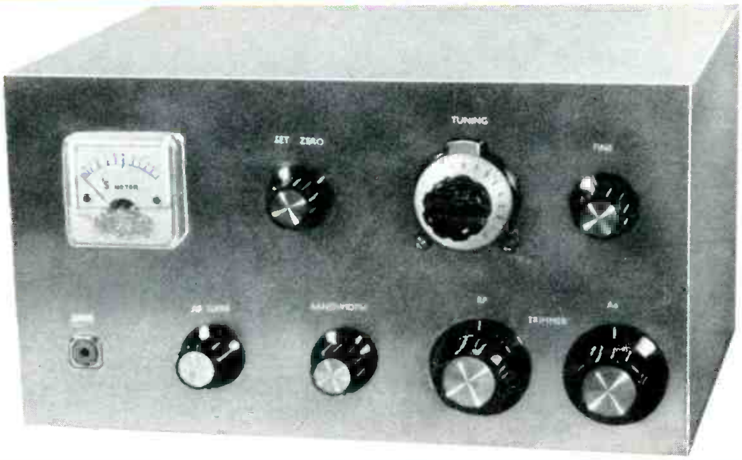
# RADIO & ELECTRONICS CONSTRUCTOR

AUGUST 1973

20p

# 4 BAND TRANSISTOR SUPERHET

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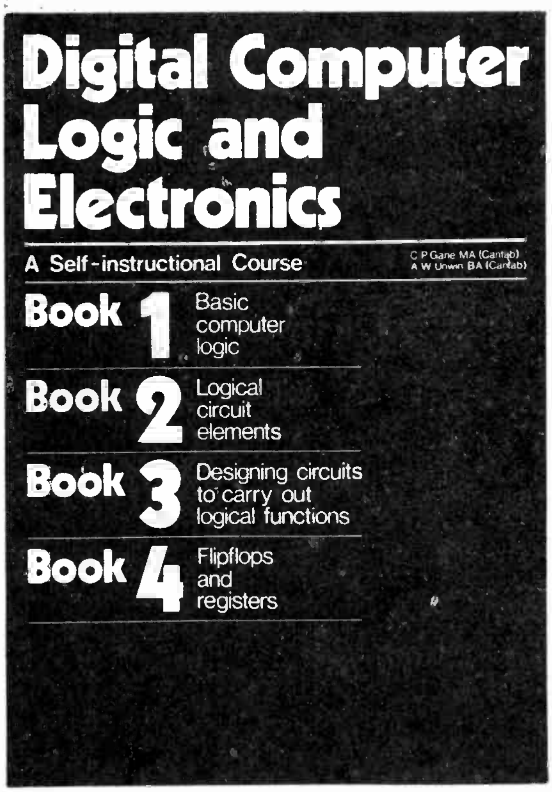


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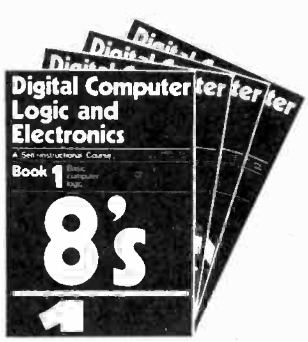


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| | |
|---|---|
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| Chassis UX7 – B5 – UX5 – B9G | 3p |
| Shrouded chassis B7G – B9A | 4p |
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6 way **2p** Single **1p**

| | |
|---|---|
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| Pole | Way | Type | |
|---|---|---|---|
| 4 | 2 | Sub. Min. Slide | 10p |
| 6 | 4 | Wafer Rotary | 12p each |
| 4 | 3 | Wafer Rotary | 12p each |
| 3 | 7 | Wafer Rotary | 12p each |
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| 1 | 3 | 13 amp small rotary | 12p |
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| 2 | 1 | 2 Amp 250V A.C. rotary | 20p |
| 1 | 2 | Toggle | 10p |

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English Numbering Machines LTD.
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6–14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

## RESISTORS

| | |
|---|---|
| $\frac{1}{8}$ $\frac{1}{4}$ $\frac{1}{2}$ watt | 1p |
| 1 watt | $1\frac{1}{2}$p |
| Up to 10 watt wire | 8p |
| 15 watt wire wound | 10p |

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5K or 500K **3p**

## SAFETY PINS

Standard size, 10 for **4p**

## THORN PTO2E 10-6s CHASSIS SOCKET 40p

| | |
|---|---|
| 5K switched volume control | 15p |
| 5K Log Pot | 10p |
| 1meg Tandem Pot | 15p |

## THERMISTORS

VA1040
VA1055
VA1066 **10p each**
VA1077
VA1100

## STEEL BOX WITH LID

10 x $5\frac{1}{2}$ x 3″ grey hammer finish **£1**

## RELAYS

6 volt, 2 pole c/o heavy duty contacts **50p**
Mains 3 pole c/o heavy duty contacts ex equipment **35p**

## ELECTROLYTICS

Mullard C426, TCC, CRL, CCL, HUNTS, STC SUB MINIATURE, ETC.

| MFD | Volt | |
|---|---|---|
| 16 | 50 | 5p each |
| 260 | 12 | |
| 50 | 50 | |
| 100 | 18 | |
| 125 | 10 | |
| 150 | 12 | |
| 150 | 25 | |
| 8 | 50 | |
| 12 | 20 | |
| 10 | 20 | |
| 8.2 | 20 | |
| 50 | 25 | |
| 2.5 | 64 | |
| 25 | 25 | |

| MFD | Volt | |
|---|---|---|
| 2 | 350 | 4p each |
| 20 | 12 | |
| 500 | 6 | |
| 100 | 25 | |
| 100 | 6 | 2p each |
| 6 | 3 | |
| 8 | 6 | |
| 25 | 6.4 | 3p |
| 250 | 18 | 7p |
| 250 | 30 | 9p |
| 400 | 16 | 6p |
| 400 | 40 | 10p |
| 8 | 500 | 9p |
| 100 | 200 | 10p |
| 100-100 | 150 | 30p |

## CONDENSERS

| MFD | Volt | |
|---|---|---|
| 0.005 | 500 | 2p each |
| 0.001 | 1,250 | |
| 3.3PF | 500 | |
| 500 PF | 500 | |
| 1000 PF | 500 | |
| 2,200PF | 500 | |
| 3,300PF | 500 | |
| 0.1 | 350 | 3p each |
| 0.1 | 500 | |
| 0.25 | 150 | |
| 0.03 | 350 | |
| 0.13 | 350 | |
| 0.056 | 5% 350V | |
| 0.061 | | |
| 0.066 | | |
| 0.069 | | |
| 0.075 | | |
| 0.08 | | |
| 0.1 | 1,500 | 4p each |
| 0.25 | 350 | |

## TUNING GANG

100PF, 50PF, 33PF
**20p each**

## TRIMMERS

100PF Ceramic
30PF Beehive
12PF P.T.F.E.
2,500PF 750V **10p each**
33PF MIN.
AIR SPACE

| | | |
|---|---|---|
| 0.5 | 350 | 5p |
| 0.5 | 500 | 7p |
| 0.22 | 250 | 5p |
| 0.25 | 500 | 5p |
| 1MFD 350 volt | | 10p |
| 5MFD 150 volt | | 40p |
| 10MFD 150 volt | | 50p |
| 0.03 12 volt | | 2p |
| 470PF 500 volt | | 2p |
| 8MFD 800 volt electrolytic | | 75p |

## WIREWOUND POTS

250, 300 OHM, 1K, 4 watt, 10K, 20K, 50K, all at **10p each**

## RECORD PLAYER CARTRIDGE

ER.5XME Mono, with turn over stylii, single hole fixing **35p**

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Takes M.E.S bulb **10p**

## CONNECTOR STRIP

Belling Lee L1469, 12 way polythene. **5p each**

## CAN CLIPS

1″ or $1\frac{3}{8}$″ or $\frac{3}{4}$″ **2p**

## T.O.5 HEATSINKS

Style 154 high conductivity **5p**

## PAXOLINE

| | |
|---|---|
| 3 x $2\frac{1}{2}$ x $\frac{1}{16}$″ | 2p |
| $4\frac{5}{8}$ x $\frac{1}{2}$ x $\frac{1}{8}$″, | 2 for 1p |
| 220K 3 watt resistors | 2p |
| **VALVE RETAINER CLIP,** adjustable | 2p |

## OUTPUT TRANSFORMERS

Sub-miniature Transistor Type **20p**

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3 pin din to open end, $1\frac{1}{2}$yd twin screened lead **35p**

10 mtrs loudspeaker extension lead fitted 2 pin din plug and socket **40p** (retail 70p)

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

| | | | | | |
|---|---|---|---|---|---|
| AC127 | 10p | BCY71 | 18p | BFX29/30 | 25p |
| AC187/8 | 12p | BD131 | 40p | BFX84 | 22p |
| AD149 | 35p | BD132 | 49p | BFX88 | 20p |
| AD161/2 | 26p | BD135 | 36p | BFY50/1/2 | 13p |
| Matched pair | 45p | BF115 | 23p | BSV64 | 40p |
| AF116/7 | 12p | BF179 | 30p | BSX21 | 20p |
| AF139 | 28p | BF167 | 18p | BU105/01 | £1.75 |
| AF178 | 30p | BF178 | 25p | OC35 | 28p |
| AF180 | 40p | BF180 | 30p | 2N706 | 8p |
| AF239 | 30p | BF181 | 30p | 2N2219 | 19p |
| BC107/8/9 | 7p | BF182 | 30p | 2N2401 (ASY26-27) | 15p |
| BC147/8/9 | 8p | BF183 | 40p | 2N2904 | 17p |
| BC157/9 | 12p | BF184 | 17p | 2N2905 | 21p |
| BC158 | 8p | BF185 | 17p | 2N2906 | 15p |
| BC187 | 25p | BF195 | 12p | 2N2907 | 18p |
| BCY40 | 25p | BF196/7 | 14p | 2N3055 | 40p |
| BCY70 | 13p | BF262 | 60p | 2N3053 | 15p |

### BRIDGE RECTIFIERS

| Amp | Volt | | |
|---|---|---|---|
| ½ | 1,600 | BYX10 | 30p |
| 1 | 140 | OSH01-200 | 30p |
| 1.4 | 42 | BY164 | 35p |

Plastic types

| Amp | Volt | | |
|---|---|---|---|
| 2 | 30 | LT120 | 30p |
| 0.6 | 6-110 | EC433 | |

Encapsulated with built-in heat sink .. 15p

### 1 AMP RECTIFIERS

| | | |
|---|---|---|
| IN4002 | 100 volt | 4p |
| IN4003 | 200 volt | 5p |
| IN4004 | 400 volt | 6p |
| IN4005 | 600 volt | 7p |
| IN4006 | 800 volt | 7½p |
| IN4007 | 1,000 volt | 8p |

### HIGH POWER RECTIFIERS

| | Amp | Volt | |
|---|---|---|---|
| LT102 | 2 | 30 | 10p |
| BYX38-600 | 2.5 | 600 | 25p |
| BYX38-300 | 2.5 | 300 | 20p |
| BYX38-900 | 2.5 | 900 | 28p |
| BYX38-1200 | 2.5 | 1,200 | 30p |
| BYX49-600 | 2.5 | 600 | 25p |
| BYX49-300 | 2.5 | 300 | 20p |
| BYX49-900 | 2.5 | 900 | 28p |
| BYX48-300 | 6 | 300 | 27p |
| BYX48-600 | 6 | 600 | 32p |
| BYX48-900 | 6 | 900 | 40p |
| BYX48-1200 | 6 | 1,200 | 60p |
| BYX72-150R | 10 | 150 | 24p |
| BYX72-300R | 10 | 300 | 35p |
| BYX72-500R | 10 | 500 | 43p |
| BYX42-300 | 10 | 300 | 40p |
| BYX42-600 | 10 | 600 | 45p |
| BYX42-900 | 10 | 900 | 55p |
| BYX42-1200 | 10 | 1,200 | 75p |
| BYX46-300* | 15 | 300 | 2.50 |
| BYX46-400* | 15 | 400 | £2.90 |
| BYX46-500* | 15 | 500 | £3.20 |
| BYX46-600* | 15 | 600 | £3.80 |
| BYX20-200 | 25 | 200 | 35p |
| BYX52-300 | 40 | 300 | £1.75 |
| BYX52-1200 | 40 | 1,200 | £2.25 |

**Avalanche type*

N50 ohm free plug (UG21D/U) 50p
N50 ohm square socket (UG58A/U) 50p

1" Terryclips black plastic coated, or chrome finish .. 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster .. 25p

Chrome Car Radio facia .. 15p
Rubber Car Radio gasket .. 10p

DLI Pal Delayline .. £2.00

Relay socket .. 12p
Take miniature 2PCO relay

B9A valve can .. 2p

0–30 in ·5 segments, black pvc, 360° dial, silver digits, self adhesive, 4¼" dia. .. 15p

### OPTO ELECTRONICS

| | |
|---|---|
| ORP12 | 43p |
| BPX40 | 25p |
| BPX42 | £1 |
| BPY10 | 75p |
| BPY68 | 75p |
| BPY69 | £1 |
| BPY77 | 75p |

Diodes

Photo transistor
BPX29 80p
OCP71 30p

CQ11B Infra red transmitter £4

### F.E.T's

| | |
|---|---|
| BFW10 | 40p |
| BSV79 | 90p |
| BSV80 | 80p |

N. Channel
BSV81 M.O.S.T. .. £1
BFS28 Dual M.O.S.T. 90p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p

Phillips Iron Thermostat .. 15p
Bulgin 2-pin flat plug and socket .. 10p
McMurdo PP108 8 way edge plug .. 15p
300 ohm moving coil insert 4103D 1¾" diameter. Make ideal mike or speaker for communication work .. 25p

### Tested unmarked or marked ample lead ex new equipment

| | | | |
|---|---|---|---|
| AC128 | 6p | OC72 | 6p |
| ACY17-20 | 8p | OC200-5 | 6p |
| ASY28/9 | 8p | 2G302 | 6p |
| BCY70/1/2 | 8p | 2N2926 | 5p |
| BCY30-34 | 10p | 2N598/9 | 6p |
| BY127 | 8p | 2N1091 | 8p |
| BZY88 series | 6p | 2N1302 | 8p |
| OA5/7/10 | 10p | Germanium diode | 3p |
| OA47/81 | 4p | GET111 | 20p |
| OA200-5 | 5p | GET120 | |
| OC23 | 20p | (AC128 In 1" sq. heat sink) | 20p |
| OC29 | 25p | | |
| OC44 | 6p | | |
| OC71 | 6p | | |

### THYRISTORS

| Amp | Volt | | |
|---|---|---|---|
| 1 | 240 | BTX18-200 | 30p |
| 1 | 240 | BTX30-200 | 30p |
| 5 6 | 700 | BT106 | 85p |
| 6.5 | 300 | BT102-300R | 42p |
| 6.5 | 500 | BT102-500R | 60p |
| 6.5 | 500 | BT107 | 90p |
| 6.5 | 500 | BT108 | 90p |
| 6.5 | 500 | BT101-500R | 68p |
| 6.5 | 500 | BT109-500R | 90p |
| 20 | 600 | BTW92-600RM | £3.00 |
| 15 | 800 | BTX95-800R Pulse Modulated | £12 |

### OTHER DIODES

| | |
|---|---|
| Centercel | 5p |
| IN916 | 5p |
| BA145 | 14p |
| BA182 | 16p |

5 pin and 6 pin 240° (Type B) Metal Chassis Din Sockets 6p

### TRIACS

| Amp | Volt | | |
|---|---|---|---|
| 6 | 400 | BT110-400 Plastic | 75p |
| 25 | 900 | BTX94-900 | £6.50 |
| 25 | 1200 | BTX94-1200 | £9 |

DIAC BRI00 30p

WESTINGHOUSE 28TIO 30 AMP 1000 VOLT THYRISTER WITHOUT NUT £5

**PHOTO SILICON CONTROLLED SWITCH**
BPX66 PNPN 10 amp .. £1

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| | | |
|---|---|---|
| 0.25MFD | 800 volt | 30p |
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12 volt red or mains neon amber, push fit round, chrome bezel 15p each

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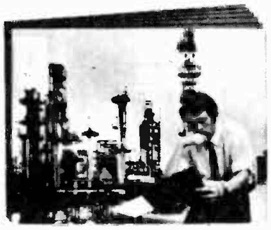

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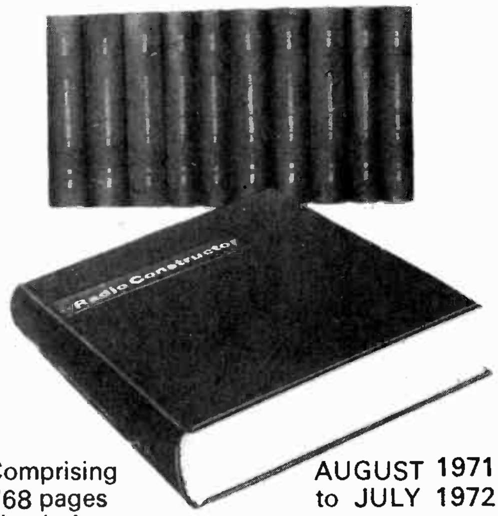


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| Device | Price | Device | Price | Device | Price | Device | Price | Device | Price | Device | Price | Device | Price |
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| AC 127 | 18½p | AF 116 | 26½p | BC 152 | 18½p | BD 139 | 60½p | BF 188 | 44p | MPF 104 | 40½p | 2G 339 | 22p |
| AC 128 | 18½p | AF 117 | 26½p | BC 153 | 31p | BD 140 | 66p | BF 194 | 13p | MPF 105 | 40½p | 2G 339A | 17½p |
| AC 132 | 15½p | AF 118 | 38½p | BC 154 | 33p | BD 155 | 88p | BF 195 | 13p | OC 19 | 38½p | 2G 344 | 20p |
| AC 134 | 15½p | AF 124 | 33p | BC 157 | 20p | BD 175 | 66p | BF 196 | 15½p | OC 20 | 69½p | 2G 345 | 17½p |
| AC 137 | 15½p | AF 125 | 27½p | BC 158 | 13p | BD 176 | 66p | BF 197 | 15½p | OC 22 | 42p | 2G 371 | 17½p |
| AC 141 | 15½p | AF 126 | 31p | BC 159 | 13p | BD 177 | 71½p | BF 200 | 49½p | OC 23 | 46p | 2G 371B | 13p |
| AC 141K | 18½p | AF 127 | 31p | BC 160 | 49½p | BD 178 | 71½p | BF 222 | £1.04 | OC 24 | 61½p | 2G 373 | 18½p |
| AC 142 | 15½p | AF 139 | 33p | BC 161 | 55p | BD 179 | 77p | BF 257 | 49½p | OC 25 | 42p | 2G 374 | 18½p |
| AC 142K | 18½p | AF 178 | 55p | BC 167 | 13p | BD 180 | 77p | BF 258 | 66p | OC 26 | 27½p | 2G 377 | 33p |
| AC 151 | 16½p | AF 179 | 55p | BC 168 | 13p | BD 185 | 71½p | BF 259 | 93½p | OC 28 | 55p | 2G 378 | 17½p |
| AC 154 | 22p | AF 180 | 55p | BC 169 | 13p | BD 186 | 71½p | BF 262 | 60½p | OC 29 | 55p | 2G 381 | 17½p |
| AC 155 | 22p | AF 181 | 49½p | BC 170 | 13p | BD 187 | 77p | BF 263 | 60½p | OC 35 | 46p | 2G 382 | 17½p |
| AC 156 | 22p | AF 186 | 49½p | BC 171 | 15½p | BD 188 | 77p | BF 270 | 38½p | OC 36 | 55p | 2G 401 | 33p |
| AC 157 | 26½p | AF 239 | 40½p | BC 172 | 15½p | BD 189 | 82½p | BF 271 | 33p | OC 41 | 22p | 2G 414 | 33p |
| AC 165 | 22p | AL 102 | 71½p | BC 173 | 15½p | BD 190 | 82½p | BF 272 | 88p | OC 42 | 26½p | 2G 417 | 27½p |
| AC 166 | 22p | AL 103 | 71½p | BC 174 | 15½p | BD 195 | 93½p | BF 273 | 38½p | OC 44 | 16½p | 2N 388 | 38½p |
| AC 167 | 22p | ASY 26 | 27½p | BC 175 | 24p | BD 196 | 93½p | BF 274 | 38½p | OC 45 | 14p | 2N 388A | 60½p |
| AC 168 | 26½p | ASY 27 | 33p | BC 177 | 21p | BD 197 | 99p | BFW 10 | 66p | OC 70 | 11p | 2N 404 | 22p |
| AC 169 | 15½p | ASY 28 | 27½p | BC 178 | 21p | BD 198 | 99p | BFX 29 | 30p | OC 71 | 11p | 2N 404A | 31p |
| AC 176 | 22p | ASY 29 | 27½p | BC 179 | 21p | BD 199 | £1.04½ | BFX 84 | 24p | OC 72 | 15½p | 2N 524 | 46p |
| AC 177 | 26½p | ASY 50 | 27½p | BC 180 | 26½p | BD 200 | £1.04½ | BFX 85 | 33p | OC 74 | 15½p | 2N 527 | 54p |
| AC 178 | 31p | ASY 51 | 27½p | BC 181 | 26½p | BD 205 | 88p | BFX 86 | 24p | OC 75 | 16½p | 2N 598 | 46p |
| AC 179 | 31p | ASY 52 | 27½p | BC 182 | 11p | BD 206 | 88p | BFX 87 | 26½p | OC 76 | 16½p | 2N 599 | 49½p |
| AC 180 | 18½p | ASY 54 | 27½p | BC 182L | 11p | BD 207 | £1.04½ | BFX 88 | 24p | OC 77 | 27½p | 2N 696 | 14p |
| AC 180K | 22p | ASY 55 | 27½p | BC 183 | 11p | BD 208 | £1.04½ | BFY 50 | 22p | OC 81 | 16½p | 2N 697 | 14½p |
| AC 181 | 18½p | ASY 56 | 27½p | BC 183L | 11p | BDY 20 | £1.10 | BFY 51 | 22p | OC 81D | 16½p | 2N 698 | 26½p |
| AC 181K | 22p | ASY 57 | 27½p | BC 184 | 13p | BF 115 | 26½p | BFY 52 | 22p | OC 82 | 16½p | 2N 699 | 38½p |
| AC 187 | 24p | ASY 58 | 27½p | BC 184L | 13p | BF 117 | 49½p | BFY 53 | 18½p | OC 82D | 16½p | 2N 706 | 9p |
| AC 187K | 22p | ASZ 21 | 44p | BC 186 | 31p | BF 118 | 77p | BPX 25 | 93½p | OC 83 | 22p | 2N 706A | 10p |
| AC 188 | 24p | BC 107 | 10p | BC 187 | 31p | BF 119 | 77p | BSX 19 | 16½p | OC 84 | 22p | 2N 708 | 13p |
| AC 188K | 22p | BC 108 | 10p | BC 207 | 12p | BF 121 | 49½p | BSX 20 | 16½p | OC 139 | 22p | 2N 711 | 33p |
| ACY 17 | 27½p | BC 109 | 11p | BC 208 | 12p | BF 123 | 55p | BSY 25 | 16½p | OC 140 | 22p | 2N 717 | 38½p |
| ACY 18 | 22p | BC 113 | 11p | BC 209 | 13p | BF 125 | 49½p | BSY 26 | 16½p | OC 169 | 27½p | 2N 718 | 26½p |
| ACY 19 | 22p | BC 114 | 16½p | BC 212L | 12p | BF 127 | 55p | BSY 27 | 16½p | OC 170 | 27½p | 2N 718A | 55p |
| ACY 20 | 22p | BC 115 | 16½p | BC 213L | 12p | BF 152 | 60½p | BSY 28 | 16½p | OC 171 | 27½p | 2N 726 | 31p |
| ACY 21 | 22p | BC 116 | 16½p | BC 214L | 15½p | BF 153 | 49½p | BSY 29 | 16½p | OC 200 | 27½p | 2N 727 | 31p |
| ACY 22 | 17½p | BC 117 | 16½p | BC 225 | 27½p | BF 154 | 49½p | BSY 38 | 20p | OC 201 | 31p | 2N 743 | 22p |
| ACY 27 | 19½p | BC 118 | 11p | BC 226 | 38½p | BF 155 | 77p | BSY 39 | 20p | OC 202 | 31p | 2N 744 | 22p |
| ACY 28 | 21p | BC 119 | 33p | BCY 30 | 26½p | BF 156 | 53p | BSY 40 | 31p | OC 203 | 27½p | 2N 914 | 15½p |
| ACY 29 | 38½p | BC 120 | 88p | BCY 31 | 28½p | BF 157 | 60½p | BSY 41 | 31p | OC 204 | 27½p | 2N 918 | 33p |
| ACY 30 | 31p | BC 125 | 13p | BCY 32 | 33p | BF 158 | 60½p | BSY 95 | 14p | OC 205 | 38½p | 2N 929 | 23p |
| ACY 31 | 31p | BC 126 | 20p | BCY 33 | 24p | BF 159 | 66p | BSY 95A | 14p | OC 309 | 44p | 2N 930 | 23p |
| ACY 34 | 23p | BC 132 | 13p | BCY 34 | 27½p | BF 160 | 44p | Bu 105 | £2.20 | P 346A | 47½p | 2N 1131 | 22p |
| ACY 35 | 23p | BC 134 | 20p | BCY 70 | 15½p | BF 162 | 44p | C 111E | 55p | P 397 | 47½p | 2N 1132 | 24p |
| ACY 36 | 31p | BC 135 | 13p | BCY 71 | 20p | BF 163 | 44p | C 400 | 33p | OCP 71 | 44p | 2N 1302 | 15½p |
| ACY 40 | 18½p | BC 136 | 16½p | BCY 72 | 15½p | BF 164 | 44p | C 407 | 27½p | ORP 12 | 44p | 2N 1303 | 15½p |
| ACY 41 | 19½p | BC 137 | 16½p | BCZ 10 | 22p | BF 165 | 44p | C 424 | 22p | ORP 60 | 22p | 2N 1304 | 18½p |
| ACY 44 | 38½p | BC 139 | 44p | BCZ 11 | 27½p | BF 167 | 24p | C 425 | 55p | ORP 61 | 46p | 2N 1305 | 18½p |
| AD 130 | 42p | BC 140 | 33p | BCZ 12 | 27½p | BF 173 | 24p | C 426 | 38½p | ST 140 | 14p | 2N 1306 | 23p |
| AD 140 | 53p | BC 141 | 33p | BD 121 | 66p | BF 176 | 38½p | C 428 | 22p | ST 141 | 18½p | 2N 1307 | 23p |
| AD 142 | 53p | BC 142 | 33p | BD 123 | 71½p | BF 177 | 38½p | C 441 | 33p | TIS 43 | 33p | 2N 1308 | 25½p |
| AD 143 | 42p |  |  | BD 124 | 66p | BF 178 | 33p | C 442 | 33p | UT 46 | 30p | 2N 1309 | 25½p |

| Device | Price | Device | Price | Device | Price |
|---|---|---|---|---|---|
| 2N 1613 | 22p | 2N 2926(R) | 11p | 2N 3906 | 30p |
| 2N 1711 | 22p | 2N 2926(B) | 11p | 2N 4058 | 13p |
| 2N 1889 | 35p | 2N 3010 | 77p | 2N 4059 | 11p |
| 2N 1890 | 49½p | 2N 3011 | 15½p | 2N 4060 | 13p |
| 2N 1893 | 40½p | 2N 3053 | 18½p | 2N 4061 | 13p |
| 2N 2147 | 79p | 2N 3054 | 50½p | 2N 4062 | 13p |
| 2N 2148 | 62½p | 2N 3055 | 55p | 2N 4284 | 18½p |
| 2N 2160 | 66p | 2N 3391 | 15½p | 2N 4285 | 18½p |
| 2N 2192 | 38½p | 2N 3391A | 17½p | 2N 4286 | 18½p |
| 2N 2193 | 38½p | 2N 3392 | 15½p | 2N 4287 | 18½p |
| 2N 2194 | 38½p | 2N 3395 | 15½p | 2N 4288 | 18½p |
| 2N 2217 | 24p | 2N 3394 | 15½p | 2N 4289 | 18½p |
| 2N 2218 | 22p | 2N 3395 | 18½p | 2N 4290 | 18½p |
| 2N 2219 | 22p | 2N 3402 | 23p | 2N 4291 | 18½p |
| 2N 2220 | 24p | 2N 3403 | 23p | 2N 4292 | 18½p |
| 2N 2221 | 22p | 2N 3404 | 31p | 2N 4293 | 18½p |
| 2N 2222 | 22p | 2N 3405 | 46p | 2N 5172 | 13p |
| 2N 2368 | 18½p | 2N 3414 | 16½p | 2N 5457 | 35p |
| 2N 2369 | 15½p | 2N 3415 | 16½p | 2N 5458 | 35p |
| 2N 2369A | 15½p | 2N 3416 | 31p | 2N 5459 | 44p |
| 2N 2411 | 26½p | 2N 3417 | 31p | 2S 301 | 55p |
| 2N 2412 | 26½p | 2N 3525 | 82½p | 2S 302A | 46p |
| 2N 2646 | 51½p | 2N 3646 | 10p | 2S 302 | 46p |
| 2N 2711 | 23p | 2N 3702 | 11p | 2S 303 | 60½p |
| 2N 2712 | 23p | 2N 3703 | 11p | 2S 304 | 77p |
| 2N 2714 | 23p | 2N 3704 | 12p | 2S 305 | 92½p |
| 2N 2904 | 18½p | 2N 3705 | 11p | 2S 306 | 92½p |
| 2N 2904A | 23p | 2N 3706 | 10p | 2S 307 | 92½p |
| 2N 2905 | 23p | 2N 3707 | 12p | 2S 321 | 61½p |
| 2N 2905A | 23p | 2N 3708 | 7½p | 2S 322 | 46p |
| 2N 2906 | 16½p | 2N 3709 | 10p | 2S 322A | 46p |
| 2N 2906A | 20p | 2N 3710 | 10p | 2S 323 | 61½p |
| 2N 2907 | 22p | 2N 3711 | 10p | 2S 324 | 77p |
| 2N 2907A | 24p | 2N 3819 | 31p | 2S 325 | 77p |
| 2N 2923 | 15½p | 2N 3820 | 55p | 2S 326 | 77p |
| 2N 2924 | 15½p | 2N 3821 | 38½p | 2S 327 | 77p |
| 2N 2925 | 15½p | 2N 3823 | 31p | 2S 701 | 46p |
| 2N 2926(G) | 14p | 2N 3903 | 31p | 40361 | 44p |
| 2N 2926(Y) | 12p | 2N 3904 | 33p | 40362 | 49½p |
| 2N 2926(O) | 11p | 2N 3905 | 31p |  |  |

## DIODES & RECTIFIERS

| Device | Price | Device | Price | Device | Price |
|---|---|---|---|---|---|
| AA 119 | 9p | BY 130 | 17½p | OA 47 | 7½p |
| AA 120 | 9p | BY 133 | 23p | OA 70 | 7½p |
| AA 129 | 9p | BY 164 | 55p | OA 79 | 7½p |
| AAY 30 | 10p | BYX 38.30 | 46p | OA 81 | 7½p |
| AAZ 13 | 11p | BYZ 10 | 38½p | OA 85 | 10p |
| BA 100 | 11p | BYZ 11 | 33p | OA 90 | 6½p |
| BA 116 | 23p | BYZ 12 | 33p | OA 91 | 6½p |
| BA 126 | 24p | BYZ 13 | 27½p | OA 95 | 7½p |
| BA 148 | 15½p | BYZ 16 | 44p | OA 200 | 6½p |
| BA 154 | 13p | BYZ 17 | 38½p | OA 202 | 7½p |
| BA 155 | 15½p | BYZ 18 | 38½p | SD 10 | 5½p |
| BA 156 | 14½p | BYZ 19 | 31p | SD 19 | 5½p |
| BY 100 | 16½p | CG 62 |  | IN 34 | 7½p |
| BY 101 | 13p | (Eq) OA 91 | 5½p | IN 34A | 7½p |
| BY 105 | 18½p | CG 651 (Eq) |  | IN 914 | 6½p |
| BY 114 | 13p | OA 70–OA79 | 6½p | IN 916 | 6½p |
| BY 126 | 15½p | OA 5 | 38½p | IN 414B | 6½p |
| BY 127 | 16½p | OA 5SL | 23p | IS 021 | 11p |
| BY 128 | 16½p | OA 10 | 38½p | IS 951 | 6½p |

## NEW COMPONENT PAK BARGAINS

| Pack No. | Qty. | Description | Price |
|---|---|---|---|
| C 1 | 250 | Resistors mixed values approx. count by weight | 0.55 |
| C 2 | 200 | Capacitors mixed values approx. count by weight | 0.55 |
| C 3 | 50 | Precision Resistors .1% mixed values | 0.55 |
| C 4 | 75 | ⅛th W Resistors mixed preferred values | 0.55 |
| C 5 | 5 | Pieces assorted Ferrite Rods | 0.55 |
| C 6 | 2 | Tuning Gangs, MW/LW VHF | 0.55 |
| C 7 | 1 | Pack Wire 50 meters assorted colours | 0.55 |
| C 8 | 10 | Reed Switches | 0.55 |
| C 9 | 3 | Micro Switches | 0.55 |
| C10 | 15 | Assorted Pots & Pre-Sets | 0.55 |
| C11 | 5 | Jack Sockets 3—3.5m 2 — Standard Switch Types | 0.55 |
| C12 | 40 | Paper Condensers preferred types mixed values | 0.55 |
| C13 | 20 | Electrolytics Trans. types | 0.55 |
| C14 | 1 | Pack assorted Hardware – Nuts/Bolts, Gromets, etc. | 0.55 |
| C15 | 4 | Mains Switches, 2 Amp Plus | 0.55 |
| C16 | 20 | Assorted Tag Strips & Panels | 0.55 |
| C17 | 10 | Assorted Control Knobs | 0.55 |
| C18 | 4 | Rotary Wave Change Switches | 0.55 |
| C19 | 3 | Relays 6 – 24V Operating | 0.55 |
| C20 | 4 | Sheets Copper Laminate approx. 10" x7" | 0.55 |

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

Component Lists for mail order available on request.

