195 | Tr7 | AC127 |
| Tr2 | MPF102 | Tr5 | BC109 | Tr8 | AC128 |
| Tr3 | BFY195 | Tr6 | BC107 | D1 | AA119 |

**Inductors**

IFT1/2 IF Transformer (Denco IFT18/465)
IFT3 IF Transformer (Denco IFT14)
L1/2 Plug-in coils, 9 pin miniature **valve** type for ranges required (Denco—'Blue' for aerial coils and 'Red' for oscillator coils)

**Miscellaneous**

Speaker, about 2½in dia., 18 to 35 ohms. Telescopic aerial. Small sockets (2). B9A valveholders, plain (2). Perforated veroboard 0·15in matrix, 1¾ x 1in, 3¼ x ¾in and 2½ x ¾in. Knobs (4). Perspex for dial.

**Casework** Plates 7 x 5in (2) (CU168)
Flanged members 7 x 1in (2) (CU54A)
Flanged members 5 x 1in (2) (CU52A)
All from Home Radio.

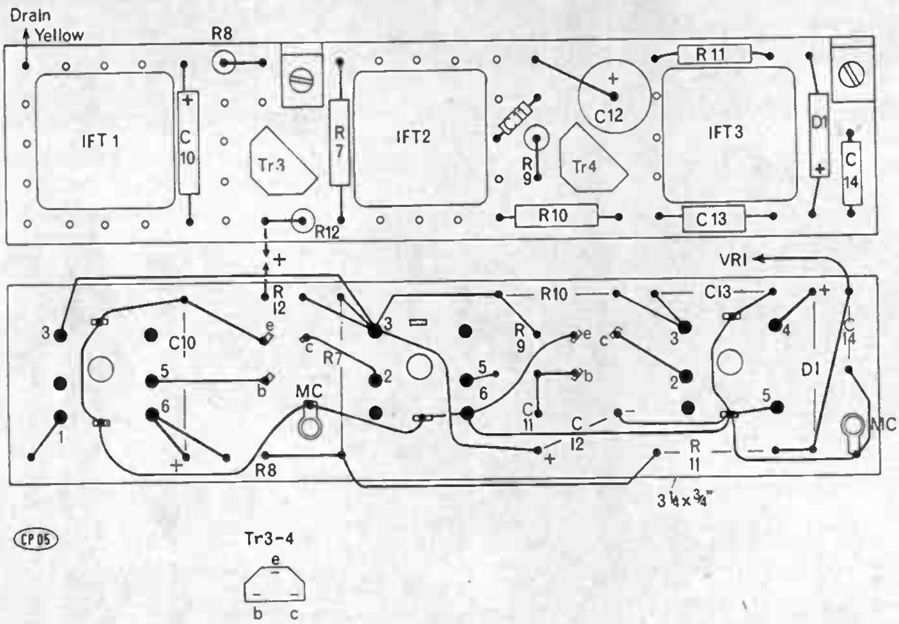



*Fig. 5. Constructional details and layout of the two-stage IF amplifier strip and detector. Note holes in board below IFT's to permit lower core adjustments.*

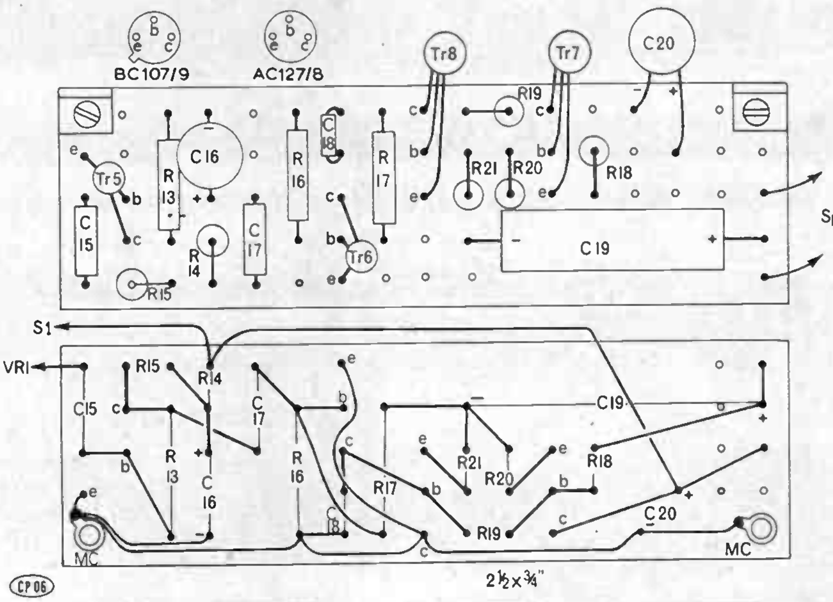



*Fig. 6. This board comprises the audio stages. Observe correct polarity of electrolytic capacitors C16 and C19. Leads to Tr7 and Tr8 may be kept shorter than indicated above.*

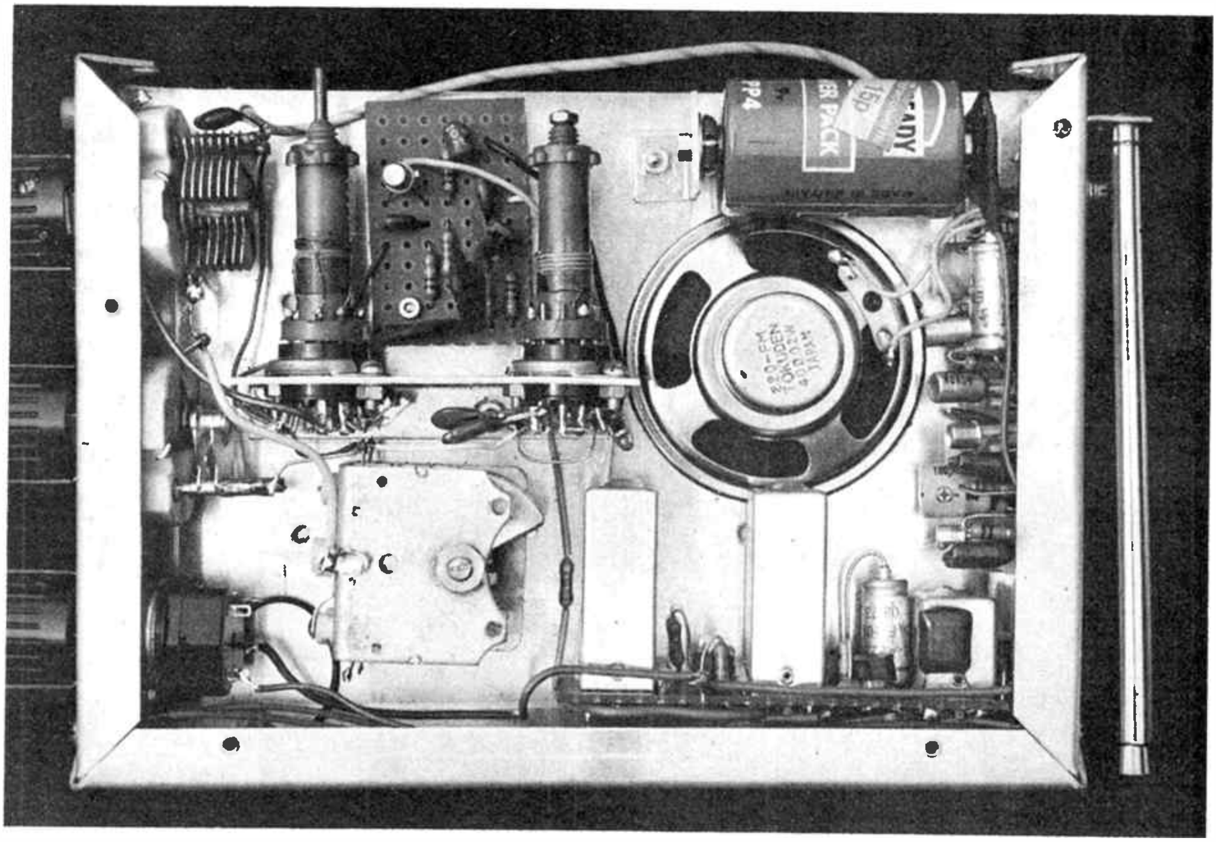
chassis, as used later for the coil holders. Both brackets and insulated board are drilled for 8BA bolts.

A piece of metal with a flange, for mounting the coil holders, is cut $2\frac{3}{4} \times 1$in so that the holders can be fitted as in Fig. 7. A small section is cut away near L2 as shown, to allow the speaker to fit.

The flange is bolted 1in. from the edge of the panel, as in Fig. 8. There is little free space so items should be positioned carefully. The flange is held with 6BA countersunk bolts and nuts. The ganged capacitor is held with three 4BA bolts, which must be cut or filed short so that they do not project beyond the thickness of the capacitor's front plate.

Wiring can then be completed as in the diagrams. The IF, AF and mixer-oscillator boards are held with 8BA countersunk bolts. The one $5 \times 1$in flanged runner is fixed with bolts or self-tapping screws so that VC3, VC4 and VR1 can be mounted, but the other flanged members are left off until later. Leads between units are run against the metal. The speaker is cemented over a $1\frac{3}{4}$in diameter hole and the leads soldered to it. Other connections will be seen in Figs. 7 and 8.

The battery is mounted by a bracket, to which a negative snap connector is bolted. This both holds the battery and provides the negative connection. Two small sockets provide A1 and Earth connections. When all wiring is finished, except for the telescopic aerial, the receiver can be aligned. Do not forget to remove the shorting collar or wire from the mixer transistor.

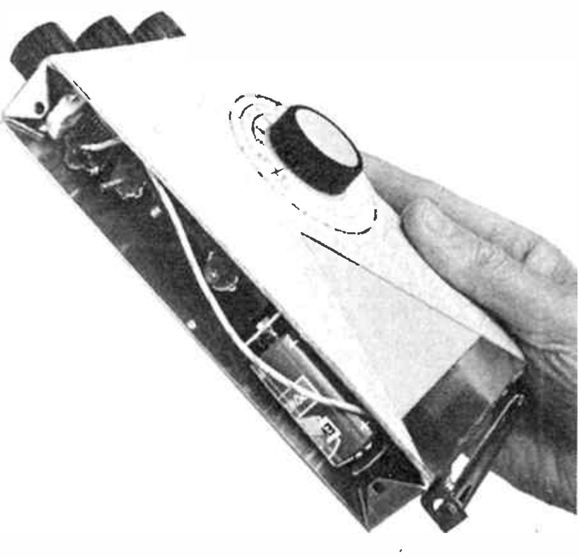


Inside the Slimline receiver. Main components may be identified from Fig. 8.

## IF ALIGNMENT

As the IFT's are supplied pre-aligned, the cores should not be touched until reasonable results are being obtained. A properly fitting tool must be used, such as that available from the IFT maker, as a wedge-shaped blade may easily break the cores so that they cannot be rotated. Where a signal generator is available, place the output lead of this near the yellow lead (mixer drain) and adjust the cores for best output.

If no generator is available turn the audio gain control to near maximum and tune in a weak but stable signal, such as that obtained from a local BBC transmitter, with no aerial at all in use. With this tuned in correctly, adjust the five cores slightly, as may prove to be necessary, for best volume. An alternative is to connect a high resistance test meter across VR1 (positive to chassis) and use a somewhat stronger signal, so that cores can be peaked for the best reading. When these cores have been adjusted, they should be left alone since their settings are not changed when dealing with the mixer and oscillator circuits.



Removal of edge panel permits easy coil changing or replacement of battery.

## MIXER/OSCILLATOR ALIGNMENT

If VC1/2 has trimmers, open fully the trimmer on VC1 and screw down the trimmer on VC2 and set VC3 and VC4 about half open. Each range is dealt with separately. Suppose that Range 3 is aligned first. Adjust the core of L2 (Red coil) so that band coverage is approximately correct. Then tune in a signal around 3·5 to 4·0MHz and adjust VC3 for best volume. Leave VC3 at this setting and tune to a signal around 1·9MHz. The core of L1 is then adjusted for best results, after which there is little need for much adjustment of VC3, throughout the band. When VC3 is peaked for best results, it should be neither fully closed nor fully open.

The other ranges are dealt with in the same manner. The cores of L2 are adjusted in that

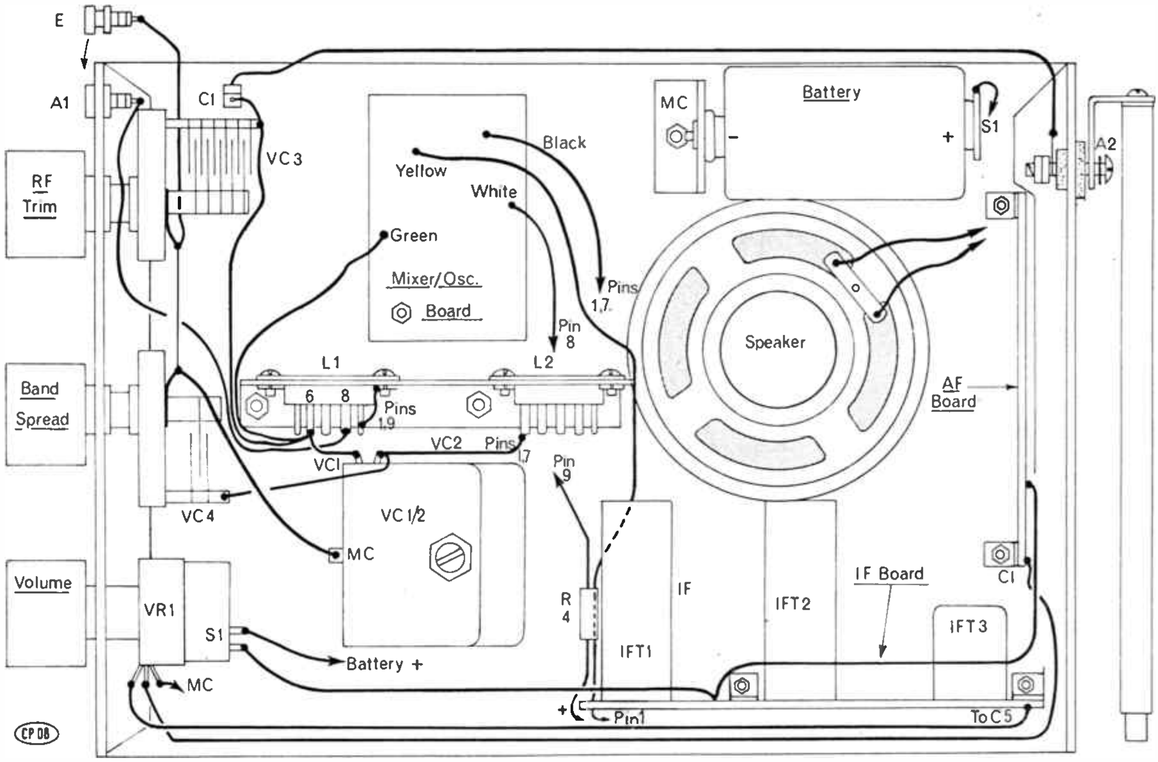



*Fig. 8 Location of the three boards and major components. The battery is held in position by the bracket holding the negative clip.*

direction which takes them away from the smaller winding for Ranges 1 and 3, otherwise continuous oscillation may prove troublesome at the high frequency end of these bands. This arises from the degree of coupling between L2 and its feedback winding. Should excess oscillation or "squegging" of the oscillator be troublesome, R4 could be increased in value. On the other hand, if Tr2 has somewhat reduced gain the value of R4 could be reduced. However, with the value shown, several MPF102 transistors proved satisfactory, so this should not be necessary.

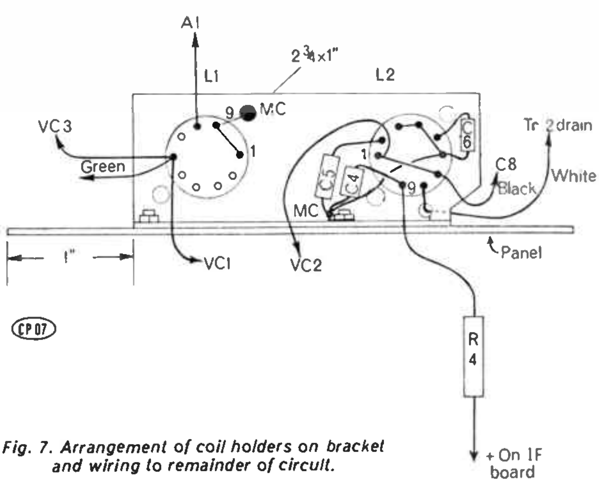



*Fig. 7. Arrangement of coil holders on bracket and wiring to remainder of circuit.*

## FINISHING OFF

The aerial is fixed to a small right angle bracket which is pivoted on a 6BA bolt passing through the side of the case. The hole is drilled to take an insulated bush and an insulated washer rests between the bracket and case. A spring washer is placed under the screw head and the nuts locked together so that the aerial can be extended vertically with the case flat or standing upright. A flexible lead runs from the aerial to C1.

