# RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1978
Volume 31 No. 7

Published Monthly (1st of Month)
*First Published 1947*

*Incorporating The Radio Amateur*

*Editorial and Advertising Offices*
*57 MAIDA VALE LONDON W9 1SN*

*Telephone* 01-286 6141
*Telegrams* Databux, London



*Annual Subscription:* £6.50 (U.S.A. and Canada $12.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

*Technical Queries.* We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

*Correspondence* should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

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*Production.*—Web Offset.



Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN

The *Radio & Electronics Constructor* is printed by Swale Press Ltd.

**THE APRIL ISSUE WILL BE PUBLISHED ON 3rd MARCH**

Lamp control panels with 5A mains triac, heat sink, 2 Multi-turn trimpots, cermet pot, 4 x 1A diodes, 9 x 1N914 neon indicator, 11 popular transistors, Hi-stab resistors, capacitors, etc. £1.00 p&p 45p

Mullard 12-0-12V, 1.4A stabilized, regulated, power supply. Approx. 8½" x 4¾" x 3½" with handbook. £15.00 p&p £1.30

POSTAL ORDERS means quicker service — unless a fee is paid for special clearance it is 8 days to ensure cheques are not returned 'unpaid'. Postal order poundage charge is offset by it now costing up to 16p bank charges on every cheque written out.

C90 Cassette Tape 50p

Greenpar 50 ohm BNC line plug, round or flanged chassis socket or t.n.c. or u.h.f. plug, all 50p each

250Ω 50 watt + Resistor 30p

## SEMICONDUCTORS

Full spec marked by Mullard, etc. Many other types in stock

| | | | | | |
|---|---|---|---|---|---|
| AC128/176 | 15p | BCY70/1/2 | 12p | BFW57/58 | 17p* |
| ACY28 | 19p | BCZ11 | 28p | BFX12/29/30 | 20p |
| AF116 | 16½p | BD113 | 50p | BFX84/88/89 | 17p |
| AF124/6/7 | 25p | BD115/6 | 31p | BFY52 | 13p |
| AF139 | 20p | BD131/2/3 | 35p | BFY90 | 50p |
| AF178/80/81 | 30p | BD135/6/7/8/9 | 30p | BR101 | 30p |
| AF239 | 30p | BD137/138 match pr | 70p | BRY39/56 | 26p |
| ASY27/73 | 30p | BD140/142 | 30p | BSV64 | 30p |
| BC107/8/9 + A/B/C | 6p | BD201/2/3/4 | 80p | BSV79/80 F.E.T.s | 80p |
| BC147/8/9 + A/B/C/S | 6p* | BD232/4/5/8 | 49p | BSV81 Mosfet | 90p |
| BC157/8/9 + A/B/C | 6p* | BDX77 | £1 | BSX20/21 | 14p |
| BC178A/B, 179B | 12p | BD437 | 50p | BSY40 | 27p |
| BC184C/LC | 9p* | BF115/167/173 | 15p | BSY95A | 12p |
| BC186/7 | 20p | BF178/9 | 20p | BU204+Mount Kit | £1.60 |
| BC213L/214B | 10p* | BF180/1/2/3/4/5 | 15p | CV7042 (OC41/44 ASY63) | 5p |
| BC261B | 8p | BF194/5/6/7 | 6p* | GET111 | 40p |
| BC327/8, 337/8 | 8p* | BF194A, 195C | 6p* | ON222 | 20p |
| BC547/7B/8/8A/8C | 10p* | BF200, 258, 324 | 20p | TIP30/3055 | 45p |
| BC556/7/7B/8/9 | 9p* | BF202/3 | 30p | TIS8BA F.E.T. | 23p |
| BCX32/36 | 12p* | BF336 | 27p | ZT1486 | £1 |
| BCY31 | 80p | BFS28 Dual Mosfet | £1 | ZTX300/341 | 7p* |
| BCY40 | 50p | BFW10/11 F.E.T. | 40p | 2N393 (MA393) | 30p |
| | | BFW30 | £1 | 2N456A | 50p |
| | | | | 2N706A | 15p |
| | | | | 2N929 | 14p |
| | | | | 2N987 | 40p |
| | | | | 2N1484 | £1 |
| | | | | 2N1507/2219 | 15p |
| | | | | 2N2401 | 30p |
| | | | | 2N2412 | 70p |

| | |
|---|---|
| 2N2483 | 23p |
| 2N2904/5/6/7/7A | 15p |
| 2N3053 | 14p |
| 2N3055 R.C.A. | 50p |
| 2N3704 | 8p* |
| 2N3133 | 20p |
| 2N3553 | 50p |
| 2N4037 | 34p |
| 2N5036 (Plastic 2N3055) | 30p |
| 2N5484 FET | 34p |
| 2SA141/2/360 | 31p |
| 2SB135/6/457 | 20p |
| 40250 (2N3054) | 30p |

### OTHER DIODES

| | |
|---|---|
| 1N916 | 6p |
| 1N4148 | 3p |
| BA145 | 14p* |
| Centercel | 24p* |
| BZY61/BA148/OA81 | 10p |
| BB103/110 Varicap | 20p* |
| BB113 Triple Varicap | 37p* |
| BA182 | 13p |
| OA5/7/10 | 15p |
| BZY88 Up to 33 volt | 8p |
| BZX61 11 volt | 15p* |
| BR100 Diac. | 15p |
| BZY96C 10V | 30p |
| BZY95C 33V | 30p |

### BRIDGE RECTIFIERS

| Amp | Volt | | |
|---|---|---|---|
| ½ | 1,600 | BYX10 | 30p |
| 1 | 140 | OSH01-200 | 26p |
| 1.4 | 42 | BY164 | 40p |
| 0.6 | 110 | EC433 | 6p |
| 5 | 400 | Texas | 90p |
| 2½ | 100 | I.R. | 40p |

### NEW B.V.A. VALVES*

| | |
|---|---|
| EB91 | 34p |
| ECL80 | 34p |
| PCC84 | 34p |
| 6SN7 | 50p |
| 6AT6 | 50p |
| EZ81 | 40p |

### TRANSFORMER

Ferromag C core. Screen-95-105-115-125-200-220-240v Input: output 17v ¾A x 2 + 24-0-24v 1.04A + 20v 1mA. These current ratings can be safely exceeded by 50%. £3.50 + £1.00 p&p.

**WOODS 240V A.C.** Approx. 2,500 r.p.m. continuous rated 5in FAN (ex-computer) **£3.60 plus £1 p&p**

**RS** *Irravin* high temperature wire, 19/0·16, minus 55° to 105°C, 600V, 3A, white, black or red. Half trade price at 30p 10M coil.

Lasso 10M x 15mm grey p.v.c. insulating tape 20p

### ENAM. COPPER WIRE

| SWG. | PER YD. |
|---|---|
| 24 | 3p |
| 26 to 42 | 2.5p |

### GARRARD

GCS23T Crystal Stereo Cartridge 95p*

Mono (Stereo compatible), Ceramic or crystal 75p*

### RECTIFIERS

| | Amp | Volt | |
|---|---|---|---|
| IN4004/5/6 | 1 | 4/6/800 | 5p |
| IN4007/BYX94 | 1 | 1250 | 5p |
| BY103 | 1 | 1,500 | 18½p |
| SR100 | 1.5 | 100 | 7p |
| SR400 | 1.5 | 400 | 8p |
| REC53A | 1.5 | 1,250 | 14p |
| LT102 | 2 | 30 | 10p |
| BYX22-200 | 1½ | 300 | 20p |
| BYX38-300R | 2.5 | 300 | 40p |
| BYX38-600 | 2.5 | 600 | 45p |
| BYX38-900 | 2.5 | 900 | 50p |
| BYX38-1200 | 2.5 | 1,200 | 55p |
| BYX48 300R | 2.5 | 300 | 26p |
| BYX49-600 | 3 | 600 | 35p |
| BYX49-900 | 3 | 900 | 40p |
| BYX49-1200 | 3 | 1,200 | 52p |
| BYX48-300R | 6 | 300 | 40p |
| BYX48-600 | 6 | 600 | 50p |
| BYX48-900 | 6 | 900 | 60p |
| BYX48-1200R | 6 | 1,200 | 80p |
| BYX72-150R | 10 | 150 | 35p |
| BYX72-300R | 10 | 300 | 45p |
| BYX72-500R | 10 | 500 | 55p |
| BYX42-300 | 10 | 300 | 30p |
| BYX42-600 | 10 | 600 | 65p |
| BYX42-900 | 10 | 900 | 80p |
| BYX42-1200 | 10 | 1,200 | 95p |
| BYX46-300R* | 15 | 300 | £1.00 |
| BYX46-400R* | 15 | 400 | £1.50 |
| BYX46-500R* | 15 | 500 | £1.75 |
| BYX46-600* | 15 | 600 | £2.00 |
| BYX20-200 | 25 | 200 | 60p |
| BYX52-300 | 40 | 300 | £1.75 |
| BYX52-1200 | 40 | 1,200 | £2.50 |
| RAS310AF* | 1.25 | 1,250 | 40p |

**Avalanche type*

### TRIACS

| Amp | Volt | | |
|---|---|---|---|
| 6 | 800 | Plastic RCA | £1.20 |
| 25 | 900 | BTX94-900 | £4.00 |
| 25 | 1200 | BTX94-1200 | £6.00 |

RS 2mm Terminals Blue & Black 5 for 40p

Chrome Car Radio facia 15p

Rubber Car Radio gasket 5p

DLI Pal Delayline 50p*

Relay Socket 15p
Take miniature 2PCO relay

B9A valve can 5p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, 4¼" dia. 10p

Mullard Semiconductor, Valve & Component Data Book 1976-8 40p

### OPTO ELECTRONICS

**Diodes**

| | |
|---|---|
| TIL209 Red | 12p |
| BPX40 | 50p |
| BPX42 | 80p |
| BPY10 (VOLTIAC) | 80p |
| BPY68, BPY69, BPY77 | 80p |

**Photo transistor**

| | |
|---|---|
| BPX29 | 80p |
| OCP71 | 45p |

**BIG L.E.D.** 0.2" 2v 50m/A max.

**RED** 14p

Wire end neons 7p

**PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00**

.3" red 7 segment L.E.D. 14 D.I.L. 0-9+D.P. display 1.9v 10m/a segment, common anode 75p

RS 0.6in green £2.00

Minitron 0.3in 3015F filament £1.10

CQY11B L.E.D. Infra red transmitter £1
One fifth of trade

Plastic, Transistor or Diode Holder 1p

Transistor or Diode Pad 1p

Holdersorpads 50pper100

Philips Iron Thermostat 15p

McMurdo PP108 8 way edge plug 10p

Multicore Solder ½kg. 16 or 18 or 20 s.w.g. £4.00 p&p 65p

### THYRISTORS

| Amp | Volt | | |
|---|---|---|---|
| 1 | 240 | BTX18-200 | 30p |
| 1 | 400 | BTX18-300 | 35p |
| 1 | 240 | BTX30-200 | 30p |
| 15 | 500 | BT107 | £1 |
| 6.5 | 500 | BT101-500R | 90p |
| 6.5 | 500 | BT109-500R | £1.00 |
| 20 | 600 | BTW92-600RM | £3.00 |
| 15 | 800 | BTX95-800R Pulse Modulated | £8.00 |
| 30 | 1000 | 28T10 (Less Nut) | £3.00 |

### PAPER BLOCK CONDENSER

| | | |
|---|---|---|
| 0.25MFD | 800 volt | 60p |
| 1MFD | 250 volt | 30p |
| 1MFD | 400 volt | 40p |

I.C. extraction and insertion tool 42p

### CHASSIS SOCKETS*

Car Aerial **9p**, Coax **6p**, 5 pin 180° **9p**, 5 or 6 pin 240° din **6p**, speaker din switched **10p**, 3.5 mm switched **5p**, stereo ¼" jack enclosed **15p**.

### INTEGRATED CIRCUITS

| | |
|---|---|
| T8A920 | £2.50* |
| TAA700 | £2.00* |
| TBA800 | £1.00* |
| 741 d.i.l. op amp | 24p |
| μA702 Op Amp | 46p |
| 723 | 50p |
| (72) 709 | 45p |
| SN76013N | £1.20* |
| TAD100 AMRF | £1.00* |
| CA3001 R.F. Amp | 50p |
| CD4013 CMOS | 36p |
| TAA300 1wt Amp | £1.00 |
| TAA550 Y or G | 22p |
| TAA263 Amp | 65p |
| 7400/7401 | 14p |
| 7402/4/10/20/30 | 14p |
| 7414 | 56p |
| 7438/74/86 | 24p |
| 7414 | 56p |
| 7483 | 69p |
| LM300, 2-20V reg | £1.00 |
| LM1303N | £1.00 |
| 74154 | 90p |
| TBA550Q | £1.50* |
| ZN414 Radio Chip | £1.20 |

### New unmarked, or marked ample lead ex new equipment

| | | | |
|---|---|---|---|
| ACY17-20 | 8p | TIC44 | 24p |
| ASZ20 | 8p | 2G240 | £1 |
| ASZ21 | 30p | 2G302 | 5p |
| BC186 | 11p | 2G401 | 5p |
| BCY30-34 | 20p | 2N711 | 25p |
| BCY70/1/2 | 8p | 2N2926 | 4p* |
| BY126/7 | 4p | 2N598/9 | 6p |
| HG1005 | 10p | 2N1091 | 8p |
| HG5009 | 3p | 2N1302 | 8p |
| HG5079 | 3p | 2N1907 | £1 |
| L78/9 | 3p | Germ. diode | 1p |
| M3 | 10p | 2N3055 Motorola | 30p |
| OA81 | 3p | GET120 (AC128 in 1" sq. heat sink | 15p |
| OA47 | 3p | GET872 | 12p |
| OA200-2 | 3p | 2S3230 | 30p |
| OC23 | 20p | | |
| OC200-5 | 20p | | |

Miniature Edge Meter 100μA f.s.d., scaled 0-5 12V, illuminated, blue perspex front, 35mm x 14mm £3.00

**TIE CLIPS**

Nylon self locking, 3½" 2p

### SPECIAL OFFERS

2500 mfd. 40v 30p*

1 mfd. 350/500v 10 for 15p*

1 mfd. 1500v 10 for 20p

10000 mfd. 15v 12p

6800 mfd. 10v 5 for 30p*

32+32 mfd. 275v 5 for 40p*

16+32 mfd. 350v 5 for 60p*

8+8 mfd. 350v 5 for 40p*

1 mfd. non-polar 350v 10 for 30p

25000 mfd. 25v 20p

12000 mfd. 12v 12p

G.E.C. 5% Hi-stab capacitors .013, .056, .061, .066, .069, .075, .08, .089 10 for 20p

Philips Head Cleaner Tape 25p

NICAD Rechargeable Batteries, 12v ex equip, Storno Flat Pack. 500m/A 5" x 2" x ½" £1.20

T8A920 10 for £10.00*

Vero card handle 10 for 50p

62 ½W Resistor £5* for 2,000 p/p £1.00

ON222 (superior matched BF181) 10 for £1.00

### HANDLES

Rigid light blue nylon 6¼" with secret fitting screws 5p

Belling Lee white plastic surface coax outlet box 20p

Miniature Axial Lead Ferrite Choke formers 2p

RS 10 Turn pot 1% 250, 500 Ω, 1K, 50K £1.50

Copper coated board 10" x 9" approx. 35p

Geared Knob 8-1 ratio, 1¾" diam., black 70p

KLIPPON 25A 440v TERMINAL BLOCKS professional leaf spring clamp, twin with clip-over cover 7p

Strip of 4 40A 440V 12p

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE. LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, PACKING, INSURANCE, ETC. OFFERS CORRECT AT 23-1-78 APPLICABLE TO ORDERS RECEIVED DURING FEBRUARY

**ADD V.A.T. — 12½% FOR ITEMS MARKED WITH AN ASTERISK (*) – All rest and p/p 8% rate**
**ALL ENQUIRIES, ETC., MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE**

# SAVING SALE BI-PAK

## YOU MAKE THE SAVING!

## POTENTIOMETERS

**der 40 MM. Travel**

| er No | | |
|---|---|---|
| 91 | 6 x 470 Ohm LIN Single | 40p* |
| 524 | 6 x 1K LIN Single | 40p* |
| 525 | 6 x 5K LIN Single | 40p* |
| 92 | 6 x 10K LIN Single | 40p* |
| 526 | 6 x 10K LOG Single | 40p* |
| 193 | 6 x 22K LIN Single | 40p* |
| 195 | 6 x 47K LOG Single | 40p* |
| 194 | 6 x 47K LIN Single | 40p* |
| S27 | 6 x 100K LIN Single | 40p* |
| S28 | 6 x 100K LOG Single | 40p* |
| S29 | 6 x 500K LOG Single | 40p* |

**ider 60 mm. Travel**

| | | |
|---|---|---|
| S30 | 6 x 2 5K LOG Single | 40p* |
| S31 | 6 x 10K LIN Single | 40p* |
| S32 | 6 x 50K LIN Single | 40p* |
| S33 | 6 x 250K LOG Single | 40p* |
| 534 | 4 x 5K LOG Dual | 40p* |
| 535 | 4 x 10K LIN Dual | 40p* |
| 536 | 4 x 100K LOG Dual | 40p* |
| 537 | 4 x 1 3 MEG LOG Dual | 40p* |

**538 MIXER SLIDER POTS. VARIOUS VALUES & SIZES OUR MIX ...... 20 FOR £1.00***

**539 6 x CHROME SLIDER KNOBS .................... 40p***

## WIREWOUND

nge of wirewound single gang pots. with linear tracks watt rating.

| er No. | Value | Order No. | Value |
|---|---|---|---|
| 1 | 10 ohms | 1896 | 470 ohms |
| 3 | 47 ohms | 1897 | 1K |
| 4 | 100 ohms | 1898 | 2K2 |
| 5 | 220 ohms | 1899 | 4K7 |

**NOW ONLY 35p Each**

der No.

| | | |
|---|---|---|
| 173 | 15 Rotary Potentiometers Assorted values and types | 40p* |
| 86 | 25 Pre-sets Assorted Values and types | 40p* |

**SALE PRICE 40p**

## MULTI-TURN PRE-SETS

540 3 x 100K LIN ........ **ONLY 50p**

## AUDIO PLUG AND SOCKET PAKS

| rder No. | | |
|---|---|---|
| | 5 x 3.5mm. Plastic Jack Plugs | 40p* |
| | 5 x 2.5mm. Plastic Jack Plugs | 40p* |
| | 4 x Std. Plastic Jack Plugs | 50p* |
| | 2 x Stereo Jack Plugs | 30p* |
| | 5 x 5-pin 180° Din Plugs | 50p* |
| | 8 x 2-pin Loudspeaker Plugs | 50p* |
| | 6 x Phono Plugs Plastic | 50p* |
| | 5 x 3.5mm. Chassis Sockets (Switched) | 25p* |
| | 5 x 2.5mm. Chassis Sockets (Switched) | 25p* |
| 0 | 4 x Metal Std. Chassis Switched Jack Sockets | 50p* |
| 1 | 2 x Stereo Jack Sockets with instruction leaflet for Headphone connection | 50p* |
| 2 | 5 x 5-pin 180 Din Chassis Sockets | 40p* |
| 3 | 8 x 2-pin Din Chassis Sockets | 50p* |
| 4 | 6 x Single Phono Sockets | 40p* |

## AUDIO LEADS

| er No. | |
|---|---|
| A.C. Mains connecting lead for cassette recorders and radios. Telefunken type | 45p* |
| 5-pin Din Headphone Plug to stereo socket | 78p* |
| 2 x 2-pin Plug to inline stereo socket for headphones | 60p* |
| 20ft. of coiled guitar lead | £1.15* |
| 3-pin to 3-pin Din Plug | 50p* |
| Audio Lead 5-pin Plug to 5-pin Din Plug | 50p* |
| Audio Lead 5-pin Din plug to tinned open ends | 50p* |
| Audio Lead 5-pin Din plug to 4 phono plugs | 90p* |
| Audio Lead 5-pin Plug to 5-pin Din Plug — mirror image | 70p* |
| 5 Meter Lead 2-pin Din plug to 2-pin Din inline socket | 45p* |
| 10 Meter Lead 2-pin Din plug | 65p* |

## HEAVY GAUGE BLACK PLASTIC BOX

With aluminium lid and fixing screws

Size: 6¼" x 3¾" x 2"

Order No. S16 **Only 75p**

## 74 SERIES TTL ICs

| TYPE | QUANTITY 1 £p | 100 £p | TYPE | QUANTITY 1 £p | 100 £p | TYPE | QUANTITY 1 £p | 100 £p |
|---|---|---|---|---|---|---|---|---|
| 7400 | 0.09 | 0.08 | 7448 | 0.70 | 0.68 | 74122 | 0.45 | 0.42 |
| 7401 | 0.11 | 0.10 | 7450 | 0.12 | 0.10 | 74123 | 0.65 | 0.62 |
| 7402 | 0.11 | 0.10 | 7451 | 0.12 | 0.10 | 74141 | 0.68 | 0.65 |
| 7403 | 0.11 | 0.10 | 7453 | 0.12 | 0.10 | 74145 | 0.75 | 0.72 |
| 7404 | 0.11 | 0.10 | 7454 | 0.12 | 0.10 | 74150 | 1.10 | 1.05 |
| 7405 | 0.11 | 0.10 | 7460 | 0.12 | 0.10 | 74151 | 0.65 | 0.60 |
| 7406 | 0.28 | 0.25 | 7470 | 0.24 | 0.23 | 74153 | 0.70 | 0.68 |
| 7407 | 0.28 | 0.25 | 7472 | 0.20 | 0.19 | 74154 | 1.20 | 1.10 |
| 7408 | 0.12 | 0.11 | 7473 | 0.26 | 0.22 | 74155 | 0.70 | 0.68 |
| 7409 | 0.12 | 0.11 | 7474 | 0.24 | 0.23 | 74156 | 0.70 | 0.68 |
| 7410 | 0.09 | 0.08 | 7475 | 0.44 | 0.40 | 74157 | 0.70 | 0.68 |
| 7411 | 0.22 | 0.20 | 7476 | 0.26 | 0.25 | 74160 | 0.95 | 0.85 |
| 7412 | 0.22 | 0.20 | 7480 | 0.45 | 0.42 | 74161 | 0.95 | 0.85 |
| 7413 | 0.26 | 0.25 | 7481 | 0.90 | 0.88 | 74162 | 0.95 | 0.85 |
| 7416 | 0.28 | 0.25 | 7482 | 0.75 | 0.73 | 74163 | 0.95 | 0.85 |
| 7417 | 0.26 | 0.25 | 7483 | 0.88 | 0.82 | 74164 | 1.20 | 1.10 |
| 7420 | 0.11 | 0.10 | 7484 | 0.85 | 0.80 | 74165 | 1.20 | 1.10 |
| 7422 | 0.19 | 0.18 | 7485 | 1.10 | 1.00 | 74166 | 1.20 | 1.10 |
| 7423 | 0.21 | 0.20 | 7486 | 0.28 | 0.26 | 74174 | 1.10 | 1.00 |
| 7425 | 0.25 | 0.23 | 7489 | 2.70 | 2.50 | 74175 | 0.85 | 0.82 |
| 7426 | 0.25 | 0.23 | 7490 | 0.38 | 0.32 | 74176 | 1.10 | 1.00 |
| 7427 | 0.25 | 0.23 | 7491 | 0.65 | 0.62 | 74177 | 1.10 | 1.00 |
| 7428 | 0.36 | 0.34 | 7492 | 0.43 | 0.38 | 74180 | 1.10 | 1.00 |
| 7430 | 0.12 | 0.10 | 7493 | 0.38 | 0.35 | 74181 | 1.90 | 1.80 |
| 7432 | 0.20 | 0.19 | 7494 | 0.70 | 0.68 | 74182 | 0.80 | 0.78 |
| 7433 | 0.38 | 0.36 | 7495 | 0.60 | 0.58 | 74184 | 1.50 | 1.40 |
| 7437 | 0.26 | 0.25 | 7496 | 0.70 | 0.68 | 74190 | 1.40 | 1.30 |
| 7438 | 0.26 | 0.25 | 74100 | 0.95 | 0.90 | 74191 | 1.40 | 1.30 |
| 7440 | 0.12 | 0.10 | 74104 | 0.40 | 0.35 | 74192 | 1.10 | 1.00 |
| 7441 | 0.60 | 0.57 | 74105 | 0.30 | 0.25 | 74193 | 1.05 | 1.00 |
| 7442 | 0.80 | 0.70 | 74107 | 0.30 | 0.25 | 74194 | 1.05 | 1.00 |
| 7443 | 0.95 | 0.90 | 74110 | 0.48 | 0.45 | 74195 | 0.80 | 0.75 |
| 7444 | 0.95 | 0.90 | 74111 | 0.75 | 0.72 | 74196 | 0.90 | 0.85 |
| 7445 | 0.80 | 0.75 | 74118 | 0.85 | 0.82 | 74197 | 0.90 | 0.85 |
| 7446 | 0.80 | 0.75 | 74119 | 1.30 | 1.20 | 74198 | 1.80 | 1.80 |
| 7447 | 0.70 | 0.68 | 74121 | 0.28 | 0.26 | 74199 | 1.80 | 1.70 |

Oevices may be mixed to qualify for quantity price. Data is available for the above series of ICs in booklet form **price 35p**

## CMOS ICs

| Type | Price | Type | Price | Type | Price | Type | Price |
|---|---|---|---|---|---|---|---|
| CD4000 | £0.14 | CD4018 | £0.85 | CD4035 | £1.40 | CD4056 | £1.15 |
| CD4001 | £0.16 | CD4019 | £0.45 | CD4037 | £0.78 | CD4069 | £0.32 |
| CD4002 | £0.16 | CD4020 | £0.95 | CD4040 | £0.78 | CD4070 | £0.32 |
| CB4006 | £0.80 | CD4021 | £0.85 | CD4041 | £0.68 | CD4071 | £0.20 |
| CD4007 | £0.17 | CD4022 | £0.80 | CD4042 | £0.68 | CD4072 | £0.20 |
| CD4008 | £0.80 | CD4023 | £0.18 | CD4043 | £0.78 | CD4081 | £0.20 |
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| PS12 | 20-30V Power Supply for AL30A | ~~£1.30*~~ | £1.15* |
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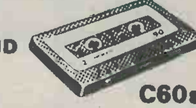

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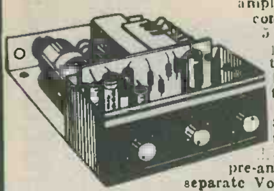

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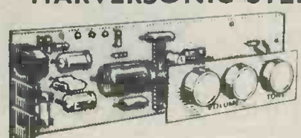
## HARVERSONIC STEREO 44



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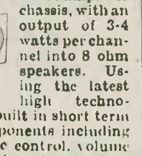

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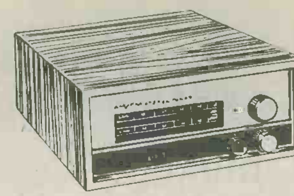

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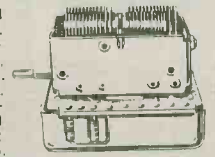

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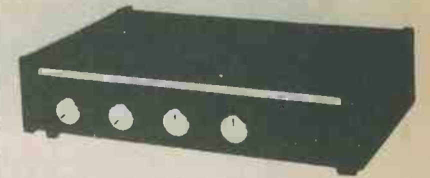

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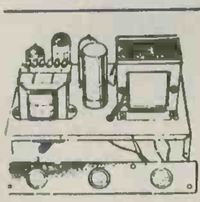

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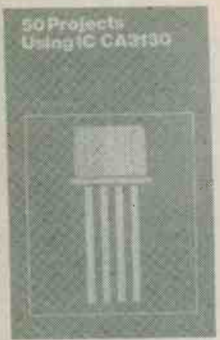


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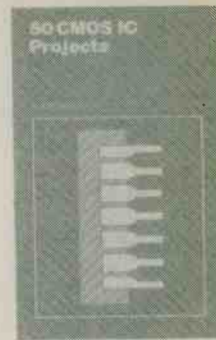


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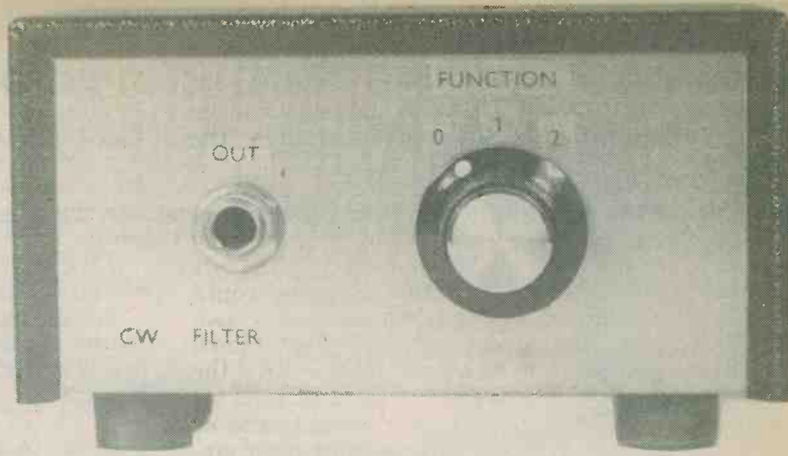



NEEDLE-SHARP c.w. tuning can be achieved with this selective a.f. filter design.

by R. A. Penfold

Needle-sharp c.w. tuning can be achieved with this selective a.f. filter design. A high Q pot core coil assembly is employed, and two filter frequencies are available.