## JUMBO COMPONENT PAKS

*MIXED ELECTRONIC COMPONENTS*
**Exceptionally good value**

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1.65 only

**BRAND NEW POST OFFICE TYPE TELEPHONE DIALS**

**ONLY 83p each**

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE **Guar. 3 Watts RMS. Module Tested and Guaranteed.**

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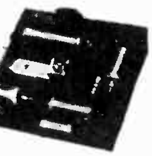

## SYSTEM 12 STEREO

Each kit contains two amplifier modules, 3 Watts RMS, two loudspeakers, 15 OHMS, The pre-amplifier, transformer, power supply module, front panel and other accessories as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

**ONLY £18.64** FREE P & P

# NOW-TURN OVER FOR MORE FANTASTIC OFFERS

# The largest selection

## NEW LOW PRICE TESTED S.C.R.'S.

| PIV | 1A TO5 Each | 3A TO66 Each | 5A TO66 Each | 5A TO64 Each | 7A TO48 Each | 10A TO48 Each | 16A TO48 Each | 30A TO48 Each |
|---|---|---|---|---|---|---|---|---|
| 50 | 0.25½ | 0.27½ | 0.38½ | 0.38½ | 0.51½ | 0.55 | 0.58½ | 1.26½ |
| 100 | 0.27½ | 0.36½ | 0.51½ | 0.51½ | 0.55 | 0.61 | 0.69½ | £1.54 |
| 200 | 0.38½ | 0.40½ | 0.54 | 0.54 | 0.62½ | 0.67 | 0.82½ | £1.76 |
| 400 | 0.47½ | 0.51½ | 0.61½ | 0.61½ | 0.73½ | 0.82½ | £1.02½ | £1.92½ |
| 600 | 0.58½ | 0.62½ | 0.75 | 0.75 | 0.84½ | £1.06½ | £1.37½ | |
| 800 | 0.69½ | 0.77 | 0.88 | 0.88 | 0.99 | £1.32 | £1.65 | £1.40 |

## SILICON RECTIFIERS—TESTED

| PIV | 300mA (DO7) | 750mA (SO16) | 1A Plastic | 1.5A (SO16) | 3A (SO10) | 10A (SO10) | 30A (SO32A) |
|---|---|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ | £ | £ |
| 50 | 0.04 | 0.05½ | 0.05½ | 0.07½ | 0.15½ | 0.23 | 0.66 |
| 100 | 0.04 | 0.06½ | 0.05½ | 0.14½ | 0.17½ | 0.25½ | 0.82½ |
| 200 | 0.05½ | 0.10 | 0.06½ | 0.15½ | 0.22 | 0.26½ | 1.10 |
| 400 | 0.06½ | 0.14½ | 0.07½ | 0.22 | 0.30 | [illegible] | 1.37½ |
| 600 | 0.07½ | 0.17½ | 0.11 | 0.25½ | 0.37½ | 0.49½ | 2.04½ |
| 800 | 0.11 | 0.18½ | 0.12 | 0.27½ | 0.40½ | 0.60½ | 2.20 |
| 1000 | 0.12 | 0.27½ | 0.15½ | 0.33 | 0.50 | 0.69½ | 2.75 |
| 1200 | — | 0.36½ | — | 0.42 | 0.62½ | 0.82½ | — |

### TRIACS

| VBOM | 2A TO5 £p | 6A TO66 £p | 10A TO48 £p |
|---|---|---|---|
| 100 | 0.33 | 0.55 | 0.77 |
| 200 | 0.55 | 0.66 | 0.82½ |
| 400 | 0.82½ | 0.99 | 1.21 |

**FULL RANGE OF ZENER DIODES VOLTAGE RANGE** 2–33V. 400mV (DO-7 Case) 14½p ea. 1½W (Top Hat) 20p ea. 10W (SO-10 Stud) 33p ea. All fully tested 5% tol. and marked. State voltage required.

### DIACS

FOR USE WITH TRIACS
BR100 (D32) 40½p each

**10amp POTTED BRIDGE RECTIFIER** on heat sink. 100 PIV. 99p each.

### FREE

**One 50p Pak of your own choice free with orders valued £4 or over.**

### NEW LINE

Plastic encapsulated 2 amp Bridge Rects.

50 v RMS 35p each
100 v RMS 48½p each
400 v RMS 50½p each

Size 15 mm x 6 mm

**BRAND NEW TEXAS GERM. TRANSISTORS**
**Coded and Guaranteed**

| Pak No. | | EQVT |
|---|---|---|
| T1 | 8 2G3713 | OC71 |
| T2 | 8 D1374 | OC75 |
| T3 | 8 D1216 | OC81D |
| T4 | 8 2G381T | OC81 |
| T5 | 8 2G382T | OC82 |
| T6 | 8 2G344B | OC44 |
| T7 | 8 2G345B | OC45 |
| T8 | 8 2G378 | OC78 |
| T9 | 8 2G399A | 2N1302 |
| T10 | 8 2G417 | AF117 |

All 55p each pak

**UNIJUNCTION**
UT46. Eqvt. 2N2646. Eqvt. TIS43. BEN3000 30p each, 25-99 27½p. 100 UP 22p.

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ORP12 47p
ORP60, ORP61 44p each

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 27½p each.

**GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8, BSY27/28/95A.** All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

| £p | |
|---|---|
| 20 For 0.55 | 100 For 1.93 |
| 50 For 1.10 | 500 For 8.25 |
| | 1000 For 18.18 |

120VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407. 2N1893 FULLY TESTED AND CODED ND 120. 1-24 18½p each. TO.5 N.P.N. 25 up 16½p each. 100 up 15½p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 p6 each. Any Qty.

| SIL. G.P. DIODES | | £p |
|---|---|---|
| 300mW | 30 | 0.55 |
| 40PIV(Min.) | 100 | 1.65 |
| Sub-Min. | 500 | 5.50 |
| Full Tested | 1,000 | 9.90 |

Ideal for Organ Builders.

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# SUPER PAKS

**NEW BI-PAK UNTESTED SEMICONDUCTORS**

Satisfaction GUARANTEED in Every Pak, or money back.

| Pak No. | | £p |
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| U3 | 75 Germanium Gold Bonded Sub-Min. like OA5, OA47 | 55p |
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| U5 | 60 200mA Sub-Min. Silicon Diodes | 55p |
| U6 | 30 Sil. Planar Trans. NPN like BSY95A, 2N706 | 55p |
| U7 | 16 Sil. Rectifiers Top-Hat 750mA Vltg. Range up to 1,000 | 55p |
| U8 | 50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202 | 55p |
| U9 | 20 Mixed Voltages, 1 Watt Zener Diodes | 55p |
| U10 | 20 BAY50 charge storage Diodes DO-7 Glass | 55p |
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| U20 | 12 1.5Amp Silicon Rectifiers Top-Hat up to 1,000 PIV | 55p |
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| U23 | 30 MADT's like MHz Series PNP Transistors | 55p |
| U24 | 20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV | 55p |
| U25 | 25 300 MHz NPN Silicon Transistors 2N708, BSY27 | 55p |
| U26 | 30 Fast Switching Silicon Diodes like IN914 Micro-Min. | 55p |
| U27 | 12 NPN Germanium AF Transistors TO-1 like AC127 | 55p |
| U29 | 10 1Amp SCR's TO-5 can. up to 600 PIV CRS1/25–600 | £1.10 |
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| U31 | 20 Sil. Planar Plastic NPN Trans. Low Noise Amp 2N3707 | 55p |
| U32 | 25 Zener Diodes 400mW DO-7 case 3–18 volts mixed | 55p |
| U33 | 15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series | 55p |
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| U35 | 25 Silicon Planar Transistors PNP TO-18 2N2906 | 55p |
| U36 | 25 Silicon Planar NPN Transistors TO-5 BFY50/51/52 | 55p |
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| U41 | 25 RF Germanium Transistors TO-5, OC45, NKT72 | 55p |
| U42 | 10 VHF Germanium PNP Transistors TO-1 NKT667, AF117 | 55p |
| U43 | 25 Sil. Trans. Plastic TO-18 A.F. BC113/114 | 55p |
| U44 | 20 Sil. Trans. Plastic TO-5 BC115/116 | 55p |
| U45 | 7 3A SCR. TO66 up to 600 PIV | £1.10 |

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

**SILICON PHOTO TRANSISTOR.** TO-18 Lens end NPN Sim. to BP 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

| Qty. | 1-24 | 25-99 | 100 up |
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| Price each | 50p | 44p | 27½p |

### F.E.T.'S

| | |
|---|---|
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| 2N3820 | 55p |
| 2N3821 | 38½p |
| 2N3823 | 31p |
| 2N5458 | 35p |
| 2N5459 | 44p |
| BFW 10 | 66p |
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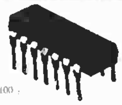

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| SN7409 | 0.20 | 0.18½ | 0.17½ |
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| SN7411 | 0.27½ | 0.26½ | 0.25½ |
| SN7412 | 0.38½ | 0.34 | 0.31 |
| SN7413 | 0.32 | 0.28½ | 0.26½ |
| SN7416 | 0.47½ | 0.44 | 0.42 |
| SN7417 | 0.47½ | 0.44 | 0.42 |
| SN7420 | 0.16½ | 0.15½ | 0.13 |
| SN7422 | 0.55 | 0.53 | 0.49½ |
| SN7423 | 0.55 | 0.54 | 0.49½ |
| SN7425 | 0.55 | 0.53 | 0.49½ |
| SN7426 | 0.49½ | 0.46 | 0.44 |
| SN7427 | 0.49½ | 0.46 | 0.44 |
| SN7428 | 0.77 | 0.71½ | 0.66 |
| SN7430 | 0.16½ | 0.15½ | 0.13 |
| SN7432 | 0.49½ | 0.46 | 0.44 |
| SN7433 | 0.88 | 0.82½ | 0.77 |
| SN7437 | 0.70½ | 0.68 | 0.66 |
| SN7438 | 0.70½ | 0.68 | 0.66 |
| SN7440 | 0.16½ | 0.15½ | 0.13 |
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| SN7442 | 0.73½ | 0.70½ | 0.64 |
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| SN7453 | 0.16½ | 0.15½ | 0.13 |
| SN7454 | 0.16½ | 0.15½ | 0.13 |
| SN7460 | 0.16½ | 0.15½ | 0.13 |
| SN7470 | 0.32 | 0.28½ | 0.26½ |
| SN7472 | 0.32 | 0.28½ | 0.26½ |
| SN7473 | 0.40½ | 0.38½ | 0.35 |
| SN7474 | 0.40½ | 0.38½ | 0.35 |
| SN7475 | 0.49½ | 0.47½ | 0.46 |
| SN7476 | 0.44 | 0.43 | 0.42 |
| SN7480 | 0.73½ | 0.70½ | 0.64 |
| SN7481 | £1.32 | £1.26½ | £1.21 |
| SN7482 | 0.95½ | 0.91½ | 0.93½ |
| SN7483 | £1.21 | £1.15½ | £1.04½ |
| SN7484 | £1.10 | £1.04½ | 0.99 |
| SN7485 | £3.96 | £3.85 | £3.74 |
| SN7486 | 0.35 | 0.34 | 0.33 |
| SN7489 | £6.05 | £5.77½ | £5.50 |

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| SN7491 | £1.10 | £1.04½ | 0.99 |
| SN7492 | 0.73½ | 0.70½ | 0.64 |
| SN7493 | 0.73½ | 0.70½ | 0.64 |
| SN7494 | 0.84½ | 0.81½ | 0.75 |
| SN7495 | 0.84½ | 0.81½ | 0.75 |
| SN7496 | 0.95½ | 0.92½ | 0.88 |
| SN74100 | £1.81½ | £1.76 | £1.70½ |
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| SN74105 | £1.06½ | £1.03½ | 0.97 |
| SN74107 | 0.44 | 0.42 | 0.39½ |
| SN74110 | 0.60½ | 0.58½ | 0.55 |
| SN74111 | £1.37½ | £1.26½ | £1.21 |
| SN74118 | £1.10 | £1.04½ | 0.99 |
| SN74119 | £1.48½ | £1.37½ | £1.21 |
| SN74121 | 0.44 | 0.40½ | 0.37½ |
| SN74122 | £1.54 | £1.43 | £1.21 |
| SN74123 | £3.08 | £2.97 | £2.86 |
| SN74141 | 0.73½ | 0.70½ | 0.64 |
| SN74145 | £1.65 | £1.54 | £1.43 |
| SN74150 | £3.30 | £2.97 | £2.75 |
| SN74151 | £1.10 | £1.04½ | 0.99 |
| SN74153 | £1.32 | £1.21 | £1.04½ |
| SN74154 | £1.98 | £1.87 | £1.76 |
| SN74155 | £1.54 | £1.43 | £1.32 |
| SN74156 | £1.54 | £1.43 | £1.32 |
| SN74157 | £2.09 | £1.98 | £1.87 |
| SN74160 | £1.98 | £1.87 | £1.76 |
| SN74161 | £1.98 | £1.87 | £1.76 |
| SN74162 | £1.40 | £4.12½ | £3.85 |
| SN74163 | £1.40 | £4.12½ | £3.85 |
| SN74164 | £2.42 | £2.36½ | £2.31 |
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| SN74166 | £3.85 | £3.57½ | £3.30 |
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| SN74195 | £2.20 | £2.09 | £1.98 |
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| SN74197 | £1.98 | £1.87 | £1.76 |
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| µA 703C—µA703C | 31p | 28½p | 26½p |
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| EA1000 | £2.89½ | | |

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*ROCK BOTTOM PRICES*

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| BP962 | 13p | 12p | 11p |
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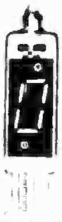
## NUMERICAL INDICATOR TUBES



| MODEL | CD66 | GR 116 | 3015F |
|---|---|---|---|
| Anode voltage (Vdc) | 170 min | 175 min | 5 |
| Cathode cur'nt(mA) | 2.3 | 14 | |
| Numeral h'ght (mm) | 16 | 13 | 9 |
| Tube height (mm) | 47 | 32 | 22 |
| Tube diameter (mm) | 19 | 13 | 12 |
| I.C. driver rec. | BP41 or 141 | BP41 or 141 | BP47 |
| PRICE EACH | £1.87 | £1.71 | £1.50 |

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## RTL MICROLOGIC CIRCUITS

| Epoxy TO-5 case | Price each 1-24 | 25-99 | 100 up |
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Data and Circuits Booklet for IC's Price 7p.

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| **Low Cost No.** | | | |
| BPS 14 | 16½p | 14½p | 12p |
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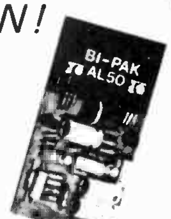
## 0.1% DISTORTION HI-FI AUDIO AMPLIFIER

# THE AL50




★ Frequency response 15Hz to 100,000 - 1dB.

★ Load - 3, 4, 8 or 16 ohms.

★ Distortion - better than .1% at 1KHz.

★ Signal to noise ratio 80dB.

★ Supply voltage 10 - 35 Volts.

★ Overall size 63mm x 105mm x 13mm.

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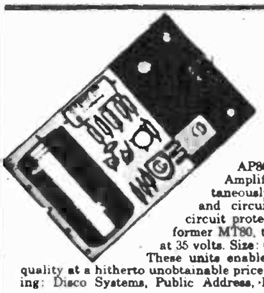

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 62mm x 105mm x 30mm.
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## TRANSFORMER BMT80 £2.15 p. & p. 25p.

## STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques.

Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

**SPECIFICATION**

| | |
|---|---|
| Frequency Response | 20Hz — 20KHz ± 1dB |
| Harmonic Distortion | better than 0.1% |
| Inputs: 1. Tape Head | 1.25 mV into 50KΩ |
| 2. Radio, Tuner | 35 mV into 50KΩ |
| 3. Magnetic P.U. | 1.5 mV into 50KΩ |

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

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

**Price £13.15**

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**The cost? Just £29·95!**
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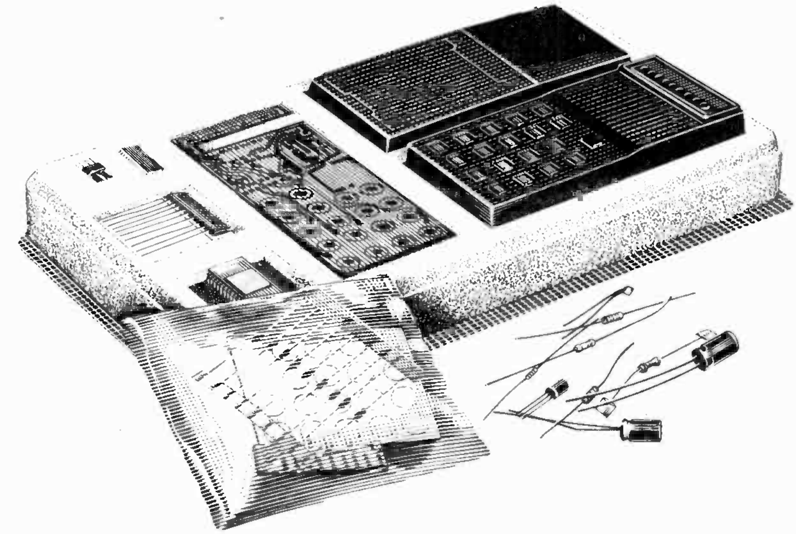

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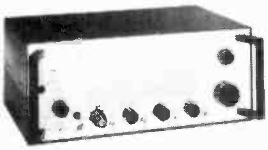

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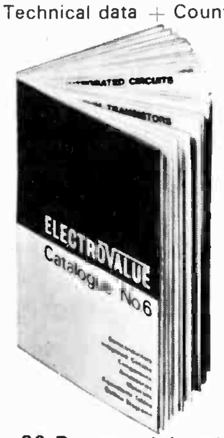


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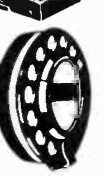

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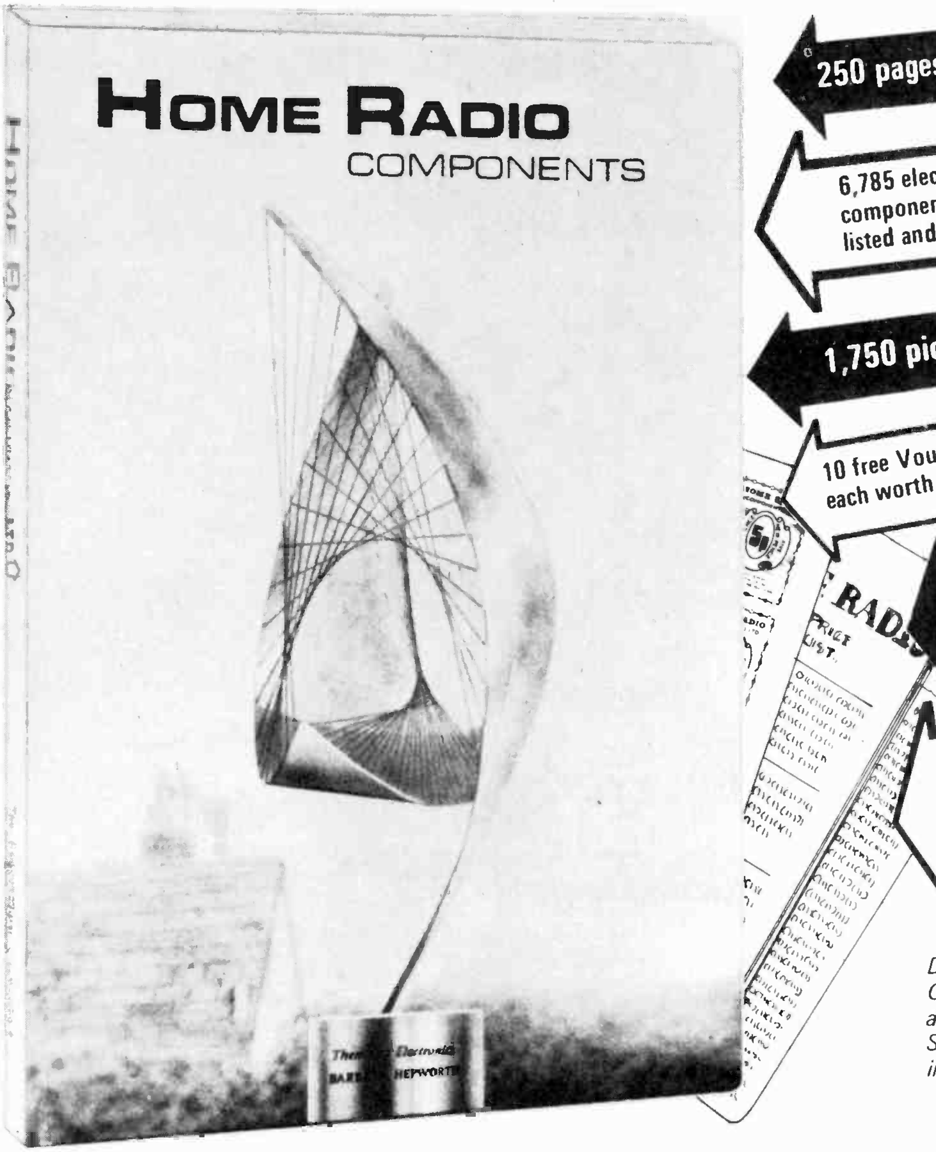


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**Vol. 27 No. 1**

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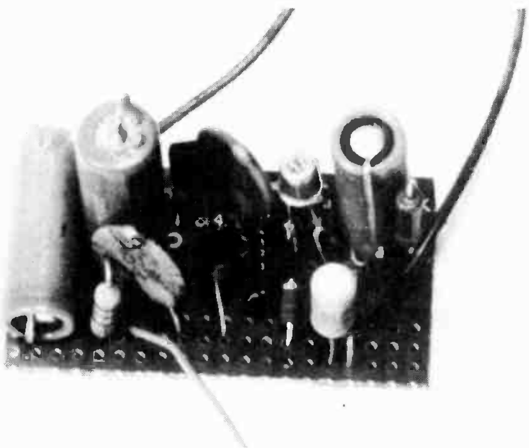
# 300mW AUDIO AMPLIFIER



By

R. A. Penfold

**Nearly all the components for this simple a.f. amplifier can be assembled on a small piece of Veroboard. The output available is 300mW into a 25Ω loudspeaker.**

THIS AMPLIFIER USES TWO SILICON TRANSISTORS AND an integrated circuit, and will develop an output power of up to about 300mW into a 25Ω impedance load. The output quality is very good due to the high degree of negative feedback which is applied to the circuit. An input sensitivity of approximately 10mV for full output is obtained with the prototype amplifier.

The use of an i.c. enables the unit to be miniaturised and the prototype amplifier, apart from the volume control, on-off switch, battery and speaker, measures slightly more than 2 by 1in. with a maximum height of approximately 1¼in. It operates from a 9 volt battery and the provision of a Class B output stage ensures good battery economy. The unit is very versatile and has many uses.

## CIRCUIT DIAGRAM

The circuit diagram of the amplifier is given in Fig. 1. This consists of the complementary output pair, TR1 and TR2, with an i.c. providing the input and driver stages. The i.c. is a Mullard TAA263, the internal circuit of which is shown in Fig. 2. As may be seen, the i.c. contains three transistors and two resistors. The transistors are direct coupled and the resistors form the collector loads for the first two of them. All three transistors operate as common emitter amplifiers. The TAA263 is housed in a Jedec TO-72 encapsulation, and is therefore the same size as a small standard transistor. There are only four lead-out wires.

Lead-out wire 4 of the i.c. is taken to earth and the negative supply rail. Lead-out wire 2 is taken to the supply rail via a decoupling network. The latter is essential in order to give good stability, and the decoupling components are C2 and R2.

The output of the i.c. is taken from lead-out 3, which must be connected to the positive supply via a suitable load resistance. In Fig. 1 this resistance is provided by R3 and R4 in series. Lead-out 1 connects to the base of the first transistor inside the i.c., and it is to this lead-out that the input signal and biasing current are applied. The input signal is connected to volume control VR1, the slider of which couples to the i.c. via C1 and R1.

In order to obtain stable bias conditions for the i.c. it is necessary to use a large amount of d.c. negative feedback in the bias circuit. Since the input and output of the device are 180° out of phase, this can be achieved by connecting a resistor network between these points. In this type of circuit a bypass capacitor is often included in the network in order to eliminate, or perhaps just reduce, the level of a.c. negative feedback which is introduced by the biasing resistors. In the present circuit, however, nothing approaching the full gain of the i.c. is required, and thus a single biasing resistor without a bypass capacitor can be used.

In Fig. 1 this approach is taken a stage further by taking the feedback point from the emitters of the two output transistors instead of from the output of the i.c. itself. This mode of operation is permissible because both the output transistors are emitter followers,

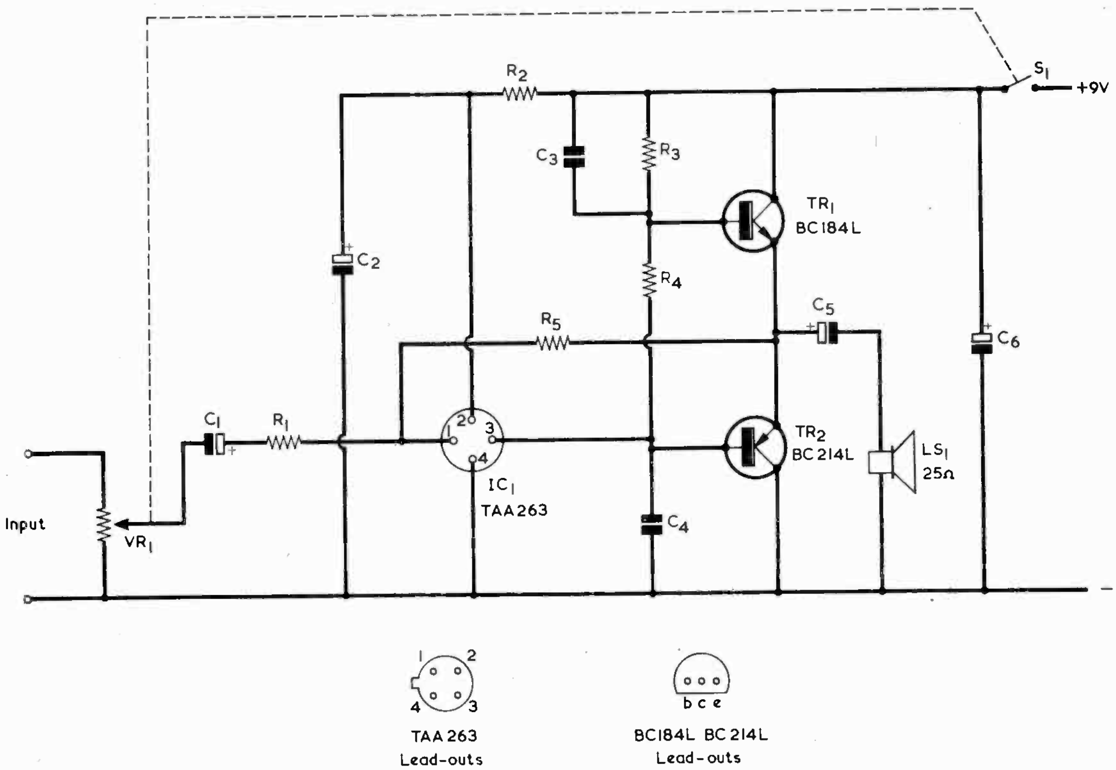



*Fig. 1. The circuit diagram for the 300mW a.f. amplifier. The heart of the input and drive circuits is an i.c type TAA263*

## COMPONENTS

*Resistors*
(All fixed values ¼ or ⅛ watt 10%)

| | |
|---|---|
| R1 | 2.2kΩ |
| R2 | 2.2kΩ |
| R3 | 1.5kΩ |
| R4 | 470Ω |
| R5 | 330kΩ |
| VR1 | 5kΩ potentiometer, log track, with S1 |

*Capacitors*

| | |
|---|---|
| C1 | 10µF electrolytic, 10V. Wkg. |
| C2 | 100µF electrolytic, 6V. Wkg. |
| C3 | 0.01µF miniature (see text) |
| C4 | 0.01µF miniature (see text) |
| C5 | 200µF electrolytic, 10V. Wkg. |
| C6 | 100µF electrolytic, 10V. Wkg. |

*Semiconductors*

| | |
|---|---|
| IC1 | TAA263 |
| TR1 | BC184L |
| TR2 | BC214L |

*Switch*

S1 s.p.s.t., part of VR1

*Speaker*

LS1 25Ω speaker

*Miscellaneous*

Veroboard panel (see text)
9-volt battery

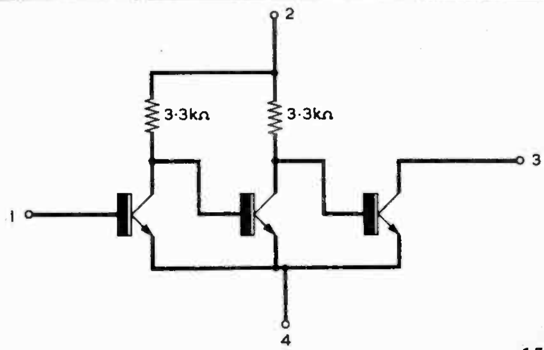
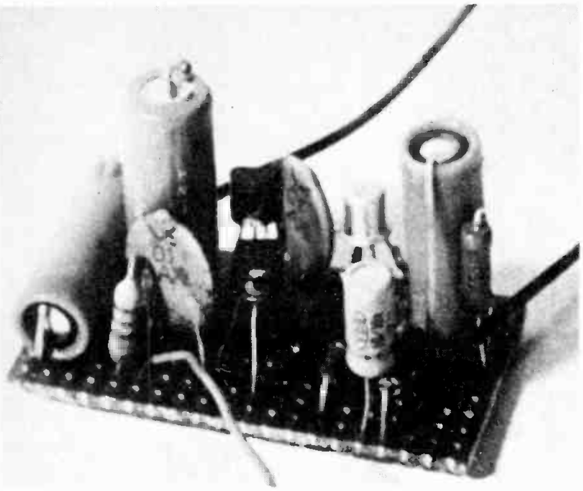



*Fig. 2. The internal circuitry of the TAA263*



*The top of the assembly, as seen from a slightly different angle*

offering zero phase change and very nearly unity gain. The feedback resistor is R5, and this provides bias together with feedback which extends over the entire amplifier including the speaker. The circuit arrangement, which allows a high level of feedback to be applied over the whole amplifier, results in a very low level of distortion, a low noise level and a very flat frequency response over the audio range. The asymmetry in the output transistor drive circuit, due to the presence of R4 in series with TR1 base, is virtually cancelled out.