The dial is marked on card and is about $2\frac{3}{4}$in. in diameter. The control knob is a shallow type to which is attached a $2\frac{3}{4}$in. diameter disc of $\frac{1}{16}$in. thick Perspex. This can be fixed with adhesive or self-tapping screws. A line is marked across the Perspex. A disc can be easily cut with an adjustable tank or washer cutter, but if this is not available a pointer knob could be substituted for the disc.

The case is completed by screwing on one 7×1in member and the remaining 5×1in member. The 5×1in members fit inside the 7×1in members so that the top 7×1in flanged member can be taken off to change the battery or coils. The back, a 7 × 5in flat plate, is permanently attached with self-tapping screws, but only one screw is run into the top member flanges.

There is some opportunity for individual choice in the way in which the case is finished. If left bare or painted, gauze or perforated metal should be fitted over the speaker aperture inside. The case shown was covered at the front with fabric and self-adhesive material as used for shelves, boxes, etc. ■

# CASSETTE RECORDER AND TUNER AMPLIFIER

**PART 2** **RICHARD COLLIN**

## POWER AMPLIFIER ASSEMBLY

The first stage in assembly is to mount all components except the plastic power transistors onto the board, ensuring correct polarity of electrolytic capacitors. Solder each joint carefully—do not over heat the components, but make sure joints are properly made. Check that all parts are in the correct position and then cut off all excess lead wires. Note that R13 and C9 are mounted on the speaker sockets, not on the printed board.

Next fit the output and driver transistors onto their respective heat sinks ensuring that the mica washers and nylon bushes are correctly located. Check that each device is isolated from the heatsink after assembly. Then form the leads for insertion into the printed board. **Do not** bend the leads less than $\frac{1}{8}$in from the transistor body. **Do** support the leads near the body with long-nose pliers whilst forming. **Do not** radius the bends tighter than $\frac{1}{16}$in.

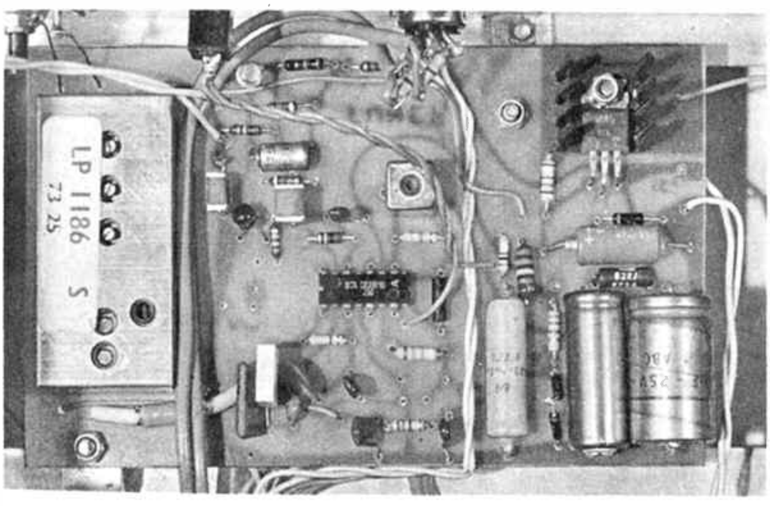
Mount the strip of four output devices onto the circuit board and solder up the connections. Then mount the two driver transistors in a similar fashion. Once soldered ensure that the power transistors are not bent back and forth on their leads—plastic packaged devices can be easily damaged by stressing the lead outs. Once complete the power board should be put away safely until needed later on.

## TUNER AND IF CIRCUIT (UNIT 3)

The AM section utilises the Ferranti ZN414 integrated circuit IC1 and a single transistor amplifier Tr1. A small ferrite rod aerial forms part of a double-tuned aerial circuit which is used to eliminate swamping effects of strong local transmissions by improving the selectivity. The circuit and printed board illustrated are for the single-station version. Further channels may be added by inserting a suitable two-pole rotary switch at the points marked "X" and "Y" in Fig. 10 to select additional pairs of trimmer capacitors for each station required.

The ferrite aerial may be insufficient in some areas of poor signal strength. The AM aerial socket, which is loosely coupled to the ferrite rod by two turns of insulated wire, allows adequate reception under such conditions by connection of an external aerial.

In the FM section, a Mullard varicap tuned module type LP1186 feeds an RCA IF amplifier integrated circuit IC2 through a ceramic filter tuned to 10·7 MHz. This integrated circuit requires only one IF coil to provide the audio output for the decoder and also an AFC control voltage.




*The prototype Tuner and IF board shown here has some variations in layout from the final version given in Fig. 12*



**continued on page 1176**

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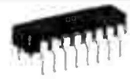

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| 6·3 VOLT | |
|---|---|
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| 68μF | 6½p |
| 150μF | 6½p |
| 470μF | 11p |
| 680μF | 13p |
| 1500μF | 18p |
| 2200μF | 18p |
| 3300μF | 26p |

| 10 VOLT | |
|---|---|
| 22μF | 6½p |
| 47μF | 6½p |
| 100μF | 6½p |
| 220μF | 8p |
| 330μF | 10p |
| 470μF | 10p |
| 1000μF | 11p |
| 1500μF | 20p |
| 2200μF | 24p |

| 25 VOLT | |
|---|---|
| 10μF | 6½p |
| 22μF | 6½p |
| 47μF | 6½p |
| 100μF | 8p |
| 150μF | 8p |
| 220μF | 10p |
| 470μF | 13p |
| 680μF | 20p |
| 1000μF | 22p |
| 2200μF | 39p |
| 5000μF | 68p |

| 40 VOLT | |
|---|---|
| 6·8μF | 6½p |
| 15μF | 6½p |
| 33μF | 6½p |

| 63 VOLT | |
|---|---|
| 1μF | 6½p |
| 2·2μF | 6½p |
| 4·7μF | 6½p |
| 6·8μF | 6½p |
| 10μF | 6½p |
| 22μF | 6½p |
| 68μF | 10p |
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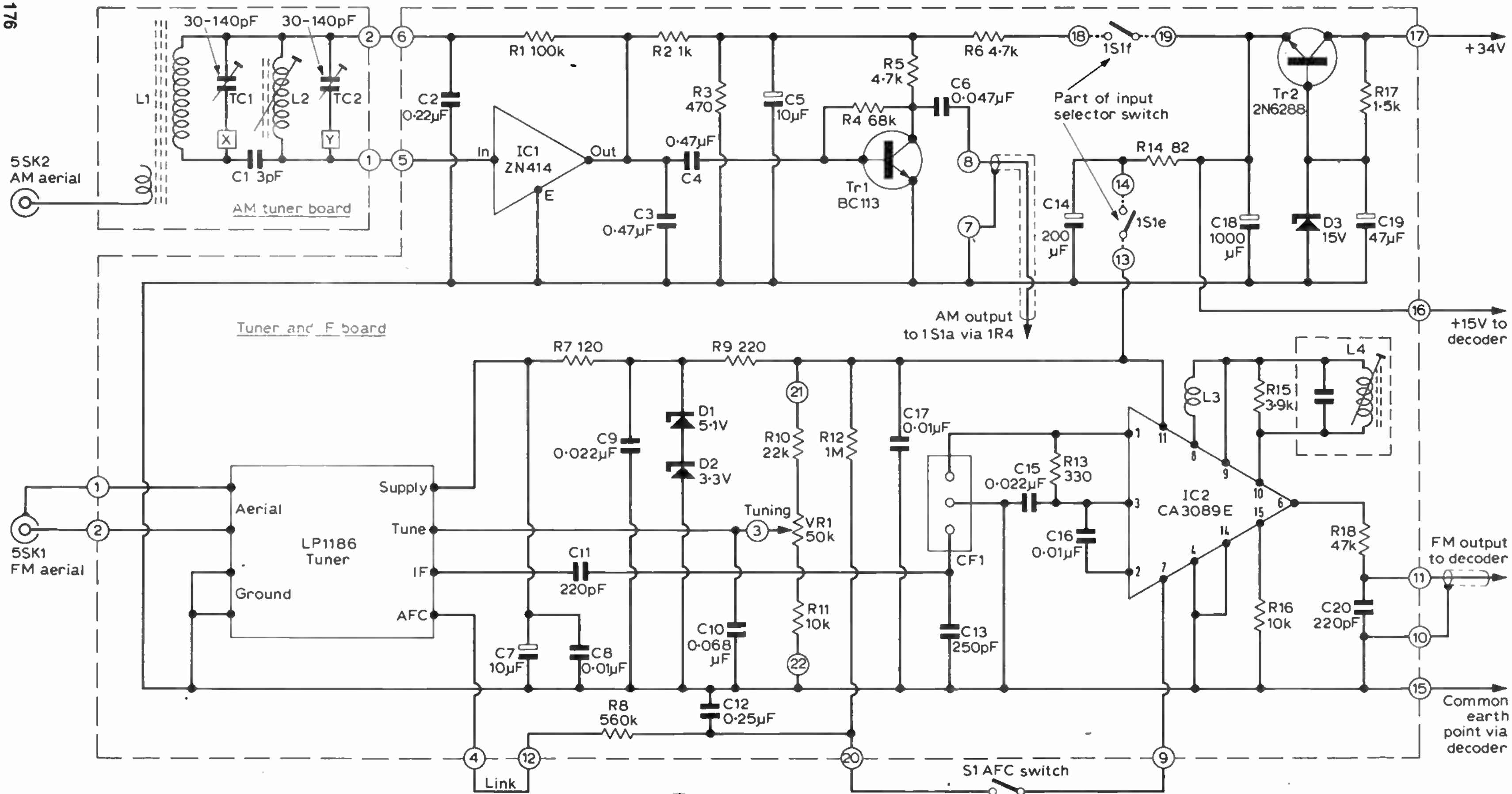
**Miniature transformers**

Prim 220 volt

| | | | | |
|---|---|---|---|---|
| BT606 | 100mA | 6–0–6v | 98p | 15p |
| BT909 | 100mA | 9–0–9v | 98p | 15p |
| BT12012 | 100mA | 12–0–12v | £1·08 | 15p |
| BT24024 | 100mA | 24–0–24v | £1·95 | 15p |

| Transistors/ Diodes | | | | | | | | | | Diodes & Rectifiers | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC107 | 16p | BC109 | 11p | BC303 | 50p | MP8121 | 33p | TIP32A | 73p | 1N914 | 8p |
| AC126 | 14p | BC113 | 15½p | BC304 | 40p | MP8122 | 44p | TIP33 | £1·05 | 1N916 | 8p |
| AC127 | 13p | BC116 | 16p | BCY70 | 17p | MP8123 | 50p | TIP34A | £1·54 | 1N4148 | 8p |
| AC128 | 13p | BC125 | 16p | BCY71 | 37p | NKT211 | 28p | TIP35A | £2·53 | 1S44 | 10p |
| AC142K | 22p | BC126 | 25p | BCY72 | 17p | NKT212 | 28p | TIP36A | £3·19 | 1N4007 | 22p |
| AC141K | 20p | BC132 | 16p | BD131 | 68p | NKT214 | 25p | TIP41A | 79p | 1S113 | 17p |
| AC176 | 15p | BC134 | 16p | BD132 | 90p | NKT217 | 55p | TIP42A | 91p | BA100 | 16p |
| AC187 | 18p | BC135 | 16p | BD135 | 42p | NKT261 | 23p | 2N706 | 13p | BA102 | 26p |
| AC187K | 20p | BC137 | 16p | BD136 | 50p | NKT271 | 20p | 2N930 | 23p | BA115 | 8p |
| AC188 | 18p | BC138 | 36p | BD141 | £1·87 | NKT274 | 20p | 2N1131 | 22p | BA144 | 14p |
| AC188K | 20p | BC142 | 33p | BD142 | 50p | NKT275 | 25p | 2N1132 | 28p | BA145 | 22p |
| ACY17 | 24p | BC143 | 33p | BF159 | 33p | NKT403 | 71p | 2N1613 | 22p | BA154 | 14p |
| ACY18 | 21p | BC144 | 30p | BF173 | 29p | NKT405 | 83p | 2N1711 | 26p | BAX13 | 14p |
| ACY19 | 25p | BC145 | 26p | BF177 | 28p | NKY603F | 66p | 2N2904 | 40p | BAX16 | 14p |
| ACY20 | 22p | BC147 | 9p | BF178 | 29p | NKT613G | 33p | 2N2904A | 44p | BAY18 | 19p |
| ACY21 | 23p | BC148 | 9p | BF179 | 35p | NKT674 | 26p | 2N2905 | 46p | BAY31 | 9p |
| ACY22 | 18p | BC149 | 9p | BF194 | 15p | NKT677G | 24p | 2N2924 | 18p | BY100 | 19p |
| ACY39 | 68p | BC153 | 16p | BF195 | 17p | NKT713 | 32p | 2N2926 | 10p | BY126 | 16p |
| AD140 | 40p | BC154 | 17p | BF244 | 27p | NKT773 | 27p | 2N3053 | 26p | BY127 | 19p |
| AD142 | 44p | BC157 | 13p | BF260 | 29p | OC19 | 55p | 2N3054 | 55p | BYX10 | 24p |
| AD143 | 39p | BC158 | 12p | BF329 | 18p | OC20 | 55p | 2N3055 | 52p | OA5 | 19p |
| AD149 | 38p | BC159 | 14p | BF330 | 18p | OC23 | 49p | 2N3702 | 11p | OA10 | 24p |
| AD150 | 60p | BC167 | 13p | BF390 | 37p | OC25 | 45p | 2N3703 | 11p | OA47 | 9p |
| AD161 | 38p | BC168 | 11p | BFX84 | 28p | OC28 | 50p | 2N3704 | 11p | OA70 | 8p |
| AD162 | 38p | BC169 | 11p | BFX85 | 35p | OC29 | 50p | 2N3705 | 11p | OA73 | 11p |
| AF114 | 18p | BC177 | 15p | BFX86 | 22p | OC35 | 50p | 2N3706 | 11p | OA79 | 8p |
| AF115 | 18p | BC179 | 15p | BFX87 | 28p | OC36 | 50p | 2N3707 | 11p | OA81 | 9p |
| AF116 | 18p | BC182L | 10p | BFX88 | 26p | OC44 | 14p | 2N3708 | 11p | OA85 | 11p |
| AF117 | 18p | BC183L | 11p | BFY50 | 21p | OC45 | 14p | 2N3709 | 11p | OA90 | 8p |
| AF118 | 92p | BC184L | 11p | BFY51 | 17p | OC70 | 23p | 2N3710 | 11p | OA91 | 8p |
| AF124 | 27p | BC186 | 33p | BFY52 | 17p | OC71 | 14p | 2N3711 | 9p | OA95 | 8p |
| AF139 | 39p | BC212L | 11p | BFY64 | 39p | OC72 | 14p | 2N3794 | 17p | OA200 | 11p |
| AF239 | 41p | BC213L | 11p | BFY90 | 72p | OC81 | 14p | 2N3819 | 28p | | |
| AL100 | 77p | BC214L | 11p | BSX20 | 19p | OC83 | 22p | 40361 | 50p | | |
| AL102 | 66p | BC258 | 9p | C407 | 22p | OC84 | 28p | 40362 | 50p | | |
| AL103 | 55p | BC259 | 9p | C426 | 33p | TIP29A | 53p | 40636 | 50p | | |
| BC107 | 11p | BC267 | 14p | C428 | 31p | TIP30A | 64p | | | | |
| BC108 | 11p | BC268 | 15p | C450 | 17p | TIP31A | 64p | | | | |
| | | BC300 | 40p | MP8111 | 35p | | | | | | |
| | | BC301 | 32p | MP8112 | 42p | | | | | | |
| | | BC302 | 30p | MP8113 | 35p | | | | | | |

CRATA—continued from page 1174



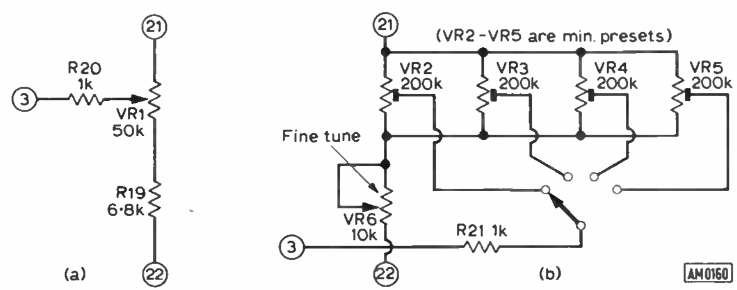




*Fig. 10: Circuit of the Tuner and IF section, including the separate AM Tuner Board.* ▲