In order to obtain the best possible results in all reception modes it is necessary for a communications receiver to have some form of variable selectivity, so that the i.f. bandwidth is no greater than is absolutely necessary. This ensures that noise generated in the early stages of the set is cut out to the fullest possible extent, and also that adjacent channel interference is reduced as much as possible.

Most government surplus communications receivers incorporate variable selectivity, but they do not all have a very narrow bandwidth position for the reception of c.w. signals. Few modern receivers have this facility either, and on those that do the c.w. filter is often an expensive optional extra.

## AUDIO FILTER

One way of improving the c.w. performance of a receiver which does not incorporate suitable filtering is to add an audio c.w. filter. Such a filter forms the subject of this article, and this is a self-contained unit which is intended to be connected between the output of the receiver and the headphones. It is relatively inexpensive and has the other advantage over alternative methods that it is not necessary to modify the receiver in any way.

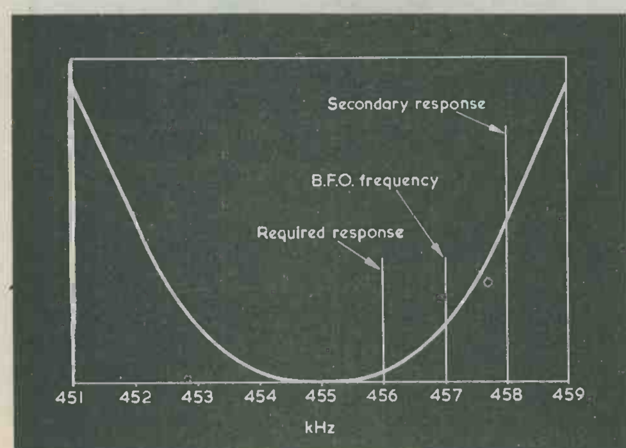



*Fig. 1. When using a 1kHz audio filter, there are two peaks of response 1kHz either side of the b.f.o. frequency. The i.f. response of the receiver is used to attenuate one response (that at 458kHz in this case) in relation to the other*

It should perhaps be explained that reducing the audio bandwidth of a receiver is not necessarily quite as effective as reducing the i.f. bandwidth to the same degree. This point is illustrated in Fig. 1, in which it is assumed that the receiver has a fairly wide i.f. bandwidth centred at 455kHz.

For c.w. reception the b.f.o. is usually tuned to one edge of the receiver i.f. response, and in this example it is tuned towards the high frequency edge, at 457kHz. If an audio filter which only allows the passage of a narrow band of frequencies around 1kHz is used for c.w. reception, the set may be tuned such that the i.f. given by the desired signal carrier appears at 456kHz. The required a.f. beat note of 1kHz will then be given. However, a 1kHz beat note will also be given by a second signal which produces an i.f. of 458kHz, whereupon the overall response curve, taking in the filter, has two peaks, separated from each other by 2kHz.

These two responses are not equal in strength because the first response (that at 456kHz in our example) is near the centre of the receiver i.f. bandpass, whilst the second response is well off centre and is therefore attenuated to some degree. In other words, advantage is being taken of the receiver i.f. passband to attenuate the unwanted second response.

The amount by which the second response is attenuated relative to the main one depends upon the placing of the b.f.o. frequency and the characteristics of the receiver i.f. passband. If the set is a type which is fitted with a high quality s.s.b. mechanical or crystal filter, then the secondary response can be reduced to an insignificant level. On the other hand, with sets fitted with inexpensive mechanical filters or ordinary i.f. transformers there will be only moderate attenuation of the secondary response.

With such sets it is beneficial to use a fairly high audio filter frequency. If, in the example of Fig. 1, this were raised to 2kHz then the desired main response could be at or near the centre of the i.f. passband whilst the secondary response would be taken virtually outside the i.f. passband of the receiver.

2kHz is probably about the highest filter frequency that it is practical to use, as such a frequency tends to be rather difficult to copy and is tiring to listen to for long periods. Indeed, 2kHz is possibly higher than most radio operators would ideally like. The unit described here has two switched filter frequencies. The main standard filter frequency is approximately 1kHz, whilst the second frequency is slightly short of 2kHz, at about 1.7kHz. Thus, the unit should be capable of providing results of a high order under most circumstances. With receivers having a fairly wide i.f. bandwidth, the higher filter frequency need, in practice, only be switched in if an interfering signal 2kHz from the desired signal proves troublesome.

## THE CIRCUIT

The complete circuit of the c.w. filter appears in Fig. 2. The input signal is applied to the base of a common emitter amplifying stage via R1 and C1. R1 is used as a pre-set attenuator, and is adjusted to reduce the input signal to a level which does not overload the circuit. C1 provides d.c. blocking.

TR1 has an ordinary LC tuned circuit as its collector load, this being formed by L1 and either C2 or C3 depending upon the position of S1(b). C3 produces a resonant frequency of about 1kHz and this is raised to about 1.7kHz when C2 is switched into circuit. R2 is the base bias resistor for TR1.

R3 is an unbypassed emitter resistor and, at first, the inclusion of this component might seem to be rather pointless. Indeed, it introduces negative feedback which could be considered to reduce performance by increasing the passband of the filter. Frequently, positive instead of negative feedback

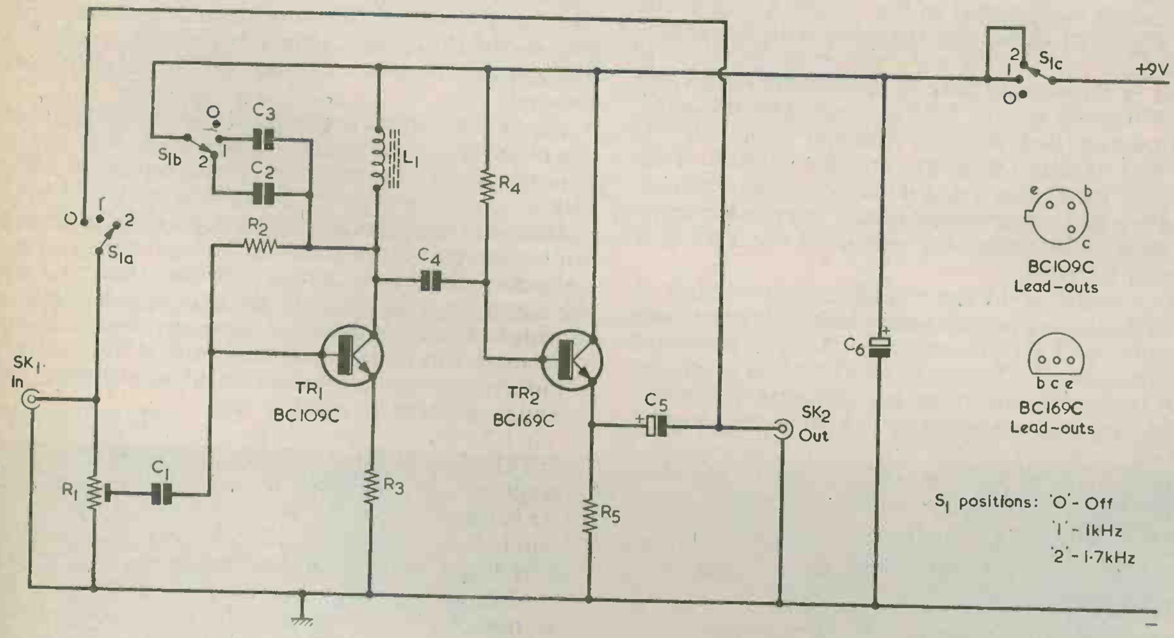



*Fig. 2. The circuit of the c.w. filter unit. When the unit is switched off the input at SK1 is coupled directly through to the output at SK2*

## COMPONENTS

*Resistors*
(All fixed values ¼ watt 10%).
- R1 2.2kΩ pre-set potentiometer, 0.1 watt subminiature horizontal
- R2 1.2MΩ
- R3 470Ω
- R4 820kΩ
- R5 1kΩ

*Capacitors*
- C1 0.0068μF polystyrene
- C2 0.1μF polyester
- C3 0.22μF polyester
- C4 330pF ceramic plate
- C5 0.47μF electrolytic, 10 V. Wkg.
- C6 100μF electrolytic, 10 V. Wkg.

*Inductor*
- L1 100mH pot core assembly (see text)

*Transistors*
- TR1 BC109C
- TR2 BC169C

*Switch*
- S1(a) (b) (c) 4-pole 3-way rotary, miniature

*Sockets*
- SK1 3.5mm. jack socket (see text)
- SK2 ¼in. jack socket (see text)

*Miscellaneous*
Case (see text)
Veroboard panel, 0.15in. matrix
Control knob
9 volt battery type PP3 (Ever Ready)
Battery connector
Wire, solder, etc.

*The input jack socket is mounted on the rear panel. Also to be seen are the heads of the two screws which secure the Veroboard panel inside the case*


is employed in a filter of this nature to give a Q-multiplier effect and thereby a narrower passband.

In practice, however, the effect of R3 is to considerably increase the sharpness of tuning of the filter rather than decrease it. This is clearly shown in Figs. 3(a) and (b). Fig. 3(a) shows the response of the circuit as depicted in Fig. 2 with C3 selected whilst Fig. 3(b) shows the response with R3 short-circuited.

What is happening here is that, with R3 in circuit, the voltage gain of TR1 is roughly equal to the impedance in the transistor collector circuit divided by the resistance in its emitter circuit. This holds true up to the point where the stage gain is limited by the current gain of the particular transistor used. The transistor specified for TR1 is a high gain BC109C.

The impedance of the tuned circuit is high at frequencies equal to and very close to its resonant frequency, and it falls off very steeply on either side of resonance. The use of R3 therefore produces a great improvement in the performance of the circuit. Its effect is enhanced by the choice of a high Q pot core coil assembly for L1.

It is necessary for TR1 collector circuit to operate into a fairly high impedance load as otherwise damping of the tuned circuit would occur, with a consequent adverse effect on performance. An emitter follower buffer stage is therefore interposed between TR1 collector and the output socket. This stage incorporates TR2, which has R5 as its emitter load resistor and R4 as its base bias resistor. C4 and C5 provide d.c. blocking.

On-off switching is given by S1(c), and C6 is the only supply decoupling component that is required. S1(a) connects the input socket direct to the output socket when the unit is switched to the "Off" position. This enables the receiver to be used for phone reception without having to unplug and reconnect the headphones. The fact that SK1 and SK2 remain connected to the rest of the circuit at this switch setting does not have any practical consequence. The unit is powered from a PP3 battery, and the current consumption of about 6mA ensures a reasonable battery life.

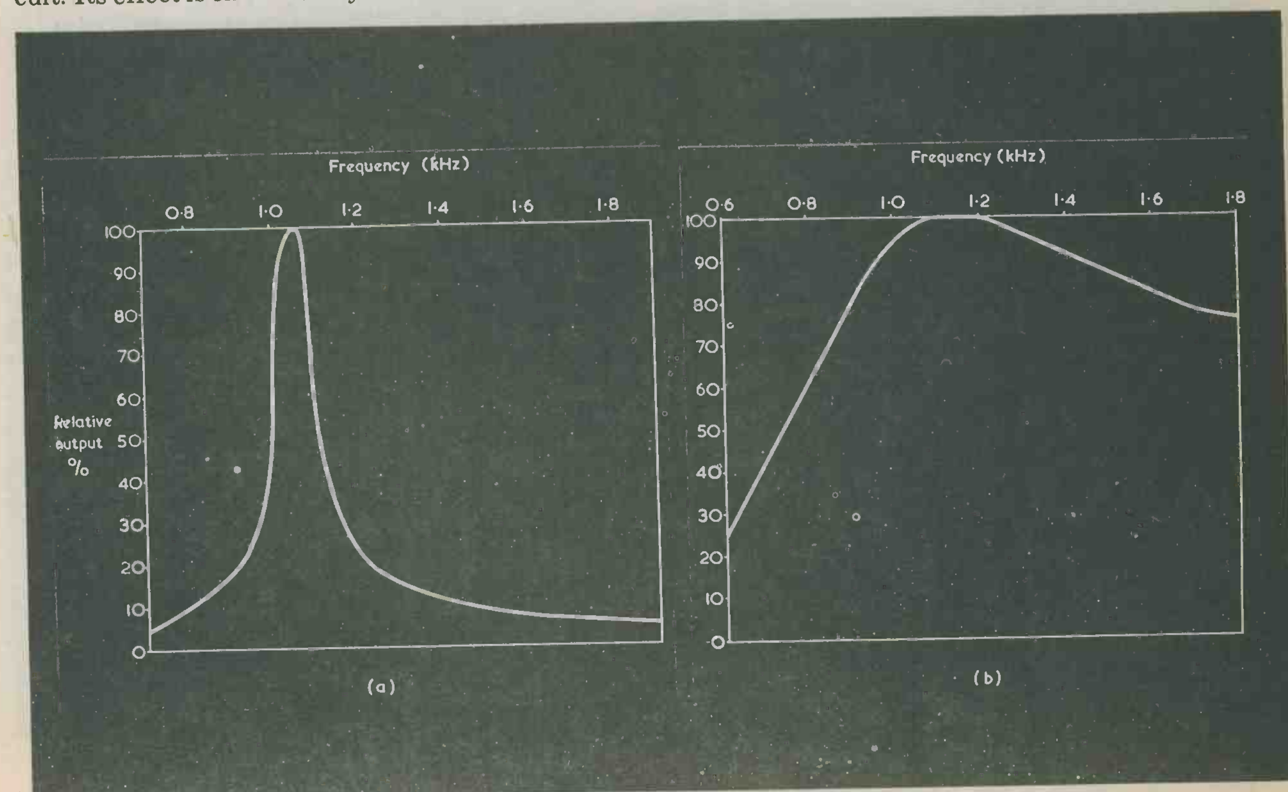



*Fig. 3(a). The response of the circuit of Fig. 2 when the 1kHz filter frequency is selected. The vertical scale represents signal voltage (b). The response with R3 short-circuited*

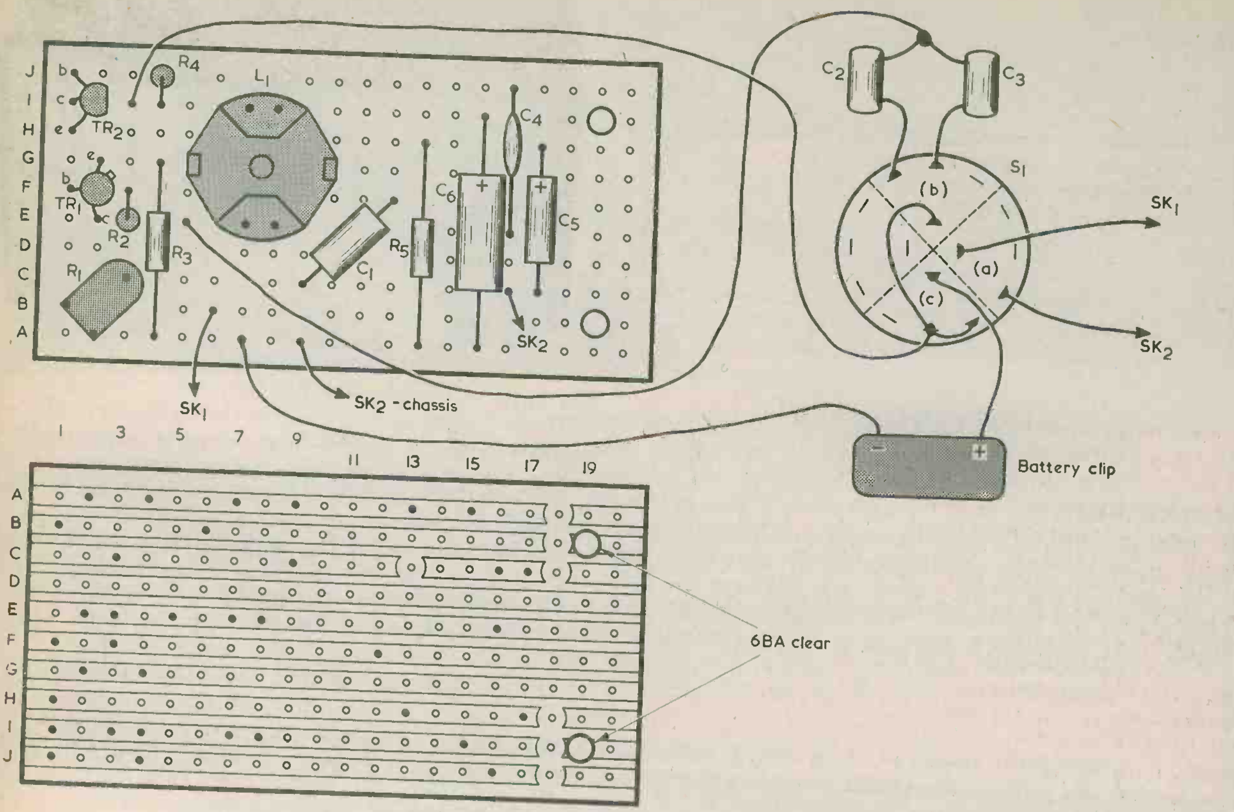
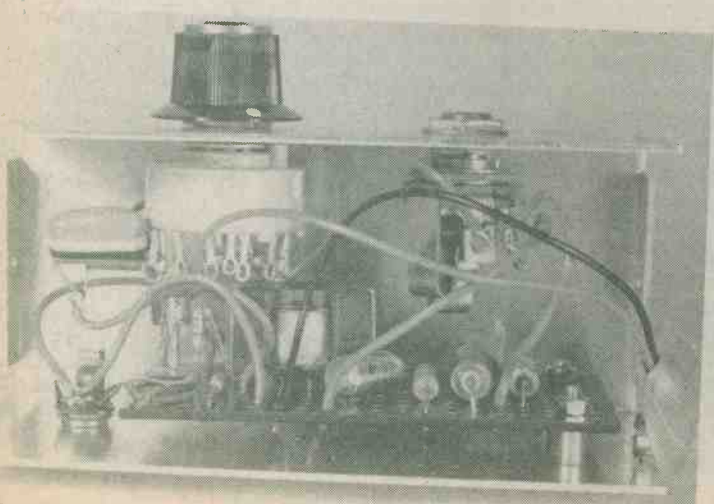



*Fig. 4. Illustrating how the components are assembled on the Veroboard panel, together with the wiring to the switch and the battery*

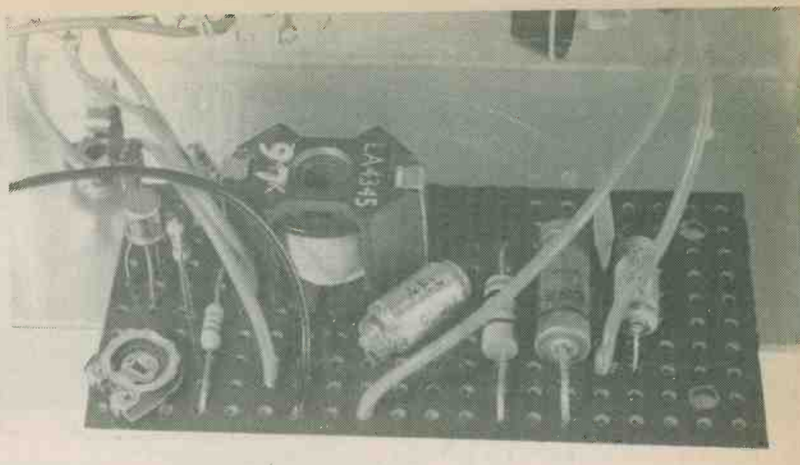
## COMPONENTS

S1(a), S1(b) and S1(c) are three poles of a 4-pole 3-way rotary switch. No connections are made to the fourth pole. The input and output jack sockets, SK1 and SK2, should be of open construction and should not be insulated types. The pre-set skeleton potentiometer employed for R1 should be a horizontal type having 0.2in. spacing between track tags and 0.4in. spacing between track and slider tags. L1 is a ready-wound pot core assembly, listed by Maplin Electronic Supplies as "GE Coil type L6". The case in which the filter is assembled is a "WB6 Vinyl" type, also available from Maplin Electronic Supplies. This measures about 112 by 42 by 55mm. high and is of 2-piece construction with an aluminium front, base and rear and a vinyl covered steel top and sides.

Capacitor C5 is specified in the Components List as 0.47 $\mu$F 10V.Wkg. Difficulty will almost certainly be experienced in obtaining a capacitor of this low value in 10V. Wkg., and it will be perfectly in order to employ a capacitor having a higher working voltage. This can be considerably in excess of 10 volts.



*The layout of parts inside the case. C2 and C3 are mounted on the tags of the rotary switch*



*Taking a closer look at the Veroboard panel. There is adequate space for the components assembled here*

## CONSTRUCTION

The general layout of the unit can be seen from the accompanying photographs. S1 and SK2 are mounted on the front panel with SK2 on the left and S1 on the right. SK2 is a ¾in. jack socket, and both this and SK1 require a 10mm. diameter mounting hole. SK1 is a 3.5mm. jack socket which is mounted on the extreme left hand side of the rear panel (when viewed from the rear). It requires a 6.5 mm. mounting hole.

C2 and C3 are mounted on the tags of S1(a) (b) (c). All the other components are assembled on a 0.15in. matrix Veroboard panel which has 20 holes by 10 copper strips. Details of this panel are shown in Fig. 4, which also shows the other wiring. When a panel of the correct size has been cut out, the seven breaks are made in the copper strips and the two 6BA clear holes are drilled out. The components are then soldered in position. The leadouts of L1 fit into the holes shown in the 0.15in. matrix board.

The Veroboard panel is then used as a template with which the positions of the two 6BA clear mounting holes in the rear panel of the case are located. The panel is wired up to the rest of the circuit before it is finally mounted in the case. Construction will probably be easiest if all the wiring is carried out with the components removed from the case, after which the completed assembly is fitted into the case. Spacers ¼in. long are used to hold the component panel a little way clear of the metal casing.

There is a space for the battery to stand vertically just to the left of SK2. The Veroboard panel assembly obtains its chassis connection from the appropriate tag of this socket.


*An angled shot of the completed filter unit. Its small dimensions can be gauged from the size of the ¼in. jack socket on the front panel*

## USING THE FILTER

The filter is connected to the phone socket of the receiver by way of a non-screened twin lead which is terminated in a 3.5mm. jack plug at the end which connects to the filter. Usually a ¼in. jack plug will be fitted to the other end of the lead, but this must, of course, be varied to suit the particular phone socket provided in the receiver. The connections should be made such that the chassis of the receiver and the filter unit are common with each other. Theoretically, only medium or high impedance headphones should be plugged into SK2, but in practice the unit works well with low impedance types as well.

R1 is simply adjusted so that, with a c.w. signal tuned to the centre of the filter passband, the volume level is slightly higher with the filter switched in than when it is switched out. Morse code reception should be much improved by the use of the filter but it is inevitable that, with the greatly increased selectivity it provides, the adjustment of the receiver tuning control will be much more critical. ■

# RECENT PUBLICATIONS

**NEWNES TAPE RECORDER SERVICING MANUAL,** Servicing Manual, Volume 2. By John Gardner. 213 pages, 245 x 185mm. ($9\frac{3}{4}$ x $7\frac{1}{2}$in.) Published by Newnes-Butterworths. Price £7.80.

The first edition of "Newnes Tape Recorder Servicing Manual" appeared in 1965 and covered most models of tape recorder available at that time. The second edition covers entirely new ground and, because of the wide detail it deals with, has been divided into two volumes. Recorders introduced in 1968 to 1970 are described in Volume 1, and models introduced in 1971 to 1974 appear in the present Volume 2.

The information in the book is taken from manufacturers' service manuals and includes numerous circuit diagrams, printed board and layout diagrams, mechanical drawings and photographs. The products of seventeen manufacturers are dealt with and the number of individual machines is no less than sixty-five. The entry for each machine includes at least a circuit diagram, supplemented in most instances by details of circuit operation and of electrical and mechanical adjustments. Following current manufacturing trends, the book has rather more entries for cassette recorders than it has for reel-to-reel machines.

A ten page introductory section at the beginning of the volume gives general information on test equipment performance tests and the Dolby system. The book will be of particular interest to the service engineer and the more technically minded recorder enthusiast, and will have especial value in situations where a wide range of recorders is serviced for which all service manuals are not stocked.

**BEGINNERS GUIDE TO BUILDING ELECTRONIC PROJECTS.** By R. A. Penfold. 107 pages, 180 x 110mm. ($7\frac{1}{4}$ x $4\frac{1}{4}$in.) Published by Bernards (Publishers) Ltd. Price £1.25.

Regular readers of ***Radio & Electronics Constructor*** will require no introduction to the author of the book under review. R. A. Penfold has contributed regularly to this journal and has presented many popular and successful constructional designs in his articles.

"Beginners Guide To Electronic Projects" is intended for the reader who wants to take up electronics construction as a hobby and has had no previous experience. The book is divided into four long chapters, each of which deals with a particular aspect of electronics construction.

Chapter 1 is devoted to components and discusses all the parts which are likely to be encountered in general electronics work. These range from resistors to integrated circuits and take in such items as speakers, relays, thyristors and triacs. Also included is advice on the problem that besets nearly all beginners, that of purchasing components.

The second chapter deals generally with tools, but it also discusses the jobs that tools do including in particular the all-important procedure of making good solder joints. The following chapter is headed "Circuit Boards" and it similarly includes information on matters with which circuit boards are associated. Examples are projects, such as a simple ZN414 radio, which can be assembled on perforated board, on stripboard or on printed circuit board. Full details on the preparation of printed boards are provided. The final chapter covers cases, both home-made and manufactured, and gives many useful hints which will be of help to the beginner.

The book is written in simple terms and will give considerable assistance to the newcomer.

**50 PROJECTS USING IC CA3130.** By R. A. Penfold. 102 pages, 180 x 100mm. ($7\frac{1}{4}$ x $4\frac{1}{4}$ in.) Published by Bernards (Publishers) Ltd. Price 95p.

Although this book appeared several months before the previous book by Mr. Penfold it deserves special mention here since it is one of the first, if not the first, book published in the U.K. which is devoted entirely to projects incorporating the CA3130 operational amplifier. Amongst other attributes, this i.c. has the exceptionally high input impedance associated with CMOS devices.

After an introductory chapter describing the CA3130 the book then proceeds to audio projects, r.f. projects, test equipment, household projects and miscellaneous projects. Typical items in the audio section are a magnetic cartridge pre-amplifier, a peak level indicator and a compression amplifier; whilst the chapter on r.f. projects describes some particularly interesting designs, including a medium wave radio in which the CA3130 functions as an r.f. amplifier. The test equipment projects feature such designs as a sine to square wave generator and a high impedance voltmeter, and the chapter on household projects deals, amongst other things, with a sound actuated switch and a simple electronic organ. The miscellaneous projects take in a diverse array of subjects, and in this chapter can be found a white noise generator, an analogue stopclock and a morse practice oscillator.