The function of R4 is to permit a small biasing current in the two output transistors in the absence of signal, thereby reducing crossover distortion. The value of R4 and, hence, the biasing current, is much smaller than would be employed in a normal Class B output stage, but here again the high level of negative feedback allows such a circuit value to be used. This feedback reduces the crossover distortion which would otherwise be evident to a level which is unnoticeable.

The operation of the output stage is basically quite simple. As already mentioned, TR1 and TR2 operate as emitter followers and thus have approximately unity voltage gain. On the other hand the two transistors have a considerable current gain, and thus produce an output signal at very low output impedance. This signal can be directly coupled to a 25Ω or 35Ω speaker without the necessity for an output transformer. With a 25Ω speaker the available output power is 300mW.

Under quiescent conditions, the voltage at the junction of TR1 and TR2 emitters with respect to the negative rail is approximately half that of the supply. When a signal is applied to the transistor bases, TR1 amplifies the positive half-cycles and TR2 the negative half-cycles. So far as the output transistors are concerned, there is only a small bias current under no-signal conditions. When a signal is applied the current drawn by the output transistors is proportional to the output power. In consequence, maximum battery economy and a minimum amount of heat generation are given in the output stage.

The output signal is coupled to the speaker via the d.c. blocking capacitor, C5. Capacitors C3 and C4 are required in order to reduce the high frequency response of the circuit; without these capacitors the response could extend well into the r.f. spectrum, with a consequent tendency towards instability.

## CONSTRUCTION

Assembly is very straightforward, a Veroboard panel having 20 by 10 holes, with the copper strips running along the board length, being employed for most of the components. The prototype used Veroboard with a hole matrix of 0.1in., but it is quite in order to use 0.15in. Veroboard instead. If 0.1in. Veroboard is employed a very compact amplifier results, but construction requires a little more skill and it is essential that the resistors and capacitors be subminiature types. Beginners are advised to employ 0.15in. Veroboard.

Fig. 3 shows the Veroboard panel assembly as seen from the component side of the board. There are no breaks in the copper strips. C1, C2, C5, R2, R3 and R5

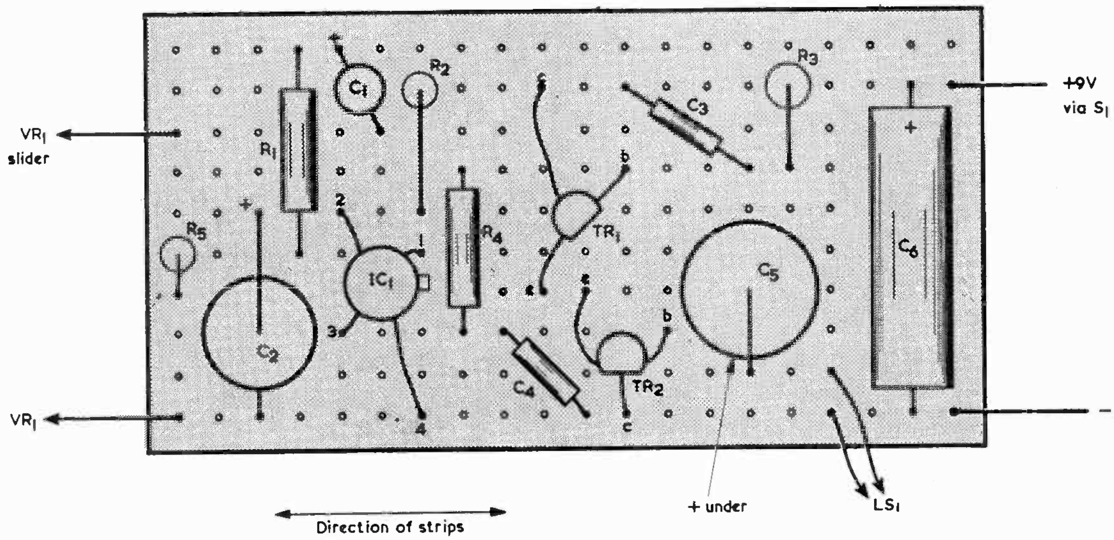



*Fig. 3. The component side of the Veroboard assembly. VR1 and S1 are external to the board*

are all mounted vertically. C3 and C4 should be types which are suitable for printed circuit mounting and which have their lead-outs projecting from the same side of the component body. Disc ceramic capacitors were employed in these two positions in the prototype.

The lead-outs of the integrated circuit are fairly short. If necessary, extension leads can be soldered to one or more of these to enable Veroboard hole positions to be reached. However, such extension leads should be kept as short as possible.

## NOTES ON USE

The optimum speaker load impedance is 25Ω. Speakers having a higher impedance may also be used but the maximum available output power will then be less than 300mW.

The earth connection for the amplifier is given by the negative supply rail. When the input connection to VR1 is made by screened wire, as is recommended, the outer braiding of the wire connects to the outside tag of VR1 which is common with the negative supply rail. Input impedance is approximately 5kΩ.

No attempt should be made to employ a supply voltage greater than 9 volts, as this might result in the destruction of the TAA263 integrated circuit. Any 9 volt battery can be used to power the amplifier, a small radio type such as the PP3 or PP4 being perfectly adequate. A quiescent current of around 5mA (drawn mainly by the TAA263) is to be expected. ■

# SIMPLE SOLDERING SCHEME

by W. J. Gadsby

**A trouble-free method of overcoming an occasional workshop problem.**

IN THE ASSEMBLY OF HOME-MADE SWITCHING DEVICES IT is sometimes necessary to be able to fit an adjustable screw to materials such as springy brass strip. If the strip forms part of a home-constructed switching assembly, the screw can then be turned to provide an adjustable contact. Other occasions can arise when it is similarly necessary to fit a screw to a thin piece of brass, copper or tinplate.

## ADDING A NUT

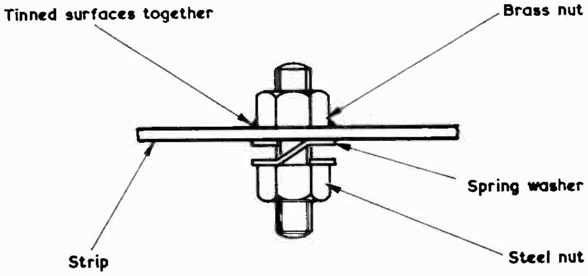
In all these cases, the metal to which the screw is to be fitted is too thin to be tapped, and it becomes necessary to solder a nut to it. The problem then arises of suitably positioning the nut and of ensuring that a reliable solder joint is made.

The accompanying diagram shows a scheme which the author has found to work very satisfactorily.

First drill in the strip, or thin metal, a hole which is clearance size for the screw to be fitted to the nut. Then tin the strip around the hole, using resin cored solder such as Ersin Multicore or Savbit.

Next, take up the nut which is to be soldered to the strip and similarly tin the surface which will be in contact with the strip. This nut must, of course, be brass.

With a steel screw or piece of steel studding fix the nut to the strip with the two tinned surfaces together, as illustrated. Fitted on the opposite side of the strip are a steel nut and a steel spring washer. Tighten the nuts so that the washer is compressed.



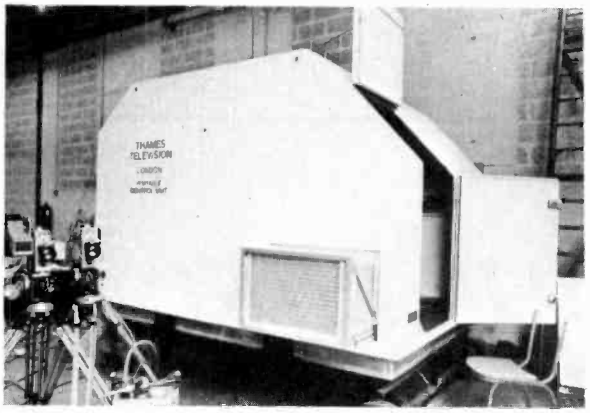

*How the parts are assembled on the strip before soldering*

Apply a soldering iron to the brass nut. The solder on the two tinned surfaces will then melt and the spring washer will force them together. Allow the assembly to cool and then remove the steel bolt or studding, the steel spring washer and the steel nut. The brass nut will now be firmly soldered to the strip.

This method relies on the facts that a small amount of flux still remains on a surface which has been tinned with resin cored solder and that the solder does not readily form a joint with the steel parts which are temporarily used to hold the brass nut in position on the strip. ■

# NEWS . . . AND .

## THAMES TV INTRODUCE AIR-TRANSPORTABLE OB UNIT



A portable colour TV control room that can be air-freighted throughout Europe has been built by Thames Television in co-operation with BEA Cargo Department. It is to be used this summer for making holiday programmes in Spain, Portugal, France, Italy and Yugoslavia.

The control-room is constructed within a double-skinned glass-reinforced plastics framework and is about 9 ft long, 7 ft 6 in wide and 6 ft high.

All the auxiliary sound and vision equipment can be stored within the main container which is transported to and from airports on flat-backed lorries.

The unit has two lightweight Philips LDK13 colour camera channels, an Ampex quadruplex videotape recorder and a four-channel sound mixer. The portable 'Skylab' is fully air-conditioned to work in a wide range of temperatures.

This new portable outside-broadcast unit – the first of its type to be built in the U.K. – is likely to encourage further use of electronic cameras for TV programmes of types formerly made in film. The use of electronic cameras allows the shots to be viewed immediately on playback without processing. The cameras are light enough to be carried on the shoulder or mounted on simple tripods.

## ALIEN EARS TUNE IN ON EARTH RADIO

A Space vehicle from another star is circling the earth at the same distance as our moon – that astonishing idea was put forward recently at a meeting of the British Interplanetary Society, covered by BBC World Service.

The idea was originally suggested in 1960 by an American professor to explain some long delayed echoes of regularly spaced radio signals transmitted from earth

These echoes were observed and recorded around 1930 by radio experimenters in Holland, Norway and France. At that time the mechanics of radio propagation were not very well understood, and it was assumed that these echoes were bouncing off the moon or being reflected within the atmosphere.

In a paper published in the British scientific journal *Nature* the professor suggested that if an alien space vehicle wanted to contact the earth, a process of re-transmitting our own signals with a suitable pause would ensure that someone heard them. At the recent BIS conference, however, Mr. Duncan Lunan, a graduate of Glasgow University, told a meeting of the British Interplanetary Society about his own interpretations.

Mr. Lunan claims that by plotting the delay times against the order in which they came in, he is able to obtain several star maps. From these maps Mr. Lunan deduces that a space vehicle from the star Epsilon Bootes is circling the earth in the same orbit as our moon.

He also believes that the vehicle arrived here about 13,000 years ago after completing the 103 light year journey from its starting point.

Most of this information is reasonably easily deduced from Mr. Lunan's charts, assuming they have been accurately drawn up. What is rather more difficult to accept is his interpretation of later, more complex charts.

The ideas are sufficiently stimulating to have persuaded EMI to make available equipment to test the theory.

Suggested Circuits - April issue

In 'High Input Impedance Amplifier' (Suggested Circuit No. 269) published in the April 1973 issue TR4 is shown as an n.p.n. transistor. The emitter arrow for this transistor should point inwards.

# . . . COMMENT

## OPEN UNIVERSITY COURSE IN ELECTRONICS AND CIRCUIT DESIGN

**Electromagnetics and Electronics, a Post-experience course by the Open University, aims to provide an understanding of the scientific basis of electronics and electronic circuit design.**

**The course is primarily, but not exclusively, intended for those preparing for higher level university study in science and technology.**

**It assumes little prior knowledge of electronics or electromagnetics but does assume a background of scientific or technical education beyond GCE 'O' Level.**

**The first part deals with the basic ideas of electricity, magnetism and electromagnetism, semiconductors and the properties of simple circuits and the remainder deals with electronic circuits.**

**The course consists of 17 written correspondence units linked to 17 television and five radio programmes. Students are required to attend a one week residential summer school and encouraged to attend evening or Saturday tutorial sessions. There are 12 assignments to complete and an examination at the end of the course.**

**Applications are now invited for the course which starts next February and lasts until November.**

**A home experiment kit, including a cathode-ray oscilloscope and a signal generator, is sent to students who are expected to design and build circuits for checking at summer school.**

**The course tuition fee is £45 plus £37 for the residential summer school. Application forms are available from The Post-experience Student Office, P.O. Box 76, Milton Keynes, MK7 6AA.**

## IN BRIEF

● Mr. William E. Harvey has been appointed director of operations for the £2 million Television Division of EMI Sound & Vision Equipment Ltd., based at Hayes, Middlesex.

● Torbay Amateur Radio Society is holding a Mobile rally on Sunday 12th August at the All Whites Rugby Football Ground, Newton Abbot.

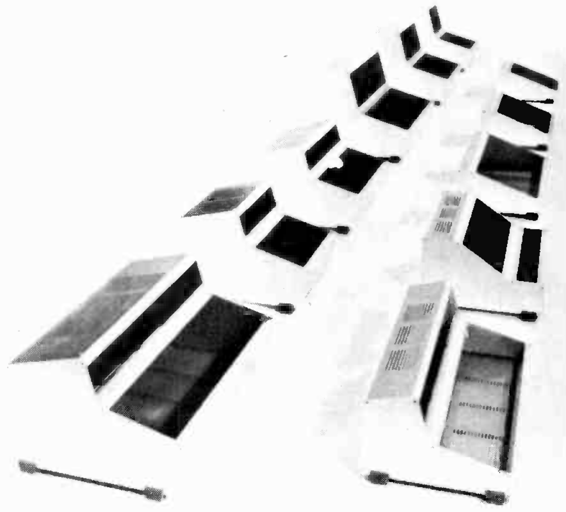
● A contract to supply audio equipment to one of the first local commercial radio stations in this country has just been awarded to Audio Ltd., of Stansted, Essex, by Birmingham Broadcasting Ltd., to be known as BRMB.

● The Committee on Broadcasting Coverage extends an open invitation to anyone, including private individuals, who wishes to submit written evidence, on any matter within its terms of reference, which relate to the coverage of broadcasting services in the U.K. Write to Committee on Broadcasting Coverage, 85 Whitehall, London, SW1A 2NP.

● AMF Venner have now published a technical data sheet describing their Digital Timer, Type TSA 240.

Specially designed for the Post Office at outside locations it may be operated from the mains supply or from external low voltage batteries.

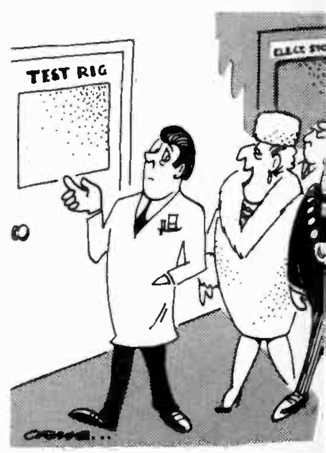
## INDUSTRIAL RACKS AND CABINETS



Daturr Ltd. is a new face in the field of racks, cabinets, instrument cases, card frames, consoles and all sheet metal work for the electronics industry.

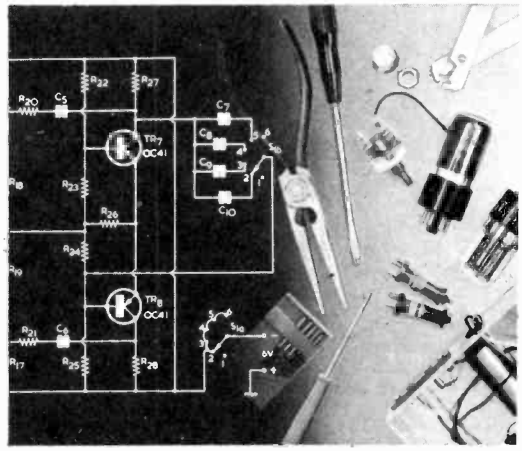
Formed by combining the design skill and experience of Hans Knurr KG of Munich; with the production facilities of D.A.T. Engineering Ltd.; Daturr Ltd., offer the U.K. electronics industry a wide new range of top quality products. Produced from anodised aluminium side panels and extrusions, the steel front, top and back panels may be supplied painted to customers choice, or in the Daturr standard blue acrylic finish. Front panels may be 19" or one of three standard widths and may be anodised or painted according to customer's choice.

Daturr consoles are despatched packed flat and may be assembled using only a screwdriver in a few minutes. Prices vary according to type and size from £12 to £26 each and delivery will normally be ex stock.




*"Don't tell me, young man — That's where you rig your tests!"*

# CLASS A AMPLIFIER



by G. A. FRENCH

An interesting transistor which has been available on the home-constructor market for some time is the Motorola MJE340. This is an n.p.n. power transistor having an hFE at 50mA collector current of 30 to 240 and a maximum collector voltage rating of 300 volts. This exceptionally high voltage rating makes the MJE340 a very useful device for American domestic entertainment products, since it can function as an audio output transistor in radios and record players which obtain their d.c. supply by direct rectification, without a transformer, of the American 117 volt mains.

This article describes a record player amplifier incorporating an MJE340 and is primarily intended to demonstrate to the more experienced co-n structor the advantages and disadvantages of this device. The output of the amplifier is in excess of 1 watt and the MJE340 is employed in a Class A circuit. The quality of reproduction, although not in the high fidelity category, is nevertheless quite acceptable. Sensitivity is sufficient to enable full output to be obtained from a crystal or ceramic pick-up.

The circuit will not be attractive to the beginner who simply requires a 1 watt amplifier and intends to buy all the components new, as a conventional Class B design of comparable performance would be cheaper and much less bulky in size when completed. The circuit should, on the other hand, appeal to the experimenter who likes to try something new and who may have most of the components required already on hand.

## CIRCUIT OPERATION

The circuit of the amplifier appears in the accompanying diagram, and it will be helpful to commence a description of its operation at the power supply section. The power for the unit is obtained by way of mains transformer T2 and rectifiers D3 and D4. Capacitor C8 is the reservoir capacitor, R13 the smoothing resistor and C7 the smoothing capacitor. It will be noted that component values here are reminiscent of those encountered in the h.t. supplies of valve equipment. The current drawn by the MJE340, which is in the TR3 position, and by its base bias potentiometer, is such that the positive plate of C7 is about 100 volts positive of chassis.

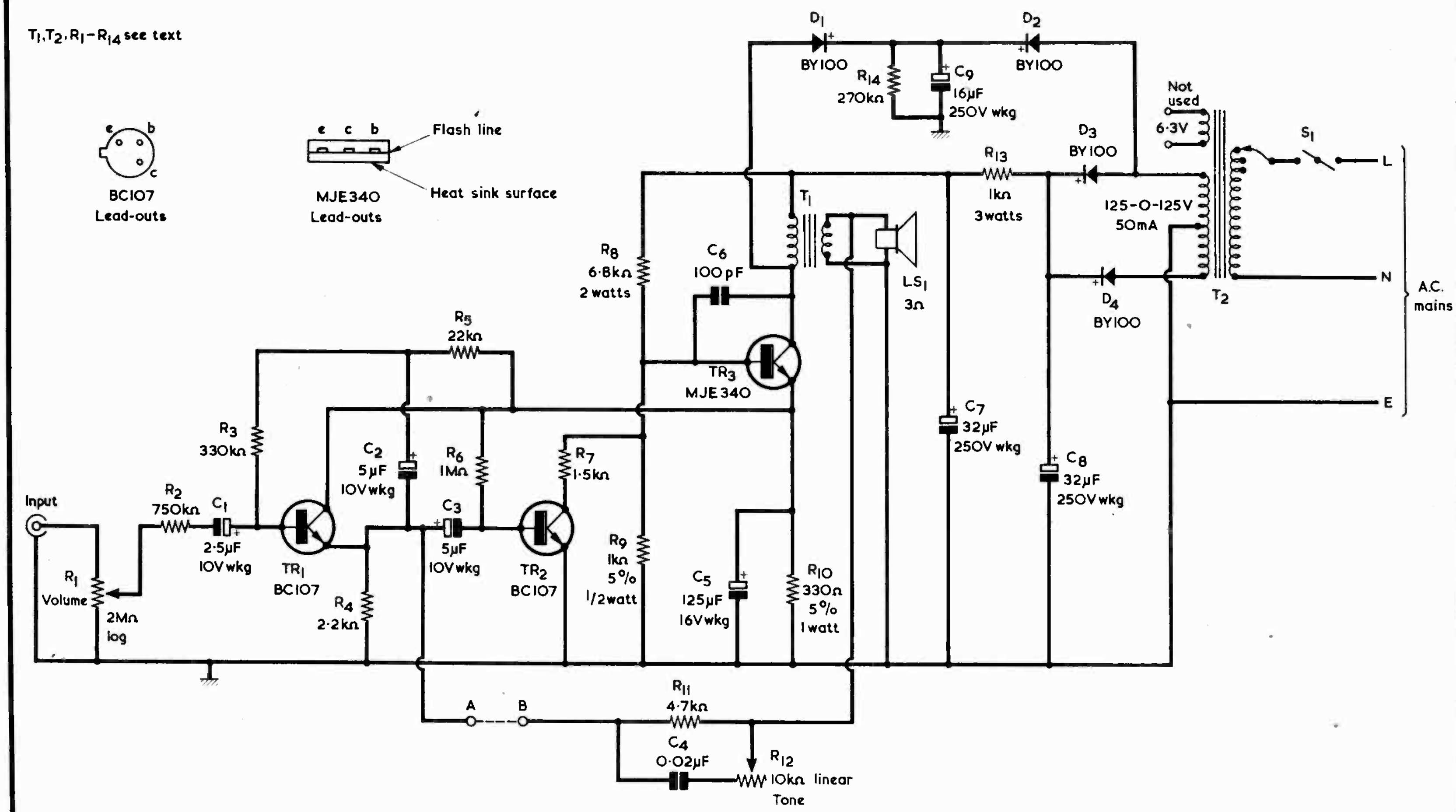
TR3 couples to the positive rail by way of the primary of T1, which is a valve-type speaker transformer having a step-down ratio of around 30:1. Its secondary connects to a 3Ω loudspeaker. Base bias for TR3 is provided by the potentiometer given by R8 and R9, whilst R10 is the emitter bias resistor. Since the voltage across R10 cannot rise above that at the base of TR3, a safely limited supply voltage becomes available at the emitter of TR3 for TR1 and TR2, which are standard low voltage transistors. About 11 volts is present across R10 and approximately 11.6 volts appears at the base of TR3. A current of slightly less than 12mA flows in R9 and one of around 14mA in R8, the extra current in R8 being due to the collector current of TR2. It is possible that standing current in R8 and R9 could be reduced by giving these resistors proportionately higher values, but the circuit functions satisfactorily in practice with the values shown and exhibits good voltage stability.

The collector of TR2, which is a common emitter amplifier, couples to the base of TR3 via R7. In conjunction with C6, this resistor limits amplification at radio frequencies and prevents instability at these frequencies. The use of a collector-to-base capacitor and a series base feed resistor is encountered in commercially produced equipment employing the MJE340, and appears to be a common circuit approach when this transistor is used in a single-ended output stage. Base bias for TR2 is obtained, via R6, from the voltage dropped across R10.

Preceding TR2 is the emitter follower TR1, whose function is to provide a high impedance input for the amplifier. The emitter load for TR1 is R4, and the coupling to TR2 is by way of C3. The collector of TR1 connects direct to the upper end of R10, and its base couples to this same source of voltage by way of R3 and R5. The emitter of TR1 is bootstrapped to the junction of these two resistors via C2, with the result that R3 has little shunting effect on the input impedance of TR1 base circuit. There is no decoupling between the upper end of R10 and the base supply to TR2, the collector of TR1 and the base supply to TR1 (although C2 might be considered to provide decoupling in the last case) since this was found to be unnecessary. Even if feedback from the emitter of TR3 did occur this would, in any case, be negative in character.

The input to the amplifier is provided via volume control R1 and the series components R2 and C1. Input impedance is 2MΩ when R1 slider is at the low-volume end of its track and is slightly less than 1MΩ when R1 slider is at the high-volume end. These impedances are suitable for a crystal or ceramic pick-up and similar sources of signal.

TR2 and TR3 provide a relatively high level of gain and a considerable amount of negative feedback is applied from the secondary of T1 via R11 to the emitter of TR1. R12 functions as a top-cut tone control. When its slider is at the end of its track which connects to C4, this capacitor is effectively in parallel with R11. In consequence, feedback increases as frequency rises, causing a reduction in the treble




*The circuit of the Class A amplifier. This has a number of unusual features which are explained in the text* response. This reduction decreases progressively when the slider of R12 is moved towards the other end of its track. The link shown as a broken line between points 'A' and 'B' denotes the fact that the feedback loop is left open at this point during construction. It is completed after the correct phasing of the connections to T1 secondary has been found, as is explained in greater detail later.

Components which have not so far been dealt with are D1, D2, R14 and C9. D2 causes C9 to charge to the peak value of the half-secondary voltage from T2, and D1 ensures that the collector of TR3 cannot rise above this potential. Without a protection circuit of this nature there is a possibility that transients in the signal being reproduced could cause voltages in excess of the maximum specified value to appear at TR3 collector, with consequent risk of breakdown. R14 is merely a high value bleeder resistor and it ensures that C9 becomes discharged after the amplifier has been switched off.

## COMPONENTS

Unless otherwise specified in the diagram, all the fixed resistors are ¼ watt 10% types. R2 to R6 inclusive should be high stability components. R1 and R12 are standard panel-mounting potentiometers. If desired, the on-off switch, S1, may be ganged with R12. An additional 100kΩ resistor, not shown in the diagram, is required for setting-up purposes.

The four diodes may be any silicon rectifiers rated at 0.5 amp or more and having a p.i.v. of at least 400 volts. The author used BY100's in the prototype as these happened to be on hand.

Transformer T2 is an R.S. Components 'Midget Mains 125V' type, which is available from Home Radio under Cat. No. TM39 or from stockists of R.S. Components parts. It has an h.t. secondary offering 125-0-125 volts at 50mA and a heater secondary giving 6.3 volts at 1.2 amps. The 6.3 volt secondary is unused, although it could if desired be employed to power a panel light which would indicate when the amplifier was switched on.

Ideally, the primary of speaker transformer T1 should present an impedance of some 2,500Ω to the collector of TR3, and this would be produced by a transformer having a turns ratio of 29:1. The writer initally checked performance with a miniature 33:1 valve output transformer and then with a larger 36:1 valve output transformer rated at 5 watts. There was little significant difference in performance between the two transformers and it would seem that any transformer ratio reasonably close to 29:1 should be satisfactory in practice. The 5 watt transformer is listed in the Home Radio catalogue under Cat. No. TO44, and is described there as offering a primary impedance of 5,000Ω at a secondary load of 3.75Ω. The primary impedance will be lower than 5,000Ω when a 3Ω load is used. It is desirable for T1 to be a fairly large component because, immediately after switch-on, there is a short current pulse through its primary which is limited by R13 to about 120mA. The pulse is caused by charging current flowing into C5. The normal standing current in T1 primary is about 35mA.

The transistor type MJE340 is available from a number of semiconductor suppliers, including Henry's Radio. Despite its high dissipation capability it is a physically small device. It has a metal surface on one side which comes into contact with the heat sink. The lead-out positioning is shown in the inset, this illustrating the transistor with the flash line (i.e. the raised line which is given where, during manufacture, the two halves of the plastic mould meet) below the lead-outs. It is, however, a little difficult to see the flash line and constructors who want to be completely certain of lead-out identification can confirm this with the aid of a testmeter switched to an ohms range. There will be continuity between the central collector lead-out and the base lead-out with the testmeter leads connected one way round. There will be no continuity between the collector lead-out and the emitter lead-out with the testmeter leads connected either way round.

The MJE340 dissipates about 3.2 watts in this circuit and needs to be mounted on a fairly large heat sink. The author employed a flat unpainted mild steel sheet about 4 in. square, mounted vertically, and with the transistor secured to it at the centre. The transistor surface indicated in the lead-out inset in the diagram should be that which is in contact with the heat sink, and the transistor is secured by means of a 6BA bolt and nut. A smaller heat sink could be used if this were of the ribbed variety and was painted black. The MJE340 must not be allowed to become too warm as, apart from any other factors, it may then cause distortion to be introduced.

The heat sink is in contact with the collector of the transistor and must, therefore, be insulated from the chassis. A word of warning is needed here. Experienced constructors who have worked with power transistors in low voltage circuits have, in some cases, fallen into the bad habit of checking transistor temperature with the back of a finger whilst the associated equipment is switched on. In the present design the heat sink has a potential of about 100 volts above chassis, and it must *not* be touched whilst the equipment is switched on since this could result in an unpleasant and possibly even dangerous shock. The amplifier must be switched off before checking heat sink temperature. Incidentally, checking transistor temperature with the back of a finger whilst the associated equipment is turned on is a bad habit because it is possible for some of the power transistors in such items as television receivers to have cases which are similarly at a dangerously high potential above chassis. The amplifier under consideration must be housed in a suitable cabinet after completion so that the heat sink and, of course, mains and other high voltage points cannot be accidentally touched.

## FEEDBACK PHASING

Construction should not raise many difficulties. The layout is not critical provided the signal circuitry around TR1 does not too closely approach that around TR3. It is important that R11 and C4 are *not* connected to the emitter of TR1 at this stage. In the circuit diagram this state of affairs corresponds to the link between points 'A' and 'B' being open.

When assembly has been completed and the usual wiring checks have been made, R1 may be set to the minimum volume position and the amplifier switched on. In its present condition, without feedback, the amplifier has a very high gain, with the input circuitry around TR1 being at high impedance. There should be quite a loud hiss from the speaker and it may be found that there are noticeable crackles from the speaker if the chassis is touched by a screwdriver. The next operation is to check the phasing of the feedback. This is done by taking up a 100kΩ resistor and connecting it across points 'A' and 'B'. These points are both at low impedance and it is quite in order to hold the resistor body between thumb and forefinger. If the hiss drops noticeably when the 100kΩ resistor is connected, the feedback phasing is correct and points 'A' and 'B' can be joined directly.

Should the application of the 100kΩ resistor cause the amplifier to break into oscillation, the feedback phasing is incorrect. The amplifier is switched off and the feedback leads (i.e. those from chassis and from R11/R12) at the secondary of T1 are transposed. The amplifier is switched on again and the check with the 100kΩ resistor at points 'A' and 'B' carried out once more. The hiss should now reduce as the resistor is applied to these two points, thereby indicating that, this time, the feedback has the correct phase. Points 'A' and 'B' may then be joined directly.

It is necessary to adopt the procedure just described because, if points 'A' and 'B' were joined directly when the amplifier had incorrect feedback phase, the consequent oscillation might be sufficiently strong to cause damage to an output component. Using the 100kΩ resistor ensures that oscillation, with incorrect phase, is at a safely low level.