*Fig. 11: Circuits of the alternative VHF tuning control arrangements described in the text:—*
*(a) Full Band II coverage*
*(b) Four-station preselected tuning.* ▶

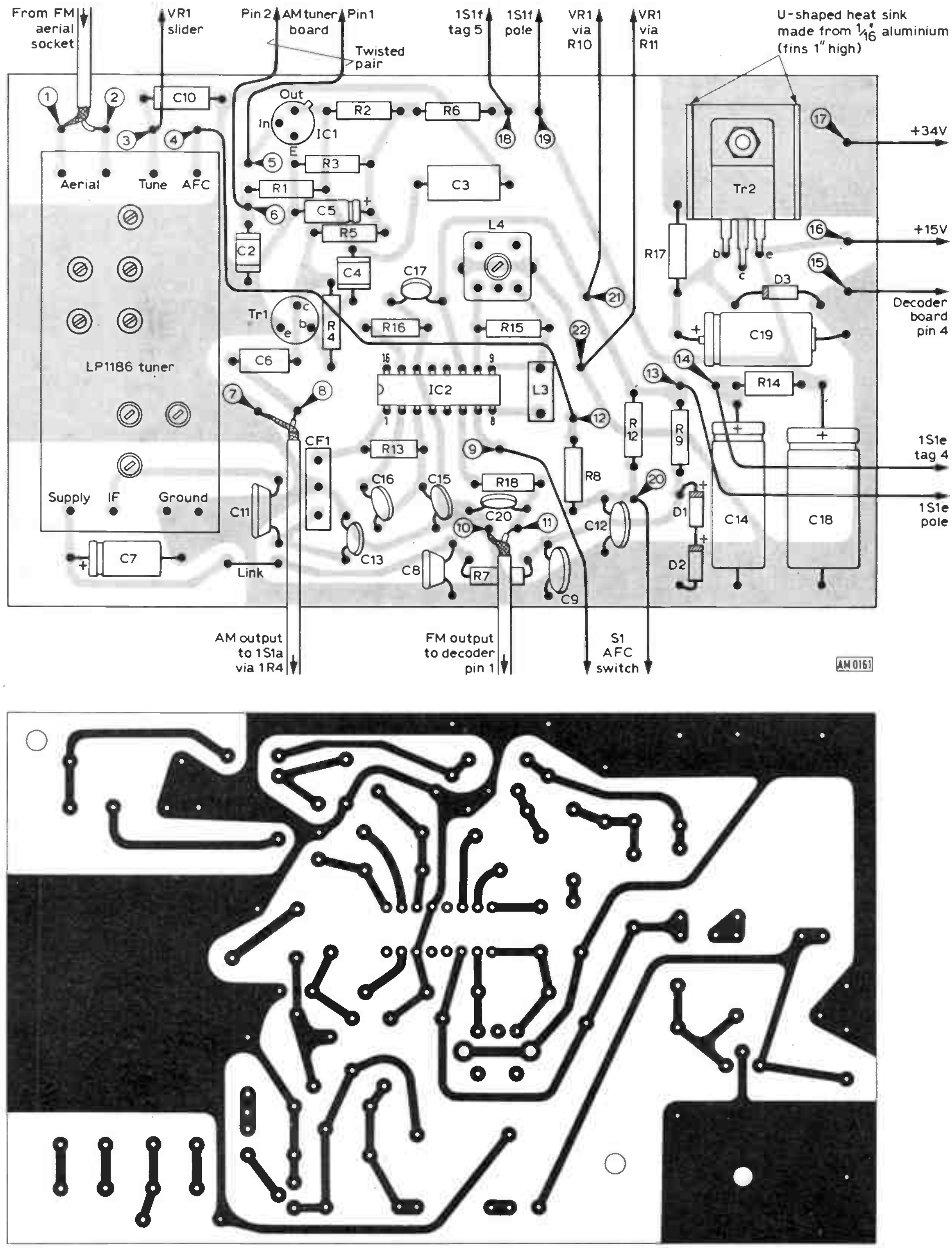



*Fig. 12: Component location and printed circuit layout for the main Tuner and IF board. Both drawings are actual size.*

## ★ components list

### TUNER & IF BOARDS

**Resistors**

| | |
|---|---|
| R1 100kΩ | R11 10kΩ |
| R2 1kΩ | R12 1MΩ |
| R3 470Ω | R13 330Ω |
| R4 68kΩ | R14 82Ω |
| R5 4·7kΩ | R15 3·9kΩ |
| R6 4·7kΩ | R16 10kΩ |
| R7 120Ω | R17 1·5kΩ |
| R8 560kΩ | R18 47kΩ |
| R9 220Ω | |
| R10 22kΩ | VR1 50kΩ lin |

Note—The alternative VHF tuning arrangements require the following changes in components.
(1) Full range continuous tuning (Fig. 11a)
Delete R10 and R11 above and add
R19 6·8kΩ R20 1kΩ
(2) Preselected tuning (Fig. 11b)
Delete R10, R11 and VR1 above and add
R21 1kΩ VR2–VR5 each 200kΩ min. preset
VR6 10kΩ lin
All fixed resistors ¼W 5% carbon film

**Capacitors**

| | |
|---|---|
| C1 3pF ceramic | C11 220pF ceramic |
| C2 0·22μF ceramic | C12 0·25μF ceramic |
| C3 0·47μF polyester | C13 250pF ceramic |
| C4 0·47μF polyester | C14 200μF 25V |
| C5 10μF 16V | C15 0·022μF polyester |
| C6 0·047μF polyester | C16 0·01μF polyester |
| C7 10μF 16V | C17 0·01μF polyester |
| C8 0·01μF polyester | C18 1000μF 16V |
| C9 0·022μF polyester | C19 47μF 16V |
| C10 0·068μF polyester | C20 220pF ceramic |

TC1 30–140pF compression trimmer
TC2 30–140pF compression trimmer

**Semiconductors**

| | |
|---|---|
| Tr1 BC113 | IC1 ZN414 (Ferranti) |
| Tr2 2N6288 (RCA) | IC2 CA3089 E (RCA) |
| D1 BZY88 C5V1 | D2 BZY88 C3V3 |
| D3 BZY88 C15 | |

**Miscellaneous**
L1 55 turns of 30swg enamelled copper wire on 2¼" x 5/16" dia. ferrite rod
L2 Single-tuned Medium Wave coil
L3 RF Choke 15μH Toko 7BA 150J
L4 Toko KACS-K586-HM
CF1 Crystal filter Vernitron FM4 or Toko CFS10·7
S1 SPST min. toggle switch
FM tuning head Mullard LP1186
Tuning drive drum 1½" dia.
Slow-motion cord drive spindle
Cord tension spring ½"
3 small nylon pulleys
Printed circuit boards

**Notes**
1. RCA semiconductors are available from E.C.S. (Windsor) Ltd. (see Part 1 of this project).
2. Toko components are available from Ambit International.

The values given for the tuning control circuit allow coverage of 88-100 MHz. A restricted coverage has the advantage of making the tuning finer and spaces the stations farther apart. The alternative circuit of Fig. 11a provides coverage of the full band 88-104 MHz whilst a four-station preselected tuning arrangement is given in Fig. 11b.

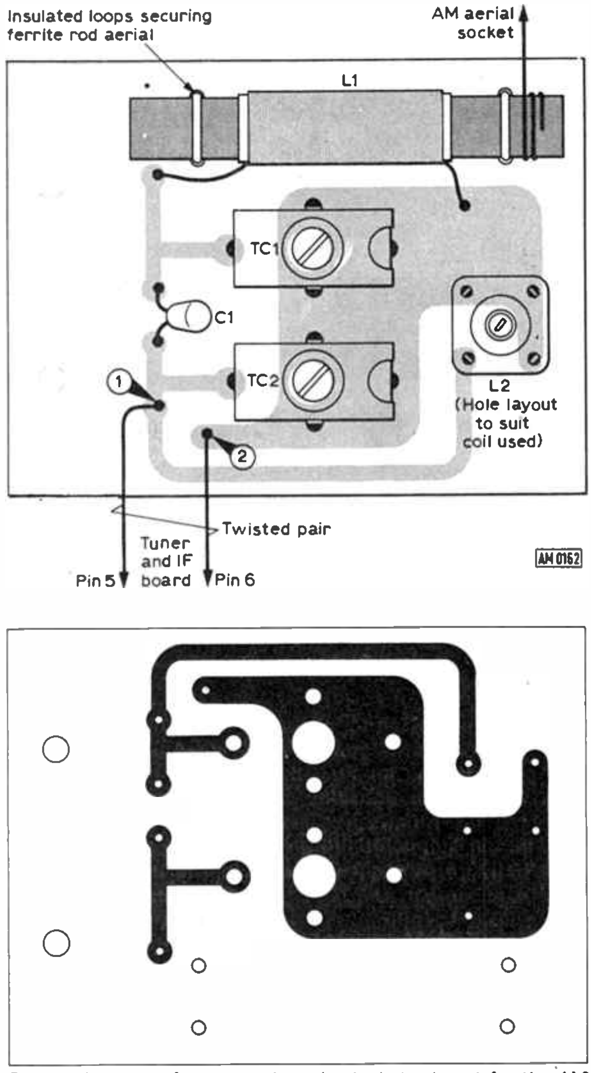



*Fig. 13: Location of components and actual size layout for the AM Tuner Board.*

Four power supplies are derived from the main 34V rail through a series stabiliser transistor Tr2 and various filter networks.
1. The decoder 15V supply is taken direct from the stabiliser and decoupled via C18.
2. The AM tuner 1·5V supply is provided by a resistive potential divider across the 15V supply R3/R6. Decoupling is provided by capacitor C5.
3. The FM IF and tuner varicap supply is taken from the 15V supply via R14 and decoupled by C14/C17. This supply is 12V.
4. The FM tuner 8V supply is provided from the 12V supply by R9, D1/D2 and R7. Decoupling is provided by C7, C8 and C9.

When assembling the printed board care must be taken not to overheat the integrated circuit pins and also not to short-circuit the adjacent connections as they are fairly close together. Ensure that all electrolytics and diodes are polarised correctly and that the ZN414 leads are correctly positioned. The ceramic filter CF1 may be mounted any way round—the centre pin is earthed and either of the other two pins may be input or output. The series stabiliser transistor Tr2 does not require isolation from either its heatsink or the copper print on the board.

PW

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Good tools are expensive to buy and it is seldom worth paying for low grade tools because they rarely do a good job for very long.

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This kit comprises the tools for doing most of the constructional projects that we publish and others too! In it you will find:

**Wire cutters with insulated handles;**

**Long-nose wiring pliers with stripping and cutting blades and insulated handles;**

**Small insulated handle screwdriver with neon mains tester;**

**Large insulated handle screwdriver;**

**Soldering iron kit containing 15 watt soldering iron with $\frac{3}{16}$" bit, two spare bits $\frac{5}{32}$" and $\frac{3}{32}$", heat shunt clip, stand, solder and instruction booklet "How To Solder".**

The normal total recommended retail value of these tools is **£6**. This kit is supplied to readers of Practical Wireless at the special price of **£3·70** (inc. V.A.T.).

*To get your special offer P.W. Tool Kit complete the attached coupon in ink and send with your remittance of £3·70 plus 50p for carriage and packing made payable to Stewart Chance & Co.

Remember, strictly one tool kit per coupon only! Please allow 14 days for delivery in U.K. only.

This offer is limited and subject to stocks still being available.

**PRACTICAL WIRELESS TOOL KIT OFFER— APRIL 1974**

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Please send to me ONE PRACTICAL WIRELESS TOOL KIT. I enclose *Cheque/Postal Order No. .............. to the value of .............. to cover the cost. I understand that you can supply only one Practical Wireless Tool Kit per coupon. (Block letters please)

NAME ................................................................

ADDRESS ............................................................

.......................................................................

.................................................... (postal code)

This offer is subject to stocks remaining available at the date of receipt of this coupon.

**CRATA—continued**

The AFC switch is mounted on the tuner back panel near the aerial sockets—it may be sited on the front panel if required, but do not locate it near to the mains neon and switch.

The AM aerial board, Fig. 13, on which the ferrite rod is mounted should ideally be mounted such that it can be rotated through 90° for maximum signal pickup. Alternatively it may be rigidly mounted in the correct position if the tuner will always be sited in one particular place. The leads between the printed board and the rotary switch in the multi-station version should be kept very short. A suitable position for the switch is immediately above the Input Selector.

**Due to pressure on editorial space, details of the Stereo Decoder have been held over until our May issue which will also describe the Power Unit and Chassis.**

# Oscilloscope techniques

PART 2 ALAN AINSLIE

## OSCILLOSCOPE DISPLAYS

The very heart of any oscilloscope is the cathode ray display tube. After all the electronic functions have been executed the ultimate result is displayed, visibly, on the face of the tube. We shall take a look at a few types of CRT and their associated circuitry as applied to oscilloscopes.

The electron beam, produced by an electron gun, passes through a deflecting mechanism and arrives at the screen where it causes the screen material to fluoresce. The whole mechanism is housed in an evacuated glass container and, in an oscilloscope, only the front face is visible. Fig. 1 shows the general arrangement. For oscillographic use we require a bright spot of light, intense but very small.

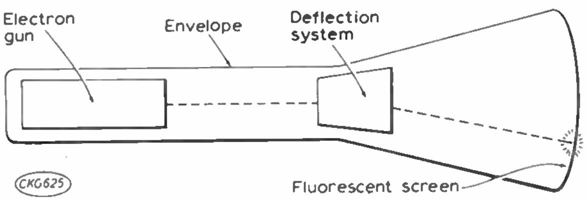



*Fig. 1: Main elements in a CRT intended for use in an oscilloscope.*

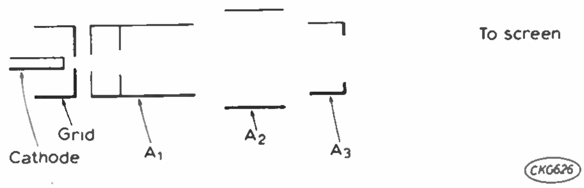
It is the purpose of the electron gun to produce the narrow stream of electrons of high energy to cause local luminescense of the screen. When the beam hits the phosphor screen it causes fluorescence. However, if the beam is cut off suddenly the screen continues to glow with phosphorescent light. It is this phosphorescent light that determines the afterglow of the tube.

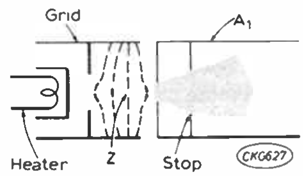
## ELECTRON GUN

A hot cathode on the axis of the tube produces electrons by thermionic emission, as in a conventional electronic valve. By a suitable arrangement of anodes an electric field distribution inside the tube is created focusing the electrons into a high velocity pencil, arranged to converge on to the screen. A simple gun arrangement is shown in Fig. 2 This type of arrangement is often used and is known as a pentode or five electrode gun.

The cathode is heated to emissive temperature and is surrounded by the grid, in this case shaped like a top hat with a hole in it, known as a Wehnelt cylinder. The grid is maintained slightly negative with respect to the cathode and focuses the space charge around the cathode along the axis of the gun.

The first anode (A1) is positive with respect to the cathode by perhaps a couple of hundred volts. Fig. 3 shows how the electrons are accelerated out of the grid area towards the first anode, and in so doing are focused at Z by the equipotential lines, shown dotted. The diameter at Z is used as an "image" and consequently should be as small as possible for a small spot on the screen. The electron beam enters the first anode diverging and a number of stops are added to keep the beam width small and keep out fringe electrons which impair definition. The diverging electron beam emerging from the first anode now needs to be focused on to the screen, or put another way, an image of Z is projected on to the screen.



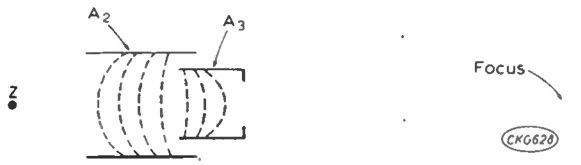




*Fig. 2: top, arrangement of electrodes used in a pentode gun. Fig. 3, centre, shows the beam focusing action of the grid and A1. Fig. 4, bottom, the effect of the remaining anodes A2 and A3 in focusing the beam on to the screen.*

Fig. 4 shows how the second (A2) and third (A3) anodes accomplish this focusing. The second anode is at a higher potential than A1, and A3, the final anode, is at a still higher potential. Thus the equipotential lines are as shown dotted. The beam of electrons now converges as it crosses the A2-A3 fields and by adjustment of the voltage between A2 and A3 the beam can be focused on the screen of the CRT.

