# PRACTICAL WIRELESS

MAY 1977

40p

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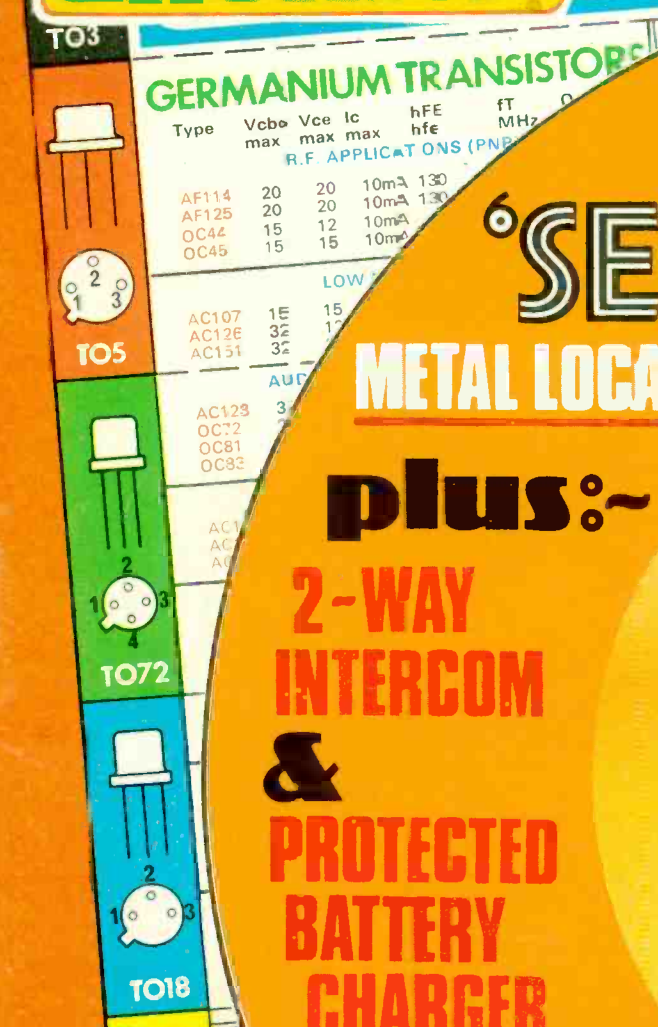
**Here's another!**

**SEMICONDUCTOR CHARACTERISTICS ~CARD**




## THE PW 'SEEKIT' METAL LOCATOR PART 1

**plus:~**

**2~WAY INTERCOM**

**&**

**PROTECTED BATTERY CHARGER**

# RADIO EXCHANGE LTD.

**ALL PRICES INCLUDE VAT**

## NEW EDU-KIT MAJOR

**Completely Solderless Electronic Construction Kit. Build these projects without soldering iron or solder**

- ★ 4 Transistor Earpiece Radio
- ★ Signal Tracer
- ★ Signal Injector
- ★ Transistor Tester NPN-PNP
- ★ 4 Transistor Push Pull Amplifier
- ★ 5 Transistor Push Pull Amplifier
- ★ 7 Transistor Loud-speaker Radio MW/LW
- ★ 5 Transistor Short Wave Radio
- ★ Electronic Metronome
- ★ Electronic Noise Generator
- ★ Batteryless Crystal Radio
- ★ One Transistor Radio
- ★ 2 Transistor Regenerative Radio
- ★ 3 Transistor Regenerative Radio
- ★ Audible Continuity Tester
- ★ Sensitive Pre-Amplifier

Components include: 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★ 5" × 3" Loudspeaker ★ Earpiece ★ Mica Baseboard ★ 3 12-way connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 3 Knobs ★ Ready Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6½ yards of wire ★ 1 Yard of sleeving, etc. Complete kit of parts including construction plans.

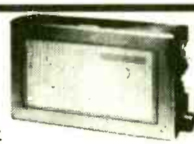
**Total Building Costs £9·00**
P & P + Ins. 85p.

## VHF AIR CONVERTER KIT

Build this Converter Kit and receive the Aircraft Band by placing it by the side of a radio tuned to Medium Wave or the Long Wave Band and operating as shown in the instructions supplied free with all parts. Uses a retractable chrome plated telescopic aerial, Gain Control, V.H.F. Tuning Capacitor, Transistor, etc.
All Parts including Case and Plans.

**£3·95** P & P and Ins. 45p.

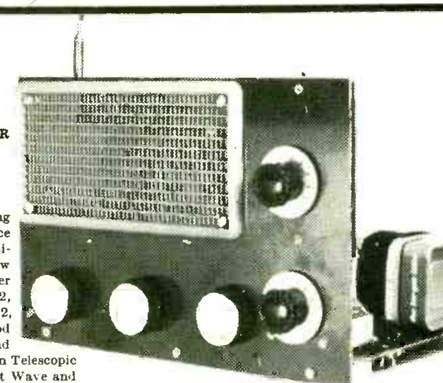
## POCKET FIVE



**NOW WITH 3" LOUDSPEAKER**
3 Tuneable wavebands. M.W., L.W., and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive black and gold case. Size 5¼" × 1¼" × 3½" approx.
All Parts including Case and Plans.

Total Building Costs **£3·60**
P&P+Ins.60p.

## NEW ROAMER TEN MODEL R.K.3.



**MULTIBAND V.H.F. AND A.M. RECEIVER**
**13 TRANSISTORS AND FIVE DIODES**
**QUALITY 5" × 3" LOUDSPEAKER**

WITH Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multi-band A.M. section with Airspaced Slow Motion Drive Tuning Capacitor for easier and accurate tuning, covering M.W.1. M.W.2, L.W., Three Short Wave Bands, S.W.1, S.W.2, S.W.3, & Trawler Band. Built in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome Plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push Pull output using 600mw Transistors. Gain, Wave-Change and Tone Controls. Plus two Slider Switches. Negative Feedback circuit and **SPECIAL POWER BOOSTER SOCKET AND RESISTOR,** to virtually double gain if required. Powered by P.P.9 9 volt battery.
Complete kit of parts including carrying strap. Building Instructions and Operating Manuals.

**£13·99** Including Post and Packing

Case Enclosure Kit (if required) £1·80 inc. P & P.

## NEW Everyday Series

**Build this exciting new series of designs.**

E.V.5. 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9" × 5½ × 2½" approx. All parts including Case and Plans.

Total Building costs **£4·30** P & P + Ins. 60p.

E.V. 6. Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output.
All parts including Case and Plans.

Total Building costs **£4·95** P & P + Ins. 65p.

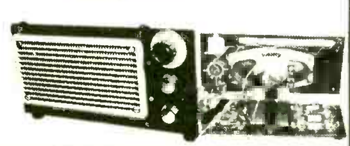
E.V. 7. Case and looks as above, 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker.
All parts including Case and Plans.

Total Building costs **£6·95** P & P + Ins. 70p.

## ELECTRONIC CONSTRUCTION KITS

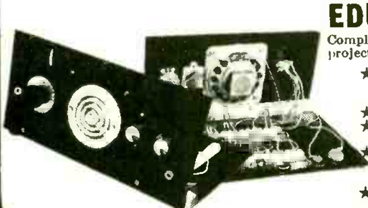
**ECK2** Self Contained Multi-Band V.H.F. Receiver Kit. 8 Transistors and 3 Diodes. Push/Pull output. 3" Loudspeaker, Gain Control. Superb 9-section swivel ratchet and retractable chrome plated telescopic aerial, V.H.F. Tuning Capacitor, Resistors, Capacitors, Transistors, etc. Will receive T.V. Sound, Public Service Band, Aircraft, V.H.F. Local Stations, etc. Operates from a 9 Volt PP7 Battery (not supplied with kit).
Complete kit of parts including construction plans.

**£7·95** P & P and Ins. 70p.



**ECK4** 7 Transistors, 6 tuneable wavebands, MW. LW, Trawler Band, 3 Short Wave Bands. Receiver Kit. With 5" × 3" Loudspeaker. Push/Pull output stage, Gain Control, and Rotary Switch. 7 Transistors and 4 Diodes. 6 section chrome-plated telescopic aerial. 8" Sensitive Ready Wound Ferrite Rod Aerial. Tuning Capacitor. Resistors, Capacitors, etc. Operates from a 9 Volt PP7 Battery (not supplied with kit). Complete kit of parts including construction plans. **£7·25** P & P and Ins. 70p.

## EDU-KIT JUNIOR



Completely Solderless Electronic Construction Kit. Build these projects without Soldering Iron or Solder.

- ★ Crystal Radio Medium Wave Coverage — No Battery necessary.
- ★ One Transistor Radio.
- ★ 2 Transistor Regenerative Radio
- ★ 3 Transistor Earpiece Radio Medium Wave Coverage.
- ★ 4 Transistor Medium Wave Loudspeaker Radio.
- ★ Electronic Noise Generator
- ★ Electronic Metronome.
- ★ 4 Transistor Push/Pull Amplifier.

All parts including Loud-speaker, Earpiece, MW Ferrite Rod Aerial, Capacitors, Resistors, Transistors, etc. Complete kit of parts including construction plans.

**£6·55** P & P + Ins. 60p.

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PW 577

VOL. 53 NO. 1
ISSUE 843
MAY 1977

# PRACTICAL WIRELESS

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

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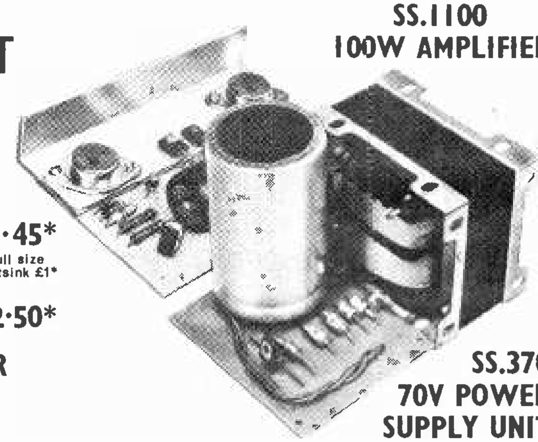
**FREE THIS MONTH!**
**THE SECOND DOUBLE SIDED INFO-CARD—Semiconductor Characteristics.**
**ALSO:**
**4 page INDEX listing all articles, letters, Production Lines, 'Kindly Note', etc., for Volume 52, May 1976 to April 1977.**

# Stirling Sound

**Q.V. MODULES FOR COST CONSCIOUS CONSTRUCTORS**

## SAVE £1·95 ON THIS 100 WATT R.M.S. POWER AMPLIFIER WITH POWER SUPPLY UNIT

SS.1100
100W AMPLIFIER



SS.370
70V POWER
SUPPLY UNIT

**SS.1100** Delivers 100 watts R.M.S. into 4 ohms using a 70 volt/2A supply. Input sensitivity 500mV for full output. Response—10Hz to 50KHz ±1dB. S/N ratio better than 75dB. Distortion at half power typically 0·1%. With heat sink mounting bracket. 5" x 3½" x 1½" (SS.1100H with full size heatsink). **£9·45*** Full size heatsink £1*

**SS.370** A new heavy duty power supply unit to deliver 70 volts/2 amps. Complete with mains transformer and low-volt outlet *P/p—£1·00)* **£12·50***

### YOU PAY ONLY £21·00* FOR THE TWO TOGETHER

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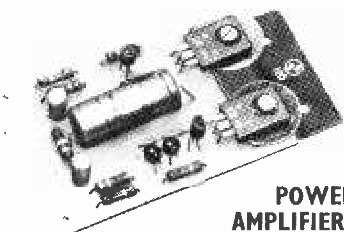
## MORE STIRLING SOUND Q.V. MODULES TO SAVE YOU MONEY



### POWER AMPLIFIERS

**3 TO 40 WATTS R.M.S.**

**SS.103** 3 watt r.m.s. mono. Uses one I.C. protected against short circuit **£1·75**

**SS.103-3** Stereo version of above using two I.C.s **£3·25**

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**SS.140** Delivers 40 watts R.M.S. into 4 ohms using 45 volts supply unit such as **SS.345.** Ideal for small disco, P.A. etc. **£3·95***

If ordering Stirling Sound power supply units with Modules **SS.103** to **SS.120**, V.A.T. becomes 12½%.

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**SS.102** Stereo pre-amp for low output magnetic P.Us. R.I.A.A. corrected. **£2·65**

### UNIT ONE

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Combined pre-amp with active tone-control circuits. ±15dB at 10Khz treble and 30Hz bass. Stereo. Vol./balance/treble/bass. 200mV out for 50mV in. Operates from 10 to 16V supply. **£7·80**

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**WE MAKE DELIVERY QUICKER** by saving time in turning round your orders. Now when ordering, you send direct to our factory where QV (Quality and Value) Modules are made. Our shop and showroom continue as usual for those calling personally.

**WATCH HOW THE STIRLING SOUND RANGE GROWS!**

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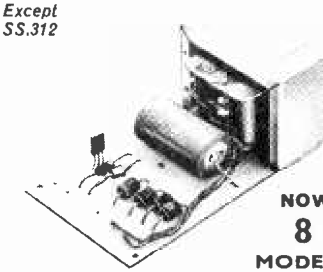
**WITH 13-15V TAKE-OFF POINTS**
*Except SS.312*



**NOW 8 MODELS TO CHOOSE FROM**

Complete with mains transformers and low volt take-off points (not SS.300). All at 8% V.A.T. rate.

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**SS.300** Power stabilising unit 10–50V adjustable for adding to unstabilised supplies. Built in protection against shorting (p/p 35p) **£3·26***

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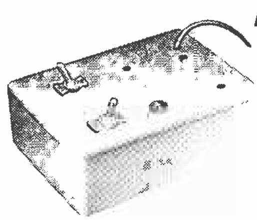

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Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 16 ohm impedance. 10 watts.
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R.C.S. BOOKSHELF SPEAKERS
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LOUDSPEAKER CABINET WADDING 18in. wide, 20p ft.

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3½in. diam. 18,000 C.P.S. 25 WATTS 8 Ω **£3·25**
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STEREO VERSION OF ABOVE £7·50.

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GROUP "25" 12in 30 watt 4, 8 or 16 ohms. **£11·95** Post £1

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Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4 to 16 ohm. Slave output. A/C mains. Guaranteed. Details S.A.E. 150w SLAVE £60
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MADE BY JENNINGS MUSICAL INSTRUMENTS **£52**
4 speaker outputs, vol., treble. bass controls
CAN BE USED AS 100WATT SLAVE Carr. £1

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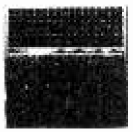
3 speed. Plays all size records. Stereo Cartridge. Cueing. Ideal Disco Deck Post 75p **£13·50**

## QUALITY LOUDSPEAKER ENCLOSURE



Teak veneered ⅝in thick wood cabinet. Size 18½in × 18½in × 8½in. Weight 23lb. This cabinet features a wide mesh Silver Grill covering a separate compartment for mounting Tweeters or Mid-Range Horn. The fully sealed bass compartment is cut out for 6½in. Woofer £5·95. Rosewood Version £6·95. Carr. £1·60. Baffle could be cut for larger speaker.

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## 8 inch PHILIPS LOUDSPEAKER

4 ohm. 4 watt. ceramic magnet **£1·95**
General purpose replacement unit.

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40 VOLT 2 AMP. £2·95. 0-20-40-60 VOLT 1 AMP. £3·50

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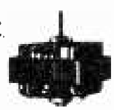
4 pole, 240 v. Size 3½ × 2½in. 1200 rpm. Spindle $\frac{1}{16}$in. diameter. 75v version £1. **£2** Post 45p



## E.M.I. GRAM MOTOR

240V a.c. 2,400 rpm 2-pole. Size 2¾ × 2¼in. Collaro gram motor 120v. 75p. **£1·25** Post 35p

## BAKER DISCO SPEAKERS

HIGH QUALITY—BRITISH MADE

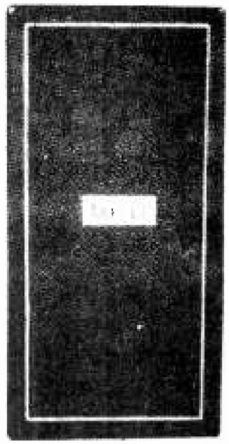
## 2 x 12" CABINETS

for Disco or PA all fitted with carrying handles and corners. Black finish. Other cabinets in stock. SAE For leaflet

50 WATT R.M.S. **£50** Carr. £3

70 WATT R.M.S. **£55** Carr. £3

100 WATT R.M.S. **£69** Carr. £4



**1 x 15" + 1 x 12" 100 WATT CABINET**
**Size 36" x 24" x 15" £75·00. Carr. £5**
**Ideal for Disco, Ogran or PA work.**
**High quality. Full range.**

## "SUPERB HI-FI"

### 12in 25 watts

A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.
Bass Resonance 25cps
FluxDensity 16,500 gauss
Useful response 20-17,000cps
8 or 16 ohms models.

**£21·95** Post £1·60

## "AUDITORIUM"

### 12in. 35 watts

A full range reproducer for high power. Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.
Bass Resonance 35cps
Flux Density 15,000 gauss
Useful response 25-16,000cps
8 or 16 ohms models.

**£20·95** Post £1·60

## "AUDITORIUM"

### 15in. 45 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home Hi-Fi.
Bass Resonance 35cps
Flux Density 15,000 gauss
Useful response 20-14,000cps
8 or 16 ohms models.

**£24·95** Post £1·60

Loudspeaker Cabinet Wadding 18in wide. 20p per ft.

Hi-Fi Enclosure Manual containing plans, designs, crossover data and cubic tables, 68p

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# GREENWELD

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SO1 OHX Tel:(0703) 772501

**THE GREENWELD DRAGON—GUARDIAN OF GOOD VALUE**

## TAPE DECKS

Reel to reel chassis, takes 7" spools. Single motor operation. Made by Telefunken. No heads or electronics, mechanics only. Diecast ally frame 13¾ x 9¼ x 6¼" overall depth. Free head (no data) supplied with every order. Only £3·50.

Data Tape Deck by D-Mac. Not much info., just arrived. Reel-to-reel, takes 3" spool. 2 heads, 12V motor. 3 position switch. 17 transistors, R's, C's, 200V 6A SCR, min 6V relay, etc. In good condition, but not new. Size 225 x 165 x 120mm high. £5·50.

## CALCULATORS - £2·75!!!

There has to be a catch—these Rapidman 1208 machines are a mains powered desk top calculator with 0-9 and dec point, and 7 function keys inc %, but the liquid crystal display is missing. However, apart from this they are complete with PSU, 3 IC's + discrete components. Overall size 11 x 7 x 3". Only £2·75. Few complete working and boxed, as new £10.

## KEYBOARDS

Front half of calculator, really. Case 130 x 75mm has display window, 2 slide switches, and 25 keys. Only £1.

## 1 WATT AMPLIFIER

PCB 100 x 80mm with LM380 and associated components to make 1W amp operating from 9V. (Can be increased to 3W output by raising supply voltage and fitting heat sink). Complete with volume control. Connexion sheet included. Also on the board is a speed control circuit comprising 10 transistors, 2 presets, 4 pole 3 way switch, etc., but no data on this. Only £1.

## POT PACKS

An overwhelming abundance of pots of all shapes and sizes, including duals, switched, sliders, etc., prompts us to make this offer: 20 asstd for £2·20, 100 for £8·50.

## PO 4 DIGIT METERS

Ex-equip, 500R coil, operates on 18V only 40p, 10 for £3, 100 for £20.

## RELAY UNITS

Units vary slightly, but a guaranteed minimum 20 relays, PO 3000 type, various coil resistances and contact arrangements. May be a few bent contacts, but excellent value at only £4·00.

Parcel of PO 3000 type Relays—Lots of diff. types. Total 12 for £2·50.

## SWITCHES

Wafer switches, 6p3w 30p.

Wafer switch mechanism, 12 way, Room for 2 wafers. 15p. Wafers to fit, 7p2w 20p, 1p 12w (few only) 40p. Bank of 5 push button switches, 4 are 6 pole c/o, interlocking, 5th is independant dpco. No knobs 70p. Sub-min dpco slide 15p; push to make 15p; push to break 20p. 10A 250V rocker 18p; DPCO rocker 40p. Sub-min toggles spco 62p; dpco 74p; dpco centre off 80p.

PO 1000 type lever switches, in vertical bank of 4, each 4 pole c/o, centre off. Ex-equip. 50p. Also with 4th switch biased, 50p. Few horizontal banks of 10, £1·50. Push button switch (No knob) DPCO, non-locking 12p. As above, but locking on or off, rated 250V 2A 19p. Microswitch 18 x 9 x 6mm, 5A 240V rating, has 55mm lever 19p.

## TRIMMERS

2-7pf, 4-15pf, 6-25pf, 8-30pf ceramic. All 15p each. Compression types, 3-40pf 18p; 100-500pf 34p; 500-1250pf 40p.

## NEON BANKS

| | |
|---|---|
| Bank of 40 sub-min neons | £1·00p |
| Bank of 20 std neons | 60p |
| Recording heads, ¼" ½ track, type X/RPS/18 | £1·00p |

## HIGH POWER POTS

Berco preset rheostat, type SEF 28·5 ohms 3·3A, with metal cover £2·30, 11 ohm 3·4A without cover £1·50. Rotary types: 25W, 6R, 25R, 114R £1·17 each; 50W, 50R, 160R 1k5 £1·44 each; 100W, 70R £1·60.

Moulded Carbon High Voltage Pots, ideal for scope brill and focus controls, etc. Rated 3W. 2k5, 3k, 5k, 10k, 50k, 100k, 250k, 500, 1M, 2M5, all 62p each.

## 7lb BARGAIN PARCEL

Hundreds of new components—pots, switches, resistors, capacitors, PC Boards with semiconductors, loads of odds and ends. Amazing value at only £2·90.

## COMPUTER PANELS

Large quantity always available; 3lb asstd. £1·75; 7lbs £3·65; 56lb £16. Pack with about 500 components inc. at least 50 transistors £1·00; Pack with 12 High quality panels, incl. IC's, power transistors, multiturn trimpots, hundreds of small signal transistors, resistors, zeners, capacitors, etc. Only £2·75.

7400 IC pack—20 74 series IC's on panels £1·20.

## PC ETCHING KIT

Contains 1lb Ferric Chloride, 100 sq ins copper clad board, DALO Quick Dri Etch resist pen, abrasive cleaner, 2 miniature drill bits, etching dish and instructions. £3·65.

## FERRIC CHLORIDE

Anhydrous technical quality in 1lb double sealed packs. 1lb £1·00; 3lbs £2·18; 10lbs £5·00; 100lbs £39·00.

## FIBREGLASS PCB

Large quantity of offcuts, all usable pieces. 200 sq ins, single sided, double sided or mixed £1·40.

## DEVELOPMENT PACKS

50V ceramic plate capacitors, 5%. 10 of each value 22pF to 1000pF, total 210 caps. £2·70.

CR25 carbon film 1/3rd watt resistors, 5%, 10 of each value 10 ohms to 1M Total 610 resistors £6·00. Electrolytics, wire ended 25V working 10 each of: 1, 2·2, 4·7, 10, 22, 47 and 100mfd. 70 capacitors for £3·20. 400mW zeners 5% 10 each 3V to 30V, 260 in all. Only £14·00.

1 watt Metal Film resistors, 5% 10 of each value 27R to 10M, E12 series. Total 680 resistors £12·00

Polystyrene capacitors, 160V 2½% 10 of each value from 10pF to 10,000pF. Total 370 capacitors £12·50.

## COMPONENT PACKS

| | |
|---|---|
| 400 asstd. carbon resistors | £1·35 |
| 100 Wirewounds 2-15W | £1·90 |
| 200 Miniature resistors, ⅛, ¼ and ½W, mostly carbon film | £1·20 |
| 200 poly, mica, ceramic caps | £1·10 |
| 100 Polyester, ·01-2·2µF | £1·00 |
| 200 miniature electrolytics, but many unmarked so only | £1·00 |

## RELAYS

Miniature Plug-in types: 1250 ohm 4c/o 40p; 700 ohm 4c/o 50p. PO 3000 type 650 ohm with 6 heavy duty c/o contacts (Ex-equip) 75p; 10 for £4·00. 8 1" easily removable reeds in 3580 ohm coil 50p; Plug in relay, B7G Base 17mm dia x 42mm long 10k coil 1 c/o contact 40p. Omron MK3P plug in relay. 230V AC coil, 3 sets 10Ac/o contacts. £1·20. Bases 30p. 6V PC type, SPCO contact 70p.

Ex-equip on PC board, min sealed type, 22 x 20 x 10mm 200R coil (ops on 6-12V) 2 c/o contacts 40p.

Ex equip 34 x 30 x 15mm, 250R coil, ops on 6-12V 4 c/o contacts, 60p. Delay relay, 115V 20 sec coil, mains contact 60p; 230V coil 30 sec delay £1.

## CRYSTAL FILTER UNIT

Chassis 210 x 115 x 80mm containing 24 way switch, 24 HC6U xtal holders, 24 beehive trimmers, + board with 4 BF115, R's C's, etc. £3·50.

## 5MHz FREQUENCY SOURCE

High stability, better than 2 x 10⁻⁹ short term, better than 1 x 10⁻⁷ per month. 12·6V drive voltage, output 5MHz into 50R £12. 4·433619MHz colour sub-carrier crystals 60p.

## BOOKS

All by R. M. Marston, these titles use readily available components.

20 Solid State Projects for the Home £2. 20 Solid State Projects for the Car & Garage £2. 110 Semiconductor Projects for the Home Constructor £2·70. 110 Thyristor Projects for the Home Constructor £2·70. 110 Integrated Circuit Projects for the Home Constructor £2·70. 110 Op Amp Projects for the Home Constructor (uses 741) £2·70. 110 CosMos Digital IC Projects for the Home Constructor £2·95. 110 Electronic Alarm Projects for the Home Constructor £3·15.

## VERO BOXES, CASES & BOARD

## VEROBOARD

| Size | 0·1" | 0·15" | 0·1" plain |
|---|---|---|---|
| 3¾ x 3¾" | 44p | 40p | N/A |
| 5 x 3¾" | 50p | 55p | 40p |
| 17 x 3¾" | £1·90 | £1·60 | £1·30 |

## PINS

Full or half pins, 0·1 or 0·15 35p 100.

Spot face cutter for 0·1 or 0·15" 75p.

## DIP BREADBOARD

Accommodates 20 x 14 way or 16 x 16 way IC's £2·00.

## OFFCUTS

Pack A, All 0·1"
Pack B, All 0·15"
Pack C, Mixed
Pack D, All 0·1" plain

Each pack contains 7 or 8 pieces with a total area of 100 sq ins. Each pack is £1·30. Also available by weight, 1lb £3·45, 10lbs £28.

We are also VERO wholesalers—Trade price list on request from Bone Fide Companies.

## VEROCASES

Plastic top and bottom, ally panels front and back.

| Type | | |
|---|---|---|
| 1410 | 205 x 140 x 40mm | £3·30 |
| 1411 | 205 x 140 x 75mm | £3·70 |
| 1412 | 205 x 140 x 110mm | £4·00 |
| 1237 | 154 x 85 x 40mm | £2·30 |
| 1238 | 154 x 85 x 60mm | £2·80 |
| 1239 | 154 x 85 x 80mm | £3·60 |

## PLASTIC BOXES

Professional quality, two tone grey polystyrene with threaded inserts for mounting PC Boards.

| Type | | |
|---|---|---|
| 2518 | 120 x 65 x 40mm | £2·25 |
| 2520 | 150 x 80 x 50mm | £2·60 |
| 2522 | 188 x 110 x 60mm | £3·50 |

Sloping front version,
Type 2523 220 x 174 x 100/52mm £6·00
Type 1798 171 x 121 x 75/37·5mm £4·50

Gen Purpose plastic potting box 71 x 49 x 24. In black or white 40p

Hand Controller box, shaped for ease of use in the hand, 94 x 61 x 23mm 62p

## S-DECS & T-DECS

| | |
|---|---|
| S-DEC Breadboard | £2·10 |
| T-DEC Breadboard | £3·75 |

## SOLDERING IRONS

| | |
|---|---|
| Antex 15W Model C | £3·70 |
| Antex 15W Model CCN | £4·00 |
| DeeGee 25W Model 3612 | £2·80 |
| Litesold 10W | £4·00 |
| EK400 40W | £2·40 |

Instant Heat Soldering Gun with built in lighting unit and 5 spare tips £4·50.

## SOLDER

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## SURPLUS CAPACITORS

| | |
|---|---|
| 15,000µF 6V 35mm dia x 55mm PC | 10p |
| 1,250µF 16V 20 x 50mm, tags | 10p |
| 1,250µF 40V 25 x 80mm, tags | 20p |
| 800µF 40V 25 x 50mm, tags | 16p |
| 10,000µF 10V 35 x 80mm, tags | 18p |
| 6,400µF 16V 35 x 80mm, tags | 20p |
| 4,000µF 25V 35 x 80mm, tags | 25p |
| 10,000µF 16V 40 x 80mm, tags | 30p |
| 50µF 350V 25 x 50mm tags | 12p |
| 1500µF 18V 18 x 34mm PC | 6p |
| 18,000µF 25V 50 x 105mm, screws | 60p |

NB: Add 30p postage for any quantity

Miniature resistors, carbon film 5% 1½p each, £1·00 per 100 of one value 1R to 10M. 1W metal film 2½p each.

## BULK OFFERS

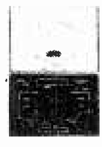
3mm wander plugs, black only at special price of £2·20/100.
63mA 20mm quick-blow fuses, £2/100
24V 1W LES lamps £3·00/100
350mA 20mm A/S fuses £4/100

## SPECIAL OFFER of PLUG-IN MODULES

Large quantity just arrived, several diff types. Case size 77 x 50 x 50mm, either octal or 11 pin base. Send SAE for full list of types and circuits. Type R: Contains 6A 200V SCR, 4 x 5A 300V diodes, 24V reed relay, C, R, etc. Octal base. With circuit. Only £1·00 each, 10 for £8·00. Type M: 5 BC184, C426, min. R's and C's 65p. Panel with 2 6A 400V triacs, 709C, 2N1711, 100V 1A bridge, 2 pots, 1 preset, zeners, R's, C's, etc. Only £1·50.

## MULTIMETER MODEL LT22

**WHAT A BARGAIN**



Probably one of the lowest priced meters featuring a mirror scale, overload protection and 20000 ohms per volt sensitivity. A modern styled meter with unusually clear scale markings. Ranges: DC Volts 0-0·5-2·5-10-50-250-1000 AC Volts 0-10-50-250-1000 DC Current 0-50µA-25mA-250mA Resistance 0-50k-500k-5M (Mid Scale 300-3k-30k) db's 4 ranges —20db to +42dB. Size 130 x 90 x 42mm. £12·70.

## 5V 12A REGULATED POWER SUPPLY

Brand new boxed fully stabilized PSU, complete with instruction manual. Load regulation 0·15%. Thermal & Electronic overload protection. Only £24·00.

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All have mains primaries, secondaries as follows: 6-0-6V 100mA 95p; 9-0-9V 75mA £1·00; 12-0-12V 50mA 95p; 12-0-12V 100mA £1·10; 6.3V 1½A £1·95; 6-0-6V 1½A £2·30; 9-0-9V 1A £2·55; 12-0-12V 1A £2·85; 12V 5A £3·65; 12V 8A £4·35; 20V 55mA 80p; 22V 100mA £1·00; 29V 50mA 80p; Multitapped types, 0-12-15-20-24-30V 1A £3·50; 2A £5·00; 20-0-20V 2A £4·40; 55-0-55V 5A £6·30; 24V 500mA £1·65.

Our retail shops at 21 Deptford Broadway, London, SE8 (01-692 2009) and 38 Lower Addiscombe Road, Croydon (01-688 2950) stock some of the advertised goods for personal callers only. Ring them for details.

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All prices quoted include VAT and UK/BFPO postage. Most orders despatched on day of receipt. SAE with enquiries please. **MINIMUM ORDER VALUE £1**

Send 10p for Multimeter catalogue—free on request on orders over £3. Official Orders accepted from Schools, etc. (Minimum invoice charge £5). Export/Wholesale enquiries welcome. Wholesale list now available for bona-fide traders. Surplus components always wanted.

**BATTERIES** 6 Volt sealed type rechargeable two types both new unused. Type A 1·8 A/Hr size 2¼ × 2 × 2″ **£5·40.** Type B 2·6 A/Hr size 5¼ × 1¼ × 2¼″ **£6·50. V.H.F. POWER TRANSISTOR** type 2N3375 stud mt 28v 7·5w at 100Mc/s 3w at 400Mc/s new **£1·80. DIAL TELEPHONE KEYBOARD** 0 to 9 digits new **£1·80. PLUG & SK** min type 12 way single hole fix round type new **£2** per pair. **BLOWER** single ended for 240v 50c/s, 50 CFM. outlet size 2 × 1¾″ very quiet brushless motor new by Woods **£6·40. TUNING COND** 3 gang 78pf per section ¼″ shaft **£1·30. CRYSTALS 10X & 10XJ** types in freq range 2 to 10Mc/s 20 different for **£2·20. RECEIVER SUB ASS** single chan crystal controlled Rx ass for use in the 120/125Mc/s range uses 9 min valves as RF stage, 3x IFs at 9·7Mc/s det & O/P for phones approx size 8 × 4 × 3½″ new **£6·50. ISOLATING TRANS** 230v pria Sec 26v at 13·5 amps with c.t. in carrying case size 10 × 7 × 7″ fitted ammeter 0 to 20 new boxed **£17·80. TRANSFORMERS.** H.T. Pria 230v Sec 1125-0-1125 rated 900v at 800Ma DC choke I/P filter size 7 × 7 × 5″ **£10·80.** Auto Trans nom 220/240 to 110/120v at 150 watts term block conn **£3·50.** H.T. Pria 230v Sec 700v 300Ma C. core **£5·40.** L.V. Pria 200/250 sec 55v at 1·5 amps potted **£3·50** all trans new. **C.R.T.s** all are 4v heater, electrostatic deflection, as follows CV2184 2¾″ dia P7 blue/yell trace **£4·50.** CV1593 6″ blue/yell trace **£6.** CV1746 6½″ PI green trace for CRDF as center cross & north marker can be removed **£6.** CV1534 11″ P7 orange trace **£10·80** all tubes in new cases. **R4187Rx** sub ass RF section 2/18Mc/s as 2xRF, Mixer 2·15Mc/s IF & 2nd mixer, tuning motor etc (there is no L.O.) **£4·75.** I.F. & A.F. section as 100Kc IFs & filter, BFO, 2nd osc, Det, N.L. AVC O/P etc both units with valves & circ **£5·50. AERIAL SYSTEM** for use on 183·6Mc/s 8 element Yagi approx 11ft long, for use on ground satelite comm channel, new in cases **£21·60. REMOTE CRYSTAL SELECTOR** as 6x BC108, 6xtub trimmers, etc holders for 6xTx & 6x Rx crystals Pye spares new **£1·80. ROTARY SWTS** larger inst type 8p 12w 8b & 2p 23w 2b both **£1·60.** 6p 12w 6b **£1·40.** 7p 23w 7b **£2** all new. **HELIPOTS** 10 turn ¼″ shaft 5K or 10K both new **£1·65. SIL BRIDGE RECT 100 PIV** 2 amps 3a on h/s new 54p. **MARCONI H.F. SPECTRUM ANALYSERS** for callers only **£45.**

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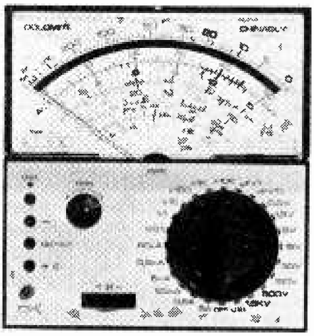

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20kΩ/V a.c. and d.c.

A NEW HIGH SENSITIVITY MULTIMETER WITH ALL THE FEATURES YOU WILL EVER NEED

**Accuracy:** D.C. ranges, ± 2·0%, A.C. & Ω ranges ± 2·5%.

**39 ranges:** d.c. V, 0·150mV, 500mV, 1·5V, 5V, 15V, 50V, 150V, 500V, 1·5kV; d.c.I, 0·50 μA, 500μA, 5mA, 50mA, 0·5A, 5A; a.c.V, 5V, 15V, 50V, 150V, 500V, 1·5kV; a.c.I, 5mA, 50mA, 0·5A, 5A; dB −10 to +65 in 6 ranges; Ω 0·0 5kΩ, 5kΩ, 50kΩ, 500kΩ, 5MΩ, 50MΩ; pF 50kpF, 500kpF.

**Automatic overload protection and high current range fusing.**
Scale mirror and fine pointer for accuracy of reading. Single knob main range switching and all panel controls. C.E.I. Class 1 movement with sprung jewel bearings. Extended 92mm scale length for extra clarity. Compact ABS case 125 × 131 × 37mm. Weight 750g with batteries. Supplied complete with carrying case, fused leads, handbook and full 12-month guarantee. Optional 30kV d.c. probe available.