After the feedback connection between points 'A' and 'B' has been finally made, the amplifier is complete and ready for use. ■

# New Products

## DEVCON RUST JELLY


**Devcon Rust Jelly is a versatile rust remover that was developed originally for industrial use, on machinery, tanks, bridges and other structures. It works on any surface – iron, steel or concrete – and will remove tarnish from copper, aluminium and other metals. The substance is applied to the surface and allowed to penetrate the rust for five minutes, before being washed away with clean water. A second application may be used if there are still traces of rust. Rust Jelly contains a neutralizing agent to help protect sound metal. No further treatment is necessary before painting. Devcon Rust Jelly can be used at any angle – even overhead or vertical surfaces can be treated – and it is quite safe to use, being non-flammable and odourless. The retail price is 55p for an 8 fluid oz. plastic applicator pack.**

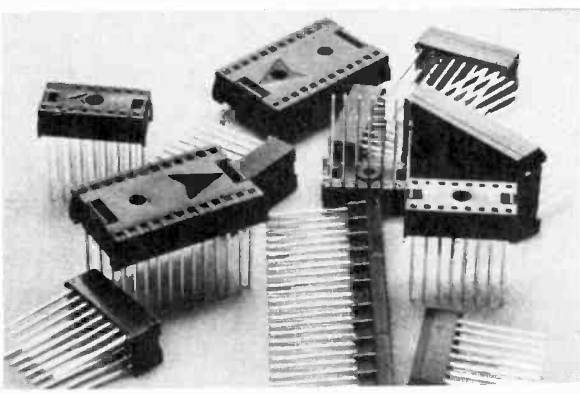
**Further details from Devcon Ltd., Station Road, Theale, Berks.**

## D.I.L. SOCKET RANGE

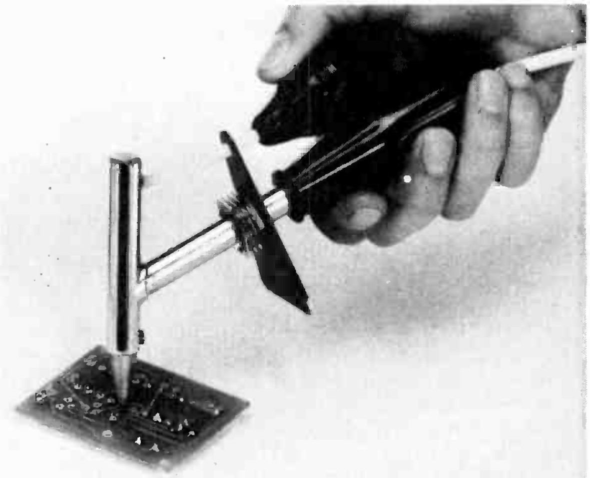
Tekdata (Trading) Ltd. are now offering the Scanbe ME 2 14-, 16- and 24-pin d.i.l. sockets, with either square wire-wrap posts or solder terminals.

The glass-filled nylon body, with latching cap, holds gold-plated phosphor-bronze wire-wrap posts or solder terminals. These have a current rating of 1 ampere in use, and a typical contact resistance (contact surface to pin tip) of 8 milliohms. Unwanted pins can be easily removed, by prising off the cap. Insertion force per pin is said to be 250 g max. (100 g typically) and extraction force 30 g min. (60 g typically). Designed for high-density p.c.b. mounting, the socket pins fall on a 0.1 by 0.3 in. grid.

ME 2 d.i.l. sockets are available ex stock. A sample price of 32p each for the 16-pin wire-wrap types in 100 lots is quoted. Tekdata (Trading) Ltd., Pentagon House, Bucknall New Road, Hanley, Stoke on Trent, Staffs. ST1 2BA.



## DE-SOLDERING GUN



A new de-soldering instrument which eliminates the necessity for air or vacuum lines has been introduced by Adcola Products Ltd.

Known as the R 500 the instrument has been designed for vertical operation over the joint to be de-soldered on printed circuit boards, etc.

To allow the operator to hold the instrument in a convenient position while maintaining the barrel vertically over the joint the handle is positioned at an angle to the barrel.

The R 500 has also been designed for simple one hand operation and features an air bulb connected to the barrel by clear PTFE tubing. In use the de-soldering 'gun' reaches operating temperature in two minutes. The air bulb is depressed and the nozzle end of the barrel is then positioned over the joint to melt the solder. Once the solder has become molten the air bulb is released to 'suck' the solder up into the barrel to leave a clean joint.

The barrel can be cleaned of solder by sharply depressing the air bulb to eject the molten solder into a suitable waste container. The tool is suitable for continuous operation and it will not lose the necessary reservoir of heat needed for efficient de-soldering operation, even under the most rigorous rectification work conditions.

The 'gun-like' design of the tool allows for clear vision of the work piece at all times, and it can be balanced on the work bench when not in use. The handle is moulded in glass filled nylon to remain cool over long periods of use, and the interchangeable nozzle can be removed for periodic cleaning.

The R 500 is available in a range of voltages from 6v to 250v and has an element rated at approximately 30w for efficient operation. It is robustly constructed for long term trouble-free operation to meet worldwide safety standards, and is priced at £6.72 plus VAT.

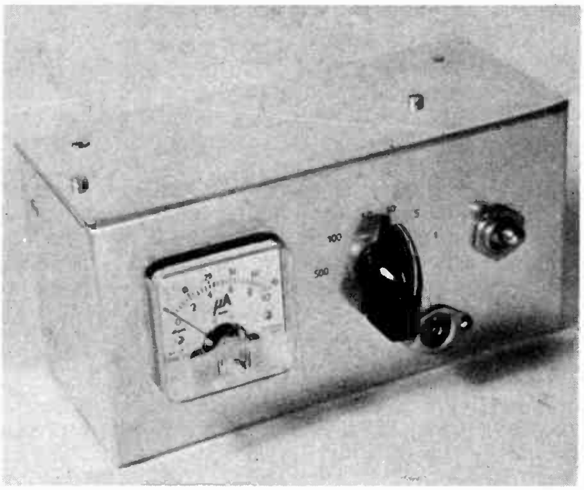
# A.C. Millivoltmeter

by A. P. Roberts

**This battery operated instrument has a flat frequency response from approximately 25Hz to higher than 100kHz, and offers ranges from 0-1mV to 0-500mV.**

IN THE DESIGN AND TESTING OF AUDIO AMPLIFIERS THE two most useful items of equipment are probably a wide-range audio signal generator and an audio a.c. millivoltmeter. With these two pieces of equipment it is possible to make accurate measurements of noise, gain and frequency response. Other useful measurements can also be carried out.

While many enthusiasts own an audio signal generator, a.c. millivoltmeters are a comparative rarity. The unit which forms the subject of this article is an inexpensive millivoltmeter for use at audio frequencies, its frequency response being relatively flat from approximately 25Hz to well over 100kHz. Six ranges are provided, these having f.s.d. values of 1, 5, 10, 50, 100 and 500mV. The input impedance is in excess of 500kΩ on all ranges. As is explained later, an audio signal generator with a calibrated output (or an audio signal generator and some form of a.c. voltmeter) is required for setting up.



*Front view of the completed millivoltmeter*

*Additional numbers were added to the meter scale in the prototype to provide a 0–10 range*

## THE CIRCUIT

The circuit diagram of the a.c. millivoltmeter appears in Fig. 1. The design consists basically of an emitter follower input stage (TR1), a switched attenuator to select the desired range (S1(a) (b) and R5 to R15), a voltage amplifier (TR2, TR3 and TR4) and finally a moving-coil meter fed via a bridge rectifier to indicate the input voltage (M1 and D1 to D4).

The input signal is fed to the base of TR1 via C1. R1 and R3 form a potential divider and provide bias for TR1, which is used in the emitter follower mode. C2 provides a bootstrap coupling back to the input and this, in conjunction with R2, considerably reduces the shunting effect on the input impedance given by R1 and R3. The input impedance obtained using a 2926G in the TR1 position, as specified, should be found perfectly adequate for nearly all practical purposes. If the constructor so desires, the input impedance can be somewhat increased by employing a BC169C for TR1; however, this article assumes that a 2N2926G is used, as occurred with the prototype.

The emitter load resistance for TR1 is provided by the attenuator network. This is positioned in the low impedance section of the input stage in order to remove the necessity for frequency compensation. Actually, the attenuator consists of a single load resistor for the 0–1mV range and five separate potential dividers for the remaining ranges. The desired range is selected by S1(a) (b). The resistors used in the potential divider sections should be 2% or, if possible, 1% high stability types. Some of the values are non-standard and may need to be made up of two resistors in series, as indicated in the Components List.

C4 couples the output from the attenuator to the voltage amplifier input. An electrolytic capacitor cannot be used in this position since the polarity of the d.c. voltage appearing across the capacitor is not the same on all ranges. Suitable capacitors for C4 are available from a number of suppliers including Marco Trading The Maltings, Station Road, Wem, Salop. The working voltage is unimportant as the maximum voltage appearing across the capacitor will only be of the order of 1 volt or so.

Three transistors, TR2, TR3 and TR4, are used in the voltage amplifier, these all being connected in the

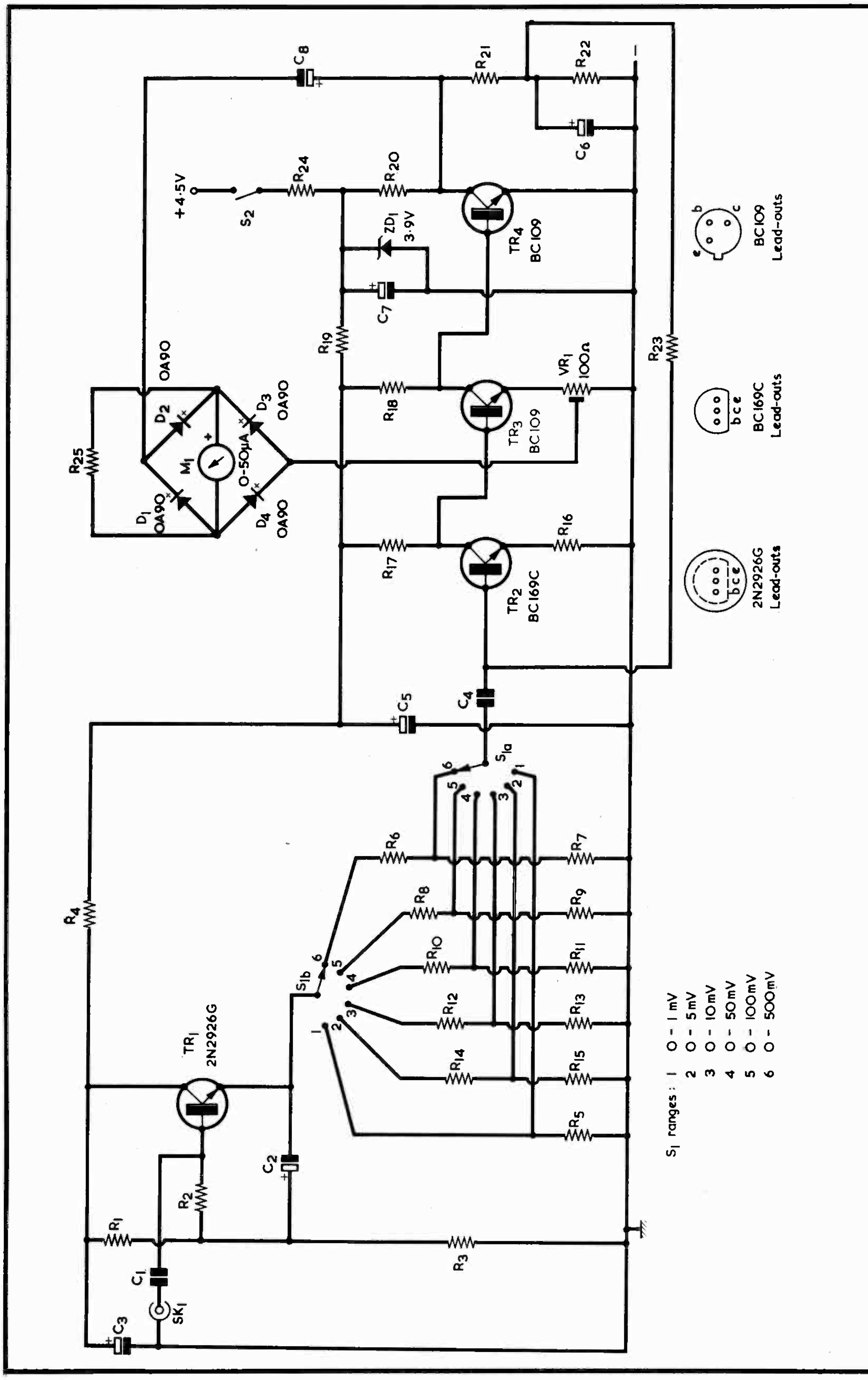



*Fig. 1. The circuit diagram of the a.c. millivoltmeter. This is powered by a 4.5 volt battery*

## COMPONENTS

*Resistors*
(All fixed values ¼ watt 10% unless otherwise stated)

| | |
|---|---|
| R1 | 100kΩ |
| R2 | 100kΩ |
| R3 | 150kΩ |
| R4 | 330Ω |
| R5 | 6.2kΩ |
| R6 | 6kΩ 2% (4.7kΩ + 1.3kΩ) |
| R7 | 12Ω 2% |
| R8 | 6.2kΩ 2% |
| R9 | 62.8Ω 2% (56Ω + 6.8Ω) |
| R10 | 6.2kΩ 2% |
| R11 | 129Ω 2% (82Ω + 47Ω) |
| R12 | 6.2kΩ 2% |
| R13 | 690Ω 2% (680Ω + 10Ω) |
| R14 | 4.8kΩ 2% (2.4kΩ + 2.4kΩ) |
| R15 | 1.2kΩ 2% |
| R16 | 270Ω |
| R17 | 10kΩ |
| R18 | 10kΩ |
| R19 | 330Ω |
| R20 | 2.2kΩ |
| R21 | 10kΩ |
| R22 | 10kΩ |
| R23 | 270kΩ |
| R24 | 68Ω |
| R25 | 680Ω (see text) |
| VR1 | 100Ω pre-set potentiometer, miniature skeleton, horizontal mounting |

*Capacitors*

| | |
|---|---|
| C1 | 0.47μF 100 V.Wkg. (see text) |
| C2 | 10μF electrolytic, 6 V.Wkg. |
| C3 | 100μF electrolytic, 6 V.Wkg. |
| C4 | 2.2μF (see text) |
| C5 | 200μF electrolytic, 6 V.Wkg. |
| C6 | 25μF electrolytic, 6 V.Wkg. |
| C7 | 50μF electrolytic, 6 V.Wkg. |
| C8 | 200μF electrolytic, 6 V.Wkg. |

*Semiconductors*

| | |
|---|---|
| TR1 | 2N2926 green (see text) |
| TR2 | BC169C |
| TR3 | BC109 |
| TR4 | BC109 |
| D1-D4 | OA90 |
| ZD1 | 3.9V 5% zener diode, 250 or 400mW |

*Switches*

| | |
|---|---|
| S1(a) (b) | 2-pole 6-way miniature rotary |
| S2 | s.p.s.t. toggle |

*Meter*

| | |
|---|---|
| M1 | 0-50μA meter, 42 × 42mm (see text) |

*Socket*

| | |
|---|---|
| SK1 | Flush mounting coaxial socket |

*Battery*
4.5V battery type 1289 (Ever Ready)

*Miscellaneous*
2 miniature crocodile clips
Chassis, 6 × 3 × 2½ in., with base plate
Pointer knob
Paxolin for component panels

common emitter mode. They are direct coupled, and bias current for TR2 is obtained, via R23, from the potential divider given by R21 and R22 which is connected across the output. This bias network also gives a large degree of d.c. negative feedback, and the presence of bypass capacitor C6 ensures that there is no a.c. negative feedback. The bias current for TR3 is obtained from the collector circuit of TR2, and that for TR4 from the collector circuit of TR3.

The unbypassed resistor, R16, in the emitter circuit of TR2 increases the input impedance of the voltage amplifier. There is, as a result, a negligible loading effect on the attenuator and a fairly low value capacitor can be fitted in the C4 position.

C8 couples the output from the voltage amplifier to the full-wave bridge rectifier, D1 to D4. The rectified output from the rectifier circuit is fed to the moving-coil meter, M1, this being shunted by R25 to give the required sensitivity. The meter used by the author was a Hioki MK38. This is very similar in appearance to the Henelec and Sew 38 series meters and either of the latter may be employed instead. The value of the shunt resistor, R25, should be approximately half the internal resistance of the meter used. The internal resistance of the Hioki meter employed by the author was 1.3kΩ, causing R25 to have a value of 680Ω. The Henelec 0-50μA meter has a quoted nominal internal resistance of 900Ω, which would argue a value of around 450Ω for R25. However, it would in practice be better for the constructor to initially employ the specified 680Ω value for R25 and only reduce this if there appears to be excessive sensitivity when the calibration procedure is carried out.

To compensate for non-linearity in the forward resistance of the diodes in the bridge rectifier, the junction of D3 and D4 is taken to the slider of the pre-set potentiometer, VR1, in the emitter circuit of TR3. This provides a level of negative feedback, the extent of which is controlled by VR1. When the slider of VR1 is at the earthy end of its track there is no negative feedback, and when it is at the TR3 emitter end of the track there is a high level of feedback.

Apart from compensating for non-linearity in the bridge rectifier diodes, this feedback also controls the sensitivity of the instrument. During setting-up, therefore, VR1 is adjusted to set the overall sensitivity of the instrument to the correct level.

In order to ensure that the sensitivity does not alter as the battery voltage drops with age, R24 and ZD1 are included to stabilize the supply voltage. The supply voltage is at the rather low level of 3.9 volts since the transistors must be operated at low voltages and currents in order to obtain a low noise level.

R4, C3, C5, R19 and C7 are the supply decoupling components. S2 is the on-off switch. Power is obtained from a 4.5 volt torch battery, which gives very economical running.

The input coupling capacitor, C1, is shown in the Components List as having a working voltage of 100. This is the working voltage of the component used in the prototype instrument, which is only intended for use with transistor equipment. If the unit is to be used with valve equipment it is possible that direct voltages of 200 or 300 may appear across the input. In this event, the capacitor in the C1 position should have a working voltage of 300, or more if necessary. A suitable component here would be the Mullard 0.47μF polyester capacitor with a working voltage of 400, which is available from Home Radio under Cat. No. 2EH41.

## CONSTRUCTION

The millivoltmeter is housed in an aluminium case measuring 6 in. wide, 3 in. high and 2½ in. deep. The author employed a standard ready-made chassis having these dimensions, the chassis deck becoming the front panel of the instrument. The chassis base plate functions as a detachable rear panel.

Some retailers of this size of chassis do not also supply a suitable base plate, and it will then be necessary for the constructor to make his own from 18 s.w.g. sheet aluminium. The base plate is secured to the four corner pieces of the chassis by four self-tapping screws. A chassis and base plate of the requisite dimensions are available from Home Radio under Cat. Nos. CU221 CU233 respectively.

Fig. 2 gives drilling and cutting details for the front panel. The large cut-out for the meter can be made with a needle file. Alternatively, a series of closely spaced ⅛ in. holes may be drilled just inside the perimeter of the hole, the centre piece then being broken out and the edges smoothed off with a large half-round file.

S1, S2 and the input socket may be mounted after work on the panel is completed. Two earthing solder tags are required under the nuts which secure the input socket in position. Connection is made to these later. The meter is not mounted at this stage as some further drilling is required in the case, and it might suffer damage whilst this is in progress.

The emitter follower input stage is assembled on a piece of $\frac{1}{16}$ in. Paxolin measuring 2¼ by 1½ in. A full-size diagram illustrating this board, as seen from the components side, is given in Fig. 3. The component lead-outs pass through holes drilled in the board, connecting to other lead-outs on the underside as indicated by the broken lines. The two points marked 'A' are joined together by a short insulated lead.

When completed, the board is mounted by two ½ in. 6BA bolts on the right-hand side of the case, next to the on-off switch, with the C3 end of the board at the top. Two short insulating spacers are employed to space the underside of the board from the inside surface of the aluminium case. If desired further protection against short-circuits to the case may be provided by primarily fitting a piece of self-adhesive plastic to the aluminium under the board area. As shown in Fig. 3, the board takes a chassis connection by way of a solder tag under one of the 6BA nuts which retains it in position.

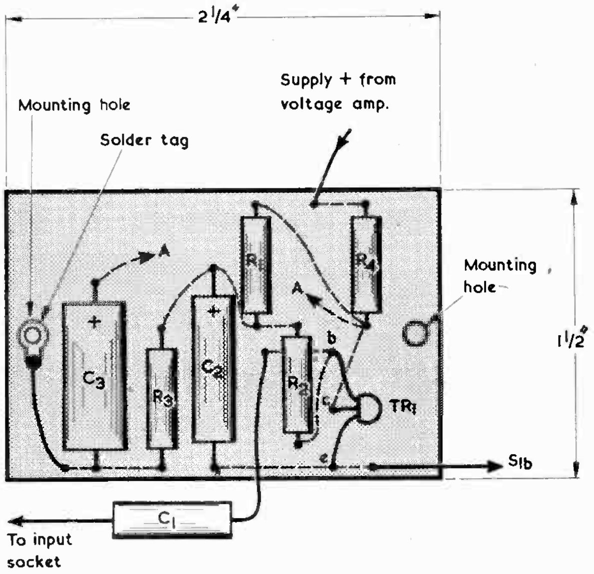



*Fig. 3. The emitter follower input board. This is reproduced full-size*

There are two flying leads from the board. One of these connects to the arm of attenuator switch S1(b) whilst the other takes a positive supply from the voltage amplifier board, which is not yet assembled. Capacitor C1 is external to the board, and is positioned between the board and the centre contact of the input socket.

The wiring of the attenuator switch, S1(a) (b), is rather complex and, to aid construction, a diagram is given in Fig. 4. In this diagram the two points 'A' and 'A' are joined together, as also are the two points 'B' and 'B', 'C' and 'C', 'D' and 'D', and 'E' and 'E'. The dashed line drawn across the switch indicates its two halves. Practical switches may, in some cases, have the two wiper tags positioned differently, relative to the fixed contact tags, than is shown in Fig. 4. Constructors

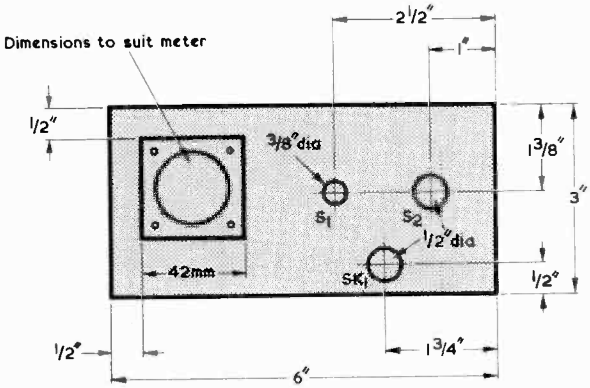



*Fig. 2. Drilling and cutting details for the front panel*

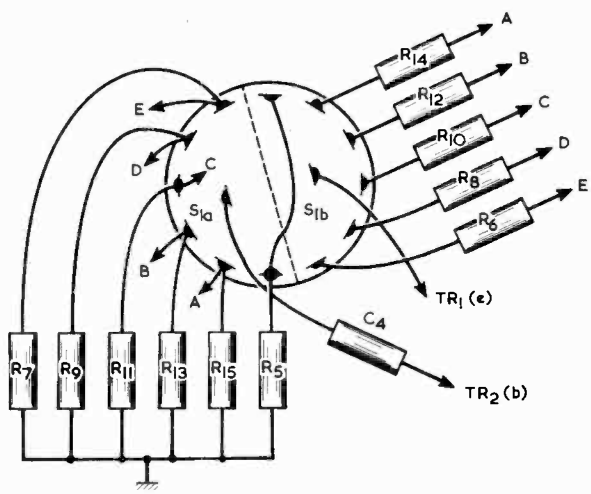
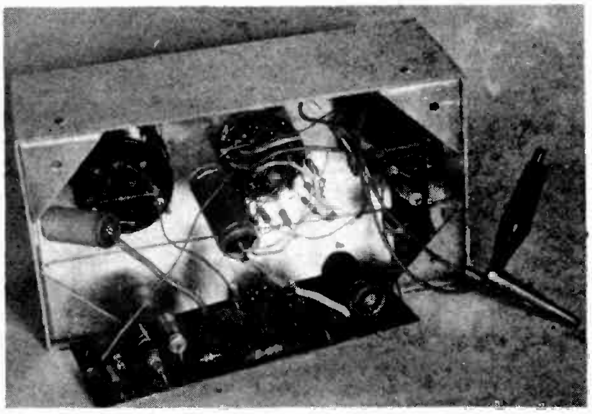



*Fig. 4. Wiring the resistors in the attenuator section*



*The voltage amplifier board partly removed in order to allow the sensitivity potentiometer to be set up*

should check this point. Mistakes can be avoided if a continuity tester is used to check the switch tag positions before these are wired. The earth connection in Fig. 4 is made at one of the tags at the input socket.

The attenuator resistors are shown spread out in Fig. 4 for clarity, but in practice they project back from the switch tags. They should not be allowed to project too far backwards, however, or their lead-out wires may touch the back of the case when this is screwed in place. The risk of short-circuits can here, again, be reduced if a piece of self-adhesive plastic is affixed to the inside surface of the case back at the appropriate position.

Capacitor C4 is included in Fig. 4 and it connects to the voltage amplifier board, which is next to be assembled. It may be found easier to connect this capacitor to the voltage amplifier board first, and then solder its other lead-out to the arm of S1(a) after the board has been mounted in position.

The voltage amplifier board, also reproduced full-size, is shown in Fig. 5, where the component side is towards the reader. The board is $\frac{1}{16}$ in. Paxolin and wiring and mounting details are the same as for the emitter follower board. The two points 'A' are joined together by an insulated lead. One flying lead from the board connects to S2, another to the junction of D3 and D4 at the meter, and a third carries the positive supply to the emitter follower input board. The zener diode should be connected into circuit with correct polarity. If it is connected the wrong way round it will function as a normal silicon diode and a voltage of about 0.6 volt only will appear across it. Capacitor C8 is external to the board, one lead-out connecting to R21 on the board and the other to the junction of D1 and D2 at the meter.

The voltage amplifier board is mounted on the top inside of the case towards the left hand side (i.e. away from the emitter follower board) with R24 at the left. As with the emitter follower board, it takes an earth connection from a solder tag under one of its securing nuts.

The meter may now be mounted. The wiring at its terminals is illustrated in Fig. 6. If the actual meter employed has its positive terminal at the left then, naturally, D1 and D2, and D3 and D4, are transposed.

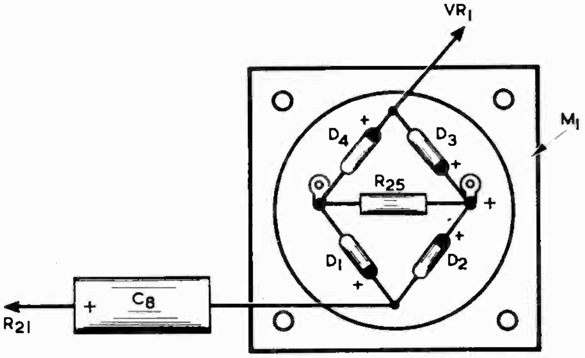



*Fig. 6. The components and wiring at the meter*

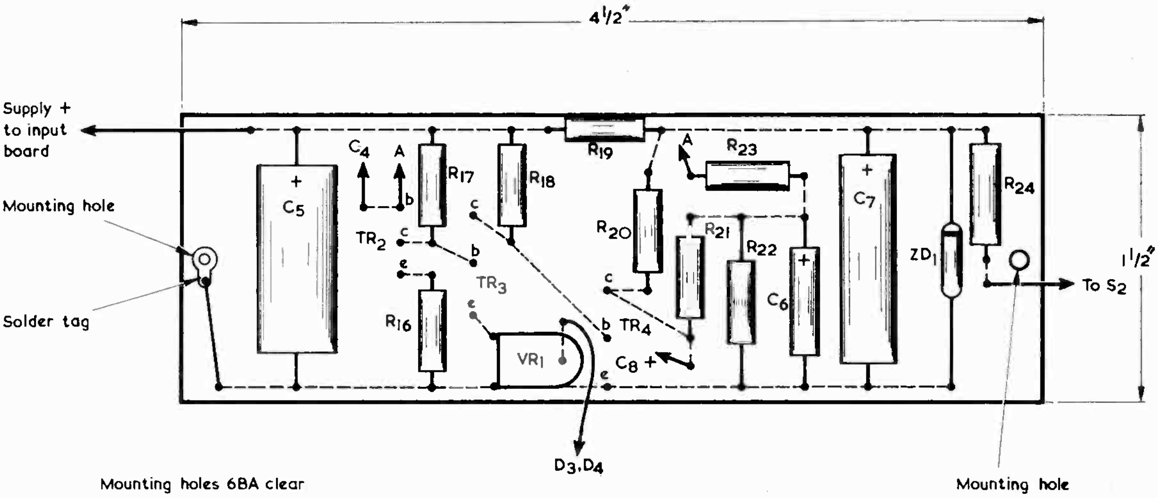
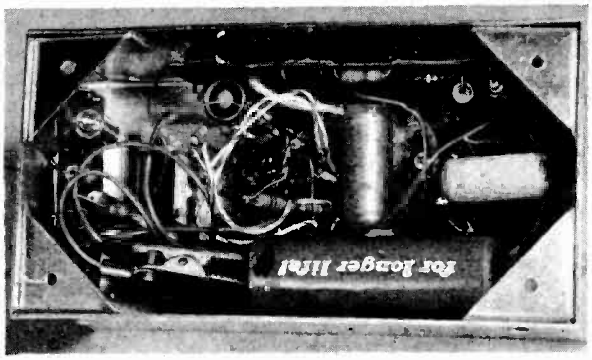



*Fig. 5. The voltage amplifier board. This is also reproduced full-size*



*The unit with the back removed*

The battery is positioned on the bottom of the case on the left hand side, opposite the voltage amplifier board. It is held in position under the bodies of the meter and S1(a) (b). If required, a pad of foam rubber or foam plastic can be glued to the bottom of the case to make the battery fit more snugly.

The battery terminals consist of two brass strips, and the battery is positioned so that these are to the right. A pair of miniature crocodile slips can be used as battery connectors. The positive clip connects to the unused tag of S2 whilst the negative clip connects to chassis at the input socket.

When construction is completed, the front panel may be marked with the ranges corresponding to the positions of S1(a) (b). The 0-500mV range is given when the knob of this switch is turned fully anti-clockwise, and the 0-1mV range is given when it is turned fully clockwise.

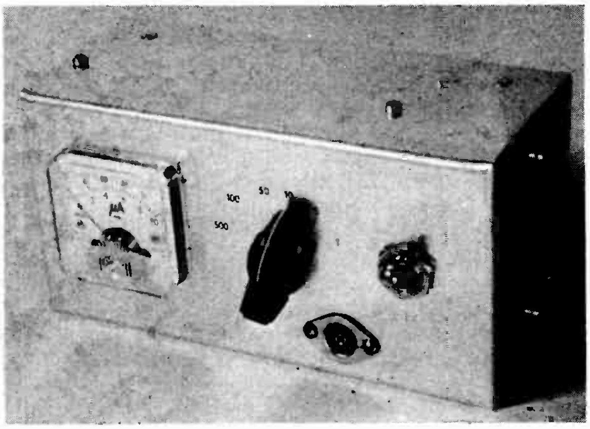
## CALIBRATION

Once the unit has been completed, VR1 must be given the correct setting. It will be necessary to temporarily disconnect the voltage amplifier board in order to allow easy access to VR1. A short lead with a crocodile clip at each end should be used to make the connection between the board and earth (the case).

The unit is set up by applying an audio signal of known amplitude to its input socket. This may be provided by an audio signal generator and another calibrated audio millivoltmeter, or by an audio signal generator having a calibrated output. If neither of these is available, an audio signal generator and a good quality multimeter capable of giving an accurate reading at 500mV r.m.s. a.c. will be satisfactory.

The method of calibration is to set an output voltage on the signal generator which is equal to f.s.d. on any of the millivoltmeter ranges. VR1 is then adjusted for f.s.d. on meter M1, and this adjustment will hold good for all other ranges. If a multimeter is being used to monitor the signal generator output voltage the latter should be adjusted for 500mV. The operating frequency of the generator should be around 1kHz. Should the millivoltmeter appear to have an excessively high sensitivity the value of R25 may need to be reduced, as was discussed earlier.