# YATES ELECTRONICS
## (FLITWICK) LTD.
ELSTOW STORAGE DEPOT
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C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

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**PLEASE ADD 10% VAT**

### RESISTORS
¼W Iskra high stability carbon film—very low noise—capless construction.
½W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm.
½W 2% ELECTROSIL TR5.

| Power watts | Tolerance | Range | Values available | Price 1–99 | Price 100+ |
|---|---|---|---|---|---|
| ¼ | 5% | 4·7Ω–2·2MΩ | E24 | 1p | 0·8p |
| ¼ | 10% | 3·3MΩ–10MΩ | E12 | 1p | 0·8p |
| ½ | 2% | 10Ω–1MΩ | E24 | 3·5p | 3p |
| ½ | 10% | 1Ω–3·9Ω | E12 | 1p | 0·8p |
| ½ | 5% | 4·7Ω–1MΩ | E12 | 1p | 0·8p |
| 4 | 10% | 1Ω–10Ω | E12 | 6p | 5·5p |

Quantity price applies for any selection. Ignore fractions on total order.

### DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

### POTENTIOMETERS
Carbon track 5kΩ to 2MΩ, log or linear (log ½W, lin ½W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

### SKELETON PRESET POTENTIOMETERS
Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 7p each.

### TRANSISTORS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AC107 | 15p | AF126 | 20p | BF115 | 25p | OC42 | 12p | 2N3707 | 12p |
| AC126 | 12p | AF139 | 32p | BF173 | 20p | OC44 | 12p | 2N3708 | 10p |
| AC127 | 15p | AF178 | 32p | BF177 | 28p | OC45 | 12p | 2N3709 | 11p |
| AC128 | 15p | AF180 | 40p | BF178 | 32p | OC70 | 12p | 2N3710 | 11p |
| AC131 | 12p | AF181 | 40p | BF179 | 32p | OC71 | 12p | 2N3711 | 11p |
| AC132 | 12p | BC107 | 12p | BF180 | 32p | OC72 | 12p | 2N3819 | 32p |
| AC176 | 15p | BC108 | 12p | BF181 | 32p | OC81 | 12p | 2N4062 | 12p |
| AC187 | 22p | BC109 | 12p | BF194 | 14p | OC82D | 12p | 2N4286 | 20p |
| AC188 | 22p | BC147 | 12p | BF195 | 14p | 2N2646 | 60p | 2N4289 | 20p |
| AD140 | 50p | BC148 | 12p | BF197 | 15p | 2N2904 | 20p | 40360 | 35p |
| AD149 | 45p | BC149 | 12p | BF200 | 32p | 2N2926 | 10p | 40361 | 35p |
| AD161 | 33p | BC157 | 14p | BFY50 | 20p | 2N3054 | 58p | 40362 | 40p |
| AD162 | 36p | BC158 | 14p | BFY51 | 20p | 2N3055 | 60p | 40408 | 40p |
| AF114 | 20p | BC159 | 14p | BFY52 | 20p | 2N3702 | 13p | ZTX108 | 15p |
| AF115 | 20p | BC187 | 22p | BUY105 | 225p | 2N3703 | 12p | ZTX300 | 15p |
| AF116 | 20p | BD131 | 75p | OC26 | 45p | 2N3704 | 13p | ZTX302 | 20p |
| AF117 | 20p | BD132 | 75p | OC28 | 50p | 2N3705 | 12p | ZTX500 | 15p |
| AF118 | 38p | BD133 | 75p | OC35 | 50p | 2N3706 | 11p | ZXT503 | 20p |

### ZENER DIODES
400mW 5% 3·3V to 30V, 12p.

### WIRE WOUND POTS.
3W, 10, 25, 50Ω and decades to 100kΩ, 35p.

### DIODES

| RECTIFIER | | | | SIGNAL | |
|---|---|---|---|---|---|
| BY127 | 1250V | 1A | 12p | OA85 | 7p |
| 1N4001 | 50V | 1A | 7p | OA90 | 5p |
| 1N4002 | 100V | 1A | 8p | OA91 | 5p |
| 1N4004 | 400V | 1A | 8p | OA202 | 7p |
| 1N4006 | 800V | 1A | 10p | 1N4148 | 5p |
| 1N4007 | 1000V | 1A | 10p | BA114 | 8p |

### SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE, 12p.
FRONT PANEL, 65p.
18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

### BRUSHED ALUMINIUM PANELS
12in x 6in, 25p
12 in x 2½in, 10p
9in x 2in, 7p

### THYRISTORS

| | | | |
|---|---|---|---|
| 2N5060 | 50V | 0·8A | 30p |
| 2N5064 | 200V | 0·8A | 47p |
| 106F | 50V | 4A | 40p |
| 106D | 400V | 4A | 55p |

### ALUMINIUM BOXES

| | | | | | |
|---|---|---|---|---|---|
| AB7 | 2½" x 5¼" x 1½" | 50p | AB14 | 7" x 5" x 2½" | 84p |
| AB8 | 4" x 4" x 1½" | 50p | AB15 | 8" x 6" x 3" | 108p |
| AB9 | 4" x 2½" x 1½" | 50p | AB16 | 10" x 7" x 3" | 122p |
| AB10 | 4" x 5¼" x 1½" | 50p | AB17 | 10" x 4½" x 3" | 108p |
| AB11 | 4" x 2½" x 2" | 60p | AB18 | 12" x 5" x 3" | 120p |
| AB12 | 3" x 2" x 1" | 44p | AB19 | 12" x 8" x 3" | 160p |

### HEATSINKS—REDPOINT

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2W | 24p | 4W | 45p | TO5 | Clip | 5p | TO1 | Single | 5p |
| 3W | 36p | 6W | 60p | TO18 | Clip | 5p | TO1 | Double | 8p |

### TRANSFORMERS All have 240V primary

| | | | |
|---|---|---|---|
| MT30/2 | 0–12–15–20–24–30V | 2A | £2·85 |
| MT50/½ | 0–19–25–33–40–50V | ½A | £1·90 |
| MT50/1 | 0–19–25–33–40–50V | 1A | £2·55 |
| MT50/2 | 0–19–25–33–40–50V | 2A | £3·50 |
| MT60/½ | 0–24–30–40–48–60V | ½A | £2·10 |
| MT60/1 | 0–24–30–40–48–60V | 1A | £2·80 |
| MT60/2 | 0–24–30–40–48–60V | 2A | £3·80 |

### MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, 2½p. 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, 3p. 0·047μF, 0·068μF, 0·1μF, 4p. 0·15μF, 6p. 0·22μF, 7½p. 0·33μF, 11p. 0·47μF, 13p.
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, 3p. 0·1μF, 3½p. 0·15μF, 4½p. 0·22μF, 5p. 0·33μF, 6p. 0·47μF, 7½p. 0·68μF, 11p. 1·0μF, 13p.

### MULLARD POLYESTER CAPACITORS C280 SERIES
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### SOLID TANTALUM BEAD CAPACITORS 12p

| | | | | | |
|---|---|---|---|---|---|
| 0·1μF | 35V | 2·2μF | 35V | 22μF | 16V |
| 0·22μF | 35V | 4·7μF | 35V | 33μF | 10V |
| 0·47μF | 35V | 6·8μF | 25V | 47μF | 6·3V |
| 1·0μF | 35V | 10μF | 25V | 100μF | 3V |

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|---|---|---|
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| 17 x 5 (plain) | — | 82p |
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| Pkt. 50 pins | 20p | 20p |

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|---|---|---|---|
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| Stereo screened | 35p | 3·5mm screened | 13p |
| Standard socket | 15p | 2·5mm socket | 8p |
| Stereo socket | 18p | 3·5mm socket | 8p |

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2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
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Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

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| | | Line Socket | 13p | | | Line Plug | 13p |
| 3 Pin | 3A | Chassis Plug | 10p | 3 Pin | 3A | Chassis Socket | 21p |
| | | Line Socket | 14p | | | Line Plug | 23p |
| 3 Pin | 5A | Chassis Plug | 16p | | | | |
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|---|---|
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| VA1077 | 15p |
| R53 | £1·35 |

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D.P. 2A 32p

### WAVECHANGE SWITCH 23p
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| | | | | | |
|---|---|---|---|---|---|
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|---|---|---|---|
| 20VA | 0-115-210-240 | MT113CT | £1·48 |
| 75VA | ,, | MT64AT | £2·95 |
| 150VA | 0-115-200-220-240 | MT4AT | £3·61 |
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**400V. Output at 50HZ.**

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Reference IT3AT £4·26

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| 20-0-20 | 30mA | MT241CS*† | £1·39 |
| 0-20 × 2 | 300mA × 2 | MT214CT*† | £2·13 |
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| 0-15-27 × 2 | 500mA × 2 | MT203AT* | £3·78 |
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AT indicates open universal fixing with tags; CT is open U-clamp fixing with tags; CS is open U-clamp fixing with P.C. spills; * with interwinding screen; † untapped 240 primary; ‡ tapped at 210-240V.; other primaries tapped at 200-220-240V.

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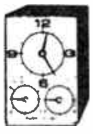

## TIME SWITCH

Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bill, etc. £1·95.

## RECORD PLAYBACK HEADS (TRUVOX)

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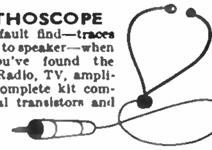

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20—twin stethoset instead of earpiece 83p. extra—post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

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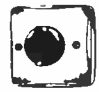

For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price £2·95 plus 20p post and insurance. Industrial model 5A £3·30. (Not on plate).

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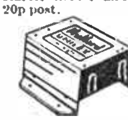

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In simpler types of CRT A2 is omitted giving a tetrode electron gun. The final focusing takes place between A1 and the final anode and geometrically is suitable for a fine spot. However, if focusing is achieved by varying A1 (the final anode potential is fixed as we shall see later) this affects the velocity of the beam because A1 is the primary accelerating anode. The change in velocity changes the position of the point Z and the range of focus is restricted for a good spot size. This situation in practice means that when the grid potential (brightness) or the A1 potential (focus) is altered the other potential must be changed as well, giving restricted focus and brightness range. It is for this reason that the pentode type of tube is almost universally used.

## BEAM DEFLECTION

An electron has a negative charge of $1{\cdot}6 \times 10^{-19}$ coulombs. This is a very small charge, and conversely any electric field acting on the electron will produce only a very small force. However the mass of the electron is very small and so large accelerations can be produced with only moderate potentials.

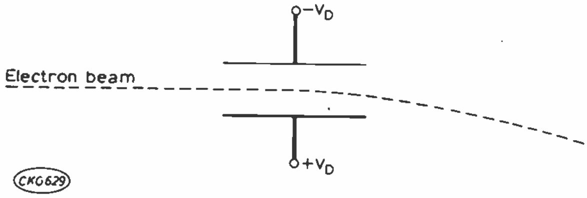



*Fig. 5: Effect of the deflecting plates on the electron beam.*

If a beam of electrons, focused into a fine pencil, is allowed to pass between two parallel plates as in Fig. 5, the electrons will experience a force towards the positive plate and it can be shown that the deflection is proportional to the deflecting voltage (Vd) and inversely proportional to the accelerating voltage (Va). A purely mathematical outlook shows that electrostatic deflection produces a (theoretically) linear deflection mechanism.

## DEFLECTION PLATES

In order to keep the sensitivity as high as possible the tube is physically large and the deflector plates are placed as close together as possible, usually of the form shown in Fig. 6 to permit high deflection sensitivity to be achieved without the beam catching the actual deflector plates. If this occurs (for example if the timebase is overdriven to give X expansion) secondary emission occurs at the surface of the plates, and the low energy secondary electrons can be accelerated towards the screen causing flare and high background illumination. This undesirable effect can be avoided by coating the plates with a material of low secondary emission, or providing "beam catchers," small cups that accept the beam when driven off the screen. The X plates are usually mounted nearer to the tube face so that the Y plates have the maximum sensitivity.

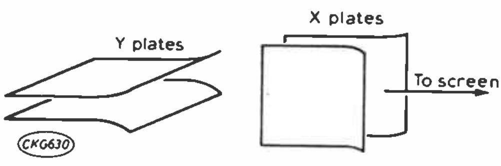
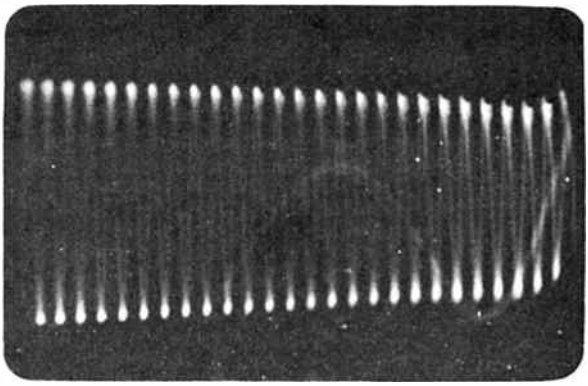



*Fig. 6: Arrangement of the X and Y plates, the Y plates being nearer to the gun system.*

To ensure that the electron beam does not become distorted in any way by extra acceleration due to the deflector plates they are arranged to be at the same potential as the final anode. Of course this is only true when the beam is travelling along the axis, but to prevent any gross errors on deflection it is common to provide symmetrical or push-pull deflection. This ensures that the mean electric field is not altered by deflection.



*Trapezium distortion on a simple CRT operating with asymmetrical deflection on both axes. The focus and definition make this scope useful only for the simplest applications.*

If the plates and final anode were at differing potentials then there would be a deformation of the circular cross-section of the beam (remember it is NOT in focus at this point, only at the screen where the cross-section area should be almost zero) by the plates attracting, or repelling, the outer electrons at opposite sides of the beam. This gives a sausage-shaped spot and the remedy is to make the final anode potential variable so that it may be matched to the Y plates. The X plates are then adjusted to be equal to the Y plate potential (as we shall see in a later section, it would be difficult to alter the Y plate potential). The control for setting the final anode volts is known as the "Astigmatism" potentiometer and is usually a front panel control.

*The same CRT displaying a 1kHz square wave. Astigmatism is most noticeable as is the lack of HF response due to the simple deflection amplifier.*

Another cause of incorrect spot size and shape is due to the pencil of electrons tending to spread, all being negatively charged. However, in high voltage tubes the velocity of the beam is high enough to keep the electrons in line by the magnetic field that they produce. The mechanism of electrostatic deflection relies on the electron beam being in the field of the deflector plates for a finite time. This means that when a very high frequency, say above 100MHz, signal is applied to the plates the signal may have changed before the electrons have emerged.

If, for example, a beam of electrons takes 10ns to travel through the plates a 100MHz signal will have completed one cycle and the deflection will be zero. In modern high velocity tubes the effect only occurs over 150 or 200MHz and the remedy is to arrange a series of deflectors, linked so that the velocity of the signal down the plates is the same as the velocity of the electron beam. However there are few uses for deflection amplifiers that can produce 200MHz output so this is of academic interest only.

## THE FINAL ANODE

In order to produce the high velocity beams that are required to display fast transients, a high accelerating voltage is required. As we have seen, if this is applied to the final anode deflection sensitivity will be reduced so we apply the accelerating potential after deflection, called post deflection acceleration or PDA. Several methods of applying the PDA potential are used but they all aim at not reducing the deflection sensitivity, most important when the deflection amplifiers use transistors having only a limited output voltage swing.

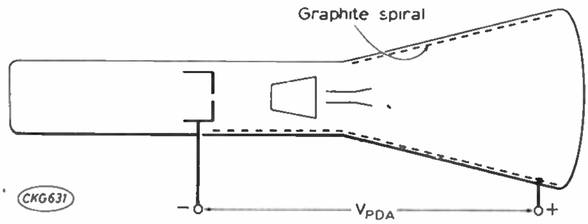



*Fig. 7: Location of post deflection acceleration electrode in CRT.*

The most popular form of PDA until a few years ago was the form shown in Fig. 7 and used in a lot of Cossor CRT's. The electron gun and tube are as they have been described so far and the beam is accelerated and deflected and focused normally. Around the inner wall of the tube is wound a resistive graphite spiral, connected to the final anode, and at the other end to a few kV positive. The beam is thus accelerated through this field to arrive at the screen with high velocity.

The screen tends to charge negatively at these high energies because more electrons are being gained than lost by secondary emission from the screen. The back of the phosphor is therefore given a very thin coating of aluminium and this conducts the charge to positive PDA, eliminating "screen sticking". This occurs where a local area of screen acquires a negative charge and tends to repel the beam, giving low light output. The aluminium also produces a more axial accelerating field giving better geometry and increased light output by reflecting the light forwards.

The field of the PDA is such as to produce a slightly convergent lens giving a smaller image and also, if it penetrates into the deflector plate region, causes acceleration before and during deflection, decreasing the scan even further. But in spite of this the PDA system offers a distinct advantage of increased trace brightness.

A fine wire mesh can be placed in the path of the beam just after deflection and if connected to the final anode acts as a screen to keep any PDA fields out of the deflection system. This arrangement gives rise to a PDA field that acts as a diverging lens, magnifying the deflection considerably, but also the spot size. Alternatively this mesh can be placed near the screen and PDA applied between the mesh and the screen. This gives very good results without affecting geometry but such tubes are prone to internal flashover.