Meter £45·90 incl. VAT (£1 P. & P.)
30kV Probe £ £12·85 incl. VAT

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**TRANSISTORS** + 200 OTHER TYPES IN STOCK

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|---|---|---|---|---|---|---|---|---|---|
| AC125 | 26p | BC109 | 12p | BC262A | 19p | BFX29 | 26p | TIP41A | 67p |
| 126 | 26p | 109B | 13p | 287 | 28p | 84 | 22p | 42A | 80p |
| 127 | 28p | 109C | 13p | 300 | 35p | 88 | 22p | TIS43 | 35p |
| 128 | 20p | 117 | 18p* | 301 | 34p | BFY50 | 25p | ZTX300 | 13p* |
| 151 | 35p | 142 | 24p | 303 | 35p | 51 | 25p | 302 | 18p* |
| 153 | 35p | 143 | 24p | 338 | 16p* | 52 | 25p | 500 | 15p* |
| 176 | 22p | 147A | 9p* | 557 | 15p* | BY164 | 40p | 502 | 18p* |
| 187 | 22p | 147B | 10p* | BCY71 | 18p | ME0401 | 18p* | 1N914 | 5p |
| 188 | 20p | 148 | 9p* | 72 | 14p | 0411 | 18p* | 1N4001 | 5p |
| AD149 | 68p | 148B | 10p* | BD123 | 90p | ME4001 | 10p* | 4002 | 6p |
| 161 | 52p | 149B | 11p* | 124 | 90p | 4101 | 11p* | 4005 | 9p |
| 162 | 52p | 149C | 11p* | 131 | 42p | MPF102 | 40p* | 4006 | 10p |
| MCH/PR | 1·24 | 154 | 18p* | 132 | 42p | OA47 | 14p | 4148 | 5p |
| | | 157B | 12p* | 139 | 54p* | 90 | 7p | 2N2219 | 30p |
| AF116 | 24p | 177 | 17p | 155 | 75p* | 91 | 8p | 2646 | 45p |
| 117 | 28p | 178B | 18p | BF158 | 20p* | 200 | 10p | 2926O | 13p* |
| 124 | 30p | 179B | 19p | 184 | 25p | OC28 | 1·20 | 2926G | 15p* |
| 239 | 46p | 184B | 12p* | 185 | 28p | 29 | 1·20 | 3053 | 25p |
| AU113 | 1·72* | 184L | 11p* | 194 | 10p* | 35 | 1·20 | 3055 | 60p |
| BC107 | 11p | 187 | 26p | 196 | 12p* | 44 | 45p | 3702 | 11p* |
| 107A | 12p | 212A | 13p* | 197 | 12p* | 71 | 35p | 3703 | 14p |
| 108 | 10p | 212L | 15p* | 199 | 15p* | ORP12 | 68p | 3704 | 13p* |
| BC108B | 11p | 213B | 12p* | 200 | 38p | TIP29A | 47p* | 3705 | 14p |
| 108C | 12p | 214 | 15p* | 338 | 34p | 30A | 56p* | 3707 | 12p* |
| | | 214L | 17p* | BFW11 | 68p | 31A | 57p | 3819E | 25p* |

**DIODES**

| | |
|---|---|
| 50V 3A | 13p |
| 100V 3A | 15p |
| 200V 3A | 18p |
| 400V 3A | 21p |

**BRIDGES**

| | |
|---|---|
| 100V 1A | 28p |
| 200V 1A | 30p |
| 400V 1A | 32p |

**THYRISTORS**

| | | |
|---|---|---|
| 60V 1A | 20p | |
| 600V 1A | 60p | TAG 1 600 |
| 700V 1A | 1·20 | BT106 |
| 400V 4A | 58p | C106D1 |
| 500V 6½A | 1·25 | BT109 |

**RESISTORS** 1½p* each
¼ WATT E12 (5%)
1 ohm – 10m ohm

**ZENERS** (400mw) BZX 83
3V, 3V3, 5V1, 5V6, 7V5, 9V1, 10V, 12V, 18V, 22V, 30V. All at 12p*each.

| **LED** | **TIL 209/0·125** | **0·2″** |
|---|---|---|
| Red | 20p | 20p |
| Grn | 29p | 29p |

Clips for above 2p.

**LINEAR I/C's**

| | |
|---|---|
| 741 | 33p |
| LM380 SL60745 | 1·29* |
| LM3900N | 69p |
| NE555 | 60p |
| SN76013ND | 1·60* |
| SN76013N | 1·75* |
| SN76023N | 1·75* |
| TBA800 | 1·35* |
| TBA810S | 1·49* |
| TBA820 | 1·29* |
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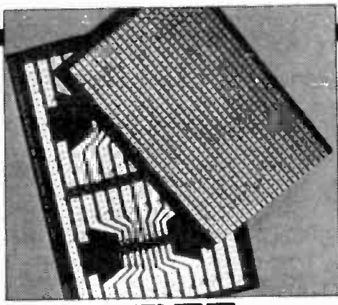

Circuit diagram to circuit board in minutes. Layout circuit plan on .1" graph paper. Select Blob Board, lay components out with leads on copper strip. Blob of solder onto lead and your circuit is complete. Blob Boards normally half price of competitive boards. Roller tinned to solder components directly. No drilling or mounting. Modifications in seconds. Blob Board is re-usable.

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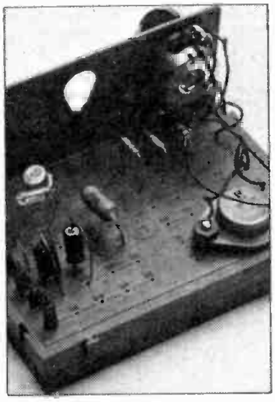

Take an S-DeC, take a small stock of components, Insert into S-DeC, no soldering, make a radio receiver, light operated switch, 3 stage amplifier. When circuit is made unplug components and use them again to make a morse practice oscillator, LC oscillator, binary counter and any other discrete circuitry. See Practical Wireless for new series of S-DeC projects. S-DeC + step by step instructions to build above projects and 3 more + which components to use + free control panel for mounting switches, lamps etc. + free Blob Board. S-DeC only £1.98 + 37p (VAT + post) send only £2.35.

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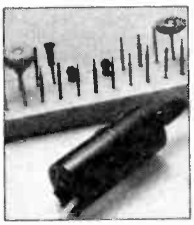

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# You lucky people!

YES, dear reader, if you have just paid your 40p for this copy of PW then you have really got your money's worth this month! Apart from the free information card contained in this issue you will also find a free copy of the index for Volume 52 of PW which finished with the April issue. 'Fine' you may say, 'So what'? Well, it is something new for PW because in the past the index was produced some time after the end of the volume had been reached and if you wanted to get a copy of it you had to pay 45p! Plus all the bother of finding writing paper, envelope, stamp and postal order or cheque!

One would need to go back into the past quite a bit to discover how this practise arose in the first place, and more to the point, why it has persisted. Anyway, that's all history now and, hopefully, you'll get your free index on time in future.

Another relic of the past also needs to be dealt with and that is to make our volume of twelve issues coincide with the calendar year! I have no intention of wading through early volumes of PW to discover just when this discrepancy occurred but in the early days of PW in 1932 it was a weekly publication and the subsequent change to a monthly appearance probably explains the mystery.

I have often wondered whether those conscientious readers of PW who bind their copies do so by the volume or by the year. Personally, mine go into binders by the year but the office copies are very neatly bound by the volume! Ah, well, perhaps we will get it all together 'ere long. I don't suppose these little matters bother our average reader in the slightest, but it was something to talk about!

**Eric Dowdeswell** *Assistant Editor*



# NEWS...

## More outlets for trio

UP to the present time, Trio High Fidelity equipment has only been obtainable from selected dealers within the UK. A move has now been successfully made to enable all Trio equipment to be available from Comet Discount Warehouses. Of course the same equipment will still be available from the selected dealers, but as from 1st February of this year, they have been redesignated as 'Trio Specialists'. *B. H. Morris and Co (Radio) Ltd., Precision Centre, Heather Park Drive, Wembley, Middx HA0 1SU.*

## Bib book

PLANNED, and written for beginners by Clement Brown, the BIB Book Of Hi-Fi explains in laymens terms the basics of Hi-Fi, stereo principles and the source of high quality programmes, and offers hints and tips to those planning new systems. Installation and adjustments are explained in a practical form, and emphasis is placed on good modern practice in equipment maintenance and record and cassette care. A glossary of Hi-Fi terms and an index conclude this latest offering from BIB. Priced at £1·98, it can be obtained from Hi-Fi dealers, bookshops, and audio components specialists.

*Bib Hi-Fi Accessories Ltd, Kelsey House, Wood Lane End, Hemel Hempstead, Herts.*

The author of the Gas/Smoke Sensor Alarm—April '77, acknowledges the help of WKF Electronics Ltd., Welbeck St., Whitwell, Worksop, Notts., in the construction of the Alarm. WKF can supply all components for this project.

**VACANCY ON PW**

Applications are invited for the post of TECHNICAL EDITOR on P.W. which will become vacant shortly.

Apply, with brief details of career, to Eric Dowdeswell, Assistant Editor.

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

## HiFi '77

ALREADY 74 exhibitors have booked space for the fourth annual HIGH FIDELITY exhibition, which is to be held at the Heathrow Hotel, London Airport, from the 19th April to the 24th April, 1977.

Special events taking place during the exhibition will include a series of lectures and demonstrations in the Hotel's York Video Theatre, while facilities are being claimed to be 'second to none'. These will include air-conditioned and soundproofed exhibition rooms; free car parking; free exhibition catalogue and free transport between the Heathrow Hotel and London Airport terminals and Hatton Cross Underground Station.

Opening times for High Fidelity '77 will be as follows:

Trade and Press only—19th to 21st April inclusive 10am to 8pm.

Public—22nd to 24th April inclusive 11am to 9pm (with the exception of the 24th which closes 6pm.)

Admission for everyone is free.

Further information from *Emberworth Ltd., London House, Oxford Road, Stokenchurch, Bucks. Tel: 024026 2674/5.*

## Bits and pieces

RADIO clubs in the UK may be interested to learn that one of our readers has acquired a large amount of pre-war and war-time radio equipment and wishes to dispose of most of it. Any clubs that would be interested please contact *M. Robinson, 13 Tolmers Gardens, Cuffley, Potters Bar, Herts.*

## PA Exhibition

IF PA Equipment is of interest to you, the Association of Public Address Engineers will be holding their annual exhibition at the New Wembley Conference Centre, from April 19th to the 21st. The displays will be located on the ground floor and will contain some of the most sophisticated and up-to-date equipment available in the World. Amongst them will be alarm systems, amplifiers, background music systems, sport event timing equipment and general PA and audio equipment.

The exhibition is open each day from 10am to 6pm (5pm on last day). Admission is free and "anyone having a professional or business interest is welcome to attend", say the organisers.

Further information from *APAE HQ, 47 Windsor Road, Slough, Berks. Tel: Slough 39455.*

## Roll up, roll up . . .

NEW members are required for the Chester and District Amateur Radio Society, whose newly formed committee is formulating a new programme for the coming months. Meetings are held at the YMCA Chester on the 2nd, 3rd and 4th Tuesdays of each month at 8pm.

Any readers interested in joining the club should contact *G. W. Chaliner GW8DMR, 34 Chestnut Avenue, Summerhill, Wrexham, Clwyd.*

## Rally call

THE North Midlands Mobile Rally will take place on Sunday 17th April at Drayton Manor Park, near Tamworth, Staffordshire. This event is organised by the Midland and Stoke-on-Trent Amateur Radio Societies, and will include the usual exhibitions.

*Further information, stickers, badges etc., from Barrie Willetts G8DEM, Alf Walton G3ZKQ or Max Gutteridge G8BHE at 68 Max Road, Quinton, Birmingham.*

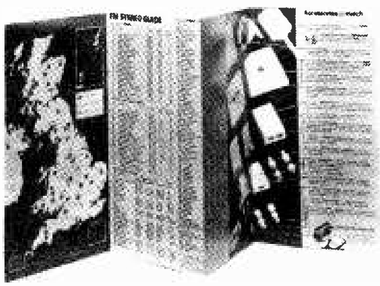
## Aerial guides

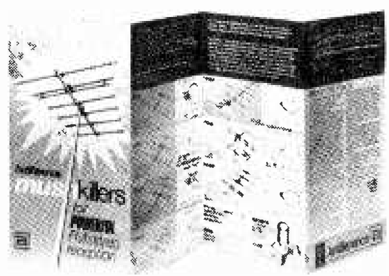
FOR many years now the general public and electronic enthusiasts have realised the importance of a good aerial system, to utilise the full potential of modern tuners and radio receiving gear.

In the forefront of modern aerial development is Antiference, who have recently published a Wall Chart and FM Stereo guide. The Wall Chart measures $23\frac{1}{2}$in $\times$ $16\frac{1}{2}$in and is printed in bright yellow, red and black and gives a complete up-to-date guide to all UHF TV transmitters, together with all the main Antiference TV aerial products.

The FM Stereo Guide comprises a three colour pocket folder illustrating the complete range of "Mushkiller" VHF/FM aerials with individual polar diagrams and comparative gain graph. The FM Station guide gives a complete "run down" on BBC and IBA transmitters showing clearly the polarisation, ERP in kW and frequency of transmissions. A map of the UK is also incorporated to show the relative positions of the transmitters, together with detailed photographs of aerial accessories.

*Further information from Antiference Ltd., Aylesbury, Bucks. Tel: 0296 82511.*





# 2-WAY INTERCOM

Steven DAVIES

THE author required a two-way intercom for his workshop, which would also permit listening for the telephone, doorbell, burglars, etc, when no-one else was at home. Suitable amplifier designs which have been published all seem to have a high input impedance. Since it was intended to use the loudspeakers as microphones, this would have necessitated a transformer to match the loudspeakers to the amplifier input. The circuit described here eliminates this need.

## The Circuit

The amplifier circuit is shown in Fig. 1. Tr2-5 form a conventional push-pull amplifier, with the quiescent current in the output transistors being set by D1 and D2. The input stage Tr1 however, is connected in the common base configuration, which gives the required low input impedance, with high voltage gain. Negative feedback is applied from the output to the base of Tr1.

The DC voltage at the emitters of Tr4 and 5 is set by R3, although for optimum performance this voltage should be half supply voltage, which could be obtained by substituting a 10kΩ preset and 12kΩ resistor in series for R3. This is not strictly necessary here, since HiFi is not really needed. The AC gain is set by the ratio of R5 and R4, and if a volume

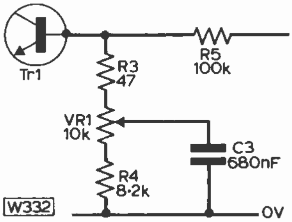



*Fig. 2: First stage of the complete circuit showing the connections and components required for the addition of a volume control. R3 and R4 are shown reversed in this drawing.*

control is required, the circuit of Fig. 2 can be used, which simply varies the amount of AC feedback applied.

Capacitor C3 has been chosen to roll off amplifier response at low frequencies to reduce pickup of mains frequency. C2 rolls of response at high frequencies to eliminate RF pickup, which can be a problem when long lines are used. (Radio 2 on 1500m is the main offender.)

## Operation

To communicate, S2 should be in the "ON" position, Fig. 3, while the direction of communication is

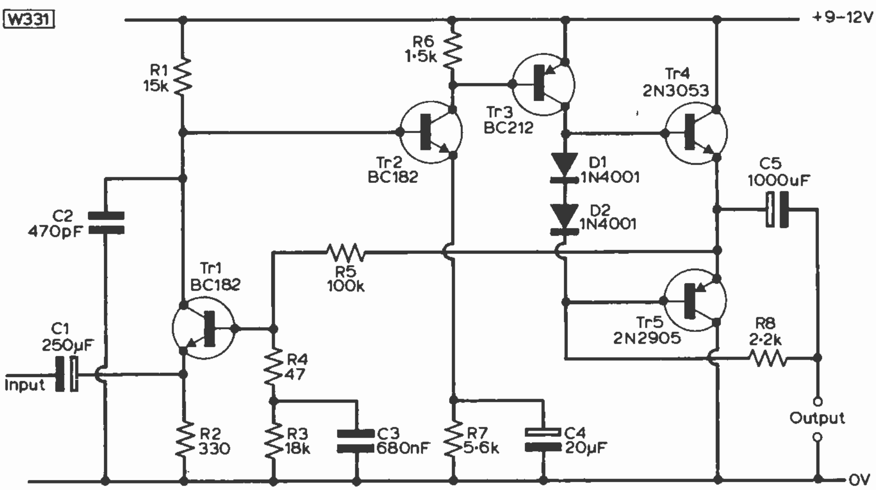



*Fig. 1: Main circuit diagram of the master unit giving details of the push-pull amplifier and the low-impedance input stage, Tr1.*

## ★ components list

**Resistors**

| | | | |
|---|---|---|---|
| R1 | 15kΩ | R6 | 1·5kΩ |
| R2 | 330Ω | R7 | 5·6kΩ |
| R3 | 18kΩ | R8 | 2·2kΩ |
| R4 | 47Ω | R9 | 680Ω |
| R5 | 100kΩ | VR1 | 10kΩ |

All ¼W 5%

**Capacitors**

| | | | | | |
|---|---|---|---|---|---|
| C1 | 250µF | 15V | C5 | 1000µF | 15V |
| C2 | 470pF | | C6 | 100µF | 15V |
| C3 | 680nF | | C7 | 2000µF | 15V |
| C4 | 20µF | 15V | | | |

**Semiconductors**

| | | | |
|---|---|---|---|
| Tr1 | BC182 | D2 | 1N4001 |
| Tr2 | BC182 | D3 | 1N4001 |
| Tr3 | BC212 | D4 | 1N4001 |
| Tr4 | 2N3053 | D5 | 1N4001 |
| Tr5 | 2N2905 | D6 | 1N4001 |
| D1 | 1N4001 | | |

**Miscellaneous**

S1, DPDT biased switch. S2, SPST switch. S3, SPST switch. S4, DPST switch. LS1, 8–35Ω loudspeaker. LS2, 8–35Ω loudspeaker. T1, mains transformer with 7 to 8V 200mA secondary. Clip-on heat sinks for Tr4 and 5. Aluminium or wooden cases to suit. PCB, 120 x 60mm (available from the PCB readers Service page 25). F1, 2A fuse. NE1, mains neon. Wire, plugs.

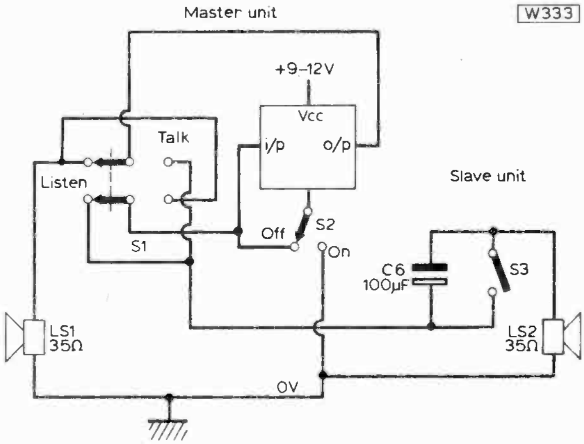



*Fig. 3: Schematic, demonstrating the wiring and switching arrangements required between the master and slave units.*

determined by the talk/listen switch S1, one speaker acting as a microphone. To conserve power, S2 will normally be "OFF" so that there is then no DC path between supply 0V and amplifier 0V, due to the capacitor C6 at the slave unit. If a DC path is made, either by shorting out C6 with S3, or by operating S1, the circuit will oscillate, the resulting tone being heard in both speakers.

The cause of oscillation is not at first sight clear. Consider Fig. 4, which is a block diagram of the system when "calling". Initially C5 will be discharged. When power is supplied to the circuit, C5 will start to charge up, via Tr4, LS1 and LS2. The resulting voltage across LS2 will increase the input voltage, and therefore the voltage drop across LS2, will fall to almost zero. This will cause a negative-going signal at the amplifier input, switching Tr5 on and discharging C5 via LS1. The cycle then starts again, producing oscillations.

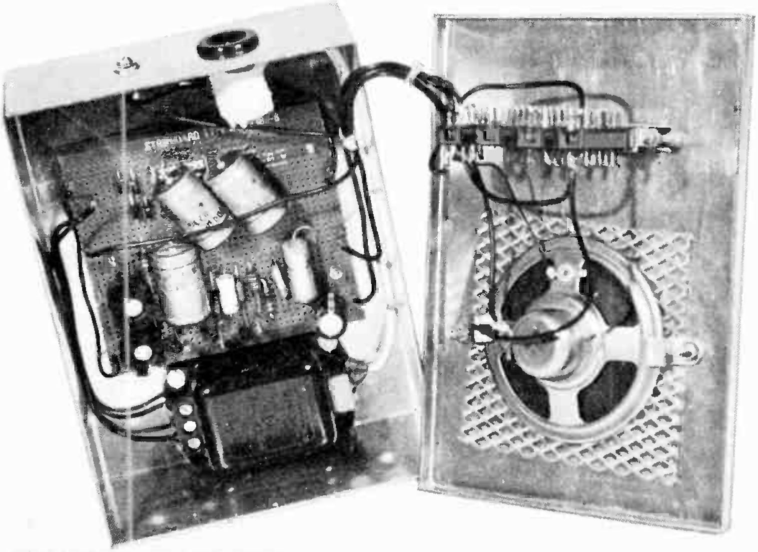
## Power Supply

The circuit can be operated off a 9V battery, but for prolonged or frequent use a mains supply is recommended. Any supply of 9-12V DC at 200mA minimum will suffice. The prototype used a small 8V bell transformer T1, with rectification and smoothing as shown in Fig. 5. Note that if a mains supply is used any exposed metalwork should be earthed, and the live line fused at a maximum of 2A, either in the plug or in the unit itself.

## Construction and Installation

No problems should be experienced with construction, as all components are housed on a single PCB as shown in Fig. 6.

The cases were standard aluminium boxes, 101×132×38mm for the slave, and 177×127×63 for the



*General interior photograph of the master unit. As this is the prototype, construction was on Veroboard and not a PCB as described in the text.*

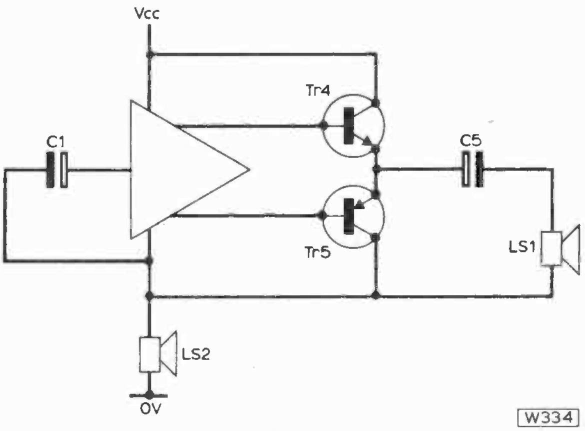



*Fig. 4: Block diagram of the system in the 'calling' mode, showing how the tone is produced.*

master. Wooden boxes are a possible alternative, since screening is not necessary. Using smaller speakers than specified would permit a smaller box, but unless space is critical there is little point in this. The amplifier will drive speakers down to 8Ω, so there should be no problem in obtaining something suitable.

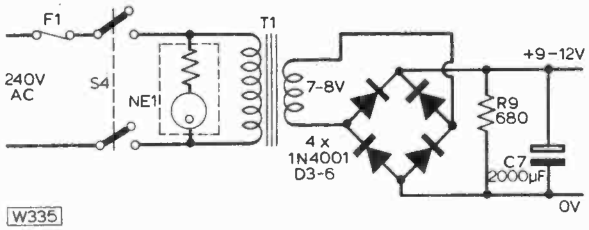



*Fig. 5: Alternative power supply for the intercom. The transformer in the prototype was an 8V bell transformer, although any transformer rated at 9-12V 200mA would suffice.*

Switch S1 should be biased, and may be difficult to obtain, although such switches are often available on the surplus market. Alternatively, it is possible to "doctor" a bank of push buttons to provide S1 and S2, as in the prototype (note that one of the banks does nothing, so three would suffice).

Once made, the units should be mounted on a convenient wall, and joined with two-core cable (screened cable could be used, but is unnecessary). Take care to get the polarity right, otherwise C3 might suffer. It is advisable to route the cable away from mains as far as possible, to prevent undue pickup, since the hum level in the amplifier itself is very low.

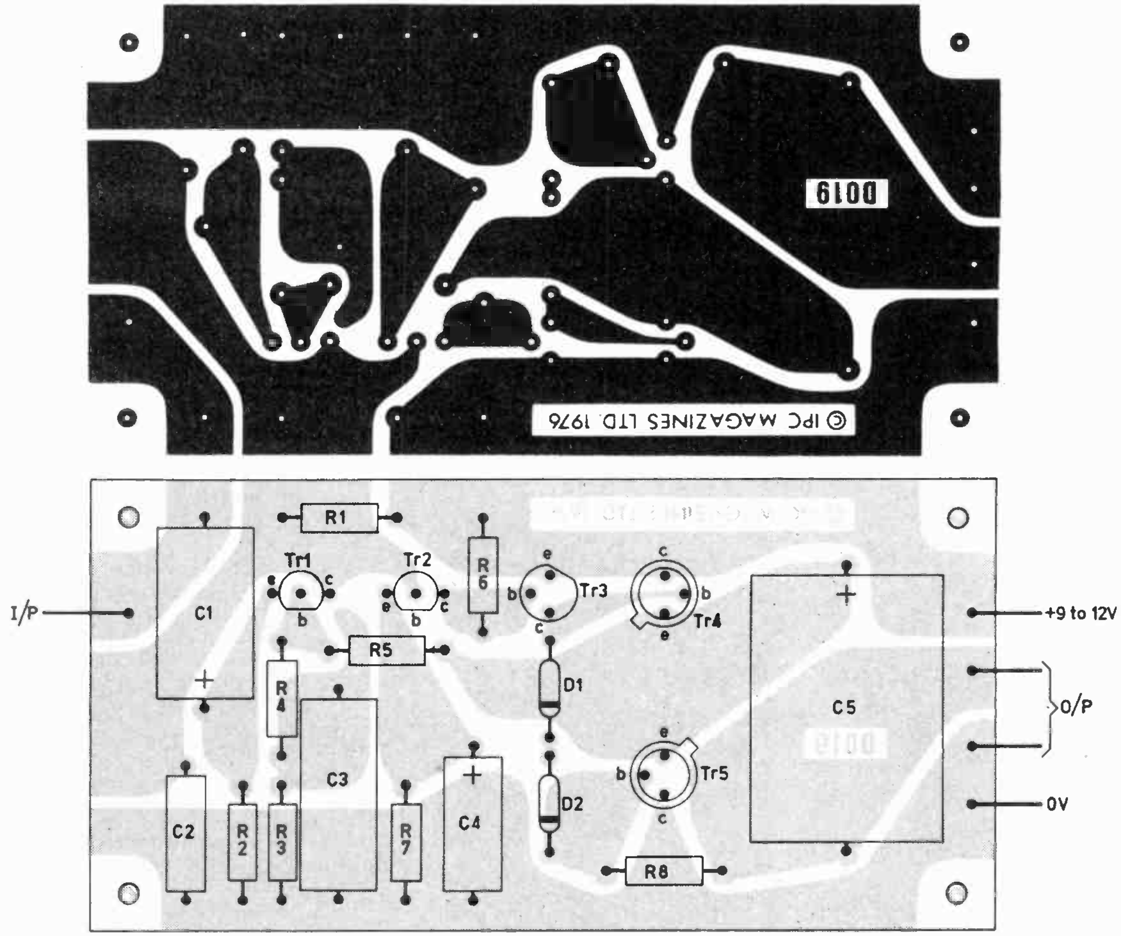
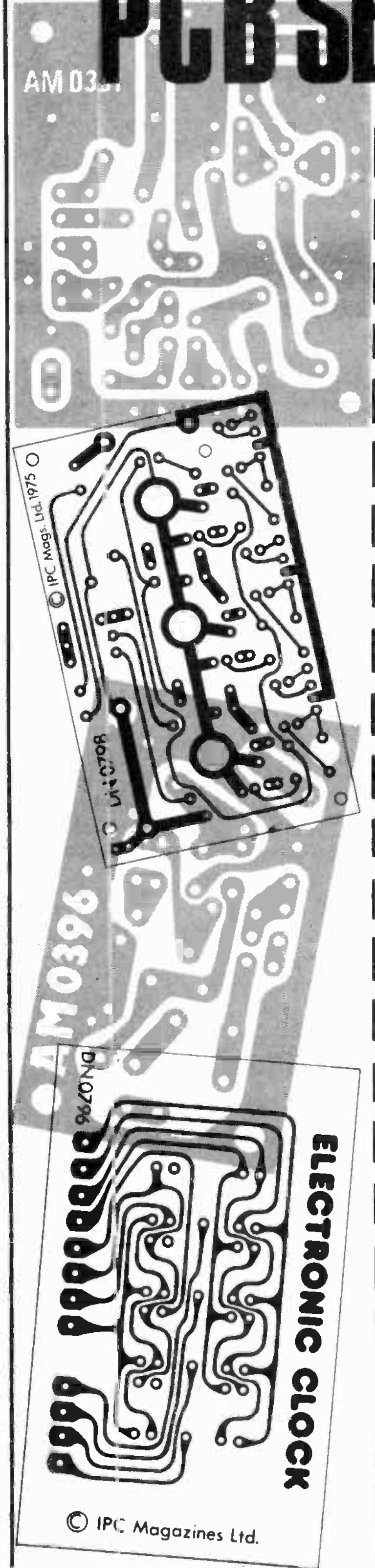



*Fig. 6: Drawing of both the foil and component side of the PCB designed for this project.*

# PCB SERVICE FOR READERS




**All boards, except SRBP, are glassfibre, drilled and roller-tinned**

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| Oct 76 | Hazard Flasher | D005 | 0·76+12 | ☐ |
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| Nov 76 | Burglar Alarm | A019 | 0·50+12 | ☐ |
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# MONOLITHIC VOLTAGE REGULATORS

Brian DANCE M.Sc

## Part 1:- FIXED REGULATORS

A LARGE number of integrated circuit voltage regulator devices are now available which enable very stable, high performance power supplies to be constructed very easily with the simplest possible circuitry. Such regulators are extremely valuable when one requires a very stable output voltage as the load current or as the input supply voltage varies. They are equally useful when the hum level from a mains power supply unit must be kept to a very low level. For example, a few mV of hum on the tuning voltage feeding a varicap front end will produce hum at the FM detector output, but a small monolithic regulator in the varicap supply can be used to prevent this.

This article has been written to guide readers on the general principles of operation of regulator devices and to provide information on the types readily available for the home constructor and the basic circuits in which they can be used.

### DEVICE CLASSIFICATION

Monolithic regulator devices can be divided into two main classes, namely fixed and variable output types. The former is basically designed to give a certain specified output voltage, although it is possible to increase this voltage somewhat whilst keeping a very simple circuit, whilst the latter gives an output voltage which can be varied by means of a potentiometer in the external circuit. Regulators can also be classified according to whether they are designed to provide a positive or a negative output voltage. However, these types are to some extent interchangeable.

Classification can be according to the maximum rated output current. The maximum current from the low current devices is about 100 to 200mA; such devices are normally mounted in a transistor type package and seldom require a heat sink. Medium current devices provide maximum outputs of 200mA to 1·5A and will usually be used with a heat sink, whilst devices delivering still higher currents are always used with a substantial heat sink.

Low current regulators can be used in more complex circuits with external power transistors to provide quite high output currents. This approach is often more economical than the use of high current monolithic or hybrid devices which are normally far more expensive than the low or medium current devices.

### PACKAGES

The low current regulators are normally supplied in transistor or dual-in-line packages. Many medium current devices are in plastic packages with a tab or metal insert for mounting the device on a heat sink, whilst high current devices are often encapsulated in the diamond shaped TO-3 metal package used for power transistors. The recent trend is for the use of low current "on card" devices, the regulator being on the same PCB as the devices to which it supplies power and this greatly reduces unwanted coupling due to the line impedance.

The general principles of operation of a voltage regulator are shown in Fig. 1 which uses a 741 op-amp as a comparator. The zener diode D1 provides a reference voltage $V_{ref}$ and the 741 compares this with the voltage tapped off by VR1. If the value of $V_{ref}$ is the greater of the two, the 741 output will be high and Tr1 will conduct so that the output voltage, $V_o$, rises towards the input voltage, $V_i$. As soon as $V_o$ rises to a value which brings the potential of the slider of VR1 to $V_{ref}$ the output of the 741 falls and Tr1 presents a higher impedance. Thus the output voltage is stabilised at a value higher than that of $V_{ref}$ the value being determined by the setting of VR1.

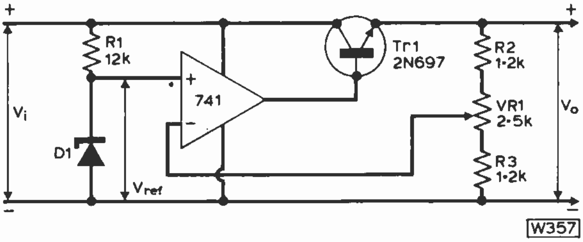



*Fig. 1: A voltage regulator using a 741 operational amplifier.*

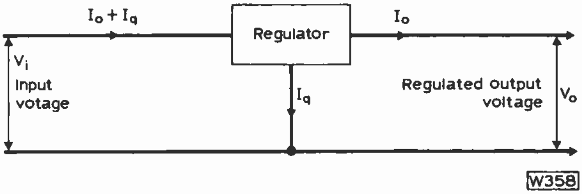



*Fig. 2: Regulator currents and voltages. $I_q$ is the quiescent current which flows even when the output current is zero.*

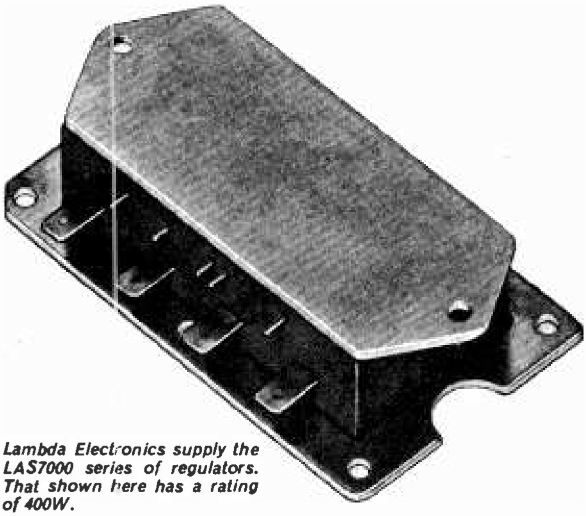
The 741 input requires little current and therefore does not affect the stability of the $V_{ref}$ voltage. Most voltage regulators operate on this principle, with all the components fabricated on a single chip and usually including protective circuits. The maximum output current is determined partly by the ratings of the series transistor Tr1.

## POWER DISSIPATION

The power dissipated internally in a regulator may be estimated using the circuit of Fig. 2. A quiescent current $I_q$ flows through the device at all times to enable it to operate correctly, usually of the order of 10mA. If no output current is taken, the internal power dissipation is $V_iI_q$ and is quite small owing to the low value of $I_q$. When an output current is taken there is an additional internal dissipation of $(V_i-V_o)I_o$ since $(V_i-V_o)$ is the potential difference through which $I_o$ falls as it flows through the device. Thus the total dissipation is $(V_i-V_o)I_o+V_iI_q$.

## INPUT VOLTAGE

What input voltage should one apply to a regulator? The maximum value is quoted on the data sheet and damage may occur if it is exceeded even for a millisecond! The minimum input voltage should always be a few volts above the output voltage, since this additional small voltage is required to enable the device to operate correctly. The minimum value of $(V_i-V_o)$ is known as the 'drop out' voltage, since at lower voltages the regulator 'drops out' and ceases to provide regulation.



*Lambda Electronics supply the LAS7000 series of regulators. That shown here has a rating of 400W.*

As the internal power dissipation is $(V_i-V_o)I_o+V_iI_q$, it is very desirable to keep $V_i$ as low as possible in order to minimise the dissipation. This is especially important in the case of high current regulators where $I_o$, and therefore the internal dissipation, is large. In the case of variable regulator circuits which provide a wide range of output voltages, $V_i$ must exceed the maximum value of $V_o$ so the value of $(V_i-V_o)$ and the dissipation can be large when the output voltage is set to a low value. If the output current is moderately high, it is advisable to consider the use of a switching regulator circuit which can offer higher power efficiency at the expense of circuit complexity.

## PROTECTION CIRCUITS

Most modern regulator devices incorporate circuits to protect them from damage if the output is shorted or if the device becomes too hot, the former by a circuit which limits the maximum value of the output current to a safe value. Thermal protection can take two possible forms. In one type an increase of the chip temperature will cause the output current to be reduced so that the temperature cannot increase further and cause damage to the device. Nevertheless, it is bad practice to operate a regulator for a considerable time at such a high temperature that this current limiting circuit operates; such high temperatures tend to reduce device reliability.

Another form of protective circuit used in low to medium current devices is that of foldback current limiting. If a low resistance is connected across the output or if the output is shorted, the current 'folds back' to a much smaller value than the maximum output. Thus the internal power dissipation is kept relatively small.

## BASIC CIRCUIT

The basic circuit used with simple three terminal voltage regulator devices is shown in Fig. 3. The input voltage is developed across the reservoir capacitor C1 and the regulator provides a constant output voltage. In addition, the hum level at the output is far less than that across C1.

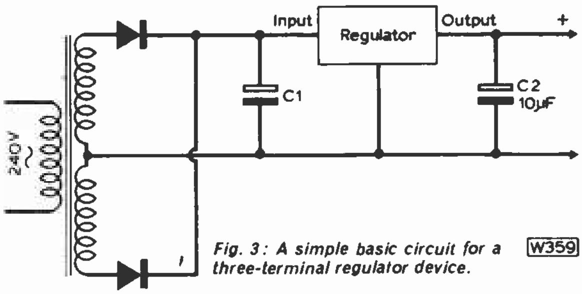



*Fig. 3: A simple basic circuit for a three-terminal regulator device.*

If a slightly increased output voltage is required, a resistor may be included between the 'earth' terminal and the zero voltage line. For example, if this resistor has a value of 270Ω and the quiescent current is 10mA, the output voltage will be raised by the voltage across this resistor, namely 2·7V. Alternatively a zener diode may be use instead of a resistor.

## LOW CURRENT DEVICES

One of the best known series of fixed output low current regulators is the TBA625A (5V), the TBA435 (8·5V), the TBA625B (12V) and the TBA625C (15V) series produced by SGS-ATES Ltd. (available from Chromasonic Electronics). They can be used in the very simple circuit of Fig. 3 to provide output currents of up to about 120mA. The devices incorporate foldback current limiting; if the output is shorted, the current falls to between 30 and 45mA. In addition, the short circuit current falls with increasing chip temperature, to provide further protection.

These regulators reduce the hum level across C1 by a factor of about 400 times (52dB). The larger the value of C1 the smaller the hum voltage across it and the lower the output hum level. If C1 is about 250μF the output hum level will be of the order of 1mV. C2 may be required with some devices to prevent instability and should be close to the device. The dropout voltage is about 2·3V at the maximum current, whilst the output impedance is of the order of 0·1Ω.

This series of regulator devices is available in the type of transistor package shown in Fig. 4(a). The devices may be used in the type of circuit shown in Fig. 5 to provide a small range of output voltage variation. In this circuit the output voltage is equal to $V(1+R2/R1)+I_qR_2$ where V is the voltage of the regulator itself. The circuit of Fig. 3 can also be used to provide a negative supply if the positive line is earthed instead of the negative line.

## THERMAL LIMITING

Another type of 100mA regulator is made by Fairchild as the μA78L00 series, by Motorola as the MC78L00C series and by National Semiconductor as the LM78LXX series, but the latter has been replaced by the improved LM340L-XX devices. When referring to a specific device in the series, the '00' or 'XX' is replaced by the voltage of that device. For example, the μA78L05, the MC78L05C and the LM3400L-05 are 5V devices, whilst the LM340L-24 is a 24V device.