When VR1 has been set up, the voltage amplifier board may be refitted in the case, and the millivoltmeter is then ready for use.



*Another view of the millivoltmeter front panel.*

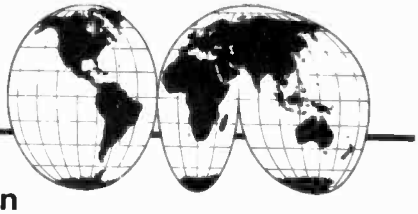
## NOTES ON OPERATION

With some units of this type, switching arrangements are provided to enable the meter to measure the battery voltage and thereby indicate when a new battery is required. Such a circuit was not considered necessary in the present instance as the current drawn from the battery is quite small when considered in terms of battery capacity, and even with quite heavy use the battery should have a long life. It should be sufficient if the battery which is a fairly inexpensive type, is replaced about every six months.

Due to the high input impedance and the sensitivity of the millivoltmeter, the test lead which connects to the input socket must be screened to avoid misleading results due to stray pick-up of mains hum and similar effects.

The existing 0-50 scale on the 0-50μA meter used in the millivoltmeter is satisfactory for the 0-5, 0-50 and 0-500mV ranges, but a little thought is required when it is used for the other ranges. If desired, the numbers 0, 2, 4, 6, 8 and 10 can be added to the meter scale at the existing 0, 10, 20, 30, 40 and 50 points, but such a modification should only be attempted by the more advanced constructor who has had working experience with moving-coil meters. The inexperienced constructor is warned to leave well alone here, as it is very easy to accidentally damage a meter beyond repair when its movement is removed from its case. ■

# SHORT WAVE NEWS



## FOR DX LISTENERS

**By Frank A. Baldwin**

*Times* = GMT *Frequencies* = kHz

There are many stations on the LF broadcast bands that attract some attention at times from the dyed-in-the-wool Dxer, either for the simple reason that they represent a Dx 'catch' or, being something of a mystery, identification is required and/or the QSL card is coveted and still required.

Although it is some years since the writer bothered about QSL cards, two Dx stations were sought on the dial, the first mentioned being for reasons of further information and the second simply for the fact that it was Dx only occasionally heard here in the U.K.

In the Indian Ocean, between Mauritius and Malagasy, lies Reunion Island and from the capital, St. Denis, programmes in French are radiated from 0230 through to 1845 on **4807** (62.40 metres) from a 4kW transmitter. The island has an area of 970 square miles and a sugar growing economy. Signals from ORTF Reunion were heard at 1825, Bill Haley at his best with "Rock Around the Clock". However, identification is made in English at 1844 "You are listening to ORTF Reunion Island, greetings to listeners on nearby islands and on passing ships." Then followed announcements in French, a choral rendition of "La Marsellaise" and off at 1855.

The following morning, at 0228, St. Denis could be heard when radiating the interval signal repeatedly till 0230, at which time the National Anthem (again choral version) and announcements in French were logged.

Probably of more interest to the Dxer are the Comoro Islands, lying midway between the continent of Africa and Malagasy, in the Mozambique channel. The islands have a total area of about 838 square miles and the economy is largely based on turtle fishing, vanilla, copra, sisal and plants for perfume manufacture.

ORTF Comoro Islands, Moroni, can be heard on **3331** (90.06m) here in the U.K. when signals rise to peak strength around 1845 to 1900, conditions permitting. The 4kW transmitter has a schedule from 0330 to 0430 and from 1500 to 1930. We logged them several times from 1840 onwards, listening to a dialogue in Comorian, African-type drums and, later, songs with a style reminiscent of Arabia. African style drums and chants are often a feature of the Moroni transmitter.

### CURRENT SCHEDULES

**● ROMANIA**

Radio Bucharest has schedules in English for Europe as follows – from 1300 to 1330 on **9690** (30.95m), **11940** (25.12m) and on **15250** (19.67m). From 1930 to 2030 on **9570** (31.34m) and on **11775** (25.47m). From 2100 to 2130 on **9690** and on **11940.**

**● HUNGARY**

Radio Budapest, in English to Europe, as follows – from 1745 to 1800 on **6170** (48.62m), **7220** (41.55m), **9833** (30.50m), **11910** (25.18m), **15415** (19.46m), **17795** (16.85m) and on **21505** (13.95m). From 1945 to 2000 on all the foregoing channels except that **6170** is changed to **6110** (49.09m). From 2130 to 2200 on **5980** (50.16m), **7220, 9833, 11910, 15415, 17890** (16.76m) and on **21505.** From 2245 to 2300 on all the latter channels, on Tuesdays and Fridays, is presented a Dx programme (also featured from 1615 to 1630).

**● JAPAN**

Radio Japan has an external service, in English to Europe, as follows – from 0800 to 0830 on **17825** (16.83m) and on **21570** (13.90m); from 2030 to 2100 on **9735** (30.81m) and on **11960** (25.08m).

**● GERMANY (EAST)**

Radio Berlin International, The Voice of the GDR, has the following programmes in English to Europe – from 1815 to 1900 and from 2130 to 2215 on **6080** (49.34m), **6115** (49.05m), **7115** (42.16m), **7185** (41.75m), **7260** (41.32m), **7300** (41.09m) and on **9730** (30.83m). From 2245 to 2330 on the foregoing channels except **7115** and **7300.**

**● PAKISTAN**

Radio Pakistan has a World Service which directs a programme to the U.K. from 1915 to 2115 – from 1915 to 2000 in Urdu, from 2000 to 2005 newscast in English, from 2005 to 2100 in Urdu (news 2030 to 2040), from 2100 to 2115 in Sylheti (news 2100 to 2108), all on **9465** (31.69m) and **11672** (25.70m).

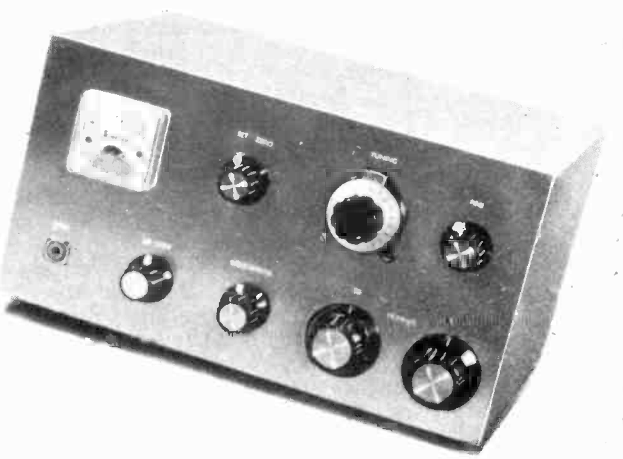
The General Overseas Service presents the news in English, at dictation speed, from 1715 to 1730 (to West Europe) on **11935** (25.13m) and on **15325** (19.57m).

**● POLAND**

Radio Warsaw offers programmes in English for Europe from 0630 to 1700 on **7285** (41.18m), **9540** (31.44m), **9675** (31.00m); from 1200 to 1230 on **7285** and **9540;** from 1600 to 1630 on **6095** (49.22m), **7125** (42.10m), **7285** and **9540;** from 1830 to 1900 on **6095, 7125, 7285** and **9540;** from 2030 to 2100 on **7285** and **9540** and from 2230 to 2300 on **5995** (50.04m), **6135** (48.89m), **7285** and **9540.**

# 4 BAND TRANSISTOR SUPERHET

*Cover Feature*



Part 1

by R. A. Penfold

**This article, the first of a 2-part series, describes a fully solid-state superhet receiver covering the medium wave band and three short wave bands extending from 180 to 9.5 metres. The concluding article will be published next month.**

THIS FULLY TRANSISTORISED SUPERHET RECEIVER covers four wavebands, these consisting of the standard medium wave band and three short wave bands. The coils employed are plug-in Denco components and the approximate ranges, using the Denco coil range numbers, are: Range 2, 0.515 to 1.54MHz (580 to 194 metres); Range 3, 1.67 to 5.3MHz (180 to 57 metres); Range 4, 5 to 15MHz (60 to 20 metres); and Range 5, 10.5 to 31.5MHz (28 to 9.5 metres). There is a slight overlap between the short wave ranges, so that if the alignment of the receiver is not quite perfect with regard to frequency, there should be no gaps in short wave coverage.

Although by modern standards the receiver would probably be considered rather basic it is still fairly complex, using 13 transistors (11 without the optional S-meter circuit). These are all modern silicon types which give high gain and a low noise level. The set is mains powered.

Fig. 1 gives a block diagram for the receiver. One r.f. stage appears ahead of a single transistor mixer/oscillator stage. A 2-stage i.f. amplifier follows, this incorporating controlled regeneration. A diode detector feeds a 1.5 watt Class B audio amplifier, and also produces the a.g.c. bias voltage. The S-meter circuit is optional.

Plug-in coils are used for simplicity and to save space, since only one set of coils is in the receiver at any one time. The desired waveband is selected by merely plugging three appropriate coils into their respective holders.

## MECHANICAL CONSTRUCTION

An aluminium chassis measuring 10 by 7 by 2½in. and a 10 by 5½in. front panel form the basis of the receiver. The chassis is commercially available (e.g. Home Radio Cat. No. CU225), but the front panel is cut out from 18 s.w.g. aluminium sheet by the constructor.

Details of the holes required in the front panel are given in Fig. 2, which also indicates the control layout.

The mounting holes for VR5 and meter M1 are omitted as an S-meter is not required. If, however, an S-meter circuit is to be added at a later date, its fitting will be much easier if the holes for the meter and VR5 are made at the same time as the other holes. The prototype employed a Sew S-meter type SR38P, but the S-meter in the Henelec 38 series may be employed instead, if desired. The S-meter movement is 1mA f.s.d. The four mounting holes around the large 1½in. hole can be marked off with the aid of the meter. The 1½in. hole can be made with an Abrafile or by cutting out a series of small holes just inside its periphery, removing the central section and then smoothing off with a large half-round file.

The horizontal dimensioning of the ¼in. hole for the 3-gang capacitor VC1, 2, 3 is not given in Fig. 2, as it is

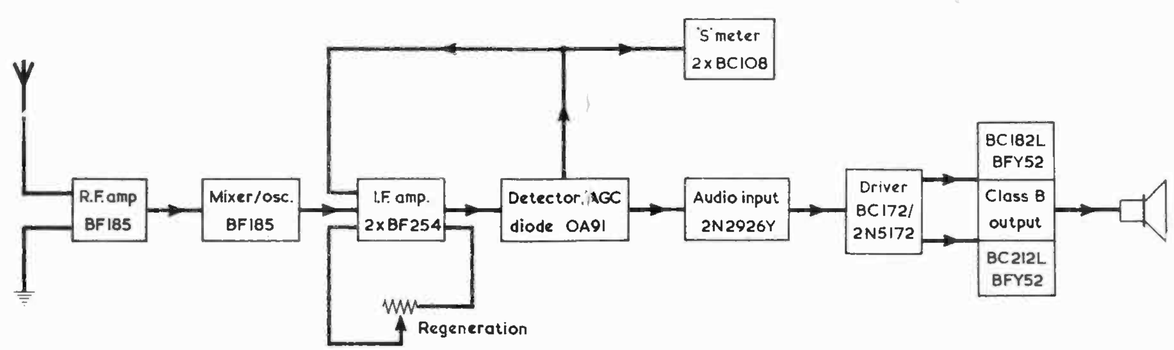



*Fig. 1. Block diagram illustrating the stages of the receiver and the transistor types that are employed in them*

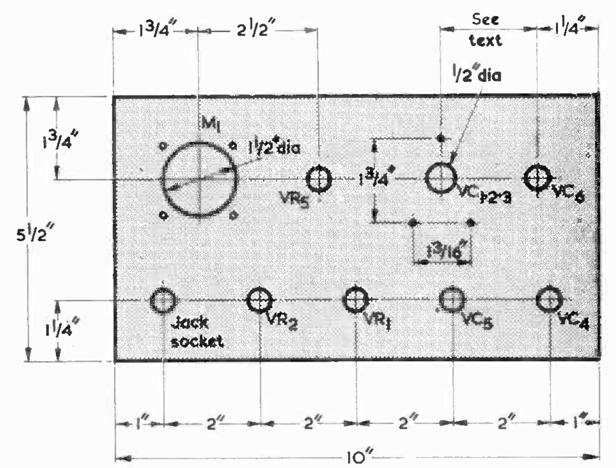



*Fig. 2. Details of the front panel. The holes for M1 and VR5 may be omitted if the S-meter circuit is not to be fitted*

more convenient, and the fitting is liable to be more accurate, if this hole is marked off with the aid of the capacitor itself. The manner in which this is done is described shortly.

The chassis, as seen from the top and with its sides opened out for clarity, appears in Fig. 3. There is ample space for the components and circuit boards and their exact positioning is not critical. The five control holes on the front chassis apron correspond with those on the front panel, and the panel and chassis are held together by the mounting bushes of the controls at these holes. Holes which are not directly associated with any component or board are intended for the passage of wires through the chassis and should be fitted with grommets. A grommet must also be fitted at the hole in the rear apron through which the mains lead passes.

The i.f. amplifier board is mounted on the inside of the rear apron and the a.f. amplifier board on the inside of the left apron. The mains transformer, T1, the power supply board and the board with the S-meter circuitry are fitted on the top surface of the chassis. The mounting holes are marked out with the aid of the transformer and the boards when the latter have been made.

The two holes marked 'A' are 6BA clear and take the screws which secure the two front lugs of the 3-gang tuning capacitor. The chassis and front panel should be temporarily fastened together and the capacitor positioned so that the holes in its two front lugs are directly behind the 'A' holes. The horizontal positioning of the centre of the corresponding ⅜in. hole in the front panel can then be marked off from the capacitor spindle and the hole cut out. This ⅜in. hole is for an 8:1 vernier reduction drive type T501, this being mounted by two 8BA bolts and a bolt supplied with it. The complete drive mechanism fits in front of the panel, and a metal bush passes through the panel to couple with the capacitor spindle. To prevent the mechanism jamming and to provide smooth operation, the drive and the capacitor spindle must be accurately aligned. The capacitor may be fitted temporarily to check for this and two 6BA screws, with plain washers under the heads, passed through the front lug holes and the 'A' holes on the chassis. The holes in the capacitor lugs are larger than 6BA clear and this enables a small amount of sideways movement of the capacitor for final alignment. If necessary, spacing washers may be fitted between the lugs and the chassis to raise the capacitor body slightly. When the capacitor positioning is satisfactory the hole for the rear mounting lug may be marked on the chassis. The capacitor is then removed and this last hole is drilled out 4BA clear.

It is advisable to drill as many of the chassis holes as possible before the 3-gang capacitor is finally fitted permanently, and some constructors may prefer to make it virtually the last item. If holes are drilled with the capacitor mounted in position, its vanes should be closed to prevent their being bent or damaged.

Two screens are required and their dimensions are given in Fig. 4. The material is 18 s.w.g. aluminium. They are positioned between the coil holder holes, as indicated in Fig. 3.

The orientation of the three coil holders is shown in the layout diagram in Fig. 6. The holder for L1 has pins 1 and 9 nearest the 3-gang tuning capacitor, while those for L2 and L3 have pins 1 and 9 away from the capacitor. There is a chassis solder tag under one of the securing nuts for L3 coil holder. A 3-way tagstrip is mounted under one of the screen securing nuts.

Each of the three trimmer capacitors, TC1, TC2 and TC3, require two 6BA ¼in. screws for mounting. A larger hole between the mounting holes allows the adjusting screw to pass through. When the capacitors

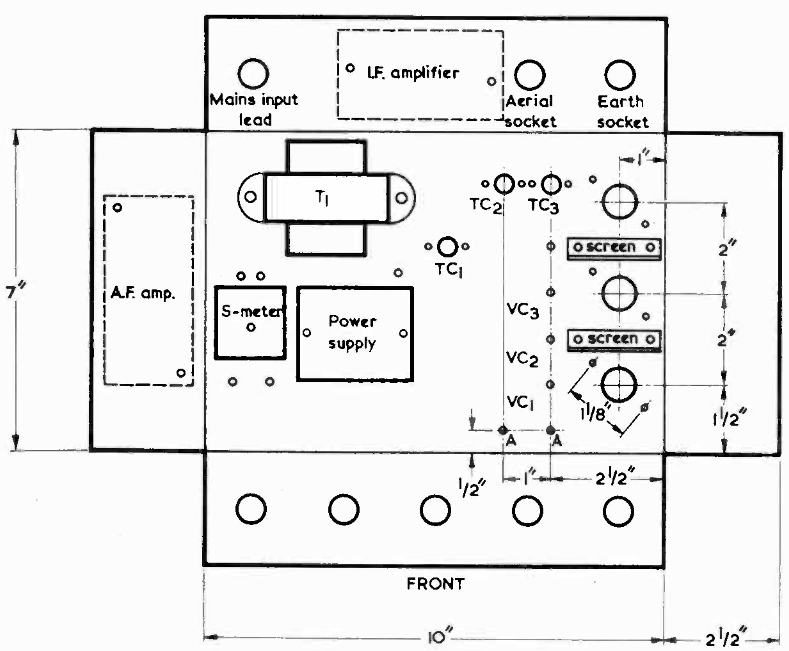



*Fig. 3. Top view of the chassis. The sides are shown opened out to assist in illustrating the layout*

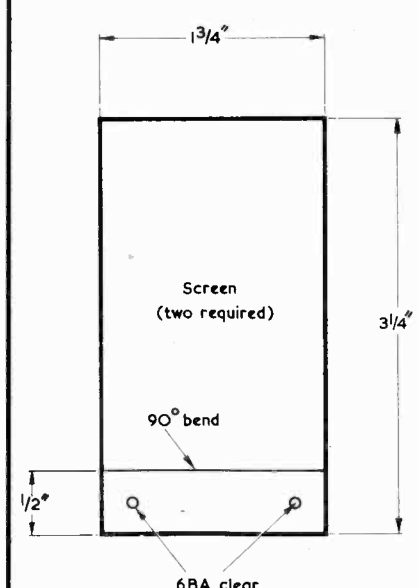



*Fig. 4. Two small screens are required. These have the dimensions shown here*



● **CZECHOSLAVAKIA**

Radio Prague at present has the following programmes in English for Europe. From 0700 to 0800 on **11855** (25.30m), **15310** (19.59m) and on **21700** (13.82m); from 1530 to 1630 on **6055** (49.54m), **9605** (31.23m), **11990** (25.02m), **15240** (19.68m), **17740** (16.91m), **17840** (16.81m).

To the U.K. and Eire from 1500 to 1530 on **6055** and **9505** (31.56m), from 1630 to 1700 and from 1900 to 1930 on **5930** (50.59m) and on **7345** (40.84m), also from 2200 to 2230 on **6055.**

Radio Prague also has an "Inter Programme" for Europe in English on **6055** and **9505** from 0745 to 0800, 0845 to 0900, 0945 to 1000, 1045 to 1100 and from 1145 to 1200.

● **NETHERLAND**

From Hilversum, Radio Nederland radiates in English to Europe from 0930 to 1050 on **6130** (48.93m) and **7275** (41.23m); from 1400 to 1520 on **6020** (49.83m), **21480** (13.96m), Madagascar relay on **11740** (25.55m) and **17810** (16.84m); from 1830 to 1950 on **6020**, **6085** (49.30m), **11730** (25.57m), **21570** (13.90m), Madagascar relay on **6020** and **9555** (31.39m), all weekdays only.

On Sundays, the "Happy Station" programmes to Europe are from 0930 to 1050 on **6020**, **6130**, **7275**; from 1230 to 1350 on **6020**, **11960** (25.08m), **15130** (19.82m) and from 2000 to 2120 on **6020**, **6085** and on **9715**, all from Hilversum.

● **IRAN**

Radio Iran has an External Service in English from 2000 to 2030 on **9022** (33.25m).

**AROUND THE DIAL**

In our wanderings around the dial, we have come across a few stations which may be of interest to readers, here are some of the transmissions we logged.

● **PHILIPPINES**

The VOA (Voice of America) transmitter with a programme in Chinese, station identification in English and sign-off at 1700 on **9555** (31.39m).

● **SRI LANKA**

Colombo on **11725** (25.58m) with a programme in English at 1720. Sign-off at 1730 after station identification.

Colombo has also been heard on **4902.5** (61.19m) from 2020 through to 2100 with continuous Buddhist chants, no breaks or identification. This time period is outside the normal schedule but transmissions of this type occur during full moon days and last throughout the night. The programming on this channel is in Sinhala.

● **CHINA**

Radio Peking on **11695** (25.65m) with Chinese songs and music during a programme in English at 2010, much praise of Chairman Mao!

● **INDIA**

Near the above channel is that of **11620** (25.81m) where AIR Delhi can be heard with an English programme directed to Africa. News of African affairs at 2015 then Indian songs and music.

AIR Delhi is also to be heard on **3905** (76.82m) at 2350 or so with Indian music and announcements in English.

● **LIBERIA**

VOA Monrovia with a news review in English at 1915 on **15445** (19.42m), also on **17875** (16.78m).

● **SOUTH KOREA**

Suwon at 0658 on **15335** (19.56m) with a programme in English for the U.K. and Europe during which the address for reports was given and "we will send you a QSL card". Full identification is given at 0659 so, if a colourful card and a pennant is required, tune to **15335** at 0630, the programme in English ends at 0700.

● **ECUADOR**

HCJB Quito with station identification and programme in English for Europe at 1900 on **17870** (16.78m), also in parallel on **11925** (25.15m) and **15315** (19.58m).

● **USSR**

Radio Tashkent with the news in English at 1400 after identification on **15460** (19.40m).

● **ISRAEL**

Jerusalem at 1200 on **15425** (19.44m) with station identification and six 'pips' timecheck after a programme in English.

● **CANADA**

Sackville at 1241 on **17820** (16.83m) with news of Canadian affairs in English.

● **CLANDESTINE**

Peyk-e-Iran at 1500 on **11695** (25.65m) with identification and programme in Farsi (Persian).

● **GHANA**

Tema at 1520 on **21545** (13.92m) with news of African affairs during a programme in English.

● **JORDAN**

Amman at 1630 on **9560** (31.38m) with a programme of Arabic-type music, announcements in English and station identification.

● **TURKEY**

Ankara Police Radio at 1826 on **6340** (47.31m) with a programme of Arabic-type music and songs, sign-off at 1900.

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# 4 BAND TRANSISTOR SUPERHET

**This article, the first of a 2-part series, describes a fully solid-state superhet receiver covering the medium wave band and three short wave bands extending from 180 to 9.5 metres. The concluding article will be published next month.**

THIS FULLY TRANSISTORISED SUPERHET RECEIVER covers four wavebands, these consisting of the standard medium wave band and three short wave bands. The coils employed are plug-in Denco components and the approximate ranges, using the Denco coil range numbers, are: Range 2, 0.515 to 1.54MHz (580 to 194 metres); Range 3, 1.67 to 5.3MHz (180 to 57 metres); Range 4, 5 to 15MHz (60 to 20 metres); and Range 5, 10.5 to 31.5MHz (28 to 9.5 metres). There is a slight overlap between the short wave ranges, so that if the alignment of the receiver is not quite perfect with regard to frequency, there should be no gaps in short wave coverage.

Although by modern standards the receiver would probably be considered rather basic it is still fairly complex, using 13 transistors (11 without the optional S-meter circuit). These are all modern silicon types which give high gain and a low noise level. The set is mains powered.

Fig. 1 gives a block diagram for the receiver. One r.f. stage appears ahead of a single transistor mixer/oscillator stage. A 2-stage i.f. amplifier follows, this incorporating controlled regeneration. A diode detector feeds a 1.5 watt Class B audio amplifier, and also produces the a.g.c. bias voltage. The S-meter circuit is optional.

Plug-in coils are used for simplicity and to save space, since only one set of coils is in the receiver at any one time. The desired waveband is selected by merely plugging three appropriate coils into their respective holders.

## MECHANICAL CONSTRUCTION

An aluminium chassis measuring 10 by 7 by 2½in. and a 10 by 5½in. front panel form the basis of the receiver. The chassis is commercially available (e.g. Home Radio Cat. No. CU225), but the front panel is cut out from 18 s.w.g. aluminium sheet by the constructor.

Details of the holes required in the front panel are given in Fig. 2, which also indicates the control layout.

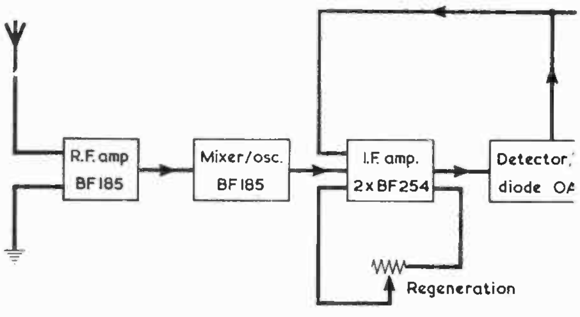



*Fig. 1. Block diagram illustrating the stages of the rece*

## Cover Feature

Part 1

by R. A. Penfold

The mounting holes for VR5 and meter M1 are omitted as an S-meter is not required. If, however, an S-meter circuit is to be added at a later date, its fitting will be much easier if the holes for the meter and VR5 are made at the same time as the other holes. The prototype employed a Sew S-meter type SR38P, but the S-meter in the Henelec 38 series may be employed instead, if desired. The S-meter movement is 1mA f.s.d. The four mounting holes around the large 1½in. hole can be marked off with the aid of the meter. The 1½in. hole can be made with an Abrafile or by cutting out a series of small holes just inside its periphery, removing the central section and then smoothing off with a large half-round file.

The horizontal dimensioning of the ½in. hole for the 3-gang capacitor VC1, 2, 3 is not given in Fig. 2, as it is

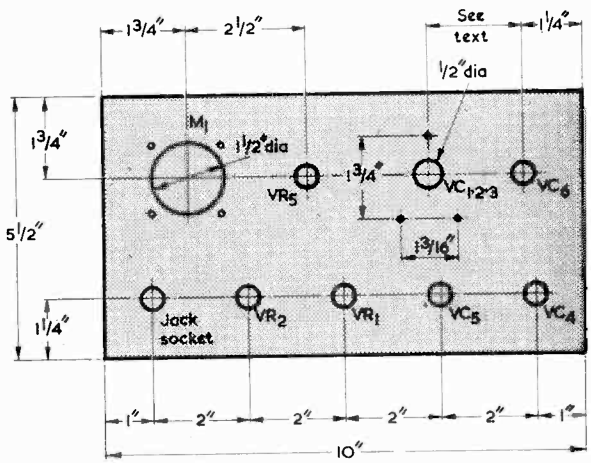
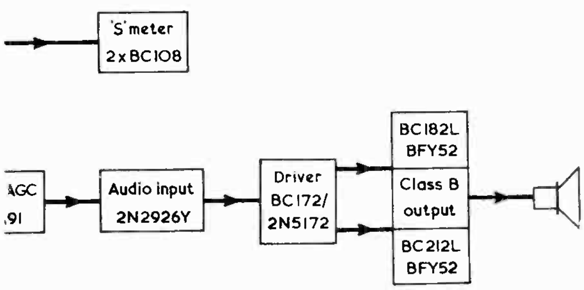



*Fig. 2. Details of the front panel. The holes for M1 and VR5 may be omitted if the S-meter circuit is not to be fitted*




*iver and the transistor types that are employed in them* more convenient, and the fitting is liable to be more accurate, if this hole is marked off with the aid of the capacitor itself. The manner in which this is done is described shortly.

The chassis, as seen from the top and with its sides opened out for clarity, appears in Fig. 3. There is ample space for the components and circuit boards and their exact positioning is not critical. The five control holes on the front chassis apron correspond with those on the front panel, and the panel and chassis are held together by the mounting bushes of the controls at these holes. Holes which are not directly associated with any component or board are intended for the passage of wires through the chassis and should be fitted with grommets. A grommet must also be fitted at the hole in the rear apron through which the mains lead passes.

The i.f. amplifier board is mounted on the inside of the rear apron and the a.f. amplifier board on the inside of the left apron. The mains transformer, T1, the power supply board and the board with the S-meter circuitry are fitted on the top surface of the chassis. The mounting holes are marked out with the aid of the transformer and the boards when the latter have been made.

The two holes marked 'A' are 6BA clear and take the screws which secure the two front lugs of the 3-gang tuning capacitor. The chassis and front panel should be temporarily fastened together and the capacitor positioned so that the holes in its two front lugs are directly behind the 'A' holes. The horizontal positioning of the centre of the corresponding ½in. hole in the front panel can then be marked off from the capacitor spindle and the hole cut out. This ½in. hole is for an 8:1 vernier reduction drive type T501, this being mounted by two 8BA bolts and a bolt supplied with it. The complete drive mechanism fits in front of the panel, and a metal bush passes through the panel to couple with the capacitor spindle. To prevent the mechanism jamming and to provide smooth operation, the drive and the capacitor spindle must be accurately aligned. The capacitor may be fitted temporarily to check for this and two 6BA screws, with plain washers under the heads, passed through the front lug holes and the 'A' holes on the chassis. The holes in the capacitor lugs are larger than 6BA clear and this enables a small amount of sideways movement of the capacitor for final alignment. If necessary, spacing washers may be fitted between the lugs and the chassis to raise the capacitor body slightly. When the capacitor positioning is satisfactory the hole for the rear mounting lug may be marked on the chassis. The capacitor is then removed and this last hole is drilled out 4BA clear.

It is advisable to drill as many of the chassis holes as possible before the 3-gang capacitor is finally fitted permanently, and some constructors may prefer to make it virtually the last item. If holes are drilled with the capacitor mounted in position, its vanes should be closed to prevent their being bent or damaged.

Two screens are required and their dimensions are given in Fig. 4. The material is 18 s.w.g. aluminium. They are positioned between the coil holder holes, as indicated in Fig. 3.

The orientation of the three coil holders is shown in the layout diagram in Fig. 6. The holder for L1 has pins 1 and 9 nearest the 3-gang tuning capacitor, while those for L2 and L3 have pins 1 and 9 away from the capacitor. There is a chassis solder tag under one of the securing nuts for L3 coil holder. A 3-way tagstrip is mounted under one of the screen securing nuts.