## SCREEN PHOSPHORS

The screen material or phosphor is arranged to give the highest possible light output of the correct colour and persistence. The table shows the range of phosphors used in cathode ray tubes, the most usual being P1 or P5, whilst P7 is sometimes used for medical applications.

| Phosphor | Persistence | Fluorescence | Phosphorescence (Afterglow) | Uses |
|---|---|---|---|---|
| P1 | Medium | Green | Green | Scopes (Visual) |
| P2 | Long or Short | Blue/Green | Yellow/Green | Scopes (Visual) |
| P3 | Medium | Yellow | Yellow | |
| P4 | Medium | White | White | Television |
| P5 | Short | Blue | Blue | Scopes (Photography) |
| P6 | Medium | White | White | Television |
| P7 | Long | Blue/White | Yellow | Radar |
| P8 | Short | Blue/White | Yellow | |
| P9 | Long | White | White | |
| P10 | Permanent | Magenta | Magenta | Storage Tube |
| P11 | Short | Blue | Blue/Green | Scopes (Photography) |
| P12 | Long | Orange | Orange | Radar |
| P14 | Long | White | Oranpe | Radar |
| P15 | Short | Blue/Green | Blue/Green | Flying Spot Scanners |
| P19 | Long | Orange | Orange | Radar |

*Table of phosphor types and principal applications.*

Although the trace produced on a tube can be intensely bright, even with only a couple of kV, the contrast between the trace and the background (grey/white) is usually quite small. A filter of about 65% transmission, of the colour of the trace, placed in front of the tube can increase the contrast by a large amount despite a decrease in light output.

## GRATICULES

The graticule or measuring scale can be engraved on the filter or a better idea is to cut the graticule into a piece of ⅛in. perspex. If the markings are on the front, the observer can move so that the reflection of the line from the back surface of the graticule are in line with the actual lines. This ensures zero parallax when making measurements. The perspex can be lit from the side by a red bulb causing the cuts in the perspex to light up red, although white light is better for photography due to the uneven spectral response of films. Constructors making their own graticules out of perspex must bear in mind that the clearest line, especially with side illumination, is produced by cutting the perspex with a sharp knife and not by scratching.

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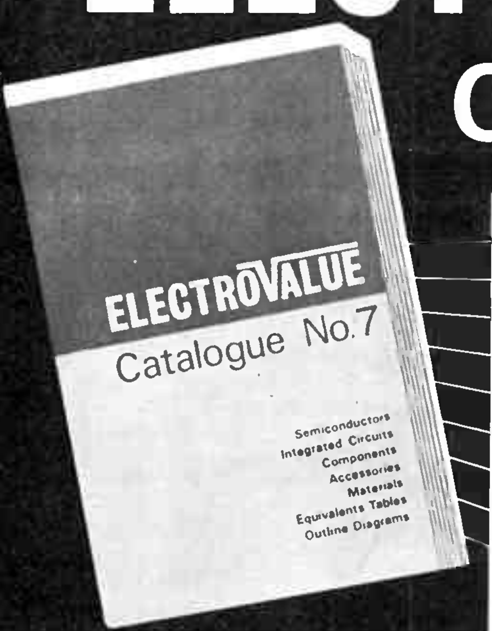
## CATALOGUE 7

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| C | 3/4 | 4·7–10M | 1·5 | 1·2 | 0·9 nett |
| C | 1 | 4·7–10M | 3·2 | 2·5 | 1·9 nett |
| MO | 1/2 | 10–1M | 4 | 3·3 | 2·3 nett |
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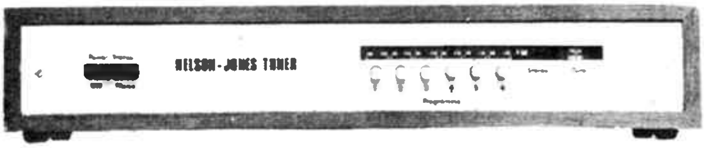


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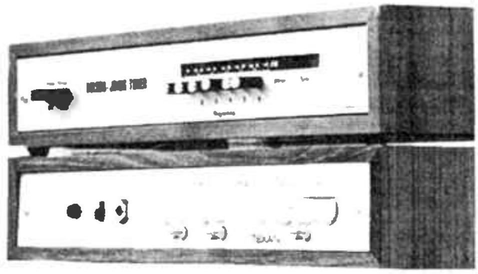

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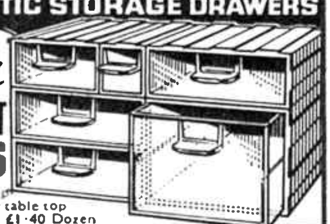

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## PHOTOGRAPHY

Photographic film (even so called panchromatic) is most sensitive in the blue region and for this reason blue tubes are best suited to making photographic records. However, fast film (400ASA) together with a wide aperture, f2·8 or better, can give reasonably short exposures from a green tube.

When using single lens reflex cameras, best suited to this type of work, it is important to remember that the image on the film is scanned from right to left (lens inversion) and the direction of motion of the blind could well be from left to right, giving a small vertical exposure if the scope sweep speed is slow. The average shutter takes 1/30 or 1/60 of a second to scan the film and so one must be aware of these difficulties when dealing with fairly slow sweep speeds at fast shutter speeds. For single shot photography it is best to have the shutter completely open before the appearance of the trace.

## ABERRATIONS

The ideal characteristics of a cathode ray tube are not always realised in practice due to assumptions in the theory, or plain constructional error (anodes off axis, etc.). One of the most important flaws or "aberrations" is that known as "Astigmatism" and this has already been dealt with, together with its cure.

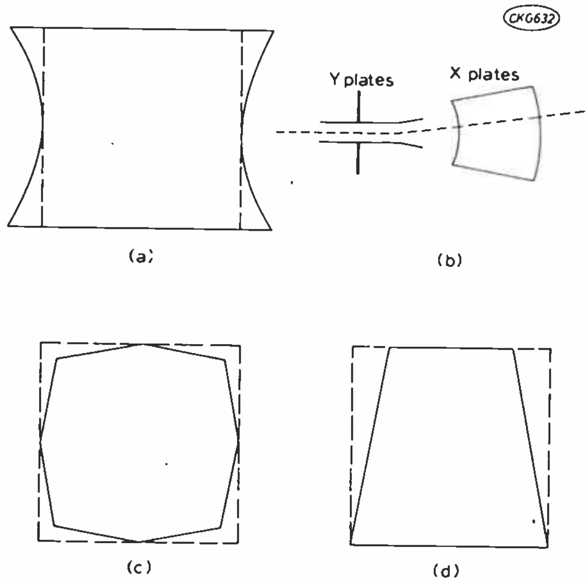


*Fig. 8: Pin cushion distortion (a) can be corrected by shaping the plates as in (b). (c) illustrates barrel distortion and (d) trapezium distortion.*

Most of the other aberrations are most apparent when the tube is displaying a raster. Ideally such a raster should be capable of being focused into a perfect square of scan lines, all in focus. Some defocusing occurs in deflections due to lens action between the final anode and plates, and between the plates. The effect between the plates is reduced by placing an "interplate shield" between the two sets of plates with a hole for the beam to pass through. This shield is at final anode potential and reduces the defocusing effects.

If the raster takes on the shape of Fig. 8a the distortion is known as pin-cushion distortion and is caused by the deflected beam travelling through a greater distance between the second set of plates thus arriving at an oblique angle. This can be reduced by making the second pair of plates as in Fig. 8b. Fig. 8c shows barrel distortion caused by loss of extreme scanning sensitivity due to the PDA fields. This can only be reduced by careful design of the PDA spiral. Fig. 8d shows trapezium distortion. This is caused by asymmetrical Y deflection accelerating the beam as the driven Y plate goes positive and decreasing the X sensitivity accordingly. Specially designed plates are available for asymmetrical deflection only.

## CRT DEFECTS

Other defects occur in specific tubes and it must be realised that any CRT is a compromise between conflicting factors. Consequently the best instrument tubes as fitted in laboratory scopes can cost several hundreds of pounds, but the home constructor can purchase surplus tubes for just a few pounds and many quite good home-made scopes have been built using these tubes.

With age or abuse cathode ray tubes tend to develop faults the most serious of which is likely to occur at virtually any time, is when the mechanical structure of the electron gun fails. The gun is constructed with tiny spot welds and severe shock or vibration can cause an element to be dislodged. If this happens the tube is almost surely destined for scrap.

Also linked to the mechanical structure of the tube is a fault producing what is known as a "soft" tube. This occurs when a small amount of air leaks into the bulb through an imperfect glass-to-metal seal. This may become evident only after many hours of operation and the symptoms are a diffuse display and a blue glow in the gun assembly. As the pressure inside the tube rises further, tracking occurs in the gun and external circuits can be damaged. In order to avoid this fault occurring it is necessary to take great care when handling the tube and making connections to it. Connections should never be soldered directly on to the tube pins as this is almost certain to break a seal or even crack the envelope, with glass flying everywhere at high velocity.

Perhaps the most common fault, linked directly to old age, is low cathode emission. The cathode surface looses emissivity either by the emissive layer evaporating or becoming poisoned by the remaining gas in the tube. The effect is that in order to see a trace at all the brightness control has to be advanced so far that the beam spot goes out of focus and silvery. The silvery effect is due to the cathode emitting in patches and on some scopes, if the focus control has sufficient range (making focus anode nearly the same potential as final anode), it is possible to produce an image of the cathode on the screen. The image looks a little like the full moon, the dark patches representing areas of low emission.

Sometimes a low emission tube can be improved by deflecting the spot off screen and turning brightness full up for a couple of hours. If this does not work a small transformer supplying 6·3V+10% can be used to supply the heater (common practice in TV's). However the insulation of such transformers is doubtful over 1kV and a breakdown would make the tube heater/cathode short or damage it in an even worse manner. A small auto transformer is perhaps the best idea, fed from the normal tube heater supply with a boost of about 10%.

Really bad tubes (that would be thrown out anyway) can sometimes be restored by the circuit in Fig. 9. The heater of the CRT is supplied with 6, 8 or 10V from T1. When the HT switch is closed a small current will flow due to cathode emission. This current strips the top coating off the cathode and if the emissive layer beneath is better then the current will rise. 10 or 15mA is typical of the current to be expected from a good tube if R1 is made 12kΩ.

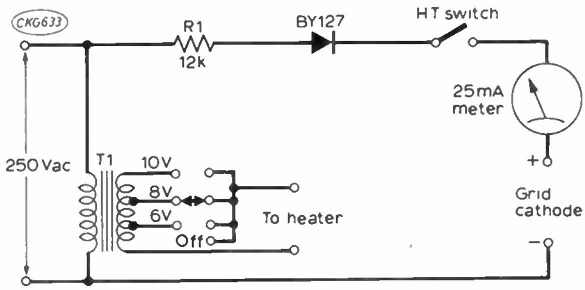


*Fig. 9 : Circuit of arrangement to restore the cathode emission of a CRT.*

The pulse nature of the HT helps the stripping, but if nothing happens then 8 volts can be tried on the heater, 10V is for a real emergency! In many cases switching the heater off with HT still applied, at low cathode temperature, quite vigorous stripping can occur. This is shown by rapid kicks of the meter and small flashes in the gun. In this way really bad tubes can be recovered but it is also possible to weld the grid and cathode together or strip the cathode completely so it should be saved as a last resort.

A3 +150V, Y plates and X plates (depending on external deflection circuits) +150V, PDA anode +1kV. Springs on A3 contact the graphite coating leading to the PDA spiral.

R1, C2 and C3 smooth the −EHT line and R4, C5, and C6 smooth the PDA line. In simple scopes with PDA tubes the PDA is sometimes connected to the highest HT line. C1 couples pulses to the grid to bias the gun off during timebase flyback and R2 is merely to isolate the grid from the EHT line.

When the PDA potential required is only low the EHT is derived from a mains transformer, but when 10kV or so is required, together with high beam currents, use is made of an RF EHT supply. This generates AC at about 30kHz and is fairly safe. We shall consider this in greater detail in a later section on power supplies, but one important advantage must be mentioned here.

Because the RF EHT supply is self generating, involving usually an oscillator and a power output stage driving a transformer, the supply is easily stabilised against variations by sampling the output and applying feedback and, because of the high frequency, smoothing is relatively simple.

## SPECIAL TUBES

Often it is necessary to present two traces simultaneously on one tube, scanned by a common X timebase. Although successful electronic methods are available to enable two traces to be presented apparently simultaneously a double beam tube is favoured for some applications.

The simplest approach is to construct two guns in one envelope, each with a set of Y plates and common X plates. This method is expensive, however, and the principle usually adopted is to split

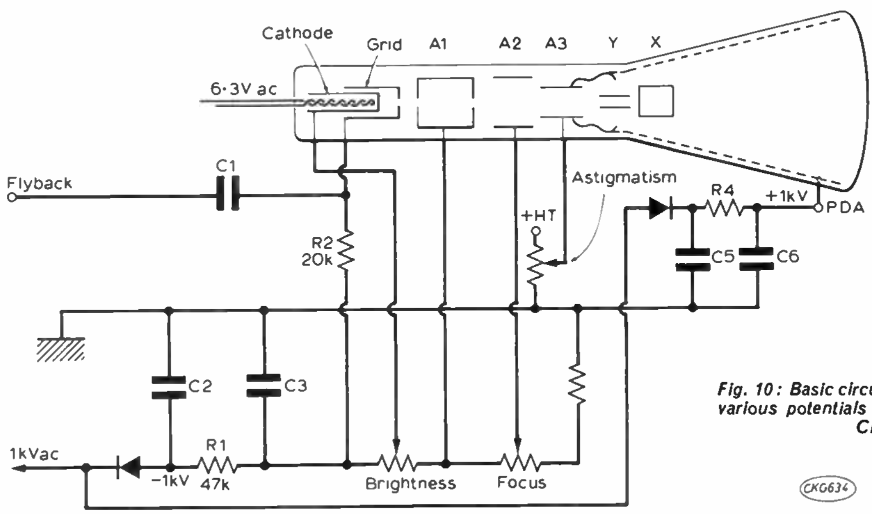


*Fig. 10: Basic circuit for supplying the various potentials required by a PDA CRT.*

## CRT POTENTIALS

We are now in a position to consider the arrangement of the potentials on the tube to provide the necessary electric fields. Fig. 10 shows a typical arrangement. As we saw earlier A3 must be the same potential as Y plates and so the potentials are decided around this. Typical potentials might be grid −1000V, cathode −995V, A1 −850V, A2 −150V,

the beam. Usually the splitting is done by a splitter plate connected to the final anode. A snag with this method is that secondary electrons produced at the plate cause high background illumination of the screen. Sometimes this is prevented by performing the splitting between A1 and A2.

**To be continued**

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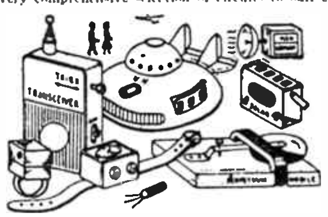

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# SAFETY IN DOMESTIC ELECTRONICS

THE British Electrotechnical Approvals Board for Household Equipment was set up by the British Standards Institution to promote the widespread practice of standard safety rules in domestic electrical and electronic apparatus. The scheme is now being extended to include audio and radio products within the first group, i.e. record players, record players with radio, radiograms and mains/battery portable radio receivers with rated audio outputs up to 6+6 watts stereo and 10 watts mono, both continuous sine wave ratings.

The scheme applies the specifications and testing procedures as detailed in BS415: 1972 (with amendments). This short article has been prepared to assist constructors and users of related equipment, since some of the specifications in BS415 are of particular interest to constructors.

The specification states the scope of the safety requirements, the definition of terms used in context, the general requirements, conditions of test, marking and instructions, ionizing radiation, heating, electric shock, insulation, fault conditions, mechanical strength, components, terminal devices, flexible cables, connections, television and other picture tubes and mechanical stability. The notes that follow are for guidance only, in the interest of practising safety considerations.

## GENERAL REQUIREMENTS

Under the terms of BS415 adopted for the scheme, the apparatus is expected to be designed and constructed to present no danger and in particular provide for personal protection against electric shock, and the effects of excessive temperature, ionizing radiation, implosion, fire, mechanical instability and moving parts.