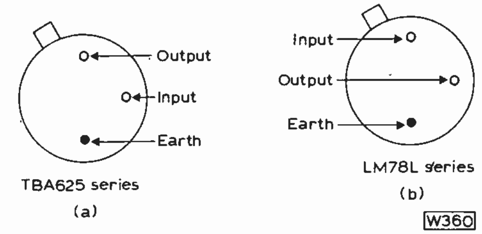
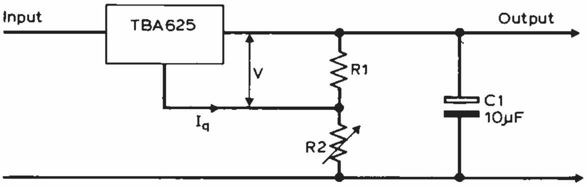



*Fig. 4: Connections for (a) the TBA625 series and (b) the LM78LXX series.*

These devices are available in TO-5 metal cans, but the connections, Fig. 4(b) are different from those of the TBA625 series; they are also available in TO-92 plastic packages. Some types are stocked by Chromasonic Electronics Ltd., whilst National Semiconductor devices are available from DTV Group Ltd., 126 Hamilton Rd., London S.E.27.

These devices can be used in the same circuits as those already discussed. The output current on short circuit does not fold back, but is limited in value and a thermal limiting circuit operates at high chip temperatures. The performance is similar to that of the TBA625 series, but the dropout voltage (1·7V) is rather less.

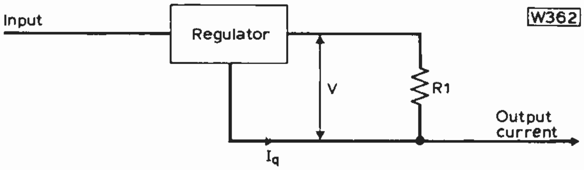



| | R1 | R2(max) | $V_{out}$ |
|---|---|---|---|
| TBA625A | 430 | 250 | 5-9 |
| TBA625B | 1k | 150 | 12-15 |
| TBA625C | 1·2k | 150 | 15-17 |

W361

*Fig. 5: above, a circuit using the TBA625 devices to provide a variable regulated output.*

*Fig. 6: below, a current regulator circuit.*




Voltage regulators of almost any type can be used as a current regulator, in the circuit of Fig. 6. The output current is held constant at a value of $V/R1+I_q$ where V is the output voltage of the device concerned.

## MEDIUM CURRENT DEVICES

The National Semiconductor LM342-XX series has similar internal circuitry to the LM340L-XX series, but can supply in excess of 200mA. The SGS-ATES TDA1405 (5V), TDA1412 (12V) and TDA1415(15V) are available from Doram Electronics Ltd, and have a similar internal circuit to the TBA625 series, but can deliver output currents of up to 500mA. They are encapsulated in a 3-lead plastic package with a hole for bolting the metal insert to a heat sink. The foldback limiting causes the current to fall to between 80 and 180mA on short circuiting the output. However, thermal damage can be caused if the device is not mounted on a heat sink. The L129 (5V), L130 (12V) and L131 (15V) are similar to the TDA1405 devices, but have a wider operating temperature range. All these devices can be used in the type of circuit already discussed.

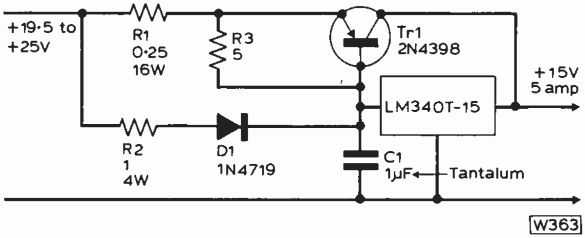



*Fig. 7: A circuit for increasing the output current from a LM340T-15 device by a factor of five.*

Another series of medium current devices has been adopted by many manufacturers, thermal limiting being employed rather than foldback limiting. The internal circuitry is similar to that of the LM342-XX series but the output current can be up to 500mA in some types and up to 1A in others. These standard types are available with nominal outputs of 5V, 6V, 8V, 12V, 15V, 18V and 24V. For example, the 1A range includes the LM340T-XX in a TO-220 plastic package, the LM340K-XX in a TO-3 package, the Motorola MC7800 series, the Fairchild μA7800 devices and the Texas Instruments SN72900 series. The 500mA devices include the National Semiconductor LM341P-XX plastic types with a tab for bolting to a heat sink and the Fairchild μA78M00C. Other devices available from Doram Electronics Ltd include the LM309K 5V regulator in a TO-3 package which can give over 1A and the LM323K in the same package for 5V at up to 3A.

## HIGHER CURRENTS

All these devices can be used in the circuits discussed, but the type of circuit shown in Fig. 7 can be used to obtain more output current. In the particular circuit shown, a LM340T-15 device is used, the maximum current being 5A instead of the 1A of the device itself.

If the voltage across D1 is equal to the base-emitter voltage of Tr1, the current flowing through R1 is about four times that through R2. This current boosting circuit takes advantage of the internal current

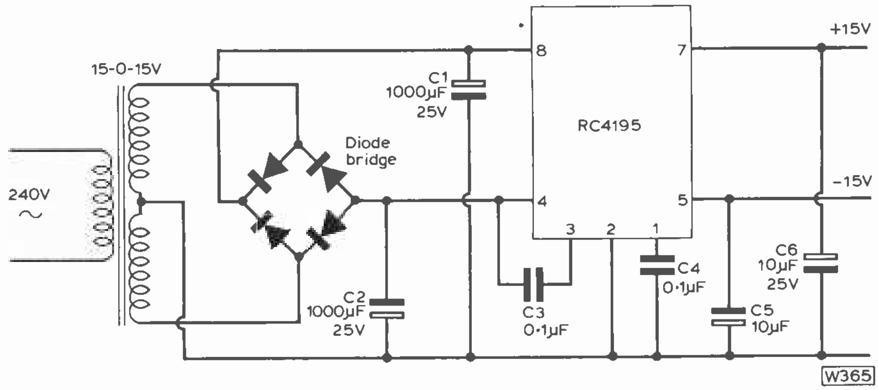
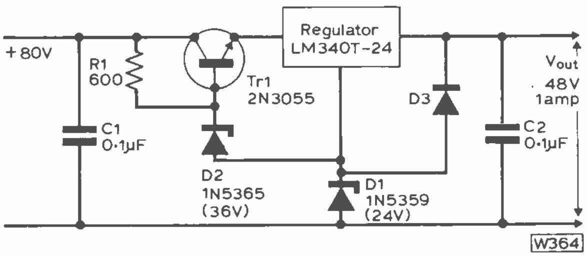



*Fig. 9: A dual tracking regulator using the RC4195 device to provide +15V and −15V outputs.*

*Fig. 8: below, a high output voltage circuit using the LM340T-24 device to provide a regulated 48V.*




limiting properties of the regulator to provide short-circuit protection of the booster section. The short circuit is limited to R2/R1 times the output limiting current of the regulator device itself. If the heat sink fitted to Tr1 has at least four times the capacity of the sink fitted to the LM340T-15 device, the thermal overload protection of the latter will be extended to Tr1. As the load current increases from 0 to 5A, there is a change of about 1% in the output voltage.

## HIGH OUTPUT VOLTAGE

The circuit of Fig. 8 shows how the LM340T-24 can be used to provide an output of 48V. Under short-circuit conditions the voltage at the input side of the regulator falls to 35V, D3 aids the start-up of the circuit and protects the regulator from high input-to-output voltage differentials during short circuits.

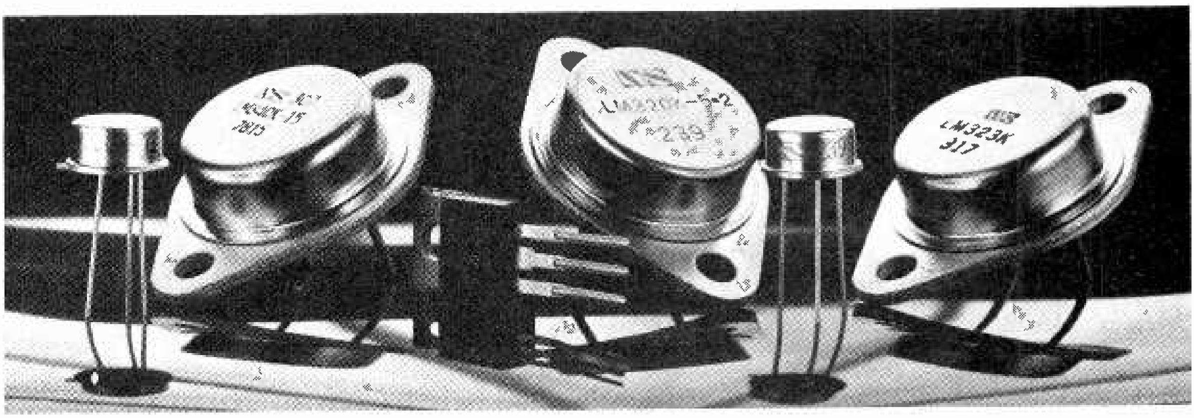
## DUAL TRACKING REGULATORS

Work with operational amplifiers normally requires dual power supplies of about ±15V and the supplies should be regulated to prevent the output voltage of the operational amplifiers from drifting. Further, it is desirable for accurate work that the drift in the voltage of one of the pair of lines should be matched by a proportional drift in the voltage of the other line; that is, the two voltages must track one another.

One of the simplest ways of constructing a dual tracking power supply unit with ±15V outputs involves the use of the Raytheon RC4195 device in the circuit of Fig. 9. This device is available from Doram Electronics Ltd (order code 303-636) as an 8-pin dual-in-line package which can deliver over 100mA from each output with short circuit currents of about 220mA. The input voltages should be in the range ±18V up to the maximum of ±30V. The frequency compensating capacitors C3 and C4 increase stability, but can often be omitted.

The RC4195 device incorporates thermal shut down and short circuit protection for both outputs. It replaces two separate regulator devices. The balance connection to pin 6 can be taken to a variable voltage so that the two output voltages can be accurately balanced. The RC4195 can also be used to provide a single regulated output of +50V at 100mA, whilst in another circuit with external power transistors it will provide a dual tracking supply of ±15V at 2·5A each.

**Next month, in Part 2, we shall deal with Fixed Regulators**



*This photograph, provided by National Semiconductor, shows voltage regulator devices in TO-5 (small circular), TO-3 (large circular) and TO-220 plastic packages.*

# HOTLINES ON RECENT DEVELOPMENTS

## Radio . . . . what?

Next time you are in the company of people who delight in using long words, get your own back; say radioimmunoassay! If they call your bluff and ask what it means, the following explanation might help.

The word radioimmunoassay (RIA for short) comes from the medical profession, well known for its love of technical tongue twisters. RIA is a technique used to measure very very tiny amounts of things in the blood such as hormones etc. The medical minnions often do this by putting in some minute but radio active tracer elements and following their path around the body. These tracers are often measured while still in the body.

A rather bright medical instrument manufacturer has now gone one better. The antigens (these are the minute traces you want to measure) are bound to microscopic flecks of iron. It is then, in crude lay terms, simply a matter of going fishing with a magnet! The fluid is passed by a magnet and the iron particles are separated leaving only the elements in the sample which are required for measurement. In practical terms this means that the manual separation part of RIA can be fully automated.

## Micro speaker

Beepers for use as alarms have been marketed for some time and are available in this country from various electronics stockists. However, although their idea is not new I am very taken with the very latest one just launched in America.

The beeper measures only 0·64in cube and weighs just 6 grams. Despite its very small size, the device has a free field output of 105dB at 1in. The secret of this great output compared to size is in the cunning construction of the inside of the cube which houses the device. This internal structure is fashioned like a miniature folded horn which is tuned to 2.1kHz. An advantage of a tuned horn as opposed to a resonant cavity is that the horn tunes very broadly and so is not critical. Yet another advantage is that the beeper, because of its broader bandwidth, can be used as a truly miniature loudspeaker. It is offered in a variety of impedances from 2Ω to 2kΩ and it even has little solder tabs for ease of mounting onto a PCB. One can imagine a very small radio set for, say, the bedroom using a ZN414, LM380 and one of these tiny speakers. Alas—they've only just been released onto the market in America and are not obtainable in this country as yet.

## Expensive games

With television games gaining greater popularity one would think that this was a real growth area for electronics and without too many problems. Sad to tell this is not the case. I hear of a report which indicates that the grid or pattern projected onto the CRT of a television (i.e. the goals for football or the walls for squash etc) is "burning" a permanent image onto the TV tube and, as such, will eventually ruin it for normal TV watching. The time taken for this effect to become noticeable is, so I'm told, about 2,000 hours of use. However, with different games, different intensity settings and, indeed, different tubes, this time is by no means a standard to judge the situation by.

Now, a group has been set up to study this affect and to report its findings to the authorities. I will mention this again as and when more news comes in. However, the thought of ruining a colour television tube is a little frightening when one thinks of the cost. Perhaps, if you play TV games, it might be prudent to keep the brightness turned down just a little?

## Straight tape

If you drill a hole how do you know if it's straight? Probably this is unimportant for your ordinary average hole, but if your drilling real big deep ones, like oil people do, then it becomes very important. A British company has manufactured what is called an inertial navigation unit (more long words). In use, this unit is lowered down the hole. On its journey it keeps careful records; it has a cassette recorder to monitor and log the distance it has travelled and deviation in terms of lateral movements. When the unit is hoisted up the tape is played to an analyser unit which in turn feeds out printed data on the accuracy of the hole at different depths.

Before you decide to use one for the precision drilling of this years potato crop, the price for one such installation is quoted as around £91,000—and that's a 'hole' lot of money.

## Hot news

If you wanted to take the temperature of something it's almost certain that you'd use some kind of thermometer. I see that the market has just been invaded by another non-contact thermometer and it struck me that some readers may not have heard of these intrigueing devices.

This latest one is a small hand-held unit which is simply pointed at the target. It will then, within one second, show the true temperature of that target in degrees C. The target can be up to 20 feet away and this particular "thermometer" has a measurement range from 10°C right up to 1,000°C.

It occurs to me that if I was only 20 feet from 1,000°C I would become medium rare in about 20 seconds!

## More expensive?

When hire transport in London changed from handsome cab to motor taxi there must have been some regretful sighs. I wonder if there will be any sighs for taxi meters. A problem is that a cab may be laid up for a matter of days while its electromechanical meter is adjusted. Owners of a few of the larger fleets of cabs have got together and formed a company to manufacturer an electronic taxi meter. Readout of the fare cost is, of course, digital while changing the meter is just a matter of unplugging one and plugging in another.

Watch out for the new best seller folks, "Electronic Taxi Meters—Are They Really Fare?"

Ginsberg

# improved etching of PCB's

J.A.KENNEDY

MANY chemicals and combinations of chemicals are suitable for etching copper but by far the most common, due to its cheapness and ease of use, is ferric chloride, either by itself or mixed with various additives. In solution ferric chloride reacts with the water to form a small amount of the insoluble salt ferric hydroxide, together with hydrochloric acid (HCl). This reaction is easily prevented by adding up to 5% HCl. In either case HCl is present and available for reaction with both ferrous chloride and cuprous chloride, converting them back to ferric chloride and cupric chloride respectively if free oxygen is present.

$FeCl_3 + 3H_2O \rightarrow Fe(OH)_3 + 3HCl$ Hydrolysis.

$FeCl_3 + Cu \rightarrow FeCl_2 + CuCl$ At copper surface.

$FeCl_3 + CuCl \rightarrow FeCl_2 + CuCl_2$ In body of solution.

$CuCl_2 + Cu \rightarrow 2CuCl$ At high copper levels.

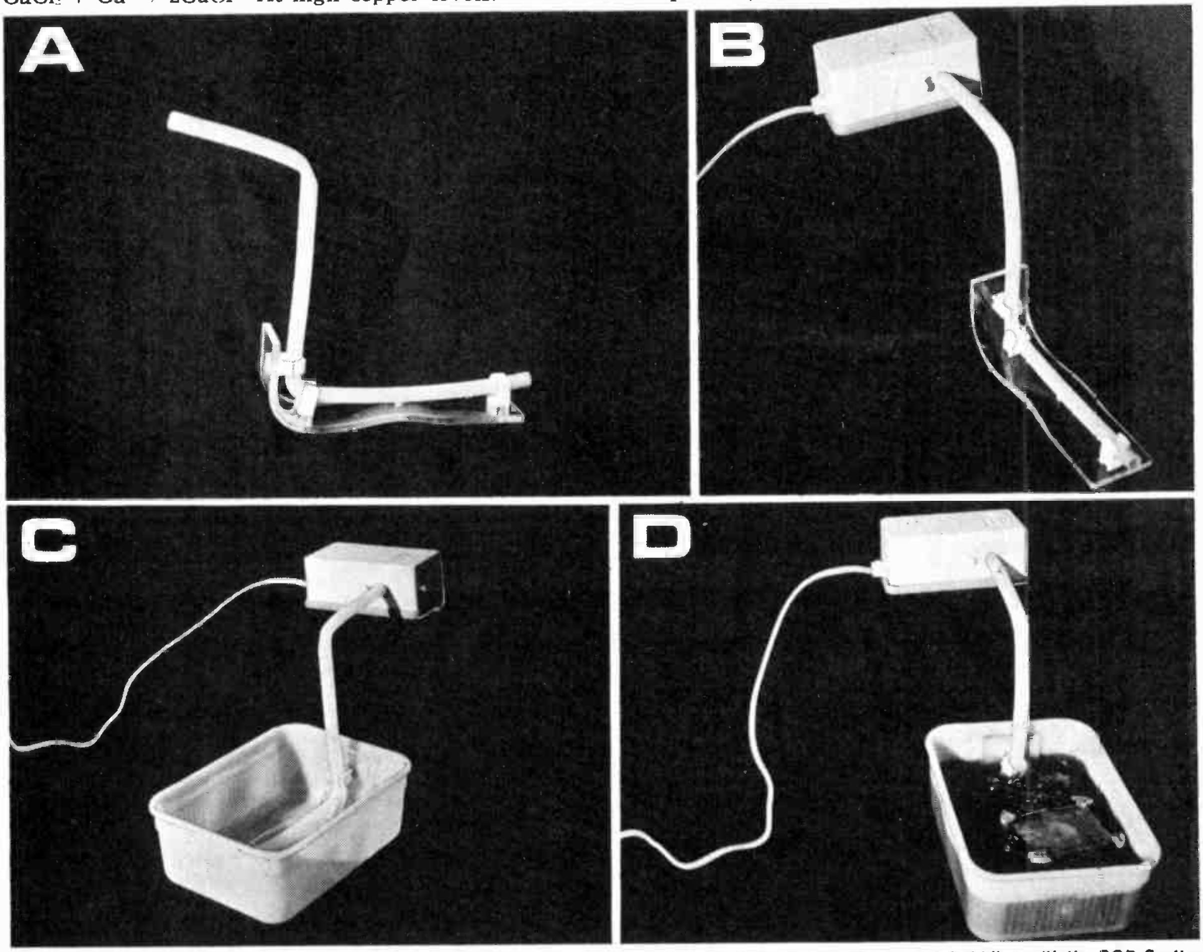
If oxygen is present:

$$4FeCl_2 + O_2 + 4HCl \rightarrow 4FeCl_3 + 2H_2O$$

$$2CuCl + O_2 + 2HCl \rightarrow 2CuCl_2 + 2H_2O$$

From the above it can be seen that it is advantageous to have an oxygenated solution. The two commonest methods of oxygenating a solution (spraying it through air or bubbling air through it) also provide mechanical agitation at the copper surface thus removing the ferrous and cuprous chlorides as they are formed and supplying fresh etchant to the surface.

Spray etching produces better results than bubble etching but the problems involved in producing a uniform spray pattern and obtaining pumps manufactured in materials that are inert to the etchant tend to cancel any advantages to the amateur. In comparison, bubble etching is very simple to imple-




*Photograph **A** shows the plastic tube suitably bent and fixed to a heavier plastic base. In **B** the tube has been fitted to the air pump. Photograph **C** shows the complete set-up with the tube in the bottom of a plastic bowl. Finally in **D** the solution is seen bubbling with the PCB floating on the surface with the aid of a cork in each corner.*

# I.C. OF THE MONTH

by BRIAN DANCE

## Number 62 SGS-ATES TBA820 LV AUDIO AMPLIFIER

THE SGS-ATES TBA820 device is not designed to give a very high output power but is very suitable for use in portable equipment where the battery voltage may be as low as 3V. The typical quiescent current consumption is only 4mA at 9V, so one can obtain a long battery life at low output power.

The TBA820 is very suitable for use in small portable radio receivers, small record players and tape recorders, etc. It enables much simpler audio power amplifiers to be constructed compared to those where only discrete components are used.

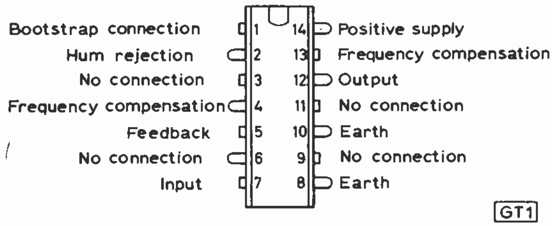



*Fig. 1: The TBA820 pin connections.*

The TBA820 is encapsulated in a quad-in-line package with the connections shown in Fig. 1. In this type of device alternate pins on each side of the plastic body are bent so that they protrude to different distances at their lower ends. This configuration provides more space between adjacent pins for ease of soldering than in dual-in-line devices, but quad-in-line sockets are more difficult to obtain.

## CIRCUITS

A typical circuit for the TBA820 is shown in Fig. 2. If the input signal has any DC superimposed on it, a capacitor of value about 0·22μF must be placed in series with the input connection. R1 may be replaced with a 100kΩ volume control, if desired, but a resistor of value not exceeding a few hundred kΩ must be present from pin 7 to earth to achieve correct biasing.

The capacitor C6 prevents a steady current flowing from the output (pin 12) through the loudspeaker speech coil. A somewhat smaller value can be used, but this will result in a reduction in the bass response. The power supply decoupling capacitor, C4, should be soldered fairly close to pin 14 to prevent spurious RF oscillation. C7 is an electrolytic capacitor in parallel with C4 which provides decoupling at lower frequencies.

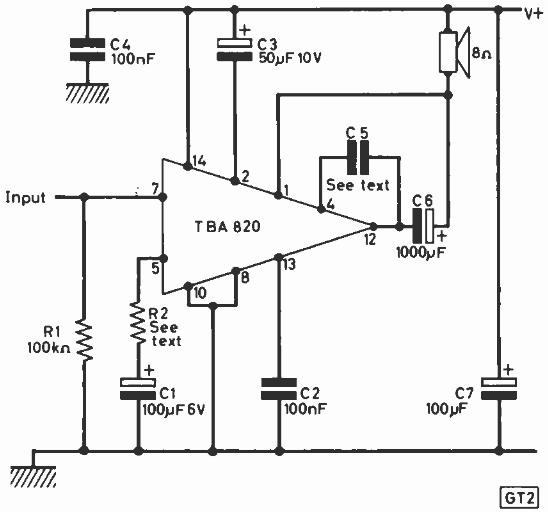


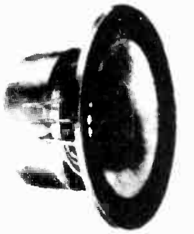

*Fig. 2: A simple TBA820 amplifier circuit.*

The gain of the circuit is determined by the value of R2. An internal feedback resistor of value 6kΩ is connected from pin 12 to pin 5, so the smaller the value of R2, the greater the gain. The gain is approximately equal to 6000/R2; thus voltage gains of 30, 60 and 120 may be obtained by using values of R2 of 200Ω, 100Ω and 50Ω respectively. The maximum value of R2 is about 390Ω if a 9V supply is employed or 270Ω with a 12V supply, since saturation of the input circuit may occur with higher values.

The value of C5 determines the high frequency response of the circuit, but the value required for any specified frequency response is affected by the value of R2. The value of C5 required for various upper cut-off frequencies is plotted against R2 in Fig. 3.

The optional capacitor C3 provides a reduction of about 42dB of any hum on the power supply line. It is not required if a well stabilised supply is employed. However, if a battery is used as a source of power, this capacitor should always be included, since it will prevent 'motor boating' when the internal resistance of the battery rises with age.

The maximum output power which can be obtained from TBA820 depends on the impedance of the loudspeaker and on the power supply voltage. For example, one can obtain 2W with an 8Ω speaker



# WILMSLOW AUDIO

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| Baker Group 35, 3, 8 or 15 ohms | £14·50 |
| Baker Group 50/12 8 or 15 ohms | £21·00 |
| Baker Group 50/15 8 or 15 ohms | £25·75 |
| Baker Deluxe 12" 8 or 15 ohms | £17·50 |
| Baker Major 3, 8 or 15 ohms | £15·00 |
| Baker Superb 8 or 15 ohms | £22·50 |
| Baker Regent 12" 8 or 15 ohms | £12·50 |
| Baker Auditorium 12" 8 or 15 ohms | £21·00 |
| Baker Auditorium 15" 8 or 15 ohms | £25·75 |
| Celestion G12M 8 or 15 ohms | £12·95 |
| Celestion G12H 8 or 15 ohms | £15·95 |
| Celestion G12/50 8 or 15 ohms | £18·00 |
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| Celestion G15C 8 or 15 ohms | £26·95 |
| Celestion G18C 8 or 15 ohms | £39·95 |
| Celestion HF1300 8 or 15 ohms | £7·50 |
| Celestion HF2000 8 ohms | £8·55 |
| Celestion MH1000 8 or 15 ohms | £13·50 |
| Celestion CO3K | £4·46 |
| Decca London ribbon horn | £31·50 |
| Decca London CO/1000/8 Xover | £6·95 |
| Decca DK30 ribbon horn | £20·50 |
| Decca CO/1/8 Xover (DK30) | £4·75 |
| EMI 14 x 9 Bass 8 ohms 14A770 | £12·50 |
| EMI 8 x 5, 10 watt, d/cone, roll surr. | £3·95 |
| EMI 6½" d/cone, roll surr. 8 ohms | £3·95 |
| EMI 8 roll surr. bass | £6·75 |
| EMI 5" mid range | £3·50 |
| Elac 59RM109 (15) 59RM114 (8) | £3·50 |
| Elac 6½" d/cone, roll surr. 8 ohms | £3·95 |
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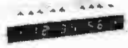

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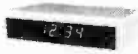

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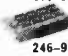

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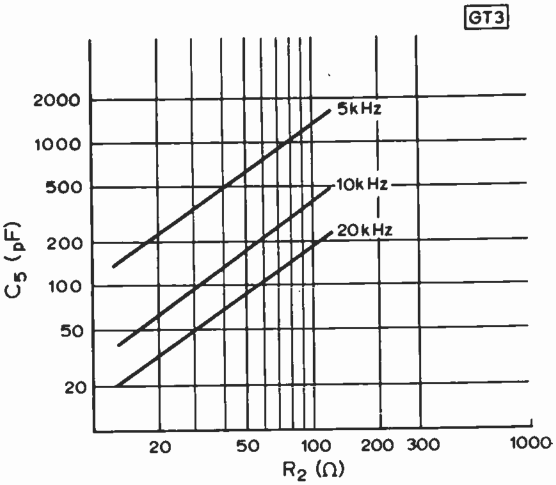
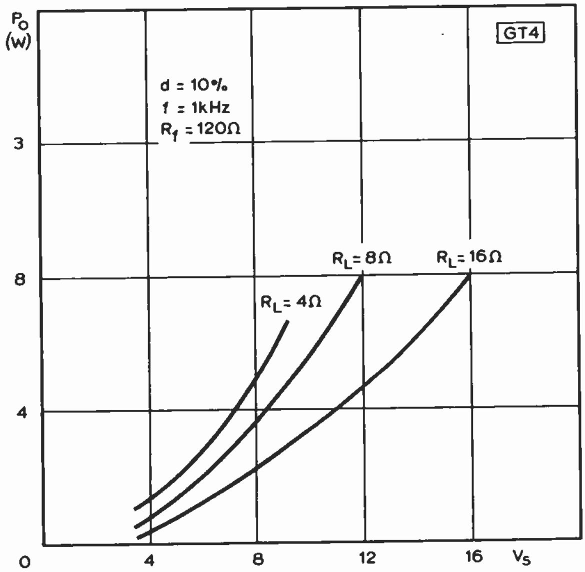



*Fig. 3: above. This graph may be used to select the optimum value of C5.*

*Fig. 4: below. Maximum power output at various supply voltages and speaker impedances, for a total harmonic distortion of 10%.*




and a 12V supply. The absolute maximum power supply voltage is 16V which will enable 2W to be obtained from a 16Ω speaker. However, it is wise to regard 14V as the maximum to allow a reasonable margin of safety. If a 4Ω speaker is employed, the power supply voltage should not exceed 9V to prevent overloading of the device. An output of up to 1·6W can then be obtained. If the circuit is operated from a 9V supply when using an 8Ω speaker, the maximum output is about 1·2W, Fig. 4.

If the supply voltage is only 3·5V, the maximum output power is about 0·2W. Although this may seem very small, the ear has a logarithmic response and this power level is quite adequate for a portable receiver; indeed, many small speakers cannot handle more. The writer found that the circuit shown will operate satisfactorily with power supply voltages down to 3V but at still lower voltages the distortion increases rapidly and the gain falls. At low supply voltages a relatively low impedance loudspeaker of 4Ω may be chosen so as to provide a reasonable output power.

Cross-over distortion is not present in the TBA820. As the power output increases, the distortion remains almost constant at a low value of about 0·2 per cent until clipping of the waveform begins. The distortion then rises very rapidly with increasing output power.

The TBA820 can dissipate up to 1·25W. In practice this means that no heat sink is required when the device is used with power supplies of up to 16V with a 16Ω loudspeaker, up to 12V with an 8Ω loudspeaker or up to 9V with a 4Ω loudspeaker.

## RADIO RECEIVERS

The writer has used a TBA651 AM radio circuit (see *Practical Wireless July 1974*) which fed a signal into a TBA820 power amplifier. This circuit used an 11V supply but a different integrated circuit must be employed in the radio section in receivers using a low power supply voltage.

A simple low voltage radio is shown in Fig. 5; only medium wave coverage is provided by the circuit shown, but a long wave coil could be switched into

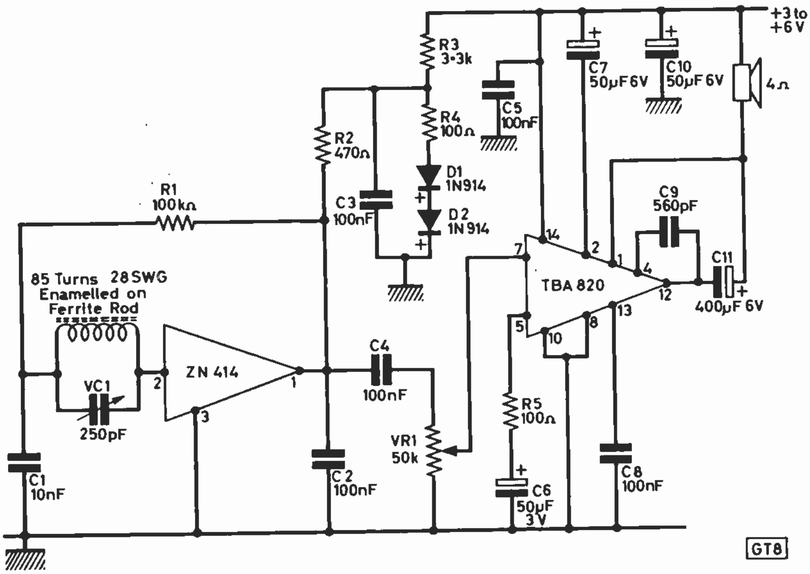



*Fig. 5: A simple integrated circuit radio tuner which will provide a low power output from a low voltage supply.*

the circuit if desired. About 220 turns of 40 SWG insulated wire is suitable for a long wave coil. The two silicon diodes D1 and D2 keep the supply voltage to the ZN414 fairly constant as the power supply voltage falls with an ageing battery. Low voltage capacitors are used in the circuit of Fig. 6, since they are smaller and cheaper than higher voltage types. However, the power supply voltage must not exceed 6V when these capacitors are used.

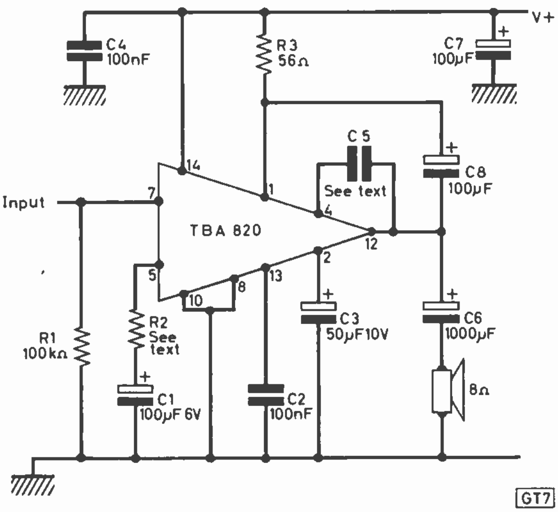



*Fig. 6: A circuit in which one side of the speaker can be earthed.*

## IN USE

The TBA820 may be soldered in position on a piece of matrix board with 0·1in hole spacing. However, a neater amplifier can be made by using a printed circuit board. It should be noted that the input earth connection should be separate from the output earth connection, to minimise unwanted coupling.

If the constructor wishes to employ a circuit in which the loudspeaker is earthed on one side, the circuit shown in Fig. 6 may be used. This does require an additional electrolytic capacitor C8 to provide the bootstrap signal to pin 1. The component values not marked should be selected in the same way as the corresponding components of Fig. 2. If a hum rejection or "anti-motorboating" capacitor is employed in this circuit, it should be connected between pin 2 and earth and not as in Fig. 2.

## KINDLY NOTE!

TUG 'O WAR — APRIL 77

Main PCB, page 1032. Track from pins 13/14 IC5 should join adjacent track going to +9V. PCBs from Readers PCB Service are correct.

**IMPROVED ETCHING OF PCB's**—*contd from page 33*

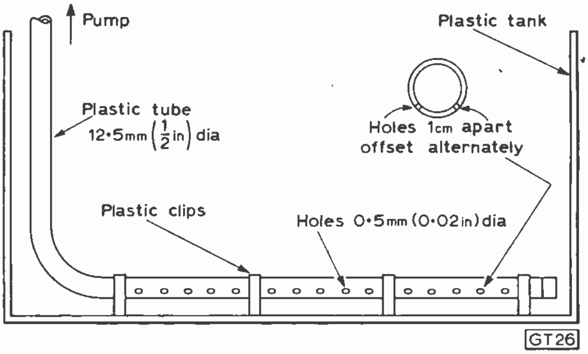



*Illustration of the plastic tube showing how the holes in the tube are drilled.*

ment, as it increases the useful life of the etchant and can reduce etching time to less than five minutes thus minimising any tendency for the resist to deteriorate. All that is required in addition to the etching tank is a high capacity air pump as used for aquariums and a length of ½" dia. PVC tubing. The pump should be capable of maintaining a pressure of 2lb/sq.in.

## CONSTRUCTION

The tube is mounted close to the bottom of the tank as shown in the diagram with 0·5mm holes spaced about 1cm apart on the underside of the tube offset alternately by about 45°. The end of the tube in the tank is sealed with a rubber bung and the other end attached to the pump, the pump being mounted above the level of the etchant.

The etch rate is greatest near the surface of the etchant therefore the best results are obtained by floating the board copper side down on the surface of the etchant. This is most easily achieved by cutting the board slightly oversize and inserting the corners into small corks. Double sided boards should be etched vertically. If it is desired to increase the etch rate still further an aquarium heater set to about 30°C can be used to heat the etchant.

A suitable etching solution would be:
Ferric Chloride ($FeCl_3$) 500 gm.
35% Hydrochloric Acid (HCl) 50ml.
Water ($H_2O$) 1 litre.

## NOTES

Up to 1ml of photographic wetting agent may be added but this may cause foaming which could prove troublesome. When in use adequate ventilation must be provided and the solution should not be left in an open tank any longer than necessary as it will promote oxidisation of any metal in the room.

The most suitable method of disposing of the ferric chloride is to neutralise it with calcium carbonate (limestone) and then bury it. (N.B. hard water should not be used for making the solution.)

The success or failure of PCB production depends to a great extent on the cleanliness of the copper being maintained at all times. An economical medium for mechanically cleaning the board is a 'Scotchbrite' pan scouring pad followed by a wipe with a tissue wetted with acetone in order to remove any grease present. Acetone is also suitable for removing 'Dalo' type resists. PW

# S-DeCnology

DAVID GIBSON

THIS MONTH

## 'The Ohm Gnome'

MANY of the previous circuits in this series have found major applications in novelty. The project described here has a more serious role.

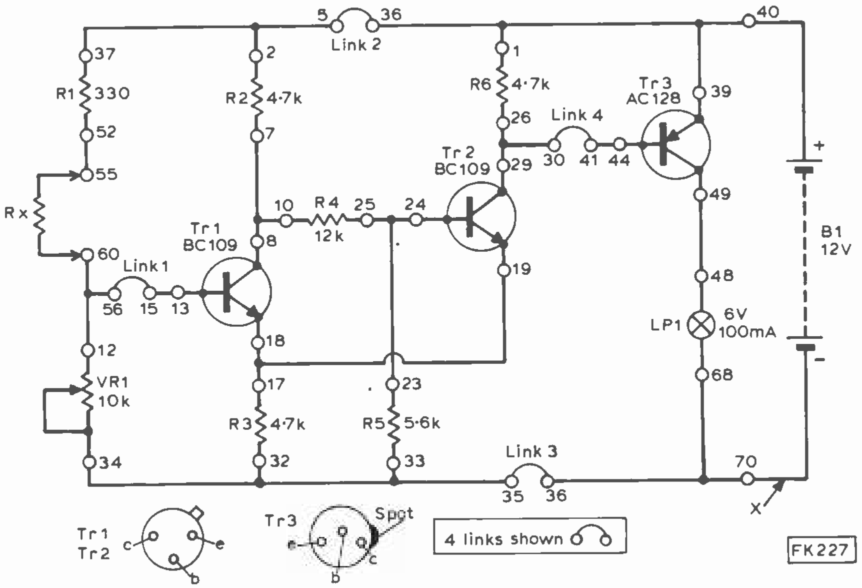
Basically it is a device for indicating the value of "unknown" resistors. To this end it employs rather novel principles—and no expensive meter. In use, the resistor whose value is unknown (or in doubt) is plugged into S-DeC holes 55 and 60. The potentiometer, VR1, is rotated until the bulb lights. The pot is then rotated slowly in the opposite direction until the lamp goes out, and the value of resistance is then read or interpolated from the calibrated dial.