Each of the three trimmer capacitors, TC1, TC2 and TC3, require two 6BA ¼in. screws for mounting. A larger hole between the mounting holes allows the adjusting screw to pass through. When the capacitors

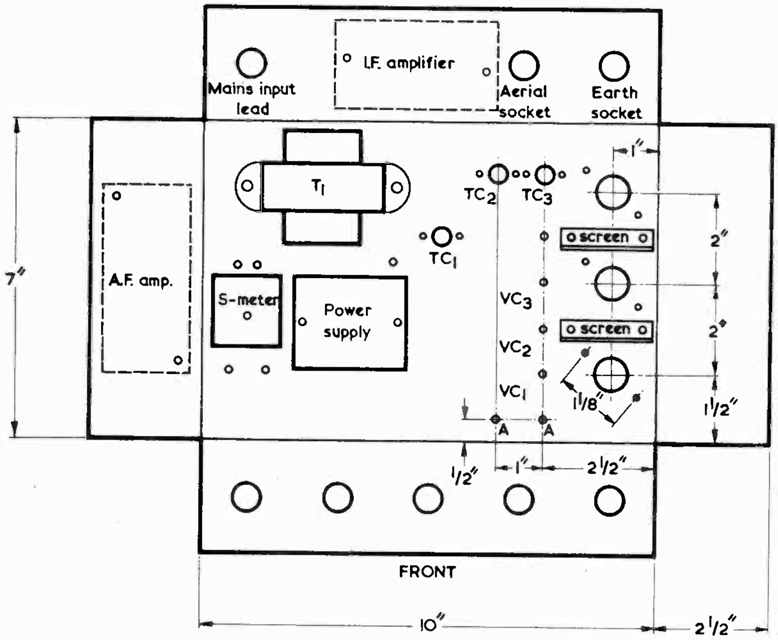



*Fig. 3. Top view of the chassis. The sides are shown opened out to assist in illustrating the layout*

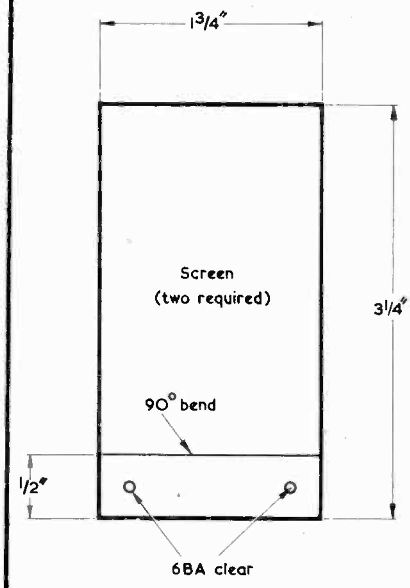



*Fig. 4. Two small screens are required. These have the dimensions shown here*

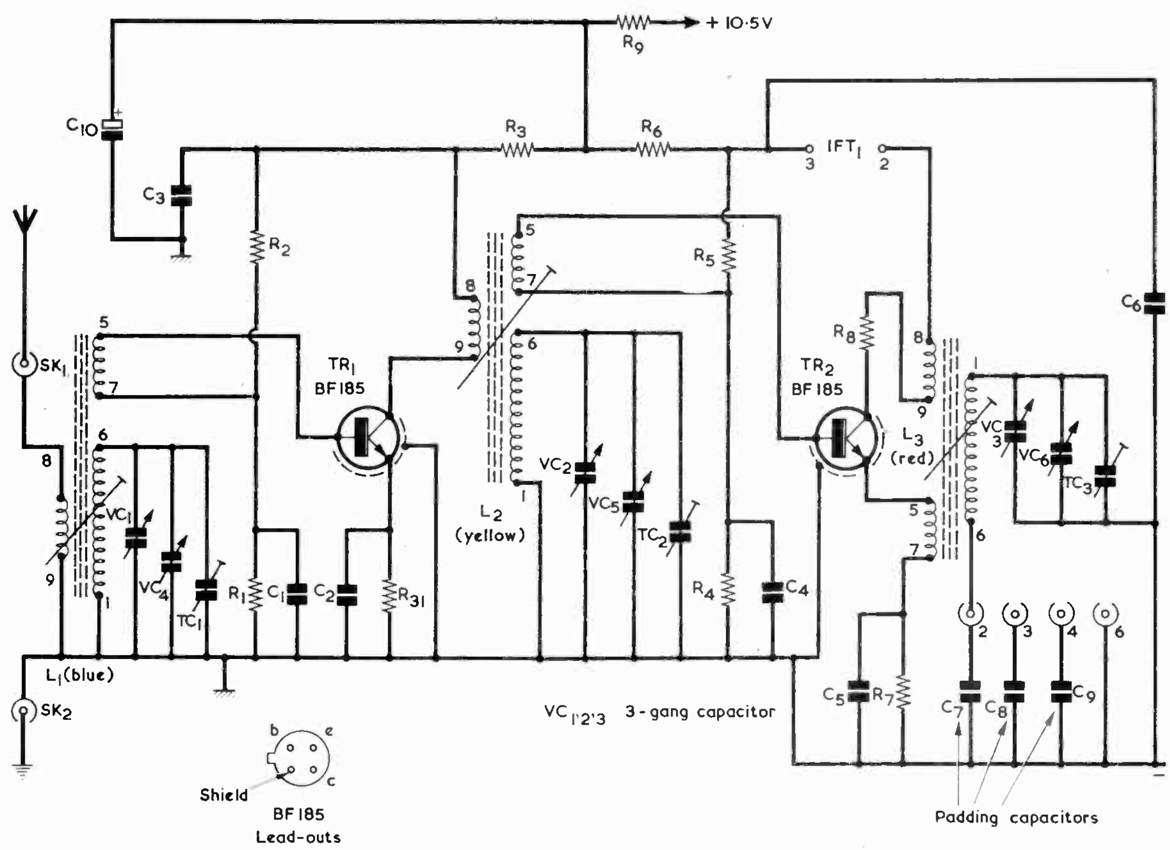


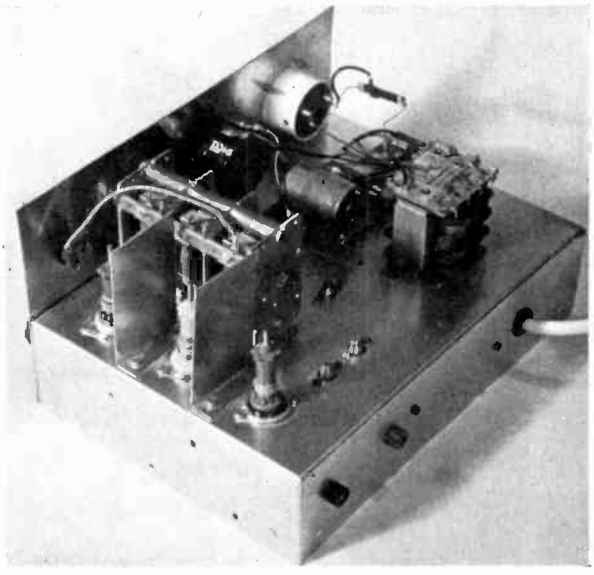

*Fig. 5. The circuit of the r.f. amplifier and mixer/oscillator stages*

are mounted, a continuity checker should be used to ensure that there are no short-circuits between the spindles and chassis.

## R.F. AND MIXER/OSCILLATOR STAGES

The circuit of the r.f. amplifier and mixer/oscillator stages is given in Fig. 5. These stages are quite conventional. The primary winding of L1 couples the aerial signal to the tuned circuit. VC1 is the main tuning capacitor for L1, and VC4 is the fine tuning control. The low impedance secondary coil couples the aerial signal to the base of TR1, and also carries the bias current from R1 and R2. C1 provides a bypass path to chassis for the lower end of L1 secondary. R31 is the emitter bias resistor for TR1, C2 being its bypass capacitor. The primary of L2 forms the collector load for TR1.

VC2 tunes the r.f. stage tuned winding, VC5 being the fine frequency control. The mixer/oscillator stage, incorporating TR2, is very similar to the r.f. stage, but the oscillator coil and its associated components have been added and the primary of the first i.f. transformer (which is mounted on the i.f. amplifier board) forms its collector load.



*A view of the receiver from the rear*

# COMPONENTS

*Resistors*
(All fixed values ¼ watt 5% unless otherwise stated)

| | | | |
|---|---|---|---|
| R1 | 2.2kΩ | | |
| R2 | 15kΩ | R17 | 680kΩ |
| R3 | 1.5kΩ | R18 | 5.6kΩ |
| R4 | 2.2kΩ | R19 | 1.5MΩ |
| R5 | 6.8kΩ | R20 | 2.2kΩ |
| R6 | 1.5kΩ | R21 | 6.8kΩ |
| R7 | 680Ω | R22 | 330Ω |
| R8 | 330Ω (see text) | R23 | 820Ω |
| R9 | 680Ω | R24 | 27kΩ |
| R10 | 5.6kΩ | R25 | 10kΩ |
| R11 | 33kΩ | R26 | 4.7Ω, ½ watt |
| R12 | 4.7kΩ | R27 | 15kΩ |
| R13 | 680Ω | R28 | 820Ω |
| R14 | 2.2kΩ | R29 | 820Ω |
| R15 | 1.5kΩ | R30 | 330Ω |
| R16 | 1kΩ | R31 | 1kΩ |

VR1 500kΩ potentiometer, linear
VR2 5kΩ potentiometer, log, with switch S1
VR3 1kΩ pre-set potentiometer, miniature skeleton, vertical mounting
VR4 250Ω pre-set potentiometer, wire-wound slider type
VR5 10kΩ potentiometer, wire-wound

*Capacitors*
C1 0.01μF disc ceramic
C2 0.04 or 0.05μF disc ceramic
C3 0.02μF disc ceramic
C4 0.01μF disc ceramic
C5 0.02μF disc ceramic
C6 0.02μF disc ceramic
C7 350pF silvered mica, 2%
C8 1,100pF silvered mica, 2%
C9 3,000pF silvered mica, 2%
C10 100μF electrolytic, 10 V.Wkg.
C11 2,700pF plastic foil
C12 2,700pF plastic foil
C13 100μF electrolytic, 10 V.Wkg.
C14 4.7pF ceramic
C15 0.022μF plastic foil
C16 0.01μF disc ceramic
C17 5μF electrolytic, 10 V.Wkg.
C18 5,000pF disc ceramic
C19 100μF electrolytic, 10 V.Wkg.
C20 5μF electrolytic, 10 V.Wkg.
C21 100μF electrolytic, 16 V.Wkg.
C22 100μF electrolytic, 16 V.Wkg.
C23 2,500μF electrolytic, 12 V.Wkg.
VC1, 2, 3 3-gang capacitor, 310pF per section, type E3 (Jackson Bros.)
VC4 50pF variable, type C804 (Jackson Bros.)
VC5 50pF variable, type C804 (Jackson Bros.)
VC6 5pF variable, type C804 (Jackson Bros.)
TC1 3.8 – 50pF trimmer, type C801 (Jackson Bros.)
TC2 3.8 – 50pF trimmer, type C801 (Jackson Bros.)
TC3 3.8 – 50pF trimmer, type C801 (Jackson Bros.)

*Inductors*
(L1, L2, L3 all Denco Miniature Dual Purpose, Transistor Usage).
L1 Blue coils, Ranges 2T, 3T, 4T and 5T
L2 Yellow coils, Ranges 2T, 3T, 4T and 5T
L3 Red coils, Ranges 2T, 3T, 4T and 5T
IFT1 I.F. transformer type IFT.18/465 (Denco)
IFT2 I.F. transformer type IFT.14/470 (Denco)
T1 Mains transformer, secondary 8 volts at 0.25 amp (see text)

*Semiconductors*
TR1 BF185
TR2 BF185
TR3 BF254
TR4 BF254
TR5 2N2926 yellow
TR6 BC172
TR7 2N5172
TR8 BC182L
TR9 BC212L
TR10 BFY52
TR11 BFY52
TR12 BC108
TR13 BC108
D1 OA91
D2-D5 IN4001

*Transfilter*
TF1 Transfilter type TF-01B

*Switch*
S1 S.P.S.T., part of VR2

*Jack*
JK1 3.5mm. jack socket

*Meter*
M1 S-meter, Sew type SR38P or equivalent, 1mA movement

*Sockets*
3 B9A valveholders
1 Aerial socket
1 Earth socket

*Speaker*
8Ω speaker, diameter 5 in. or more (see text)

*Drive*
Vernier drive type T501, 1.5 in. diameter (Eagle)

*Miscellaneous*
Chassis, aluminium, 10 × 7 × 2½ in.
Panel, aluminium 18 s.w.g., 10 × 5½ in.
2 clip-on heat sinks (TO-5 size)
6 knobs
1 3-way tagstrip, centre earthed
1 2-way tagstrip
Paxolin
Bolts, nuts, wire, etc.

TR2 operates in the common emitter mode for the r.f. signal fed to its base, and in the common base mode for the oscillator section of the stage since the base is effectively bypassed to chassis at oscillation frequency via the secondary of L2 and C4. Positive feedback from the collector to the emitter is provided by L3, the tuned winding of which is tuned by VC3 and fine tuner VC6. The r.f. input signal is thus modulated by the oscillator frequency, causing a mixing action to take place. One of the frequencies appearing at the collector of TR2 is the difference frequency of 465kHz, and this is fed to the subsequent i.f. amplifier, which rejects the other frequencies produced by TR2.

VC3 is the oscillator tuning capacitor and this is ganged with VC1 and VC2. Although the tuning capacitor is fitted with an 8:1 reduction drive to make tuning easier on the cramped short wave bands, the reduction provided on Range 5 is not quite sufficient.

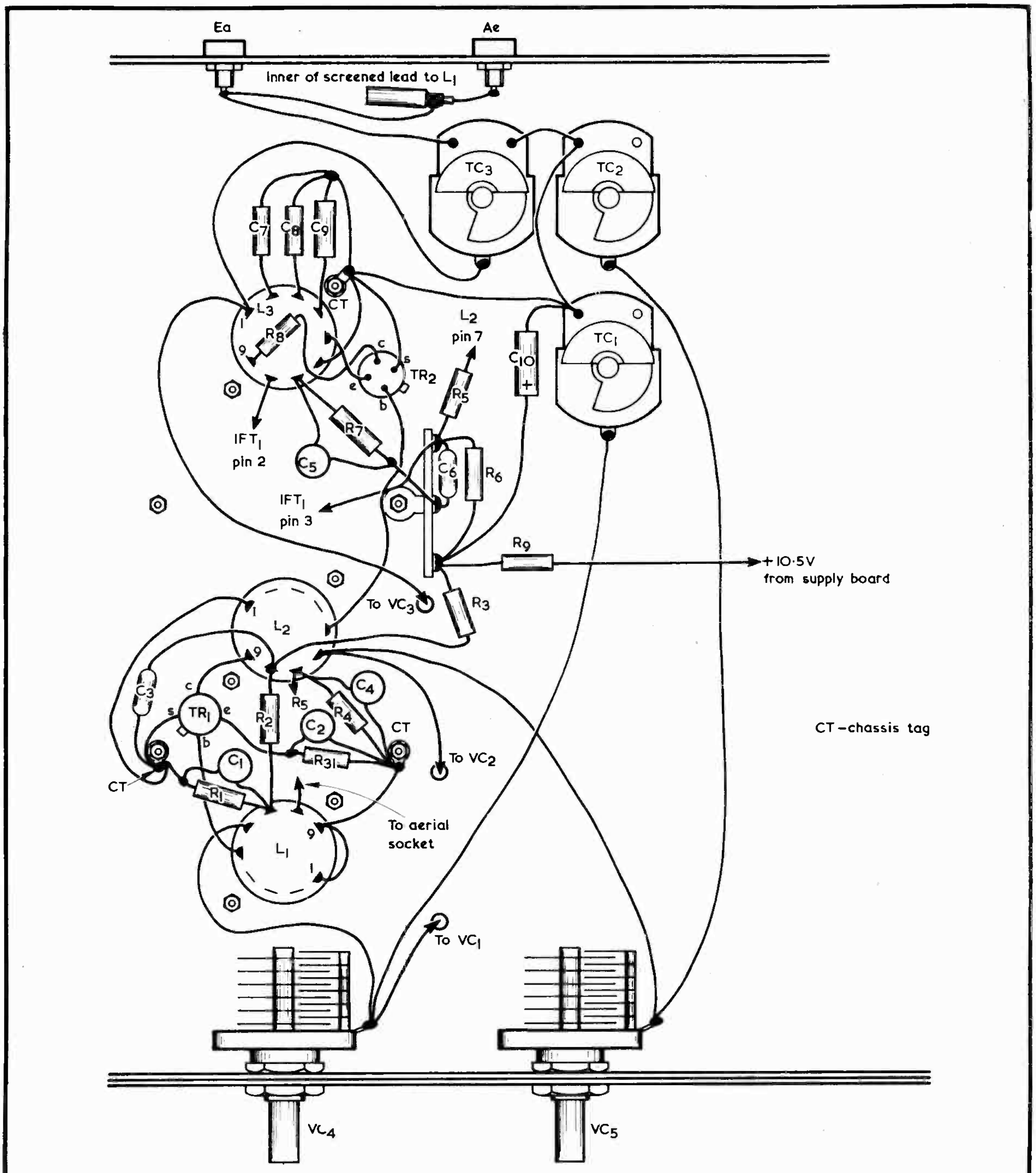


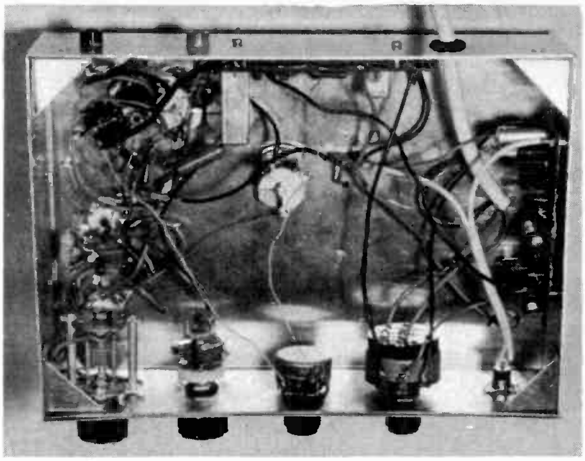

*Fig. 6. Under-chassis layout of the r.f. amplifier and mixer/oscillator stages*

VC6 is, in consequence, included to provide bandspread. It gives an effective reduction ratio, in terms of its own maximum capacitance and that of VC3, of 62:1, but it only covers a very small proportion of the band.

Each oscillator coil requires a different padding capacitance. The padding capacitor for each coil connects to a different pin of the coil holder, allowing the correct one to be selected automatically when each coil is inserted. There is no padding capacitor on Range 5, the lower end of the tuned winding being connected directly to chassis. If difficulty is experienced in obtaining a 1,100pF capacitor for C8, this may consist of a 1,000pF and a 100pF capacitor in parallel.

The r.f. and mixer/oscillator wiring is shown in Fig. 6. Note that the lead from the aerial socket to pin 8 of L1 is screened, the braiding being earthed at the earth socket. The lead to pin 2 of IFT1 from pin 8 of L3 is also screened, the braiding being earthed at the adjacent chassis tag. This connection is not shown in Fig. 6. TC1, in this diagram, is in a slightly different position from that visible in the photographs. Its positioning is not critical, but the wire which couples it to VC4 should be kept reasonably clear of the wiring to VC5. The fixed vanes of VC3 connect to the fixed vanes of VC6 above the chassis.

The transistors are modern silicon types and have very short lead-out wires. These should not be shortened further, and it will be necessary to use a small length of insulated wire to extend the base lead of TR2 so that it can reach the appropriate tag on L2 coilholder.



*Under the chassis. The leads to VR1 were not screened when this photograph was taken*

## I.F. AMPLIFIER

The i.f. amplifier circuit is shown in Fig. 7. The input signal is fed from the secondary of IFT1 to the base of TR3 via C11. TR3 has no tuned circuit other than the transfilter, TF1, in its emitter circuit. The a.g.c. bias voltage is fed to the base of this transistor via R18,

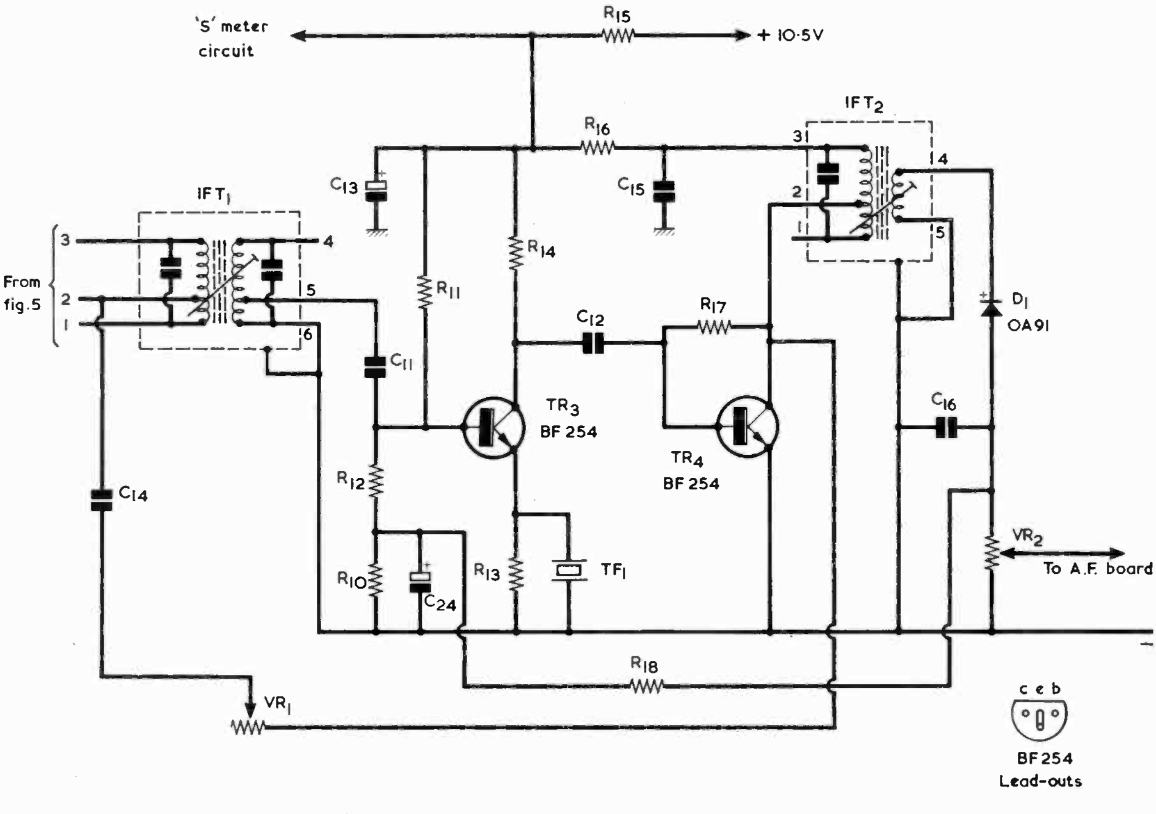



*Fig. 7. The i.f. amplifier. VR1 provides controlled regeneration*

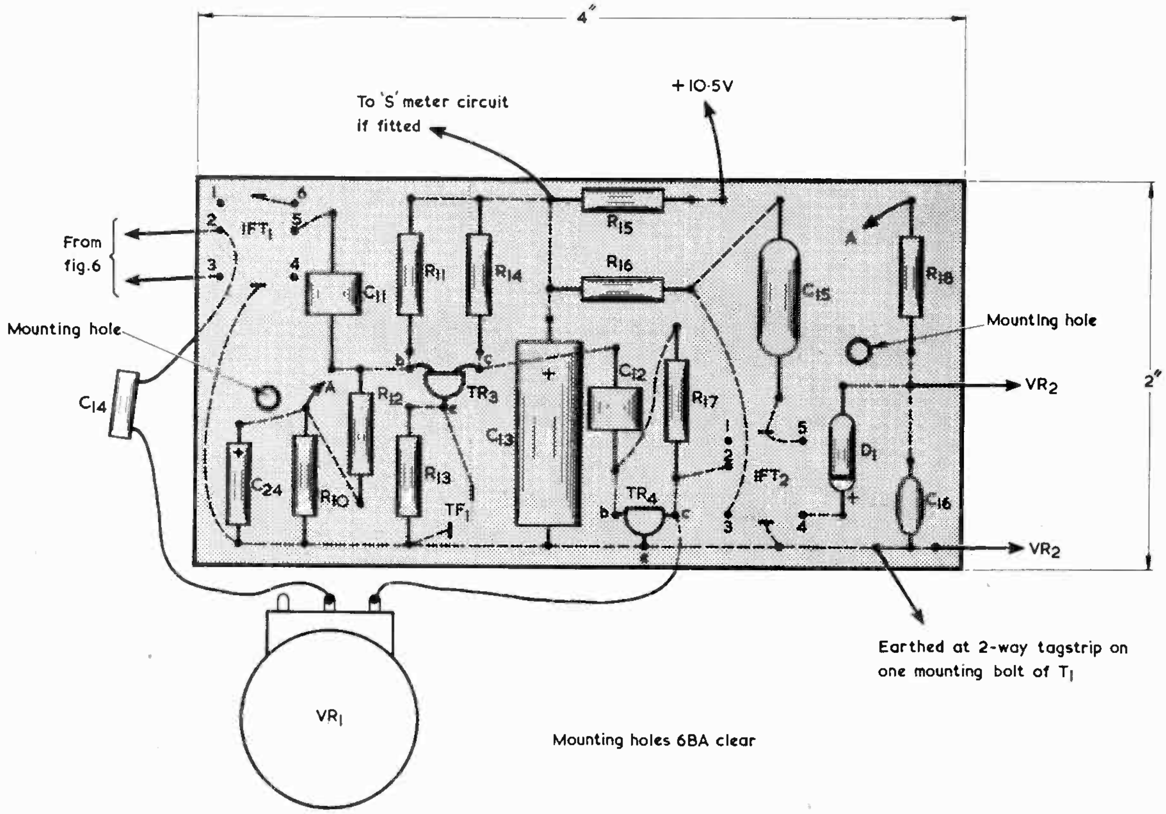
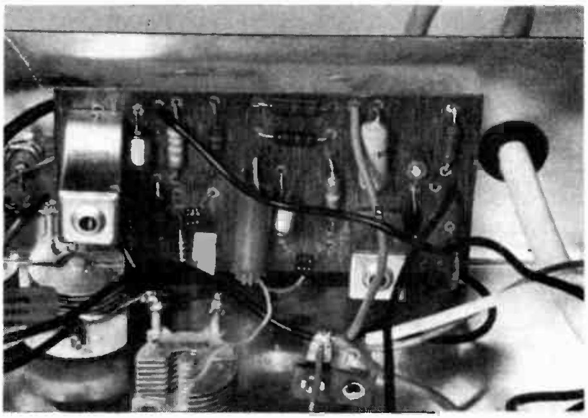



*Fig. 8. The i.f. amplifier board as seen from the components side. This is reproduced full size*

R10, R12 and C24. An aperiodic coupling, given by C12, is used between the two i.f. transistors.

TR4 is the second i.f. transistor, this being biased by R17 and having the primary of IFT2 as its collector load. The output from IFT2 is detected by diode D1, capacitor C16 removing the i.f. signal. The audio signal developed across volume control VR1 is passed to the audio amplifier board, and the d.c. component of the detected signal provides the a.g.c. voltage applied to R18.

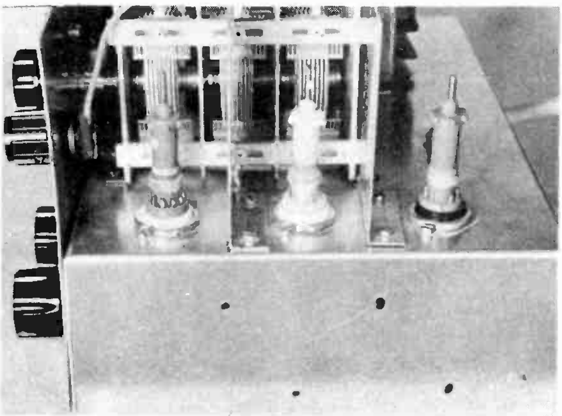


*The i.f. amplifier board in position at the rear of the chassis*

Positive feedback is given between TR4 collector and the input of the i.f. amplifier in order to offer variable selectivity. The feedback path is through VR1 and C14, with VR1 controlling the level of the feedback. Feedback increases as the resistance inserted by VR1 is reduced, with a consequent increase in selectivity. As the resistance inserted by VR1 is decreased a point is reached where the circuit commences to oscillate. C.W. signals can be resolved when the circuit is in this state.

The components required for the i.f. amplifier are standard types. The transistor type BF254 may be obtained from Electrovalue and the transfilter type TF-01B from Home Radio. The i.f. transformer specified for IFT2 is nominally a 470kHz component but it tunes satisfactorily to 465kHz, as is required here. Incidentally, the cores of the i.f. transformers should not be touched until alignment of the receiver commences. They are accurately set up at the factory and should only require a small final adjustment in the receiver.

The i.f. amplifier is assembled on a $\frac{1}{16}$ in. Paxolin panel measuring 4 by 2 in. This is illustrated full size in Fig. 8, which shows the component side of the board. Small holes are drilled in the board for component lead-out wires, these being passed through, bent over through 90°, and then connected together as indicated in the diagram by the broken lines. Where component leads are too short to reach the other leads to which they connect, extension tinned copper leads of around 22 s.w.g. may be added. The two leads marked 'A' are joined together by a short length of insulated wire.



*Side view, with the three coils for a band plugged into their holders*

The holes for the i.f. transformer pins may be marked out from the transformers themselves and from the data supplied with them. The holes for the transfilter are marked out with the aid of the component. Note that the i.f. transformer can lugs carry chassis connections by way of the can itself. Thus, the can lugs of IFT1 carry a chassis connection to pin 6 of that transformer, whilst the can lugs of IFT2 carry a chassis connection to C15.

When the board is completed it is mounted on the rear apron of the chassis with its input end nearest the coil holder for L3. It is secured by two 1 in. 6BA bolts, with $\frac{1}{4}$ in. spacers between the board and the chassis to keep the two slightly apart. If desired, additional protection against short-circuits can be given by primarily fitting a piece of self-adhesive plastic to the inside surface of the chassis edge over the area to be covered by the board. As already stated, the lead to pin 2 of IFT1 is screened. This lead should be kept reasonably short in order to keep stray capacitances low. The two leads from the board to VR1 should be screened, the braiding being earthed to chassis at the potentiometer. In Fig. 8, VR1 is shown from the rear, with the spindle pointing away from the reader.

## NEXT MONTH

In the concluding article, to be published next month, details will be given of the a.f. amplifier board, the power supply, and the S-meter section. Also to be described will be the setting-up procedure.

For convenience, the full Components List accompanies the present article. Some of the items listed (including those marked 'see text') will be discussed in greater detail next month, and readers will find that the next article should clear any queries they may have about these. Resistors R27, R28, R29, R30, VR4 and VR5, together with transistors TR12 and TR13 and meter M1 are all part of the S-meter circuit. These are not required if the S-meter is to be omitted.

(*To be concluded*)

# KIT REVIEW . . .

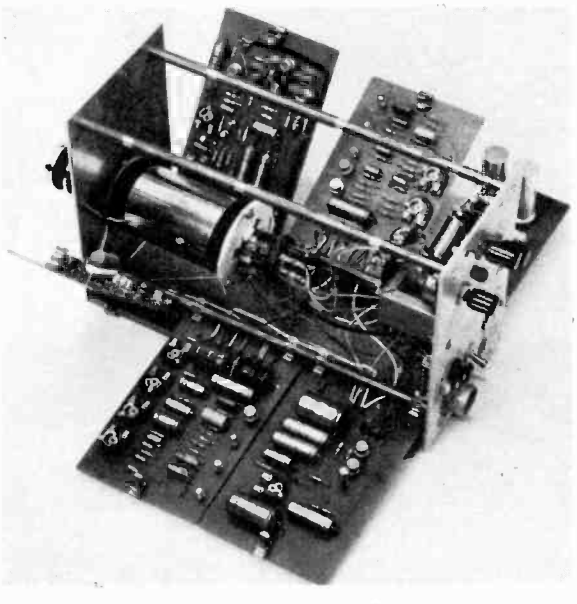
# CLOSED CIRCUIT TV CAMERA KIT

A CLOSED CIRCUIT TELEVISION CAMERA KIT OF HIGH quality and professional performance has been made available by Crofton Electronics, 15-17 Cambridge Road, Kingston-upon-Thames, Surrey, KT1 3NG. Based on a Mullard Educational Service design, the camera may be employed with a 405 or 625 line black and white monitor or, with the addition of a modulator, with a 405 or 625 line monochrome television receiver. A u.h.f. modulator kit can be obtained from Crofton Electronics and this can be mounted inside the camera case. Alternatively, Crofton Electronics can provide instructions and the necessary components to enable a black and white television receiver to function also as a monitor. The video output of the camera is compatible with most video recorders.

## SERVICING FACILITIES

A particular feature of the Crofton kit is that the performance of a finished camera may, if desired, be brought up to full specification by an engineer who is based in the area in which the customer resides. However, very explicit instructions are provided with the kit and these, in most instances, should enable the completed camera to be set up correctly by the constructor. All components are guaranteed for a year, and Crofton Electronics give an unequivocal guarantee that the camera will produce satisfactory pictures.


*The rear panel of the camera. This carries the input fuse and the electronic controls*



*Inside the camera. The printed circuit boards may be laid open whilst the camera is operating*

A clearly detailed and well produced instruction manual is provided and this gives all the information required for assembly. Provided in this manual also are a full circuit diagram, a test card, and the waveforms to be expected at different circuit points. Whilst an oscilloscope is helpful for setting up the camera it is not essential, and the presence of scanning waveforms can be detected with as simple an item of equipment as a headphone. The various parts of the kit can be purchased in modules. If desired, each module may be bought, assembled, tested and roughly aligned before purchasing the next. Yet another alternative consists of having the kit fully built by Crofton Electronics. The complete assembly incorporates 23 transistors and a vidicon camera tube.