Each of the 50 projects is presented as a circuit diagram with appropriate information. Not only do the designs provide viable projects which can be built as they stand, but the circuit ideas will also spark off new ideas in the more experienced engineer who takes up this interesting book.

# NEWS . . . . AND .

## EMI INSTRUMENTATION RECORDER DEVELOPMENT

For over 50 years EMI has been renowned in research and advanced technology. Their interests in recording stems from the early mechanical sound recording systems developed in the 1920's. It was further nurtured by their invention of the first television system to go into public service in 1936. Shortly after that, radio direction finding and many war-time developments by EMI, both theoretical and practical, added to their wealth of knowledge and advanced technology.

Post war years saw, at EMI, a veritable explosion in all facets of professional electronics which included computers, instrumentation, automation and control systems, broadcast equipment, medical checking and diagnostic systems and, of course, their world famous record company.

Behind many well known developments now commonplace in science, industry and the home, there has been the expertise of EMI Research and EMI Technology. In recording alone there are some fifty years of high intensity experience and expertise.

It is from this background that a relatively new part of EMI — SE Labs (EMI) Ltd. and EMI Technology can draw expertise and experience when they are needed.

Although EMI engineers had established an excellent reputation for developments in the field of advanced magnetic recording, it was not until the early 1970's that the Company decided to challenge the American domination of the world markets for commercial high-technology instrumentation recorders.

In 1971 they launched the world's first general purpose multi-format recorder capable of operation in 14, 28 and 42-track configurations. This was the Series 5000 laboratory-based recorder.

The Series 5000 quickly captured for SE Labs a substantial share of the U.K. and European markets for advanced laboratory systems and helped to establish them as one of the world leaders in this specialised branch of technology.

The next step was to bridge the gap between the high performance but bulky laboratory-based machines and the medium-performance transportable (so-called portable) recorders. To meet this objective SE Labs entered a joint-venture arrangement with the National Research and Development Corporation (NRDC*). The planned outcome of the development programme was to produce a truly portable recorder with a performance equal to the large fixed, and expensive, laboratory recording systems. They achieved their objectives.

The outcome of this project was the SE 7000 family of recording systems — which cover the full spectrum of applications from the run-of-the-mill 14 track mid-band recording, through 42 track high density recording to "half-speed" wideband recording (i.e. 2 MHz at 60 i.p.s. DR or d.c. to 500 kHz at 60 i.p.s. f.m.). Furthermore, all this is provided in a package weighing about 100 lb.

* NRDC (National Research & Development Corporation) is a British Government body set up primarily to sponsor and fund selected high technology developments in Britain.

## WHITE NOISE BOOKLET

**A new booklet published by Marconi Instruments Limited offers a useful guide to the choice of white noise test equipment for f.d.m. systems.**

**The theory of the test techniques is explained clearly with the help of diagrams, and the commonly used quantities noise power ratio (n.p.r.), baseband intrinsic noise ratio (b.i.n.r.) and signal-to-noise ratio (S/N) are defined.**

**Various test systems may be built up from the basic hardware and five such systems are described, with lists of the necessary equipment for each.**

**Copies of the booklet, entitled "White Noise Testing of Frequency Division Multiplex Systems", are available from the Marconi Instruments Publicity Department, Longacres, St. Albans, Herts.**

## IEA EXHIBITION STAYS TWO-YEARLY

It has been decided that the IEA — International Instruments, Electronics and Automation Exhibition, will continue on a two-yearly cycle in March of the even-dated years — this ends speculation that it would go three-yearly.

The exhibition has joined forces with ELECTREX — International Electrical Exhibition, and has moved to the National Exhibition Centre, at Birmingham.

IEA 78, the 12th since it started in 1957, will be held at the NEC from 13-17 March 1978 side-by-side with the 19th ELECTREX to form IEA-ELECTREX — 2nd International Electrical, Electronic and Instrument Exhibition. The IEA, which has enjoyed the Patronage of H.R.H. The Duke of Edinburgh, became a member of UFI — Union des Foires Internationales, the hallmark of a major international trade fair, as did ELECTREX.

# . . . COMMENT

## DUAL TRACE OSCILLOSCOPE NOW AVAILABLE IN UK

Dartron Instruments are pleased to announce that their Dual Trace Oscilloscope D12 is now available on the U.K. market with ITT as the sole distributor. Already extensively marketed in twelve European countries, also New Zealand, Canada, South Africa and the U.S.A., its proved reliability and performance assures it a prominent place in the home market.

Alex Andrew, Manager of ITT Instrument Services says, "I am delighted with this new addition to our range of instruments and forecast large sales on the basis of its performance and low price."

Mr. Dennis Robinson, Managing Director of Dartron Instruments Ltd., states that its very favourable reception in the many countries where it is now represented ensures that it is a desirable addition to the oscilloscope market in the U.K.

The Company have been manufacturing oscilloscopes for many years for various organisations and it is only now that an instrument is available carrying the Dartron name.

The D12 is a D-17 MHz dual trace oscilloscope operating in the chopped or alternate sweep moves which are automatically selected according to sweep speed. The sensitivity is 10mV/cm to 50V/cm or, with cascaded amplifiers, 1mV/cm with a bandwidth from 2Hz-10MHz. X-Y performance is DC-1MHz both channels calibrated from 10mV/cm-50V/cm. Triggering is available from both channels. A 5in helical post deflection accelerator cathode ray tube is used operating at 3.6kV overall. The full specification may be obtained from ITT Instrument Services, Edinburgh Way, Harlow, Essex.

## SOME DIARY DATES

### ● Royal Naval Amateur Radio Society

The R.N.A.R.S. are holding an activity period from 24th March to 2nd April between 0800 hrs. and 1800 hrs. each day, on HMS Belfast in the Pool of London. Three stations will be operational using the call sign GB3RN and all contacts will be acknowledged by QSL.

Visitors are welcome, the ship is well worth seeing, and there is plenty to interest all the family, this being the only surviving heavy cruiser in the Royal Navy.

### ● 1st Essex Electronics Exhibition

To meet a demand for regional exhibitions, the Department of Electrical Engineering Science at the University of Essex is organising the Essex Electronics Exhibition to be held on 18th and 19th April, 1978, in the department's electronics laboratories.

Entry to the exhibition will be by complimentary ticket issued either by the department or by one of the participating companies.

The University is set in 300 acres of parkland and was started in 1964 and the Electrical Engineering Department recently celebrated its tenth year.

### ● Exmouth Hobbies Exhibition

The Exeter Amateur Radio Society have been asked to support the above Exhibition and it has been decided to have an H.F. TX/RX station — VHF/UHF and Amateur TV stations on their stand, and a fully equipped S.W.L. station, plus an Electronics Section.

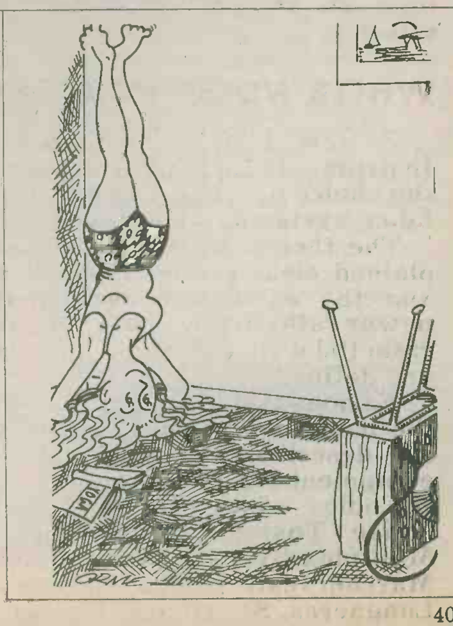
The exhibition is to be held at The Pavilion, Exmouth, Devon. Monday to Thursday 13th to 16th March 1978.

## CHANGE OF NAME

**There has been some confusion in the minds of electronics enthusiasts because there has been more than one well known advertiser trading under the name "Radio Shack".**

**To help remedy the situation, our advertiser who formerly traded under the foregoing name, is now trading under the name Brian J. Reed at the same address as previously — 161 St. John's Hill, Battersea, London SW11 — Telephone 01-223 5016.**

**Messrs. Brian J. Reed will continue their successful policy of offering a large selection of components at competitive prices — see our advertisement pages.**



SUGGESTED CIRCUIT

# BATTLESHIPS!

By G. A. French

Electronic versions of familiar paper and pencil games are almost always popular with home-constructors, even though they often involve quite a considerable amount of work and require a relatively high number of components. The design which is to be described in this month's "Suggested Circuit" article requires 46 light-emitting diodes and 36 silicon controlled rectifiers but, as circuit operation is extremely non-critical, it should be possible to employ job lots of these components as are advertised from time to time. The suggested power supply is also a little unusual, if judged in the light of circumstances some five years or so ago, but is less remarkable under present-day conditions.

## "BATTLESHIPS"

Virtually all readers should be aware of the game of "Battleships", in which two contestants each have a sheet of paper on which are ruled out a number of squares identified in the horizontal direction by letters and in the vertical direction by numbers. There are variations of the game, but that recalled by the author has 16 squares in both directions, and each player has a battleship (four squares), two cruisers (three squares), three destroyers (two squares) and four submarines (one square). The multi-square vessels have to occupy adjoining squares in either the vertical or horizontal directions and no two vessels are allowed to "touch" each other, i.e. there has to be at least one square spacing between vessels.

If one contestant calls out, say, "B6" the other states whether he has "hit a battleship", "sunk a submarine" or has "hit nothing", as the case may be. The skill of the game lies in finding and sinking the opponent's fleet in the least number of moves.

An electronic version of the game having 16 by 16 squares would require an exceptionally large number of components, but a smaller version having 6 by 6 squares is quite realistic, and the layout of squares will readily accomodate one battleship, one cruiser, one destroyer and one submarine. The positions of these vessels are set up by one player and it is then up to the second player to locate and sink the vessels in the minimum number of moves.

The front panel of the electronic version of "Battleships" is laid out in the manner shown in Fig. 1. The panel can consist of plywood on

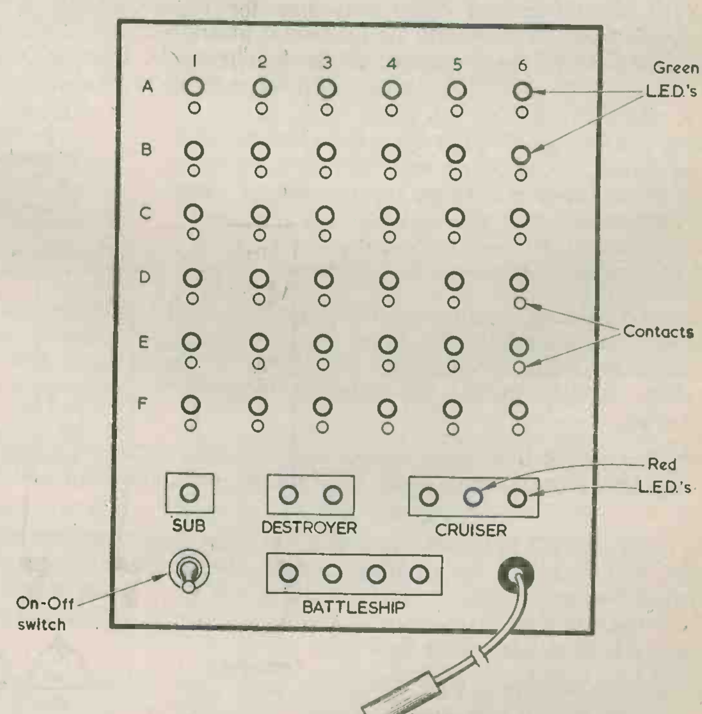



*Fig. 1. The front panel of the electronic "Battleships" game has the appearance shown here. The appropriate red l.e.d.'s light up when a vessel is hit*

which are assembled 36 green l.e.d.'s, laid out in rows "1" to "6" vertically and rows "A" to "F" horizontally. Each green l.e.d. represents a square in the paper and pencil version of the game. Below each l.e.d. is a contact which can, in practice, be the head of a 4BA or M3 screw passed through the plywood. At the bottom of the panel are engraved a square containing one red l.e.d. for the submarine and rectangles containing two red l.e.d.'s for the destroyer, three red l.e.d.'s for the cruiser and four red l.e.d.'s for the battleship. There is also a flexible lead terminating in a probe and an on-off toggle switch.

When this switch is initially turned on all l.e.d.'s are extinguished. The contestant then picks up the probe and, with its tip, touches one of the contacts. The green l.e.d. above the contact at once lights up and stays illuminated. If, on touching the contact the player has also hit a vessel then one of the red l.e.d.'s in the appropriate square or rectangle at the bottom of the panel will also light up and remain illuminated. Should touching a contact not cause a hit, only the corresponding green l.e.d. stays alight. By carefully choosing which contacts to touch, the player endeavours to locate and sink all the vessels, after which the number of moves he has made can be determined by counting the number of green l.e.d.'s which are alight.

The pattern formed by the vessels can be initially set up at any time using flying leads and crocodile clips by the contestant's opponent or by whoever is operating the game. The presentation will be found particularly attractive as a party game or in such activities as small charity fetes in which contestants pay a small fee if they do not manage to sink all the vessels within a pre-determined number of moves.

## GREEN L.E.D. CIRCUIT

The circuitry in which the green l.e.d.'s appear is extremely simple and is illustrated, for four of the l.e.d.'s, in Fig. 2. Looking at LED1A, it will be seen that its anode couples to the positive rail and its cathode, via current limiting resistor R1A, to the silicon controlled rectifier, or thyristor, TH1A. The gate of the thyristor connects to contact 1A, which is the contact mounted immediately below the l.e.d. on the front panel. When on-off switch S1 is initially closed, TH1A is non-conductive (as are all the other silicon controlled rectifiers) and LED1A is extinguished. If the probe is momentarily applied to contact 1A, a gate current flows into the silicon controlled rectifier via R7. TH1A then becomes conductive and remains in this state, causing LED1A to light up continually. The silicon controlled rectifier is only turned off, and LED1A extinguished, when switch S1 is opened. All the other green l.e.d.'s appear in precisely similar circuits, each one having its own silicon controlled rectifier, series 330Ω current limiting resistor and front panel contact.

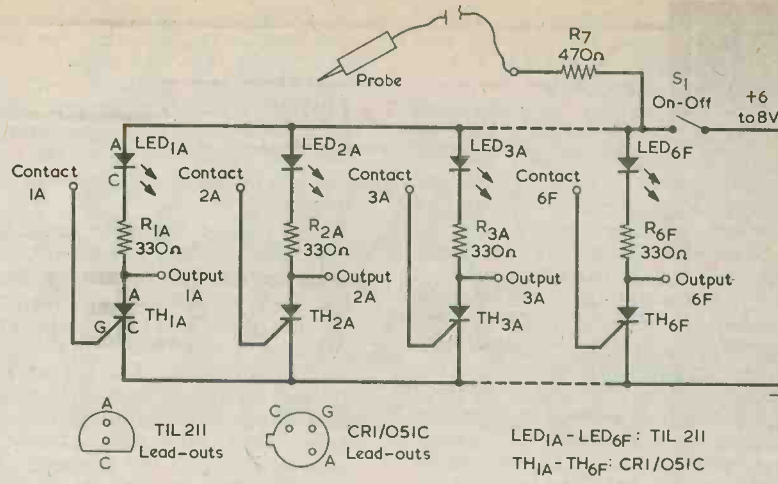



*Fig. 2. All the green l.e.d.'s on the front panel have identical circuits, and four of these are shown here*

Each l.e.d. circuit also has a second contact point which does not appear on the front panel, this being designated the "Output" point for the circuit. These Output points allow for connection to the red l.e.d.'s at the bottom of the front panel. The red l.e.d. circuit appears in Fig. 3 and, here, the anode of each l.e.d. connects to the positive supply rail. The cathodes connect, via 330Ω current limiting resistors, to flexible flying leads terminated in crocodile clips, and the latter are clipped to whichever l.e.d. Output points meet the requirements for a particular pattern of vessels. If, for instance, it is desired to have a submarine on square 3A, the crocodile clip from LED7 is clipped to Output point 3A. The result is that when silicon controlled rectifier TH3A is triggered, it not only causes LED3A to light up but also LED7. The lighting of LED7 indicates that the submarine has been sunk. The destroyer is sunk when both LED8 and LED9

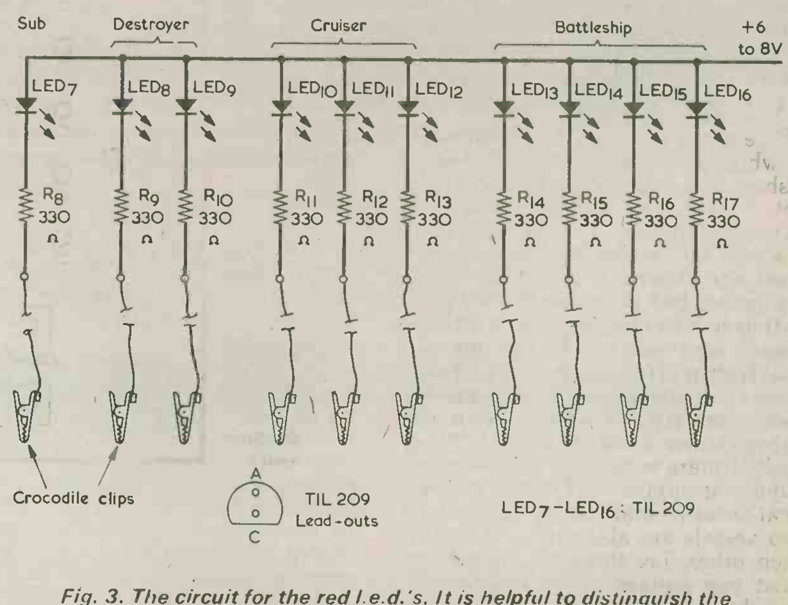



*Fig. 3. The circuit for the red l.e.d.'s. It is helpful to distinguish the flying leads by using different colours for each vessel, the lead for the submarine being say, green, those for the destroyer blue, those for the cruiser yellow and those for the battleship red. All resistors have and in Fig. 2 are ¼ watt 10%*

are lit, the cruiser when LED10 to LED12 inclusive are lit, and the battleship when LED13 to LED16 inclusive are lit.

The destroyer, cruiser and battleship crocodile clips can be similarly clipped to any desired Output points provided that the corresponding green l.e.d.'s are in a vertical or horizontal row as prescribed by the rules of the game. The vessels can, therefore, take up any position desired by the person who sets up the crocodile clips. The individual clips for a destroyer, cruiser or battleship should be connected to the appropriate Output points in its group in random fashion as, otherwise, the contestant will be able to guess more readily the position of a vesel after a first hit. This point applies particularly to vessels in a horizontal row.

## BEHIND THE PANEL

Each Output point appears behind the front panel alongside the green l.e.d. to which it corresponds, whereupon it is an easy matter for the setter to visualise the pattern taken up by the vessels selected by the crocodile clips. A suitable rear panel layout is shown, for LED3A to LED1A, in Fig. 4. Below each green l.e.d. is the rear end of the bolt whose head provides the front panel contact. This has a nut passed over it which secures a solder tag. A lead from the tag then travels to the gate of the appropriate silicon controlled rectifier. The cathode of each green l.e.d. couples, via its 330Ω series resistor, to its Output point, this consisting of a small brass woodscrew driven partially into the plywood so that its head is abut ¼in. clear of the rear surface of the panel. The resistor is soldered to this screw, as also is a lead which travels to the anode of the corresponding silicon controlled rectifier. The point of the screw does not penetrate through the front of the panel, and at the rear it provides an excellent profile onto which a crocodile clip can be readily affixed. Provided it is in a dry condition, the plywood will give adequate insulation for the circuit points in contact with it. A common bus lead connected to all the l.e.d. anodes provides the positive rail supply.

The size of the front panel and the remaining constructional details are left to the reader. Possible panel dimensions are 7in. wide by 10in. high, and the panel may be fitted to a base which allows it to slope backwards. The silicon controlled rectifiers may be mounted and wired on tagstrips affixed to the base. They may alternatively be mounted behind the corresponding l.e.d.'s, although this is liable to clutter up the rear of the panel and make access to the Output points more difficult.

Up to now we have referred to "green l.e.d.'s" and "red l.e.d.'s", and the circuit diagrams have specified TIL211's and TIL209's respectively. However, any single small l.e.d.'s may be employed, and they can in practice have any colour favoured by the constructor. To obtain a neat finish they may be fitted to the panel by means of panel mounting bushes. An easier method of mounting them is to drill two small holes through which their lead-outs can pass, whereupon the whole body of each l.e.d. is in front of the panel.

The silicon controlled rectifiers are specified as CR1/051C. This is an equivalent of the CRS1/05, and both types are rated at 1 amp maximum, have a maximum reverse voltage of 50 volts and a minimum gate trigger current rating of 10mA. In practice, any other silicon controlled rectifiers with these ratings may be employed, and it is very probable that other 1 amp silicon controlled rectifiers with higher reverse voltages will work equally well, although the author has not checked this point. All standard silicon controlled rectifiers in TO-5 or TO-18 cans have the lead-out layout shown in the inset in Fig. 2. When the supply voltage is at 6 volts the gate current passed via R7 is approximately 12mA and the current through each conducting silicon controlled rectifier is about 11mA for one l.e.d., and double this figure if two l.e.d.'s are lit up. At 8 volts supply potential the gate current is about 16mA and the current for a single l.e.d. approximately 17mA.

## POWER SUPPLY

As mentioned at the start of this article, power supply requirements are a little unusual. Current consumption increases as more and more l.e.d.'s are lit up and, with a supply at 8 volts, the total current drawn, with all l.e.d.'s alight, is 780mA. A basic mains supply employing a step-down mains transformer, a bridge rectifier and a high value reservoir capacitor is unsuitable here, since at this high current the voltage across the reservoir capacitor between a.c. voltage peaks can fall to a value which does not allow the holding current to pass through the silicon controlled rectifiers. The latter can then become non-conductive again after having been triggered. A higher performance mains supply unit offering a ripple-free output at currents up to 780mA would be satisfactory, but the simplest solution of all is to employ a 6 volt accumulator. The use of accumulators appears to be finding favour for low voltage high current applications, and the author has noted that a 6 volt accumulator was suggested for some of the recent "Blob-A-Job" projects which appeared in the June 1977 to February 1978 issues of this journal. A small 2 ampere-hour 6 volt motor-cycle accumulator is certainly not a large or heavy item, and it could offer more than 3 hours continual use of the "Battleships" design on a single charge. ■

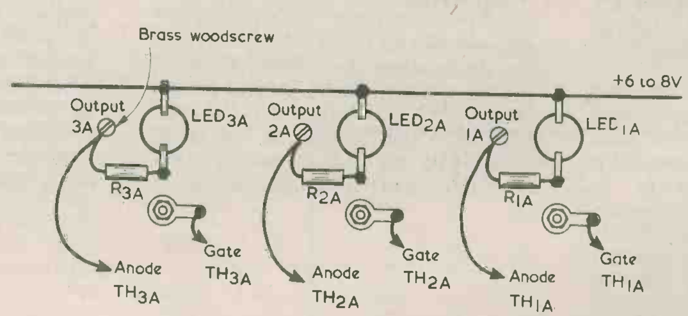



*Fig. 4. A suitable layout behind the panel for each green l.e.d., series resistor and Output contact*

# THE 'CASCODE' MEDIUM AND LONG WAVE PORTABLE

**By Sir Douglas Hall, K.C.M.G. Part 2 (conclusion)**

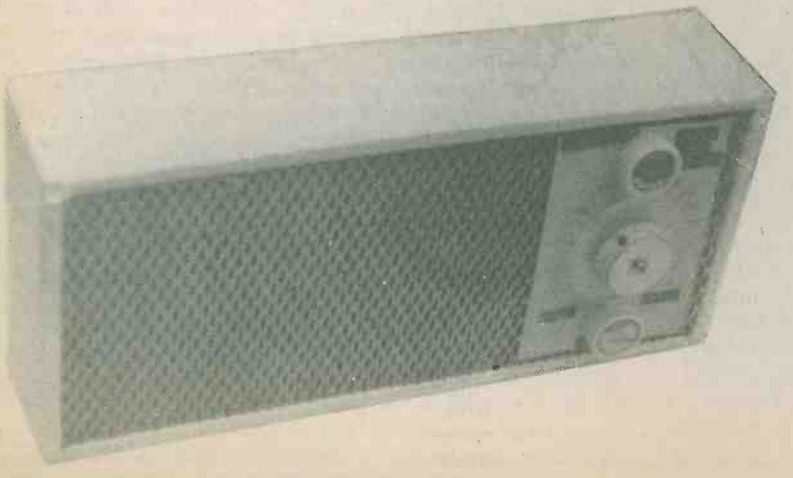
**Coil winding, wiring and setting up are fully described in this concluding article**

In the article which appeared in last month's issue details were given of the circuit of this receiver, and the first constructional steps were then described. Next to be dealt with is the assembly of the ferrite rod aerial coils.

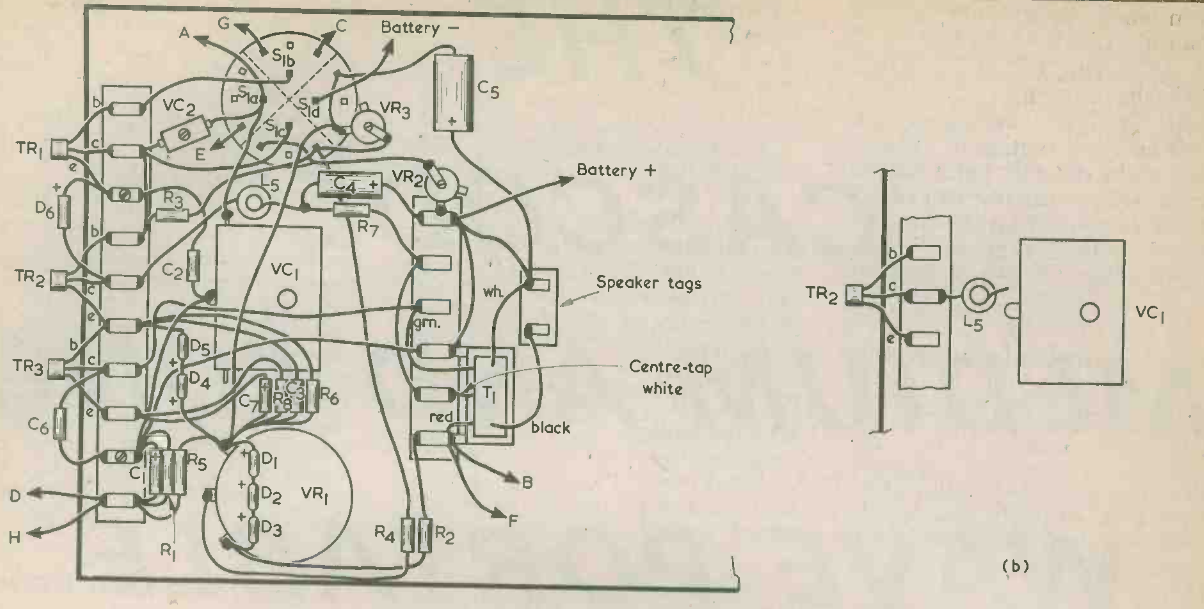
## AERIAL COILS

The coils are wound on two thin sleeves. Each Sleeve is made from a piece of Fablon or Contact measuring 3 by 3 in. and having all the backing paper left on except for a strip ½in. wide along one side. The Sleeves are formed by wrapping the Fablon round the ferrite rod with which it is to be used, the exposed strip being wrapped on last This exposed section will adhere to the previous layer and will hold the sleeve secure. The sleeves should not be wrapped on too tightly as it is necessary for them to be able to move along the rods.