## MARKING

The equipment should have indelible markings, that cannot be removed by rubbing with cloth soaked in petrol or water, on the exterior (but not on the bottom) or inside a removable lid. The information to be marked should include the following:

1. The nature of the supply, a.c. or d.c. using symbols according to BS3939.
2. The rated supply voltage or range of voltages. In the latter case the indicated voltage setting being used must be clearly shown.
3. The rated mains frequency in hertz if a.c.
4. The voltage and current or power which may be drawn from the main unit to supply other units.
5. Warning of live parts made accessible by removing or opening a cover.
6. Mains flexible leads should have a label attached if permanently connected to the equipment, or a marking should be close to the mains connecter on the equipment, giving the following information (for U.K.): "Warning: this apparatus must be earthed".
7. Mains flexible leads should be connected in accordance with the British Standard colour code: Brown to "live", L, or red painted terminal; Blue to "neutral", N, or Black painted terminal; Green and Yellow to "earth", E, green painted or earth symbol terminal.
8. Fuses should be used to protect equipment and the ratings marked close to the fuse (if mounted on equipment) or by labelling the mains supply lead. (As a guide, for equipment of power consumption rated at less than 500W use a 3A fuse, or to withstand switch-on surges, a 5A fuse; for power consumption rated at less than 800W use a 5A fuse; for less than 3kW use a 13A fuse. It is seldom wise to use a 13A fuse to protect small equipment of less than 500W.) The power consumption should be indicated and not exceeded by more than 10%.

## TERMINALS

1. Where a separate safety earth terminal is fitted the standard symbol (BS3939) should be visibly marked adjacent to it.
2. Where terminals are live under normal operating conditions a symbol should be marked adjacent to it to indicate this fact. This should include the output terminals of high power amplifiers and transmitters.
3. The outputs of "battery eliminator" units should clearly indicate by marking near the terminals the load power and voltage that can be handled.
4. Terminals used for inter-connecting one or more units to a "master" power supply source should indicate ratings as in number 3 above.

## SHOCK PROTECTION

Inaccessible live terminals used for providing connections to other units should be protected by an insulated and captive cover. Live terminals should not be easily accessible during normal operation.

Accessibility is determined by BSI as being touchable by inserting through apertures, or otherwise easily applying, a "standard test finger". For test purposes, this finger is approximately equivalent in size to an average adult index finger 80mm long by 12mm across its narrowest thickness. Also used is a "standard test pin" 25mm long by 6mm diameter, being near the size of a pencil.

Live operating shafts and apertures should be adequately protected so that a free hanging endless metal test chain of 2mm diameter (approximating to a lady's metal necklace chain of small links) cannot make electrical contact through any aperture.

Knobs, levers, push-buttons and similar manually operated devices should be fastened so that their operation will not impair the protection against shock. When removed by detaching the fixing screw, pin, or clip, there should be no exposed live parts.

A metal pin 100mm long and 4mm diameter should not be capable of being brought into contact with any live part, through any aperture, when held by the fingers.

Access holes for setting up of preset controls by means of a screwdriver or hexagonal key wrench should not introduce a risk of the tool touching live parts with a risk of shock. Any other hole within 25mm of this hole should not involve the risk of a shock.

### OTHER POINTS

Accessible metal parts should be connected to the earth wire of a 3-core mains cable and effectively earthed through the mains wiring system.

Resistors should not present unstable overload conditions in the event of a short-circuit or disconnection through fault conditions, presenting a hazard under any of the safety requirements. Similarly, with the breakdown of capacitors, normally having adequate dielectric strength for the voltage rating quoted by the maker, such a hazard should not result.

High voltage components and assemblies (above 5kV) should not give rise to risks of fire to surrounding apparatus or give rise to any other hazard.

For equipment provided with a connector socket for the mains supply, the safety earth terminal should be an integral part of this socket.

Terminations (including screw, soldered or crimped) should be so located or shielded that even one strand of the conductor, that may escape the termination, does not present a risk of accidental contact with another live part or metal accessible part.

Screw terminals should be fixed so that they will not work loose when the nut or screw is tightened or loosened during normal fixing or detachment of connections. Screw terminals should not cause damage to the wire when tightened, thus risking a subsequent fracture.

Flexible mains leads should comply with BS6500.

### FINALLY

These are just some of the points worth noting. We would add here that small children are at particular risk unless special care is exercised regarding accessibility to equipment and, of course, hot soldering irons. If you have small children please do not leave your workbench unattended without first making sure that they connot gain access to your work. Best to lock the door and/or switch everything off. Large electrolytics hold their charge for some time; it is wise to tape the terminals to insulate against accident touching.

Always use a protective guard for your soldering iron and never leave an exposed hot iron hanging by a hook. Splashes of hot solder and flux can ruin your clothes; wear an overall or old working trousers.

It is always a wise move to have a first aid kit for cuts and shock. Minor burns can be best treated by running cold water on the affected area immediately for at least three minutes. More serious burns should be seen by a doctor. Never apply ointments or creams to a burn without first seeing your doctor.

British Standard specifications can be inspected free of charge at the BSI library in London, W.1. Purchases should be addressed to BSI Sales Dept., Newton House, 101 Pentonville Road, London N1 9ND.

Manufacturers and vendors wishing to be considered for application of BEAB approval to their products are invited to apply to BEAB, Mark House, 153 London Road, Kingston-upon-Thames, Surrey KT2 6NX with full details of their products. All applications within these categories should be received by 8th March, 1974. ■

# off the record

As this is the last issue of *Practical Wireless* in Volume 49, we thought that readers would be interested in a few details before we launch into the 50th volume next month.

Volume 49 carried the most number of pages (1,232 plus covers) in the 33½ years history of monthly *Practical Wireless*. The previous best was 1,184 in volume 37, 1961-62, for 12 monthly issues. Pre-September 1940 issues were weekly. Of these (taken over a six-month period) Volume 1 1932-33 carried 1,256 pages and Volume 3 1933-34 carried 1,184 pages.

There were 89 constructional articles and serial parts, 46 features and serial parts, 8 Datacards, 3 Crosswords, 2 Supplements, 1 competition, 1 special offer, plus the usual regular News and Comment items, all in Volume 49.

We have not counted the number of components that have been listed for our projects, but would make an estimate of several thousands. This may explain the reason why we have broken records with advertisements too, more than 760 pages in Volume 49. There were more than 500 pages of editorial material. What a bargain for £2·50!

The official ABC (Audit Bureau of Circulations) figure for the circulation of Practical Wireless for the six-month period July to December 1973 showed a 0·37% increase over the same period of 1972. This was greater than its nearest rivals in a similar field in the U.K., and it still represents the highest ABC figure of all U.K. do-it-yourself radio and electronics journals.

It does show that the magazine's strength is in the active participation of you, the readers, buying components and making them into working projects. Our records of response to advertisements endorse this statement. There must be many of you who are equally content to read about other constructors' activities. For these readers and those of you who are just starting to follow our projects, why not have-a-go now? What's that—you have no good tools? Then you simply must invest in our Special Offer Tool Kit!

### COMING SOON

We have some unusual ideas coming in our summer issues, details of which will be given next month. If you can't afford a holiday this year, you can afford 25p for *Practical Wireless* each month. If you can afford a holiday, take P.W. with you. Thousands do!

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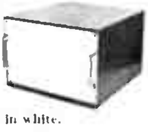

Model 120 all aluminium two part construction. Top and sides, blue hammer finish, front, rear and base: white. Others: mild steel three part construction.
Top, base, sides and detachable rear panel, blue hammer. Detachable aluminium front panel finished in white.

Dimensions in inches. Model 320

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| 221 | 8 | 6 | 6 | £2·90 |
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| 15 | 63 | 6p | 150 | 40 | 10p | 680 | 40 | 22p |
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| 22 | 25 | 6p | 220 | 4 | 6p | 1000 | 10 | 12p |
| 22 | 63 | 6p | 220 | 10 | 6p | 1000 | 16 | 18p |
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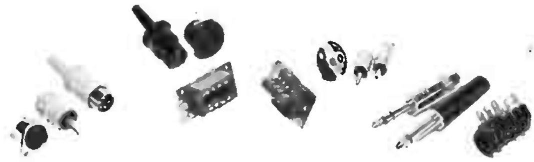
| 47 | 63 | 6p | 330 | 63 | 22p | 4700 | 4 | 22p |

## PLUGS AND SOCKETS



**DIN PLUGS**
2 pin (1 flat) 8p
3 pin 9p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p

**DIN Sockets**
2 pin 6p
3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 7p

**MAINS**
P360 3 pin 1·5A chassis plug with line socket. Per pair 28p
8A 2190 3 pin 5A chassis plug 20p
8A 1862 Line socket for above 23p

**McMURDO**
RP8 8 way chassis plug 47p

RS8 8 way chassis socket 62p

**PHONO**
Plug plastic 5p
Plug screened 9p
Chassis socket 4p

**JACK**
Std. ¼" mono plug
Plastic 13p
Screened 17p

Std. ¼" stereo plug
Plastic 18p
Screened 25p
Open mono socket ¼" 10p; Moulded mono socket ¼" with 2 break contacts 13p; Moulded stereo socket ¼" with 3 break contacts 18p; 3·5mm. plug plastic 8p; screened 11p; open socket 8p.

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Silicone grease in special dispenser 20ml. 43p

Red neon 240V panel mounting 25p

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Panel fuse holders 20mm 20p; 1¼" 35p

Transformers
LT700 min. output transformer Pri. 1·2k Ω Sec. 5 Ω 200mW 37p

Sub-min. Mains Transformer
6-0-6V 100mA 95p

12-0-12V 50mA 95p
Size: Both approx. 30 × 27 × 25mm.

Min. Mains Transformer (Size: 46 × 31 × 38mm) 0-12V 250mA, 0-12V 250mA £1·36

Mains transformer MT3AT
Pri. 200-220-240V, Sec. 12-15-20-24-30V 2A £3·05

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Single gang Lin or Log
5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) 12p

Dual gang (Stereo) without switch Log or Lin 5k to 2M as above 38p.

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 23p

**PRESETS**
Sub-miniature 0·1W
Vert or Horiz
100, 250, 500, 1k, 2·5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M 6p

Wirewound 10% 1W ¼" spindle 10, 50, 100R 34p; 250, 500, 1k, 5k 33p; 10k, 37p; 25k 40p; 50k 44p.

## RESISTORS

| | | | |
|---|---|---|---|
| Carbon Film ⅛W 5% | 1 Ω to 1M; 10% 1·2M to 10M | E12 | 1p |
| Carbon Film ¼W 5% | 1 Ω to 10Ω; 10% 1·2M to 10M | E12 | 1p |
| Carbon Film ½W 5% | 11 Ω to 910k | E12 & E24 | 1p |
| Carbon Film 1W 5% | 10 Ω to 10M | E12 | 3p |
| Metal Oxide ½W 2% | 10 Ω to 1M | E12 & E24 | 4p |
| Wirewound 2½W 10% | 0·22ohms to 0·47ohms | E12 | 10p |
| Wirewound 2½W 5% | 1ohm to 270ohms | E12 | 10p |

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

## KNOBS

All ¼" shaft. Grub screw fixing

Diameter shown in brackets

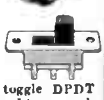
K30/1 (13mm) 26p
K30/3 (17mm) 23p
K30/2 (13mm) 26p
BK12 32mm long, black pointer with white stripe 6½p
K30/6 (32mm) 42p
F18 (26mm) with numbered skirt 23p
F12 (33mm) 23p
MK50 (34mm) 29p
CK4 (36mm) 15½p

## SWITCHES

Rotary with adjustable stop 1 pole 2 to 12 way; 2 pole 2 to 6 way; 3 pole 2 to 4 way; 4 pole 2 or 3 way, each 24p.
Mains rotary DPDT 250V 2A 20p.

Push to make non-locking 13p

Toggle 250V 1·5A with ON/OFF plate 25p.



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# ON THE AIR

## BROADCAST BANDS

### SHORT WAVE DX

**by MALCOLM CONNAH**

ONE of the most frequent questions asked by those of you who have written to me recently has been about the modification of the CR100 receiver mentioned in an earlier article. These modifications were described in detail by C. Molloy in the April 1968 issue of *Practical Wireless.*

I appreciate that an issue of this age is rather difficult to come by, but I feel sure that anyone who is really interested should be able to obtain one. (Out of print—Ed.) Perhaps the best way of tackling the problem of finding a copy is to use the CQ column of this magazine.

Two months ago I mentioned that Radio New Zealand should soon be audible again. News has just reached me, via DX Corner Belgium, that the station has recently been heard in the U.S.A. Radio New Zealand was heard on 9540kHz at 0600 and again on 11780 at 0700. Reception was better on the latter frequency.

I know that it means getting up early in the morning, or alternatively staying awake all night; but how about one (or more) of our readers trying to receive this fairly rare station.

Radio Clube de Mozambique is reported to be using 120kW on 7210 from 0700 to 1400 and on 11820 from 0350 to 1500. Tests are also being carried out on 15293kHz.

### Readers' Logs

By way of coincidence the first log this month comes from New Zealand. **Ian Cook** of Nelson has a Stewart-Warner R-146X, 7-valve receiver and a 120ft end-fed aerial which extracted the following signals from the Antipodean ether:

3995 *Solomon Islands BS,* in English at 0945.
5960 *R. Canada Int.,* in French at 0610.
9009 *Kol Israel* in English at 0510.
9520 *RNE, Spain* in Spanish at 0310.
9625 *R. Canada,* in English at 0830.
10135 *Voice of Vietnam, Hanoi* at 1030.
11745 *HCJB, Quito, Ecuador* in English at 0530.
11875 *Radio Japan,* in English at 0930.
11890 *FEBC, Manila* in English at 0935.

**Simon Wormleighton** and **"J. P." Fletcher** have returned to school in Cirencester and send the following log using an impressive line-up of equipment (Heathkit SW717 with 35ft wire; Astrad-Altair with 150ft wire and HRO with 8 metre folded dipole):

6090 *R. Luxembourg* in German at 1130.
7095 *R. Pakistan* in English at 1820.
9770 *ORF, Vienna* in German at 1200.
11705 *Kol Israel* in English at 2000.
15012 *Voice of Vietnam, Hanoi* at 1800.
15155 *RSA, South Africa,* in Dutch at 1700.
15185 *R. Finland* in English at 1820.
17920 *R. Cairo, U.A.R.* in English at 1405.

A gentleman from Northville Road, Bristol who remains anonymous as there is no name on his letter used his CR-100 (Modified) and 150ft long-wire to hear:

5930 *R. Prague, Czechoslovakia* at 1930.
5995 *VOA, Tangier* noted at 2130.
6005 *R. Berlin Int.* in English at 1735.
6155 *ORF, Vienna* in English at 1830.
6190 *Vatican Radio* noted at 2000.
7065 *R. Tirana, Albania* at 2210.
7110 *VOA, Rhodes* noted at 2125.
7275 *RAI, Rome* in English at 1920.
9735 *TWR, Monte Carlo* noted at 0915.

**Paul Broadhurst** from Clevedon in Somerset obtained a Trio 9R59-DS three weeks before sending in this report which is the result of those three weeks of listening. The antenna was a 150ft long wire.

5930 *R. Prague, Czechoslovakia* at 1915.
6020 *R. Kiev* in English at 1932.
6025 *R. Portugal* noted at 2105.
6050 *RAI, Rome* in English at 1930.
6065 *R. Sweden* in English, at 1600.
6070 *R. Sofia, Bulgaria* noted at 1930.
6150 *R. Belgrade, Yugoslavia* at 2010.
6165 *Swiss Broadcasting Co.,* English at 1330.
6190 *Vatican Radio* in English at 2050.
7220 *R. Budapest, Hungary* noted at 1630.

**Richard Starkey** of Southampton is another reader with a new receiver, this time a Vega VEF 206. Using only the built-in telescopic aerial Richard heard the following stations:

5930 *R. Prague, Czechoslovakia* at 1900.
6025 *R. Budapest, Hungary* in English at 2300.
6065 *R. Sweden* in English at 2100.
6100 *R. Belgrade,* Yugoslavia at 2000.
9625 *R. Canada Int.* in English at 2100.
11740 *AFRTS, U.S.A.* in English at 1900.
11970 *RSA, South Africa* in English at 1900.

## MEDIUM WAVE BROADCASTS
### by CHARLES MOLLOY

FROM Orkney, **G. M. Christie** reports hearing BBC Radio London on 1457kHz and IBA Radio Clyde 1151kHz at good strength but subject to fading. He remarks how surprising it is to hear local stations at such a distance. This of course highlights the attraction of medium wave DXing. The majority of medium wave stations serve areas limited by the ground wave (daylight range) but after dark signals can be propagated by skywave far beyond the service area to be picked-up, when conditions are favourable, by 'eavesdroppers' thousands of miles away.

**F. F. Wildman** (Bournemouth) has been listening to the "As it Happens" programme broadcast by CBA Moncton N.B. in Canada on 1070kHz between 2300hrs and midnight GMT. Using his Codar CR70A receiver with the *Practical Wireless* Medium Wave loop antenna he has logged WNEW 1130kHz in New York City; CHER in Sydney, Nova Scotia on 950kHz and WCBS also in NYC on 880kHz.