The kit does not require any special skills in its assembly, and it will be of particular value in the training of students. The Mullard design on which the camera is based is entitled 'A Simple Closed Circuit Television Camera' and is the latest in the series 'Educational Projects in Electronics'. This booklet costs 60p and requests for copies should be sent with cash to the Mullard Educational Service, Mullard Ltd., New Road, Mitcham, Surrey, CR4 4XY. It should be noted that components for the camera are not available from Mullard Ltd.; these are provided by Crofton Electronics. ■

# MODIFYING THE GC1U RECEIVER. Part 2.

by P. Cairns, R. Tech. Eng., M.I.P.R.E., G3ISP

**In this concluding article constructional details are given of the added product detector.**

THE ARTICLE PUBLISHED IN LAST MONTH'S ISSUE described a new stabilized mains power supply unit for the popular GC–1U receiver and covered the replacement of the existing fixed resistors with high stability types. The additional product detector circuit was next discussed and a Components List showing the new parts required was published. In the constructional details for fitting the product detector which now follow it will be necessary to refer to Fig. 5, which appeared in the previous issue.

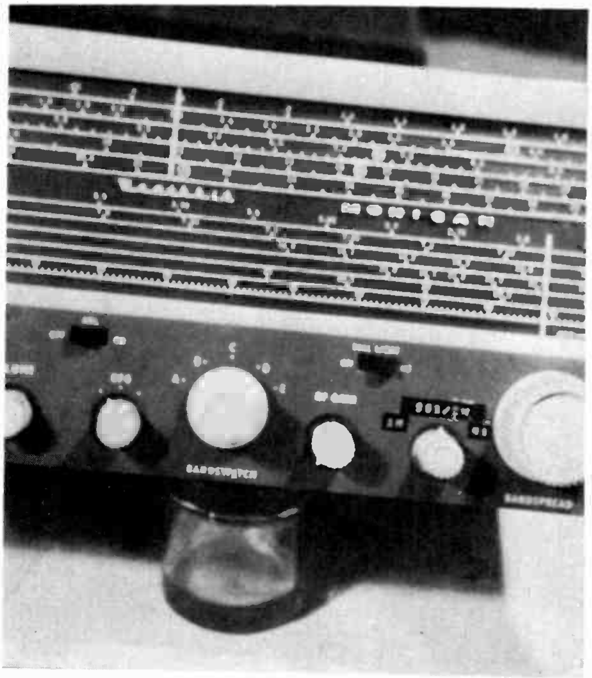
## CONSTRUCTION

The construction of the product detector is quite straightforward, the complete circuit, except for C8, being mounted on a piece of Veroboard. Component layout, dimensions and bracket mounting details for the Veroboard are given in Fig. 7. No extra controls or holes are required on the front panel and no drilling of the chassis is necessary.

The completed Veroboard is mounted vertically by means of two U-shaped brackets fitted to the inside edge of the receiver i.f.–a.f. printed board. The existing 6BA screws which fasten this board to the chassis are used. An aluminium bracket along the bottom of the Veroboard fixes the board to the two mounting brackets. Full details are given in Fig. 7. As will next be described, S1 and R47, the latter with its new value of 1kΩ, are mounted. The existing b.f.o. frequency control is removed, the wiring on the control and rear switch being first unsoldered.

To make room on the front panel for S1 the aerial trim control is removed. This means that the aerial trimming capacitor has now to be pre-set for optimum matching with the particular aerial used. This control was of little practical use, particularly if an aerial coupling unit was used and, due to its position in the circuit, caused a noticeable frequency shift on the h.f. bands. The removal of its variable function is, in some respects, something of an advantage. The ¼in. fibre spindle is removed from the capacitor coupler and the brass bush set in the front panel is unscrewed. S1 is mounted in place of this bush.

The 4.7pF b.f.o. coupling capacitor (C60) is removed from under the receiver i.f. printed board. R54, the



*The new function switch, S1, is fitted in place of the panel bush for the aerial trim control*

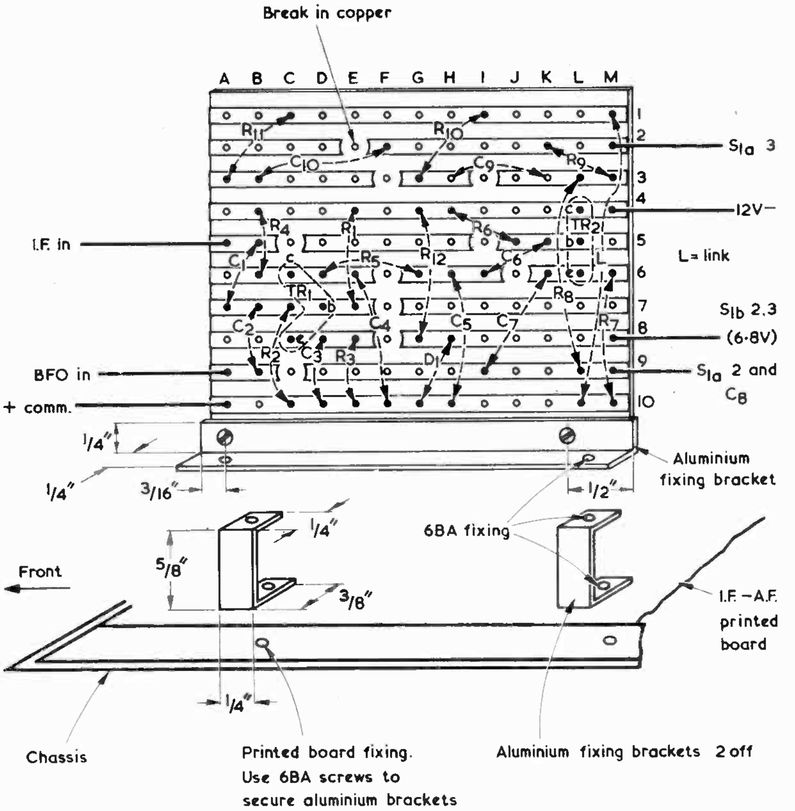
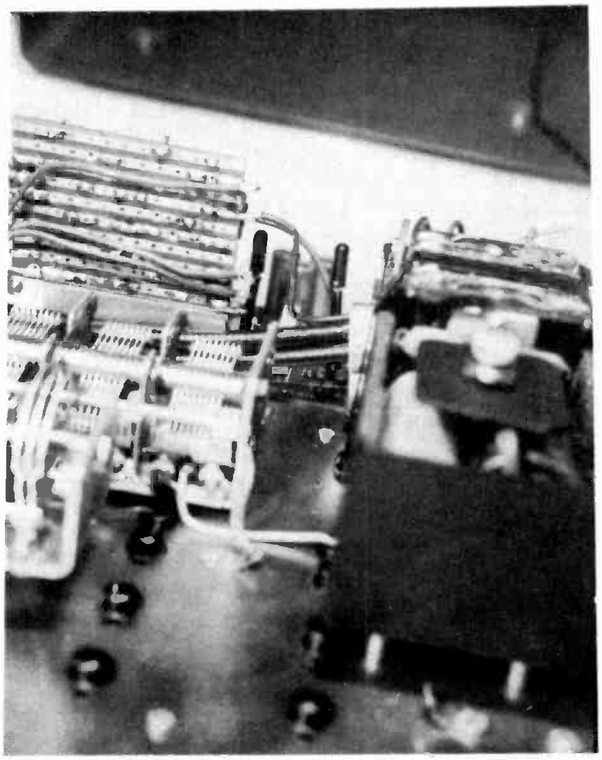



*Fig. 7. The copper side of the Veroboard on which the product detector components are fitted. Also shown are fixing details and the mounting brackets required*

1.5kΩ resistor which is wired between the b.f.o. potentiometer R47 and an earth tag on the rear of the front panel is replaced by the new 2.2kΩ resistor. The new 1kΩ potentiometer which replaces the old 2kΩ R47 is mounted at the same time. Next, the output from I.F.T.2 (a.m. detector output) which passes to one end of the a.f. volume control is disconnected from this control and wired to the appropriate point on S1(a). The output from S1(a) arm is then wired to this same point on the a.f. volume control. This completes the receiver modifications, leaving only the few interconnection wires to be put in.

The i.f. input to the product detector is taken from the emitter tag of transistor X6 on the top of the i.f. printed board. The b.f.o. input to the detector is taken from the b.f.o. output tag, one end of which can be found on top of the i.f. printed board adjacent to the top-right hand corner of the b.f.o. coil (L16), as seen looking from the front panel. It is next to the 62kΩ resistor (R55) and labelled 'B.F.O.3'. These leads should be short, direct and kept away from other components.

The 12 volt supply is now wired to the Veroboard and the appropriate outputs, including the 6.8 volt b.f.o. supply, taken from this board to S1. The replacement R47 b.f.o. control is also wired in. The wire carrying the old b.f.o. d.c. supply which was disconnected from the old b.f.o. switch is cut short and taped up. The other supply lead from the original switch is extended so as to reach the appropriate point on S1(b). C8 is wired between S1(a) and the adjacent earth tag on the rear of the front panel. (See Figs. 5 and 7.) This completes the additional wiring.



*A view of the copper side of the Veroboard panel. Also visible to the right is the new power supply fitted in the battery box*

## SETTING UP

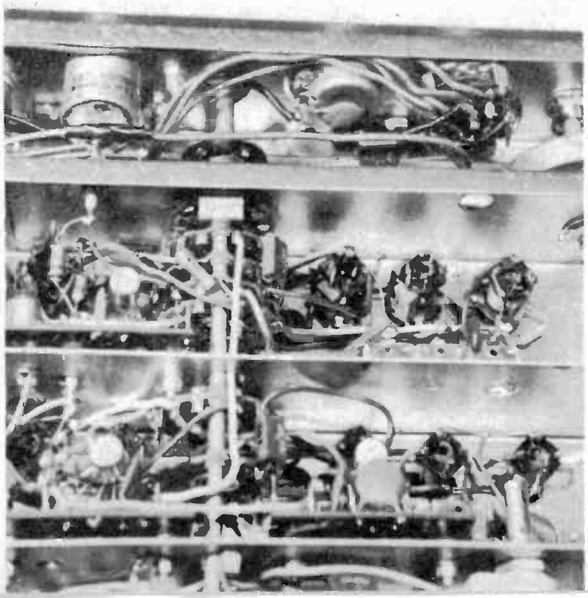
The receiver can now be set up, no instruments being required for this process. Switch on and set S1(a)(b) for a.m., tune in a known station and note that the signal level has not changed compared with pre-modification level. Next switch to the h.f. band most used and adjust the aerial trimmer (which is now pre-set) for maximum output. This should be done using either the internal whip aerial or the external aerial normally employed with the receiver. The tuning indicator meter can be used for signal strength comparisons during these tests.

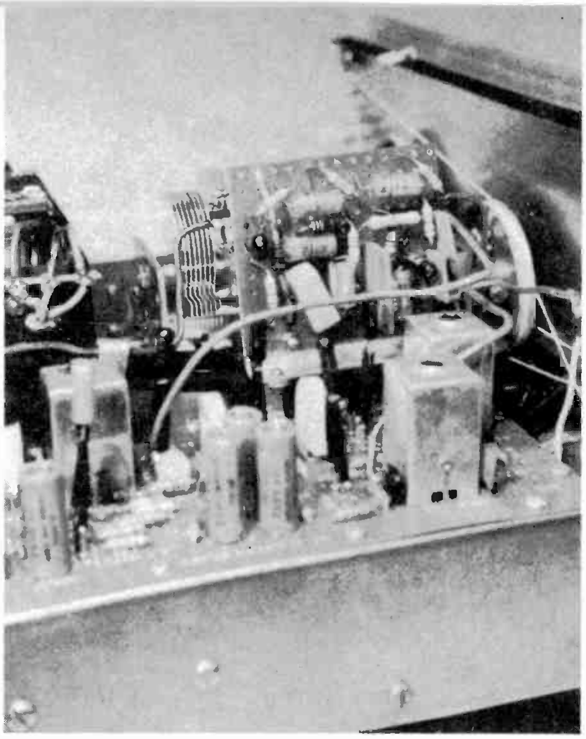
Now, using the tuning meter, tune in a station with a strong carrier for maximum output. It is essential that this signal be tuned in exactly and not slightly off to one side or the other. Next, set S1(a)(b) to position 2 and reduce the r.f. gain. Set the b.f.o. control (R47) to mid-point and adjust the core in the b.f.o. coil (L16) for zero-beat. This should be done with great care, removing the trimming tool at intervals to ensure there is no shift in frequency due to external stray capacitances. This coil should be tuned for exact zero-beat with R47 in the centre position.

The receiver can now be tried out on some s.s.b. signals. These should be tuned in with R47 in its centre position, a.v.c. off, a.f. gain at or near maximum and r.f. gain adjusted to suit signal strength. With the required station exactly in tune on the main and bandspread controls, the final tuning is resolved by slight adjustment of the b.f.o. control. In practice the writer found that in many cases the b.f.o. control could be off-set and the various stations resolved simply by tuning across the band by means of the bandspread control. Under these conditions the r.f. gain control can be adjusted to suit each signal without appreciable effect on the received signal intelligibility.

The circuit allows for some adjustment if the performance is not quite up to expectations. The overall apparent sensitivity can be increased for s.s.b. and c.w. signals by reducing the value of C8. Values as low as 0.1μF can be tried if required. Due to differences which could occur between various receivers, it might be found necessary to increase or decrease the amount of i.f. signal input. This is done by increasing or decreasing the value of C1. This capacitor can be safely increased in value to 200pF without having any noticeable loading effect on the i.f. circuit. Increasing C1 too much will, of course, mean that the b.f.o. injection will be insufficient. If it is thought necessary to experiment a little with C1, it should only be increased sufficiently to allow a strong s.s.b. signal to be resolved with the existing b.f.o. injection. Generally speaking, however, C1 should require no adjustment.

*The fibre spindle for the aerial trim capacitor is removed, and it now becomes a pre-set component*





*The added product detector Veroboard in position. The relatively bulky rectangular capacitor C7, can be seen near the left edge of the board*

## OTHER RECEIVERS

As was mentioned at the beginning of the previous article, the product detector circuit of Fig. 5 offers scope for experiment to the interested constructor having another communications receiver which falls into the 'older' category. The circuit should be added to many receivers where s.s.b. facilities are required, though the i.f. and b.f.o. injection levels would have to be adjusted to suit individual sets. Changes in the values of C1 and C2 would effect this. A suitable matching point into the i.f. circuit would also be required, though this should not necessarily prove an insurmountable problem. The other point which is also of importance with any such conversion is frequency stability of both local oscillator and b.f.o. This can often be largely catered for by the use of zener diodes in transistor receivers and neon stabilizers in valve receivers. Any components in these circuits which are temperature sensitive should also be replaced if at all possible.

In conclusion, the modifications described offer a relatively cheap and simple method of up-dating a basically good receiver at a modest cost. The overall improvement in performance is, in the opinion of the writer and several others who have tried the modified GC–1U under operating conditions, well worth the time and expense involved. ■

# Integrated Circuit Timebase by A. Foord

**Our contributor commences by discussing general timebase principles, then proceeds to a description of a comprehensive timebase which takes full advantage of modern integrated circuits.**

A LINEAR TIMEBASE GENERATOR PROVIDES AN OUTPUT waveform a proportion of which has a linear variation of voltage or current with time. One major application of such a waveform is in a cathode ray oscilloscope. Here the timebase waveform is applied to the X deflecting plates so that the electron beam is swept horizontally across the screen with time. Since this waveform is used to sweep the electron beam it is sometimes called a sweep voltage in this application. Timebase circuits are also used in radar and television indicators, in precise time measurements, in time modulation, and other instrumentation applications.

## TIMEBASE WAVEFORM

A typical timebase voltage is shown in Fig. 1. The voltage starts from an initial value, increases linearly with time to a maximum value, and returns rapidly to its minimum value. The time required for the return to the initial value is called the 'return', 'restoration' or 'flyback' time. Normally, the shape of the waveform during the return time is not important, although its duration must usually be short compared with the time taken for the linear sweep part of the waveform.

Timebase waveforms can be generated by vacuum or gas filled valves, transistors, or integrated circuits, depending on convenience, the application, and the required speed.

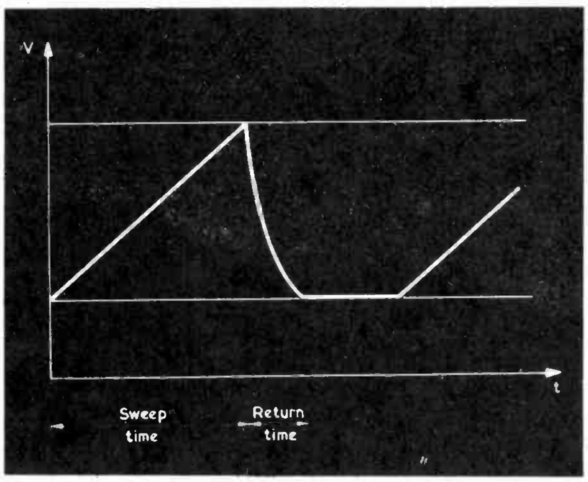



*Fig. 1. A typical sweep voltage, showing sweep and return times*

## SWEEP VOLTAGE GENERATION

There are several methods of generating a sweep voltage of good linearity. Some of these will now be discussed.

*Exponential charging*. Here, a capacitor is charged through a resistor to a voltage level which is small in comparison with the supply voltage. See Figs. 2 (a) and (b). When the switch in Fig. 2 (a) is opened the capacitor

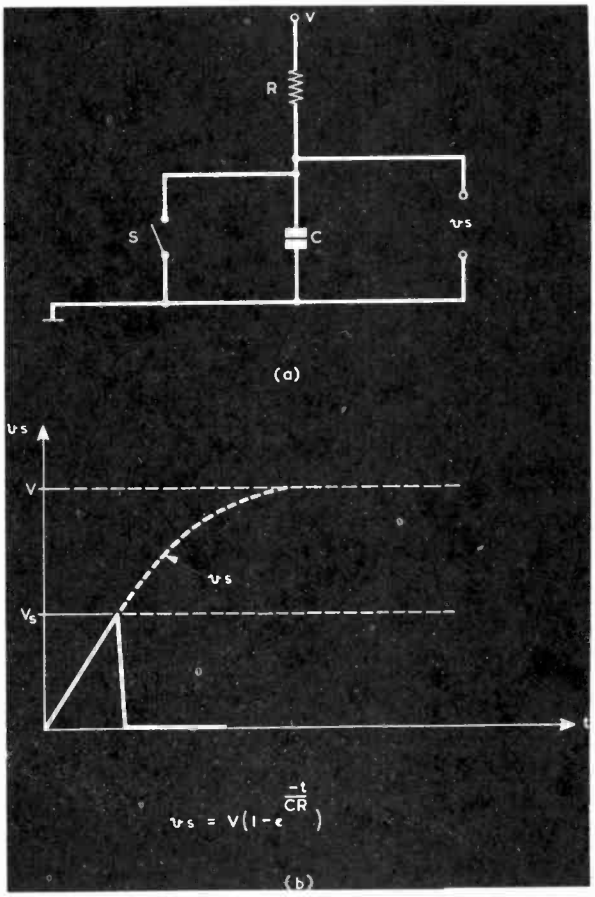



*Fig. 2 (a). Charging a capacitor from a fixed voltage via a resistor*
*(b). The voltage appearing across the capacitor*

charges up according to an exponential law, and as the required threshold is reached the switch is closed to discharge the capacitor. In order that the part of the sweep used is reasonably linear, the supply voltage V must be much greater than Vs. For example a 20V sweep can be obtained with a sweep speed error of less than 10% by using a supply voltage of at least 200V. As a result, this simple circuit is only useful in applications where a low sweep voltage is needed. In practice, the switch in Fig. 2 (a) would be replaced by an electronic device which discharges the capacitor.

*Constant current charging.* In this instance, a capacitor is charged linearly from a constant current source. Except for very small values of collector to base voltage, the collector current of a transistor connected in the common base mode is nearly constant when the emitter current is held fixed. This characteristic is used in Fig. 3 (a) to generate a constant current supply to charge a capacitor. The voltage across the capacitor is shown in Fig. 3 (b). When the capacitor, C, is charged by a constant current I, then the voltage across the capacitor is given by:

$$V = \frac{It}{C}$$

where V is in volts, I is in amps, t is in seconds and C is in farads.

It follows that the rate of change of voltage against time is given by:

$$\text{Sweep speed} = \frac{I}{C} \text{volts/sec.}$$

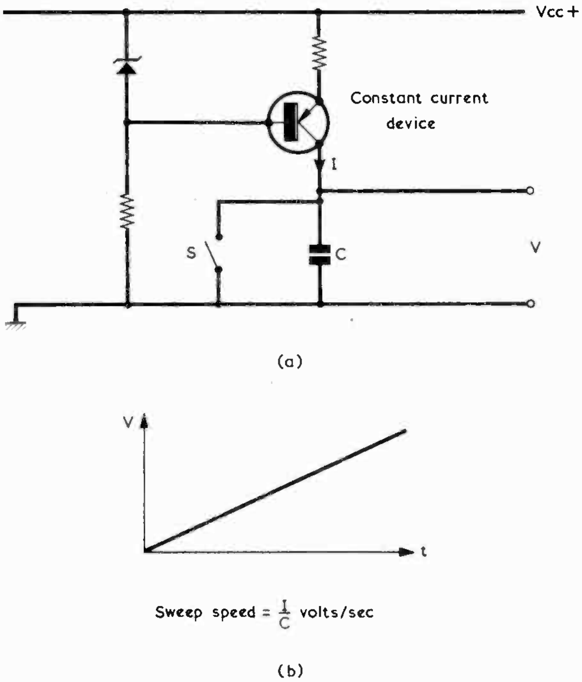



*Fig. 3 (a). Constant current charging of a capacitor*
*(b). The linear voltage change developed across the capacitor*

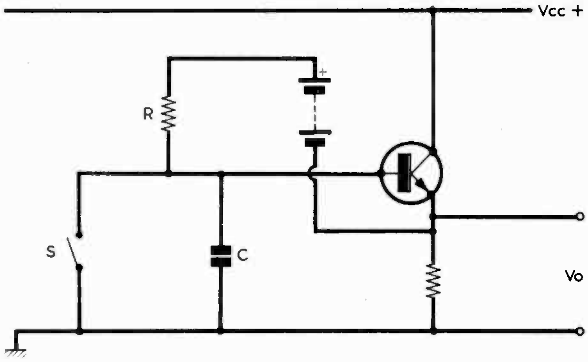



*Fig. 4. The basic bootstrap sweep circuit*

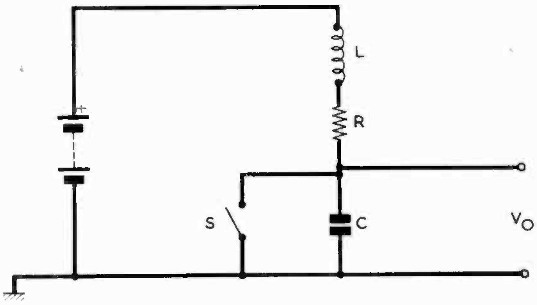



*Fig. 5. An LRC sweep circuit*

The constant current charging circuit enables a linear sweep to be obtained if only a low voltage supply is available. It suffers from the disadvantage that the circuit cannot be loaded appreciably without seriously deteriorating the linearity, and the sweep voltage must be applied to the load through an emitter follower or a similar type of buffer amplifier.

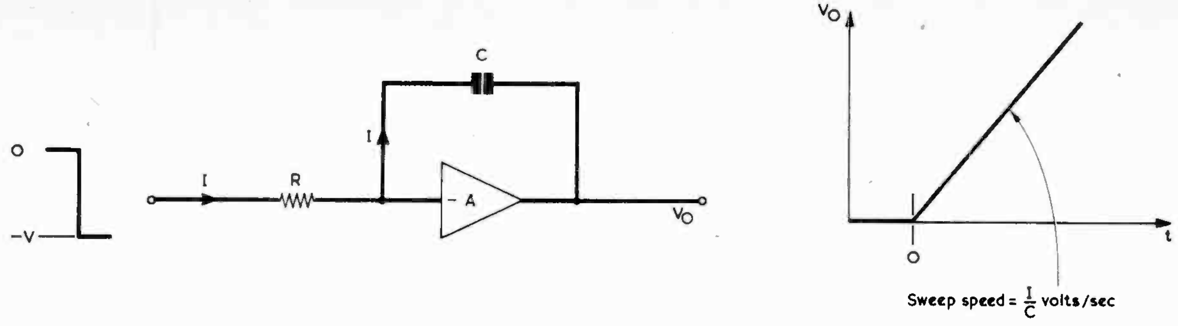
*The Phantastron Circuit.* This is a valve circuit based on the Miller Integrator and only requires an input pulse to trigger it, and not an external step or gating waveform. It is limited to the generation of linear sweeps of the order of 10µS or longer because of the effect of stray capacitance to earth at the various valve electrodes.

*The Bootstrap Circuit.* With this circuit a constant current is approximated by maintaining a nearly constant voltage across a resistor in series with the charging capacitor. This is achieved by using a unity gain amplifier in a feedback configuration, as in Fig. 4.

*An Inductor Circuit.* An LRC series circuit can be used to give more linear capacitor charging than is possible without the inductor. See Fig. 5. This circuit improves the linearity of a simple RC sweep and also allows a sweep to be obtained whose amplitude is larger than the supply voltage because of the oscillatory nature of the circuit.

In practical applications the most useful circuits are the constant current one and the final one to be considered, the Miller Integrator.

*The Miller Integrator.* A basic Miller Integrator circuit is shown in Fig. 6 (a), and it consists of a high gain inverting amplifier with overall negative feedback from output to input via a timing capacitor. The input




(a) (b)

*Fig. 6 (a). A Miller Integrator circuit incorporating an op-amp*
*(b). The circuit gives a linear sweep, as indicated here*

point remains at a 'virtual earth' with current summing at this point, where any input current I is forced to charge the capacitor by feedback action. The output waveform of the Miller integrator is actually the initial part of a large exponential. The higher the amplifier gain the better the linearity. Since the circuit has a low output impedance a buffer amplifier is not required (unlike the constant current supply fed into a capacitor).

If we assume that initially the voltage across the capacitor is zero, then when an input step is applied a constant current flows into the capacitor and the output rises at a rate determined by the current and the capacitor. As indicated in Fig. 6 (b):

$$\text{sweep speed} = \frac{I}{C} \text{ volts/sec.}$$

In order to produce a complete timebase circuit we must determine when the output of the integrator has reached the required level and terminate the sweep and hold the capacitor in a discharged state. This can be achieved with a circuit of the type show in Fig. 7 (a).

Initially, in this diagram, V2 is high and the transistor switch is closed, maintaining an effective short-circuit across the capacitor. When the bistable is triggered by the input pulse the transistor switch is opened, and the output of the integrator will run up at a rate depending on the time constant and the negative supply. When the ramp reaches the comparator reference level, shown here as 5 volts, a reset pulse is generated which resets the bistable and closes the transistor switch. This rapidly discharges the capacitor and then maintains the amplifier output at earth potential until the circuit is retriggered by another start pulse.

The ramp slope is equal to

$$\frac{I}{C} \text{ volts/sec, or}$$

$$\frac{V}{CR} \text{ volts/sec.}$$

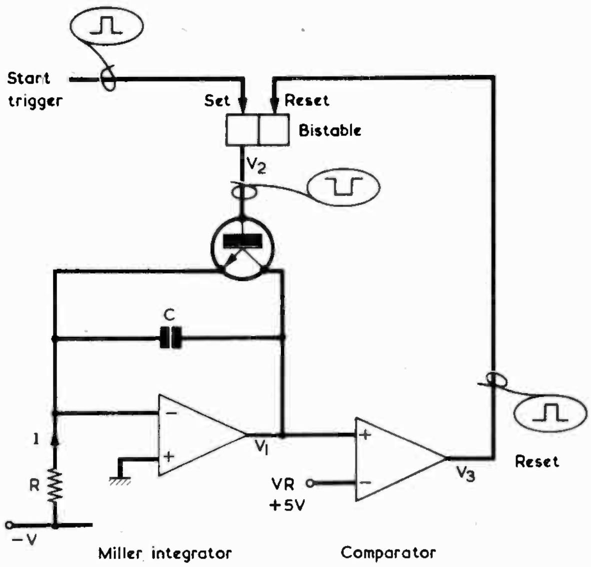
The duration of the ramp depends on its slope and the chosen reference level voltage, and is equal to

$$\frac{\text{reference level}}{\text{ramp slope}}$$

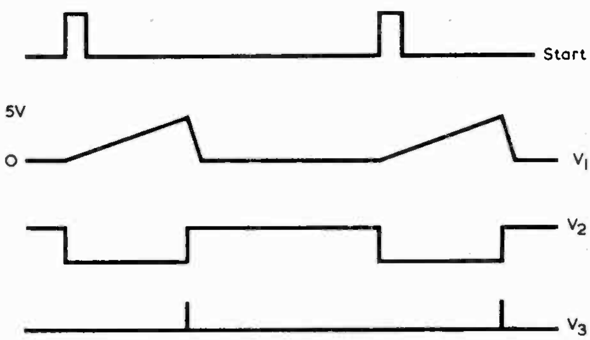
$$= \frac{VR}{V} \times CR \text{ secs,}$$

where VR is the reference voltage.

Fig. 7 (b) illustrates the waveforms appearing in the circuit.




(a)




(b)

*Fig. 7 (a). A more comprehensive version of the Miller Integrator timebase*
*(b). Waveforms appearing in the circuit of (a)*

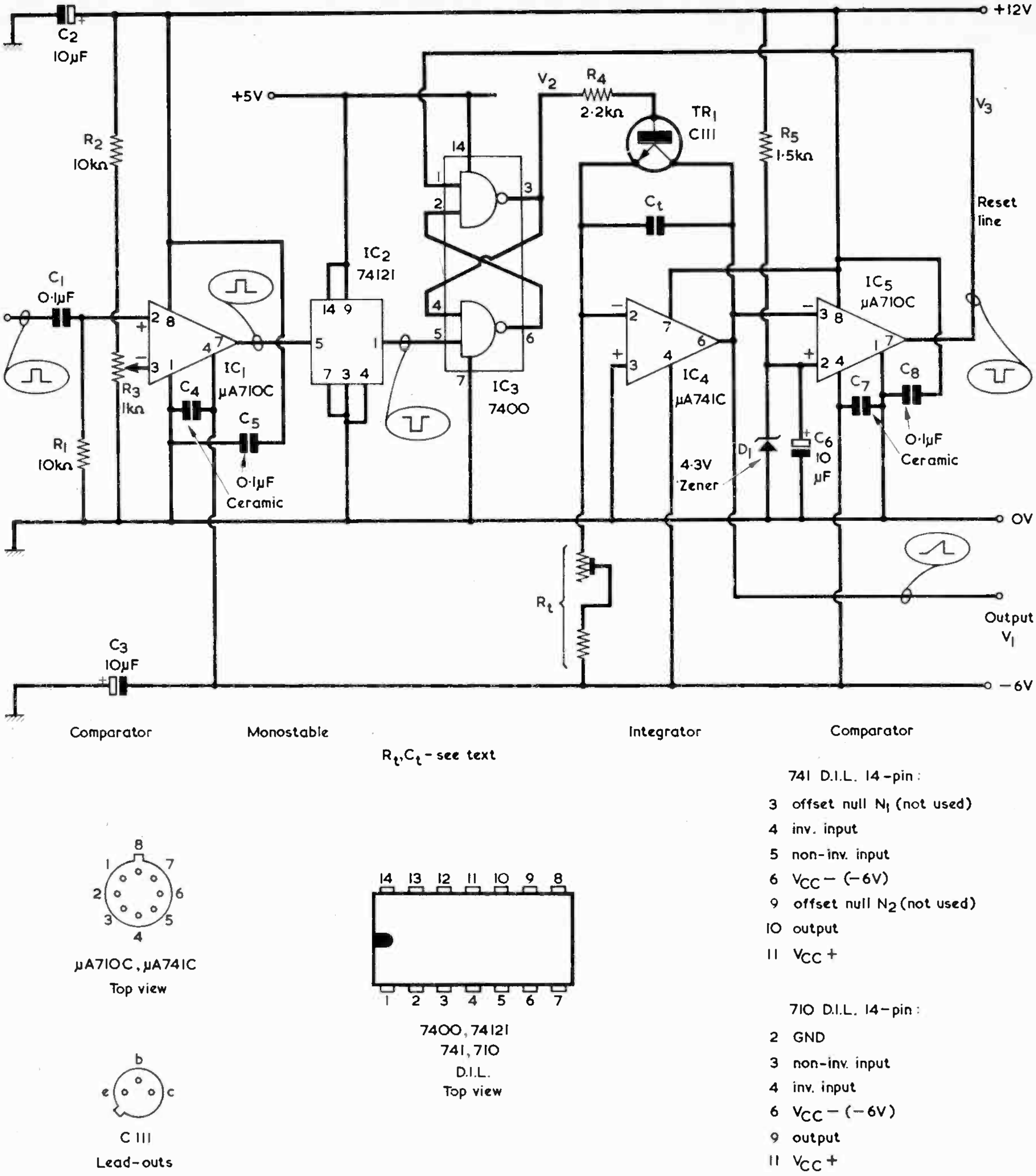



*Fig 8. Complete circuit of the integrated circuit timebase*

## COMPLETE CIRCUIT

A complete timebase circuit is shown in Fig. 8. A comparator given by ICI, a μA710C, is used to shape an input waveform to the t.t.l. logic level for the 74121 monostable multivibrator. This produces a short pulse (30 nS) to trigger the 7400, which is cross-coupled as a bistable circuit. When the clamp on the integrator is released it runs up at the rate previously discussed. On reaching the 4.3 volt level set by the zener diode the μA710C comparator in the IC5 position operates, and its negative-going edge initiates the stop action. As the capacitor discharges the comparator input goes below the 4.3 V threshold and the comparator output returns positive. The comparator reference level must be kept below the 5V limit allowed for its differential input, so that a 4.3V zener diode is suitable. Circuit waveforms are given in Fig. 9.