L1 and L2 are wound on one sleeve, using 38 s.w.g. enamelled copper wire. L1 is first, and starts ⅛ in. from the end of the sleeve. It consists of 250 turns wound side by side in a single layer. There is then a gap of ⅛ in., after which L2 starts. This is wound in the same way, and has 35 turns. L3 and L4 are wound with 24 s.w.g. enamelled copper wire. L3 starts ⅛ in. from the end of the sleeve and consists of 72 turns wound side by side. After a gap of ⅛ in. 12 turns of the wire are then wound side by side for L4. All four coils are wound in the same direction and the coil ends can be secured with tape. All the lead-outs should be about 6in. long and will be cut down to their final length later.



*Despite the simplicity of its construction, the receiver case provides a neat and attractive presentation.*




(a) (b)

*Fig. 3 (a). Wiring up the receiver. In practice, all the components should be inside the boundary of the front panel. The letters "A" to "H" refer to connections to the ferrite rod aerials*

*(b) For ease of presentation, L5 is shown displaced from its correct position in (a). It should take up the position shown here*

## WIRING

Wiring is next carried out as illustrated in Fig. 3(a). The core of L5 should be vertical to avoid excessive coupling between this choke and the ferrite aerial coils. For clarity of presentation it is not shown in its correct position in Fig. 3(a), and it should be placed between VC1 and the tags to which TR2 connect in the manner illustrated in Fig. 3(b). The common connection of L5, C4 and R7 is not secured at a tag; this allows slight re-orientation of the choke should this be necessary during setting up. The leads of C4 and R7 may pass over the rear plate of VC1. VR2 and VR3 are each mounted by one tag only. The mounting lugs of the clamp for T1 are soldered to the appropriate tags of the 6-way tagstrip. Part of the receiver circuit is completed by way of this clamp.

The coils L1, L2, L3 and L4 and their ferrite rods are next wired into the circuit. The rods and coils take up the positions shown in Fig. 2(b) (published last month) and the leads designated "A" to "H" are connected to the corresponding points in Fig. 3(a). The leads from L3 and L4 may be cut to their final length as they are connected up, but those from L1 and L2 are left uncut. This is because it may be necessary to reverse the L1, L2 winding assembly on the ferrite rod during setting up adjustments.

## SETTING UP

A battery must now be fitted and connected up. Adjust VR2 and VR3 so that their sliders are in the middle of their tracks. VC2 should be about half a turn from the fully screwed up position. Turn S1 to the medium wave position and put VR1 to a central setting. Adjust VC1 until a local medium wave station is heard; this will indicate that no serious wiring mistakes have been made. Next set VC1 to nearly minimum capacitance and try to find a station by carefully adjusting VR1 to the point where a hiss is heard. If this point cannot be reached, tighten VC2 a little until the hiss commences. This hiss denotes oscillation and if it starts at a low setting of VR1, or if its onset is rough or sudden, slightly reduce the capacitance of VC2. Next adjust VC1 so that its vanes are about three-quarters of fully enmeshed and search for a station. It is possible that the signal may be distorted by a whistle when VR1 has been advanced to some point about half-way or more of its maximum setting, and there may also be motor-boating or loud howls. In this event alter the angle of L5 slightly until matters improve. Moving L5 in one direction introduces positive feedback, which is not wanted in this part of the circuit as it causes the noises just described. Moving L5 in the other direction introduces negative feedback, which makes the circuit more stable. If, however, it is moved too far in this last direction the positive feedback deliberately provided by TR1 will not be sufficient to give the smooth sliding into oscillation which is required for maximum sensitivity and selectivity.

When VC2 is properly adjusted and the angle of L5 is just right, tune to a powerful station and adjust VR3 for the zero volume effect which was described in Part 1. Finally, if the medium wave band is not fully covered adjust the position of the coil sleeve on the ferrite rod. Moving this sleeve to the left, as shown in Fig 2(b), will lower the minimum wavelength which can be received.

Now switch to long waves. Regeneration on this band is also affected by the setting of VC2, but this trimmer has already been properly adjusted for medium waves and should be left alone. Instead, satisfactory reaction control by VR1 can be obtained by moving coils L1 and L2 along the ferrite rod. Whether moving to the left or to the right, as seen in Fig.2(b), increases the reaction effect depends on the direction of winding of L1 and L2 in relation to the direction of winding of L5. The sense is correct when moving the coil sleeve to the left decreases the reaction effect. If the sense of the windings is wrong, remove the coil sleeve from the rod, turn it through 180 degrees and replace it. The position of the coil sleeve should be such that oscillation is just about to begin with VR1 at maximum. When the L1, L2 assembly has been correctly positioned on the rod, its leads can be shortened as required and connected finally into circuit. VR2 may then be set up for correct volume and reaction functioning.

The receiver draws about 13 to 14mA from a new 9 volt battery, this falling to about 10 to 11mA when the battery voltage has dropped to 7.5 volts.

## CASE

A case consisting of top, bottom, back and two sides may be made up as illustrated in Fig. 4. The top and bottom are secured to the sides by thin woodscrews and adhesive, and the Formica back is then similarly fixed to the rectangular frame thus formed. The whole is painted or covered with Fablon of a suitable colour. The receiver "chassis" slides in from the front.

The dimensions shown in Fig. 4 should be used as a guide only, as they assume that the front panel has been made precisely to size and they allow no clearances. In practice the case should be made up to accommodate the "Chassis" as constructed. The dimensions will also need to be modified as appropriate if, due to the speaker diameter being in excess of $4\frac{1}{2}$in., the front panel has been cut out to 11 by 5 in., or if the speaker depth is greater than $1\frac{7}{8}$ in.

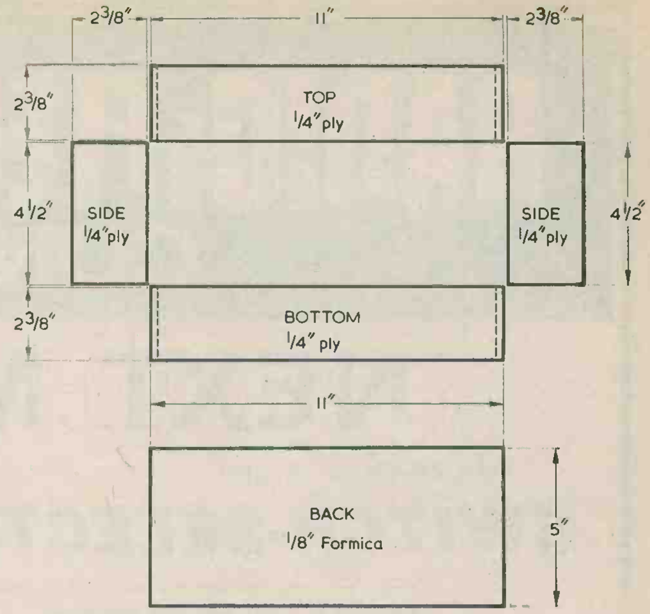



*Fig. 4. Details of the items which make up the case. The dimensions may require slight amendment as described in the text*

It is suggested that the whole of the front panel be covered with non-metallic speaker gauze, a piece of white or coloured card being cut out to pass over the spindles of the three controls. This card may be marked up with the control functions and a tuning scale with wavelengths. The knob on VC1 can have a circular Perspex disc glued to its underside with two lines ruled on it to act as a tuning cursor, and the card may be covered with a transparent plastic sheet or thin Perspex for protection.

# BOOK REVIEW

**RADIO COMMUNICATION HANDBOOK,** Fifth Edition, Volume 2. 336 pages, 250 x 185mm. ($9\frac{3}{4}$ x $7\frac{1}{4}$in.) Published by Radio Society of Great Britain. Price £8.12 including postage.

This is Volume 2 of the fifth edition of a deservedly highly renowned work. It is due to its large size that this new edition has had to be split into two volumes, and Volume 1 was reviewed in the last June issue of ***Radio & Electronics Constructor***.

The book complements Volume 1 by dealing with propagation, h.f. aerials, v.h.f. and u.h.f. aerials, mobile and portable equipment, noise, power supplies, interference, measurements, amateur satellite communication and image communication. There is also a chapter on operating technique and station layout, a chapter on the R.S.G.B. itself and a chapter giving general data.

The text is well backed up with numerous line drawings and photographs, these having excellent clarity and presentation. The fact that the book reflects current interests is well demonstrated by sections on f.m. repeaters and slow-scan television, and also by a complete chapter on amateur satellites.

The book offers exceptionally good guidance to the amateur, whether he be an s.w.l. or a fully licensed transmitter, as well as to the professional engineer whose work takes him into areas of parallel interest.

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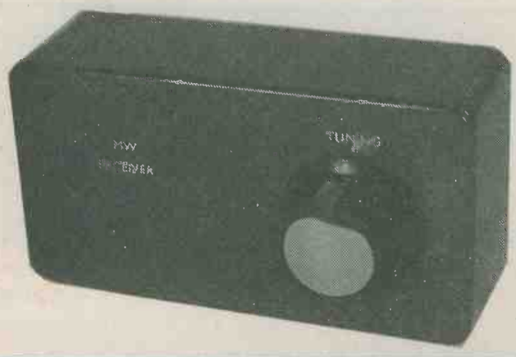

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### BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 58p, inclusive of postage and packing.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

# STOP THE SHOPLIFTER!

**Low-cost unit prevents pilfering**

By R. J. CABORN

One of the major hazards in running a shop or store is the continual loss of stock due to petty thieving. Fortunately, in cases where items on display have handles or apertures through which a wire can pass, these may be protected by threading a flexible insulated wire through them. The ends of the wire are connected to an alarm unit which causes a bell or buzzer to sound when the wire is broken.

It is possible to make up an alarm unit of this nature for indoor use quite easily and at low cost, and such a unit is the subject of this article.

### ELECTRICAL CIRCUIT

For purposes of illustration, Fig. 1 shows what is probably the simplest circuit for the application. A consideration of its disadvantages will enable us to proceed to the main circuit to be described.

It is obviously desirable that the alarm unit be battery powered so that it is independent of power cuts and mains failures. In Fig. 1. there are two batteries, one to operate a relay and the other to operate a bell. The relay has a normally-open contact set and a normally-closed contact set, and these are drawn with "detached" presentation, in which the contact sets may appear anywhere in the diagram. They are shown in the de-energised position.

The unit is switched on with the "Press to Set" push-button depressed, whereupon the relay energises and its contacts change to the energised position. The normally-closed contacts in series with the bell open and the normally-open contacts close. The push-button may now be released, whereupon the relay remains energised by way of the circuit through the protection wire (which is threaded through the items being protected), the normally-open contacts and the relay coil. The circuit is then ready for operation.

If at any time the protection wire circuit is opened the relay releases and its normally-open contact set opens, with the result that the relay remains released even if the protection wire circuit is completed again. At the same time the normally-closed contact set closes and the alarm bell sounds.

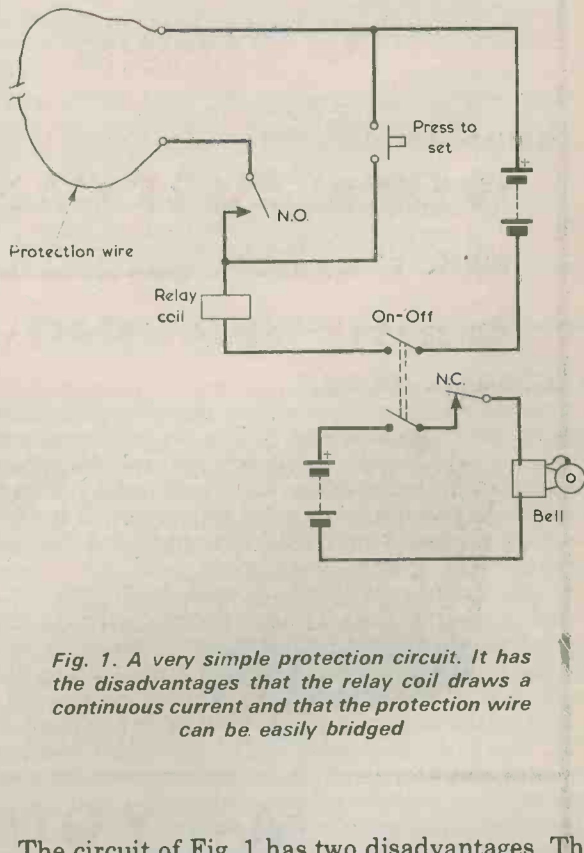



*Fig. 1. A very simple protection circuit. It has the disadvantages that the relay coil draws a continuous current and that the protection wire can be easily bridged*

The circuit of Fig. 1 has two disadvantages. The first of these is that a continuous and relatively heavy current is drawn from the battery which supplies the relay coil during the period when the circuit is in the alerted state. The second disadvantage is that the circuit is too vulnerable. If it is desired to cut the protection wire it is merely necessary to first bridge the wire on either side of the point at which the cut is to be made. Temporary connection at the bridging points can be achieved by stripping the insulation or by passing pins through the wire. Both of these disadvantages can be overcome with a simple electronic design.

## COMPONENTS

*Resistors*
(All ¼ watt 10%)
R1 10kΩ
R2 1MΩ
R3 2.2MΩ
R4 1MΩ
R5 1MΩ
R6 4.7kΩ

*Semiconductors*
TR1 BC107B
TR2 BC107B
TR3 BC107B
D1 1N4002

*Switch*
S1 s.p.s.t. toggle

*Relay*
RLA see text

*Batteries*
BY1 9 volt
BY2 voltage to suit bell

*Sockets*
SK1 coaxial socket
SK2 coaxial socket

*Miscellaneous*
Flexible screened wire
2 coaxial plugs
Bell

## ELECTRONIC CIRCUIT

The electronic circuit which forms the basis of this article appears in Fig. 2. The protection wire is now a screened audio cable having braided rather than lapwound screening. It is terminated in two coaxial plugs which may be phono or 75Ω TV aerial types. SK1 and SK2 are matching coaxial sockets.

If the unit is switched on with both plugs inserted in their sockets a circuit is completed via the protection wire braiding between the negative rail and the emitter of TR1. A second circuit, from the positive rail, is completed via R1, the centre conductor of the screened cable and R2 to the base of TR1. The collector load of TR1 is the 1MΩ resistor R5, and this transistor is in consequence able to turn hard on with its collector about 0.1 to 0.2 volt above the negative rail. Transistors TR2 and TR3 are cut off, and the relay is de-energised.

The only current drawn from the 9 volt battery, BY1, when the circuit is in this state is that flowing through R1 and R2, through R4 and through R5, plus leakage currents in TR2 and TR3. The last currents will be negligibly low, whereupon the total current from the battery calculates at a little less than 27μA. With the prototype circuit it measured in practice at 25μA. This is a very low current and will ensure that the 9 volt battery has a long life.

Let us say that the centre conductor of the screened protection wire becomes cut whilst the braiding remains intact. The base bias circuit for TR1 is now broken with the result that its base is taken to the potential of the negative rail via R3, and the transistor cuts off. The potential at the lower end of R5 rises, allowing bias current to flow into the base of TR2. The combined current gain of TR2 and TR3 is high and TR3 turns hard on, energising the relay coil in its collector circuit. Contacts RLA1 close, latching the relay on so that it will not de-energise even if the bias circuit to TR1 base is completed again. Contact set RLA2 also closes, causing the alarm bell to ring.

The alarm bell will also ring if the braiding of the protection wire is cut whilst the centre conductor remains intact. What happens this time is that the circuit between the negative rail and TR1 emitter is broken and the emitter goes positive via R4. The transistor cuts off and TR2 and TR3 turn on as before, thus energising the relay. No harm will result if the reverse voltage across the base-emitter junction of TR1 reaches breakdown level; the junction then merely acts as a zener diode and additional current flows into the base of TR2 via R4, TR1 base-emitter junction and the now forward biased base-collector junction of TR1.

If both the braiding and the centre conductor of the protection wire are cut, then TR1 turns off because, first, it has no base bias and, second, its emitter is taken positive.

Should a thief, in attempting to bridge the protection wire, cause its braiding and centre conductor to be short-circuited together, TR1 will again cut off and the alarm will sound. This is because the short-circuit causes the end of R2 remote from TR1 base to be taken to the negative rail, thereby cutting off the base current for this transistor. The short-circuit current is limited to around 0.9mA by R1.

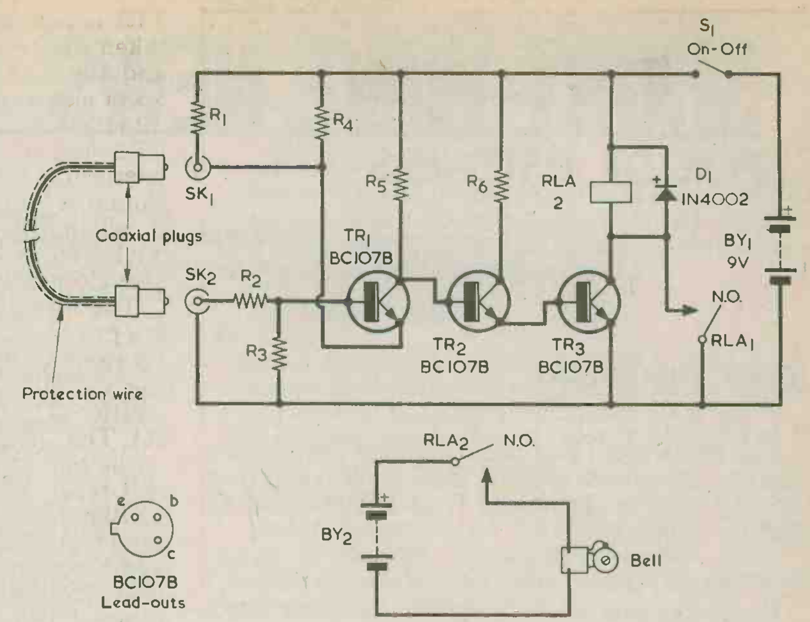
As can be seen, the only way in which the protection wire can be bridged is by bringing out the centre conductor through the braiding at the bridging points without interrupting the braiding circuit, and then bridging over the centre conductor and the braiding separately, taking care to ensure that the two do not accidentally short-circuit together in the process. You try doing that in the comfort of your workshop and see how long it takes you!

## FURTHER POINTS

A few further details need to be cleared up. It is possible for the braiding to be cut (whereupon the alarm will be given) and for the braiding connnecting to SK1 to short-circuit to the centre conductor. This will cause no damage to TR1. Its base will rise to about 1.8 volts positive of the negative rail and its emitter to almost the positive rail potential via R1, or to a voltage limited by zener diode effect in the base-emitter junction. R1 will limit zener current to a safe value. Should both the braiding and the centre conductor be cut, and the braiding and centre conductor connected to SK1 be short-circuited, again no damage will result. The emitter of TR1 will merely be taken to the positive rail via R1 as well as R4. R1 will again limit current to a safe level if the base-emitter junction of TR1 is giving the zener diode effect.

The relay may be any reasonably quick operating type having two normally-open contact sets and a coil resistance of 150Ω or more, and which is capable of energising reliably at around 6 to 7 volts. With a 150Ω coil, maximum current in TR3 is 60mA and maximum power dissipation

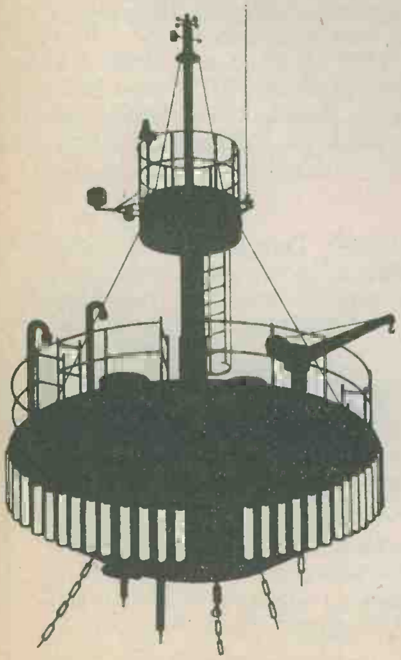
Fig. 2. The electronic protection circuit. This consumes a very low stand-by current from the 9 volt battery and the protection wire can only be disabled with great difficulty




(when 4.5 volts appears across the transistor) is 135mW. The power dissipation is low when TR3 is off or hard on. Naturally, current drain from BY1 when the alarm is sounding reduces as relay coil resistance increases. A suitable relay would be the type listed by Home Radio; this has 2-pole double throw contacts, a coil resistance of 185Ω, and it energises at 6 volts. The relay used by the author was a type P.O. 3000 with a 500Ω coil. A diode across the relay coil prevents the appearance of a high reverse voltage when the relay de-energises. The bell is powered by a separate battery to ensure that bell current transients do not affect the electronics.

The whole unit can be assembled in a small plastic or metal case of suitable size. If a metal case is used it may be made common with the 9 volt negative rail, and it should then be remembered that the outer conductor of socket SK1 must be insulated from it. ■

# THE UK NATIONAL DATA BUOY



In January 1974 the Ship and Marine Technology Requirements Board of the Department of Industry awarded a contract to Hawker Siddeley Dynamics Ltd., for the construction of a prototype high capability data buoy and shore terminal. Towards the end of 1975, after undergoing various trials, it was placed on station near the Smith's Knoll Lightvessel in the southern part of the North Sea where it has been giving good service ever since.

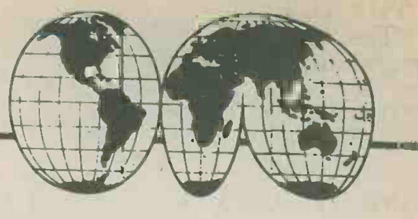
The development was a joint venture of a number of Government bodies and commercial firms.

The buoy has a discus wave-following shaped hull 7.6 metres in diameter. It is secured to the seabed 50 metres beneath the sea surface by a three point chain mooring, which limits any tendency to rotate and enables the buoy to cope with the 20 metre high waves found at times in that part of the North Sea.

Apart from providing synoptic data it can form a platform from which sensors may be tested and correlated with relevant environmental parameters; 90 data channels are provided for the processing and storage of meteorological oceanographic and housekeeping information! This data is then sequentially sampled and transmitted by a MFSK telemetry link for 5 minutes every hour. Every third hour a 20 minute continuous data stream is transmitted in which 5 sensors are sampled repetitively in a time cycle of 1 second to provide information on the flotation motion of the discus hull from which can be computed the characteristics of the sea wave motion.

The main power source is interesting in that it is a Stirling-Cycle generator run on propane gas giving a continuous output of 30 watts with a two year supply of the liquid propane gas. The telemetry consists of a MFSK twelve-tone system based on the 'Piccolo' equipment developed by the Diplomatic Wireless Service. ■

# SHORT WAVE NEWS
## FOR DX LISTENERS



**By Frank A. Baldwin**

*Times* = GMT *Frequencies* = kHz

### HERE AND THERE

● **LAOS**
The Houa Phan Regional Domestic Service now operates from 1000 to 1115, 2300 to 0015 and from 0330 to 0445 on **6202** and from 1000 to 1115 on **4320.**

● **CAMEROON**
Radio Bertoua operates in parallel with Radio Yaounde until 1930 and then carries local programmes until sign-off at 2030. R. Bertoua is on **4750** whilst R. Yaounde is on the **4850** and **4972** channels.

● **ANGOLA**
Radio Nacional de Angola uses **3375** and **4820** for the Domestic Service "A" programmes in Portuguese whilst the "B" Domestic Service, mainly in local languages, uses **7245** and **9535.**

● **SYRIA**
Damascus Radio has been logged here on **6200** with the scheduled English transmission from 2030 to 2200.

● **CHINA**
P.L.A. Fukien Front Station, Network 1 in Standard Chinese, may be heard on the LF channels as follows — on **2490** from 1157 to 0117; **3000** from 1227 to 2311; on **3535** from 1300 to 2240; on **3640** from 1300 to 2242; on **4045** from 1000 to 0530 and on **4330** from 1058 to 0155.

Some Network 2 channels (Amoy and Standard Chinese), on **2430** from 1255 to 1900; on **2600** from 1201 to 1900; on **3200** from 1119 to 1900; on **3300** from 1127 to 1900; on **3400** from 1119 to 1900 and on **3900** from 1124 to 1900.

### CURRENT SCHEDULES

The schedules published here are correct at the time of writing but some are subject to change. Many of these changes coincide with the commencement of each so-called radio season and these take place on the first Sundays in March, May, September and November. We therefore have two long seasons of four months duration (Winter and Summer) and two of two months (each known as Equinox). During the latter two periods the sun crosses the equator and the position of the sun relative to the earth has some bearing on the choice of frequencies. Many stations do not change channels at all and remain on one or more frequency throughout the year.

● **KUWAIT**
"Radio Kuwait" broadcasts in English to East and South East Asia from 0500 to 0800 on **9650** and on **15345** and to Europe from 1700 to 2000 on the same channels. The Domestic Service in Arabic, also intended for listeners abroad, may be heard on various channels in differing time periods throughout the day. Listeners here in the U.K. should try **11940** from 0400 through to 1500 continuous. Programmes in Urdu can be heard from 1500 to 1700 on **9580** and on **9650.**

● **SPAIN**
"Radiotelevision Espanola", Madrid, radiates programmes in English to Europe from 2030 to 2230 (not on Sundays) on **6100, 7155** and on **9505.**

● **ISRAEL**
The Domestic Service Network "B" relays in Hebrew for abroad now conform to the following schedule — from 0400 to 0610 on **5882, 7465, 12077**; from 0610 to 1740 on **12077** and **15545**; from 1740 to 2000 on **7465, 12077** and **15545** and from 2000 to 2315 on **7465, 9355** and on **12077.**

● **IRAN**
"The Voice of Iran", Tehran, has an English programme consisting of a newscast, commentary of the day and a press review. Timed from 1930 to 2000 it is beamed to Europe and can be heard on **9022.**

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### AMSAT-UK GENERAL SECRETARY

AMSAT-UK announce that Ron Broadbent, G3AAJ, has taken on the duties of General Secretary. Up until now, secretary's activities have been shared by various volunteers, the bulk of the work falling on the shoulders of Pat Gowen G3IOR. From now on, Ron will accept all matters relating to AMSAT-UK and his address will become AMSAT-UK's official address, which is:– 94 Herongate Road, Wanstead Park, London, E12 5EQ.

## ● TURKEY

"The Voice of Turkey", Ankara, presents a programme in the English language directed to Europe, North Africa and North America from 2200 to 0030 on **7175** and **9515**. Newscasts are at 2200, 2300 and at 0001.

## ● SOUTH AFRICA

The Domestic Services from Johannesburg will be of great interest to the Dxer. On the higher frequencies these are as follows — English Service on **7285** from 0520 to 1620 and on **9680** from 0635 to 1520. The Afrikaans Service from 0521 to 1621 on **7170** and on **9560** from 0636 to 1521. The English and Afrikaans Commercial Service from 0522 to 1622 on **7185** and from 0637 to 1522 on **9710**. The English and Afrikaans Popular Music Service is from 0530 to 1530 on **6010**.

On the lower frequencies, the following schedules apply — the English Service from 0358 (Saturdays 0430, Sundays 0500) to 0520 and from 1620 to 2115 (Saturdays until 2205) on **3285**; from 0358 (Saturdays from 0430, Sundays 0500) to 0635 and from 1520 to 2115 (Saturdays until 2205) on **3965**. The Afrikaans Service from 0358 (Saturdays from 0427, Sundays 0458) to 0521 and from 1621 to 2115 (Saturdays until 2200) on **3320**; from 0358 (Saturdays from 0427, Sundays 0458) to 0636 and from 1521 to 2115 (Saturdays until 2200) on **3955**.

The English/Afrikaans Commercial Service "Springbok Radio" from 0300 (Sundays 0400) to 0522 and from 1622 to 2200 on **3250**; from 0300 (Sundays from 0400) to 0637 and from 1522 to 2200 on **3980**.

The English/Afrikaans "Radio Five" (the Popular Music Service) may be heard from 0300 to 0530 and from 1530 to 2200 on **3388**.

## AROUND THE DIAL

In which are listed some of the stations logged in recent weeks, some being for the interest of the Dxer whilst others are for the relative beginner.

## ● EGYPT

Cairo on **9755** at 0415, OM with readings from the Holy Qu'ran (Koran). This is the Holy Qu'ran station which is on the air from 0230 to 0905 and from 1200 to 2100 on this channel.