### Circuit ideas

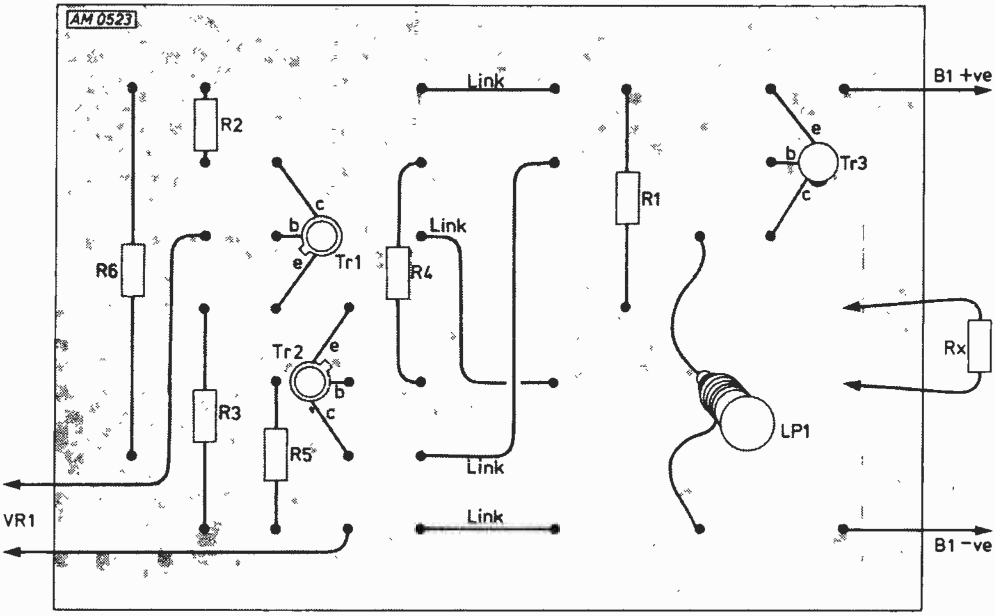
The most immediate thought in designing such a circuit would be to use a simple bridge of some sort,

### you will need . . . . .

| | | | |
|---|---|---|---|
| R1 | 330Ω | Tr1 | BC109 |
| R2 | 4·7kΩ | Tr2 | BC109 |
| R3 | 4·7kΩ | Tr3 | AC128 |
| R4 | 12kΩ | LP1 | 6V 100mA bulb |
| R5 | 5·6kΩ | B1 | 12V battery |
| R6 | 4·7kΩ | One S-DeC | |
| VR1 | 10kΩ pot | One Blob Board ZB-5D | |




*Full circuit diagram of the 'Ohm Gnome' resistance checker. If power is applied continuously, it's a good idea to keep some sort of resistance in the Rx position to prevent Tr3 from getting overheated.*




*Component layout on the S-DeC giving the exact numbered holes in which the semiconductors and resistors are plugged.*

and indeed circuitry exists which advocates this. However, despite the most careful tests this idea was rejected. To turn the potentiometer until the lamp was extinguished was almost impossible without using a magnifying glass to be really sure that the bulb was out or at least at "minimum red glow".

In the circuit diagram, transistor Tr3 drives LP1 upon receipt of a suitable signal from Tr2 and so the Tr3 part of the circuit is quite straight forward. Let's look at the role played by Tr1 and Tr2.

These transistors are connected as a Schmitt trigger circuit. This useful arrangement can be used for our purpose because it triggers at a reasonably precise level/value of input signal.

## Potential divider

In the circuit we are varying the input by rotating the potentiometer. The latter, together with R1 and the unknown value of resistor under measurement forms a potential divider. The setting of VR1 at which the circuit triggers will vary depending upon the value of the unknown resistor. Thus by calibrating the potentiometer dial using known values, the unknown ones can be read directly or interpolated.

The circuit will work well by simply "tuning" for the bulb to switch on, but it seemed easier on test to set the pot more precisely by "tuning" for bulb-off. The only real difference in practical terms is that the dial readings are slightly displaced between the two sets of readings. Providing, when calibrating, the constructor settles for one method or the other and sticks to it (i.e. the bulb-on or-off giving indication) then either method is entirely satisfactory. Using a 10kΩ potentiometer for VR1 gave a measurement range from 33Ω to just over 33kΩ. The useful measurement range was found to extend from 1kΩ to 33kΩ because the lower end of the range (below 1kΩ) tended to be very cramped and difficult to read with any degree of accuracy. Substituting a 1MΩ potentiometer for VR1 gave a measurement range from about 33Ω to 2·2MΩ but the dial was rather cramped.

## Just plug-in

Assembling the circuit on the S-DeC is extremely simple and easy. Just plug in the components via their own leads. Push the leads into the S-DeC hole number(s) given in the circuit and check again, against the full size S-DeC layout drawing. Using the little jumper leads with plugs on each end is helpful when links are required.

For those constructors who would like to make a permanent unit of the Ohm Gnome the following suggestions are offered. The simplest method of construction, once the circuit has been "proved" on the S-DeC, is to transfer the components directly onto a piece of BloB Board. Because all the components are soldered and fitted on one side of the board only, the BloB Board may be stuck (with any good adhesive) directly to the inside of a suitable case.

A push button should be inserted between the negative terminal of the battery and the negative line of the circuit (point X in the circuit). In operation, press the push button and hold it down. Rotate the pot until LP1 lights, then release the push button (if tuning for lamp-off, hold push button until you've "tuned" back to extinguish the light). In this way the battery life will be considerably extended since the circuit will only draw current when actually measuring.

## Dial construction

With a reasonable size case, a useful size of dial can be employed, and it is suggested that the constructor consider making the dial with the aid of a protractor. Mark the dial around the potentiometer pointer accurately, in degrees. Then, using a piece of graph paper mark degrees along the X axis, and the known resistance values along the Y axis. Plug in, say, a 1kΩ resistor, 2·2kΩ, 4·7kΩ 10kΩ 12kΩ 22kΩ 27kΩ 33kΩ. These will give you all the points you need to draw a graph. You will find most of these resistors from previous projects in this series.

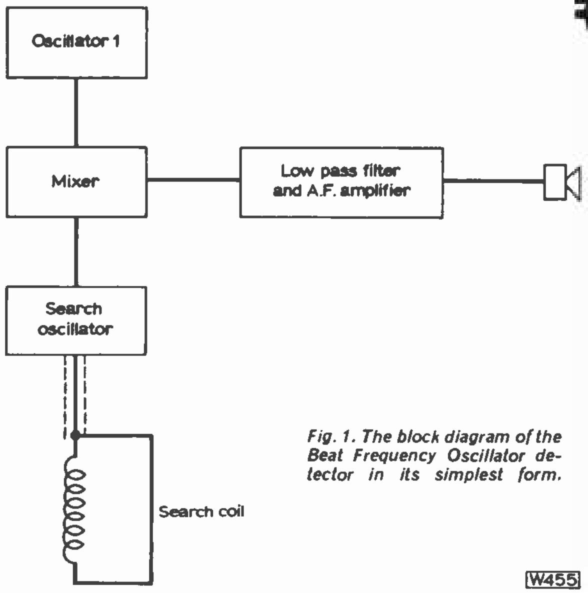
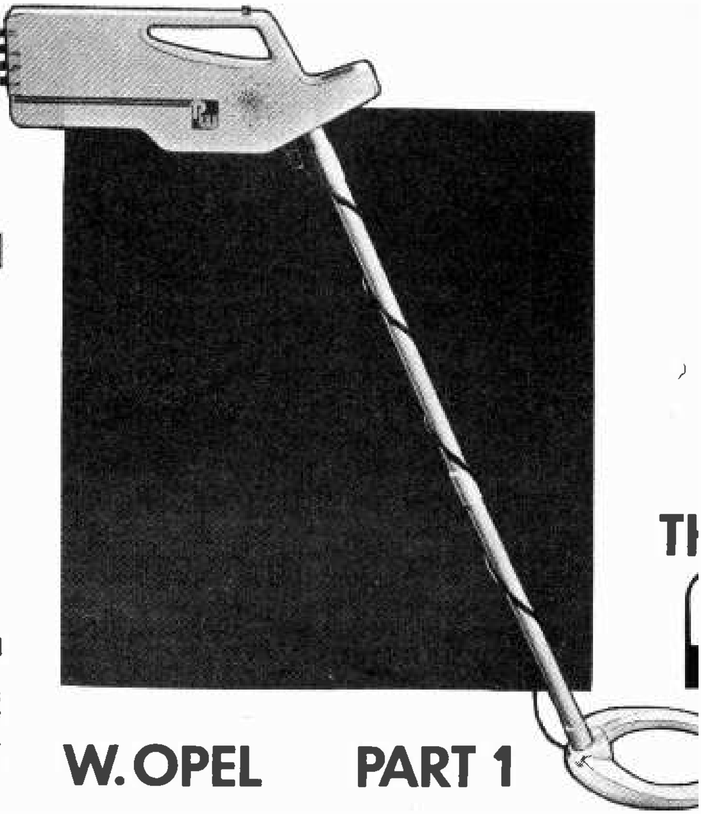



*Fig. 1. The block diagram of the Beat Frequency Oscillator detector in its simplest form.*



W. OPEL PART 1

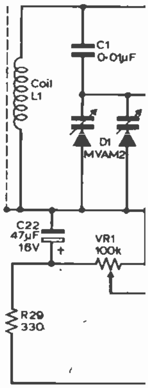
COVER PROJECT

TRUE Beat Frequency Oscillator detectors operate on the principle that the outputs of two separate oscillators are combined to produce an audio tone although the oscillators may be at non-audible frequencies.

The metal locator uses the search coil as the tuned circuit of one oscillator so the presence of metal objects modify the resonant circuit causing a change in the beat note. Fig. 1 shows the block diagram of a typical detector.

Although this type of detector is easy to construct it does have drawbacks, namely:—

1. Metering facilities are ineffective and insensitive.
2. The two oscillators may drift in different directions and make operation tedious.
3. It is difficult to obtain high detection sensitivity combined with stable (drift free) operation.
4. In general the battery life is proportional to the output volume and, since the output is usually a sine wave, high outputs are required.



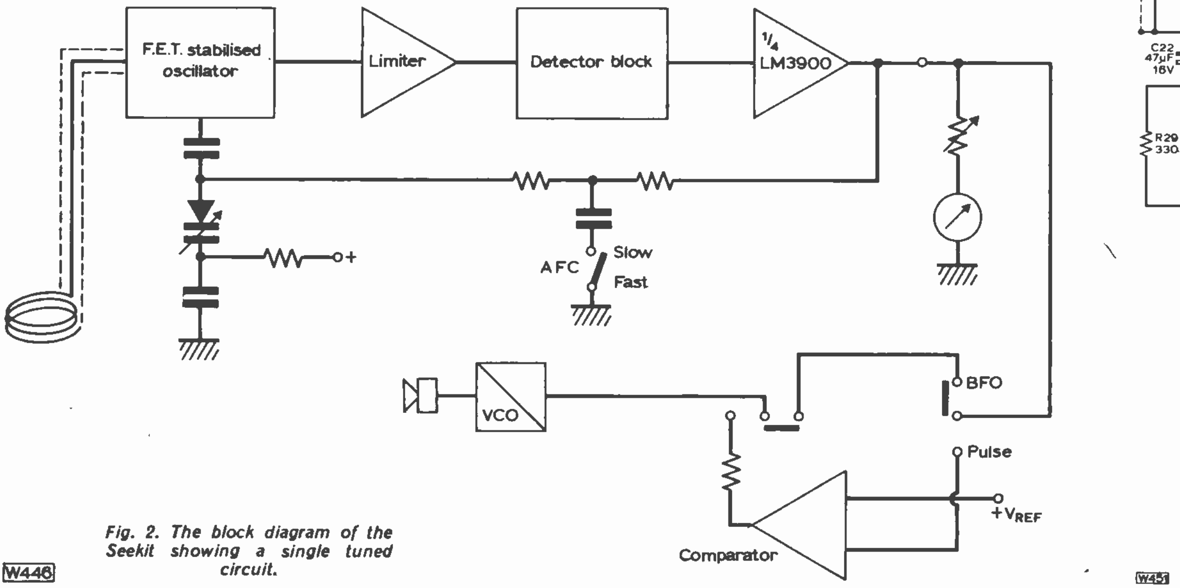




*Fig. 2. The block diagram of the Seekit showing a single tuned circuit.*

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## CIRCUIT OPERATION

This new unit overcomes the first two of these problems by using a single search oscillator whose output is fed into a discriminator coil and the frequency changes are converted to voltage variations in a similar manner to an FM tuner. Fig. 2 is the block diagram of this unit and Fig. 3 is the full circuit diagram.

Since only one oscillator is employed it becomes that much more effective to apply AFC to the oscillator to cure drift and improve the long term tuning stability. To accomplish this effectively, the small voltage differential at the detector output is amplified in a Norton Amplifier (an LM3900) and fed to the oscillator, via a variable time constant (R17 and C15), and applied to D2. Provision is made to switch C15 in or out in order to give two sensitivity settings.

# 'SEEKIT' METAL LOCATOR

With C15 in circuit the high output at pin 10 of IC1, resulting from the presence of a metalic object entering the field of the search coil, takes an appreciable time to effect the oscillator and the detector is at maximum sensitivity to varying frequency fluctuations.

With C15 switched out the output of ICla is fed direct to the oscillator and input variations produce virtually instantaneous AFC correction. In this mode the range is effectively halved.

The output of ICla is sufficient to drive a sensitive meter. This meter provides an earlier warning of the presence of metal objects since the eye can detect smaller changes than the ear.

ICla also drives the audio amplifier circuit, based on IClc and d, when the unit is switched to BFO. The output is available either through a speaker or plug-in earphones. This audio is in the form of a square wave and produces a higher audibility than a sine wave consuming the same power thus prolonging battery life.

The main tuning of the unit is performed by the varicap diode D1 with resolution afforded by VR1, a 22 turn preset potentiometer. Because the oscillator utilises a very high L/C ratio it is important to use a heavy gauge wire for the search coil (the prototype used 22 SWG) to maintain the "Q". This also means that the large amount of capacity used to tune the circuit results in relatively small frequency variations, even with the abrupt type of varactor used.

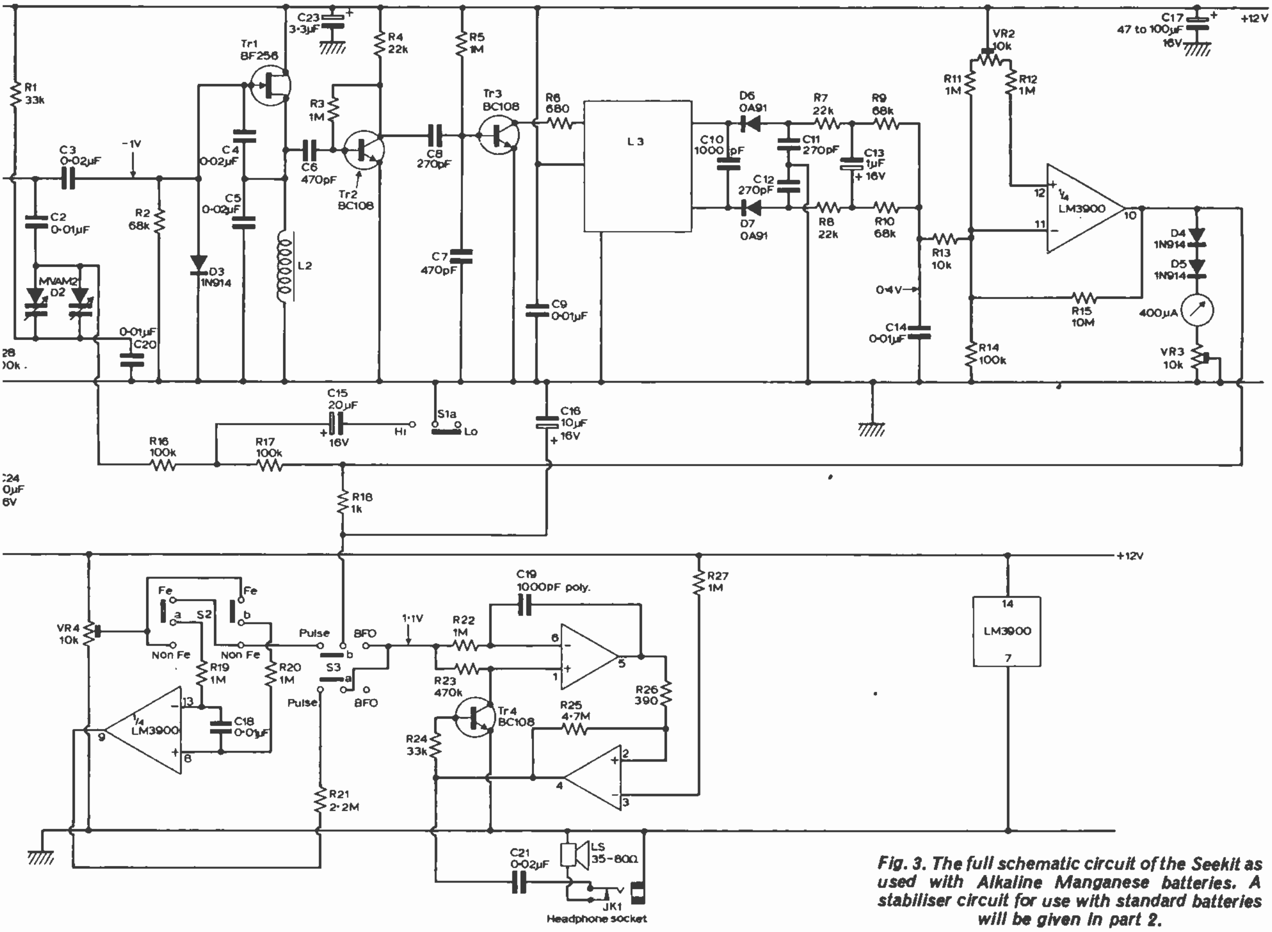



*Fig. 3. The full schematic circuit of the Seekit as used with Alkaline Manganese batteries. A stabiliser circuit for use with standard batteries will be given in part 2.*

With the unit switched to "Pulse" it is possible to adjust VR4 such that IC1b is just below the threshold of conduction. Under this condition the output of ICIa is fed to one input of ICIb but, because of the setting on the other input, the audio amplifier is off. When a signal is present at the search coil it results in a change at pin 10 of IC1 and ICb switches to the on state. Its output is fed to the input of the audio stages and the treasure is advertised. This mode has the advantage that the detector can be used on the speaker output without annoying others present.

In conjunction with the pulse operation is switching for Ferrous or Non-Ferrous detection. The presence of ferrous (iron based) objects will lower the frequency of the tuned circuit whilst non-ferrous will increase it. In the Seekit type of detection this will result in deviations in opposite directions, see Fig. 4, and by switching from ferrous to non-ferrous, whilst in the pulse mode, it is possible to decide if the object is what we are looking for. Unfortunately, at the frequencies used, large pieces of ferrous material can cause the detector to react as if it had located something non-ferrous due to HF eddycurrents set up within the material. Although a sweep of the area will indicate whether the find is large or small it could still be a large non-ferrous item.

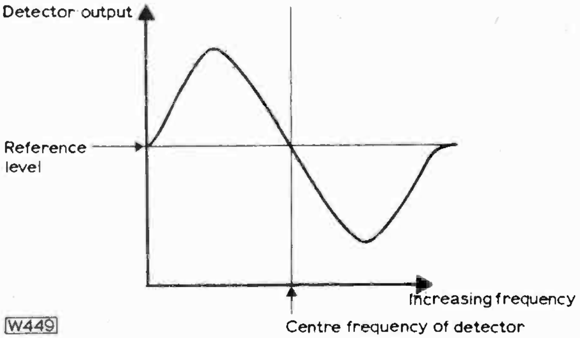



*Fig. 4. The changes in output voltage resulting from frequency changes. Use is made of the positive and negative changes to identify ferrous or non-ferrous materials.*

## THE SEARCH HEAD

The capability of the unit is largely a function of the search coil. Small coils are best for detecting small objects fairly near the surface whilst large diameter coils will sweep a large area and detect objects at a greater depth. Thus the coil used will depend to a large extent on the type of hunt.

Whatever size of coil is used it is essential to exercise care in its construction, details of a satisfactory method are given later. The varying numbers of turns for various diameter coils are given as Table 1. These coils have been calculated to give an operating frequency of about 90kHz since this is within the approved range of the Home Office and has advantages over lower frequencies in the band.

| Coil diameter | Number of turns | Inductance | Frequency with ·01$\mu$F Capacitor |
|---|---|---|---|
| 7″ (175 mm) | 25 | 243$\mu$H | 102kHz |
| | 24 | 224$\mu$H | 106kHz |
| 8″ (200 mm) | 23 | 235$\mu$H | 104kHz |
| | 22 | 215$\mu$H | 108kHz |
| 9″ (225 mm) | 22 | 242$\mu$H | 102kHz |
| | 21 | 220$\mu$H | 107kHz |
| 10″ (250 mm) | 21 | 245$\mu$H | 101kHz |
| | 20 | 222$\mu$H | 107kHz |

*Table 1. The approximate resonant frequencies for coils of varying diameter and number of turns.*

## ★ components list

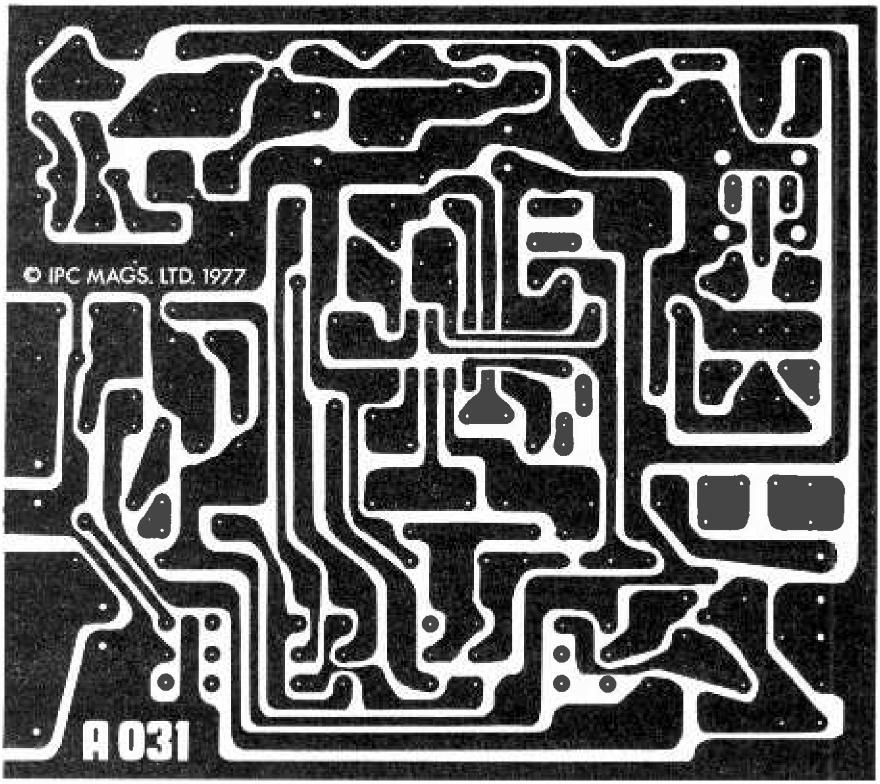
**Resistors**
R1 33kΩ
R2 68kΩ
R3 1MΩ
R4 22kΩ
R5 1MΩ
R6 680Ω
R7 22kΩ
R8 22kΩ
R9 68kΩ
R10 68kΩ
R11 1MΩ
R12 1MΩ
R13 10kΩ
R14 100kΩ
R15 10MΩ
R16 100kΩ
R17 100kΩ
R18 1kΩ
R19 1MΩ
R20 1MΩ
R21 2·2MΩ
R22 1MΩ
R23 470kΩ
R24 33kΩ
R25 4.7MΩ
R26 390kΩ
R27 1MΩ
R28 100kΩ
R29 330Ω
All ¼W 5%
VR1 100kΩ multiturn type AB47
VR2 10kΩ preset type PT10V
VR3 10kΩ preset type PT10V
VR4 10kΩ preset type PT10V

**Capacitors**
C1 0·01$\mu$F ceramic
C2 0·01$\mu$F ceramic
C3 0·02$\mu$F poly-carbonate/Mylar
C4 0·02$\mu$F poly-carbonate/Mylar
C5 0·02$\mu$F poly-carbonate/Mylar
C6 470pF ceramic/polystyrene
C7 470pF ceramic/polystyrene
C8 270pF ceramic/polystyrene
C9 0·01$\mu$F ceramic/polystyrene
C10 1000pF polystyrene
C11 270pF ceramic
C12 270pF ceramic
C13 1$\mu$F 16V
C14 0·01$\mu$F ceramic
C15 20$\mu$F 16V
C16 10$\mu$F 16V
C17 47 to 100$\mu$F 16V
C18 ·01$\mu$F ceramic
C19 1000pF polystyrene
C20 ·01$\mu$F ceramic
C21 ·02$\mu$F
C22 47$\mu$F 16V
C23 3·3$\mu$F 16V
C24 10$\mu$F 16V
Use polycarbonate where specified

**Semiconductors**
IC1 LM3900
Tr1 BF256 (FET)
Tr2 BC108 or similar
Tr3 BC108 or similar
Tr4 BC108 or similar
D1 MVAM2, MVAM115
D2 MVAM2, MVAM115
D3 1N914, 1N4148
D4 1N914, 1N4148
D5 1N914, 1N4148
D6 0A91, 0A90
D7 0A91, 0A90

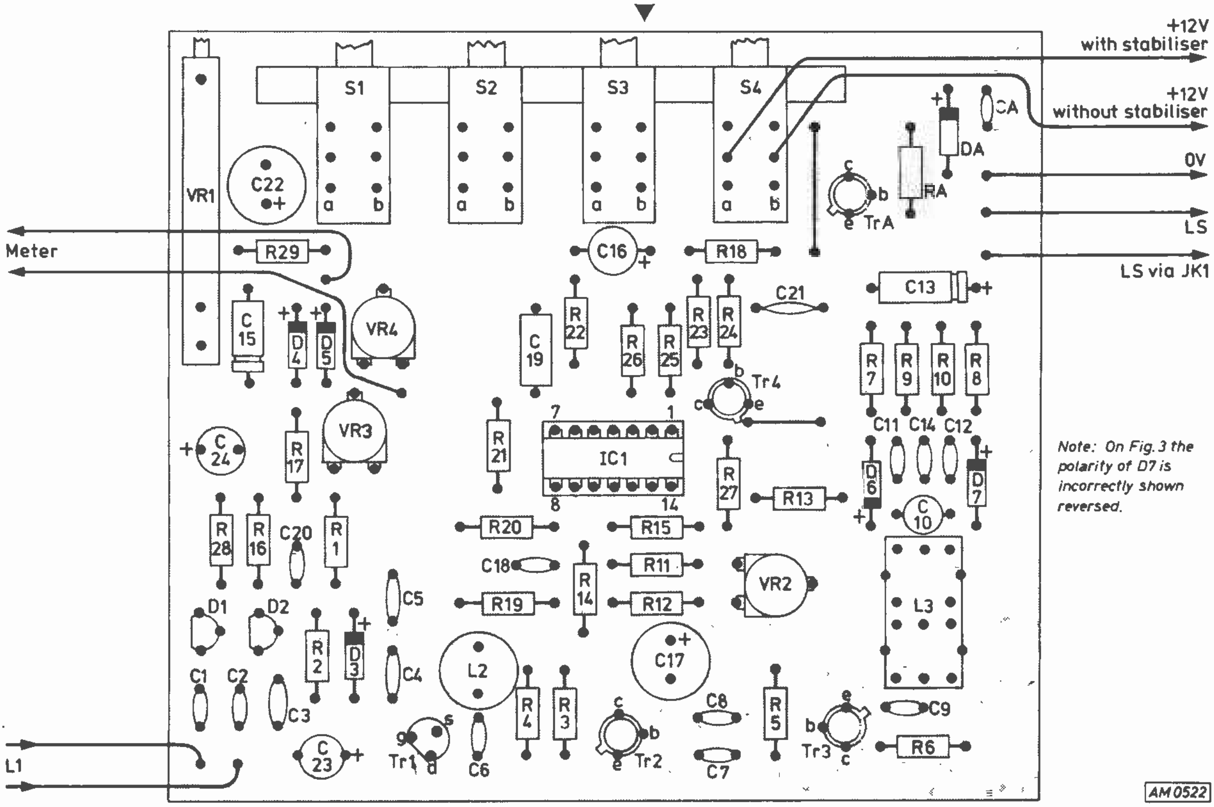
**Inductors**
L1 search coil, see text
L2 20 to 43 mH screened choke, Toko type 10RA/RB
L3 Detector assembly, high Q, Toko type ST3/D2

**Miscellaneous**
Speaker, 35 to 80Ω. Crystal earpiece with plug and socket. 4 way change-over switch, push button, non-interlocking. Meter, edge reading, 400$\mu$A or better. Case, moulded or suitable box to hold components. Detector head, moulded or home made. Plastic tubing and joints if required. Coax plug and socket. Coax cable, approx 1 metre (3ft).




▲ Fig. 5. The wiring pattern of the electronics board, shown full size to enable direct copying for the 'Do-It-Yourselfer'.

Fig. 6. The component positions and orientations. Note that provision is made for the stabiliser required if standard batteries are to be used over long periods. ▼

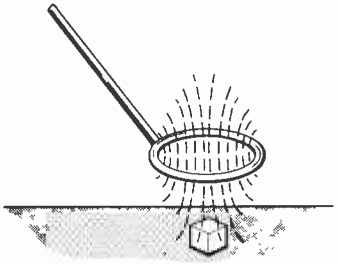



Note: On Fig. 3 the polarity of D7 is incorrectly shown reversed.

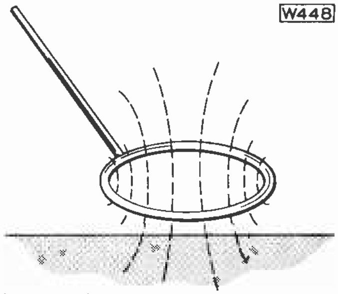
If searching for a particular object recently lost (e.g. coins on the beach or a ring in the garden) a small coil is required but if combing an old battle field looking for swords etc., then the large coil is the answer, see Fig. 7. The 8 inch (200mm) coil on the prototypes was able to detect a 2 pence piece at between 8 and 10 inches in free air and, with a well shielded coil, in most other non-metalic materials.

to the individual constructor but the following points must be observed.

1. The wire should be 20 or 22 SWG.
2. The windings must be wound tight and held tight after winding.
3. A Faraday electrostatic shield should be fitted but remember that the shield must not be a complete short circuit around the coil.



Smaller coil concentrates field and assists pinpointing




Larger coil offers better depth of penetration, though less ability to pin-point smaller objects

*Fig. 7. An impression to show that although the field may be more concentrated in a small search head the penetration and area covered is much reduced. For most applications a head of about 8 inches (200mm) diameter will provide a reasonable compromise. The use of large diameter heads could result in more digging than searching due to the greater depth scanned.*

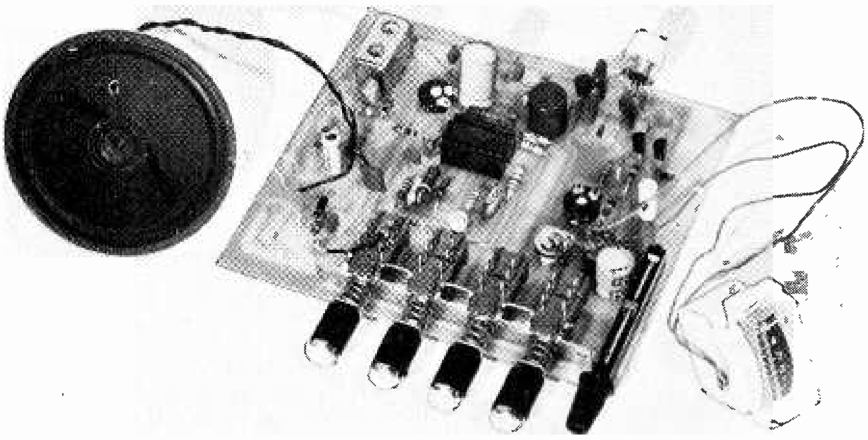
## CONSTRUCTION

Apart from the speaker, the phone socket, the meter, the batteries and the search coil all the components are mounted on a single printed circuit board. Fig. 5 shows the wiring pattern of the board whilst Fig. 6 shows the component location and orientation on the board.

The prototypes were constructed as follows and took care of the above conditions.

Firstly several strips of adhesive tape were fastened to a saucepan of about 7 inches diameter such that a portion of the sticky side faced outwards. Next, 25 turns of 20 SWG enamelled copper wire, with a quality lacquer coating rather than a polyurethane finish, were wound tightly around the former

*Fig. 8. A photograph of the prototype board, complete with the stabiliser circuit components. Comparison with the component overlay of Fig. 6 will show some changes in the components used. These were necessary to improve long-term stability of the oscillator. The second prototype, constructed to Fig. 6, was working when photographs were needed.*



The meter and an output socket are mounted on the case of the unit and, if the moulded case is used, the mounting positions are cast in during manufacture.

The batteries are fixed into standard holders and the holders themselves are bolted to the case.

The electronic items do not present any problems in their assembly since it is largely a matter of wiring-up a printed circuit board. The coil, on the other hand, does require very careful construction. The details of a suitable former etc., can be left

and on the tape. When the winding was completed the ends were held tightly whilst the tape was folded over the turns. The winding was slid off the former and the tapes bound tightly around the turns, covering as much of the winding as possible. Extra tape should be wound over the wire to cover it completely. The tape should be wound as tight as possible and if heat shrink tape is available it could be used with advantage.

**This article will be completed next month.**

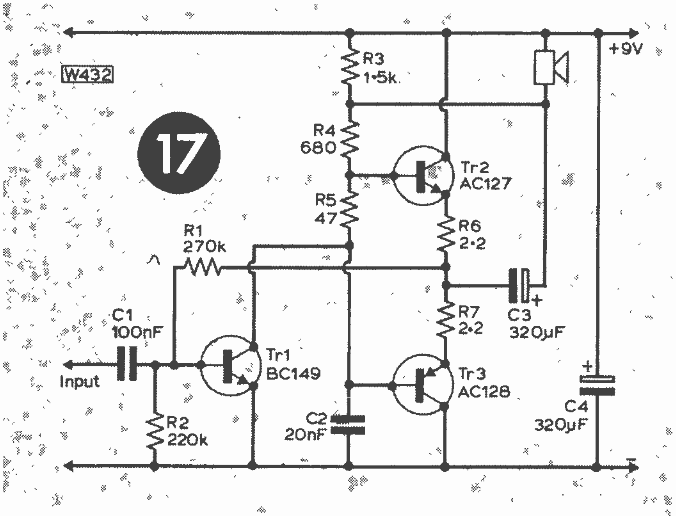
# Circuits for AUDIO AMPLIFIERS

## PART 3

F.G.RAYER G3OGR

### COMPLEMENTARY SYMMETRICAL OUTPUT

Fig. 17 is a more convenient circuit, using a single battery. The speaker is coupled by C3. Each output transistor has its own emitter resistor, to help to stabilise working conditions. Overall stabilisation is obtained by R1 from the output emitter circuit back to Tr1 base. DC feedback of a similar type is found in many driver/output circuits of this kind. It is necessary to use the transistors shown (or near equivalents) or the value of R5, in particular, may need changing.




With circuits of this kind, best results are obtained with the correct speaker impedance. Somewhat higher impedances may be used with a loss of volume. Lower impedances should not be used, as this may damage the output stage transistors.

### SPEAKER IMPEDANCE

The speaker impedance specified for a circuit should be used, depending as it does on operating conditions and power output expected. A lower impedance may cause peak currents to be exceeded or result in too high a dissipation in output devices. A higher impedance than specified usually causes reduced power output and possibly other troubles. Changes to output load can upset feedback circuits and the correct load is particularly necessary with high fidelity equipment.

Where a matching transformer is used, its ratio is obtained from the formula:—

$$\sqrt{\frac{\text{Optimum Load}}{\text{Speaker Impedance}}}$$

For example, a 3Ω speaker is operated from an output stage requiring a 255Ω load, so $\sqrt{255/3}=9{\cdot}2:1$ approx. These are the operating conditions for the amplifier in Fig.14.

The transformer must be able to handle the required power, from a few hundred milliwatts with small amplifiers up to hundreds of watts with large amplifiers. Windings must be of low DC resistance for the rated power to be realised.

### THERMISTOR COMPENSATION

It was seen that acceptable working conditions are easily maintained over a range of temperatures and voltages in the case of low power amplifiers where emitter stabilisation was possible. In other circumstances additional means of stabilisation are needed, and Fig.12 included a thermistor in a Class A stage.

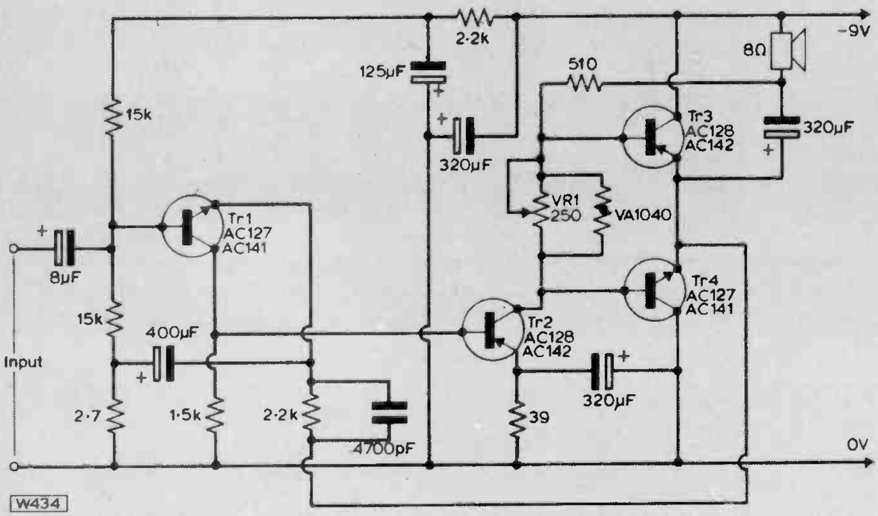
Fig.18 is a 1W transformerless amplifier in which the VA1040 thermistor stabilises the operating current of the output pair Tr3 and Tr4. The resistance of the VA1040 falls as temperature rises, thus reducing the base/emitter bias voltage of the pair. This effect is the opposite of that arising in the transistors themselves.

Quiescent (no signal) current is set by VR1 to between 12 and 15mA. The emitter of Tr1 samples the DC voltage at the emitters of Tr3/Tr4, and by DC coupling through Tr2, maintains DC operating conditions. Tr3 and Tr4 require heat sinks about 4×4cm of 16SWG aluminium, or larger. DC operating conditions of all stages are related, so values should be as shown.