**W. Pennington** (Grimethorpe, Yorks) sent in an excellent log of North American DX using his Trio 9R59DS receiver and 25ft outdoor aerial. Canadians heard include CKCM Grand Falls. Newfoundland on 620kHz; CBN St John's Nfld on 640kHz; CJOX Grand Bank, Nfld 710kHz; CJON St John's on 930kHz; CHNS Halifax N.S. on 960kHz; CFRB Toronto on 1010kHz; CBA Moncton N.B. on 1070kHz. From the United States WHDH Boston on 850kHz; WCBS 880kHz; WINS 1010kHz; WHN 1050kHz and WNEW 1130kHz, the last four being in New York City. Reception was between 2300hrs and midnight in January but it is possible to hear these stations in March and April from approx. 0100hrs GMT until sunrise.

**Ed Baker** brought along his Eddystone EB35 when he went on holiday to Majorca and he hooked onto the hotel heating pipes for an aerial. On the Long Waves Azilal, Morocco 209kHz and Tipaza, Algeria 251kHz were heard during daylight together with medium wave outlets in Algeria on 548kHz, 890kHz, 980kHz and 1421kHz. After dark, Caltanisetta, Sicily was heard on 566kHz; Cagliori, Sardinia on 1061kHz; Libya on 1124kHz and 1250kHz. Ed has been interested in MW DXing since 1962 and has received verifications from MW stations in 136 countries.

**Simon Hockenhall** (Helston, Cornwall) has an HMV 4-band receiver and a 60ft longwire antenna. He reports afternoon reception on the long waves of Motala, Sweden on 191kHz and Azilal, Morocco on 209kHz. On the medium waves Oviedo, Spain 548kHz; Cork, Eire 1250kHz and Nice, France 1554kHz were heard. **John Thorburn** (Glasgow) used a Vasco Radio with internal ferrite aerial to log BBC R. Merseyside 1484kHz; R. Bristol and R. Teesside on 1546kHz; Tunis on 629kHz; Cairo, Egypt 773kHz; Lisbon, Portugal 755kHz. **Philip Allott** (Knaresborough, Yorks) has an HRO receiver with vertical antenna and has picked-up BBC local stations at Blackburn 854kHz; Sheffield 1034kHz; Leeds 1106kHz; Stoke 1502kHz; Nottingham 1520kHz; Teesside 1546kHz.

**Richard Buckby** of BBC Radio Derby sends details of the transmitter operating on 1115kHz (269m). The temporary caravan transmitter is situated at the village of Burnaston, between Derby and Burton and runs 500W into a 110ft vertical mast. Reception reports are welcome and should be sent to Richard at BBC Radio Derby, St Helen's Street, Derby, DE1 3HY.

## VHF/FM DXING
### by SIMON DAVID

MUCH as I dislike saying this, some of you really are not trying hard enough. Often the cry comes up that you can get BBC programmes but no continentals and, in the south not a good IBA station. This is incredible for the Greater London area and home counties readers who write to me.

Success depends on a combination of factors including tuner sensitivity, aerial used, the nature of the terrain between aerial and transmitter, the rotational direction that achieves maximum pick-up by the aerial, atmospheric conditions. *Practical Wireless* has published considerable information recently to help which I recommend to all DXers of FM.

In the February issue, my article mentioned details of an aerial I have tried. One important aspect in its characteristics was uniformity of loading impedance over a broad band of the FM scale involving broadcast programmes. Without this inbuilt factor in the aerial design, the aerial is usually designed to tune at one frequency, the response tailing off slightly on either side.

This is usually the cause of noisy reception and lower levels at extreme ends, i.e. the 89MHz and 97MHz extremes. Since BBC Radio 2 and the L.B.C. programmes are near these frequencies their signal strength and/or noise will be inferior unless a broadband near perfect match aerial is employed, such as the Antiference FM263T, 264T and 266T or the equivalents by other manufacturers.

Having fitted such an aerial, then you stand a better chance of picking up the French stations I mentioned, although weak stations may still be subject to fading and drifting.

Many of you in Northern districts and in Scotland have some difficulty because of the hilly country but it should be possible to receive something, if your aerial is aimed in the right direction with reflector behind the dipole. You could try picking up Irish stations (in the north-west and Wales) and local BBC radio stations up to about 200 miles away. For those of you near the east coast from Aberdeen right down to Kent, you could try for stations in Scandinavia, Holland and Belgium.

Here are some stations to aim at: Oslo 88·65MHz, Bokn 93·5MHz (both Norway); Roermond 88·2MHz(s), 90·9MHz(s), 94·5MHz, all Netherlands; Aalter (Begium) 90·4MHz, broadcasting the Dutch Network. Mild weather conditions and high humidity should help you.

Let me know how you get on and I will include your results in my article. In the meantime my thanks to the following readers, among others, who have written to me on subjects related to this article. **H. Lincoln** of Enfield also comments on the effects of mains voltage reductions; **S. A. Logier** of Belfast has just taken up DXing on retirement; **N. S. Gonzales** of Chiswick, London, wants less noise, particularly from disc jockeys.

Finally, some details on IBA developments; the following commercial stations are expected to go on the air in 1974, most frequencies to be announced: Birmingham (Feb.), Manchester (March/April), Swansea (summer), Tyneside Wearside (summer), Edinburgh and Liverpool in late '74.

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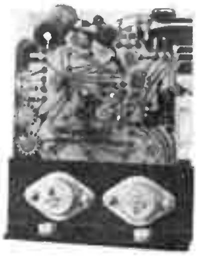

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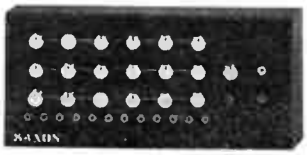


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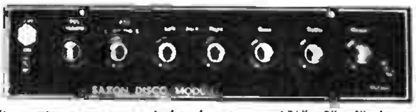


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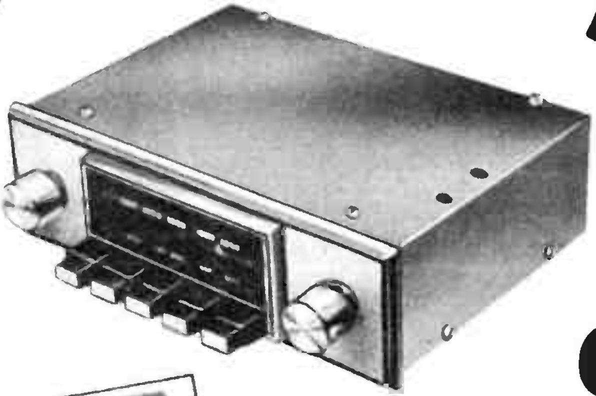

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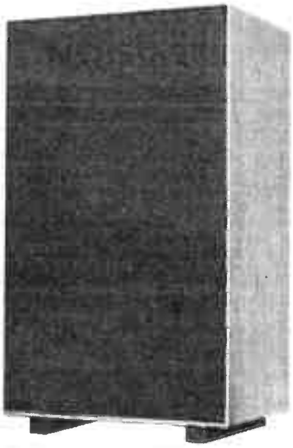

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|---|---|---|---|---|
| 60 | 149 | — | £ 8·40 | 0·38 |
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| 200 | 151 | £ 9·20 | 6·80 | 0·52 |
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| 350 | 153 | 13·00 | 10·40 | 0·80 |
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| 1000 | 156 | 28·22 | 24·97 | 1·20 |
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| Amps 12V | Amps 24V | Type No. | Price £ | P & P £ |
|---|---|---|---|---|
| 0·3 | 0·15 | 242 | 1·22 | 0·22 |
| 0·5 | 0·25 | 111 | 1·22 | 0·22 |
| 1 | 0·5 | 213 | 1·45 | 0·22 |
| 2 | 1 | 71 | 1·90 | 0·22 |
| 4 | 2 | 18 | 2·50 | 0·38 |
| 6 | 3 | 70 | 3·24 | 0·42 |
| 8 | 4 | 108 | 3·60 | 0·52 |
| 10 | 5 | 72 | 4·25 | 0·52 |
| 12 | 6 | 116 | 5·16 | 0.52 |
| 16 | 8 | 17 | 6·04 | 0·52 |
| 20 | 10 | 115 | 9·30 | 0·69 |
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| 60 | 30 | 226 | 20·50 | 1·10 |

## 30 Volts

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

| Amps | Type | Price | P & P |
|---|---|---|---|
| 0·5 | 112 | £1·44 | £0·22 |
| 1 | 79 | 2·00 | 0·38 |
| 2 | 3 | 2·90 | 0·38 |
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| 4 | 21 | 4·25 | 0·52 |
| 5 | 51 | 5·28 | 0·52 |
| 6 | 117 | 6·30 | 0·52 |
| 8 | 88 | 8·18 | 0·67 |
| 10 | 89 | 10·00 | 0·67 |

## 50 Volts

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

| Amps | Type | Price | P & P |
|---|---|---|---|
| 0·5 | 102 | £1·92 | £0·30 |
| 1 | 103 | 2·80 | 0·38 |
| 2 | 104 | 3·90 | 0·42 |
| 3 | 105 | 5·25 | 0·52 |
| 4 | 106 | 6·80 | 0·52 |
| 6 | 107 | 10·00 | 0·67 |
| 8 | 118 | 12·90 | 0·97 |
| 10 | 119 | 16·00 | 0·97 |

## 60 Volts

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

| Amps | Type | Price | P & P |
|---|---|---|---|
| 0·5 | 124 | £1·92 | £0·38 |
| 1 | 126 | 2·70 | 0·38 |
| 2 | 127 | 4·25 | 0·42 |
| 3 | 125 | 6·50 | 0·52 |
| 4 | 123 | 8·50 | 0·67 |
| 5 | 40 | 10·50 | 0·67 |
| 6 | 120 | 12·34 | 0·82 |
| 8 | 121 | 14·56 | 1·00 |
| 10 | 122 | 17·65 | 1·00 |
| 12 | 189 | 19·66 | 1·10 |

## MINIATURE AND EQUIPMENT

Prim. 240V with screen.

| Volts Sec. 1 | Volts Sec. 2 | Milliamps Sec. 1 | Milliamps Sec. 2 | Type No. | Price £ | P & P £ |
|---|---|---|---|---|---|---|
| 3-0-3 | — | 200 | — | 238 | 1·12 | 0·10 |
| 0–6 | 0-6 | 500 | 500 | 234 | 1·30 | 0·10 |
| 0–6 | 0 6 | 1000 | 1000 | 212 | 1·58 | 0·22 |
| 9–0 9 | | 100 | – | 13 | 1·12 | 0·10 |
| 0–9 | 0-9 | 330 | 330 | 235 | 1·30 | 0·22 |
| 0–8–9 | 0–8 9 | 500 | 500 | 207 | 2·04 | 0·30 |
| 0–8–9 | 0–8 9 | 1000 | 1000 | 208 | 2·76 | 0·10 |
| 15–0-15 | | 40 | -- | 240 | 1·12 | 0·10 |
| 0–15 | 0–15 | 200 | 200 | 236 | 1·80 | 0·10 |
| 20–0-20 | -- | 30 | – | 241 | 1·12 | 0·10 |
| 0–20 | 0–20 | 150 | 150 | 237 | 1·80 | 0·10 |
| 0—15 20 | 0–15 20 | 500 | 500 | 205 | 2·70 | 0·38 |
| 0–20 | 0–20 | 300 | 300 | 214 | 1·60 | 0·22 |
| 0–20 | — | 3500 | - | 1116 | 3·00 | 0·40 |
| 20–12 0 12 20 | – | 700 (D/C) | – | 221 | 1·41 | 0·30 |
| 0–15–20 | 0–15 20 | 1000 | 1000 | 206 | 8·80 | 0·38 |
| 0–15–27 | 0–15–27 | 500 | 500 | 203 | 2·80 | 0·38 |
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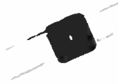
| 600 Volt | 30p | 400 Volt | 50p | 600 Volt | 75p | 400 Volt | 90p |



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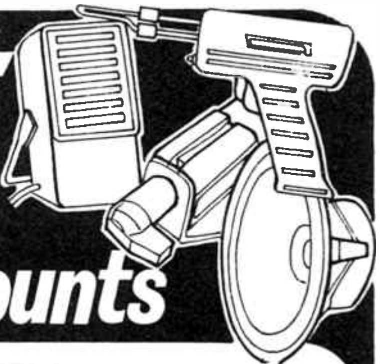

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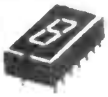

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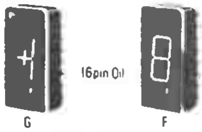


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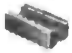

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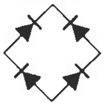

| PIV | 1 amp | RMS | 2 amp |
|---|---|---|---|
| 100V | 20p | 50V | 35p |
| 200V | 22p | 100V | 40p |
| 600V | 25p | 200V | 45p |
| 1000V | 38p | 400V | 50p |

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| PIV | 1 amp | | 3 amp | |
|---|---|---|---|---|
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| 1 watt | Carbon Film | ±5% | E12 Series | 10Ω to 10MΩ | 3p |
| 2 watt | Carbon Film | ±5% | E12 Series | 10Ω to 10MΩ | 6p |
| 2½ watt | Wire Wound | ±10% | E12 Series | 0·22Ω to 0·47Ω | 10p |
| 2½ watt | Wire Wound | ±5% | E12 Series | 1Ω to 270Ω | 10p |
| 5 watt | Wire Wound | ±5% | ~E12 Series | 0·5Ω to 8·2KΩ | 10p |
| 10 watt | Wire Wound | | | 0·5Ω to 6·8KΩ | 11p |
| 10 watt | Wire Wound | ±5% | 10KΩ 15KΩ 20KΩ | 25KΩ | 17p |
| 15 watt | Wire Wound | | | 10Ω to 6·8KΩ | 13½p |

DISCOUNTS 10% on any 100 or more mixed value or wattage, 25% on any 100 or more same value and same wattage

## CAPACITORS

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

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

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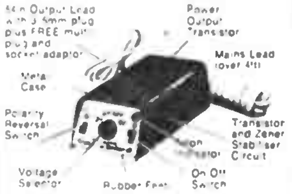
**MULLARD C280 (250V POLYESTER)**—0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, 3½p; 0·068µF, 4p; 0·1µF, 0·15µF, 4½p; 0·22µF, 5½p; 0·33µF, 7p; 0·47µF, 9p; 0·68µF, 12p; 1·0µF, 14½p; 1·5µF, 22p; 2·2µF, 26½p.