## ● VIETNAM

Hanoi on **4945** at 1557, YL in Vietnamese, local-type music. This is the Home Service 1, scheduled here from 2055 to 1630 daily.

## ● ISRAEL

Jerusalem on **9820** at 0500, OM with identification, news and time-check, local weather forecast. This is the External Service in English directed to Europe, Middle East, South and East Asia, Pacific and North America, scheduled from 0500 to 0515 on this channel and in parallel on **7412, 11780, 11960** and on **12045**.

## ● CHINA

Kunming on **4760** at 1550, Chinese classical music with YL announcer. This is a relay of Yunnan 1 which is scheduled in Chinese from 2150 to 0600 and from 0920 to 1620.

## ● BULGARIA

Radio Sofia on **9700** at 1755, YL in German in a programme for Europe scheduled from 1730 to 1800. The English programme can be heard on this channel from 1930 to 2000.

## ● BURMA

Rangoon on **4725** at 1532, YL in Burmese, local music — which doesn't agree with the schedule, this being from 1030 to 1500, but probably extended for some local special event.

## ● HUNGARY

Radio Budapest on **9655** at 1804, OM with a newscast in Italian, this programme being scheduled from 1800 to 1830. The English programme on this channel can be heard from 2130 to 2200.

## ● SINGAPORE

Radio Singapore on **5010** at 1522, YL with songs in English, YL announcer, also heard in parallel on **5052**. This is the English Service which operates from 2230 to 1630.

## ● YUGOSLAVIA

Belgrade on **9620** at 1800, OM with identification at commencement of the Bulgarian programme to Europe and the Middle East, scheduled from 1800 to 1830. Programmes in English on this channel may be heard from 1530 to 1600, 1830 to 1900, 2000 to 2030 and from 2200 to 2215.

## ● PERU

Radio Quillabamba on **5025**, at 0403, OM with song in Quecha, YL announcer in the same language. Scheduled from 1100 to 0500, this station uses the Spanish and local languages.

## ● ALBANIA

Radio Tirana on **9500** at 1824, OM with the programme in French intended for Europe, scheduled from 1800 to 1830. A programme in English for Europe may be heard on this channel from 0630 to 0700.

## ● COLOMBIA

Ondas del Meta, Villavicencio on **4885** at 0404, OM in Spanish, programme of local pops. The schedule is from 0900 to 0500 and the power is 1kW.

## ● ANGOLA

Emisora Reg. de Cabinda, Cabinda, on a measured **5033** at 1855, European-style dance music records, announcements in Portuguese. This one is scheduled from 0530 to 2100, relays the R. Nacional programme and has a power of 1kW.

## ● DOMINICAN REPUBLIC

La Voz de las Fuerzas Armadas, Santo Domingo, on **4825** at 0320, piano solo, YL with ballad in Spanish, identification at 0330. Scheduled from 1000 to 0400, this one has a power of 3kW.

## NEW HEAR THIS

"Voice of Lebanon", OM in Arabic, Arabic music, YL with commentary. This is the clandestine Phalangist transmitter operating on **6500**, logged here at 0555.

# DIGITAL REACTION TIMER

By R. A. Penfold

- 2 DIGIT DISPLAY READING UP TO 0.99 SECONDS
- SIMPLE CIRCUIT ONLY 5AC
- POWERED BY A 9 VOLT BATTERY!

Details of human reaction timing devices have been published in the past and, to the best of the author's knowledge, these have all used an analogue readout consisting of a moving-coil meter, or a very elementary form of digital readout. However, improvements in digital devices, plus their falling cost in relation to that of a meter movement, have meant that there is now little or no advantage in using anything other than a proper digital display.

The reaction timer which forms the subject of this article has a two-digit display which reads up to 0.99 seconds. The circuit is very simple and has only five active devices. By utilising CMOS display drivers and low current seven-segment l.e.d. displays, economic battery operation has been achieved. In fact the unit does not even need a high capacity battery supply and it is powered by an ordinary PP3!

Provided the timer is set up properly it is very accurate and although it was only really designed as a game, and has proved to be very popular as such, it could also be used for more serious applications.

## USING THE TIMER

The timer is very simple to use, and it has only a single conventional control. This is a toggle switch which is set to the "On" position by the person who is being tested. After a few seconds an indicator light (which is also the decimal point of the display) comes on, and the timer starts to count. The person being tested can halt the count by touching two contacts on the front panel of the unit, and the idea is to touch these contacts as soon as possible after the indicator lamp has come on.

Both the seven-segment displays are normally off, but they can be turned on by activating a further set of touch contacts so that a reading is obtained. This results in a low power consumption, since the seven-segment displays draw by far the largest current in the circuit. This point is well illustrated when the different currents are considered: the unit draws 1mA when the toggle switch is initially closed, 5mA when the count commences and up to about 45mA (depending upon the segments lit) when the displays are on.

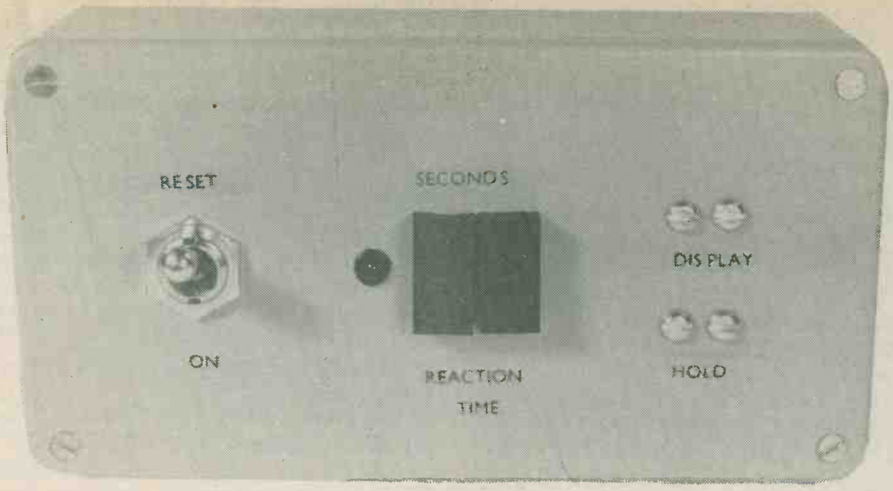
In order to start the timer on another cycle it is merely necessary to briefly put the toggle switch to the "Reset" position and then return it to the "On" position. The timer is switched off when the switch is in the "Reset" position.

## BASIC OPERATION

The block diagram of Fig. 1 outlines the way in which the timer functions. A two digit counter is fed with a 100Hz clock signal, but it will not begin to register the clock pulses until its normally high clock enable input is taken low.

This is precisely what happens when the 5-second timer reaches the end of its timing period. Simultaneously with the clock signal input being enabled the indicator lamp which also functions as the decimal point is turned on by the timer circuit.

A thyristor is connected between the clock enable input and the positive supply, and this can be turned on by bridging the appropriate touch contacts with a finger. Doing this causes the clock enable input to go high once again, and the count is held at whatever point it reached at the instant the thryistor was triggered. Once turned on, the






thryistor remains conductive until the current it is passing is reduced to virtually zero. It is thus only necessary to momentarily operate the touch contacts in order to permanently stop the count.

The counters used have a display enable input which is normally held low (display off) by a high value resistor. The display is switched on by bridging a second set of touch contacts which are connected between the positive supply and the display enable input. This takes the display enable input high.

It is worth noting that the only effect that the voltage at the display enable input has is to turn the display on and off, and that it does not affect the counter circuit in any way.

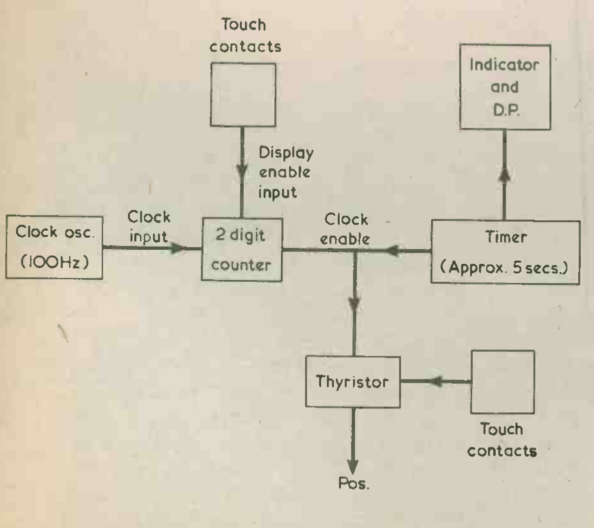



*Fig. 1. Block diagram illustrating the operation of the digital reaction timer*

## COMPONENTS

*Resistors*
(All fixed values ¼ watt 10%)
- R1 330kΩ
- R2 3.3MΩ
- R3 1.8kΩ
- R4 8.2MΩ
- R5 10kΩ
- R6 10kΩ
- R7 47kΩ or 50kΩ pre-set potentiometer, horizontal skeleton, standard
- R8 5.6kΩ
- R9 8.2MΩ
- R10 10MΩ
- R11 220kΩ

*Capacitors*
- C1 10μF electrolytic, 10v. Wkg.
- C2 0.047μF type C280 (Mullard)
- C3 0.01μF type C280 (Mullard)
- C4 0.22μF type C280 (Mullard)
- C5 0.1μF type C280 (Mullard)

*Semiconductors*
- IC1 CD4011AE
- IC2 CD4026AE
- IC3 CD4026AE
- TR1 BC177
- TR2 BC108C or BC109C
- D1 TIL209
- DY1 DL704
- DY2 DL704

*Switch*
- S1 s.p.d.t. toggle

*Miscellaneous*
- Plastic case (see text)
- Veroboard, 0.1in. matrix, 5 x 2.5in.
- Panel Holder (for D1)
- 14 pin d.i.l. i.c. holder
- 2-off 16 pin. d.i.l. i.c. holders
- 9 volt battery type PP3
- Battery connector
- 4-off M3 panhead screws and nuts
- Wire, solder, etc.

## THE CIRCUIT

The full circuit of the digital reaction timer appears in Fig. 2.

IC1 is a 4011 quad 2-input NAND gate, and two of its gates are connected to form an astable multivibrator in conjunction with C4, R6 and R7. R7 permits the frequency of oscillation to be adjusted to 100Hz. Although this clock circuit is extremely simple, it has been found to have adequate stability for the present application, and a crystal controlled clock generator would not be economically viable here anyway. The accuracy is more than sufficient for a two digit readout even when such factors as the effects of changing battery voltage are taken into account.

The two remaining gates of IC1 are connected as a simple Schmitt trigger which appears in the timer controlling the indicator lamp and the clock enable input of the counter. An RC timing network consisting of C1 and R1 is connected at the input of the trigger circuit. When S1 is set to the "On" position C1 commences to charge via R1; when the voltage across C1 reaches the Schmitt trigger threshold level the normally high output of this circuit, at pin 3 of IC1, immediately goes low.

The light emitting diode, D1, is the decimal point and indicator lamp, and is connected to the Schmitt trigger output via the current limiting resistor R3. It is therefore turned on at the end of the timing period. At first sight it might appear better to use a decimal point in the display indicating tenths of a second rather than to employ a separate l.e.d. Unfortunately, the DL704 displays used here, and most other readily available types which are suitable, have a right-hand decimal point whereas a left-hand one is needed. Using a separate l.e.d. does, however, have the advantage of giving a clearer indication because of its relatively large size. It also eases circuit requirements as the l.e.d. can simply be connected, via R3, between the positive rail and the Schmitt trigger output.

The output from the Schmitt trigger timer is also connected via R5 to pin 2, the clock enable pin, of IC2. This i.c. is a 4026 decade counter seven-segment decoder and its divided-by-10 output at pin 5 is fed to the clock input of IC3, which is a further 4026 counter. It is only necessary to control the clock enable input of the first counter, and so pin 2 of IC3 is connected to the negative supply. The outputs of the 4026 i.c.'s are suitable for driving the display segments directly, and without series current limiting resistors. The displays, DY1 and DY2, are common cathode types.

The thyristor which holds the count does not consist of a single component but is formed by TR1, TR2, R8, R9 and C2. The circuit is very sensitive and can be turned on by a small base current for TR1. This is obtained from the negative supply line when the "Hold" contacts are touched.

The display enable inputs (pin 3) of IC2 and IC3 ae held low by R10. Touching the "Display" contacts takes these inputs high and causes the displays to be turned on.

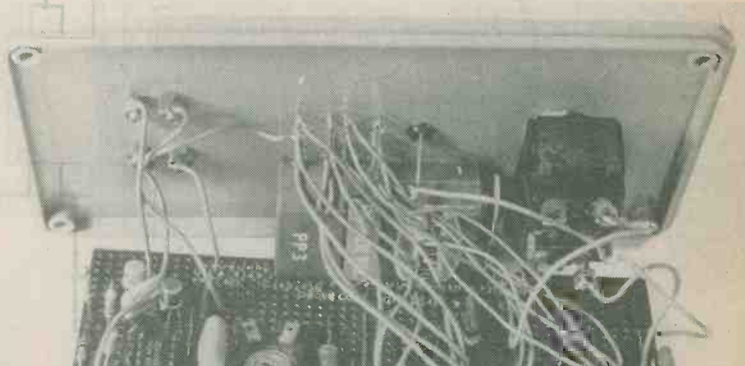
When S1 is in the "Reset" position it short-circuits and discharges C1, so that this capacitor is ready to commence another timing period when S1 is put to the "On" position again. A positive pulse is applied to the reset terminals (pin 15) of the counter i.c.'s by way of C3 when S1 is set to "On", and this ensures that they are both at zero when the count begins.

The components required for the reaction timer are readily available. The displays type DL704 can be obtained from Ambit International. The DL704 has the same pin spacing as a 14 pin d.i.l. integrated circuit with pins 3, 5, 10 and 11 omitted. Pins 4 and 12 are the common cathode and the negative supply connection need only be made to one of these points. The decimal point, which is not used in the present application, is at pin 9.

## CONSTRUCTION

The prototype reaction timer was housed in a plastic case measuring about 150 by 80 by 50 mm., and any plastic case of these or slightly larger dimensions can be employed. The case listed by Home Radio which is stated to have dimensions of 150 by 75 by 47mm., would be suitable. It is essential that the front panel be plastic because the touch contacts are mounted directly onto this and the display pins pass through holes in it without any insulation.

The very simple front panel layout can be seen from the photographs. The TIL209 l.e.d. is fitted with the aid of a plastic panel bush. The displays



*The Veroboard panel and the components which are fitted to the front panel of the reaction timer*

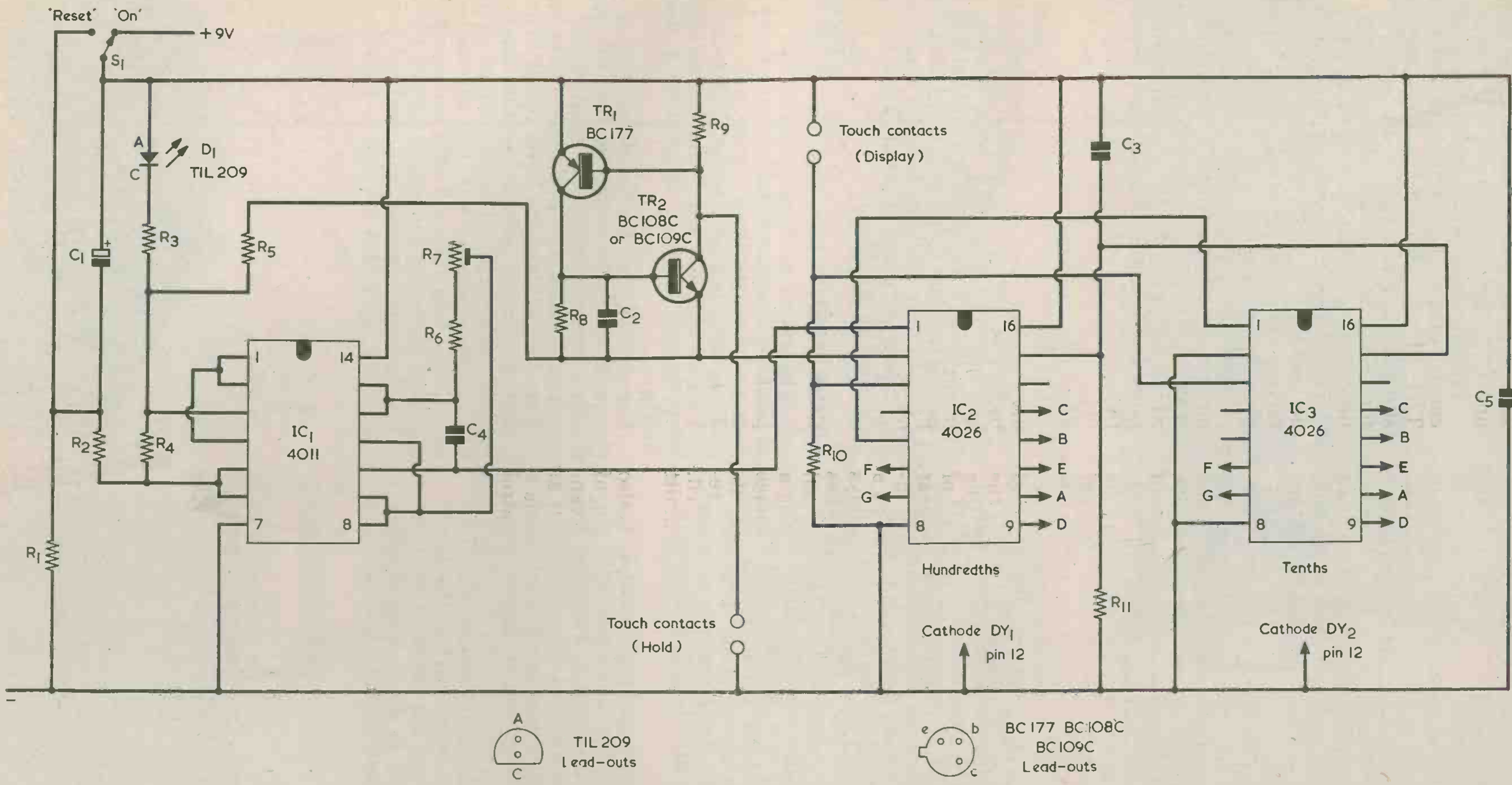
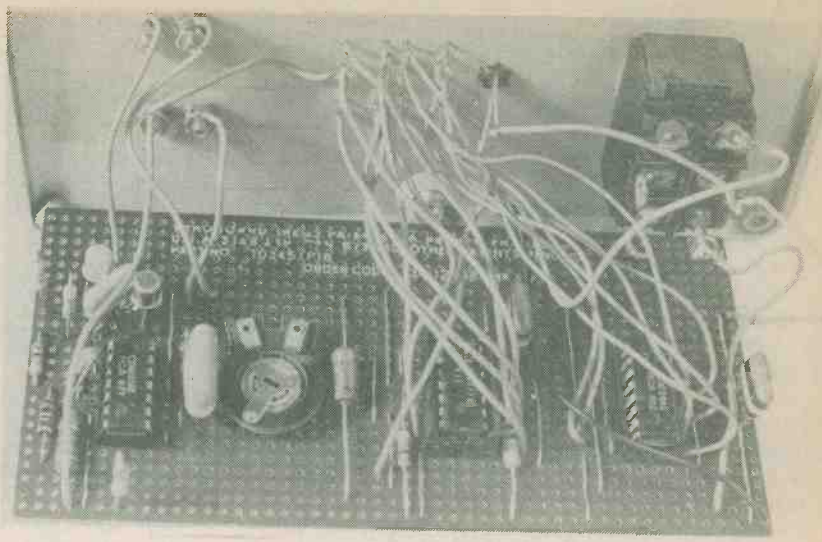



*Fig. 2. The circuit of the reaction timer. An output at 100Hz is taken from IC1 and applied to IC2 and IC3, each of which divide by 10 respectively. The outputs from IC2 connect to segments , to G of display DY1, and those of IC3 to segments A to G of DY2*

A closer view of the component board



are mounted by drilling 3/64in. diameter holes for their pins, and then pushing these through the panel. The two pairs of touch contacts consist of short panhead M3 bolts spaced at centres about 8mm. apart. Solder tags are secured under the nuts on the inside, and connections are then made to these.

The circuit is assembled on a piece of 0.1 in. matrix Veroboard measuring 5 by 2.5 in. The layout on the component side of the board is shown in Fig. 3, breaks in the strips below the board being indicated by crosses. R7 is a standard, and not a miniature, horizontal skeleton potentiometer. The three integrated circuits are mounted in sockets; these are soldered on the board and the i.c.'s are plugged into them after all wiring has been completed and checked.

Fig. 3 also shows all the wiring external to the board. The two displays are illustrated with the pins pointing towards the reader. Provided the wires between the Veroboard and the components on the front panel are kept reasonably short these will suffice to maintain the board in position when the front panel is fitted to the case, the board being roughly parallel with the front panel. The PP3 battery fits between the lower part of the board (lines A to E in Fig. 3) and the inside of the front panel. Readers who wish to do so may devise a suitable clamp for the battery and a mounting for the board. The latter could, for instance, be secured by two long 6BA bolts passing through holes in the bottom of the front panel and through matching holes on line B or C of the board, nuts being passed over the bolts to space the board away from the front panel. Threaded mounting pillars could also be employed.

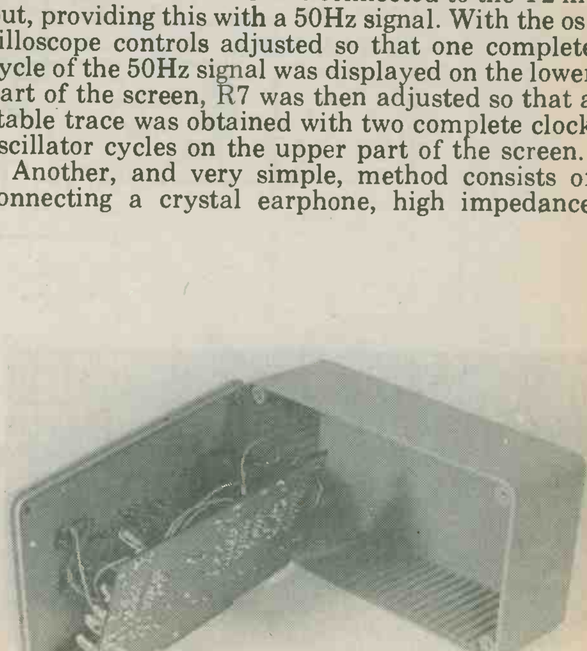
## ADJUSTMENT

It is necessary to adjust R7 for a clock frequency of 100Hz before the reaction timer is ready for use. If a suitable frequency meter with a high impedance input is available the clock oscillator output, at pin 10 of IC1, can be fed to this, after which R7 is simply adjusted to produce a reading of 100Hz.

The method used by the author was to connect the clock oscillator output to the Y1 input of a double-beam oscilloscope. A lead placed near an unscreened mains wire was connected to the Y2 input, providing this with a 50Hz signal. With the oscilloscope controls adjusted so that one complete cycle of the 50Hz signal was displayed on the lower part of the screen, R7 was then adjusted so that a stable trace was obtained with two complete clock oscillator cycles on the upper part of the screen.

Another, and very simple, method consists of connecting a crystal earphone, high impedance

The Veroboard is in an almost vertical position, with strip "A" at the bottom, when the front panel is secured to the plastic case



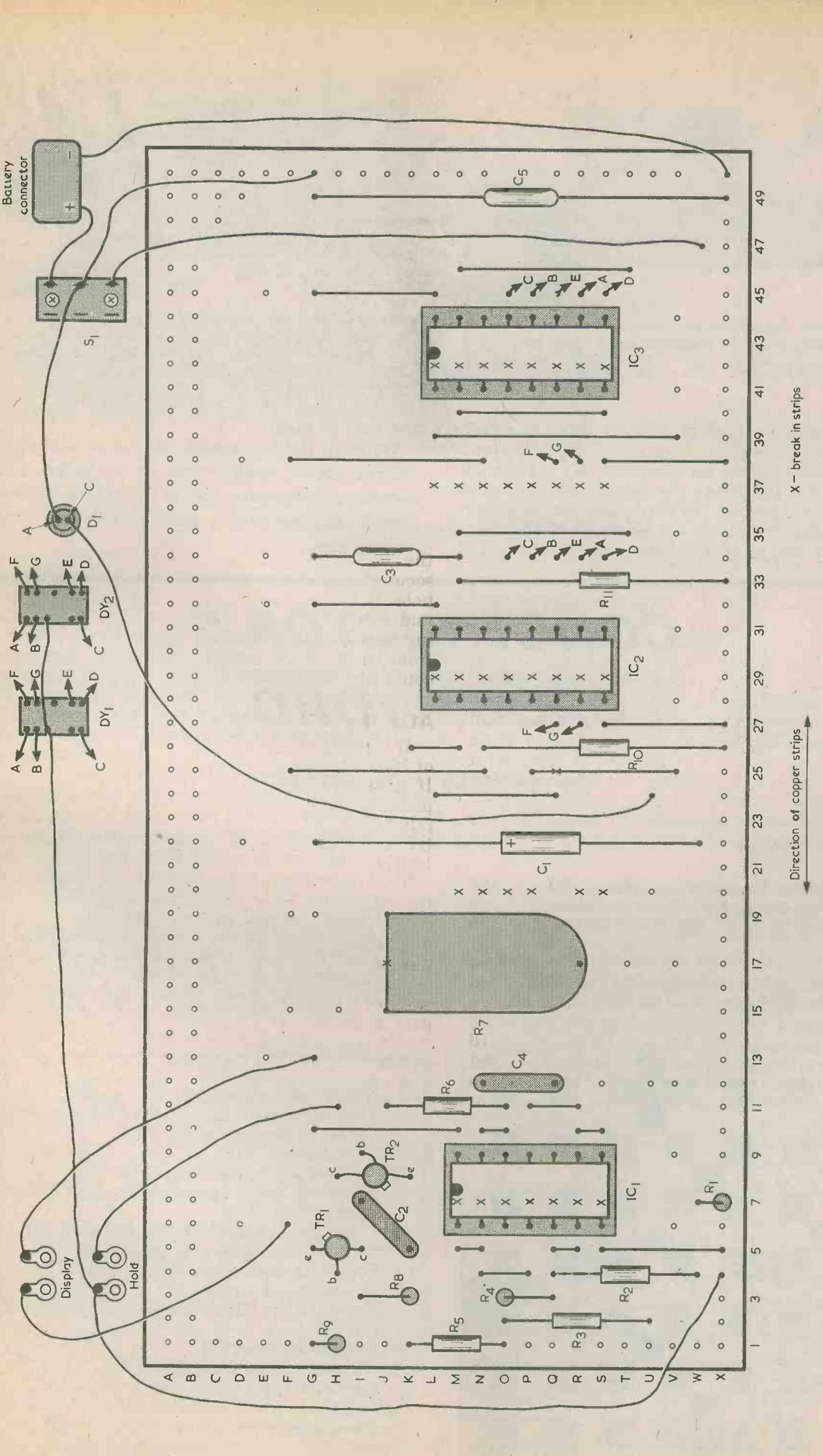
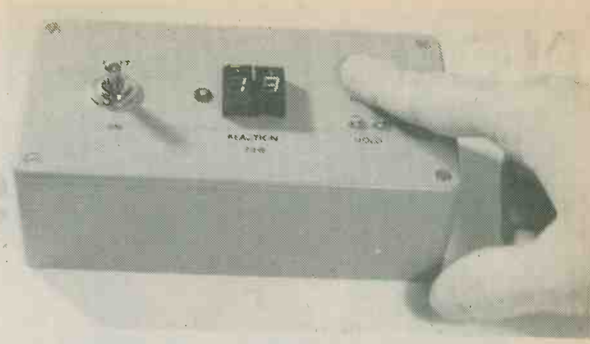



*Fig. 3. The component side of the Veroboard panel on which nearly all the components are assembled. Note that there are a number of link wires on the board. The two displays are shown with their pins pointing towards the reader, and as seen looking at the rear of the front panel*

*Stopping the count by touching the "Hold" contacts after the indicator lamp lights up*



*Touching the "Display" contacts allows the elapsed time to be shown by the seven-segment displays. The indicator l.e.d. also provides the decimal point*

headphones or the high impedance input of an a.f. amplifier and speaker to pin 5 of IC3. Using a clock or watch with a second hand, R7 is then adjusted so that 120 clicks per minute are produced from the earphone, headphones or speaker. Although this method is not as quick as the other two, a high degree of accuracy can be attained if due care is taken.