### QUIESCENT CURRENT

The "silent" or quiescent current of an output stage is very easily adjusted with circuits such as Fig.19, as DC operating conditions are isolated from other stages. R1 and R2 set the base bias point and their relative values control the collector current of Tr1 and Tr2. Reducing the value of R1, or increasing the value of R2, moves the base bias negative and increases collector current (with PNP devices). Reducing R2 or increasing R1 has the opposite effect.

If the quiescent current is low, objectionable cross-over distortion arises, especially with falling supply voltage or reduced temperature. If current is high,



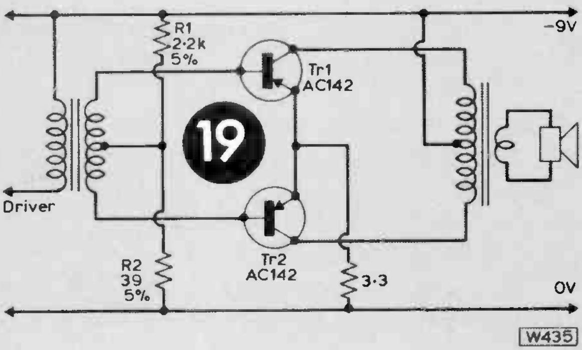

18

*A 1W four-transistor amplifier in which a thermistor VA1040 is used to stabilise the output pair.*

dissipation in the transistors rises, so close-tolerance resistors are often necessary for R1 and R2. An alternative is to use a pre-set resistor, such as 100Ω for R2. The total collector current can then be set to 8 to 10mA, for the transistors shown.

## INTEGRATED CIRCUITS

Numerous ICs suitable for audio applications are available and they can be used in a wide range of circuits. They may be obtained with gain, power-handling and other ratings suitable for pre-amplifier, output and other purposes. Some require relatively few extra discrete components (resistors and capacitors) and they are available for a considerable range of operating voltages. Some have integral overload protection. These devices may be used alone or in conjunction with transistors and can often offer advantages compared with the use of individual transistors for all stages.



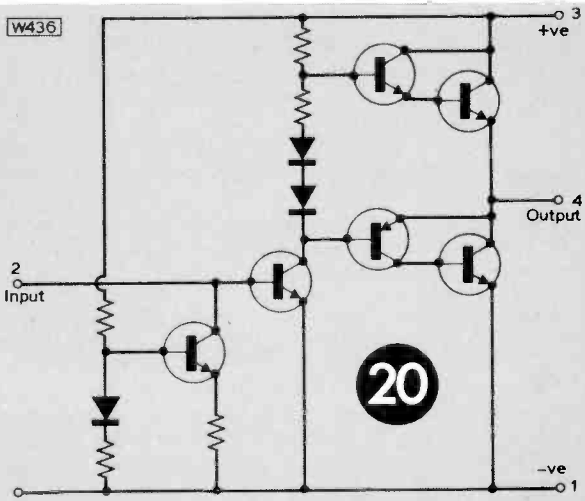

Amplifiers using ICs may be assembled on perforated board or PCBs prepared for the purpose. Some ICs have tabs which must be soldered to areas of the board, for heat sinking. This in turn, may depend on the operating voltage, or power required. For example, the TBA800 audio IC requires no heat sink provision, other than the tabs provided on it, for up to 1W but for higher outputs the tabs are soldered to copper areas of the PC board. Other ICs rely on the use of certain pins, or alternative methods, of carrying heat away from the interior of the device.

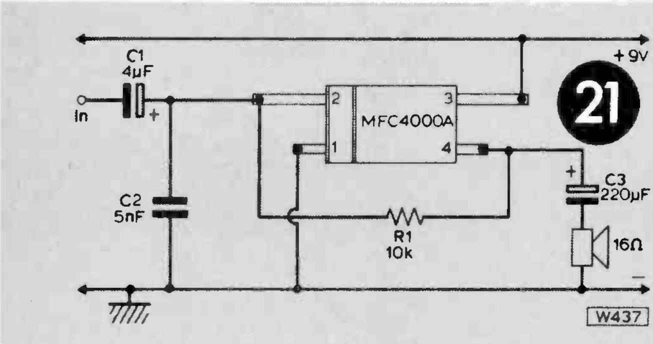
With many ICs there are optional speaker loads, depending on the operating voltage and power dissipation. The TBA800 is also an example of this and can be expected to deliver up to about 1·8W with a 16Ω speaker but about 3W with an 8Ω speaker, when using 14V. Apart from the obvious advantage of using a pair of ICs for stereo, ICs may be combined in arrangements similar to the push-pull output stage, allowing more power than would be available from a single IC of the same type.

## THE MFC4000A

This is a simple, low-power audio IC having the configuration shown in Fig.20, employing stabilised driver and output stages. There are four external connections only, as shown. Fig. 21 is an operating circuit for this IC the extra components consisting of an input coupling capacitor C1, by-pass capacitor C2, speaker coupling capacitor C3, and feedback resistor R1.

The more important ratings for an audio IC are similar to those which would apply to an amplifier constructed from discrete components. These characteristics allow an IC to be chosen to suit the





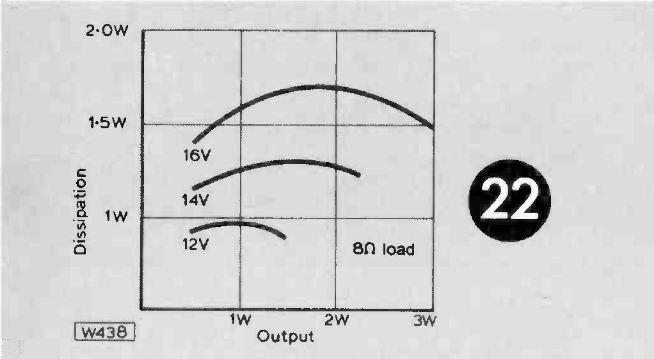

purpose in view. For the MFC4000A typical ratings are:

| | |
|---|---|
| Operating voltage | 9V |
| No signal current | 3·5mA |
| Maximum output | 350mW |
| Sensitivity (50mW output) | 15mV |
| Harmonic distortion (50mW) | 0·7% |

If complete details of an IC are required, or an internal circuit (such as that in Fig.20) these are often available from the maker or supplier. Otherwise it is more general to show only the external circuit (Fig.21) as this is all that is required to build an amplifier. In Fig.21, the top of the device is shown, with pins in their actual locations. With other circuits, pins are numbered, and do not usually appear in their actual locations. The latter are found by reference to a diagram of the device.

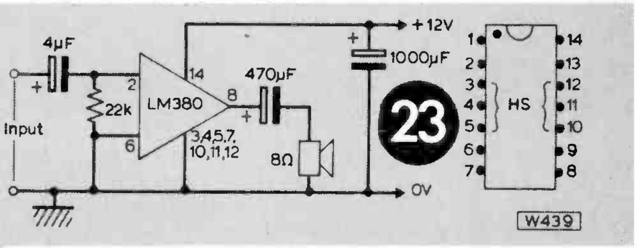
## VOLTAGE/POWER

With an IC amplifier there is a range of possible operating voltages. The lower limit is set by the device ceasing to give an adequate performance (or to operate at all) while the upper limit depends on the device itself, heat sink and speaker impedance. With many circuits less than maximum operating voltage is used, but the voltage should only be increased when it has been checked that operating conditions are still suitable.

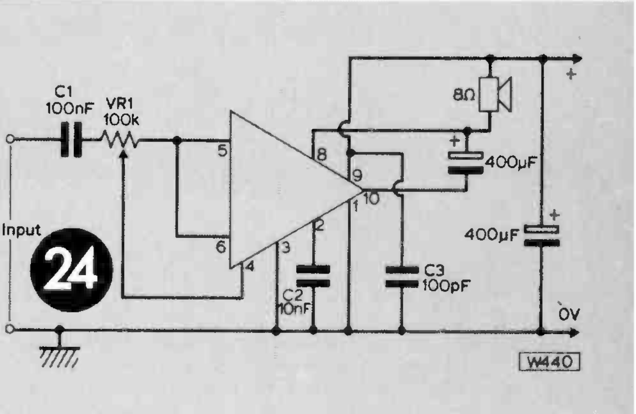



In Fig.22 the dissipation expected in the LM380 IC is shown for 12, 14 and 16V, with an 8Ω speaker. When no heat sink is fitted, dissipation should be kept under 1·25W. This sets 14V as a maximum safe voltage with an output of a little over 2W. With 12V about 1·5W output would be expected. With 16V a heat sink is necessary.

Fig.23 is a circuit for the LM380 and it also shows the pins. When a heat sink is necessary, pins marked HS are soldered to it and it may be a foil area of the PCB. If high frequency oscillation arises, a 1000µF capacitor with a 2·7Ω resistor in series may be




connected from pin 8 to negative line. The 1000µF capacitor should have short leads to pin 14 and the negative line. Top-cut tone controls may be connected from pin 2 to 6.




## SL414A/SL415A

These IC's provide 3W or 5W, with 18V or 24V using an 8Ω speaker, the power dropping to approximately 2·2W and 3·8W with a 16Ω speaker. The IC includes a pre-amplifier (24dB) and main amplifier (26dB) sections and automatic overload protection. Fig.24 is a simple circuit for these ICs with input for the main amplifier (4) taken from the volume control VR1. Satisfactory working, with reduced output, is possible down to 9V.

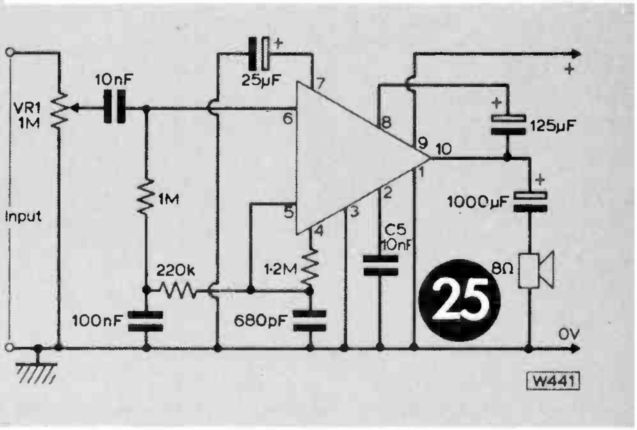


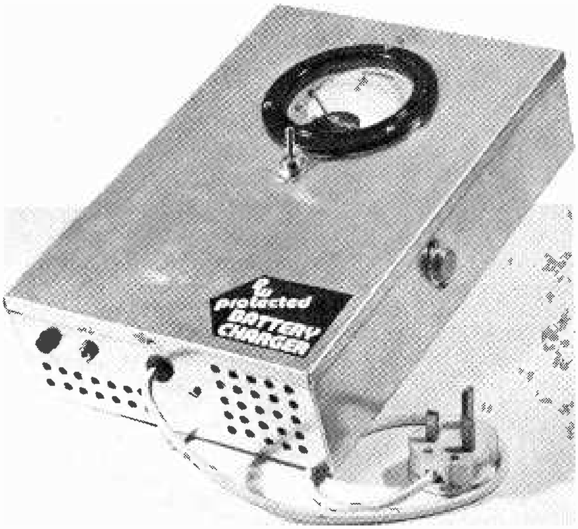

Fig.25 is also suitable for the SL414A or SL415A. More components are required but the pre-amplifier output (5) is taken to the main amplifier input (4) and gain is increased. A high-frequency by-pass capacitor may be required from pin 9 to pin 1 near the IC (as in Fig.24). In some cases a 22Ω resistor and 47nF capacitor in series may also be required from pin 10 to pin 1.

**TO BE CONTINUED**

PW protected

# BATTERY CHARGER

G.O.H.SJOGREN




THIS battery charger offers several features which are usually omitted on the general run of charger circuits.

In particular, it protects itself and the battery from damage in the event of the charging leads being connected the wrong way round, it protects itself against damage from the charging leads shorting together, its charging rate and the end voltage of the battery are easily adjusted during manufacture or subsequently and the components are relatively easy to obtain.

## DESIGN IDEA

To provide the above features the author chose a circuit using a constant current generator and a variable on/off period of charging. The switching for the on/off is a mixture of electronics and electro-mechanics since the charging current is switched by a thyristor whilst the thyristor itself is switched by a pair of contacts on a relay.

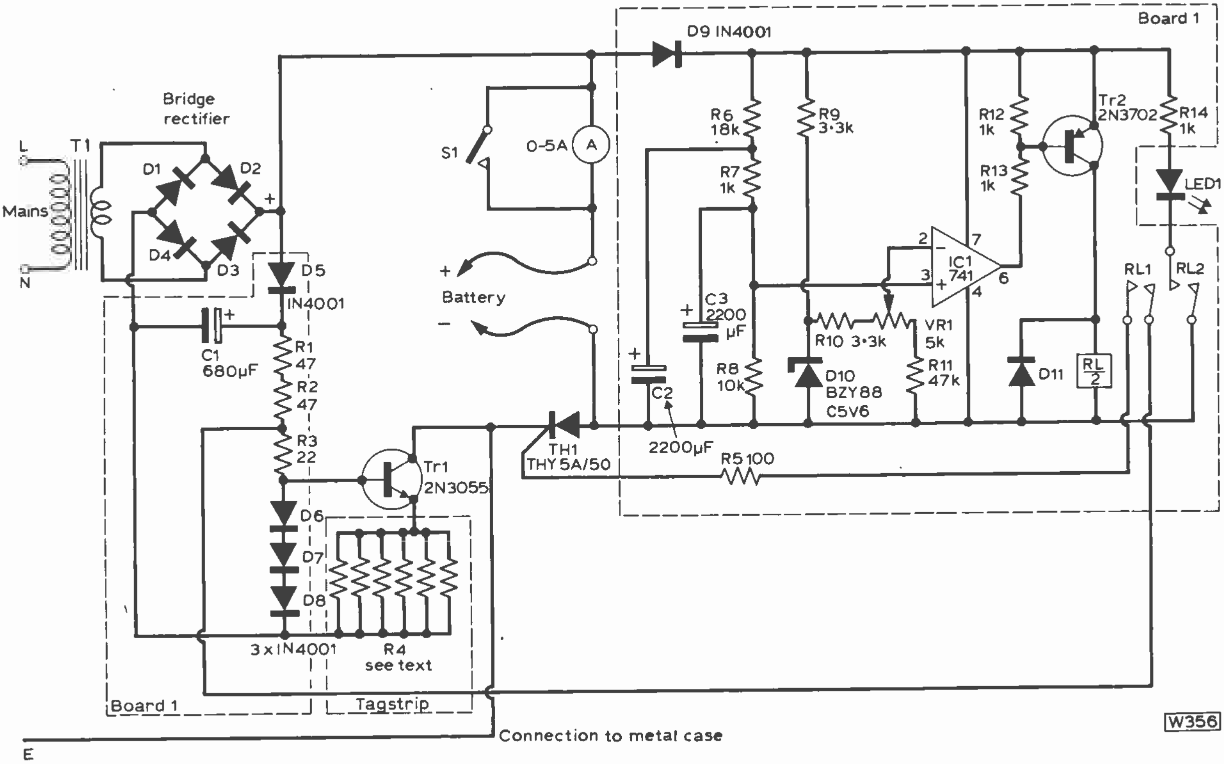



*Fig. 1. The complete circuit diagram of the charger. Although a single PCB is used the components mounted on it have been split to enable normal progression through the circuit.*

Having determined the charging rate and the end voltage the unit will regulate its on/off cycle quite automatically, providing a rapid charge initially but not tailing off quickly (as a normal charger) when the battery voltage approaches its charged state.

## CIRCUIT OPERATION

Fig. 1 shows the complete circuit for the charger.

The mains are stepped down by the transformer T1 and the low voltage output is bridge rectified by diodes D1 to D4 to provide the pulsating DC required for charging.

The additional circuitry of D5 and C1 provides a smoothed DC supply for the base of Tr1. This potential, and the base current, of Tr1 is controlled by R1, R2, D6, D7 and D8.

The charging current has to flow through Tr1 and, with its base stabilised, the current is limited by the emitter resistor R4. The charging current must also flow through the thyristor Th1 and it is this device which switches the charging current on and off.

## ★ components list

**Resistors**

| | |
|---|---|
| R1, R2 | 47Ω, 5W, Wire wound |
| R3 | 22Ω, 5W, Wire wound |
| R4 | see text |
| R5 | 100Ω 5% ¼W |
| R6 | 18kΩ 5% ¼W |
| R7 | 1kΩ 5% ¼W |
| R8 | 10kΩ 5% ¼W |
| R9, R10 | 3·3kΩ 5% ¼W |
| R11 | 47kΩ 5% ¼W |
| R12, R13, R14 | 1kΩ 5% ¼W |
| VR1 | 5kΩ lin. horiz. preset |

**Capacitors**

| | |
|---|---|
| C1 | 680μF or 1000μF, 35V |
| C2, C3 | 2,200μF, 16V |

**Semiconductors**

| | |
|---|---|
| D1–D4 | Silicon rectifier, 5A, 50V individual units or single bridge |
| D5–D9, D11 | Silicon rectifier 1A (1N4001) |
| D10 | Zener diode 5·6V, 400mA |
| LED1 | Any light emitting diode |

**Miscellaneous**

T1, transformer, 16V and 18V tapped secondary at 4A. PCB, Readers PCB Service. RL1, relay, 12V coil, 2 N/O contact sets. S1, switch, S.P.S.T. 5A rated. Ammeter, 0–5A. Box (size will depend on meter and transformer used). Double tag strip, 10 tags each side. DIL socket, 8 pin. Terminals. Battery clips. Grommets.

**Note 1**

Most of the components used can be obtained from local sources. Minimum requirements have been given and devices better than these can be used. Most mail order companies will supply against the specifications given.

**Note 2**

Suitable transformers are available from Everest Instruments Ltd., 34 Shakespeare Street, Nottingham and Barrie Electronics, 3 The Minories, London EC3N 1BJ

| Time (mins) | Battery Voltage | Current (amps) |
|---|---|---|
| start | 9 | 3·4 |
| 5 | 11 | 3·1 |
| 30 | 12 | 3·0 |
| 110 | 12 | 2·9 |
| 140 | 12 | 2·8 |
| 200 | 12 | 2·8 |
| 440 | 13 | 2·8 |
| 530 | 14 | 2·7 |
| 590 | 14 | 2·8 |

*Table 1. The charging rate and time to bring a flat battery to fully charged. The current and voltage figures have been rounded off. Note that although the charging rate does fall-off it is effectively level over a significant portion of the charging time.*

The heart of the thyristor charging circuit is the operational amplifier IC1, which is acting as an under voltage switch. The negative input, pin 2 of IC1, is fixed by tapping across VR1 which is, in turn, regulated against supply variations by zener diode D10. The sampling voltage on pin 3 of IC1 is a fixed percentage of the battery voltage and is determined by the potential divider R6, R7 and R8. Capacitors C2 and C3 slow down the "hunting" action of IC1 when the battery is in the fully charged state.

With a discharged battery connected the sampling voltage will be below the reference voltage and IC1 will cause Tr2 to conduct. The supply for the circuit is obtained from the battery itself when first switched on. When Tr2 conducts, the relay RL1 is energised and a DC current is fed to the gate of the thyristor. The anode of the thyristor is connected to the negative side of the bridge rectifier and the cathode is fed, via the battery, with the pulsating DC from the positive of the bridge. Therefore the thyristor can pass the charging current. Transistor Tr1 already has base current and now has a collector voltage so it too can conduct. The battery is therefore being charged.

When the battery reaches its fully charged voltage, usually set at about 14·3V, the positive input at pin 3 of IC1 exceeds that at pin 2 and IC1 switches off transistor Tr2. In turn, Tr2 de-energises the relay which removes the gate supply to TH1. With no gate current, TH1 will switch off at the next half cycle trough and will not switch on again.

The removal of the charging voltage permits the battery to drop from its "voltage on charge" to its "voltage off charge" and the cycle is repeated. Without the capacitors C2 and C3 the cycle is governed by the relay energise and de-energise times and the relay chatters.

## PRACTICAL CONSIDERATIONS

Before obtaining any components it is necessary to decide on the charging current required. For most home garages about 3A is sufficient. Table 1 shows the time taken for a nominal 3A unit to bring a very flat battery up to its fully charged condition. Although the unit is a constant current design the current does decrease as the battery voltage increases but not by a significant amount. The author settled for 3A and the components list is based on that current.

Having chosen the charging current the choice of components can be made bearing the following points in mind.

The transformer should be double wound and have a secondary of 16V to 18V, if higher currents are required then voltages above 18 may be required. Since the secondary is bridge rectified it doesn't require a centre tap.

The rectifier bridge can be an encapsulated unit or separate diodes. Silicon rectifiers are preferred because of space and reliability but it may be possible to pick up a suitable selenium stack at a local shop. Although in a bridge circuit each diode supplies only half the rectified current it is better to use devices with a generous safety margin, say a 5A device for a 3A or 4A charger.

Tr1 can be a 2N3055 for currents up to 15A but will need a heat sink, (if a metal box is being used, bolt it onto the side). By earthing the collector, as in Fig. 1, there is no need to use insulating washers.

R4 may be dissipating several watts at the higher charging currents and voltages. To assist in setting and adjusting the current several resistors in parallel have been used. The values and numbers will depend on what is available locally. Table 2 gives the currents obtained against various values of emitter resistance. Since the prototype used 2Ω units the table is based on numbers of these in parallel.

| Number of 10Ω resistors in parallel (R4) | Charging current at 16V setting (amps) | Charing current at 18V setting (amps) |
|---|---|---|
| 10 | 2·8 | 3·0 |
| 8 | 2·5 | 2·8 |
| 5 | 1·7 | 2·0 |
| 2 | not measured | 1·1 |

*Table 2. The charging rates against Tr1 emitter resistance and supply voltage. Note that the charging current does not have a linear relationship with the supply voltage. Higher voltages were not tried on the prototype and the requirements for higher currents cannot be specified.*

Current setting can be achieved by adding or removing resistors and, subject to the ratings of the rectifiers, transformer and thyristor not being exceeded, no components need to be changed.

Current levels could be changed by switching the resistors in or out but the switch must be rated at several amps. No details of switching are given nor is a switch called for in the components list.

The thyristor passes the full charging current and for a 3 to 4A charger should be rated at 5A minimum. The applied voltage is low and the lowest standard working voltage of 50V is ample. Similarly there is a large gate current available and the device doesn't need to be a sensitive one.

The relay needs two pairs of contacts, both normally open, one pair for the thyristor gate and the other pair for the indicator. When an open relay is used together with a large metal box for the unit it will probably make a sufficiently loud noise to enable the indicator to be dispensed with. In this instance, of course, a single pole relay will suffice.

The relay noise and/or the indicator lamp coupled with the reverse polarity protection built into the unit makes it possible to connect the battery to the charger in complete darkness. If the polarity is wrong nothing happens. No noise, no light and, more importantly, no damage. On reversing the connections at the battery or at the charger the system should operate correctly.

The relay resistance should be at least 100 ohms and the transistor Tr2 should be capable of passing at least 200mA collector current.

## CONSTRUCTION

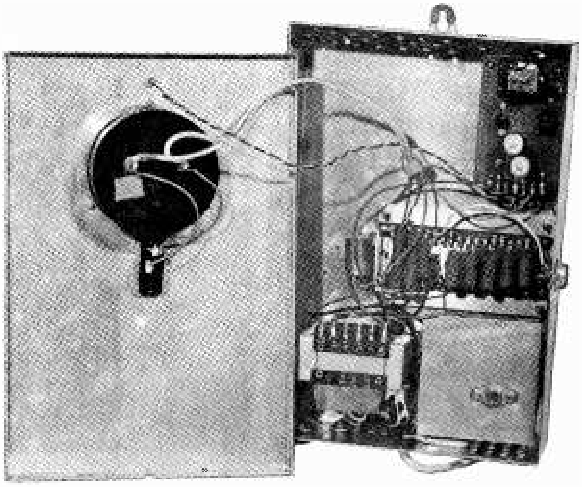
The small electronic components, which will be common irrespective of the charging current selected, are mounted on a single P.C.B. The wiring pattern for this board is shown as Fig. 2 whilst the component positions and orientations are shown as Fig. 3.

The only large component common to all charging currents is the relay. This is also mounted on the P.C.B. but, to leave the choice of type as great as possible, provision is made to make connections between it and the board by flying leads. Some form of mechanical fixing will be required but the type and location will depend on the relay selected.

Although a metal box is not essential for containing the circuitry it has many advantages, both mechanical and electrical.

The power transistor, Tr1, will require a heat sink approximately 3½ inches square for a 3 or 4A charger but could be bolted directly onto the side of a metal box. Since the design earths the collector of this transistor there is no need to use insulating washers.

Whether the box is metal or not, heat sinks will be required for the thyristor and the bridge rectifier. These can be of 16 gauge aluminium approximately 3½ inches square. To save space they can be folded into channel sections but must be mounted vertically to ensure an adequate air flow. The thyristor must be fitted with insulating washers and if individual stud mounting diodes are used they too must have insulating washers.



*A photograph of the inside of the prototype. This unit did not use a PCB and several of the components now mounted on the board were mounted on the tag strip.*

The resistors making up R4 were mounted on tag-board. This made changes easy and would assist switching if required. Although 2Ω units were used the individual components can be of any low value.

Although the prototype didn't get more than just warm, holes were drilled in the ends of the case to enable an air flow when fixed to the wall. Several

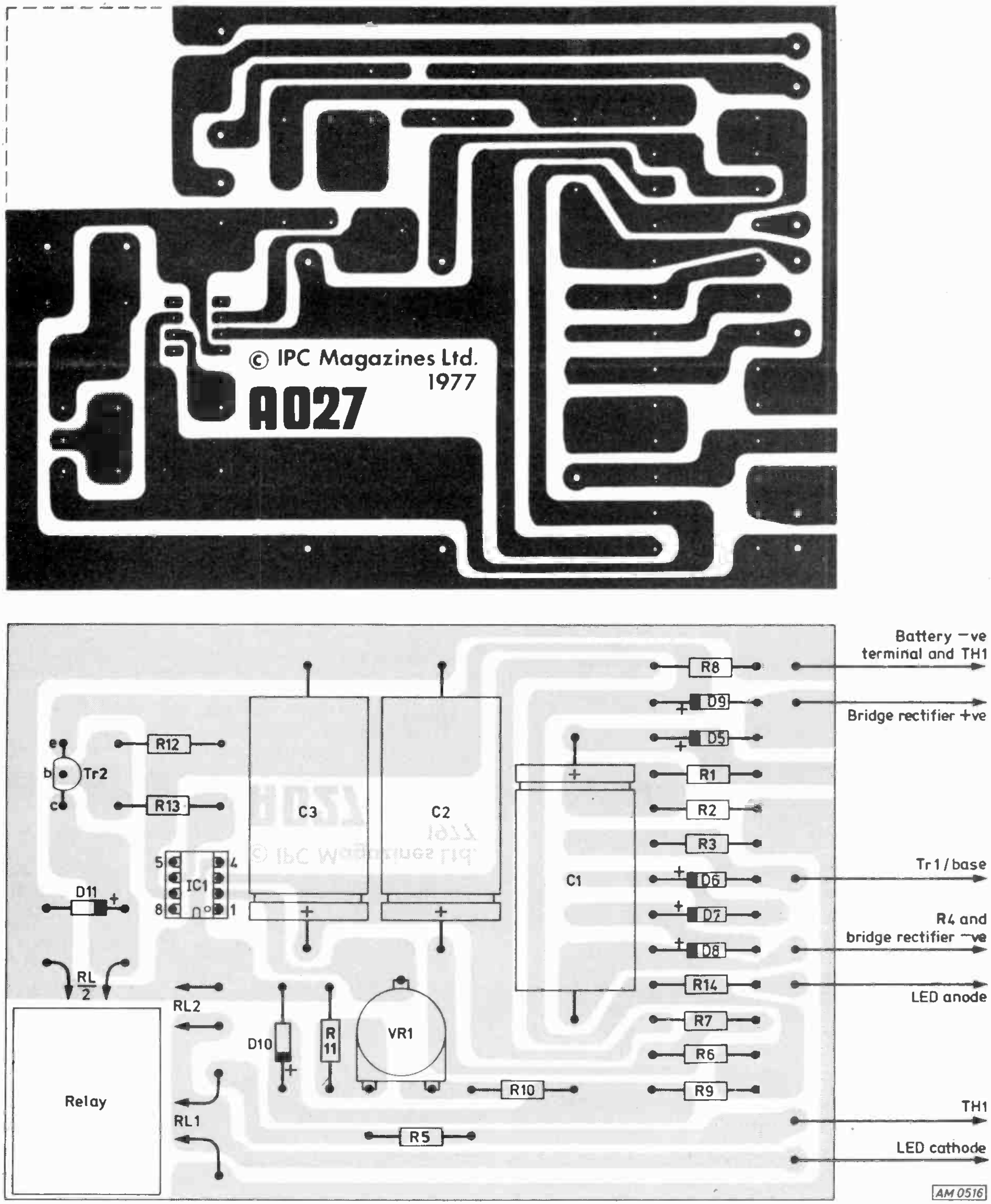



*Fig. 2. The upper drawing gives the wiring pattern of the PCB designed for this charger, drawn full size. The individual tracks are capable of carrying well over the 3A used. The lower drawing shows the location and orientation of the components.*

small holes are better than a few larger ones unless a screen is used to prevent items falling in.

When the battery has reached its "fully-charged" state the relay will de-energise. Because of the differences in "on-charge" and "off-charge" voltages the relay will pull in and drop out all the while the charger is connected. The rate will depend on the charging current set but will be of the order of 10 seconds. The meter will try to follow this change from full charge to no charge and will seem to fluctuate. To minimise possible damage to the movement a switch has been incorporated and the meter can be short circuited. The relay noise and the indicator will show that the charger is still working.

# PRODUCTION LINES

bill tull

## Order in comfort

Regular readers of PW, will I'm sure, have seen the Maplin advertisements regularly carried on the back cover of this magazine. Now, to make the job of ordering components an easy, accurate and enjoyable pastime, Maplin have come up with a brand new catalogue containing hundreds of photographs and illustrations. Measuring 285 × 205 × 10mm, this latest offering contains 216 pages packed with details of components, circuit ideas, diagrams & PCB's, kits for synthesiser, organs, amplifiers, and sections containing tools, books and cabinet hardware. In fact just about everything the DIY electronics enthusiast requires.

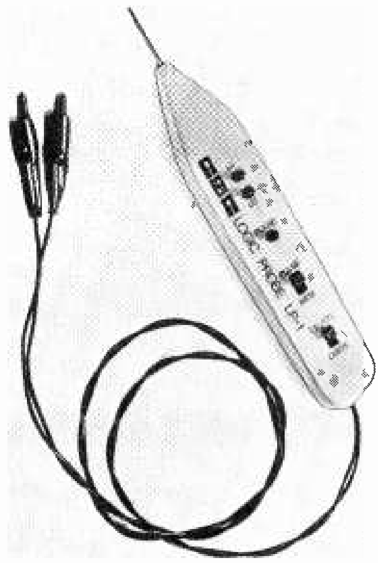
The catalogue comes complete with up-to-date price list, order form, postage paid envelope, and money back guarantee if returned within 14 days of purchase. The price incidentally is 50p.

For those interested, contact *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex. Tel: 0702 715155 or call at Maplin's shop 284, London Road, Westcliff-on-Sea, Essex. Tel: 0702 47379.*


## Probe for faults

Electronic enthusiasts are well aware of the ever increasing use that is made of DTL, TTL/C-MOS devices in almost every tvpe of circuit that not so very long ago would have necessitated the use of hundreds of transistors. Unlike transistors though, logic IC's are generally more difficult to test in circuit, especially C-MOS devices which require extreme caution, if they are to survive the rigours of testing.

A logic test probe is the answer, and the latest to appear in the UK market is sold by Rastra Electronics Ltd, who have launched the LP-1 logic probe. A few of the parameters of this probe are a detectable pulse width of 50nS, a maximum input frequency of 10MHz and a power requirement of from 5 to 36V. LED's are used to indicate logic '1' (2.25V± 0.015V 70%Vcc) or logic '0' (0.8V± 0.01V 30% Vcc) and pulse, which blinks on for ⅛S transients. Price is £28.60 plus VAT.



*Rastra Electronics Ltd., 275-281 King Street, Hammersmith, London W6 Tel: 01-748 3143*

## I see new chips

Three new devices that have recently come onto the market are discussed below and are available from Rastra Electronics, Distronics, and SGS-ATES, respectively:—

The first is a precision waveform generator/voltage controlled oscillator, and designated the ICL8038-CCPD. The IC is said to be capable of producing sine, square, triangular, sawtooth and pulse waveforms at frequencies ranging from less than 1/1000Hz to more than 1MHz. FM and sweeping can be accomplished with an external voltage, and it is claimed to be highly stable over the temperature range of 0°C to 70°C. Package is a standard 14 pin DIL. *Further information from Rastra Electronics, 275-281 King Street, Hammersmith, London, W6. Tel: 01-748 3143.*

Continuing with oscillators, Distronic have released details of their crystal controlled oscillators, which combine crystal techniques with hybrid integrated circuit technology.

The units are claimed to have the high stability temperature and aging characteristics associated with AT-cut quartz crystals, and are available for driving multiple TTL or C-MOS loads. For TTL types, the available frequency range is from less than 0·25Hz up to 30MHz with an input voltage of 5V DC.

The frequency range of the C-MOS oscillators is from 300Hz up to 10MHz for TO-5 package types and from 0·0002Hz up to 10MHz in 14 pin DIL packages. *Distronic Limited, 50-51 Burnt Mill, Elizabeth Way, Harlow, Essex. Tel: Harlow 32947.*

The new SGS-ATES chip is a 5 terminal voltage regulator—the L200. Output voltage is adjustable between 3 and 30V and output current adjustable from 0 to more than 1·8A. Thermal overload and short circuit protection are also incorporated, as is second breakdown and overload protection which enables the L200 to withstand spikes of up to 60V. Load regulation is said to be 0·1% of $V_{out}$, while ripple rejection is better than 70dB. Other applications for this device are precision current limitation and switching regulation in which neither external transistors nor additional protection circuitry is required.

Further information on this product from *SGS-ATES (UK) Ltd., Walton Street, Aylesbury, Bucks. Tel: 0296 5977.*

## Disco Separates

Rather than 'Cart around' a heavy disco comprising of decks and amplifiers combined in a single cabinet, it is often advantageous to have separate units. The new RTVC 70W and 100W RMS mono disco amplifiers fit into this category, each providing a full range of mixing facilities and an input for a separate slave mixer amplifier. Both units are fully protected against speaker malfunction and against any short circuit conditions. Maximum power is developed into 4ohms.

Inputs 'Deck 1' and 'Deck 2' are for ceramic cartridges with outputs in the order of 200mV, while the 'Mic' input is a dual sensitivity type, accepting either 1mV or 10mV outputs. Microphones may be of either high or low impedance. Other inputs provided are 'Tape in' (300mV into 50k ohms), 'Tape out' (150mV at 100k ohm) and 'Slave in', 'Slave out', both at 150mV at 5k ohm.

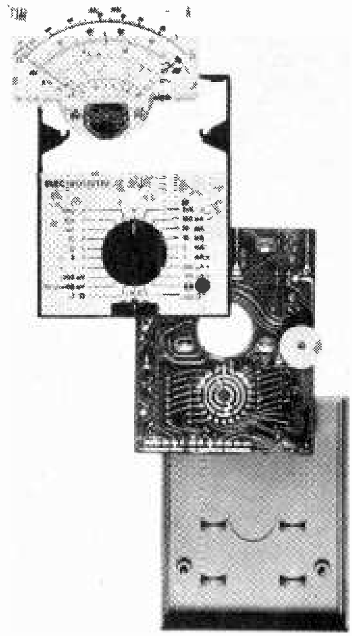
PFL—pre-fade listening is also incorporated on each input regardless of the level, and is controlled by a separate rotary control.

Along with other RTVC products, these Disco Amplifiers are very competitively priced, with the 70W model selling for £49·00 plus £3·00 p&p and the higher powered 100W model carrying a price tag of £65·00 plus £4·00 p&p.—*RTVC, (Dept. PW), 21 High Street, Acton, London, W3 6NG and 323 Edgware Road, London W2.*


## 4-piece meter

One of the most frustrating factors in owning any instrument is that of servicing and calibration. Alcon Instruments claim that they have solved this problem with the introduction of their new pocket-size range of multimeters from Miselco. These instruments have been designed for repair in a simple and easy manner using factory matched replacement modules which, by virtue of their design, obviate the need to recalibrate each time.

The Miselco Tester range of four Multimeters cover between them a high current model capable of measuring up to 30A; a model with a high sensitivity figure of 1MΩ/V; a general purpose model with a sensitivity of 20kΩ/V and finally one intended for electronic work with a sensitivity of 50kΩ/V The latter model has claimed accuracy figures of 2·5% on DC and 3·5% on AC,

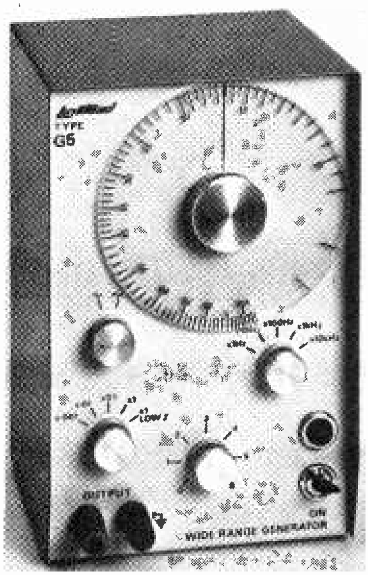


while all the other models claim 2% on DC and 2·5% on AC.

Each model comprises two case parts, a movement and a PCB Any one module may therefore be replaced by the user, using only a screwdriver to complete the job.

*Alcon Instruments Ltd, (Dept. PW) 19 Mulberry Walk, London SW3 6DZ.*

## Everymans Sig. Gen.




Test equipment these days tends to be so expensive, that only the largest of service centres can afford to keep up with new products. This of course leaves the average enthusiast completely 'high and dry' when it comes to the latest techniques in test equipment.

To overcome this apparently insurmountable problem, Linstead have launched a signal generator that is one of the cheapest on the market today, but without sacrificing quality or facilities. Called the Linstead G5, signals can be of either sine or square wave, and range in frequency from 10Hz up to 1MHz in steps of 1Hz on the lower range. The output is fed from a power amplifier which allows output impedances from 600 ohms down to 5 ohms.

Claimed accuracy figures are 2% +1Hz with sine wave distortion less than ½% harmonic content. The output voltage of 5V RMS can be reduced to less than 1mV by means of a continuously variable control and the switched attenuator. Size is 130 x 130 x 121mm and is priced at £58·70.