## new stabilised
POWER PACK/CONVERTER

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




Our Price £3·99 + P. & P. 16p.

| | |
|---|---|
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| Other Eliminators (unstabilised)* | |
| 6 volts at up to 50mA | £1·65 |
| 9 volts at up to 50mA | £1·65 |
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P. & P. on all models 16p

## ZENERS

All 5% tolerance

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

## TRANSISTORS and DIODES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AC107 | 16p | ASY26 | 33p | BC328 | 24½p | BF180 | 33p | BSY95A | 14p | TIP41A | 81p |
| AC126 | 13p | BC107 | 11p | BCY70 | 17p | BF181 | 33p | BU105 | £1·75 | TIP42A | 99p |
| AC127 | 13p | BC108 | 11p | BCY72 | 17p | BF184 | 28p | BU105/02 | £1·92 | TIS43 | 36½p |
| AC128 | 13p | BC109 | 11p | BCZ10 | 28p | BF185 | 28p | D13V | 53p | TIS73 | £2·10 |
| AC176 | 15p | BC114 | 15½p | BCZ11 | 28p | BF194 | 15p | MJ4000 | £1·49 | TIS91 | 33p |
| AC187 | 22p | BC117 | 22p | BD115 | 74p | BF195 | 17p | MJ4010 | £1·49 | 2N697 | 16½p |
| AC187K | 20p | BC147 | 10p | BD124 | 82p | BF196 | 16p | MJE340 | 52p | 2N706 | 13p |
| AC188 | 22p | BC148 | 10p | BD131 | 55p | BF197 | 16p | MJE2955 | £1·82 | 2N708 | 16½p |
| AC188K | 25p | BC149 | 10p | BD132 | 66p | BF200 | 32p | MJE3055 | 92p | 2N914 | 24½p |
| ACY19 | 25p | BC157 | 13p | BD131/2 | £1·19 | BF200 | 27½p | MPF102 | 27½p | 2N1302 | 20p |
| ACY20 | 22p | BC158 | 12p | BD133 | 72p | BF244B | 27p | MPF103 | 41p | 2N1303 | 24p |
| AD140 | 49p | BC159 | 14p | BD135 | 42p | BF262 | 25p | MPF104 | 45p | 2N1304 | 24p |
| AD149 | 49p | BC168B | 11p | BD136 | 44p | BF263 | 25p | MPF105 | 45p | 2N1305 | 24p |
| AD161 | 29p | BC169 | 12p | BD137 | 50p | BF272 | £1·21 | MPF106 | 49½p | 2N1306 | 24p |
| AD162 | 29p | BC171 | 20p | BD138 | 55p | BF390 | 37p | OC28 | 50p | 2N1307 | 27½p |
| AD161/2 PR | 59p | BC172 | 17½p | BD139 | 61p | BFS28 | £1·61 | OC35 | 50p | 2N1308 | 35p |
| AF114 | 17p | BC174B | 35p | BD140 | 66p | BFW10 | 66p | OC36 | 50p | 2N1309 | 35p |
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| AF116 | 17p | BC178 | 22p | BD202 | £1·37 | BFW87 | 38p | OC45 | 14p | 2N1711 | 28p |
| AF117 | 17p | BC179 | 24p | BD203 | £1·55 | BFX29 | 43p | OC71 | 14p | 2N1893 | 52½p |
| AF118 | 92p | BC182L | 11p | BD204 | £1·37 | BFX30 | 37½p | OC72 | 14p | 2N2160 | £1·54 |
| AF124 | 27p | BC183L | 12p | BF109 | 75p | BFX88 | 26p | OC75 | 15p | 2N2219 | 41p |
| AF125 | 27p | BC184L | 12p | BF115 | 25p | BFY50 | 22p | OC81 | 14p | 2N2646 | 55p |
| AF126 | 27p | BC187 | 27½p | BF160 | 25½p | BFY51 | 22p | OC83 | 25p | 2N2905 | 48p |
| AF127 | 27p | BC212L | 12p | BF167 | 24p | BFY52 | 22p | OC140 | 22p | 2N2924 | 18p |
| AF139 | 35p | BC213L | 13p | BF173 | 24p | BR100 | 43p | OC170 | 28p | 2N2925 | 18p |
| AF172 | 25p | BC214A | 11p | BF177 | 28p | BRY39 | 44p | OC171 | 33p | 2N2926 all | 10p |
| AF179 | 71½p | BC268 | 15p | BF178 | 29p | BSX20 | 18p | TIC44 | 48p | 2N3053 | 19p |
| AF239 | 41p | BC327 | 26½p | BF179 | 33p | BSX21 | 22p | TIC226D | £1·97 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2N3054 | 51p | 2N4289 | 18p | AAZ13 | 11p | BAX13 | 9p |
| 2N3055 | 52p | 2N4441 | 87p | BA100 | 10p | BAX16 | 10p |
| 2N3391A | 29p | 2N4442 | £1·08 | BA102 | 27½p | BAY38 | 41p |
| 2N3566 | 18p | 2N4443 | £1·45 | BA110 | 45p | BB105 | 42p |
| 2N3638 | 20p | 2N4444 | £2·09 | BA111 | 55p | BB141 | 99p |
| 2N3702 | 13p | 2N4871 | 60p | BA112 | 99p | BB142 | 82p |
| 2N3703 | 12p | 2N5129 | 18½p | BA114 | 9p | OA5 | 99p |
| 2N3704 | 13p | 2N5172 | 11p | BA115 | 18p | OA10 | 94p |
| 2N3705 | 12½p | 2N5459 | 89p | BA116 | 9p | OA47 | 11p |
| 2N3706 | 14p | 2N5[illegible] | 47p | BA128 | 11p | OA79 | 10p |
| 2N3707 | 12p | 2N6026 | 18½p | BA129 | 23p | OA81 | 8p |
| 2N3708 | 10p | 3N140 | £1·01 | BA143U | 75p | OA85 | 10p |
| 2N3709 | 10p | 3N141 | 89p | BA143V | 67p | OA90 | 8p |
| 2N3710 | 11p | 3N152 | 181p | BA144 | 20p | OA91 | 8p |
| 2N3711 | 11p | 3N153 | 89p | BA145 | 22p | OA95 | 6p |
| 2N3771 | £1·82 | 40360 | 51p | BA148 | 22p | OA200 | 11p |
| 2N3772 | £2·75 | 40361 | 50p | BA154 | 20p | OA202 | 12p |
| 2N3773 | £2·20 | 40362 | 50p | BA155 | 15½p | OA210 | 19½p |
| 2N3819 | 28p | 40408 | 55p | BA156 | 16½p | OA211 | 30p |
| 2N3823 | 99p | 40430 | £1·39 | BA182 | 26½p | IN914 | 8p |
| 2N3903 | 16½p | 40432 | £2·17 | BA220 | 7p | IN916 | 10p |
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| 2N3905 | 23p | AA119 | 10p | BA222 | 7½p | | |
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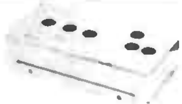
UNLESS SHOWN OTHERWISE P&P ON U.K. ORDERS IS 8p. OVERSEAS ORDERS AT COST



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

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

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1 watt. TAA300 £1·79
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3 watt. SL414 £1·76
5 watt. TBA800 £1·59
7 watt. TBA8105 £1·70
15 watt. BHA0002 £3·95
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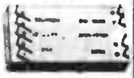
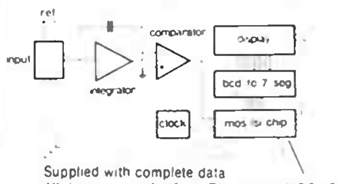


NEW SL414 pin for pin = SL403D 3 watt £1·76

## 3½ decade DVM





- Maximum Display + or − 1 999V
- Minimum Display + or − 1mV
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Supplied with complete data
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inc. all parts for decoder, inc. Veroboard, V.A.T., P. & P. (Leaflet alone 10p.)

## Linears

| | 8 pin Dip | TO99 | 14 pin Dil |
|---|---|---|---|
| [illegible] | 34p | 40p | 35p |
| [illegible] | 35p | 40p | 39p |
| [illegible] | | 45p | 39p |
| 723 | | 96p | 95p |
| 741 | 42p | 45p | 43p |
| [illegible] | | | 92p |
| 748 | 42p | 45p | 43p |

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# the component people

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

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Transistor Range:
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Our Price £1.32

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
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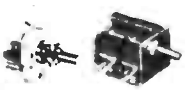
| BFS98 | 20p | ZTX312 | 10p | ZTX503 | 14p | ZS141 | 43p | KSO30A | |
| | | ZTX313 | 11p | ZTX504 | 43p | ZS142 | 33p | Zener | |
| ZTX107 | 10p | ZTX314 | 13p | ZTX510 | 17p | ZS170 | 10p | Series | |
| ZTX108 | 10p | ZTX320 | 31p | ZTX530 | 21p | ZS171 | 13p | as | |
| ZTX109 | 15p | ZTX330 | 15p | ZTX531 | 22p | ZS172 | 16p | BZY88 | |
| ZTX212 | 14p | ZTX331 | 16p | ZTX550 | 17p | ZS174 | 17p | Series | |
| ZTX213 | 14p | ZTX341 | 22p | ZTX551 | 17p | ZS176 | 23p | 11p | |
| ZTX214 | 15p | ZTX382 | 13p | | | ZS178 | 38p | each. | |
| ZTX300 | 12p | ZTX383 | 15p | DIODES | | ZS270 | 11p | | |
| ZTX301 | 13p | ZTX384 | 18p | ZS120 | 8p | ZS271 | 16p | | |

## ELECTROLYTICS

| µF | 4V | 6.3V | 10V | 16V | 25V | 40V | 63V | 100V | 160V | 450V |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | 6½p | | 6½p | 15p |
| 1.5 | | | | | | | 6½p | | | |
| 2.2 | | | | | | | 6½p | | 6½p | |
| 3.3 | | | | | | | 6½p | | | |
| 4.7 | | | | | | | 6½p | | 6½p | 17p (4µF) |
| 6.8 | | | | | | 6½p | 6½p | 8½p | | |
| 8 | | | | | | | | | | 21p |
| 10 | | | | | 6½p | | 6½p | 6½p | | |
| 15 | | | | 6½p | | 6½p | 6½p | | | 24p (16µF) |
| 22 | | | 6½p | | 6½p | | 6½p | 11p | | |
| 33 | | 6½p | | 6½p | | 6½p | | | | 33p (32µF) |
| 47 | 6½p | | 6½p | 6½p | 6½p | 6½p | 8p | | | 25p (50µF) |
| 68 | | 6½p | | 6½p | | | 11p | | | (350V) |
| 100 | 6½p | | 6½p | | 6½p | 8p | 14p | 25p | | |
| 150 | | 6½p | | 6½p | 6p | 11p | 14p | | | |
| 220 | 6½p | | 6½p | 6p | 11p | 14p | 19p | 31p | | |
| 330 | 6½p | | 8p | 11p | | | 25p | 44p | | |
| 470 | | 8p | 11p | | 14p | 20p | 28p | 47p | | |
| 680 | | 10p | | 14p | 20p | 25p | | 59p | | |
| 1000 | 13p | | 14p | 19p | 22p | 25p | 44p | 79p | | |
| 1500 | | 18p | 19p | 25p | | | | | | |
| 2200 | | 18p | 24p | | 39p | 44p | 79p | 149p | | |
| 3300 | | 28p | | | | | | | | |
| 4700 | 25p | | | 44p | 68p | 79p | 148p | 252p | | |
| 6800 | | | | 75p | | | | | | |

## Tuning Gangs



Type C804
5pF 61p 50pF 66p
10pF 61p 60pF 79p
15pF 61p 75pF 79p
20pF 66p 100pF 75p
25pF 61p

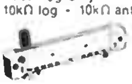
Type 0
365pF 80p
365 + 365pF 96p
Type 00
208 + 176pF with screen and trimmers 99p

P & P all types 10p

## Potentiometers

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

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



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

New Silver and Black Knob 16½p

## Presets

Vertical or Horizontal
0 1 watt 5½p   0 25 watt 7p

| | | | | |
|---|---|---|---|---|
| 100Ω | 1kΩ | 10kΩ | 100kΩ | 1MΩ |
| 250Ω | 2 5kΩ | 25kΩ | 250kΩ | 2 5MΩ |
| 500Ω | 5kΩ | 50kΩ | 500kΩ | 5MΩ |

Cermet Type to 1MΩ only 41p.

## VDR's & Thermistors

| | | | |
|---|---|---|---|
| A15B | 98p | GL23 | £1·21 |
| CZ1 | 16½p | R53 | £1·49 |
| CZ4 | 18p | R54 | £1·61 |
| CZ13A | 18p | VA1005 | 16p |
| CZ19 | 18p | VA1026 | 16p |
| E298CD A258 | 13p | VA1033 | 16p |
| E298ED A256 | 13p | VA1034 | 16p |
| E298ED A260 | 13p | VA1039 | 16p |
| E298ED A262 | 13p | VA1040 | 16p |
| E298ED A265 | 13p | VA1053 | 16p |
| E298ED P268 | 13p | VA1055S | 16p |
| E298ZZ 05 | 13p | VA1056S | 16p |
| E298ZZ 06 | 13p | VA1066S | 17p |
| E299DD P336 | 14p | VA1067S | 19p |
| E299DD P338 | 14p | VA1077 | 19p |
| E299DD P342 | 14P | VA1098 | 21p |
| E299DD P348 | 14p | VA1104 | 31p |
| GL16 | £1·21 | VA1107 | 29p |

Other types obtainable upon application

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**. . . until you tune in to stereo perfection with 'Varicap'**


'p.e.' f.m.
**varicap stereo tuner**

Size approx. $8\frac{1}{4}'' \times 2\frac{3}{4}'' \times 6\frac{3}{4}''$

This elegant and practical stereo tuner features push button 'spot-on' tuning with up to five simple pre-set stations (no difficult tuning dial and drive cord). It's easy 'no problem' construction requires only a few simple setting adjustments with a O.C. Voltmeter. It incorporates NEW pre-set modules for R.F. and I.F. circuits, this eliminates the need for the usually difficult circuit alignment.
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The 'Varicap' is, in our opinion, THE most easily constructed stereo tuner available which will achieve professional results.
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**Total kit price ONLY £28 50 (inclusive of VAT and postage).**

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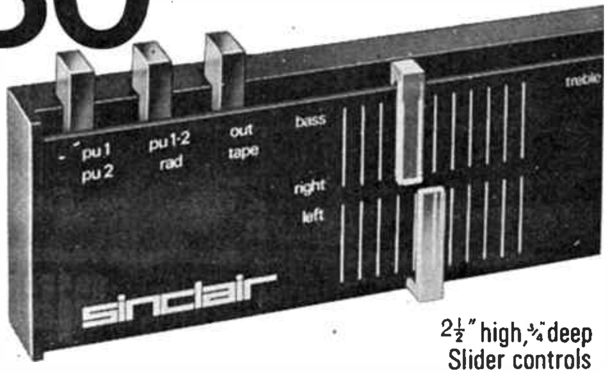


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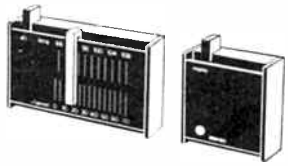

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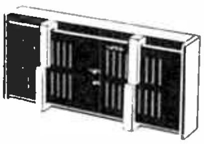

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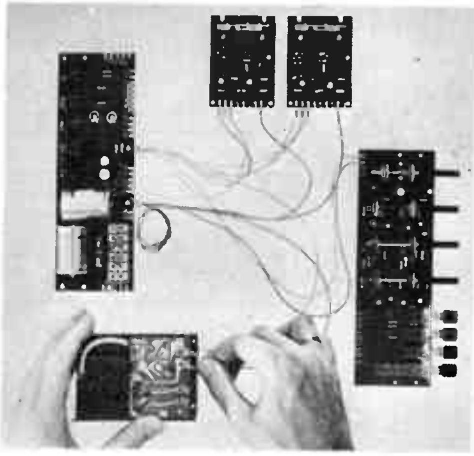

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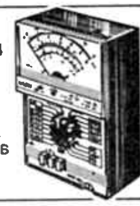

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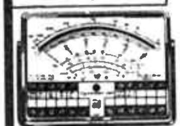

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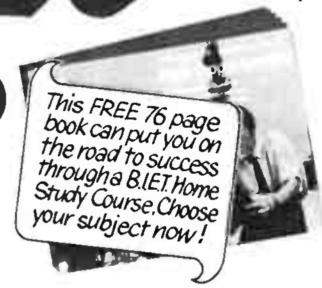


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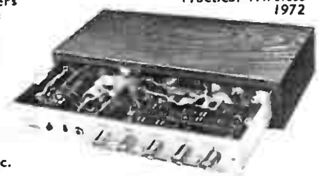

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A completely new high stability stereo FM tuner Features variable capacity diode tuning, stabiliser power supply, IC Decoder, high gain low noise. IF stages. LED indicators. Tuning meter, AFC, easy to construct and use. Mains operated. Slim modern design with fibre glass PC, teak cabinet, etc. Available as a kit to build or ready built. Overall size 8" x 2¼" x 6¾". Produced to give high performance with a realistic price. (Parts list and constructional details Ref. No. 5 30p). Henry's are sole distributors UK and Europe.

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| **R100** 100 watt mixer/amplifier | £57·50 |
| **DISCO AMP** 100 watt mixer/amplifier | £73·00 |
| **Northcourt:** | |
| 400 40 watt mixer/amp | £37·50 |
| 800 80 watt mixer/amp | £45·00 |
| **DISCO MIXER/PREAMPLIFIERS** (OP for up to 6-100 watt amplifiers) | |
| **SDLI** (rotary controls) | £49·50 |
| **SDLII** (slider controls) | £58·50 |
| **DISCO VOX** (slider controls) the complete disco preamp | £72·00 |
| **DJ100** 100 watt power amplifier for above | £49·50 |
| **DJ30L** Mk II 3 channel 3kw sound to light | £41·25 |
| **DJ30L** Mk III slider controls | £45·50 |
| **DJ DISC LITE** as 30L-2 plus variable speed flashes | £54·00 |
| **DIMAMATIC** 1 kW adjustable speed auto dimmer | £25·00 |
| **Carlsboro** Reverberation Unit | £44·00 |
| Disco anti-feedback microphone | £11·95 |
| **Colt** 150 watt liquid wheel projector | £23·50 |
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| Spare Effects and liquid cassettes large range of patterns | £6·00 |
| 6 inch Liquid wheels, various cassettes | £6·00 |
| Mini spot bank fitted 3 lamps | £12·95 |
| Auto Trilite (mini with flashers) | £17·00 |
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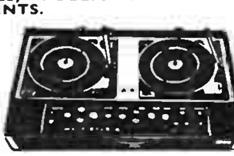

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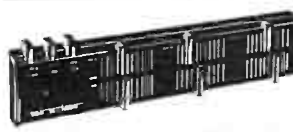

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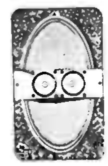

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| **8 ohms full range (post 20p)** | | | | |
| FR4 | 4" | 5 watt | | £4·75 |
| FR65 | 6½" | 10 watt | | £6·30 |
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| AA12 | 5" | 15 watt | | £3·75 |
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