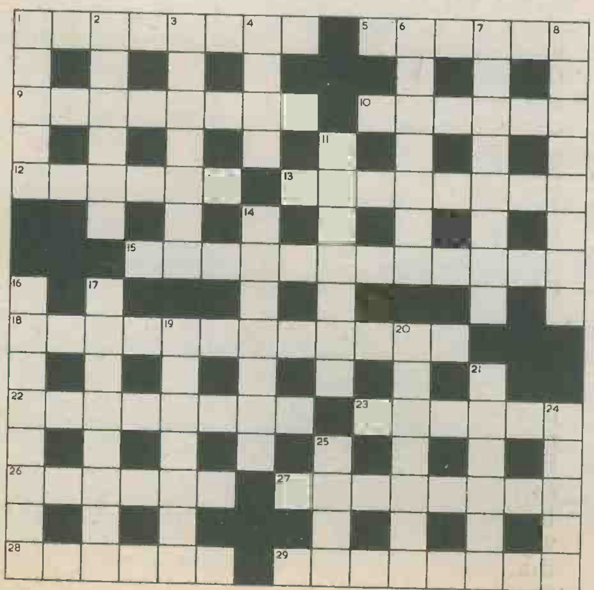
With all these methods, the chassis of the frequency meter, oscilloscope or amplifier is connected to the negative rail of the reaction timer, as also is the remaining lead of the earphone or headphones. ■

# CONSTRUCTOR'S CROSSWORD

**Compiled by J. R. Davies**

## CLUES ACROSS

1. Signal this for signal insertion. (8)
5. Drive like mad. (6)
9. One who services? (8)
10. What the 4 down switch does to the circuit. (6)
12. Valuable when indulged in prudently. (6)
13. Muddle that rose to offer resistance. (8)
15. Energy acquired by going up 1 volt. (8-4)
18. Graphic picture of irate group. (5-7)
22. Transducer encountered in linear phone systems. (8)
23. The stylus will go over this. (6)
26. Appearance of the American doughnut. (6)
27. Describes the 3 down on the front panel. (8)
28. Adjusts the pot afresh. (6)
29. A d.c. ideal if you want a cell. (4-4)



## CLUES DOWN

1. Not a very active gas. (5)
2. Transistor with high input impedance. (6)
3. Do what the knobs do. (7)
4. Uninhibited. (4)
6. Audible sounding device. (3, 4)
7. Holding back politically but otherwise regenerative. (8)
8. Don't go, the tea is badly brewed! (8)
11. As cold as this is cold indeed. (7)
14. Prohibits undesirable couplings. (7)
16. Series tuned circuit. (8)
17. Provided by Wheatstone bridge resistances. (4,4)
19. Trigger creator. (7)
20. Unit of magnetising force. (7)
21. Particles from outer space. (6)
24. Simply made a mistake. (5)
25. Circuit breaker. (4)

(Solution on page 433)

# NOVEL A.F. OSCILLATOR

By G. H. Wallis

**A very basic a.f. oscillator circuit.**

In the circuit shown in Fig. 1 the headphones are standard magnetic types with a nominal resistance of 4,000 Ω (2,000 Ω per phone). BY1 and BY2 are 1.5 volt dry cells, the transistor is a BC107, and the two capacitors and the single resistor have the values shown. And what is it? It's an a.f. oscillator!

When connected up, the circuit produces a loud sine wave tone of around 1kHz in the headphones. It can be used as a morse practice oscillator, as an a.f. signal generator or for any other function which requires an a.f. oscillator.

## COLPITTS OSCILLATOR

A simple sine wave oscillator requires an LC tuned circuit, and in Fig. 1 the capacitance for the tuned circuit is provided by C1 and C2 in series. The inductance is given by the inductance of the headphones which reproduce the signal.

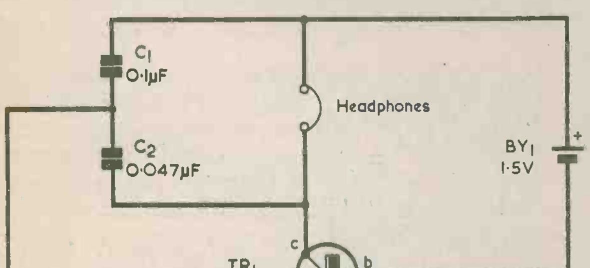



*Fig. 1. The basic circuit of the oscillator. Despite its simplicity it functions satisfactorily with headphones of the type specified in the text*

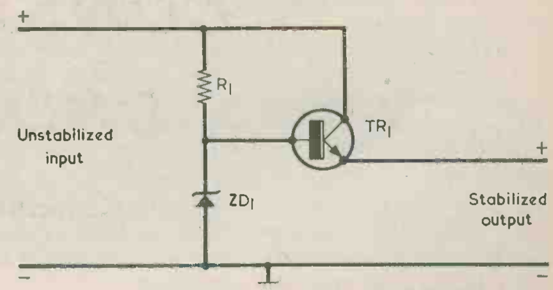



*Fig. 2. The oscillator employs the Colpitts configuration, in which an earthy tap is made into the capacitive side of the tuned circuit*

The circuit is actually a Colpitts oscillator, in which an earthy tap is made into the capacitive side of the tuned circuit. In Fig. 1 this tap is at the junction of C1 and C2. If it is assumed that BY1 has negligible impedance at oscillator frequency the signal-carrying part of the circuit can be redrawn as in Fig. 2. By looking upon the transmitter emitter as the earthy point of the circuit, it can be seen that there is positive feedback from the collector to the base, with the base being 180 degrees out of phase with the collector as is required for regeneration.

## COMPONENT VALUES

The oscillator works best with 4,000Ω headphones and the component values shown. It will work in many cases with single magnetic earpieces having impedances of 1,000Ω or more, but it may then be necessary to increase the voltage of BY1 to 3 volts for satisfactory operation. Single earpieces will almost certainly have inductances lower than that given by 4,000Ω headphones, whereupon the oscillation frequency will be higher than 1kHz. The frequency can be lowered by experimentally increasing the values of C1 and C2.

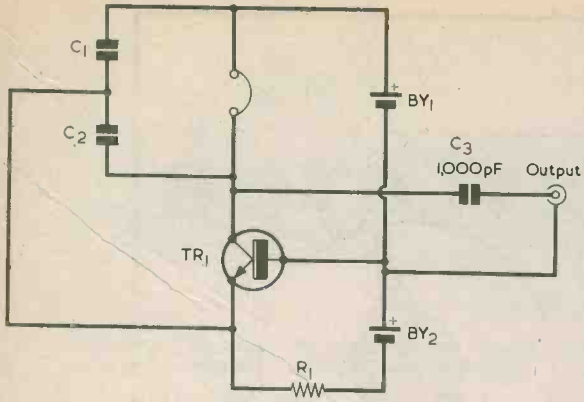



*Fig. 3. Adding a series output capacitor enables the oscillator to function as an a.f. signal generator*

C2 should always have a value which lies between a quarter and a half of the value of C1.

The current drawn for both BY1 and BY2 is about 0.1mA. This is to be expected since there will be a voltage drop of slightly less than 0.6 volt in the base-emitter junction of the transistor. The remaining voltage, about 1 volt, then appears across the 10kΩ resistor R1; and 1 volt across 10kΩ gives a current of 0.1mA. The collector current will be virtually the same as the emitter current.

An a.f. output can be taken from the oscillator by using the circuit shown in Fig. 3, in which a 1,000pF d.c. blocking output capacitor has been added. The output should preferably couple into a circuit having an input resistance of 5kΩ or more, although lower input resistances will not cause sufficient loading to stop the oscillator.

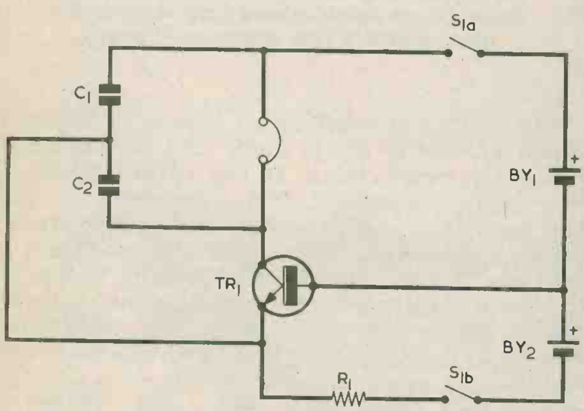



*Fig. 4. On-off switching is required if the oscillator is to be assembled in permanent form*

An on-off switch will be needed if the circuit is to be built up in permanent form. This can be a d.p.s.t. (double-pole single-throw) toggle type and is represented by S1(a) and S1(b) of Fig. 4. If the oscillator is to be used for morse practice the morse key may be inserted either in series with S1(a) or in series with S1(b). ■

# Parallel-R Box

**By J. L. Andrew**

**Analogue computer using two pots and a meter.**

One of the more tiresome tasks in electronics is the calculation of parallel resistance values. You are in a hurry to get your new super blockbuster amplifier finally completed and all you want is one 22kΩ resistor. But the nearest value the spares box will yield is a 33kΩ resistor and a number of assorted resistors of higher value. Now, there is no reason why, as a stop-gap expedient, you couldn't use a parallel combination of that 33kΩ resistor and another resistor to make up a temporary 22kΩ resistance unit. This can then be replaced later by a proper 22kΩ resistor after you have called on your local components shop or sent off your next mail-order list.

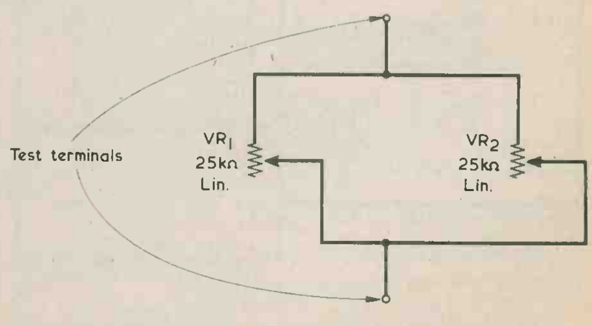



*Fig. 1. The circuit of the parallel-R box. A multimeter switched to a suitable ohms range connects to the test terminals*

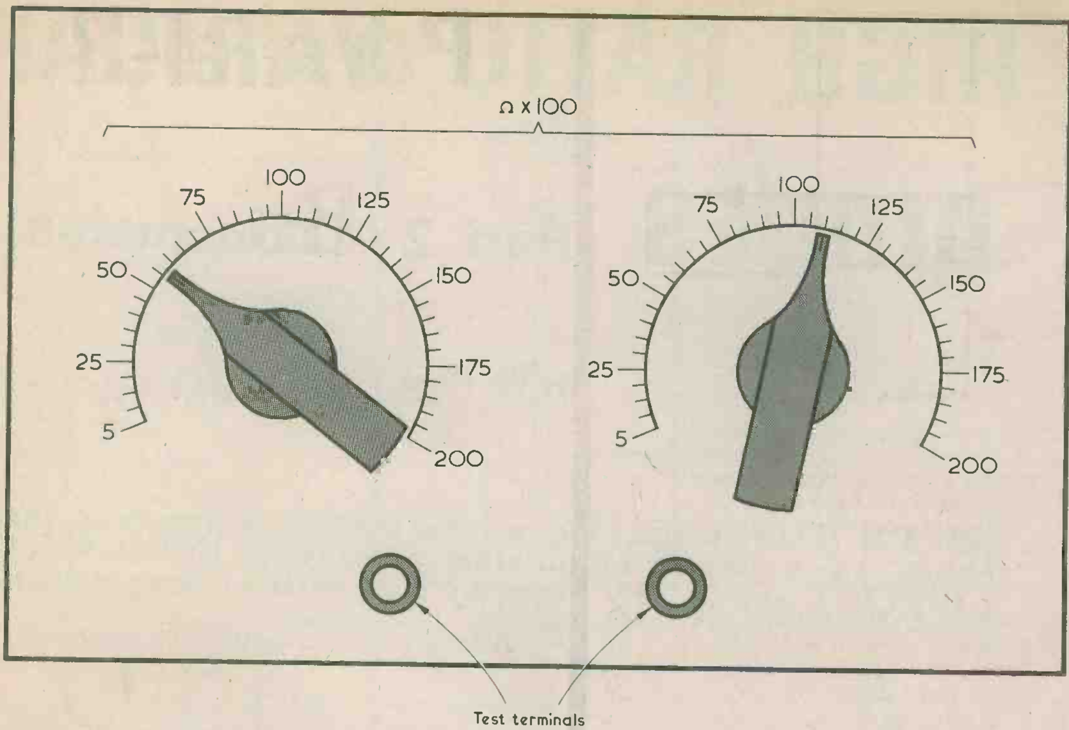



*Fig. 2. A front panel layout for the box. The panel can be covered with a sheet of white card on which the scales are marked out. The legend at the top acts as a reminder that units are in hundreds of ohms*

## FINDING THE VALUE

Everything seems rosy until you start to work out the value of resistance which, in shunt with 33k Ω, gives 22k Ω. The equation for two resistors in parallel is:

$$RA = \frac{RB \times RC}{RB + RC}$$

where RA is the total resistance and RB and RC are the individual resistances in parallel. RA is 22k Ω and RB can be 33kΩ, so all you have to do is find RC. Ahem!

If you don't mind permanently tying up two potentiometers and if you have a multimeter with a resistance range or ranges covering 250 Ω to 10k Ω you can make up a very simple test unit which very quickly solves any parallel-R problem you are likely to encounter in the future. The circuit, which could hardly be simpler, is given in Fig. 1, and the two potentiometers are fitted in a box with pointer knobs and scales, as in Fig. 2. A multimeter switched tc a suitable ohms range connects to the two test terminals. The potentiometers have been previously calibrated and the scales indicate the resistance they insert into circuit in hundreds of ohms. Thus, the "5" calibration point corresponds to 500 Ω and the "200" calibration point to 20kΩ.

To solve the 22kΩ problem you connect the multimeter to the test terminals, set one potentiometer to 33, adjust the other until the meter reads 2.2kΩ and note the position of the potentiometer scale marking. This will be just mid-way between 65 and 70, and so a suitable resistance to connect in parallel with 33kΩ to give 22kΩ is 68kΩ.

These readings similarly show that 3.3kΩ and 6.8kΩ in parallel give 2.2kΩ or that 330kΩ and 680kΩ in parallel give 220kΩ. You just move the decimal point the same number of digits with all the three values. The range of 5 to 200 in each potentiometer gives more than ample scope for the resistance calculations likely to be encountered in practice.

Each potentiometer is calibrated (with the other one disconnected, of course) by means of the multimeter. The more accurate the multimeter, the more accurate will be the overall results obtained. However, using the same multimeter for calibration and for final use will tend to neutralise any inherent errors in the meter itself.

The parallel-R box can also be used to find the overall value of capacitors in series, where the same equation applies. It will tell you, for instance, that 33pF and 68pF in series give 22pF overall.

The two potentiometers are standard panel-mounting carbon types. 25kΩ components are specified rather than the more common 22kΩ types. This is because the normal tolerance on potentiometer track values is 20% and, if you bought new 22kΩ potentiometers you may be unlucky enough to find that one or both were near the lower end of the tolerance and could not give 20k Ω at the maximum setting. If, however, you have a 22kΩ potentiometer on hand and it does offer 20kΩ then it would be perfectly in order to use it. ■

# HIGH RATIO VARICAP DIODES Part 2 (Conclusion)

By W. Poel

**AN A.M. TUNER for long waves, medium waves and three short wave bands employing only ONE INTEGRATED CIRCUIT and is fully tuned by high ratio varicap diodes.**

Radio i.c.'s are available from most manufacturers these days, and some of these may require exhaustive testing and development to evolve a satisfactory working model. But there is now available an exceptionally stable device offering a high performance and all the facilities that are required — the HA1197.

## A. M. TUNER

A circuit for an a.m. tuner based on this i.c. is given in Fig. 10. As can be seen, the r.f. amplifier, oscillator, mixer, i.f. amplifier and detector are all integrated into one package. Furthermore, an 80dB a.g.c. loop is provided, giving quite exceptional control for short wave listening. By fitting the appropriate coils for signal and oscillator frequencies, any of the following bands can be covered.

Band A, 150 to 300 kHz, LW,
Band B, 525 to 1,605 kHz, MW,
Band C, 1,600 to 4,000 kHz, SW1,
Band D, 4 to 14 MHz, SW2,
Band E, 14 to 30 MHz, SW3.

If desired, a crystal oscillator may be employed when it is intended to monitor one particular channel continuously. Sensitivity is 4 to 6$\mu$V at 1.6MHz and 8 to 10$\mu$V at 21MHz for a weighted signal-noise ratio of 26dB. Band switching facilities are not provided; the complications introduced would be enormous and it is debatable if they would be even worth-while when so much radio performance can be squeezed onto the very small printed board which is all that the tuner requires. Indeed, it is attractive to consider employing a separate board for each band. Each board could have its own separate optimized antenna and there would be no r.f. band switching. Construction and alignment would then be a relatively simple matter when compared with the procedures adopted with switched short wave and communications receivers.

The only r.f. switching would be for an s.s.b. demodulator, which it is hoped will be the subject of a later article.

## THE CIRCUIT

The input circuits comprise a bandpass top-capacitively coupled filter. Cc is the top-coupling capacitor and, on Bands B and C, can have a value of 8.2pF. 100pF will be satisfactory for Band A, and 2.2pF for the remaining Bands. Lower or, indeed, higher values can be used, remembering that increasing the capacitance gives higher gain but reduces selectivity, and vice versa.

The two tuned circuits are tuned by varicaps (surprise) and are coupled to the i.c. at pin 2. It was decided to employ a bandpass pair of tuned circuits at the input rather than tune the r.f. output at pin 4, since the amplified r.f. voltages with strong signals could have caused the cross-modulation effect described last month. All Bands are fed from long wire type antennas at an average impedance of 75 Ω.

From the internal r.f. stage the signal passes into the mixer at pin 7. The oscillator at pins 5 and 6 then mixes with the signal to produce an i.f. of 470kHz. The oscillator frequency is above signal frequency. The i.f. passes through the CFU ceramic i.f. filter before further i.f. amplification and detection inside the i.c. The a.g.c. input at pin 14 is controlled by the external time constant components. This voltage is internally fed to the meter driver stage, to provide a logarithmic meter reading which is surprisingly consistent over an 80dB range.

This last feature lends the receiver to panoramic adaptor uses, where the Band is electronically tuned in synchronism with an oscilloscope to display signals and their relative amplitudes, as illustrated in Fig. 11. Electronic tuning is readily applicable to these extensions and it is anticipated that, as the use of the unique MVAM series of high capacitance ratio varactor diodes spreads, so will the electronic adaptions which provide automatic tuning, panoramic displays — and even microprocessor control. The author would be pleased to hear of any readers' adaptations and extensions that take advantage of the d.c. tuning system of the receiver module.

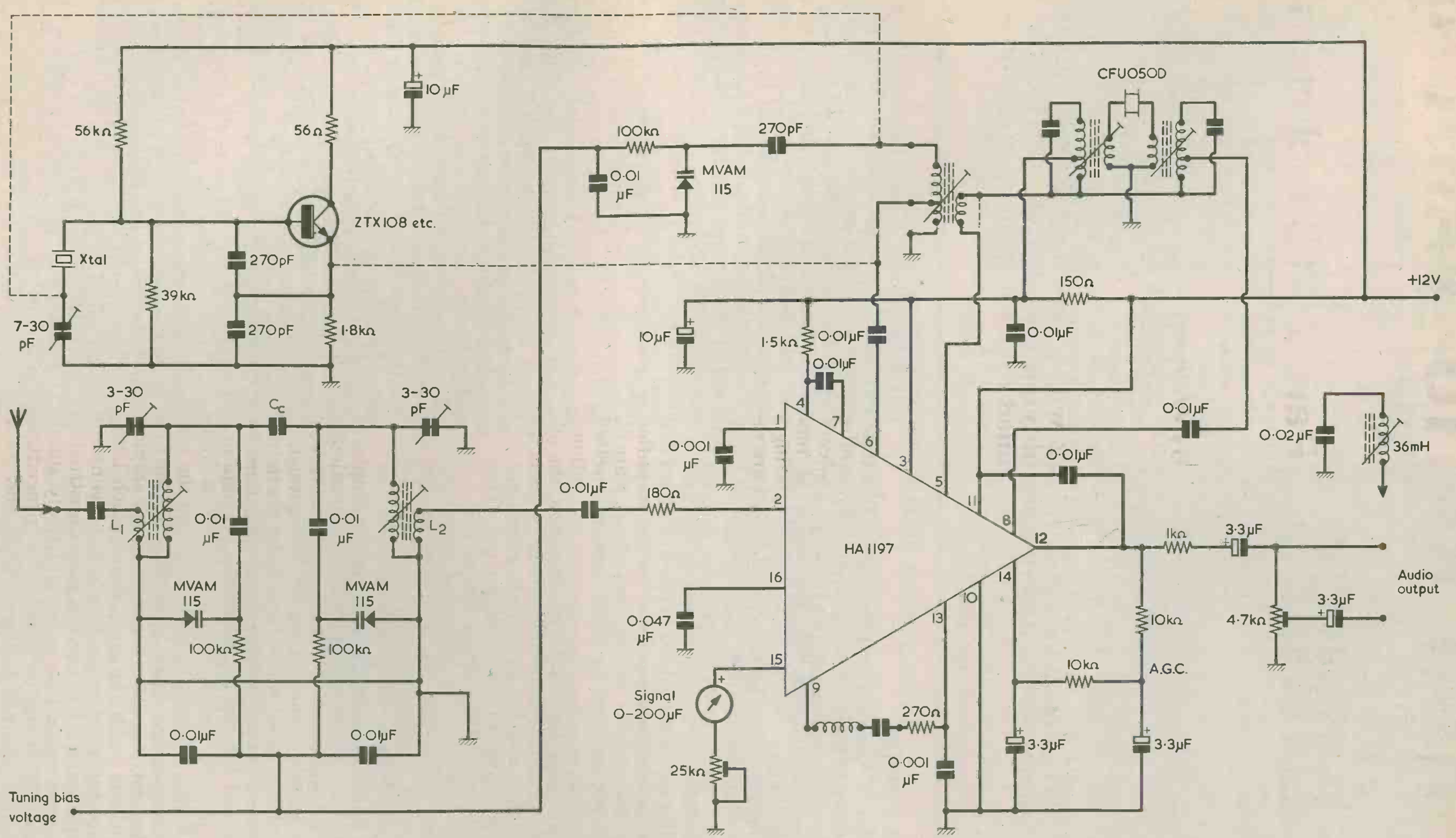



*Fig. 10. The circuit of an a.m. tuner which, by choice of suitable coils in the L1, L2 and oscillator positions, is capable of reception over the long wave band, the medium wave band or one of three short wave bands*

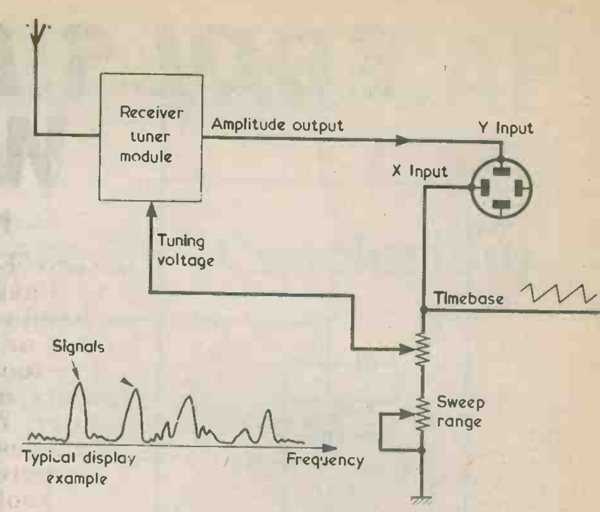



*Fig. 11. Receivers tuned by varicap diodes lend themselves readily to panoramic display systems. Here, an oscilloscope timebase sweeps the receiver over the band of interest, whereupon the c.r.t. trace reveals the presence and amplitude of signals within the band*

## PRACTICAL POINTS

It is essential that the circuit be assembled on a specially designed printed circuit board, and such a board can be obtained from Ambit International, who can also supply the coils, varicap diodes and the integrated circuit.

If crystal control of the oscillator is required, the oscillator coil coupling to pins 5 and 6 of the i.c. is omitted. Pin 5 then connects direct to the ceramic filter unit, as shown by the right hand dotted line, and the 0.01$\mu$F capacitor coupled to pin 6 connects to the emitter of the crystal oscillator transistor, as indicated by the bottom dotted line. Also, the varicap diodes are replaced by fixed capacitors of appropriate values.

For varicap tuning the crystal components are omitted, apart from the 7-30pF trimmer capacitor. This capacitor then couples, by way of a short rigid wire below the board, to the oscillator coil. This connection is shown by the upper dotted line.

Two audio outputs are provided, one unattenuated and the other via a 4.7k $\Omega$ pre-set potentiometer. An audio notch filter consisting of the 36mH coil and the series 0.02$\mu$F capacitor can be connected to the unattenuated output for short wave listening, where adjacent channel heterodynes are usually at 8kHz. Tuning of the notch filter is simply accomplished by tuning the unit to a broadcast signal with a loud heterodyne whistle from an adjacent channel, and then adjusting the core of the coil for minimum whistle.

## SETTING UP

When the circuit has been assembled in its varicap tuning form, alignment is simple enough to accomplish without much test equipment. It is anticipated that readers with signal generators, frequency counters and the like will not need instructing in how to use these. For those without, the following procedure should be followed.

Attach an audio amplifier with 100mV sensitivity (such as the LM380 i.c. amplifier, for instance) to the output, and apply a moistened fingertip to pin 2 of the i.c. Much general hash and radio noise will be heard, and this can be peaked by minor adjustment of the ceramic filter and i.f. (brown) coil. Adjustment of the brown cored coil is quite broad but the filter core is more precise. The cores should not be adjusted by more than half a turn in either direction if nothing can be heard, since the chances are that a fault lies elsewhere.

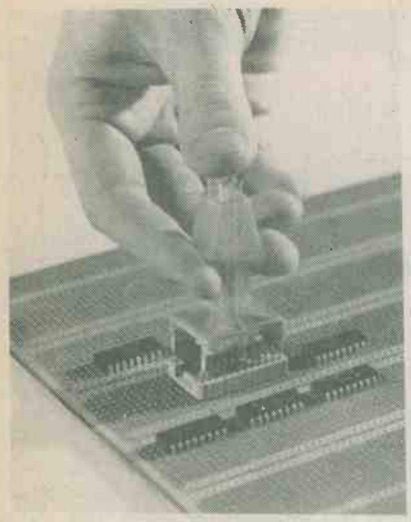
Next, set the tuning voltage to the maximum bias end of its range and try to locate a transmission of known frequency. If long wave or medium wave coils have been fitted this should provide no great problem, whilst on short waves a suitable signal may need greater selection. Starting at minimum capacitance, the trimmers may be closed gradually to peak the signal, as displayed on the signal level meter. If the signal cannot thus be peaked slightly adjust the cores of the coils as required. Now change the tuning bias to 2 volts, which should be the minimum used, and look for a signal to peak at the low frequency end of the chosen band.

For these tests, ten feet of wire antenna should be sufficient. If you need to use a feeder remember that the impedance of a short wire at much less that a quarter wavelength is very high, so some form of impedance matching network, such as a pi-network or aerial tuning unit, is desirable. On long waves the possibility of the impedance of a short antenna loading the primary of input transformer L1 is slight, so you may bypass the coupling winding and connect the aerial direct to the top of the tuned winding without seriously affecting the tuning — but increasing the gain considerably. (The impedance at the non-earthy end of a parallel tuned circuit is extremely high at resonance.)