*Linstead Electronic Instruments, (Dept. PW), Roslyn Works, Roslyn Rd, London N15 5JB. Tel: 01-802 5144.*

*Dear Sir,*

# letters

## Designers—please note

I am one of the unfortunates so roundly condemned by Paul Heath of Wolverhampton on your letters page in the February issue. Unfortunately my QTH is quite useless for VHF transmitting, so my activity is therefore confined to low-power portable working using FM. If it were not for repeaters such as MP and RF, I would have no contacts at all. I rarely hear any signals on the simplex channels.

Working through repeaters is a great boon for mobiles also, handicapped by low power and whip aerials. And if we all incur the wrath of the critics for not listening on the input channels, that is because of a shortage of receiver designs. P.W. has published some splendid articles on 2-metre converters, and on hi-fi equipment for the FM broadcast bands. But *never* have I seen a design for a straightforward FM receiver for 2-metre work.

May I suggest a possible specification? (a) single conversion receiver with tunable front-end, using a variable capacitance diode; (b) integrated circuit (e.g. CA 3089E) for the complete IF strip, possibly including the cheap Toyocom crystal filter to avoid the headache of alignment problems; and (c) a small integrated circuit for the audio side, such as the LM 380. This receiver would work from the 12V vehicle battery or from a small mains power pack. I'm sure that there would be a great interest in it on the part of SWLs, many of whom enjoy listening to the repeaters but are handicapped through the use of the inefficient method of "slope detection".

PW has many gifted contributors: surely one of them could come up with an effective design along the lines indicated. And then you could follow it up with a design for a converter for the 70cm band, to work into the PW FM receiver! **F. Ness** GD3ESV (Douglas, IoM).

## Hot tip

Re the stripping of Litz wire (Letter H. Pruim) in the February issue. I am now retired after a lifetime in many branches of work using all sorts of wires, and for years I have used a simple method of stripping Litz that needs only a small meths lamp with wick and shallow tin lid.

Just put about a $\frac{1}{4}$in of meths in the lid and put it by the lamp. First hold the end to be stripped in meths flame till just red hot. Then quickly dip the hot end into the meths, presto—perfectly clean strands just right for soldering. Not much knack required, but a few trys will soon prove the idea. **George Comber** (Tadley).

## High power interference

Democracy, according to the Radio Society of Great Britain requires that minority groups be given absolute priority over other amateurs—or so it seems on the 2m band. I will not challenge Dr. Allaway's remarks in your February issue about minority groups having a right to exist, but they must not be allowed to take up unduly large portions of any band, in a way that absolutely prevents anyone else using that band segment.

I am referring to the Oscar command station which is located at Surrey and requires about 100 kHz of the 2m band. The power which is radiated (believed a few kW E.R.P.) completely obliterates any but the most local legal-limit transmissions. The transmission is in the "all-modes" part of the band, which should be shared by all and not monopolised by a minority service which already has its own "space" segment elsewhere.

The RSGB required the greatest persuasion even to publicise the source of the nuisance. They will now have nothing more to do with the matter—I cannot even get them to tell me when to avoid the frequency! The transmission begins without warning about once every two hours or so. It has caused interference as far north as Liverpool.

"RSGB represents all UK radio amateurs." It says so on my membership card. The blatant white-wash over the mistake in licensing this wide-band transmission in an Amateur band seems to suggest that the statement is in some way at fault.

How can I trust a society that performs in this manner to safeguard my interests at WARC in 1979? It is the same society that had a 6-month option on a very costly investment, and although promising "informed discussion" on the wisdom of the purchase and suggesting that they would wait to hear any views that informed members may have on the subject, they abruptly bought the machine in question with most of the 6-month option period still left to run.

Yet the RSGB is probably the only body that can make representations to the delegation from this country that will vote at WARC.

RSGB, you are in a position of trust. You must be above suspicion, in all your claims. Please realise your responsibilities.—**G. L. Manning**, G8JBH (Edgware).

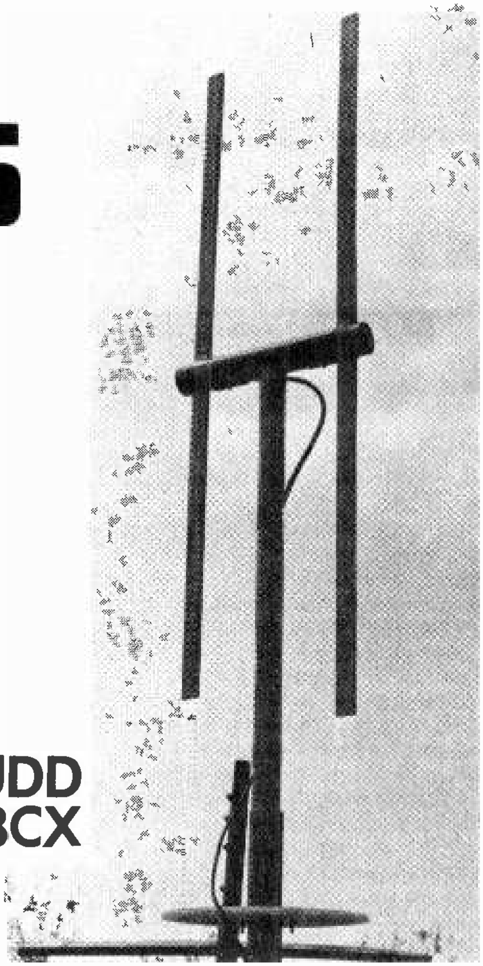
## More 'scope

Just a small but important observation I thought we ought to share. Many useful projects have been featured in PW associated with oscilloscopes including the "bolt on" goodies and details on operation and fault-finding techniques. However, many of us, and specifically myself, haven't got the basic and necessary item, i.e. **an oscilloscope.** The last featured scope, correct me if I'm wrong, was August 1973 "PW Student".

Could it be that 1977 is going to give us a super new scope project? Well, that's it, except one specification. Please! a minimum 4 inch tube. **G. Starkey (Warwickshire).**

*The Editor will be pleased to hear from potential contributors on the above projects.*

# COMPACT 2m BEAM AERIALS



F. JUDD G2BCX

THE previous article "Vertical Aerials for 144MHz" (*Practical Wireless July 1976*) dealt with omnidirectional types such as the ground plane and vertical colinear which are convenient for transmitting or receiving in any direction but have relatively little gain over a dipole. For example, a 4-element colinear has but 4·3dB gain and is a sizeable aerial, some 14ft or so long. Beams are the only way of obtaining relatively high directivity and gain and there are many to choose from with the Yagi or parasitic array being the most popular.

However, fairly small but efficient beam aerials for 144MHz are not difficult to make and gain as high as 10dB over a dipole is possible without resorting to large numbers of elements as are necessary for Yagi or colinear arrays. The corner reflector aerial, which employs only one driven element, may be an exception and although a high gain, around 12dB or more, is possible, the reflector itself is of somewhat unwieldly dimensions.

## TWO DRIVEN ELEMENTS

Small beams with a useful degree of directivity and gain may be derived from "end-fire" or "broadside" arrays consisting of two driven radiators spaced a specific distance apart with the current in each phased according to the directivity required. In the case of the "end-fire" array the pattern has zero radiation broadside (at right angles) to the plane of the array and maximum end-fire radiation when the spacing between the elements is a half-wavelength or less and the currents in the elements are equal in amplitude but in opposite phase i.e. 180° phase difference.

The configuration of this array is shown in Fig. 1 in which the spacing "d" may be from $\frac{1}{8}\lambda$ to $\frac{5}{8}\lambda$ to obtain the requisite horizontal plane end-fire radiation pattern when the array is vertical as in Fig. 2(a) and looking down on the ends of the elements. Radiation in the vertical plane i.e., with reference to an angle to the ground, will be as shown in Fig. 2(b).

To obtain "broadside" radiation, at right angles to the array, the spacing between the elements is usually a half-wavelength and the elements fed in phase. The available directivity/gain is greatest when the elements are spaced $\frac{1}{2}\lambda$ or $\frac{5}{8}\lambda$ but not closer. The end-fire array is of greater interest since considerable gain can be obtained with closer spacing between the elements thus allowing for a more compact aerial plus uni-directional or bi-directional radiation pattern as required. Such an aerial may be operated horizontally (for horizontal polarization) or vertically (for vertical polarization).

Greatest bi-directional gain is obtained when two driven half-wave elements are spaced $0{\cdot}125\lambda$ apart and fed out of phase as in Fig. 3. The gain is about 4dB with reference to a half-wave dipole. However, for 144MHz operation the high feed point impedance presents a problem as it is not suitable for direct connection to commonly used 50Ω co-axial cable although this can be overcome by the use of a matching stub.

Since beam aerials have to be rotated for maximum radiation in a desired direction there is little point in using a bi-directional array. Better to use a uni-directional system and obtain a little more gain. This can be achieved with a two-element close spaced array in which one element is fed 135° out of phase with respect to the other. The radiation pattern then becomes a cardioid as shown in Fig. 4 and remains virtually the same whether the aerial is used vertically or horizontally.

An aerial based on this arrangement, to provide even more gain, was designed by the writer some 26 years ago and is known as the "ZL Special" although it was originally intended for HF bands operation. It employs two driven elements fed 135° anti-phase but the element lengths are such that one operates as a driven element/director whilst the other behaves as a driven element/reflector. The radiation pattern is cardioid as in Fig. 4 and the gain a little over 6dB with reference to a half-wave dipole.

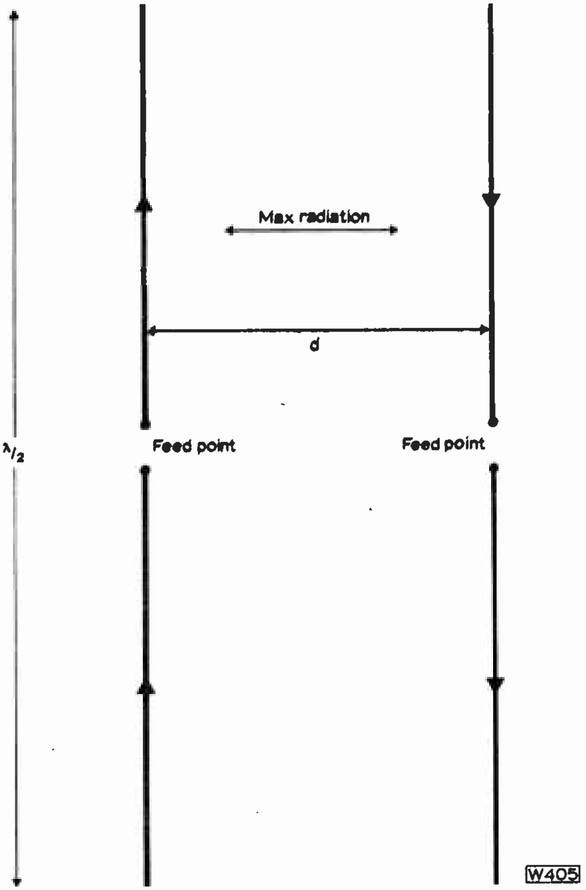


*Fig. 1: Configuration of an end-fire aerial array.*

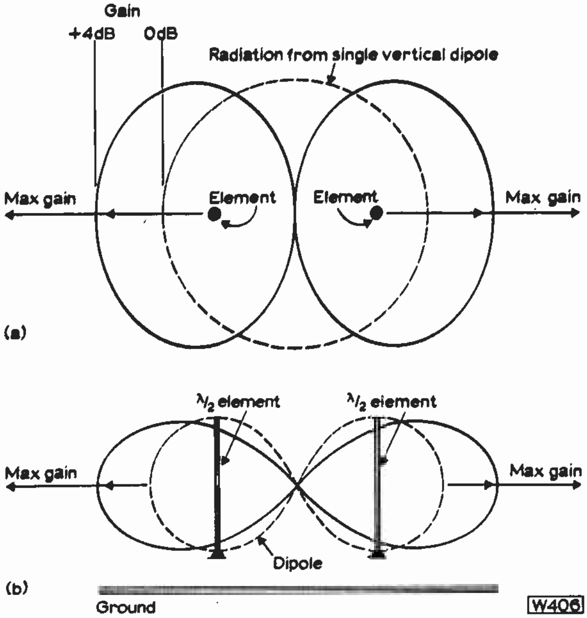


*Fig. 2: Radiation patterns and gain of an end-fire array compared with a dipole.*

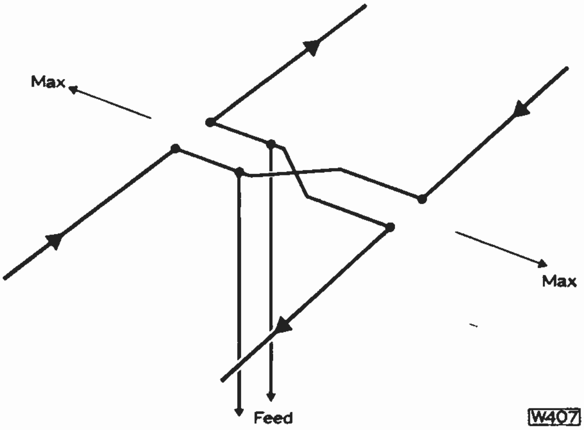


*Fig. 3: One method of feeding an end-fire array (see text).*

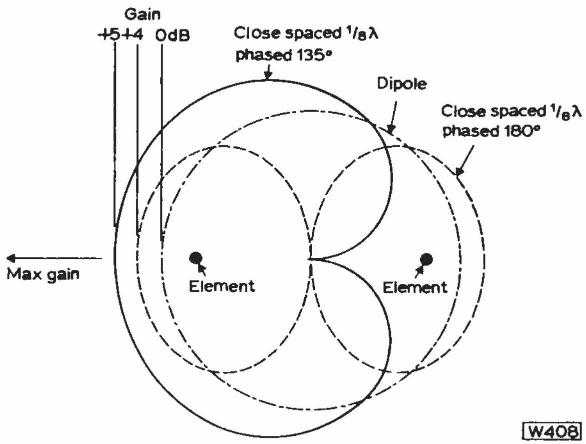


*Fig. 4: Gain and radiation pattern of a close spaced end-fire array with currents 135° anti-phase.*

## "ZL SPECIAL" FOR 2M

This beam is identical to the original model except that an alternative feed method to suit 50Ω co-axial cable was necessary and the element lengths are appropriate for 2m band operation. It is easy to construct and the elements and phasing line may be made from copper wire, copper tube or even 300Ω ribbon feeder. Quite a large number of this 2m version have been constructed and tested and being a very compact aerial it has proved ideal for use indoors since it is not generally affected by the proximity of walls and even conductive structures, providing these are not too close.

This beam has a broadband characteristic and properly constructed and adjusted should exhibit around a 1:1 SWR over the whole 2m band. Constructional details are shown in Fig. 5 and providing the phasing line length and the element spacing and lengths are adhered to, the materials for these may be as mentioned above. If 300Ω ribbon feeder is used the distance between conductors will of course be that of the feeder itself.

The small air-spaced 20pF variable capacitor is necessary to achieve a correct match to 50Ω co-ax cable and is adjusted for minimum SWR at 145 MHz. Not more than about 10pF of this capacitance should be necessary to achieve this. *Do not use mica or ceramic type trimmer capacitors*. It is important to curve the feed line away and down as shown in the inset in Fig. 5 when the aerial is operated vertically

# next month in Television

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Amongst the servicing features next month will be an article by John Coombes on the GEC single-standard monochrome chassis and advice on the French (EMO, Eurovox and Eurosonic) colour receivers that were imported into the UK during the colour boom period.

● **THE COLOUR SUBCARRIER PARADOX**

As we all know, suppressed subcarrier transmission is used for the colour signal in the PAL and NTSC systems. Yet a 4.43MHz signal is still present. Do you know why, or what effect suppressing the subcarrier has on the composition of the transmitted signal, and how this affects modulation? These matters are basic to understanding colour television but are seldom clearly explained. E. J. Hoare remedies this situation and in doing so brings home the full subtleties of the PAL system.

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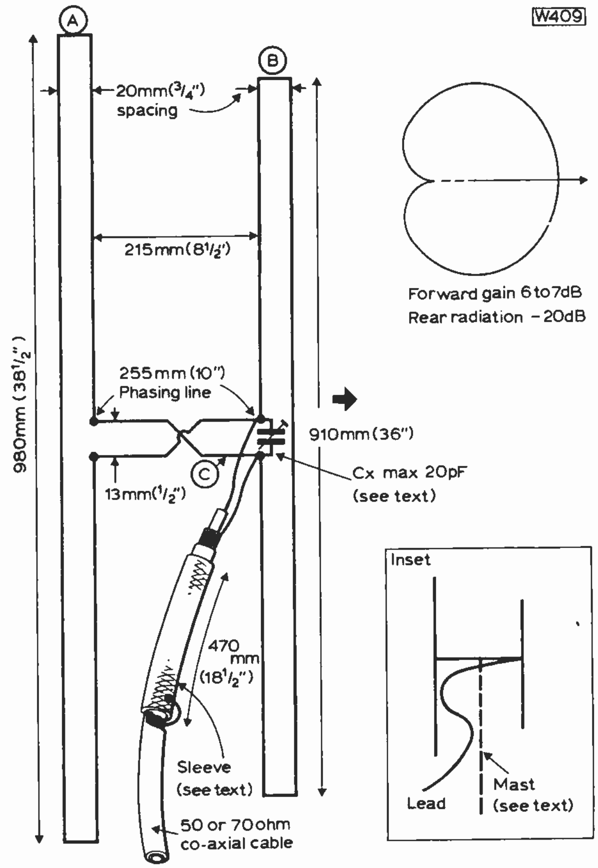


*Fig. 5: Details for the construction of a ZL Special aerial for 2 metres.*

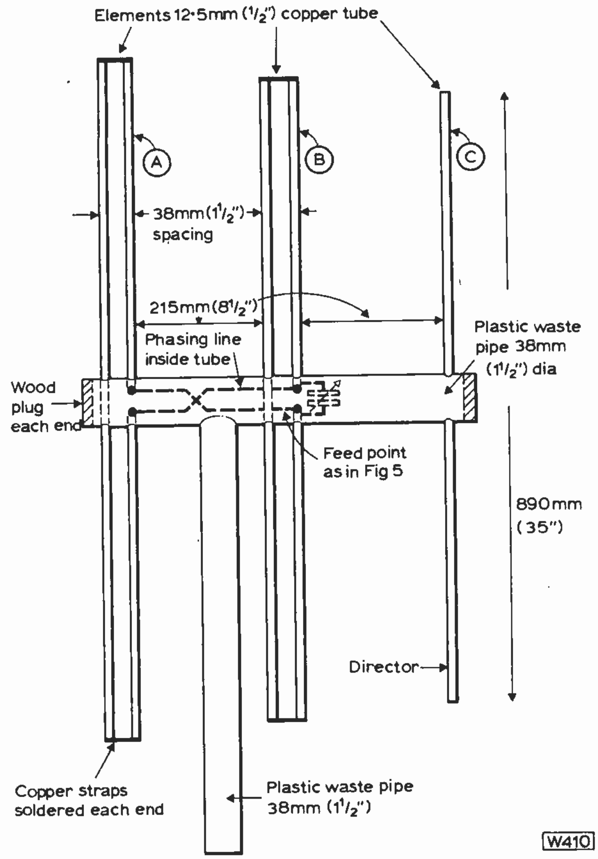


*Fig. 6: Construction of a three element ZL Special beam.*

and the matching capacitor should be adjusted only when the feeder has been secured. The short stub mast used to support the aerial must be of insulating material, wood or plastic tube and extended to a few inches below the bottom ends of the elements when it may be coupled to a metal mast. The gain remains the same when the aerial is used horizontally but the cardioid pattern becomes a little narrower to the sides. Note the unbalance-to-balanced co-axial connection using a $\frac{1}{4}\lambda$ sleeve which is bonded to the main co-axial braid only where shown, at point X in Fig. 5. The end near the feed point is not connected to anything. For use outdoors the feed connections and tuning capacitor must of course be protected from weather as must the elements and for this a small plastic electrical junction box could be used. The elements and supporting frame (this must be wood or plastic tube) can be given two or three coats of polyurethane varnish.

This aerial is used by the writer on a cabin cruiser (G2BCX/MM) at a height of only 9 feet above the water and so far 10 European countries as well as many UK DX stations have been worked. The photo shows the aerial enclosed entirely in plastic "plumbing" tube for complete protection from weather and salt water. The aerial is also ideal for portable work as it will fit comfortably in the boot of a car.

Since the basic ZL is a driven array and the radiation pattern uni-directional it has been found possible to add parasitic director elements to obtain an increase in forward gain. One director mounted

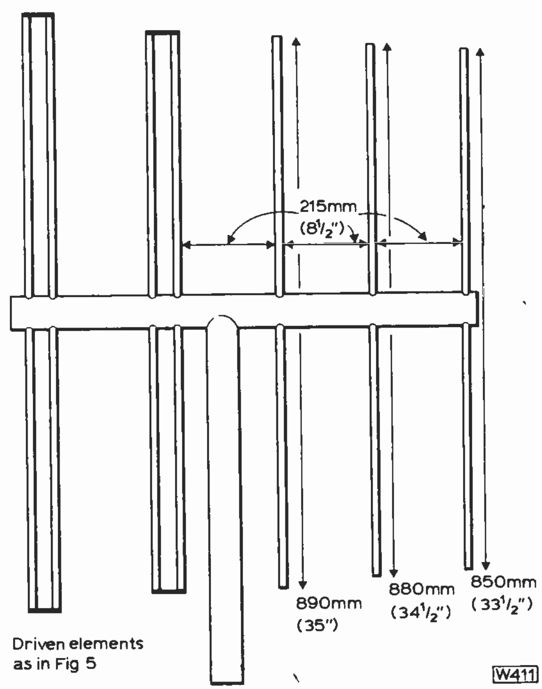


*Fig. 7: Details for the director lengths and spacing for a five element ZL Special. Other constructional details as in Fig. 6.*

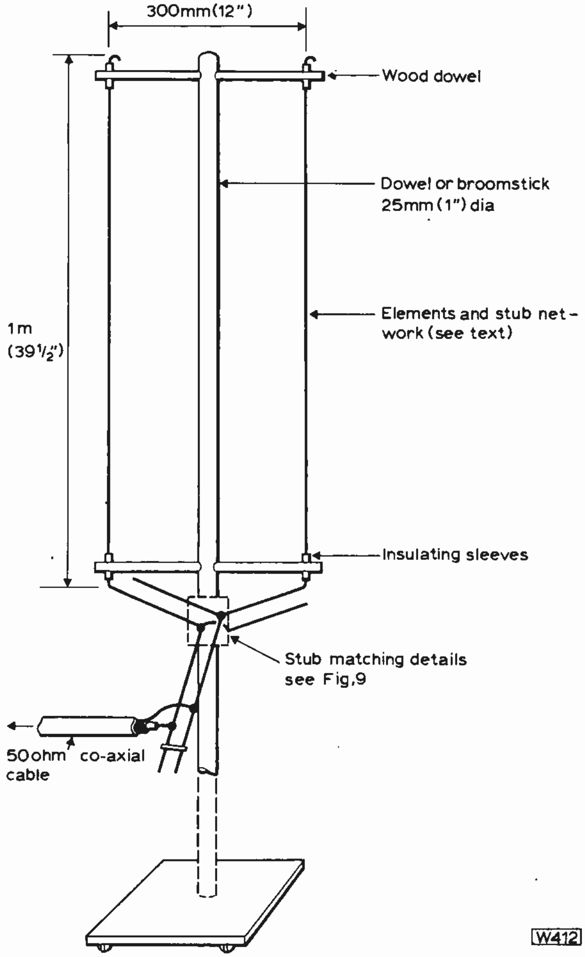


*Fig. 8: Details for the construction of a bi-directional end-fire array with about 4dB gain.*

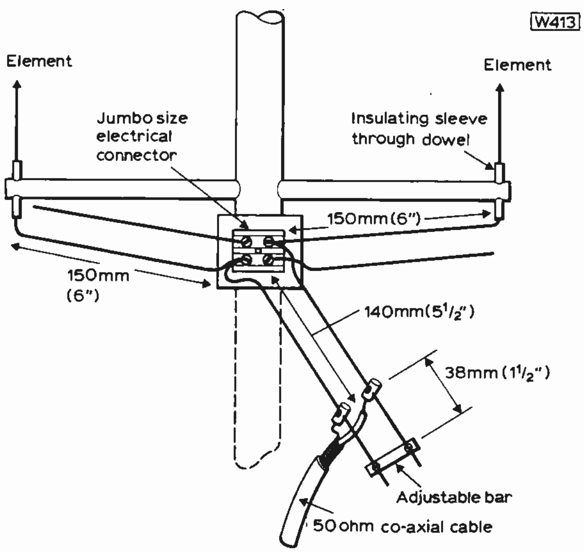


*Fig. 9: Details of the feed system for the end-fire beam shown in Fig. 8.*

0·12λ in front of the main driven element (B in Fig. 5), increases the forward gain by slightly over 2dB thus providing a total gain of 8dB which is quite considerable for a beam measuring only about 50cm (20in.) from front to rear. The addition of three directors, still making the beam only about 1·2m (40in.) high, yields a forward gain of a little over 10dB which is comparable with that of an 8-element Yagi having a physical length of about 2·8m (110in.), or twice the length.

The construction of a ZL with directors is much the same as for the basic aerial shown in Fig. 5 except that the element support is extended for mounting the directors. This must be insulating material, such as wood or plastic tube, and one suggested method of construction, particularly suitable for outdoor use, is given in Fig. 6. The main support which consists of the boom and stub mast is made of plastic pipe. The stub mast is fitted into the boom either by cutting a hole in the boom and gluing the mast in with Araldite, or by using a pipe "T" piece to make the join. The copper tube elements are fitted tightly into holes through the boom section and secured by screws through the side of the pipe. The phasing line which may be two copper wires (12 to 16 SWG) are inside the tube as is the small capacitor. To ensure that the phasing lines do not touch, they may be insulated with sleeving.

This 3-element ZL Special has been tested over a long period and operated both vertically and horizontally with considerable Continental DX worked. The half-power beamwidth (3dB) is about 90° and radiation directly from the rear is about 25dB down although the overall radiation pattern is still cardioid but narrower than that from the 2-element ZL Special.

The addition of two more directors, making a total of three, and the aerial therefore a 5-element version, will provide a gain of about 10dB. The aerial is still not very large and may of course be operated vertically or horizontally. Construction is the same as for the 3-element version except for the three extra directors cut to length and spaced as shown in Fig. 7. Note that the amount of capacitance required across the 50Ω feed to effect a good match may be much less or even nil with the directors in use.

## VERTICAL END-FIRE ARRAY

This is relatively easy to construct and will provide about 4dB gain over a dipole and is bi-directional. It needs only to be turned through 90° to achieve all round coverage and being compact could prove useful to flat dwellers unable to put up an aerial outside. It consists of two half-wave radiators fed 180° anti-phase to produce the radiation pattern as in Fig. 2a. It may be assembled on a wooden frame and the elements and stubs can be made from copper wire as shown in Fig. 8. It could also be set up to rotate on a floor stand, as the extension of the diagram illustrates, making it suitable for indoor use. Details of the matching stub and feed are shown with more detail in Fig. 9. Adjustment for minimum SWR is carried out by sliding the shorting bar along the stub in conjunction with moving the tapping point of the 50Ω co-ax feeder. The approximate positions for these are given in Fig. 9 and very little further adjustment should be needed to obtain an SWR approaching 1:1 over the whole 2m band. Used in the writer's workshop at about 10ft. above the ground, this aerial could receive a substantial signal from the GB3PI repeater nearly 40 miles away.

# CHROMASONIC electronics

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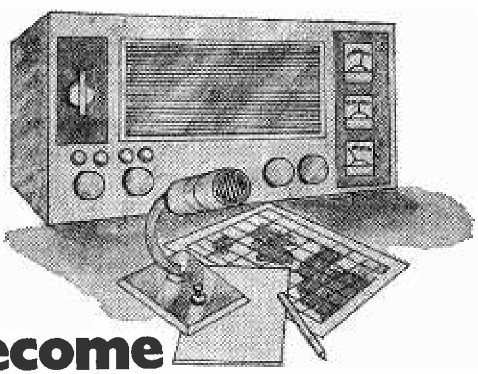

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# ON THE AIR

# AMATEUR BANDS

***by Eric Dowdeswell G4AR***

HAPPY man this month is **Neil Braeman** of Southwater, near Horsham, and regular contributor to this column. He has passed his RAE and he is now G4FUP. Congratulations Neil, I know the bit of effort required to get down to the necessary studying will be found to have been worthwhile, for very many years to come. He has sold his bike to get funds to buy a better receiver and intends to make his own transmitter, a policy which I heartily endorse!

When **John Taylor** of Cheadle Hulme found the cost of a decent receiver a bit beyond his means he dragged out an old R107 that hadn't worked since 1953! A simple signal generator and multimeter and it was soon going again. John is thinking of building a converter for the higher frequency bands which is a very sound arrangement. In Stocksfield, Northumberland **Simon Robinson** is just starting to listen to the SW bands and is thinking of getting a surplus CR100 and 'hotting it up'. Well, Simon, unless you have the requisite test gear and a bit of experience I should tread warily. Make one change at a time, re-aligning if necessary, before doing anything else. Personally speaking, I would get it going properly on the LF ranges and use a convertor, as previously mentioned.

A note from **Jim Martin** A7089, Secretary of the newly-formed Edinburgh and District ARC, tells me that a group of about 20 members meets every Tuesday at 1930 at the club's rooms situated at the City Observatory, Catton Hill, Edinburgh. One could say that things are looking up! The club is active from 2m to 160m with calls GM4AJV/A and GM4BWT/A until they get their own call. Interested? then write to Jim Martin at 22 Ross Gardens, Edinburgh EH9 3BR. Still in GM-land, the Aberdeen ARS got all excited recently with a visit from the BBC involving interviews with several members, later broadcast on Radio Aberdeen. The producer is interested enough to suggest a monthly spot on Radio Scotland dedicated to amateur matters. In the meantime more mundane meetings take place at the hall to the rear of 91 Crown Street, Aberdeen. On 8 April there's a demonstration of an automatic CW reader and a try out of a new Jap receiver that covers LW to 500MHz! On 15 April an RSGB Tape Lecture will be illustrated with slides while 22 April sees RSGB Council member GM3ZBE visiting the club to talk of Society affairs. Secretary **Stan Sutherland** awaits your enquiries at 67 Greenfern Road, Aberdeen or ring 691716.

Back to regular correspondent **Robin Bayley** A9203 who is now settled at Kemberton, near Shifnal, Shropshire. He has been assessing his new QTH from the DX aspect from 15 to 80m with the aid of his EC10. With HK0's on 80, 40 and 15m and KH6 on 20m things look promising. **Andrew Work** A9091 in Beverley, E. Yorks, changed his 66ft wire round the loft to a straight wire outside and naturally found a big improvement in results including VP2 and VP5 on 80m. In Wallasey **E. J. Shaspe** has progressed through a couple of receiver kits to an Eddystone 670A which he found going cheap. He's anxious to beg or borrow a handbook on the same so if you can help write to 36 Warren Drive, Wallasey, Merseyside L45 0JS.

Zone 23 is a very rare place and many aspirants for the Worked All Zones award have had long waits for a QSL from there. **B. Harrison** in Hastings heard JT1KAA from Mongolia which is a good start to getting a card. KC6 was another good catch in the East Caroline Islands in the Pacific. **Steve Budd** A8713 also on the sunny south coast, in Worthing, has been logging stuff on the downlink from Oscar 6 10m and the 2m downlink from Oscar 7. However he still did not desert the HF bands. **Steve Cottis** A8961 seeks the DX from Harrogate and has QSL's from HP7, VQ9 and VR8 to prove he has been successful. I'd hesitate to attribute the improved conditions on 15m to a general rise in sunspot activity, Steve. Rather it is the usual improvement as we move towards the summer in the northern hemisphere.

**David Peck** BRS37621 has done us proud this month from Cambridge with logs for SSB and RTTY somewhat restricted by a move with all the gear from the house to a shed in the garden!! David started with a Creed 7B printer plus 'RTTY the Easy Way' built the terminal unit and he was away! The receiver is a Yaesu FRG7 fed from a 135ft wire. **D. Anderson** BRS36591 has not written for a while from Brookwood, Surrey, but makes up this month with a good log. Normally he tapes his DX but at the moment the recorder is u/s. Dennis takes the RAE next December and in the meantime G8LVB is helping him with the necessary studies.

Now a note for all! The Annual Convention and Exhibition of the Northern Radio Societies will take place at Belle Vue, Manchester on Sunday 24 April. See the box in the News feature of this issue for further information.

## Log Extracts

**J. Taylor:— 20m** KG4DHD VE8SO 7X2LTA

**R. Bayley:— 80m** AP2AD EA9CR FP8DX HK0COP JA1JRK KH6PP PY7PO **40m** CT2AP EA9CF HK0CAT **20m** FP8DH KH6PA TG9TL VP8AA **15m** EA6DA FP8DA HK0KOC TG9TY ZL3AK

**A. Work:— 80m** VP2DAC VP5LDH

**B. Harrison:— 20m** FG7AK FM7WE FY7YM HC1SC HK0BKX KG4PF PJ2FR SV0WZ (Rhodes) TI2FM VP2EEQ (QSL WA6AHF) ZD7SD **40m** HC1DK VP2KF ZS3AW **20m** P29PN S79P (Seychelles) 7P8AC 7Z1AB

**D. Anderson:— 80m** VS6DO 7Y4MD **20m** C21PS (Nauru) CP5GR HM0SM KC6KO P29BS VP2AG ZP6KR

**D. Peck:— 20m** KC4AAA KC4USD KL7IEU **15m** JR6HJJ WB2CJF/HZ1 **20m RTTY** IC8POF K9KHI OH0NI UK3ACR WA0YDJ/4 YU2CE 9K2EP

**N. Braeman:—** **80m** KP4AST 9Y4NP **20m** OE5GML/YK PZ1DR W6QL/VP2A(CW) YS7VI

**S. Cottis:—** **80m** CT2BU KP4EBH **20m** JW7FD KL7IEU VR4DX **15m** D2ASW FP8DX HP7XJS WB6EWH/VQ9 (Chagos) 3B8CV 5U7AG

**S. Budd:—** **80m** FM7WS JY9CR PJ8KG TI2FJC 6Y5EM **20m** D2AFE (Ex-CR6FE) FR7ZL/T (Tromelin) TR8LE W6QL/VP2A YB2CR 8P7GN **15m** N4PN (USA) PY0ZAE (QSL PY1CK) 7P8BC **Oscar 6 (10m)** GJ8EZA VE3EYR **Oscar 7 (2m)** CT1WW HW6ADB IT9ZDA K4UQ TU2EF VE3FKU W2BXA W9QQO

All SSB except where stated otherwise.

# BROADCAST BANDS

## MEDIUM WAVE DX

*by Charles Molloy*

A report from **Ralph Newman** in Reading mentions an unidentified station on 945kHz between 2300 and midnight which created a 1kHz heterodyne with the Russian on 944kHz. The writer has made a tape of the closedown announcement, which is in English, and although no location was obtained, two frequencies on the medium waves were referred, to 602kHz and 945kHz. The transmission ended with the Nigerian national anthem at 0002. The Western Nigeria Radiovision Service has a 10kW outlet on 602kHz located at Abafon and it seems likely that they now have another on 945kHz. Although the signal is quite strong at times interference makes reception difficult. DXers who use communications receivers and a loop might like to take up the challenge offered by this new broadcaster and try to obtain a more definite identification.

In a letter from Horsham in Sussex, **Kes Otley** reports hearing CKVO Clarenville in Newfoundland on 710kHz using his Roberts portable radio connected to a long wire aerial and earth. He asks how to use a loop with this receiver. From St. James in Barbados, **Paul Griffith** poses a similar question when he asks how can he connect a loop to a portable receiver which has no external jacks for earth or aerial. A number of DXers have written on similar lines and the short answer is that a loop is really unsuitable for use with a receiver that has an internal aerial. Even if aerial and earth sockets are fitted to the portable, they are intended for use with a wire aerial and if a loop is connected to them then poor results will be obtained.

The internal aerial in a transistor portable is wound on a ferrite rod or slab and this type of aerial is directional. There are two positions of maximum pick-up at right angles to the rod and two other directions of minimum pick-up which lie along the length of the rod. A loop aerial which is based on the frame aerial used in the early days of radio, has similar properties and if an attempt is made to use both aerials at once then problems will arise. The loop may detune the receiver input causing poor selectivity. If the null (direction of minimum pick-up) of the loop is pointed at an interfering station, there may still be pick-up from that station via the internal aerial, the overall effect being to reduce the directional properties of the loop.

One method of overcoming this problem is to attach the receiver to the centre of the loop in such a way that the nulls of loop and receiver coincide. In most cases this will mean that the receiver will be at right angles to the plane of the loop windings. Coupling between loop and receiver is inductive, so no direct connection should be made between them. The loop and receiver are rotated together to null out interference. This method should provide an interesting field of experiment but at best it is only a makeshift.

The most effective DX tool on the medium waves is a communications receiver and readers will note that most of the DX reported in this column comes from users of this type of equipment. Newcomers to the hobby who are thinking of investing in a receiver should think along the lines of a Realistic DX160, Trio 9R59D/E or the Heathkit or Eddystone range, rather than of portables or hi-fi tuners which do not possess the selectivity or sensitivity required by the serious DXer.

**Robin Bayley** has moved to a new QTH at Kemberton in Salop and is now the owner of an Eddystone EC10. He reports hearing a DX programme from Thames Valley Radio on 1430kHz during the Golden Days programme which is on the air on Sundays between 2200 and 2300. Another programme of interest to the DXer is the weekly 'Sweden Calling DXers' which is on the air on Tuesdays at 2315.

Latin American medium wave stations come in well in the UK, the long sea path across the Atlantic favouring propagation from this area. Reception from South America is often at its best when DX from North America is poor so it is worthwhile investigating Spanish and Portuguese speaking stations when DX from North America is absent. It is unusual if there is no DX at all on the medium waves! **John Wildey** who uses a Grundig Satellit 2000 in Doncaster says he has positively identified Radio Margarita on 1020kHz but he finds that the fast speaking style of South Americans makes identification difficult. He has heard a number in the 800 to 1000kHz and 1200 to 1400kHz areas.

Latin American countries most frequently heard are Colombia, Venezuela, Argentina and Uruguay where Spanish is the language and Brazil where Portuguese is spoken. Although callsigns are allocated they are seldom used but most broadcasters have names such as Radio Globo, R. Nacional followed by the location, such as Radio el Mundo Buenos Aires (which is on 1070kHz). The 'World Radio and TV Handbook' gives a comprehensive listing of LA stations both by frequency and country together with station addresses. In answer to **J. Williams** of Frome in Somerset, the WRH is distributed in the UK by Fountain Press and it can be ordered through bookshops.