The 270pF capacitor between the oscillator tuned coil and the varicap diode is the correct padding value for medium waves. For the SW1 band the capacitor should be changed to a value of 680pF, and to 1,000pF on the SW2 and SW3 bands. The 270pF capacitor is retained on the LW band, and a 220pF capacitor is connected across the oscillator tuned coil to lower the frequency by an appropriate amount.

*(Concluded)*

# TOOLS FOR THE WORKSHOP



## NEW TOOL PROTECTS ICs

Vero Electronics of Industrial Estate, Chandler's Ford, Eastleigh, Hants, have introduced a new and simple hand tool for the insertion of integrated circuits into boards or sockets.

The tool is moulded from orange polycarbonate, and consists of a DIP holder body and a spring-loaded plunger. When a DIP is located in the holder, the close tolerances ensure that the normal splay of the DIP leads is corrected, in order to give trouble-free insertion. Use of the tool not only avoids the risk of lead damage encountered with manual insertion, but also protects contact surfaces from contamination by moisture, chemicals, or grease which could otherwise be left by finger contact.

Two sizes of tool are available, one for 8, 14, and 16-way devices, and the other for 24-way.

## STIREX CUTTERS NOW AVAILABLE

Tele-Production Tools Ltd., announces the availability of the C-10 and C-2 Stirex cutters. Designed with the 'Easy Grip' self-opening handles, they incorporate a finger tip operating technique which helps to reduce operation fatigue.

The cutters are ideal for use in the laboratory, production line and workshop or in craft applications. They can cut copper wire or component leads of up to one millimetre.

Weighing 18 grammes, the C-10 features a lay-on joint with a knife edge of eight millimetres and an overall length of 145 millimetres. The C-2 cutter has a lap joint, a seven millimetre cutting edge and a total length of 150 millimetres.

The Stirex cutters are assembled and marketed in the U.K. by Tele-Production Tools Ltd, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW.

## NEW DESIGN IN PLIERS

Elliott Lucas Limited, a James Neill hand tool company and one of the country's leading manufacturers of pliers and pincers for over 60 years, has introduced a radically new type of plier design with its 300 Super Series. New handle shape for greater leverage, slip-free grip, extra-tough induction hardened cutting edges, metal-bonded finish and a long-life hinge are features which distinguish the seven pliers in the 3000 range.

For use equally by home handymen and women as well as by general and electrical engineers, prices range from £2.86 to £3.98, but for a limited period James Neill is offering 30p off the price of all models. The range is available throughout the country in selected hardware and D.I.Y. shops, as well as many department stores.

## Mail Order Protection Scheme

The publishers of this magazine have given to the Director General of Fair Trading an undertaking to refund money sent by readers in response to mail order advertisements placed in this magazine by mail order traders who fail to supply goods or refund money and who have become the subject of liquidation or bankruptcy proceedings. These refunds are made voluntarily and are subject to proof that payment was made to the advertiser for goods ordered through an advertisement in this magazine. The arrangement does not apply to any failure to supply goods advertised in a catalogue or direct mail solicitation.

If a mail order trader fails, readers are advised to lodge a claim with the Advertisement Manager of this magazine within 3 months of the appearance of the advertisement.

For the purpose of this scheme mail order advertising is defined as:

"Direct response advertisements, display or postal bargains where cash has to be sent in advance of goods being delivered."

Classified and catalogue mail order advertising are excluded.

# CMOS Precedence Monitor

By D. Snaith

**Simple low-cost circuit drawing virtually zero standby current.**

Precedence monitors, in which an l.e.d. readout indicates which of two buttons has been pressed first, are not new to the pages of electronic journals. They lend themselves readily to use in quizzes and in contests in which the first person to press his button on receipt of a stimulus is the winner. Precedence monitors also have more serious applications in the investigation of switch and relay functioning.

The precedence monitor described here is suitable for two push-buttons, uses cheap readily available components and draws almost zero quiescent current from its 6 volt battery supply.

## NAND GATE

The monitor circuit is given in Fig. 1, and it employs a CMOS quad 2-input NAND gate type CD4011. To understand circuit functioning it is merely necessary to remember that the output voltage of a NAND gate goes low only when all its input voltages are high.

The monitor is switched on by means of S4, power being applied to the i.c. at pin 14 (positive) and pin 7 (negative). Pin 2 of gate G1 is held low via R3, whereupon the output at pin 3 must be high. This high output is fed to G2 which functions as an inverter, causing its output at pin 4 to be low.

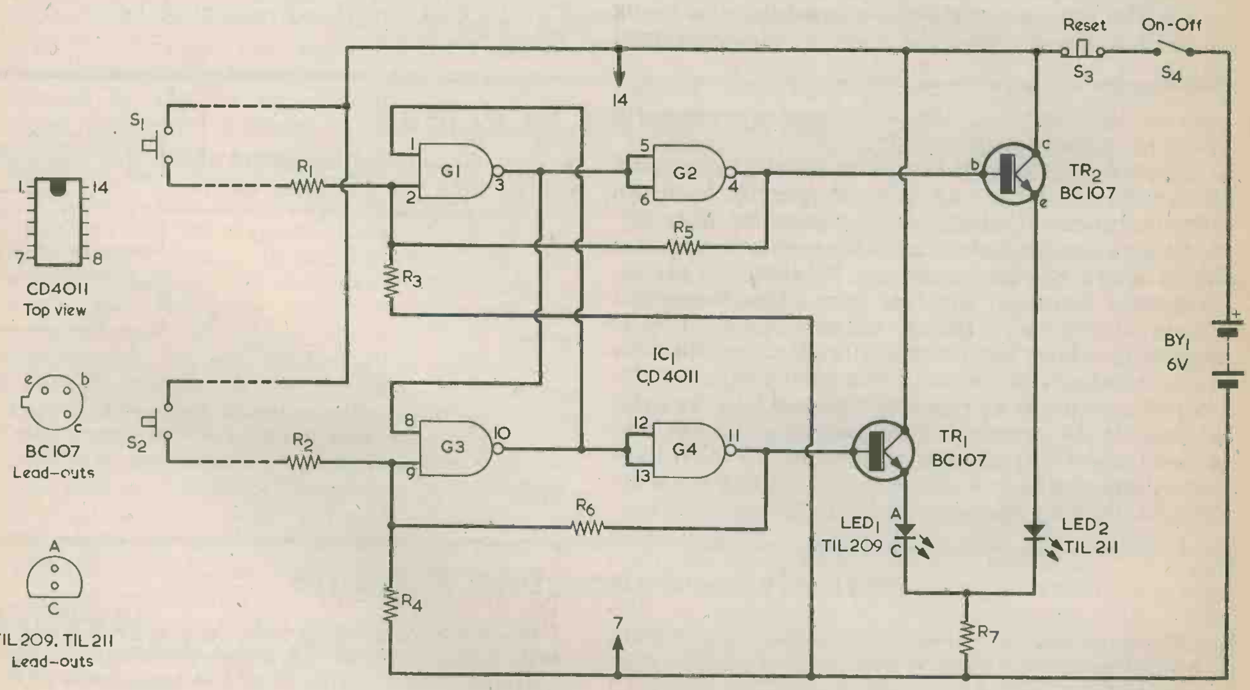



*Fig. 1. The circuit of the precedence monitor. The four gates of the CD4011 form two separate latches, each being inhibited when the other latch changes state.*

## COMPONENTS

*Resistors*
(All ¼ watt 10%)
R1 10k Ω
R2 10k Ω
R3 1M Ω
R4 1M Ω
R5 47k Ω
R6 47k Ω
R7 270 Ω

*Semiconductors*
IC1 CD4011
TR1 BC107
TR2 BC107
LED1 TIL209
LED2 TIL211

*Switches*
S1 push-button, press to close
S2 push-button, press to close
S3 push-button, press to open
S4 s.p.s.t., toggle

*Battery*
BY1 6 volt battery

Pin 4 couples back to pin 2 via R5, and G1 and G2 are therefore stably latched into their existing state, with the low at pin 2 via R3 being reinforced by the low passed to it via R5.

G3 and G4 are in an identical circuit, and G3 input at pin 9 and G4 output at pin 11 are similarly latched in the low condition.

The high output at pin 3 of G1 is coupled to pin 8 of G3. At the same time the high G3 output at pin 10 is cross-coupled to the G1 input at pin 1.

If, now, push-button S1 is pressed, it passes a high voltage via R1 to pin 2 of G1. Both of G1 inputs are now high, with the result that its output goes low and the output of G2 goes high. If S1 is released, G1 and G2 remain latched in this new state because pin 2 of G1 is still held high via R5. The high output at pin 4 is passed to the emitter follower TR2 and the emitter of this transistor also takes up a high potential, causing LED2 to light up. Thus, even a momentary closure at S1 results in LED2 being continually illuminated.

When G1 and G2 change over to the new state pin 3 of G1 goes low. So also, in consequence, does pin 8 of G3, and it is then impossible to cause G3 and G4 to change state by closing S2. If, on the other hand, S2 had been pressed first, G3 and G4 would have changed state and LED1 would be continually illuminated. The consequent low at pin 10 of G3 would then be passed to pin 1 of G1, and G1 would be inhibited.

Thus, if S1 is pressed first, LED2 lights up and stays illuminated. If S2 is pressed first it is LED1 which lights up and remains in this condition. The circuit is brought back to its previous state by pressing the Reset button, S3. This breaks the supply to the gates, and when it is released the gates commence operation latched in their first condition.

## RESISTOR VALUES

Resistors R5 and R6 limit output current at pins 4 and 11 of G2 and G4 respectively. Resistors R1 and R2 are not really necessary, but they limit any input current which can flow in the, admittedly rather unlikely, possibility of high static voltages being picked up by the leads to S1 and S2. The values of R1 to R6 are such that, when pin 2 or pin 9 is high, the voltage on the pin is well in excess of two-thirds of supply voltage.

R7 is the current limiting resistor for the two light-emitting diodes. Since only one l.e.d. is ever alight, only one resistor is required. LED1 is a red TIL209 and LED2 is a green TIL211. Other small l.e.d.'s of different colours could alternatively be employed.

In practical form, the circuit is assembled in any suitable small case with S3, S4 and the two l.e.d.'s mounted on the front panel. S1 and S2 are coupled to the case via lengths of twin flex. If the leads to S1 and S2 are very long, say longer than 20 feet or so, it may be preferable to couple these switches to the case by means of screened cable, as shown in Fig. 2. The braiding of each cable connects to the positive supply rail and screens the lead connecting to the appropriate gate input. Flexible audio screened cable will be quite satisfactory.

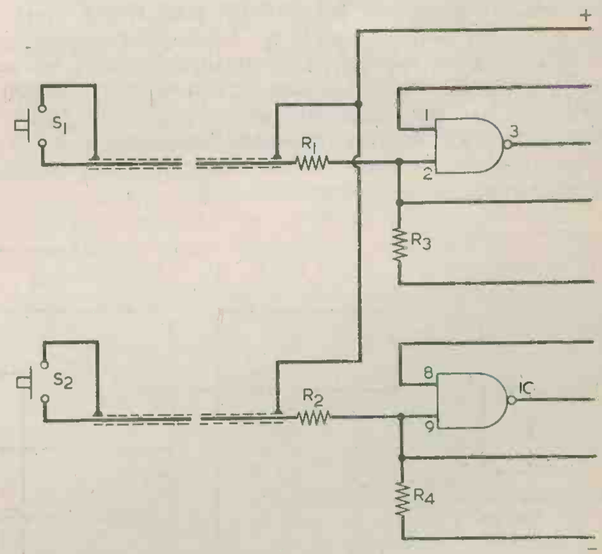



*Fig. 2. In instances where the leads to S1 and S2 are very long it is advisable to couple them to the main part of the circuit by way of screened cable.*

The current drawn from the 6 volt battery before either S1 or S2 is operated is negligibly low, being typically 0.005μA. After one of these push-buttons has been pressed the current is that drawn by the illuminated l.e.d., and is about 12mA.

The CD4011 integrated circuit should have its inputs protected against high static voltages during construction. A good approach here consists of wiring up to a 14 pin i.c. holder, into which the i.c. is plugged after all connections have been completed. ■

# R.C. '53

**By D. E. Attwood**

## Flashback over nearly a quarter of a century

How many years have you been reading *Radio & Electronics Constructor* or, as it was called until August 1972, *The Radio Constructor?* The writer recently came across a tattered copy of *The Radio Constructor* for June 1953 and it has a certain fascination, now that the Jubilee year is just over, since it was something of a "Coronation" issue. G6MN offered special "Coronation design" QSL cards for sale, and "See the Coronation on Large Screen TV," enthused Lasky's Radio. In those days Lasky's Radio was a component shop in N.W. London and a far cry from the string of audio supermarkets it has since become.

### HOME CONSTRUCTED TV

for this was the heyday of the home constructed TV receiver, or 'televisor', as it was often called then; a facet of the hobby which has since sadly almost totally disappeared. Operation was of course on v.h.f. 405 lines. Glancing through the pages one realises the advances in television technology made during the past 25 years. "Did you build your own TV receiver?" enquires an advertisement for English Electric cathode ray tubes. "If you have a

*How we appeared some 25 years ago. The cover, showing the Royal Emblem in Royal Blue and Gold, was specially designed for the June 1953 issue*

9in. or 12in. set and want to convert to big screen viewing, how better than by using an English Electric 16in. tube . . ." A feature of this tube was the "wide angle scanning", namely 70 degrees!

"Many amateur TV experimenters have managed to get really well defined pictures from their war surplus 6in. c.r.t. receivers," remarks the author of a short article on the problems of astigmatism in electrostatic tubes. June 1953 also saw Part 1 of "The Universal Large Screen Televisor"; this was an a.c./d.c. design for, as was pointed out in the first paragraph, "many people are still tied down to the limitations imposed by d.c. mains."

Henry's Radio were offering a set of valves for a "personal" TV receiver incorporating the $2\frac{1}{2}$in. 3BP1 tube, which has reappeared quite recently in these pages (September to November 1975) in the "New Transistorised Oscilloscope" design.

A glimpse of future developments was provided by a short news item which announced that "speaking at the Television Society's Annual Dinner on April 13th, Sir Robert Renwick, President of the Society, said they would shortly be building an experimental 625 line transmitter in order to provide a service to both amateurs and the radio industry."

"Centre Tap", writing in "Radio Miscellany", mentioned the likelihood of sponsored (i.e. commercial) television in the future and discussed the feasibility of 3D and colour television. He pointed out that the most direct way of adding colour to the existing system was by means of coloured filters rotating in synchronisation in front of both camera and receiving tube, but noted that RCA were developing an all-electronic system employing a 3-gun tube.

## "CONDENSERS"

What else? In the early 50's the magazine had a page size only about $8\frac{1}{2}$ by $5\frac{1}{2}$in., *The Radio Amateur* was a separate companion journal, capacitors were unashamedly called "condensers" and the valve reigned supreme (and these were mostly Octal types like the 6V6 or B8A like the EL41). Smithy and Dick had yet to arrive on the scene, but G. A. French's "Suggested Circuit" series had reached No. 30: "An Accurate Null Indicator". Transistors were not to become generally available to home constructors for several years, and when they did were at first extremely expensive. (In 1957 a humble OC71 would have cost you about £1.10s.; nowadays a BC109 with 10 times the gain is about 10p. so there is something to be said for progress.) The vast popularity of small transistor radio kits blossomed in the late 50's and early 60's, and many of the electrical gadgets we are familiar with today were only made an economical proposition by the arrival of the semiconductor. In 1953 the main features were sound radio (usually mains operated, for a battery valve receiver was heavy and expensive to run), amplifiers and, as we have seen, TV. The June issue, however, included an article on electromechanical equipment for radio control.

Whatever the design, readers would, needless to say, be building it on a chassis, but G3IIZ had been to the 1953 Radio Component Exhibition, and reported that on show was the first printed circuitry he had seen " 'in the flesh' so to speak".

For the home constructor, then, change was clearly in the air. But here, in conclusion, is "Centre Tap" again, on the future of the British Electronics Industry.

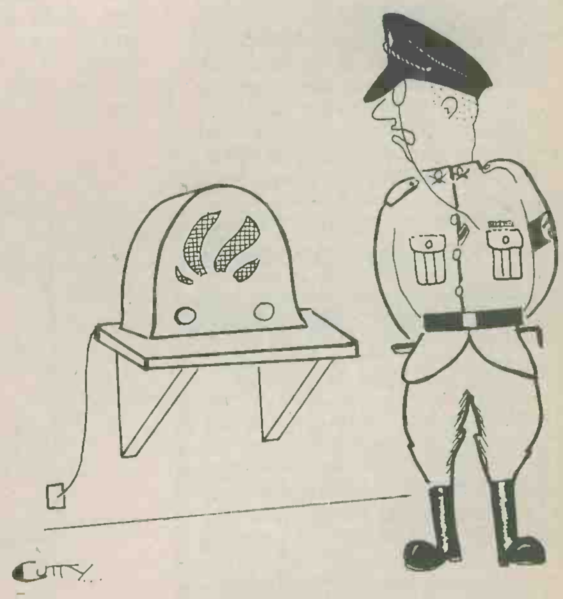
"We must regain our diminishing lead in technical developments. A couple of years ago we, and America, had a very long lead over the rest of the world. But TV has expanded rapidly since then . . . the sales of our receivers has not been in proportion. With the entry of Japan into the receiver market at cheaper prices, the need for retaining our technical superiority becomes paramount." 25 years later, the wisdom of those words is surely painfully evident. ■

## CONSTRUCTOR'S CROSSWORD — SOLUTION

**ACROSS** — 1, Injector. 5, Scorch. 9, Engineer. 10, Breaks. 12, Theory. 13, Rheostat. 15, Electron-volt. 18, Cross-section. 22, Earphone. 23, Groove. 26, Toroid. 27, Customer. 28, Resets. 29, Lead-acid.

**DOWN** — 1, Inert. 2, Jugfet. 3, Control. 4, Open. 6, Car Horn. 7, Reaction. 8, Hesitate. 11, Charity. 14, Screens. 16, Acceptor. 17, Four Arms. 19, Schmitt. 20, Oersted. 21, Cosmic. 24, Erred. 25, Fuse.

*Notes on the answers.* An electron-volt is the energy acquired by an electron in passing through a potential difference of 1 volt. In domestic electronic equipment, accessible adjustments are often called the customer controls. A jugfet is a junction gate field-effect transistor. A basic Wheatstone bridge has six arms: the four resistances, the null indicator and the source of energising current. Cosmic rays reaching the earth are elemental particles.




*"I'm warning you, I have vays of making you talk'*

In your work-shop

# An Electronic NIM Game

**Smithy devises an easy electronic game which can be used as a demonstration model for simple ideas in maths**

"Games," stated Dick. "Everything in electronics these days seems to be games."

Smithy took an enormous bite of his pork-pie, and proceeded to chew it.

"That," he remarked indistinctly, "is a pretty inevitable development with electronics at its present level."

Reluctantly, Dick allowed his eyes to wander over the busily champing lower jaw of the Serviceman.

"If you only knew," he remarked critically, "just how repulsive you look when you're eating your lunch, you'd have them put screens up around you or something. And why do you always take so long chewing everything you put in your mouth?"

With a convulsive movement of his Adam's apple, Smithy swallowed the now thoroughly masticated pork pie.

"It's my false choppers," he explained cheerfully. "When you've got false choppers like I've got you can't chew sideways. You can only chew up and down, so it's bound to take longer."

## NIM GAME

Smithy popped the last of his pork-pie into his mouth, whereupon Dick hastily averted his eyes and waited until this was eventually dispatched. When he heard the sound of a tin mug being lifted from the bench and the subsequent smacking of Smithy's lips he turned his gaze, with relief, back to the Serviceman.

"Now that my daily lunch-time ordeal is over," he remarked, "what do you mean when you say that electronic games are an inevitable development?"

"It stands to reason," stated Smithy, wiping his mouth with the back of his hand. "Engineers these days have got things like integrated circuits, light-emitting diodes and seven-segment displays to lark around with. These don't have to be used *always* for serious purposes, and there's no reason whatsoever why they shouldn't be employed also in either simple or quite complicated games. It's funny that you should have raised the subject of games incidentally, because I spent last night putting the finishing touches to a little game of my own design. If we hadn't been so busy this morning I'd have shown it to you earlier. Anyway, here it is."

Smithy opened the door of the cupboard under his bench and reached inside. He took out a shallow plastic case and, straightening up, placed it on the surface of his bench. His ever-latent curiosity aroused, Dick picked up his stool, placed it alongside Smithy and examined the Serviceman's handiwork keenly.

On the front panel of the case, which was about 8 inches long by 4½ inches wide, were fitted three rows of six miniature toggle switches, with three light-emitting diodes in panel-mounting bushes at the right of each row. A further switch, graced by the legends "Off" and "On", appeared at the bottom of the panel. (Fig. 1.)

"What on earth is this?"

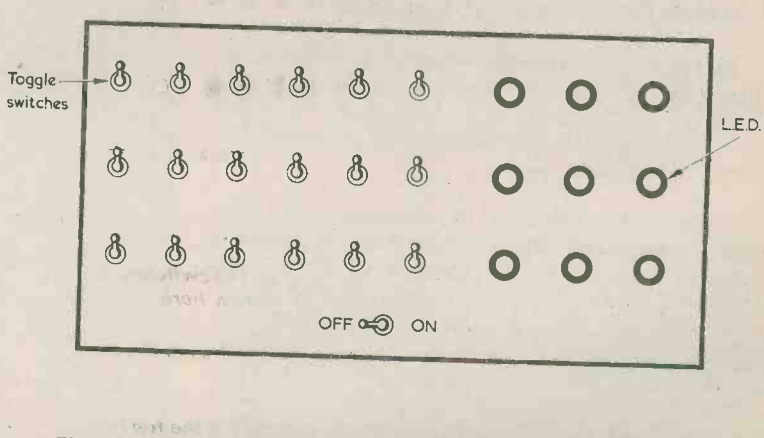



*Fig. 1. The front panel layout of the NIM game. There are two players, each of which puts down any number of switches in a single row. The loser is the person who puts down the last switch*

"It's my electronic NIM game," replied Smithy proudly. "It's rather an easy game really, and it's just a little more advanced than, say, noughts and crosses. But when it's all dressed up with switches and l.e.d.'s it becomes quite attractive, particularly with non-technical people. I've knocked it up for a chap I know at our local Tech who intends using it as a demonstration model for simple ideas in maths."

"How do you play it?"

"You start off," said Smithy, "with the dollies of the switches in the three rows all turned up. There are two players and each in turn then puts one or more switches down, the only proviso being that, with more than one switch, all the switches must be in the same row. The loser is the one who has to put down the last switch."

Dick looked unbelievingly at the Serviceman.

"Are you telling me," he stated incredulously, "that there's any skill in *that*? Why, *anyone* could move those switches so that the other player has to put down the last one. Blimey, I could do it on my head!"

"Could you?" queried Smithy gently. "Do you feel like having a trial run?"

"Too true I do," returned Dick boastfully. "It will take more than a silly game like this to beat me. Incidentally, what is there inside the case?"

"Only a 4.5 volt battery," replied Smithy, "and current limiting resistors for the l.e.d.'s on the front panel."

"They're something I hadn't thought of seriously," said Dick, regarding the light-emitting diodes with sudden distrust. "Why do you need l.e.d.'s in a game like this?"

"Well, they add a little interest," replied Smithy smoothly. "Okay, let's get started. All the switches are up, as they should be at the start of the game. Incidentally, when you put a switch or switches down in a row, you must always start with the left-hand one and proceed to the right. I'll switch on now."

Smithy set the switch at the bottom of the panel to "On". At once the left-hand and centre l.e.d.'s of each row lit up. (Fig.2(a).)

"All right, Smithy," said Dick magnanimously, "you can have first go."

"Thank you," replied Smithy, putting out his hand towards the panel.

He put down the first two switches at the left of the bottom

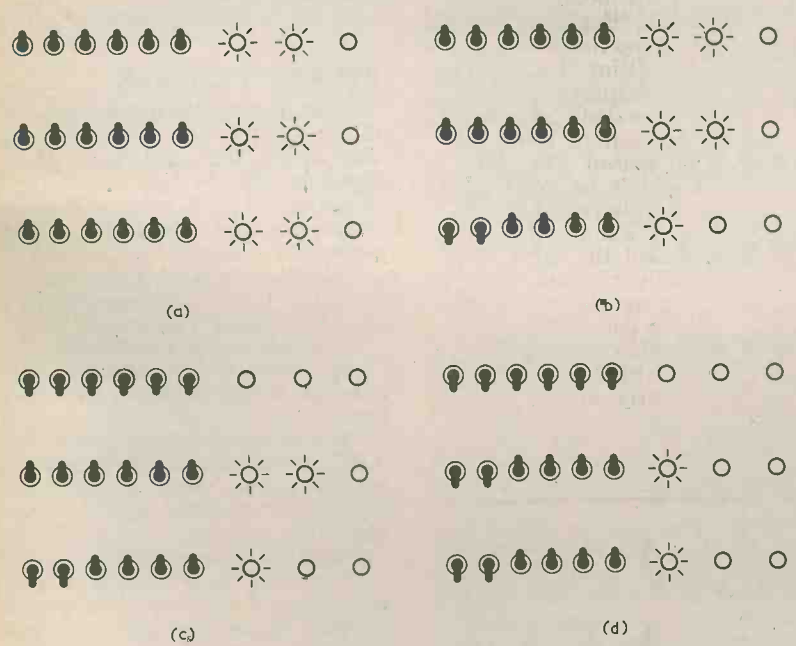



*Fig. 2(a). When the game is turned on initially, all the switches are up and the l.e.d.'s are illuminated as shown here.*

*(b). Smithy's first move was to set down two switches in the bottom row.*

*(c). Dick followed by putting down all the switches in the top row.*

*(d). Unknown to Dick, Smithy gained control by putting down two of the middle row switches.*

row. The centre l.e.d. in that row extinguished. (Fig.2(b).)

"Fair enough," commented Dick. "Did you say I could put down any number of switches?"

"I did," said Smithy, "provided they're all in one row."

"Right," replied Dick with alacrity. "Well, I'll soon get this game finished off. How about this, then?"

He reached forward and set down all the switches in the top row, then looked triumphantly at Smithy. All the three l.e.d.'s in the top row were now extinguished. (Fig.2(c).)

## FINAL MOVE

"That," remarked Smithy equably, "was quite a good move. Now, let's see what I shall do next."

He looked at the switches and l.e.d.'s reflectively, then put down the first two switches at the left-hand end of the centre row. After this, only the left-hand l.e.d. in the centre row remained lit. (Fig.2(d).)

"Your move," continued Smithy, looking at the l.e.d.'s with satisfaction.

"Okeydoke," returned Dick. "Let's try putting down the next two switches in the bottom row."

He leaned forward to put the switches down. The centre l.e.d. in the bottom row was now lit up on its own.(Fig.3(a).)

"Good," commented Smithy. "Now let me make my next move."

The Serviceman moved his hand over the panel and set down the next two switches in the middle row, whereupon only the centre l.e.d. in that row lit up. (Fig.3(b).)

"We're getting near the end now," stated Dick excitedly. "Get ready for defeat, Smithy!"

Gleefully, he pressed down the next switch in the middle row, with the result that the centre l.e.d. in the row extinguished and the right hand one became illuminated. (Fig.3(c).)

"Finished?" questioned Smithy.

"Yep!"

Smithy leaned forward and put down the last two switches in the bottom row. There now remained only the last switch of the centre row. (Fig.3(d).)

Dumbfoundedly, Dick stared at this switch.

"Hell's teeth," he snorted wrathfully, "you've left me the last switch! A dead easy game like this and I'm the loser!"

Disgustedly, he set down the last switch. The central right-hand l.e.d. extinguished.

"How in heck," he went on, "did you fix that? It's just a question of putting down switches and yet I had to be the mug who put the last one down!"

"I shouldn't worry about it," said Smithy soothingly. "After my second move you just didn't stand a chance of winning."