"Wonders never cease, I got a verification yesterday from Radio Sutatenza, Magangue, in Colombia, HJHN on 960kHz" writes **Harold Emblem** from Mirfield in Yorkshire. Latin American stations are notoriously difficult to verify. Receiving a station is only the first and usually the easiest part of the exercise. They are unpredictable too. The DXer can plug away for years with reports that are unanswered and then suddenly receive a cordial letter with pennant, QSL card and detailed information about the station and its locality. This appears to have happened to Harold who now has details of

the Radio Satatenza network in Colombia. Each station calls itself Radio Satatenza following this with the name of the town. HJCR Medellin is on 590kHz with 100kW, HJCX in Cali is on 700 with 120kW, HJCY in Bogota on 810 with 250kW, HJHN in Magangue on 960 with 120kW and HJGL in Barranquilla on 1010 with 10kW. HJHN in 960 is often logged by DXers in the UK.

More LA DX comes from **Ralph Newman** in Reading with his homebrew receiver and loop which pulled-in Radio Margarita on 1020 and Radio Vision, the 50kW outlet in Maracay, Venezuela on 650kHz. **Roy Patrick** who DX'es in Derby with a Trio 9R59D and loop reports hearing Trans-World Radio Bonaire on 800kHz at 0200. This station is on the island of Bonaire which is part of the Netherlands Antilles which lie off the northern coast of South America. Multi-lingual programming, which includes English is radiated from a 500kW transmitter and is mainly of a religious nature.

# BROADCAST BANDS

## SHORT WAVE BROADCASTS

***by Derek Bell***

FIRST we must tie up a loose end from a month or so back. **Tony Cook** had an HAC set that was giving trouble on its band spread section and thus thought it wise to ask, via this column, if his confréres in the DX world could assist. As a result a letter is before me from **Joe Owens** of Dolgellau, North Wales who describes himself as "an old time PW'er from the nineteen thirties". He suggests that it might be worth trying to connect the BS capacitor to the main tuning capacitor via a small series fixed capacitor. If Tony has not got one of these he can twist two equal lengths of thin wire together. Well there seems to be enough there to pass a few happy hours tinkering! I hope that it achieves the required result.

As a footnote Joe says that he has six redundant loudspeakers that need good homes and for the price of the return postage he will pass them on. If I may inject a personal note here it might be nice if they went to school clubs or disabled or pensioner DX'ers.

For once in my life, as the song says, I can be in the forefront and let you have advance news of a station. This rare event is due to the good offices of **Robin Bayley** from Kemberton, Salop. Robin has sent several items of station news the high spot of which is that the Red Cross organisation is to run one of its periodic station tests on 26, 28 and 30 July at 0600 to 0700, 1130 to 1230, 1700 to 1800 and 2200 to 2300 on 7210. These test transmissions are to ensure that in the event of an emergency the Red Cross has a viable means of world-wide communication from Geneva. They will QSL if you report to 7 Ave. de la Paix 1211 Geneva 8. Robin also reports that the BBC is to supply Marconi SW transmitters and aerials to Masirah Island station by December and that Russia is supplying four 250kW transmitters to Radio Prague between 1977 and 1980.

Our newcomers take the floor now led by **Jeffrey Raynor** from Prestwich who runs a domestic radio/cassette recorder. Despite the fact that this is hardly a communications set Jeffrey says that he has loads of fun listening to "the affairs of distant nations". He has connected a 25ft long wire and pulled in the following:—

Radio Pekin on 6100 at 0215
Radio Norway on 6050 at 0030
Radio Sweden on 6850 at 0030
Voice of Turkey on 9550 at 2300

I can assure Jeffrey that he has not as he suspects moved the cursor needle, the fact that his frequencies are not spot on are a result of the crude calibration of domestic receivers. This extra aerial, in my experience, can throw the calibration by affecting the oscillator. Lock on to a station of known frequency and then add the aerial. When this is done one finds the station again and notes the difference remembering to take this difference into consideration when logging in that band.

**Marcus Duncan** from Thornaby also notices this phenomena of calibration movement on his Alba and seventy-foot long wire. He has made a start on the PW General Coverage set with which project your column wishes him the best of luck. He logs as follows:—

Israel Radio on 7412 at 2250
Voice of Iran on 9005 at 2015
Radio Cairo on 9700 at 2210
WYFR on 11645 at 1810

Two rarely reported stations come from our old friend **Roy Patrick** of Derby with his Trio 9R59 and Joystick. In this lean spell Roy cheers us all up by proving that some DX is still running by logging Emissor Regional Dos Acores (Azores) on 4865 and Radio Omdurman (Sudan) on 5039 at 1645. Coupled with this may I include another old friend **Bob Burgess** who writes but once a year but when he does he brings good cheer. From his Chelwood Gate QTH Bob and his Satellit 2000 bring a list 'as long as yer arm' of Latin Americans and Africans. While I admit that a Satellit is not a run-of-the-mill set it is still a portable and Bob uses it as a bedside set with all the hazards that local QRM can throw at him. I wish that I could list all of the loggings but space does not permit; however here is a handful:—

Radio Nacional Argentina on 11710 at 1900
Radio Nacional Brasilia on 11780 at 2300
Radio Nacional Chile on 9566 at 2300
Radio Rumbos Venezuela on 4970 at 2315
Conakry, Guinea on 4910 at 2245
Pointe Noire, Congo on 4843 at 2240

Bob mentions that Radio Nacional Chile is heavily jammed from Eastern Europe. Bob is hoping to retire shortly so we wish him well and wonder what sort of a logbook he will have, with more time to spend DXing.

We end this month on the subject of the Voice of America. **J. H. Collick** of Erdington would like to get in touch with VOA regarding their Big Band shows run by the veteran Willis Conover. The address to write to is VOA US Information Agency, Washington DC 20547 USA. This address also covers QSLs. With that I will wish you best 73s and all the best.

# VHF

*by Ron Ham*

WE start 'down-under' with another interesting letter from **Anthony Mann,** Western Australia, who tells of some mouth-watering DX on Febuary 11 and 12, almost at the end of their sporadic-E "season". The 12th was most unusual, says Anthony, video signals on Ch·0 (46·25MHz) from eastern Australia (1900 miles) was received as early as 0800, local time. Later, between 1240 and 1400 video was received from New Zealand on 45·25MHz (3400 miles). Prior to this a strong signal from an Hawaiian amateur was heard on 10m (KH6AHL working VK8AC). Around 1800 (1000 GMT) the 10m band opened toward Europe, with both UK and French amateurs dominating the band. At 1037 GMT the German beacon DL0IGI (28·195MHz) was heard for less than a minute. Anthony uses a Barlow-Wadley XCR-30 with a folded dipole on 10m. While listening to an amateur broadcast he heard that, on January 24 and 25, the Great Australian Bight between Adelaide in VK5 and Albany in VK6 (1200 miles over water) had been bridged on 1296MHz. Our congratulations to the stations concerned.

In 14 years of routine observations the writer has never known a month like February when the VHF bands were so quiet. From the 1st to the 24th the atmospheric pressure did not rise above 30·0", in fact for 10 of those days it was nearer 29·5", so, at no time was there any 'life' in the troposphere for our radio signals. However, this has not daunted our readers. **George Zitterstein,** G8ITS, City of London, has now installed a barograph at his station, he was lucky to find one with an electric motor to drive the drum, to try and find out why the changing AP can become frequency critical within the VHF/UHF part of the spectrum.

**Alan Baker,** G8LGQ, our watchdog in Newhaven, noticed a 'lift' on 2m around 1500 on the 12th, when he heard signals from PA0, but this did not last long and dashed the hopes of both Alan and Ernie Hoare, G8BDJ, Southwick, Sussex, of some good dx.

During the 500th edition of World Radio Club, broadcast by the BBC World Service on February 16th, the team was asked, "When is sunspot minimum?" and this prompted your scribe to examine his records and put you all in the picture. After all, we are at the beginning of a new cycle and as it develops over the next few years, the increased solar activity will affect our mutual interests with DX again on the 10m band and more auroral activity to upset our VHFs. The following figures show the number of days each year that the writer's telescope recorded solar radio noise during the old sunspot cycle:— 1969—101, 1970—176, 1971—203, 1972—160, 1973—118, 1974—140, 1975—65, 1976—72. The peak activity was in 1971, followed by a downward trend until the end of 75 and the slight increase shown in 1976 may well be the start of the new cycle. **Nigel Fisher,** Co-ordinator of the Radio Astronomy Group of the South East Essex Astronomical Society, says that they have now completed their solar radio telescope and made satisfactory tests.

The solar radio waves will be collected on a Yagi aerial and fed to a Microwave Modules 136MHz converter; an Eddystone communications receiver is used as the IF amplifier and detector and an integrated circuit DC amplifier drives an Evershed and Vignoles pen recorder. Nigel's group will be observing between 1000 and 1400 hrs daily and will be supplying both the British Astronomical Association and ourselves with information as soon as they are properly organised.

**Cmdr. Henry Hatfield,** Sevenoaks, reports seeing a tiny solar flare and a plage through his spectrohelioscope on the 8th and on the 13th he saw a group of several sunspots. This accounts for the solar radio noise recorded by your scribe at 136MHz from the 10th to 13th inc. **John Smith,** Cranleigh, Surrey, noted that the mean solar noise level had increased at 140MHz over that period. John has been making radio observations of the sun for more than 12 years.

No doubt some form of solar activity was responsible for the ionospheric disturbance reported by the BBC World Service during the early hours of the 1st; this sort of information from the BBC is most useful to those readers who use the DX bands. Apart from a couple of short bursts of signals from the Cyprus beacon, 5B4CY, (28·180MHz) at 0830 on the 16th and 0905 on the 19th, the 10m band has been dead.

Did you know that the "hissing" which you can hear above the background noise of your receiver when the sun is "active", was first discovered in 1935 by Denis Heightman, G6DH, on the 10m band? Our readers are active in many fields. On February 18th **Flt./Lt. John Keegan,** CO 2464 (Storrington) Squadron, ATC, used 5 vehicles, each equipped with a Pye Cambridge, during a night exercise. These mobile units were spread over a 10 mile area of hills, vales, and woodland, not ideal for VHF communication with the short aerials attached to the cars. In addition the AP was low and falling and a moderate gale was blowing, but, despite this, and the undulating terrain, good communications were maintained throughout. On board each vehicle was a cadet wireless operator, and each one a keen radio enthusiast. After the exercise they were convinced that the "low-band" frequency was much better than the "high-band" frequency for reliable communications when conditions are bad.

The writer plans to be at the RSGB Convention at Alexandra Palace on May 7th and will be pleased to meet any of our readers who may be there. Thanks again to all who have sent in reports.

**BROADCAST BANDS**

**Short Wave** Reports by the 15th of the month to Derek Bell, 169 Max Rd., Chaddeston, Derby. **Medium Wave** Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

**AMATEUR BANDS**

Logs covering any amateur band/s in band/alphabetical order by the 25th of the month to **Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.**

**VHF**

Reports on VHF matters to Ron Ham, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.


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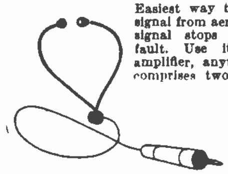

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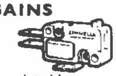

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Prices include VAT & postage.

## SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. £7·95 plus 95p VAT & Postage

## RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined in series or parallel thus relay will operate off voltages between 5 and 30 volts DC. Price 44p each, 10 for £4 post and VAT paid.

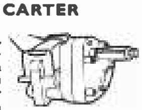
## MULTISPEED MOTORS

Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼ in. diameter and approximately 1 in long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx, 2 in. dia × 5 in. long. Price £2·00 including Post & VAT.

## SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in £2·33. Post & VAT 60p.
13in × 10in £1·85. Post & VAT 50p.

## SPIT MOTOR WITH CARTER GEAR BOX



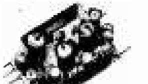
Probably one of the best spit motors made. Originally intended to be used in very high priced cookers however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact, there are no ends to its uses. Normal mains operation. £3·25 including POST & VAT.

## ROOM THERMOSTAT

Famous Satchwell, elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0·30°C. Special snip this month £2·50, post and VAT paid.

## MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied

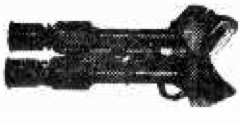


Model 1153 500mW power output £1·50 including Post & VAT.
Model 1172 1W, power output £1·85 including Post & VAT.
Model EP9000 4 watt power output £2·90 including Post & VAT.
EP 9001 twin channel or stereo pre-amp. £2·90 including Post & VAT.

## NEED A SPECIAL SWITCH

Double lead contact. Very slight pressure, closes both contacts 12p each. Plastic pushrod supplied for operating. 10p each. 10 for 68p.

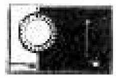
## INFRA RED BINOCULARS



Made for military purposes during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (5KV approx.) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra red cell, technical data on which is available. The binoculars are unused, believed to be in good order. In fact they were never issued, but since they were made a long time ago they can hardly be called new. Sold without guarantee. Price £17·50 per set. Post & VAT £2·50.

## SMITHS CENTRAL HEATING CONTROLLER

Push button gives 10 variations as follows (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off.



A handsome looking unit with 24-hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over £15—we offer these, while stocks last at £7·50 each including VAT and postage.

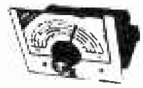
## MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Goodmans speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £14·00 including VAT and postage.

## 250 WATT TRANSFORMER

Heavy duty power transformer which can be used for many purposes. Rated at 250 watts it is very well built with frames for upright mounting and is varnish impregnated. Its primary is for 230/240 volts 50 cycles, it has four secondaries each 10v very high current windings. Just a few of the circuits it can power are 10-0-10v at up to 12 amps, 20-0-20v at up to 6 amps; single 10v at 25 amps; single 20v at 12½ amps; single 30v at 9 amps, single 40v at 6·5 amps. The transformer can be used for power circuits (charging, etc.) or for amplifiers, there being an earth screen between primary and secondaries. A transformer like this today would cost at least £15 from the makers, however, we are making a special offer at £5·95. Post & VAT Paid. Grab some while you can, our stock may not last long.

## SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis front panel and all the parts £1·90—crystal earphone 55p including VAT and postage.

## 8 POWERFUL BATTERY MOTORS

For models, Meccano's, drills, remote control planes, boats, etc., £2·00.

## ROTARY PUMP

Self priming, portable fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertilizer, chemicals, anything liquid. Hose connectors each end. £2·00 Post Paid.

## MOTORISED DISCO SWITCHES

With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 2000w's can be controlled and this would provide a magnificent display. For mains operating £4·25 post & VAT Paid. Ditto 9 switch £4·95 Post & VAT Paid. DITTO BUT 12 SWITCH £5·75 POST & VAT PAID.

## MAINS RELAYS

With triple 10 amp changeover contacts— operating coil wound for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment 60p each, 10 for £5 post and VAT paid.

## TWIN OUTPUT POWER PACKS

These have two separately R.C. smoothed outputs so can operate two battery radios or a stereo amp without cross modulation (they will of course operate one radio/tape cassette/calculator, in fact any battery appliance, and will save their cost in a few months). Specs: Full wave rectification, double insulated mains transformer—total enclosed in a hard P.V.C. case—three core mains lead—terminal output—when ordering please state output voltage 4½v, 6v, 7½v, 9v, 12v or 24v.
Price £3·95. Post and VAT included.

## CAR STARTER

Most drivers who use their car around town find that on a very cold morning they have difficulty in starting because the battery has not any charge left in it. This always seems to happen on the morning when you are in a particular hurry so a charger/starter is well worth having. Our kit for this comprises: a heavy duty 250w transformer and full wave rectifier which for short periods will deliver 20 amps. This is usually enough to get the car started, directly it has started of course it can be disconnected from the battery as the car's internal charger will take over. Special offer price of this is £6·50p including post and VAT.

**TERMS: Where order is under £6 please add 50p surcharge to offset packing expenses**

# J. BULL (ELECTRICAL) LTD.

**(Dept. P.W.), 103 TAMWORTH ROAD, CROYDON CR9 1SG.**

## ITS FREE!

**Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and its free—just send S.A.E. Below are a few of the Bargains still available from a recent list.**

**100 watt Mains Transformer.** 240v 50hz primary wound in separate halves, primary screen. This has three secondries 24-0-24v, 0-49v and 0-88v tapped to 80v. Any one of these secondries may be loaded up to the 100 watts or the load can of course be spread over to all the secondries. Upright mounting, impregnated and varnished. Size 4" × 3½" × 3". Price £3·50 + 28p. Post 80p + 6p.

**Connector Strip for Push on tags.** 7 pole, each pole accepting 6 push on tags on strong plastic base with fixing holes. Price 45p + 4p.

**Stereo Flex** twin screen fig. 8 type. PVC insulated overall. 10 metres for £1 + 8p.

**Latching Relay** by Guardian Electric, mains operated it is in fact two relays mounted on a metal base plate. The relays being mounted in such a way to ensure that when one closes the other opens and vice versa thus when closed relay A would remain locked until manually released or electrically released by energising relay B. Each relay has 2 sets of 10 amp changeover contacts. Ahould be ideal for burglar alarms and similar applications. Price £1·95 + 16p.

**Connecting Wire.** 7 Stranded PVC insulated on 500 metre drums, 6 different colours available, price £4 per 500 metres + 32p. Post £1 + 8p. Please give alternative colours when ordering.

**Mains Motor**—double ended with normal mounting feet, ideal for small fan heater, etc. Price 75p + 6p. Post 30p + 3p.

**Magnetic Clutch xerox** ref. nos. 121 5494 and PN 866–10. This is a two part device, the main section with the coil fits to the spindle of the machine and the break plate only has to be mounted close to the main section. Price £3·00 + 24p. Post 30p + 3p.

**Photo Multiplier Tube.** American RCA, their type no. 4555. These tubes have a gain of a million or more, regular price over £20 but we offer these brand new at £4·50 + 36p.

**Push Button Double Changeover Switch.** Honeywell type No. 14 DMG. Contact rated at 10 amps 250 volts, a tough spring return switch definitely strong enough to be used as a foot switch. Price 50p + 4p.

**Clockwork Time Switch** for delaying switch for up to 12 hours. Being clockwork this is independent of the mains and is therefore ideal for remote places, worked by batteries. Front dial, which is calibrated in hours, is turned through the required degrees together with preset time up to 12 hours. Double pole switch rated 15 amps 30 volts. Price £3·00 + 24p.

**Delay Switch** electrically operated—will give delay of up to 2 hours—contact suitable for 2 × 10 amp appliances. Price 75p + 6p.

**Open Type Relay** with 10 amp Changeover contacts. Mains operated coil, ex-equipment but perfect. Price 50p + 4p.

**Portable Radio Case.** size 11" × 8" × 3½", mounting studs for standard 5" speaker and panel to take the normal three controls. Price £1·50 + 19p. Post £1 + 12p.

**Tuning Dial,** fits normal slow motion type condenser suitable for above cabinet. Price 50p + 6p. Self adhesive scale L & M, price 25p + 3p.

**Disco Black Light Lamp.** We have just received a new delivery of these 175w ultra violet lamps but regret to say that the price has increased and the new price is now £6·75 + 86p. Post £1·00 + 12p.

For the benefit of of our readers not knowing this lamp we wish to point out that it is probably the most useful ultra violet lamp available especially for disco work as it does not require choke or starter. It can simply be plugged into the nearest lamp holder. It is a true black light and has proper "Woods" filter glass.

**Ferric Chloride Crystals** for etching copper, making printed circuit boards, etc. Special purchase enables us to offer this in 1lb bags at 50p + 4p + 20p + 2p.

**7 Digit Counter.** Another special purchase enables us to offer this mains operated counter for only about a quarter of its proper price. It works off 240v 50hz mains and requires no step down. There is only one point about this that is it counts in even numbers only, 2, 4, 6, 8, 10, etc. If you want to count single you must divide the final figure by 2. Price 50p + 4p. Post 10p + 1p.

**2kw Heater Assembly.** Spiral elements in metal frame, size 6½" × 2½" elements centre tapped so can be used for 1kw or 2kw. Unusual shape, looking at it sideways the frame looks rather like a ship's ventilator. Probably made for some well known fan heater. Price £1 + 8p. Post 30p + 3p.

**Stereogram Cabinet.** Long low modern teak veneered cabinet size approximately 4' 2" × 15' × 5' probable cost to make today over £20. We have a few of these, they are slightly second, at prices ranging from £5 each, depending on condition—sorry but these are for callers only.

**Digital Display Unit (Digivisor).** A precision made instrument which is basically a moving coil voltmeter. Instead of having a pointer, however, the scale is punched out with numerals, 0, 1, 2, 3, 4 and so on. When you apply a voltage for instance 8 volts—fig. 8 comes in front of a lamp and is focussed on to the screen. This device which must have cost a small fortune to develop and make can also be used for a variety of other purposes. Voltage regulation by making beam of light trigger a photocell, etc., etc. price £5 + 40p.

**Valves**—send for your requirements, most types in stock.

# THE METAC DIGITAL CLOCK

★ COMPLETE KIT ★


- Pleasant Green display . 12/24 Hour readout
- Silent Synchronous Accuracy . Fully electronic
- Pulsating colon . Push-button setting
- Building time 1 Hr. . Attractive acrylic case
- Easy to follow instructions . Size 10·5 x 5·7 x 8 cm
- Ready drilled PCB to accept components

**KIT PRICE £9·60**
+ 76p VAT P&P inc.

# THE METAC DIGITAL ALARM CLOCK

★ Fully Built, Tested and Guaranteed ★
**WITH SLEEP-OVER FEATURE**


- Bright Orange 12 Hour Display or
- Soft Green 24 Hour Display
- 24 Hour Alarm
- 10 Minute Repetition
- Alarm Set Indicator
- Accurate Silent Timekeeping
- British Designed and Built
- 5 in. across, 3½ ins. deep

**COMPLETE CLOCK £12·99**
+£1·04 VAT P&P inc.

Cash, Cheque or Postal Order or if you wish to use Barclaycard or Access, simply quote name, address and card number when ordering.

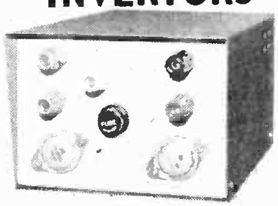
Buy it with Access

*Direct from :—*
**METAC ELECTRONICS AND TIME CENTRE**
**3 NEW ARCADE, HIGH STREET, UXBRIDGE, MIDDX.** Tel.: Uxbridge (0895) 56961
**67, HIGH STREET, DAVENTRY, NORTHANTS.** Tel.: Daventry (032 72) 76545

BARCLAYCARD

WHY NOT PAY US A VISIT AND SEE FOR YOURSELF THE FULL RANGE OF TOP QUALITY WATCHES, CLOCKS AND OTHER CONSUMER ELECTRONIC PRODUCTS.

# INVERTORS



240v–50Hz from your 12v car battery

| | |
|---|---|
| 25 watt–£4·75 | 300 watt (12v)–£33·08 |
| 40 watt–£8·27 | 400 watt (24v)–£39·05 |
| 75 watt–£12·03 | 500 watt (24v)–£48·18 |
| 150 watt–£21·27 | 1 Kw (50v)–£127·00 |
| 300 watt (24v)–£26·45 | 1·5 Kw (110v)–£140·80 |

All above invertors are in kit form but may be purchased built up in metal case and ready for use. Price list sent on receipt of s.a.e. Prices include p. and p.

**P.W. AUTOMATIC EMERGENCY SUPPLY**

240v–50Hz–150 watt inverter with built in battery charger. In event of power failure switches over automatically from battery charging to inverter operation. Cct. as appeared in Dec. 72 P.W. Complete kit of parts (excluding meter) **£24·50** plus £1·70p.p.

**DIGITAL WATCH**

FOUR FUNCTION DIGITAL WATCH FOR ONLY **£16** with 1 Year Guarantee HOURS . MINS. . SECONDS . DATE American Design, UK Manufacture.

**TRANSFORMERS AND COILS**

Both high volume and small order capacity available.
Special offer. Miniature mains transformer 6-0-6v-6vA. **85p** + 10p p. & p.

# P.E. ORION STEREO AMPLIFIER & TUNER


20 + 20 Watts r.m.s. into 8 ohm load. Distortion less than 0·01% 100Hz–10kHz. Frequency response ± 1dB 20 Hz to 20kHz. Hum level virtually nil with volume full on.

This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc, tape, tuner, etc.

Complete kit of parts including slim line bookend case, silk screened front panel and knobs **£48·60 inc. VAT and p. & p.**

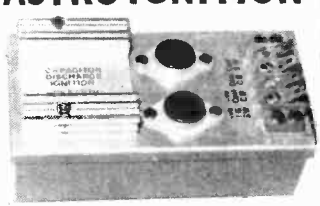
The bookend case, I.C's and semiconductors, P.C. board, Transformer, etc. may be purchased separately if desired. Send S.A.E. for further information.

**P.E. ORION TUNER UNIT**

PARTS MAY BE PURCHASED AS FULL KIT OR SEPARATE ITEMS. SEND S.A.E. FOR DETAILS.

**N.B.—DELIVERIES ON ALL ITEMS MAY TAKE UP TO 28 DAYS. DEPENDING ON AVAILABILITY AND DEMAND. CASH IN REGISTERED ENVELOPE OR POSTAL ORDERS CAN REDUCE TIME by NOT HAVING TO CLEAR CHEQUES**

# ASTRO IGNITION




**ASTRO IGNITION SYSTEM**

Complete kit of parts for this proven and tested system **£10·45 inc. VAT** Ready built with only two connections to alter **£13·75 inc. VAT.** Thousands have used this system both home and abroad. Consider these advantages—more power, faster acceleration, fuel economy, excellent cold starting, smoother running, no contact breaker burning. Also because of the high energy spark the fuel mixture can be made weaker giving further economy and fewer plug problems. Fitting time when built 5 minutes approx. Please state whether positive or negative earth.

TRADE and EXPORT ENQUIRIES WELCOMED ON ALL PRODUCTS

**ASTRO ELECTRONICS**
**Springbank Road, West Park**
**CHESTERFIELD. 31475**

# NEW & MAZDA VALVES

**All individually boxed. Full trade discounts to bona fide companies. Prices on application.**

**EXPRESS POSTAGE**
15p for 1 Valve. Each additional Valve add 2p in UK.

| | |
|---|---|
| DM70 | 0·69 |
| DY86/7 | 0·70 |
| DY802 | 0·53 |
| EB91 | 0·97 |
| EBC81 | 0·89 |
| EBF80 | 0·63 |
| EBF83 | 0·66 |
| EBF89 | 0·50 |
| EC86 | 0·82 |
| EC88 | 0·86 |
| EC90 | 0·94 |
| EC97 | 0·69 |
| ECC81 | 0·70 |
| ECC82 | 0·70 |
| ECC83 | 0·70 |
| ECC84 | 0·63 |
| ECC85 | 1·02 |
| ECC88 | 1·22 |
| ECC189 | 0·77 |
| ECF80 | 0·63 |
| ECF82 | 0·90 |
| ECF86 | 0·78 |
| ECH81 | 1·73 |
| ECH83 | 1·06 |
| ECH84 | 1·50 |
| ECL80 | 1·02 |
| ECL82 | 0·69 |
| ECL83 | 0·93 |
| ECL86 | 0·82 |

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|---|---|
| EF80 | 0·62 |
| EF83 | 1·10 |
| EF85 | 0·70 |
| EF86 | 1·73 |
| EF89 | 1·73 |
| EF91 | 1·35 |
| EF92 | 1·51 |
| EF95 | 1·63 |
| EF183 | 0·93 |
| EF184 | 0·93 |
| EH90 | 1·22 |
| EL34 | 1·40 |
| EL36 | 1·50 |
| EL84 | 0·70 |
| EL86 | 1·40 |
| EL95 | 1·02 |
| EM81 | 1·24 |
| EY51 | 0·89 |
| EY86 | 0·50 |
| EY86/87 | 0·70 |
| EY88 | 0·81 |
| EZ80 | 0·84 |
| EZ81 | 0·70 |
| GY501 | 1·73 |
| GZ34 | 1·22 |
| OC83 | 0·60 |
| PC86 | 1·40 |
| PC88 | 1·40 |
| PC97 | 0·70 |
| PC900 | 0·84 |

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|---|---|
| PCC84 | 0·84 |
| PCC85 | 1·02 |
| PCC88 | 0·98 |
| PCC89 | 0·97 |
| PCC189 | 1·22 |
| PCF80 | 0·34 |
| PCF82 | 1·37 |
| PCF86 | 0·97 |
| PCF200 | 1·50 |
| PCF201 | 1·50 |
| PCF801 | 0·97 |
| PCF802 | 1·02 |
| PCF806 | 0·97 |
| PCH200 | 1·73 |
| PCL82 | 0·84 |
| PCL83 | 0·97 |
| PCL84 | 0·93 |
| PCL85 | 0·72 |
| PCL86 | 0·97 |
| PCL805/850 | 0·97 |
| PD500 | 3·00 |
| PFL200 | 1·23 |
| PL36 | 1·40 |
| PL81 | 1·23 |
| PL81A | 1·40 |
| PL82 | 0·48 |
| PL83 | 1·73 |
| PL84 | 1·02 |
| PL500 | 1·40 |

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|---|---|
| PL504 | 1·40 |
| PL508 | 1·73 |
| PL509 | 2·33 |
| PL802 | 2·33 |
| PY33 | 0·73 |
| PY81/800 | 0·72 |
| PY82 | 0·70 |
| PY86/7 | 70p |
| PY88 | 0·84 |
| PY500A | 1·50 |
| PY800 | 0·72 |
| PY801 | 0·72 |
| U26 | 1·22 |
| U191 | 1·17 |
| U193 | 0·56 |
| UBC81 | 0·80 |
| UBF89 | 0·65 |
| UCC85 | 0·66 |
| UCH81 | 1·73 |
| UCL82 | 1·02 |
| UCL83 | 1·02 |
| UL84 | 1·23 |
| UY85 | 0·73 |
| 6/30L2/ ECC804 | 1·20 |
| 6F23/EF812 | 1·16 |
| 30C1/PCF80 | 0·84 |

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|---|---|
| 30C15/ PCF800 | 1·22 |
| 30C17 | 1·29 |
| 30C18/ PCF805 | 1·29 |
| 30F5/PF818 | 1·35 |
| 30FL1/ PCE800 | 0·98 |
| 30FL2 | 1·02 |
| 30FL12 | 1·44 |
| 30FL14 | 1·20 |
| 30L1/PCC84 | 0·63 |
| 30L15/ PCC805 | 1·35 |
| 30L17 | 1·12 |
| 30P4MR | 1·63 |
| 30P1Z/ PC801 | 1·22 |
| 30P19/ PC802 | 1·06 |
| 30PL1/ PCL801 | 1·35 |
| 30PL13/ PCL800 | 1·47 |
| 30PL14/ PCL88 | 1·72 |
| 30PL15 | 1·44 |

MULLARD PRICES AVAILABLE ON REQUEST

# NEW VALVES

**Individually boxed and guaranteed but of European or other origin at greatly reduced prices. Quotations for any valve not listed.**

| | |
|---|---|
| AZ1 | 1·00 |
| AZ31 | 1·00 |
| CBL31 | 1·40 |
| CL33 | 1·50 |
| CY31 | 1·00 |
| DAF91 | 0·40 |
| DAF96 | 0·60 |
| DCC90 | 1·85 |
| DF91 | 0·40 |
| DF96 | 0·60 |
| DK91 | 0·50 |
| DK92 | 1·00 |
| DK96 | 0·75 |
| DL92 | 0·50 |
| DL94 | 0·85 |
| DY96 | 0·55 |
| DY86 | 0·45 |
| DY87 | 0·45 |
| DY802 | 0·47 |
| EABC80 | 0·38 |
| EAF42 | 0·70 |
| EB91 | 0·30 |
| EBC33 | 1·00 |
| EBC41 | 0·75 |
| EBC81 | 0·40 |
| EBF80 | 0·40 |
| EBF83 | 0·40 |
| EBF89 | 0·32 |
| EBL31 | 2·00 |
| ECC81 | 0·45 |
| ECC82 | 0·38 |
| ECC83 | 0·38 |
| ECC84 | 0·35 |
| ECC85 | 0·45 |
| ECC88 | 0·50 |
| ECH35 | 1·50 |
| ECH42 | 0·85 |
| ECH81 | 0·35 |
| ECH83 | 1·65 |
| ECL80 | 0·60 |
| ECL82 | 0·42 |
| ECL83 | 1·65 |
| ECL86 | 0·55 |
| EF37A | 3·00 |
| EF39 | 1·78 |

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|---|---|
| EF80 | 0·35 |
| EF85 | 0·45 |
| EF86 USSR | 0·40 |
| EF86 Mullard | 2·04 |
| EF89 | 0·35 |
| EF91 | 0·65 |
| EF92 | 0·50 |
| EF95 USSR | 0·45 |
| EF95 UK | 1·65 |
| EF98 | 0·80 |
| EF183 | 0·40 |
| EF184 | 0·40 |
| EL32 | 0·60 |
| EL33 | 3·40 |
| EL34 | 0·70 |
| EL36 | 0·60 |
| EL37 | 3·40 |
| EL41 | 1·20 |
| EL42 | 1·65 |
| EL84 | 0·35 |
| EL95 | 0·60 |
| EM80 | 0·55 |
| EM81 | 0·60 |
| EM84 | 0·40 |
| EM85 | 1·00 |
| EM87 | 1·00 |
| EY51 | 0·45 |
| EY86 | 0·50 |
| EZ40 | 0·60 |
| EZ41 | 0·75 |
| EZ80 | 0·30 |
| EZ81 | 0·81 |
| GY501 | 1·32 |
| GZ30 | 0·65 |
| GZ32 | 0·65 |
| GZ34 | 0·75 |
| HN309 | 1·50 |
| KT61 | 3·40 |
| KT66 | 4·00 |
| KT81 (7C5) | 2·00 |
| KT88 | 4·75 |

| | |
|---|---|
| KTW61 | 1·50 |
| MU14 | 1·00 |
| N78 | 7·50 |
| OA2 | 0·45 |
| OB2 | 0·45 |
| PC86 | 0·65 |
| PC88 | 0·65 |
| PC97 | 0·55 |
| PC900 | 0·55 |
| PCC84 | 0·45 |
| PCC88 | 0·62 |
| PCC89 | 0·55 |
| PCC189 | 0·65 |
| PCF80 | 0·40 |
| PCF82 | 0·42 |
| PCF86 | 0·65 |
| PCF801 | 0·60 |
| PCF802 | 0·72 |
| PCF805 | 1·28 |
| PCF806 | 0·80 |
| PCF808 | 1·28 |
| PCL82 | 0·45 |
| PCL83 | 0·70 |
| PCL84 | 0·50 |
| PCL85 | 0·60 |
| PCL86 | 0·50 |
| PCL805/85 | 0·60 |
| PD500 | 3·00 |
| PEN45 | 0·85 |
| PL36 | 0·63 |
| PL81 | 0·55 |
| PL82 | 0·50 |
| PL83 | 0·50 |
| PL84 | 0·50 |
| PL504 | 0·96 |
| PL508 | 1·32 |
| PL509 | 2·16 |
| PL802 | 1·80 |
| PY33 | 0·63 |
| PY81 | 0·50 |
| PY82 | 0·45 |
| PY83 | 0·50 |
| PY88 | 0·68 |
| PY500A | 1·36 |

| | |
|---|---|
| PY81/800 | 0·50 |
| PY801 | 0·55 |
| U14 | 0·75 |
| U25 | 1·00 |
| U26 | 0·85 |
| U191 | 0·75 |
| UABC80 | 0·40 |
| UAF42 | 0·75 |
| UBC41 | 0·60 |
| UBC81 | 0·50 |
| UBF80 | 0·50 |
| UBF89 | 0·50 |
| UCC85 | 0·50 |
| UCH42 | 0·80 |
| UCH81 | 0·50 |
| UCL82 | 0·40 |
| UCL83 | 1·25 |
| UL41 | 0·75 |
| UF89 | 0·50 |
| UL41 | 0·85 |
| UL84 | 0·50 |
| UY41 | 0·55 |
| UY85 | 0·45 |
| VR105/30 | 0·40 |
| VR150/30 | 0·45 |
| 1R5 | 0·50 |
| 1S5 | 0·40 |
| 1T4 | 0·40 |
| 3S4 | 0·50 |
| 3V4 | 0·85 |
| 5R4GY | 1·20 |
| 5U4G | 1·25 |
| 5U4GB | 0·70 |
| 5Y3GT | 0·65 |
| 5Z4G | 0·95 |
| 6/3OL2 | 0·90 |
| 6AK5 USSR | 0·45 |
| 6AK5 UK | 1·65 |
| 6AM5 | 2·00 |
| 6AQ5 | 0·50 |
| 6AS7G USSR | 1·00 |
| 6AS7G RCA | 4·50 |
| 6AT6 | 0·60 |
| 6AU6 | 0·40 |
| 6BA6 | 0·88 |
| 6BE6 | 0·45 |
| 6BH6 | 1·20 |
| 6BJ6 | 0·80 |
| 6BQ7A | 0·55 |
| 6BR7 | 3·00 |
| 6BS7 | 4·00 |
| 6BW6 | 3·00 |
| 6BW7 | 1·12 |
| 6C4 | 0·40 |
| 6CD6GA | 2·50 |
| 6CH6 | 3·85 |
| 6CW4 | 4·00 |
| 6F23 | 0·90 |
| 6F25 | 1·00 |
| 6F28 | 0·96 |

| | |
|---|---|
| 6J5M | 0·65 |
| 6J5G | 0·45 |
| 6J6 | 0·35 |
| 6J7G | 0·80 |
| 6J7M | 0·65 |
| 6K6GT | 0·80 |
| 6K7G | 0·85 |
| 6K7M | 0·45 |
| 6K8G | 0·45 |
| 6K8M | 0·70 |
| 6L6G | 2·50 |
| 6L6GC | 1·20 |
| 6Q7G | 0·40 |
| 6Q7M | 0·60 |
| 6SL7GT | 0·55 |
| 6SN7GT | 0·55 |
| 6SQ7GY | 0·40 |
| 6U5G | 1·50 |
| 6V6G | 0·80 |
| 6V6GT | 0·60 |
| 6X4 | 0·45 |
| 6X5G | 0·45 |
| 6X5GT | 0·55 |
| 7B6 | 0·80 |
| 7B7 | 0·80 |
| 7C5 | 2·00 |
| 7C6 | 1·00 |
| 7H7 | 0·80 |
| 7R7 | 1·30 |
| 7S7 | 2·25 |
| 7Y4 | 0·80 |
| 12AT6 | 0·45 |
| 12AT7 | 0·45 |
| 12AU6 | 0·50 |
| 12AU7 | 0·38 |
| 12AX7 | 0·38 |
| 12BA6 | 0·50 |
| 12BE6 | 0·60 |
| 30C1 | 0·40 |
| 30C15 | 1·00 |
| 30C17 | 1·00 |
| 30C18 | 1·28 |
| 30F5 | 1·00 |
| 30FL1 | 1·00 |
| 30FL2 | 1·00 |
| 30FL14 | 1·28 |
| 30L15 | 0·95 |
| 30L17 | 0·95 |
| 30P4MR | 1·30 |
| 30P12 | 1·00 |
| 30P19 | 0·95 |
| 30PL1 | 0·95 |
| 30PL13 | 1·44 |
| 30PL14 | 1·68 |
| 35W4 | 0·60 |
| 35Z4GT | 0·70 |
| 50CD6G | 2·50 |
| 807 | 1·00 |
| 813ITT | 17·50 |
| 813 USA | 27·50 |
| 813USSR | 6·00 |
| 866A | |