"Didn't I?" queried Dick suspiciously. He gazed broodingly at the switches and the l.e.d.'s. "I'm beginning to think that there's something fishy going on here. Knowing you, Smithy, you're bound to have some crafty secret tucked up your sleeve."

Smithy assumed a bland expression.

"Now what on earth could make you think a thing like that?"

"Just the fact that I know you. If ever they gave out a Nobel Prize for guile and cunning you'd hog it every year!"

"Nonesense," protested Smithy. "All I've done is show you an elementary game which incorporates switches and l.e.d.'s."

"That's true," admitted Dick reluctantly. "Hey, wait a minute, though. Why do we need the l.e.d.'s, anyway? If the game consists of putting down switches, you can tell which have been put down simply by looking at the switches themselves. There's something very dodgy about those l.e.d.'s."

Experimentally, he started setting up the switches in the top row, starting from the right. As he did so, he frowned down at the l.e.d.'s. Then, visited by a sudden inspiration, he returned all the switches to the down position and started setting them up again.

## BINARY FIGURES

"I've got it," he exclaimed exultantly. "I've got it! What those l.e.d.'s do is tell you in binary how many switches in a row are left up! When an l.e.d. is lit it represents binary 1, and when it's out it represents binary 0."

"That's very good," commented Smithy. "I must confess I didn't think you'd twig it as soon as this."

"Ah well," said Dick modestly, "I don't like to talk about myself but I'm really pretty bright, you know."

"I have no doubt about it."

"Did I tell you that it's only my bone structure which stopped me getting a top-notch job in journalism?"

"Your bone structure?"

"I could never master the technique of holding a telephone handset against my ear with my shoulder!"

"All right, all right," said Smithy hastily, "let's get back to this NIM game. As you so rightly point out, the switches are wired up to the l.e.d's so that the l.e.d's tell you, in binary, how many switches in a row are in the up position. If only one switch at the right hand end is up, only the right hand l.e.d. lights up to indicate binary 001. When two switches are up the centre l.e.d. comes alight, to give binary 010. As the number of switches in the up position increases, the binary

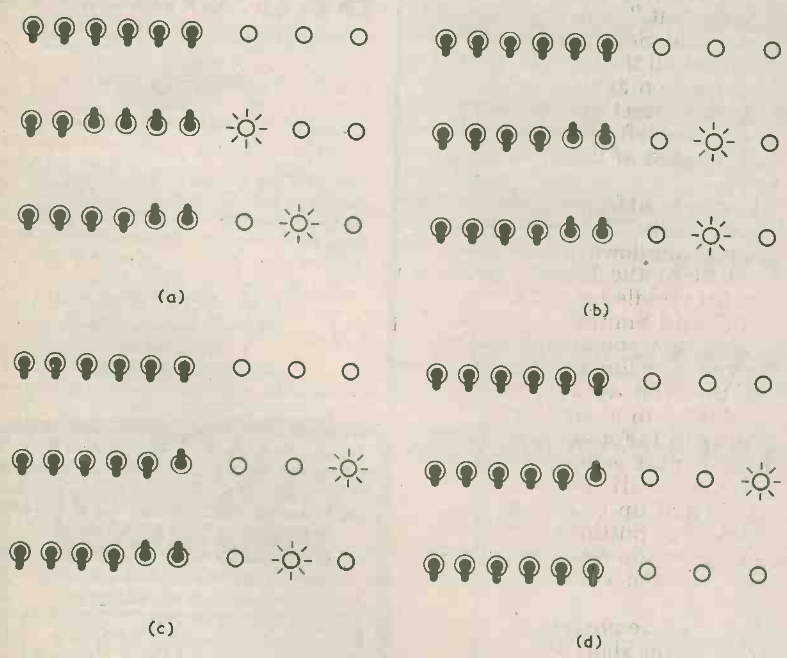



*Fig. 3(a). Continuing the game of Fig. 2, Dick put down two further switches in the bottom row.*
*(b). Smithy again took command by pressing down two more switches in the centre row*
*(c). Dick next put down the fifth switch in the middle row leaving the field open for Smithy to win the game.*
*(d). Smithy's final move left only one switch for Dick to set down.*

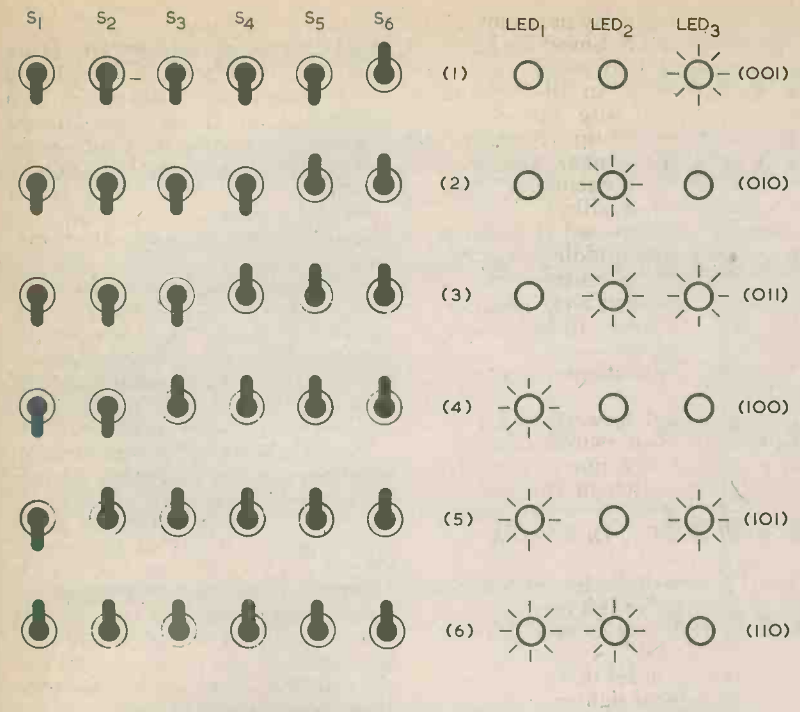



*Fig. 4. The l.e.d.'s indicate, in binary notation, the number of switches which are up. The displays, from one to six switches, are shown here.*

numbers ascend through 011 for 3, 100 for 4, 101 for 5, and 110 for 6."

As he mentioned the figures Smithy activated the switches to demonstrate the lighting up of the l.e.d.'s. (Fig.4)

"That," stated Dick, "does at least explain part of the mystery behind those l.e.d.'s. But what's baffling me now is the next step. *Why* do you have the l.e.d.'s express the number of switches which are up in binary form?"

"It's because of a basic factor concerned with the game of NIM," replied Smithy. "We've been using switches in this version, but you can also play NIM with matches. These are arranged in three or more groups and the two contestants, in-turn, take out one or more matches from a group, the loser being the one who has to pick up the final match. Now, it is possible to force a win if, during the game, you arrange matters such that the number of matches in the groups, when expresed in binary, add up to an even number or to nought when added vertically. If you do this at any point in the game, and take care at your final move where this rule usually breaks down, you will always win. You probably won't remember it but, in my second move in the game we've just played, I arranged matters such that I caused the lit l.e.d.'s in the vertical columns to either add up to 2 or to zero. That put me in a commanding position which you simply couldn't overcome."

## NEW GAME

"Gosh," said Dick, bemused. "This takes a bit of getting used to. Let's have another game and see how it works out."

"Okay," said Smithy obligingly. "Let's just get all the switches back to the up position again."

He quickly reset the switches. Once more, the left-hand and central l.e.d. in each of the three rows lit up.

"I'll start off this time," volunteered Dick. "To make things easy I'll just put down one switch."

He put down the left-hand end switch in the middle row. (Fig.5(a).)

"Right," said Smithy, looking at the l.e.d.'s "Now you are obviously not in a commanding position here because the first vertical row of l.e.d.'s adds up to 3, and the third row adds up to 1. For me to get into command I must actuate switches which causes all the vertical columns to add up to 2 or nought. This I can do by putting down three switches in the top row."

Smithy set the switches down. (Fig.5(b).)

"I now," he remarked happily, "have you by the short and curlies, because all the three vertical columns add up to 2. It is now impossible for you to move the switches so that you can obtain command of the game and you're bound to lose."

Dick scratched his head and looked at the switches.

"I think I can see what you

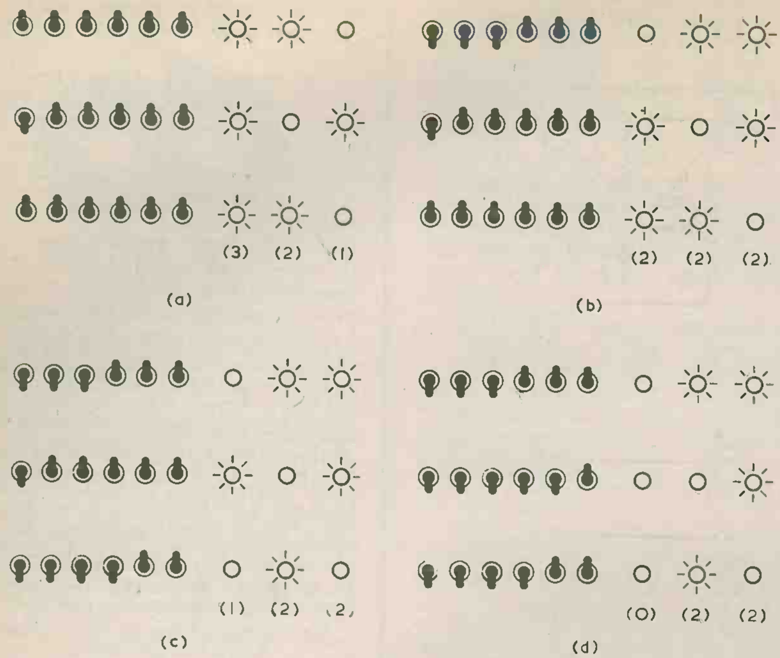



*Fig. 5(a). The first step in the second game of NIM. Dick put down a centre row switch.*
*(b). Smithy at once took over the game by putting down three switches in the top row*
*(c). Dick's next move. He pressed own four switches in the lower row.*
*(d). This was countered by Smithy, who set four further switches down in the centre row*

mean," he remarked eventually. "All right, I'll just put down four switches in the bottom row."

He put the switches to the down position and the pair looked at the l.e.d.'s (Fig.5(c).)

"The first vertical column," stated Smithy, "has only one lit l.e.d. in it, which doesn't meet the requirements for command. What I'll do now is put down four further switches in the centre row. Like this."

Smithy moved the switches. (Fig.5(d).)

"That puts you back in command again," admitted Dick. 'The first vertical row adds up to zero, and the second and third rows add up to 2."

He reached out and pressed down two more switches in the top row. (Fig.6(a).)

"We're reaching the end now," commented Smithy thoughtfully, "and I've got to be a bit careful because the rule of 2 or nought may not apply here. Indeed, a little inspection shows that the rule obviously doesn't apply. If I were to put down the two bottom switches I would be left with two l.e.d.'s alight in the right-hand column. But at the same time I'd leave only two switches up, whereupon you could put one down and it would be me who had to put the last one down. So what I do now is simply put down *one* switch at the bottom."

Smithy put his finger out and pressed the switch dolly down. (Fig.6(b).)

"Well," remarked Dick philosophically, "I'm bound to lose now."

He put down the last switch in the top row. Smithy put down the last switch in the centre row and Dick, patently defeated, pressed down the last switch in the bottom row.

## SWITCHING CIRCUIT

"I must say," he remarked enthusiastically, "that this is quite a good game, once you get into it. It's certainly got a few surprises in it."

"It does have a few hidden points," agreed Smithy. "If you're playing it with someone who doesn't understand binary you can win nearly all the time, provided the other chap doesn't happen to hit the command combinations by luck."

"What about the switching circuit for those l.e.d.'s?" asked Dick. "Is it a pretty easy one?"

"It's fairly easy," stated Smithy, reaching into his cupboard again.

He produced a piece of paper on which he had already drawn a circuit, and laid it out on his bench. (Fig.7)

"The circuit is a bit fiddling," he went on, "but it's not all that complicated. I've laid out the switches and the l.e.d.'s in the circuit in the same order as they appear on the front panel of the game, and the switches are all shown in the up position. Five of the switches are single-pole types and one is a double-pole type."

"Fair enough," commented Dick. "What happens when all the six switches are up, as they are in the circuit?"

"This," stated Smithy, "corresponds to binary 110, and so we want LED1 and LED2 to light up. You can trace a circuit from supply positive at the left through S1 to LED2, and another circuit through S3 to LED1. So these two l.e.d.'s are illuminated. If we put down S1 there are five switches left and we want binary 101 to show up. There is now a circuit from supply positive through S1 and the upper section of S2 to LED3, and we still have the circuit through S3 to LED1. Okay?"

"Sure. Let's put down S2."

"Right! There are now four switches left up, which corresponds to binary 100. S3 continues to give

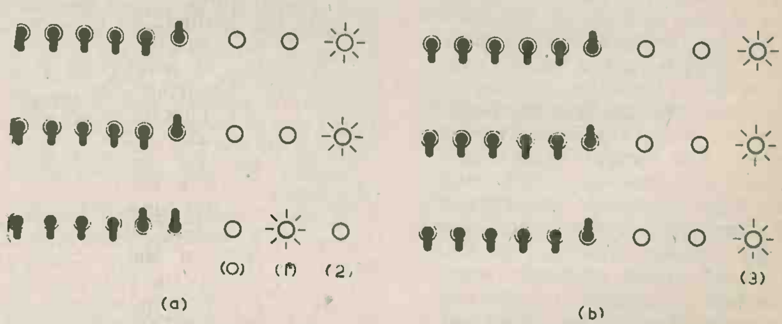



*Fig. 6(a). Final steps in the second game. Dick put two of the top row switches down.*
*(b). Smithy put down the fifth switch in the bottom row, whereupon Dick was bound to be the loser.*

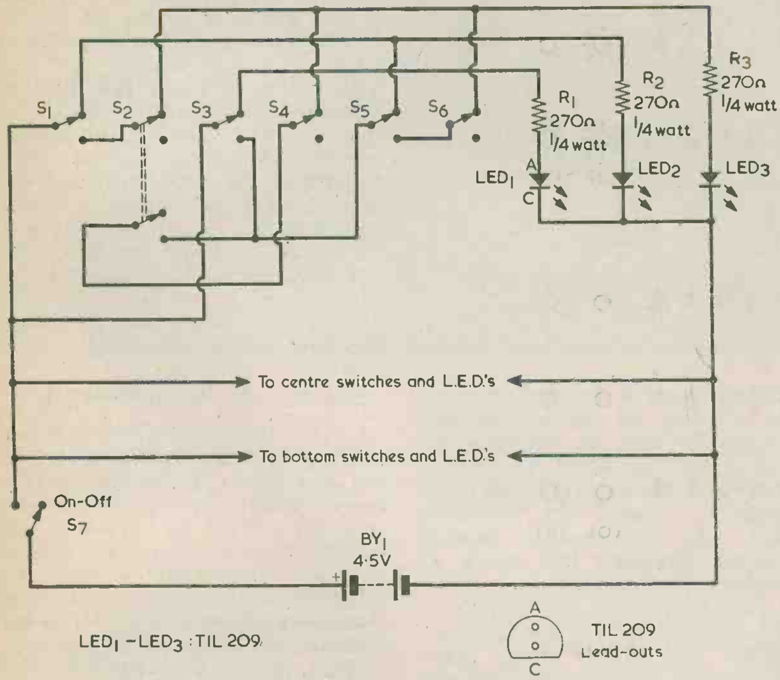



*Fig. 7. The switching circuit for the top row of switches and l.e.d.'s. The switch and l.e.d. suffix numbers correspond with those shown in Fig. 4. Identical circuits are used in the centre and bottom rows.*

us the circuit to LED1, which remains alight. But there are no circuits from supply positive through to LED2 and LED3, which are consequently extinguished. We carry on next to putting S3 down. This breaks the circuit to LED1, which goes out and stays out for all further switch operations. There are three switches left up, so we want binary 011. A circuit exists from supply positive through S3 and S5 to LED2, and a second circuit goes through S3, the lower section of S2, and S4, to LED3. When we put S4 down, we break the circuit to LED3, with the result that we get binary 010."

"All that's remaining now are S5 and S6."

"True," agreed Smithy. "When we put S5 down there's only one switch left up, and so we want binary 001. Our circuit now goes through S3, S5 and S6 to LED3. There is no circuit through to the other two l.e.d.'s, which remain extinguished. The final step is to put S6 down. This breaks the circuit to LED3 and so all l.e.d.'s are out."

"Is that switching and l.e.d. circuit repeated for the centre and bottom rows?"

"It is," confirmed Smithy. "The l.e.d.'s I used were red TIL209's but in practice, virtually any small l.e.d.'s can be employed. The battery can be a 4.5 volt flat flash lamp battery or three HP7 cells in series. Each l.e.d. draws about 12mA and you can't have more than six on at any one time. So the battery current varies from zero to about 72mA maximum.

Smithy gazed fondly at his creation, then turned to his assistant. As he did so his eye fell on his disreputable tin mug.

"Well, I'm dashed," he said, surprised. "I've got so wound up in this NIM gubbins of mine that I've completely forgotten about my lunch-time tea. This lot's cold now, so could you chuck it out and make me some fresh?"

Obligingly, Dick took Smithy's mug over to the sink, alongside which were ranged the sketchy culinary effects of the Workshop, and proceeded to empty and replenish the Serviceman's mug. He quickly returned with a new supply of the precious steaming liquid, so necessary for the maintenance of Smithy's fluidic equilibrium, and that worthy drank mightily and noisily of its contents.

## FINAL MATCH

"Would you," asked the Serviceman, now fully rehydrated, "care to have another game?"

"All right."

Smithy returned all the switches to the upper position, whereupon once more the left-hand and centre l.e.d.'s in each row lit up to indicate binary 110.

"You can start," conceded Smithy graciously.

"Okeydoke," replied Dick.

With one quick movement he set all the switches in the centre row down so that the three l.e.d.'s in that row were extinguished. Smithy looked at the remaining l.e.d.'s and gulped. The first vertical column added up to a commanding 2, the second vertical column to an equally commanding 2 and the third vertical column backed these with a total of zero. (Fig.8.)

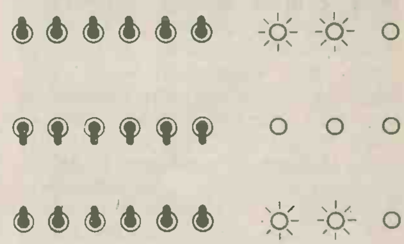


*Fig. 8. Smithy outsmarted! Dick's first move in the third game put him firmly in control of the situation.*

"There you are," pronounced Dick gleefully. "I've now got *you* by the short and curlies!"

And, as Smithy ruefully conceded to himself, his assistant's statement was completely true. In effect, at least, even if not in precise anatomical detail. ■

# Radio Topics

## By Recorder

★★★★★★★★★★

Here is a story with two morals.

A friend of mine, who isn't particularly musically inclined, recently bought for himself quite an expensive music centre complete with two separate speakers. The outfit carried a good brand name in the radio and television world and, whilst I would perhaps hesitate to say that the equipment entered what I call the true high fidelity class, the output was certainly quite pleasant enough to listen to and to live with.

My friend, indeed, was delighted with his acquisition and at once started a collection of the lighter classical records together with, for his children, a smattering of the more acceptable current pop. Which, by the way, even someone as conservative as myself can listen to with enjoyment now that the emphasis is swinging back to melody again.

At my friend's house musical evenings were in. As the jargon has it, things were looking good.

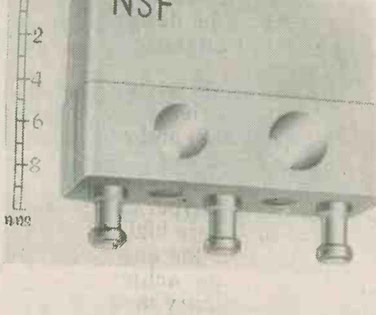
### ENTER AN EXPERT

I met him again after a period of a month or so, and in the passage of conversation asked him how his music centre was going. A look of intense pain crossed his face and, after some moments, he told me the whole sad story.

He had asked an acquaintance, a self-avowed expert, to check out his equipment and give his opinion on it. Which undoubtedly with relish the expert did, to find at once that there was an unexplained little click at each revolution of the gram turntable (not a changer, by the way) and a bass buzz in the speakers. He found the first shortcoming by listening to the turntable with everything very quiet, and he found the second by turning the amplifier volume control to maximum, the tone controls to full treble cut and full bass boost, and by playing a record with plenty of bass thump on it.

Up till that episode my friend had been supremely happy with the equipment, but thereafter his whole outlook changed. Instead of listening serenely to his gramophone records he took to haunting the retailer who had sold him the music centre and the speakers. The latter obligingly cleared the turntable click and presumably hunted around through his stock of speakers for that particular model to find two which had minimum bass buzz. Despite these improvements, my friend now plays his records with an anxious ear open for distortions in the reproduction, and has fallen into the hi-fi addict's trap of listening to the amplifier instead of to the music.

As I said at the start, there are two morals to this story. Moral number one is: if, as an inexperienced person, you buy expensive hi-fi or near-hi-fi equipment take an expert with you. Or you can live by moral number two: if, similarly inexperienced, you buy the equipment on your own, forever afterwards lock, bolt and bar your doors to anyone professing to be an expert.




*Sub-subminiature microswitch manufactured by Cutler Hammer and now available from N.S.F. Switches and Controls. This changeover unit has three turret tags at the bottom with the operating button at the top*

### MILLION OP. MICROSWITCH

Let's now have a look at some of the latest industrial news items.

The first photograph shows a Cutler Hammer microswitch which is described as being a sub-subminiature component. The case of the microswitch is only some 9mm. high and its length is approximately 12mm. Ideal for electronic applications, the switch is rated for 50,000 operations at its full normal electrical load whilst the mechanical life exceeds 1 million operations!

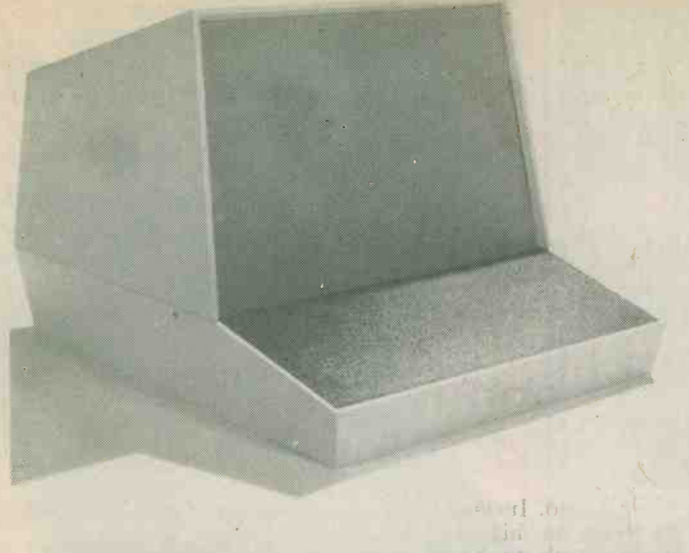
Designed to handle up to 7 amps with a 25 amp inrush the microswitches are available in three types, these being the Standard version with an operating force of 5oz. maximum, the Low Force version with an operating force of 3oz. maximum, and the Low Differential version where the operating differential is 0.002in. maximum.

There is a choice of four terminal configurations: single turret, double turret, straight pin or quick-connect, and the switches are particularly suitable for low potential circuits which require good contact without wetting voltages. The switches are distributed by N.S.F. Limited, Keighley, Yorkshire, BD21 5EF.

### UNIVERSAL HOUSING

The handsome plastic cabinet which appears in the second photograph is the Mentor "Jubilee" enclosure which has been designed as a universal housing for video display units, computer terminals, TV games, audio equipment or electronic test equipment.

Measuring some 21 by 19 by 15in., the enclosure is available unpainted for user painting to match existing equipment or, as shown in the illustration, painted in textured black and grey. The removable sloping keyboard plate is locked in place by the neutral toned screen section, and the upper cover is easily unscrewed from the base, allowing excellent access to the interior. Inside the housing are ribs and



*The Mentor "Jubilee" enclosure. This multi-purpose cabinet is suitable for many uses including video display units, computer terminals and electronic TV games*

bosses for component mounting and there are moulded-in ventilation grilles together with a 4in. blower opening. The housing is injection moulded by the structural foam process and uses high-impact thermoplastic material.

Further details can be obtained from Mentor Electronics Ltd., Ryefield Crescent, Northwood, Middlesex, HA6 1NN.

## CONDUCTIVE CONCRETE

Researchers at Marconi Communication Systems Limited, a GEC-Marconi Electronics company, have developed a really revolutionary building material. This is an aggregate which allows the production of electrically conductive concrete, and it has been given the Registered Name of "Marconite".

Marconite produces concretes of normal compression strengths with a wide range of pre-determined volume resistivity values when used in place of conventional concrete fine aggregates. As such, the material offers the possibility of permanent earthing, screening for electrical and electronic equipments, and of protection from the hazards of static electrical charges. Whilst the entire gamut of Marconite's applications have not yet been fully explored, it seems likely that it will have a host of other uses including permanent electrodes for cathodic protection systems of such items as underground cables.

Using conventional methods the provision of power and radio frequency earths for radio, television and radar transmitters, signal processing equipments, computers and similar equipments, and the screening of areas from electromagnetic interference can be complicated and time-consuming exercises. Not only is there the necessity to take electrical connections back to the conventional earths physically buried in the ground, but the actual siting of the earth electrode system is critical in many cases to avoid mutual interference between equipments installed in the same location.

In contrast, the use of Marconite to provide an earth plane in the form of a conductive floor material provides simple universal earthing and screening which can be continuously extended as building work progresses. Its laying requires no skills other than those already present in the civil engineering and building industries.

Marconite is a granulated electrically conductive aggregate which replaces normal concrete fine aggregates such as natural sand, permitting electrically conductive concretes to be designed by applying conventional concrete technology.

Compared with metals the volume resistivity of conductive concrete is high and can range from 0.5 Ω per cm. or lower for preformed sections cured under pressure to 15 Ω per cm. for trowelled floors. Where higher resistivities are required for anti-static floors, these can be achieved by substituting ordinary sand for a portion of the Marconite.

Marconite is chemically inert at normal temperatures, and in particular the sulphate and chloride contents are low, thus permitting it to be used with all conventional types of cement, proprietary resin-based cements, gypsum plasters and adhesives. ■

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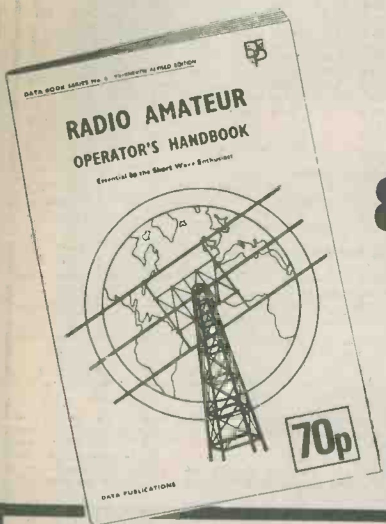


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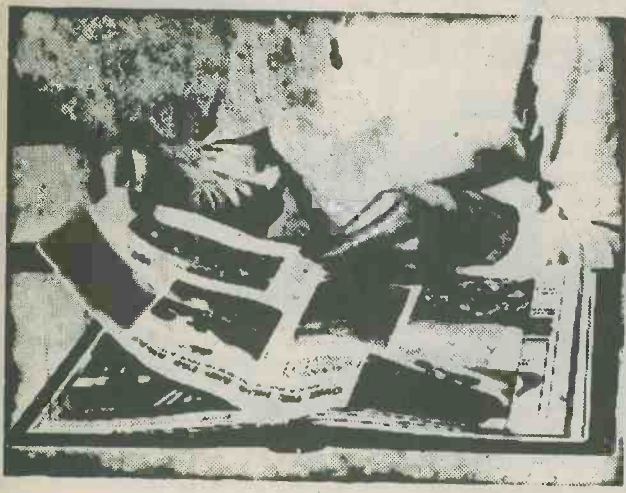

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