# TRANSISTORS-INTEGRATED CIRCUITS

**EXPRESS POSTAGE**
15p per order in UK.

**All transistors, I.C's offered are new and branded. Manufactured by Mullard, Texas, RCA, Ferranti, Motorola, ITT, Fairchild, Lucas, etc. Quantity discounts on application.**

| | |
|---|---|
| AA119 | 0·07 |
| AAZ13 | 0·18 |
| AAZ15 | 0·12 |
| AC107 | 0·75 |
| AC126 | 0·25 |
| AC127 | 0·25 |
| AC128 | 0·22 |
| AC176 | 0·27 |
| AC187 | 0·25 |
| AC188 | 0·25 |
| ACY21 | 0·55 |
| ACY39 | 1·00 |
| AD140 | 0·65 |
| AD149 | 0·65 |
| AD161 | 0·45 |
| AD162 | 0·45 |
| AF115 | 0·25 |
| AF116 | 0·25 |
| AF117 | 0·25 |
| AF186 | 1·60 |
| AF239 | 0·45 |
| ASY27 | 0·45 |
| ASY28 | 0·25 |
| BA102 | 0·25 |
| BA115 | 0·15 |
| BC107 | 0·14 |
| BC108 | 0·14 |
| BC109 | 0·15 |
| BC113 | 0·15 |
| BC117 | 0·22 |
| BC143 | 0·30 |
| BC147 | 0·10 |
| BC148 | 0·08 |
| BC169C | 0·15 |
| BC182 | 0·12 |
| BC182L | 0·12 |
| BC184L | 0·13 |
| BC338 | 0·15 |
| BCY32 | 1·00 |
| BCY33 | 0·70 |
| BCY34 | 0·75 |
| BCY70 | 0·13 |
| BCY71 | 0·22 |
| BCY72 | 0·17 |
| BCZ11 | 1·25 |
| BD121 | 1·55 |
| BD124 | 0·75 |

| | |
|---|---|
| BD131 | 0·40 |
| BD132 | 0·45 |
| BF115 | 0·20 |
| BF167 | 0·20 |
| BF173 | 0·25 |
| BF179 | 0·30 |
| BF180 | 0·30 |
| BF181 | 0·30 |
| BF194 | 0·10 |
| BF195 | 0·10 |
| BF197 | 0·12 |
| BF200 | 0·32 |
| BFS61 | 0·25 |
| BFS98 | 0·25 |
| BFW10 | 0·61 |
| BFX29 | 0·28 |
| BFX88 | 0·25 |
| BFY50 | 0·21 |
| BFY51 | 0·21 |
| BFY52 | 0·23 |
| BR100 | 0·40 |
| BY100 | 0·45 |
| BY126 | 0·12 |
| BY127 | 0·12 |
| BFX61 series | 0·20 |
| BZY88 series | 0·12 |
| CRS1-05 | 0·45 |
| CRS1-40 | 0·60 |
| CRS3-05 | 0·45 |
| CRS3-40 | 0·75 |
| MJE340 | 0·42 |
| MJE370 | 0·65 |
| MJE520 | 0·60 |
| MJE2955 | 1·25 |
| MJE3055 | 0·75 |
| MPF102 | 0·40 |
| MPF103 | 0·40 |
| MPF104 | 0·40 |
| MPF105 | 0·40 |
| NKT404 | 1·25 |
| OA5 | 0·75 |
| OA10 | 0·55 |
| OA79 | 0·12 |
| OA81 | 0·15 |
| OA91 | 0·07 |

| | |
|---|---|
| OA200 | 0·10 |
| OA202 | 0·10 |
| OC16 | 1·25 |
| OC20 | 2·00 |
| OC23 | 2·25 |
| OC25 | 0·65 |
| OC28 | 0·75 |
| OC35 | 0·75 |
| OC36 | 0·75 |
| OC42 | 0·50 |
| OC44 | 0·45 |
| OC45 | 0·45 |
| OC71 | 0·25 |
| OC72 | 0·45 |
| OC76 | 0·45 |
| OC77 | 0·75 |
| OC81 | 0·50 |
| OC81D | 0·28 |
| OC81Z | 1·00 |
| OC83 | 0·55 |
| OC140 | 1·50 |
| OC170 | 0·50 |
| OC171 | 0·50 |
| OC200 | 1·00 |
| OC201 | 1·75 |
| OC202 | 1·50 |
| OC203 | 1·50 |
| OCP71 | 1·25 |
| ORP12 | 0·60 |
| ORP60 | 0·65 |
| TIC44 | 0·30 |
| TIC226D | 1·40 |
| TIL209 | 0·22 |
| TIP42A | 0·70 |
| ZTX107 | 0·10 |
| ZTX108 | 0·10 |
| ZTX300 | 0·12 |
| ZTX301 | 0·13 |
| ZTX302 | 0·17 |
| ZTX304 | 0·22 |
| ZTX500 | 0·12 |

| | |
|---|---|
| ZTX501 | 0·13 |
| ZTX503 | 0·16 |
| ZTX531 | 0·25 |
| ZTX550 | 0·18 |
| IN914 | 0·06 |
| IN4001 | 0·07 |
| 1N4002 | 0·07 |
| 1N4003 | 0·08 |
| 1N4004 | 0·08 |
| 1N4005 | 0·09 |
| 1N4006 | 0·10 |
| 1N4007 | 0·11 |
| 1N4009 | 0·08 |
| 1N4148 | 0·08 |
| IS921 | 0·08 |
| IS2033 | 0·20 |
| IS2051A | 0·20 |
| IS2100A | 0·20 |
| IS3010 | 0·25 |
| 2N696 | 0·20 |
| 2N697 | 0·17 |
| 2N706 | 0·12 |
| 2N706A | 0·12 |
| 2N1131 | 0·23 |
| 2N1132 | 0·25 |
| 2N1302 | 0·30 |
| 2N1303 | 0·40 |
| 2N1304 | 0·45 |
| 2N1305 | 0·45 |
| 2N1306 | 0·50 |
| 2N1307 | 0·50 |
| 2N1308 | 0·50 |
| 2N1309 | 0·50 |
| 2N1613 | 0·21 |
| 2N2147 | 1·20 |
| 2N2369A | 0·25 |
| 2N2646 | 0·50 |
| 2N2904 | 0·25 |
| 2N2904A | 0·25 |
| 2N2905 | 0·30 |

| | |
|---|---|
| 2N2005A | 0·25 |
| 2N2906 | 0·22 |
| 2N2926 | 0·18 |
| 2N3053 | 0·20 |
| 2N3055 | 0·60 |
| 2N3525 | 0·90 |
| 2N3614 | 1·00 |
| 2N3615 | 1·50 |
| 2N3702 | 0·13 |
| 2N3703 | 0·13 |
| 2N3704 | 0·15 |
| 2N3705 | 0·13 |
| 2N3706 | 0·13 |
| 2N3707 | 0·13 |
| 2N3708 | 0·09 |
| 2N3709 | 0·12 |
| 2N3710 | 0·13 |
| 2N3711 | 0·13 |
| 2N3819 | 0·37 |
| 2N3820 | 0·55 |
| 2N3823 | 0·60 |
| 2N3903 | 0·15 |
| 2N3904 | 0·15 |
| 2N3905 | 0·17 |
| 2N3906 | 0·17 |
| 2N4058 | 0·16 |
| 2N4059 | 0·12 |
| 2N4060 | 0·13 |
| 2N4061 | 0·13 |
| 2N4062 | 0·14 |
| 2N4289 | 0·30 |
| 3N125 | 1·75 |
| 3N141 | 0·80 |
| 40360 | 0·40 |
| 40361 | 0·45 |
| 40362 | 0·40 |
| 40430 | 0·85 |

| | |
|---|---|
| SN7400 | 0·16 |
| SN7401 | 0·16 |
| SN7402 | 0·16 |
| SN7403 | 0·16 |
| SN7404 | 0·26 |
| SN7405 | 0·22 |
| SN7406 | 0·42 |
| SN7407 | 0·42 |
| SN7408 | 0·28 |
| SN7409 | 0·28 |
| SN7410 | 0·16 |
| SN7411 | 0·25 |
| SN7412 | 0·30 |
| SN7413 | 0·36 |
| SN7416 | 0·36 |
| SN7417 | 0·38 |
| SN7420 | 0·16 |
| SN7422 | 0·25 |
| SN7423 | 0·37 |

| | |
|---|---|
| SN7428 | 0·40 |
| SN7430 | 0·16 |
| SN7433 | 0·37 |
| SN7437 | 0·37 |
| SN7438 | 0·37 |
| SN7440 | 0·22 |
| SN7441AN | 0·92 |
| SN7442 | 0·79 |
| SN7450 | 0·16 |
| SN7451 | 0·16 |
| SN7453 | 0·16 |
| SN7454 | 0·16 |
| SN7460 | 0·16 |
| SN7470 | 0·36 |
| SN7473 | 0·41 |
| SN7474 | 0·42 |
| SN7480 | 0·60 |
| SN7483 | 1·10 |

| | |
|---|---|
| SN7486 | 0·47 |
| SN7490 | 0·55 |
| SN7491AN | 1·00 |
| SN7492 | 0·70 |
| SN7493 | 0·70 |
| SN7494 | 0·80 |
| SN7495 | 0·80 |
| SN7496 | 0·95 |
| SN7497 | 3·87 |
| SN74100 | 1·89 |
| SN74107 | 0·45 |
| SN74110 | 0·58 |
| SN74118 | 0·90 |
| SN74119 | 1·68 |
| SN74121 | 0·50 |
| SN74122 | 0·70 |
| SN74123 | 1·00 |
| SN74141 | 0·90 |

| | |
|---|---|
| SN74145 | 1·26 |
| SN74150 | 1·75 |
| SN74151 | 1·00 |
| SN74154 | 2·00 |
| SN74155 | 1·00 |
| SN74156 | 1·00 |
| SN74157 | 0·95 |
| SN74170 | 2·52 |
| SN74174 | 1·57 |
| SN74175 | 1·10 |
| SN74176 | 1·26 |
| SN74190 | 2·00 |
| SN74191 | 2·00 |

| | |
|---|---|
| SN74192 | 2·00 |
| SN74193 | 2·00 |
| SN74194 | 1·30 |
| SN74195 | 1·10 |
| SN74196 | 1·20 |
| SN74197 | 1·20 |
| XN74198 | 2·77 |
| SN74199 | 2·52 |

| | | |
|---|---|---|
| **DIL** | 8 pin | **15p** |
| **DIL** | 14 pin | **15p** |
| **SOCKETS** | 16 pin | **17p** |

# VAT

**To be added to all orders**

**Valves & Plastic Transistors 12½%**

**Integrated Circuits & Metal Can Transistors 8%**

# THIS MONTH'S

- OSCILLOSCOPE TUBES
  Types CV 1526, VCR 139A
  All at £8·00 each, + p & p 50p
  Add 8% VAT

# SPECIAL OFFER

**TERMS OF BUSINESS:** C.W.O. A/c's available to approved companies on application. Telephone and telex orders accepted. Export and trade enquiries welcome. Open daily to callers 9 a.m.–5 p.m. Monday to Friday. Prices correct when going to press. Prices on application for any types not listed. Obsolete valves a speciality.

# RST VALVE MAIL ORDER CO.

**Climax House, Fallsbrook Rd., Streatham SW16 6ED**

**TELEPHONE 01-677 2424**

# CRESCENT RADIO LTD.

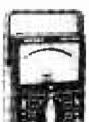
**164-166 HIGH ROAD, LONDON N22 6EJ 888-3206**
**(also) 13 SOUTH MALL, EDMONTON, N.9 803-1685**

**MAIL ORDER DEPT.**
**1 ST. MICHAELS TERRACE, WOOD GREEN, LONDON N22 4SJ Phone 888 4474**

**ALUMINIUM BOXES +8%**
Metal project boxes give your work a professional finish

| | L | W | H | |
|---|---|---|---|---|
| AB7 | 2½ | 5¼ | 1½ | 54p |
| AB8 | 4 | 4 | 1½ | 63p |
| AB9 | 4 | 2½ | 1½ | 54p |
| AB10 | 4 | 5¼ | 1½ | 63p |
| AB11 | 4 | 2½ | 2 | 54p |
| AB12 | 3 | 2 | 1 | 45p |
| AB13 | 6 | 4 | 2 | 69p |
| AB14 | 7 | 5 | 2½ | 84p |
| AB15 | 8 | 6 | 3 | £1·02 |
| AB16 | 10 | 7 | 3 | £1·35 |
| AB17 | 10 | 4½ | 3 | £1·02 |
| AB18 | 12 | 5 | 3 | £1·20 |
| AB19 | 12 | 8 | 3 | £1·50 |

**MULTI-METER MM12**
50,000 o.p.v.



If you need a good instrument for your work/hobby and you're not prepared to settle for a small scale and poor ranges, then read the specifications for the MM12, and send for one! AC volts: 0 to 1·5, to 0/500 in 10 ranges. DC volts: 0 to 0·5, to 0/500 in 12 ranges. DC current: 0 to 25 μA, to 0/10 amps 10 ranges. Resistance: 0 to 100 ohms, to 0/16 meg ohms in 4 ranges. Decibels: −20 to +62 db in 10 ranges. Size: 6½ × 4½ × 2¼inch.
Price £19·50 + 8% VAT.

**"C100" 100 WATT AMPLIFIER**
All built and tested, mounted on a plain aluminium chassis which measures 18" × 9½" × 4" and which you can mount into a cabinet of your choice. Four controlled inputs, master volume, treble, middle and bass controls. S/c protected output. 100 watts clean into 8ohm L/S. Ideal for disco, music groups, PA. and clubs. A bargain at £48 + £1 carr. + 8% VAT.

**P.C. ETCHING KIT**
This kit contains all that the constructor will need to etch the circuits of his own design.
Contents—Plastic etching dish. Sample copper clad board. Laminate Cutter. 1 lb Ferric Chloride. Large Plastic Spoon. Etch Resist Pen. Full Etching Instructions.
Complete and Big Kit Value at £4·25 + 8% VAT.

**BARGAIN PROJECT BOX**
A plastic box with moulded extrusion rails for PC or Chassis panels with metal front plate fitted with four screws (all supplied). SIZE (internal) 81mm × 51mm × 28mm.
OUR PRICE 50p. +8%

**POWER SUPPLY UNITS**
+8%

PP1 switched 3, 4½, 6, 7½, 9 and 12 volts at 500 m/a, with on/off switch and pilot light. Size: 130mm × 55mm × 75mm.
ONLY £5·50

**TI MULTI-METER**

Ideal tester for everybody interested in electronics. Weighing less than 100 grammes and only 60 × 24 × 90 mm Ranges: A.c. volts: 0-10V, 50V, 250V, 1,000V, D.c. volts: 0-10V, 50V, 250V, 1,000V. D.c. current: 0-1mA, 0-100mA. Resistance: 0-150 kohm.
Price £5·50 + 8% VAT.

**FERRIC CHLORIDE**
Anhydrous ferric chloride in double sealed one pound poly packs. Our Price 65p + P/P + VAT @ 8% per lb.

**M3 CONDENSER MICROPHONE**
Cardioid and omni-directional 600 ohm and 50K ohm impedance. 20-18,000 Hz. On/off switch and wind shield. Complete with stand adaptor. Packed in presentation box.
Price £14·50 + 12½% VAT.

**3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT**

Three Channel Bass, Middle, Treble, Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed.)
**£18·50** plus 75p P. & P. +8%

**BARGAIN TRANSFORMERS**
**12-0-12 volt 500m/a**
240 volt primary transformer bargain.

| | |
|---|---|
| approx size | 60mm x 40mm x 50mm |
| fixing centres | 75mm |
| **Our Price** | **£1·20 + 8%** |

**HEAVY DUTY 12 VOLT POWER SUPPLY**
1·5 amp at 12 volt power supply approx. size 6" × 4" × 3½". Ideal for using your car entertainment in the home from domestic mains. Suitable for 8 track cartridge or 4 track cassette machines. Price £7·50 + VAT 8%.

**2 WAY AND 3 WAY CROSSOVERS +12½%**
NT206 2-way network for 8 ohm speakers up to 30 watts. Price £2·00.

NT206H 2-way, as above, 100 watts. Price £2·25.
NT306
3-way network for 8 ohm speakers up to 30 watts. Price £3 25.
NT306H
3-way, as above, 100 watts. Price £4·00.

**TIE-CLIP CONDENSER MICROPHONE**

Omni-Directional 600 ohm 40–15,000Hz. Extra long lead. Ideal for stage work, conferences, etc. Price £9·50 + 12½% VAT.

**LOW NOISE LOW PRICE CASSETTES +8%**
Good quality tape in well made screw type cassettes. Presented in single plastic cases.
C60 = 38p C90 = 48p C120 = 60p
10% Discount on ten or more cassettes of one type

**EFFECTS PROJECTOR "150"**
No Disco should be without our new effects projector, we believe that this is the most versatile machine for projecting coloured images to supplement your music. Spec:—Volts = 220/240 AC 50Hz. Lamp = A1/167 150 watts. Standard Lens = 60 m/m.

A sturdy metal construction and takes a range of lenses and accessories. Comes complete with 6" liquid wheel and ready to use. A bargain at £27 + VAT 8%.

**LOUDSPEAKERS +12½%**

| | | |
|---|---|---|
| 2½" 8 ohm | | 90p |
| 2½" 40 ohm | | 90p |
| 2½" 80 ohm | | 90p |
| 5" 8 ohm | ceramic | £1·50 |

**ABS PLASTIC BOXES**
Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels. Fitted with 1mm front panels.

| | |
|---|---|
| 1005—105mm × 73mm × 45mm | 60p |
| 1006—150mm × 74mm × 47mm | 80p |
| 1007—185mm × 124mm × 60mm | £1·80 |
| 1021—106mm × 74mm × 45mm (sloping front) | 57p |

Plus 8% VAT

**U.K. CARRIAGE 30p UNLESS OTHERWISE STATED**
**ACCESS AND BARCLAYCARD ACCEPTED**
**VAT—All prices are excluding VAT. Please add to each item the VAT rate indicated.**

# FANE SPECIALIST RANGE SPEAKERS

DISCO "80"

Each designed to produce the individual sound requirement for its purpose. Robust Cast Aluminium Chassis

| | | Rec. Price |
|---|---|---|
| **12" DISCO/80** | Linen Cone Surround | **£27·95** |
| **12" GUITAR/80L** | For Lead Guitar | **£25·75** |
| **12" GUITAR/80B** | Prs. rec. for Bass Guitar. | **£26·95** |
| **12" PA/80** | For general purpose P.A. | **£25·95** |
| **15" BASS/85 85w** | For Bass Guitar | **£39·95** |
| **15" BASS/100** | | **£42·00** |

## FANE 'POP' RANGE SPEAKERS

| | | | | |
|---|---|---|---|---|
| 12" | POP | 33T | 33w | £14·95 |
| 12" | POP | 50/2 | 50w | £16·99 |
| 12" | POP | 55 | 60w | £22·95 |
| 15" | POP | 60 | 60w | £25·95 |
| 15" | POP | 70 | 70w | £29·95 |
| 18" | POP | 100 | 100w | £46·95 |

## HIGH FREQUENCY HORNS

**J44**
Range: 2·5KHz-15KHz
Power: 50w with HPX2
Power: 30w with HPX1
Imp: 8 ohms
Size approx 3½" × 3½" × 3"
**£7.95**

**J104**
Range: 2KHz-15KHz
Power: 50w with HPX1
Power: 70w with HPX2
Imp: 8 ohms
Size approx 10½" × 3½" × 7¾"
**£16.95**

HIGH POWER 'CROSS-OVERS'
HPX1 (3·5KHz)
HPX2 (5KHz)
**£2.75**

**910/2**
Range: 2KHz-15KHz
Power: 50w with HPX1
Imp: 8-16 ohms
Size approx 6½" × 3½" × 6½"
**£17.75** Rec. Price

**920/2**
Range: 1KHz-18KHz
Power: 100w with HPX1
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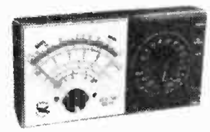

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| 2N2905 | 37p | 2N3772 | 2·00 | 2N6027 | 53p | AF239 | 74p | BC182 | 11p |
| 2N2905A | 28p | 2N3773 | 2·90 | 2N6101 | 65p | AF240 | 98p | BC182L | 14p |
| 2N2906 | 28p | 2N3789 | 2·90 | 2N6107 | 42p | AF279 | 80p | BC183 | 11p |
| 2N2806A | 25p | 2N3790 | 3·10 | 2N6109 | 42p | AF280 | 85p | BC183L | 14p |

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**Prices correct at 28th. Feb., 1977, but all exclusive of VAT. P. & P. 30p**

# SMALL ADS

The prepaid rate for classified advertisements is 17 pence per word (minimum 12 words), box number 40p extra. Semi-display setting £14.00 per single column inch (2.5cm). All cheques, postal orders etc., to be made payable to Practical Wireless and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Practical Wireless, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846).

### CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

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2. The publishers reserve the right to refuse or withdraw any advertisement.
3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

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When replying to Classified Advertisements please ensure:

(A) That you have clearly stated your requirements.

(B) That you have enclosed the right remittance.

(C) That your name and address is written in block capitals, and

(D) That your letter is correctly addressed to the advertiser.

This will assist advertisers in processing and despatching orders with the minimum of delay.

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These KITS replace conventional light switches and control 300W of lighting. No mains rewiring required. Insulated Touchplates. All with easy to follow instructions.
NEW! TSD300K—TOUCHSWITCH and DIMMER combined. ONE touchplate to switch light on or off. Brightness controlled by small knob. ONLY £5·95.
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LD300K—LIGHTDIMMER KIT—£2·45.

CMOS (Motorola)

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|---|---|---|---|---|---|
| 4000 | 16p | 4013 | 51p | 4040 | 97p |
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| 4007 | 16p | 4017 | 91p | 4501 | 20p |
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Diac 21p

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2N6027 (PUT) 34p
2N3055 36p

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**T. K. ELECTRONICS (PW)**
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**WIRE** Recorder Webster 1947 Working with wires. OFFERS Bristol 0272-550876 Office Hours.

**NUMBER** of magnificent informative SONY radio-cassette-corder, t/recorder service manuals for sale. 01 422 5185.

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We can supply manuals for most makes of Colour Television Recievers by return of post.
B.R.C. PYE ECKO PHILIPS ITT/KB SONY G.E.C. HITACHI BAIRD ULTRA INVICTA FERGUSON H.M.V. MARCONI AND MANY MORE
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**Otherwise cannot be attended to**
(Uncrossed P.O.s please, original returned if service sheets not available.)

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We operate a "by return of post" service. Any claims for non-delivery should be made within 7-days of posting your order.

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Large Stocks of Colour Manuals
NO OVERSEAS MAIL PLEASE

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| | |
|---|---|
| World Radio TV Handbook 1977 | £5–75 |
| The Cathode Ray Oscilloscope and its Uses | £3–90 |
| 1st & 2nd Books of Transis Equiv & Substitutes (Set) | £1–55 |
| Radio Receiver Constr'n using ICs & Transistors | £0–70 |
| Radio Antenna H'book for Long Dist. Receptn | £0–95 |
| 79 Electronic Novelty Circuits | £0–85 |
| Audio Enthusiasts Handbook | £0–95 |
| The Complete Car Radio Manual | £0–85 |
| Solid State Power Supply Handbook | £0–95 |
| ICs & Transistor Gadgets Construction Handbook | £0–70 |
| Integrated Circuits Equiv & Substitutes Handbook | £0–95 |
| Manual of Electronic Circuits for the Home | £0–60 |
| Electronic Gadgets & Games | £0–95 |

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This unique instruction manual shows step by step how to rewind motors, working part or full time, without previous experience. Everything you need to know easily explained, including where to obtain materials, how to get all the work you need, etc. A goldmine of information and knowledge.
Only £3·90 plus 26p P&P.
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Overseas Distributors wanted.

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**LADDERS.** Varnished. 20ft 9in extd. £25·33. Carr. £1·90. Leaflet. Also alloy ext. up to 62½ft. The Ladder Centre (WLS) Halesfield (1) Telford, Salop. Tel: 586644. Callers welcome.

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TXers and S.W.L's.—Have a proper aerial system, anti-TVI, individually designed, purpose built for your particular interests, QTH and Equipment by an ex-BBC Transmitter and Aerial Engineer.
*Details large S.A.E. and 3 8½p stamps.*
**LAMBDA ANTENNA STUD FARM WHITEBALL, WELLINGTON, SOMERSET**

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4T Inserts, ideal for all sound speaking and listening applications.
Very rugged—d.c. resistance 20 ohms.
Size: 1¼" dia. ⅝" deep.
40p ea. + 10p P & P.
6 for £2·20 + 20p P & P.
12 for £4·50 P & P free.
*S.A.E. for list of many other items.*
*Trade enquiries welcome.*
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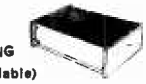
**LOW-COST I.C. MOUNTING** for any size DIL package. 100 Soldercon sockets 65p. 7 and 8 hole plastic supports 5p/pair. Quantity rates. SAE details and sample. Trial pack 65p. (P & P 10p/order). P.K.G. Electronics, Oak Lodge, Tansley, Derbyshire DE4 5FE.

**H. M. ELECTRONICS**
275a FULWOOD ROAD, BROOMHILL, SHEFFIELD S10, 3BD.
SEC CABINETS (illus'd)



METAL CASES
DRY TRANSFER LETTERING
Send 15p for leaflets (Refundable)
*Trade enquiries invited*

## NOTICE TO READERS

*Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine.*

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Head Office and Warehouse
44A WESTBOURNE GROVE
LONDON W2 5SF
Tel: 727 5641/2/3

# Z & I AERO SERVICES LTD.

Please send all correspondence and Mail-Orders to Head Office

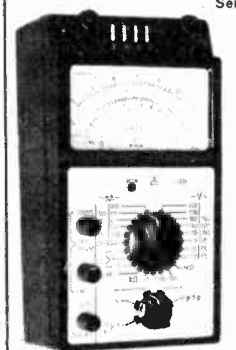
Retail Shop
85 TOTTENHAM COURT ROAD
LONDON W1
Tel: 580 8403
Open all day Saturday

## AC/DC TAUT SUSPENSION MULTIMETERS (Made in USSR)

| TYPE | U4312 | U4313 | U4315 |
|---|---|---|---|
| Sensitivity D.C. | 667 o.p.v. | 20,000 o.p.v. | 20,000 o.p.v. |
| Sensitivity A.C. | 667 o.p.v. | 2,000 o.p.v. | 2,000 o.p.v. |
| D.C. Current | 300 μA-6A | 60μA-1·5A | 50μA-2·5A |
| A.C. Current | 1·5mA-6A | 0·6mA-1·5A | 0·5mA-2·5A |
| D.C. Volts | 75mV-900V | 75mV-600V | 75mV-1000V |
| A.C. Volts | 300mV-900V | 15V-600V | 1V-1000V |
| Resistance | 0·02-3kΩ | 1K-1M | 300Ω-500kΩ |
| Capacity | — | 0·5μF | 0·5μF |
| Accuracy | 1% D.C., 1·5% A.C. | 1·5% D.C., 2·5% A.C. | 2·5% D.C., 4% A.C. |
| Price complete with pressed steel carrying case and test leads. | £14·50 | £17·50 | £14·95 |

TYPES U4313 AND U4313 ARE PROVIDED WITH ANTI-PARALLAX MIRROR SCALES

### TYPE U4341



Sensitivity:
16700Ω/V D.C.,
330Ω/V A.C.
Ranges:
D.C. current: 0·06–0·6–6–60–600mA
A.C. current 0·3–3–30–300mA
D.C. Voltage: 0·3–1·5–6–30–60–150–300–900V
A.C. Voltage: 1·5–7·5–30–150–300–750V
Resistance: 2-20-200kΩ-2MΩ
Transistor collector cut-off current 60μA
Transistor D.C. current gain in two ranges 10–350
Accuracy: 2·5% D.C.
4·0% A.C.
5% D.C. current gain
Power supplies: 4·5V battery
(Eveready 1289)

Complete with steel carrying case, test lead, battery and instruction manual **£14·50**

### TYPE U4324

D.C. Current: 0·06-0·6-60-600mA-3A
A.C. Current 0·3-3-30-300mA-3A
D.C. Voltage: 0·6-1·2-3-12-30-60-120-600-1200V
A.C. Voltage: 3-6-15-60-150-300-600-900V
Resistance: 500Ω-5-50-500kΩ
Accuracy: D.C. 2·5%; A.C. 4% (of F.S.D.)

**PRICE** complete with test leads and fibreboard storage case **£14·50**

**NO OVERLOAD PROTECTION IS INCORPORATED IN THESE INSTRUMENTS**

THE ABOVE PRICES ARE EXCLUSIVE OF VAT (at present 8%) HANDLING AND POSTAGE CHARGES £1·25 PER INSTRUMENT

OUR NEW 1976/1977 **CATALOGUE** IS NOW READY AND WILL BE SENT ON RECEIPT OF REMITTANCE FOR £0·30

# TRANSFORMERS

ALL EX-STOCK—SAME DAY DESPATCH

### AUTO TRANSFORMERS

| Ref | VA (Watts) | Auto Taps | £ |
|---|---|---|---|
| 113 | 20 | 0-115-210-240 | 2·81 |
| 64 | 75 | " " | 4·65 |
| 4 | 150 | 0-115-200-220-240 | 6·24 |
| 66 | 300 | " " | 8·62 |
| 67 | 500 | " " | 13·10 |
| 84 | 1000 | " " | 19·70 |
| 93 | 1500 | " " | 23·62† |
| 95 | 2000 | " " | 31·56† |
| 73 | 3000 | " " | 45·76† |

### CASED AUTO TRANSFORM

240V cable in and USA 2 pin out.

| | | |
|---|---|---|
| 20VA | £ 4·95 | Ref 113W |
| 150VA | £ 8·94 | Ref 4W |
| 500VA | £15·11 | Ref 67W |
| 1000VA | £22·84 | Ref 84W† |
| 2000VA | £35·66 | Ref 95W† |

### 30 VOLT RANGE

Prim. 220-240V
Sec. 0-12-15-20-24-30V

| Ref. | Amps | £ |
|---|---|---|
| 112 | 0·5 | 3·15 |
| 79 | 1·0 | 4·00 |
| 3 | 2·0 | 5·55 |
| 20 | 3·0 | 6·87 |
| 21 | 4·0 | 7·93 |
| 51 | 5·0 | 9·55 |
| 117 | 6·0 | 10·69 |
| 88 | 8·0 | 14·15 |
| 89 | 10·0 | 14·51 |

### BRIDGE RECTIF'S

| | | |
|---|---|---|
| 200V | 2A | 0·67 |
| 400V | 2A | 0·72 |
| 200V | 4A | 0·89 |
| 500V | 10A | 2·70 |

### POWER UNITS

CC 12-05. 3–4·5–6–7·5–9–12V at 500mA **£5·18**

### STABILISED

3–6–7·5–9V at 400mA **£6·98**
3300. Fits into 13A socket 6–7·5–9V 300-mA £3·59

### 60 VOLT RANGE

Prim. 220–240V
Sec. 0–24–30–40–48–60V

| Ref. | amps | £ |
|---|---|---|
| 124 | 0·5 | 3·94 |
| 126 | 1·0 | 5·43 |
| 127 | 2·0 | 7·65 |
| 125 | 3·0 | 11·00 |
| 123 | 4·0 | 13·07 |
| 40 | 5·0 | 14·20 |
| 120 | 6·0 | 16·64 |
| 121 | 8·0 | 19·56† |
| 122 | 10·0 | 24·09† |
| 189 | 12·0 | 25·16† |

### SCREENED MINIATURES

| Ref | mA | Volts | £ |
|---|---|---|---|
| 238 | 200 | 3-0-3 | 2·50 |
| 212 | 1A, 1A | 0-6, 0-6 | 2·97 |
| 13 | 100 | 9-0-9 | 2·28 |
| 235 | 330, 330 | 0-9, 0-9 | 2·39 |
| 207 | 500, 500 | 0-8-9, 0-8-9 | 3·14 |
| 208 | 1A, 1A | 0-8-9, 0-8-9 | 4·51 |
| 236 | 200, 200 | 0-15, 0-15 | 2·28 |
| 214 | 300, 300 | 0-20, 0-20 | 3·22 |
| 221 | 700 (DC) | 20-12-0-12-20 | 3·66 |
| 206 | 1A, 1A | 0-15-20, 0-15-20 | 5·37 |
| 203 | 500, 500 | 0-15-27, 0-15-27 | 4·77 |
| 204 | 1A, 1A | 0-15-27, 0-15-27 | 6·00 |
| S112 | 500 | 12, 15, 20, 24, 30 | 3·15 |

### TEST METERS

| | |
|---|---|
| AVO 8 MK5 | £67·33 |
| AVO 72 | £26·86 |
| AVO MM5 | £23·48 |
| AVO TT 169 | £28·94 |
| U4315 | £13·93 |

(USSR) inc. Steel carry case

# PLUS

### DECS

**Solderless Bread boarding**

| | |
|---|---|
| S Dec 70 contacts | £2·41 |
| T Dec 208 contacts | £3·92 |
| U Dec 'A' for IC's | £4·58 |
| U Dec 'B' for IC's etc. | £7·82 |
| Stab 3–6·5–9V 400mA | £6·95 |

### MINI-MULTIMETER

D.C.—1,000V. A.C.—1,000V, 1,000-Ω/V
D.C.1—100mA Res.—150kΩ £6·21

### AUDIO KIT 25W

2 + 25W Amplifiers, 1 + Pre-Amp
1 + Power supply, 1 + Transformer
1 + Front Panel.
1 + Kit of parts to include on/off switch, neon ind. Stereo headphone socket Plus Instructions book £32·18

### TEAK AUDIO KIT 25W

Teak veneered cabinet
Aluminium chassis, heat sink and front panel brackets plus back panel and sockets etc. £11·21

### STEREO FM TUNER WITH PHASE-LOCK LOOP

4 Pre-selected stations supply 20-35V 90mA Max, £24·21

### ELECTRONIC CONSTRUCTION KIT

10 projects (including Electronic Organ). Ideal gift at £8·63 (no soldering)

### COMPONENT PACKS

200 Mixed value resistors (count by weight)
150 Mixed value capacitors (count by weight)
30 Mixed value precision resistors ½W 2%
15 Assorted pots and pre-sets
10 Reed switches
3 Micro switches
15 Wire wound resistors — mixed wattage
1 Pack wire 50 metres, assorted colours

PLEASE STATE PACK REQUIRED
90p PER PACK

### MAINS ISOLATING

PRI. 120/240V
SEC 120/240V
CENTRE TAP WITH SCREEN

| Ref | Vg(Oatts) | £ |
|---|---|---|
| 071 | 20 | 4·57 |
| 149 | 60 | 6·68 |
| 150 | 100 | 7·65 |
| 151 | 200 | 11·95 |
| 152 | 250 | 14·47 |
| 153 | 350 | 17·14 |
| 154 | 560 | 19·73 |
| 155 | 750 | 27·25† |
| 156 | 1000 | 37·97† |
| 157 | 1500 | 43·33† |
| 158 | 2000 | 48·34† |
| 159 | 3000 | 78·36† |

/115V or 240V Sec. only.

### HIGH VOLTAGE

**Mains Isolating**
Prim. 200/220 or 400/440
Sec. 100/120 or 200/240

| VA | Ref. | £ |
|---|---|---|
| 60 | 243 | 6·62 |
| 350 | 247 | 15·23 |
| 1000 | 250 | 32·68† |
| 2000 | 252 | 54·80† |

### 12 and or 24 Volt

PRIMARY 220-240V
PRIMARY 220-240 VOLTS

| Ref. | 12V amps | 24V amps | £ |
|---|---|---|---|
| 111 | 0·5 | 0·25 | 2·30 |
| 213 | 1·0 | 0·5 | 3·01 |
| 71 | 2 | 1 | 3·68 |
| 68 | 3 | – | 5·10 |
| 18 | 4 | 2 | 4·58 |
| 85 | 5 | – | 5·61 |
| 70 | 6 | 3 | 6·36 |
| 108 | 8 | 4 | 7·34 |
| 72 | 10 | 5 | 7·86 |
| 116 | 12 | 6 | 8·39 |
| 17 | 16 | 8 | 10·48 |
| 115 | 20 | 10 | 15·42 |
| 187 | 30 | 15 | 19·50 |
| 226 | 60 | 30 | 21·94† |

### 50 VOLT RANGE

Prim. 220-240V
Sec. 0-19-25-33-40-50V

| Ref. No. | Amps | £ |
|---|---|---|
| 102 | 0·5 | 4·07 |
| 103 | 1·0 | 5·27 |
| 104 | 2·0 | 7·17 |
| 105 | 3·0 | 8·77 |
| 106 | 4·0 | 11·26 |
| 107 | 6·0 | 17·29 |
| 118 | 8·0 | 18·67 |
| 119 | 10·0 | 22·04† |

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| | |
|---|---|
| 3 Watt RMS AMPLIFIER | £2·78 |
| 5 Watt RMS AMPLIFIER | £3·17 |
| 10 Watt RMS AMPLIFIER | £3·51 |
| 25 Watt RMS AMPLIFIER | £4·67 |
| 125W RMS AMPLIFIER | £17·50 |
| PRE-AMP for 3-5-10W | £7·50 |
| PRE-AMP for 25W | £15·79 |
| POWER SUPPLIES 3-5-10W | £1·54 |
| POWER SUPPLIES 25W | £3·56 |
| TRANSFORMER 3W | £2·54 |
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B.S.R.
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GOLDRING
G800 £5·96
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**Prices include VAT and P & P except † where carriage will be according to weight and distance. Electrosil Resistors, Semi-conductors, Multi-meters, wide range of Panel Meters, Audio Accessories, send stamp for lists. Prices correct at 21st January 1977.**

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