The speed at which this circuit can operate is limited by the slew rate of the μA741C, which is typically 0.5V per microsecond. Since the excursion is 4.3V the return time will be about 8μS. In practice it appeared as a little less because the transistor aids the integrated circuit in its recovery. However the length of ramp which can be obtained also depends on slew rate and should be much slower than the amplifier slew rate in order to maintain a good linearity. For the circuit shown the minimum time should be a (say) 80 μS ramp.

Rt should be between 1kΩ and 100kΩ. The maximum duration time for the ramp is limited by drift in the integrator, but 500mS or longer can readily be obtained. If it is required to check that the 74121 is working, then the 30nS pulse may be lengthened to (say) 100μS by connecting a 0.1μF capacitor between pins 10 and 11.

As an example for calculating Rt and Ct let us suppose that the ramp has to be 500μS long. Then, from the last equation given above:

$$500 \times 10^{-6} = \frac{4.3}{6} \times CR$$

$$CR = 0.7 \times 10^{-3}$$

Thus CR has to be 0.7mS.

A 0.05μF capacitor and a resistor of 14kΩ are required, so that a 10kΩ potentiometer in series with a 6.8kΩ fixed resistor would be suitable.

The stability of the ramp depends on the 4.3V reference and the constant current through Rt. If the 12V supply is stablised then the 4.3 reference will have excellent stability and require no further thought. However, changes in the 6V negative line will directly influence the slope of the ramp. The ramp stability and linearity could be improved by using a constant current source in place of the resistor Rt.

(The transistor type C111 shown in Fig. 8 is available from several suppliers, including Henry's Radio Ltd. The 7400 and 74121 can be obtained from most suppliers of t.t.l. integrated circuits. A d.i.l. equivalent of the μA741C is the '741C D.I.L.' (Henry's Radio) and an equivalent of the μA710C is the R. S. Components 710-MOPA, which is available from Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN. Other suppliers also stock 741 and 710 integrated circuits. The pin numbering in the circuit diagram of Fig. 8 for both the 741 and 710 is that for the 8 lead radial version. The pinning insets in this diagram also give pinning for the 14-way dual in-line versions. All i.c. pinning diagrams are with the leads pointing away from the reader. The transistor lead-out diagram is with the leads pointing towards the reader. – Editor.)

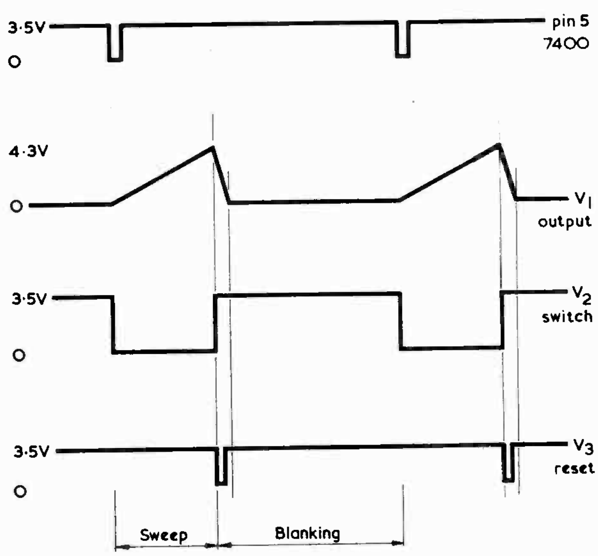



*Fig. 9. Waveforms illustrating the sequence of operations in the timebase*

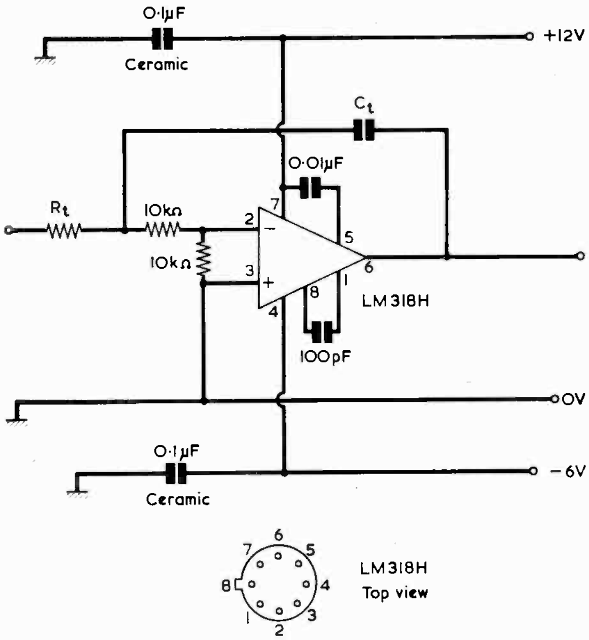



*Fig. 10. An alternative integrator circuit incorporating a wide band operational amplifier*

A constructional point is that the four 0.1μF capacitors, C4, C5, C7 and C8, should be wired close to the i.c. pins to which they connect.

## IMPROVED TIMEBASE SPEED

Fig. 10 is included for the professional reader since, at the time of writing, the integrated circuit employed is not widely available in the retail market. It does show, however, what speeds can be obtained with the latest devices.

As was previously discussed, the maximum timebase speed is limited, by the slew rate of the amplifier used, to about 80μS long. Where the expense is justified a wide band operational amplifier can be used as the integrator. The National Semiconductor LM318H (distributed by Athena Semiconductor Marketing Company, 140 High Street, Egham, Surrey – Editor) may be employed in a similar circuit, and it was found that the recovery time was better than 0.25μS, so that a ramp duration time of 2μS is possible. The circuit for an integrator section using an LM318H is given in Fig. 10. With this circuit, the 100pF, 0.01μF and 0.1μF capacitors should all be positioned close to the integrated circuit.

If the 2μS long ramp is used for an oscilloscope display of 10 cm, length then this represents 0.2μS/cm., which is adequate for many applications.

## CONCLUSION

In this article we have shown how a timebase circuit can be developed for simple applications. The manner in which the sweep and blanking pulses are used will depend on the application, but the circuits as they stand are compatible with the linear and digital integrated circuits normally used in modern circuit design. ■

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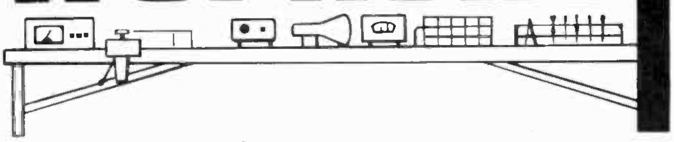


**This month Smithy the Serviceman and his able assistant, Dick, take their annual August holiday away from the Workshop. We find them relaxing on a sunny beach where, despite the surroundings, Smithy still finds time to explain to Dick the mysteries of the programmable unijunction transistor.**

"AH," SAID SMITHY CONTENTEDLY, "this is the life."

Dressed only in a bathing costume and with his clothes in a heap beside him, he sat forward on the sand. Screwing up his eyes against the morning sun, he gazed happily at the scene in front of him. Before him stretched the golden sands of the beach which he and Dick had chosen to patronise on their annual day off together, the sand breaking away in the distance to a sparkling silvery sea. He listened to the distant shrieks and shouts of holidaymakers as they swam and played in the cool water. All was as it should be, and he lay back, allowing the sun to warm his body.

"It's all right for you," grumbled Dick, who lay alongside him and was similarly clad in swimming trunks. "But who did all the donkey-work bringing the scoff down here?"

"Now please don't start spoiling things already," remonstrated Smithy mildly. "All you had to do was to carry a hold-all bag – which, incidentally, I provided – containing the food you brought for yourself, the food I brought for myself, and a little something to drink."

"A *little* something?" repeated Dick incredulously. "Blimey, there are at least four thermos flasks in that bag for a start."

"Ah yes," concurred Smithy, lying back comfortably on the sand, "but don't forget that it's a hot day today and we'll need the odd spot of tea every now and again to keep the body fluids in a state of equilibrium. In any case," he concluded magnanimously, "I'll carry the bag on the way back."

## PROGRAMMABLE UNIJUNCTION

"Blow me," snorted Dick indignantly. "That won't be much of a hardship, will it? After we've eaten all the nosh and you've drunk all the tea, there won't be any weight to carry at all. Hallo, what's that dog up to?"

Smithy turned on one side and glanced in the direction of Dick's pointing finger. A large shaggy dog of indeterminate breed was wandering morosely around the beach.

"Perhaps he's lost," volunteered Smithy. "Perhaps he's wondering where his owners have put themselves."

"Could be," concurred Dick disinterestedly. "By the way, it's funny that you should mention the word 'put'."

"Why?"

"Because I've just been reading something about electronic devices which are called 'puts'," explained Dick. "I can't say I was any wiser after I'd finished reading than when I started!"

Smithy sat up and regarded his assistant balefully.

"Don't you," he queried irritably, "*ever* ease off on your questions about electronics? Dash it all, we're supposed to be having a day free from technical things today."

"All right," said Dick equably. "But at any rate it won't hurt you to tell me what a 'put' is."

"To begin with," replied Smithy shortly, "you don't call the device a 'put', you call it a 'p.u.t.' And those letters stand for 'programmable unijunction transistor'."

There was silence for a moment.

"How does it work?"

Smithy sighed.

"In rather the same way as a thyristor," he said resignedly. "It's a four-layer device, like the thyristor, and you trigger it off by increasing the circulating current inside the layers."

There was a further silence. Smithy prepared himself for the inevitable.

"I'm not too certain," persisted Dick, "how a thyristor works, either. And what exactly do you mean by a four-layer device?"

Giving up the unequal struggle, Smithy leaned forward and, with his finger, drew out on the sand a rectangle with four sections. (Fig. 1.)

"Here we are," he stated. "Now here are the four layers which you find in a thyristor or, to give it its earlier name, a silicon controlled rectifier. All the layers are silicon and they are p-type, n-type, p-type and n-type respectively. In an initial examination of the device we can start by applying a positive voltage to the p. end via a load resistor

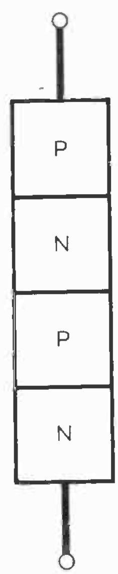
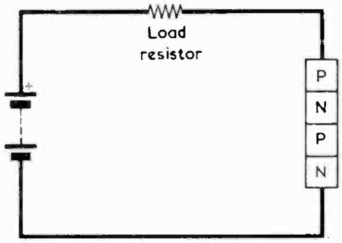
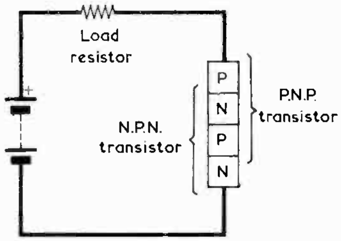



*Fig. 1. The four layers which appear in a thyristor*




(a)

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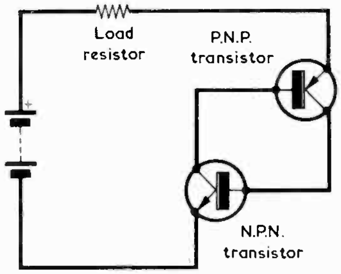



(c)

*Fig. 2 (a). Applying a voltage to the four-layer device*
*(b). Two effective transistors appear within the four layers*
*(c). Redrawing the circuit with the transistors shown as discrete components*

and a negative voltage to the n. end." (Fig. 2 (a).)

"A p.n.p.n. device, eh," commented Dick musingly. "So far as I can see, it just consists of three diodes in series, these being a p.n. diode, an n.p. diode and another p.n. diode."

"True," agreed Smithy. "But if you think a little more deeply about it, you'll see that there are, in actual fact, two transistors lurking away in those four layers. The first of these is a p.n.p. transistor and the second is an n.p.n. transistor. See what I mean?"

Smithy indicated the two effective transistors existing in the four-layer device. (Figs. 2(b) and (c).)

"These two transistors," he went on, "are going to act like any other transistors. They both share the n. and p. sections in the centre and it is quite easy to look upon them as two separate transistors with their shared sections joined together. Now, let's say that the voltage applied across the four-layer device is relatively low. What current will flow through it?"

"At a guess," hazarded Dick, "I'd say it would be leakage current."

"And that's the right answer," replied Smithy. "This leakage current flows in the n.p. junction in the middle. The two outside p.n. junctions, which are the base-emitter junctions of the two transistors, are forward biased. As you can see, the middle n.p. junction is the base-collector junction for both transistors. If the applied voltage is small the leakage current will be very low and the two transistors will offer hardly any current gain."

"What happens if you increase the voltage?"

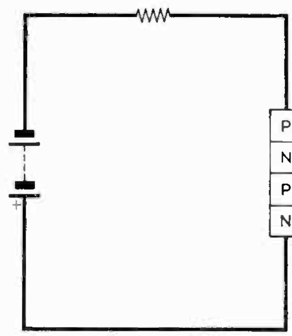
"Naturally," said Smithy, "the leakage current increases also. So also, in consequence, does the current gain offered by the two transistors. When this leakage current passes a certain level, the transistors offer sufficient current gain for a sudden regenerative process to take place. The current flowing in the base of the p.n.p. transistor is amplified by that transistor, the amplified current at the collector flowing into the base of the n.p.n. transistor. And the current flowing in the base of the n.p.n. transistor is similarly amplified by that transistor and caused to flow in the base of the p.n.p. transistor. So both transistors are now amplifying, with the amplified collector currents flowing in the bases of the opposite transistors. As you can imagine, this constitutes a regenerative loop and the transistors quickly become fully saturated. In consequence, the voltage across the four-layer device suddenly drops to a value which is of the same order as that given across two forward biased silicon diodes in series."

"And this drop in voltage across the device occurs at a particular applied voltage level?"

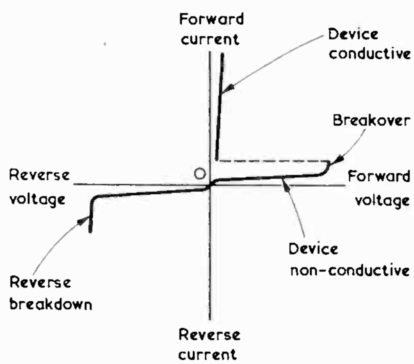
"It does," confirmed Smithy. "The voltage level at which the effect occurs is known as the 'breakover' voltage and it varies for different specimens of the device. To recap, the device passes hardly any current at all for applied voltages below the breakover value. As soon as the breakover value is reached the device suddenly becomes almost a direct short-circuit. A further point we must now consider is that, after breakover, the device stays in the conductive condition provided that the current flowing through it is not reduced below a certain very low level. The minimum current level at which the device remains conductive is called the 'holding current'."

"What happens," asked Dick, "if you apply the voltage the other way round?" (Figs.3(a) and (b).)

"In this case," said Smithy, "the device acts like three diodes in series because the current which flows is in the wrong direction for transistor action. The n.p. diode in the middle is forward biased and the two outside p.n. diodes are reverse biased. If the applied voltage is taken high enough, the outside diodes go into avalanche breakdown, rather like a zener diode. But in this case the voltage across the device doesn't go down to a low level as occurred previously, because there is no transistor regenerative action. Come here, boy!"




(a)




(b)

*Fig. 3 (a). If the polarity of the applied voltage is reversed, there is no transistor action within the device*
*(b). Graph illustrating the relationship between voltage and current. As soon as forward voltage reaches breakover level the device changes to the conductive mode*

## ADDING A GATE

"I *am* here," responded Dick, puzzled.

"I'm talking to the dog not you, you nit. There's a good boy!"

The large shaggy dog of indeterminate breed had now wandered over towards them, and was yawing back and forth in front of the Serviceman, wagging a conciliatory tail furiously from side to side. He approached sufficiently close to allow Smithy to pat him on the head. With a sudden burst of confidence he flopped down beside the Serviceman and rested his muzzle on Smithy's thigh.

"How about that?" said Smithy, obviously pleased. "Now that's what I call a *sensible* dog."

"Blow the dog," retorted Dick. "Keep on about thyristors."

Ignoring his assistant, Smithy reached into the hold-all bag and produced a neat packet wrapped up in greaseproof paper. The rustling of paper caused the dog's ears to perk up, and he threw an enquiring glance at the Serviceman's face.

"Are you hungry, old boy?" said Smithy, addressing the dog. "Here, have one of these."

He produced a sandwich and offered it to the dog. The latter sniffed suspiciously, then took it in his mouth. After several gulps, it had disappeared. Smithy gave the dog another sandwich.

"Hey, what the devil are you up to?" expostulated Dick. "Those are my ham sandwiches."

"Surely," said Smithy reproachfully, "you wouldn't deny a little food to a hungry animal?"

"Wouldn't I just, " replied Dick indignantly. "I didn't cart those sandwiches all the way down here just to see them go down the gullet of *that* rapacious mongrel."

But Smithy's attention was centred on the dog and he gave it several more sandwiches, each of which was demolished with similar dispatch. Reaching over, Dick attempted to pull the heavily depleted packet from Smithy's hand but the Serviceman snatched it out of reach. This action caused the packet to come within reach of the dog, who stuck his nose inside the paper and sniffed eagerly at its contents.

"You might as well give him the lot now," said Dick in disgust. "I don't fancy them after he's been slavering his great chops all over them."

"Fair enough," replied Smithy, as he passed the sandwiches, one by one, to the apparently insatiable dog. The last sandwich was consumed as quickly as the first, and the dog, seeing that the packet was patently empty, ran his tongue appreciatively around the outside of his mouth. He then contentedly rested his head once more on Smithy's thigh.

"That's a fine state of affairs, I must say", complained Dick bitterly. "All my ham sandwiches have gone."

"Well, you've brought some other things to eat as well, haven't you?"

"I have," confirmed Dick heatedly, "and it's a jolly good thing I did, too, or I'd be starving today. Anyway, go on a bit more about thyristors."

"All right," said Smithy cheerfully. "Well, we've got as far as the four-layer device and we've seen that, if the p. end is positive and the n. end is negative, the device changes abruptly, as the applied voltage is increased, from offering a high resistance to behaving in a manner analagous to a diode. We can use the diode terms 'anode' and 'cathode' here. The end of the device to which we apply the positive potential is referred to as the 'anode', and the end to which the negative potential is applied is known as the 'cathode'."

"Fair enough," remarked Dick. "I'm a bit puzzled here, though. Working from the little I know about thyristors, I don't seem to remember any applications in which they are meant to become conductive when the voltage across their outside terminals exceeds a certain level."

"You don't meet such applications very often in practice," agreed Smithy. "Normally, a thyristor is employed with voltages across the anode and cathode which are much lower than the breakover voltage. However, when explaining the functioning of a thyristor, it's convenient to first of all refer to its operation as a two-terminal device, because this helps you understand the way in which it functions when it appears, in its usual form, as a three-terminal device."

"Ah," said Dick, his interest mounting. "That sounds a bit more like it."

"The third terminal," said Smithy, "is known as the 'gate', and it connects to the p. layer near the cathode end."

Smithy added a line in the sand to the four-layer device he had already traced out. (Fig. 4(a).)

"Let's think," he continued, "in terms of the two transistors which make up the device. Let us say that the voltage applied to the anode and cathode is below breakover level, whereupon the two transistors don't have sufficient current gain to turn the device on and make it conductive. The only current which passes under these conditions is a low leakage current. Now, see if you can tell me what happens if we next apply, via a limiting resistor, a current to the gate which is obtained from a voltage source that is positive with respect to the cathode." (Figs. 4(b) and (c).)

Dick contemplated this circumstance.

"Well," he said musingly, "that gate current will flow in the base-emitter junction of the bottom n.p.n. transistor. Its collector current must then increase. I suppose that this will cause increased base current in the upper p.n.p. transistor, with the result that *that* transistor will also pass increased collector current."

Dick abruptly smote the sand with the flat of his hand. The dog jerked his

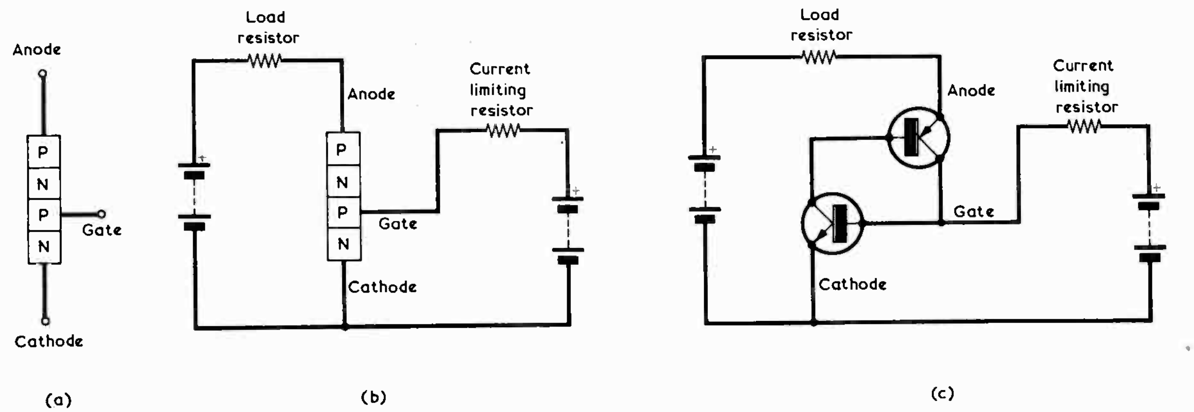



*Fig. 4 (a). The thyristor also incorporates a gate terminal*
*(b). The thryistor is made conductive under the conditions shown here*
*(c). Thyristor operation is easier to visualise if considered in terms of the integral transistors*

head at the sudden sound then settled down again, gazing reproachfully at Smithy's assistant.

"Why, of course," went on Dick excitedly. "What happens is that the gate current causes the thyristor to become conductive in just the same manner as it does when it reaches breakover voltage."

"Exactly," confirmed Smithy. "We know that the thyristor is triggered on at breakover voltage because the leakage current then given is just sufficiently high to enable the transistors in the thyristor to offer the requisite current gain. At voltages below breakover voltage, we can still cause the thyristor to be triggered on, but this time we have to give the transistors a little bit of outside assistance. And this we do by feeding into the gate a current from a source which is positive of the cathode. This makes the bottom n.p.n. transistor pass more collector current and this initiates the whole regenerative action between the two interconnected transistors. The thyristor comes on, and it then stays on even when the gate current is removed. The thyristor can only be turned off again, in the absence of gate current, by reducing the anode-to-cathode current below the holding level. This may be done by removing the supply voltage."

"Would the thyristor also turn off if the anode and cathode were shorted together?"

"It would," agreed Smithy, "provided there was no gate current, of course. If gate current was present, the thyristor would come on again as soon as the short-circuit was removed. This ability to remain turned on is one of the advantages of the thyristor, incidentally, and it is possible for a thyristor to be turned on by a gate pulse which only lasts for a microsecond or even less. There is also a great deal of amplification, too. A thyristor rated at around 25 amps can be turned on by a gate current of only 50mA or so, which represents an effective amplification of – let me see now – 500 times."

## UNIJUNCTION TRANSISTOR

"Not bad for a power device," commented Dick.

"Not bad at all," agreed Smithy. "And that tells you how a thyristor works, whereupon I can next turn to the programmable unijunction transistor which started this whole business off. Before leaving the thyristor, though, I'd better just mention that its circuit symbol consists of a conventional diode symbol with a sloping line coming out of the cathode line. That sloping line represents the gate connection." (Fig.5.)

"Right," said Dick briskly, "let's carry on to the p.u.t. then."

Now that he had completed his dissertation on the thyristor, Smithy momentarily turned his gaze towards

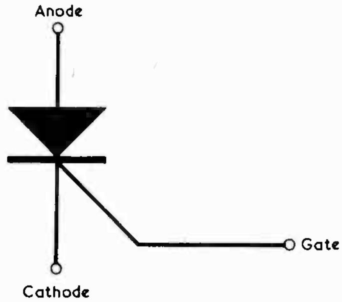



*Fig. 5. Circuit symbol for a thyristor*

the dog, which was still settled comfortably with his head on the Serviceman's thigh. The dog looked back at him with melting, beseeching eyes.

"The poor thing," said Smithy compassionately, "he must be starving."

"*He's* not starving," pronounced Dick contemptuously. "Dash it all, Smithy, can't you see you're being taken? That's no ordinary hound, that's a con-dog!"

But Smithy's heart was moved and he took another paper package from the hold-all. He unwrapped this, to reveal a large piece of fruit cake which he passed over to the dog. The dog wolfed it down in three gulps.

"Ye gods," commented Dick, glancing venomously at the dog. "That cake hardly touched the sides at all. At any event, I see you gave it a bit of your own food this time."

"I don't know whose food it was," said Smithy absently, as he stroked the dog's back. "I didn't bring any cake myself."

"Blow me," raged Dick, as realisation came flooding in, "you've given that voracious flea-bag *my* cake."

But Smithy was luxuriating in the inner content of one who, at no cost whatsoever to himself, has perpetrated a Good Work.

"Tut, tut," he remarked, blandly ignoring his assistant's complaints. "Let's press on to the p.u.t. now."

Leaning over, he traced out on the sand another rectangle with four sections, Fig. 6(a).)

"Now this," he remarked, "shows the basic make-up of the programmable unijunction transistor. It's almost identical to the thyristor and it has anode and cathode connections at the same ends. The only difference is that the gate connection now goes to the n. section next to the anode instead of to the p. section next to the cathode, as with the thyristor."

"Can you," asked Dick, forgetting for the moment the deprivation of his food supplies by the do-gooding Serviceman, "think in terms of two transistors, as with the thyristor?" (Fig. 6(b).)

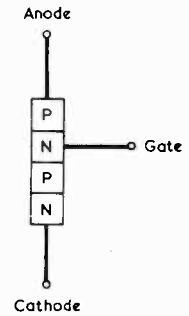
"You can," confirmed Smithy.

"Then," said Dick slowly, "I suppose you turn the p.u.t. on by making its gate go negative. This will increase the base current in the upper p.n.p. transistor, whereupon this transistor will have an increased collector current, thereby turning on the lower n.p.n. transistor, and so on."

"That's the general idea," confirmed Smithy. "The device will come on when the gate is sufficiently negative of the anode to cause the p.n.p. transistor, and hence the n.p.n. transistor, to go into the regenerative condition. Once the device has triggered it stays turned on, in the same way as a thyristor stays turned on."

"Why," asked Dick, "is it called a programmable unijunction transistor?"

"Because it replaces the ordinary unijunction transistor in relaxation oscillator circuits and in similar applications," replied Smithy. "Actually, it's rather a pity that the word 'unijunction' has been chosen to describe it, because its internal operation is quite different from that of a standard unijunction transistor. The 'programmable' bit arises from the fact that you can use external components to 'program' the voltage at which it fires."

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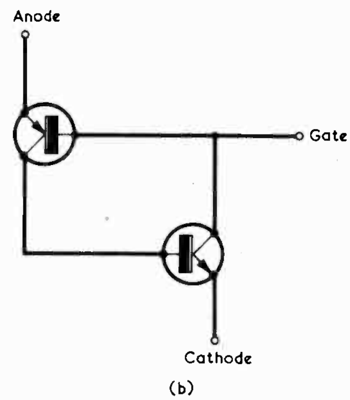


(b)

*Fig. 6 (a). Basic structure of a programmable unijunction transistor*
*(b). The programmable unijunction transistor has the gate connection made to the base of the internal p.n.p. transistor*

"Thank you very much," said Dick sarcastically, "I know as much now as I did before I asked that last question!"

Smithy glanced irately at his assistant.

"I'll try and explain it in a bit more detail then," he stated irritably. "Let's smooth up this sand a bit."

Smithy brushed his hand over the sand until he had a flat even surface. Subconsciously, he noted that the sounds of the swimmers in the sea had become much closer. Carefully, he traced out a simple diagram with his finger. (Fig. 7.)

"This," he remarked, "is the standard unijunction oscillator circuit. The material between the base 1 and the base 2 is n-type silicon and the emitter consists of a p-type spot about a third, say, of the way up the base material. When the supply is switched on the capacitor is discharged, and the n-type silicon acts like a resistor. The capacitor begins to charge via the resistor above it until the voltage on its upper plate is sufficient to cause the p.n. junction given by the emitter and the n-type silicon with which it is in contact to become conductive. There is then a negative resistance effect which causes the capacitor to discharge rapidly into the resistor connected between the base 1 and the negative supply rail. The negative resistance effect ceases when the capacitor is nearly fully discharged, and the transistor reverts to its previous condition. The capacitor then commences to charge up once more until the voltage on its upper plate is at triggering level. The transistor once more exhibits the negative resistance effect and the capacitor again discharges rapidly into the resistor connected to base 1. This process continues indefinitely and results in a series of positive-going pulses across the base 1 resistor."

"That seems simple enough," commented Dick. "What's the snag with an oscillator circuit of this nature?"

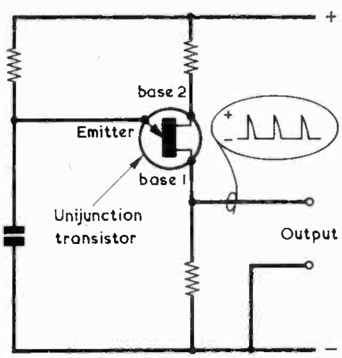


*Fig. 7. A unijunction transistor relaxation oscillator*

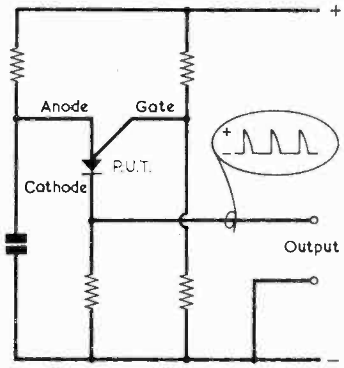


*Fig. 8. A p.u.t. relaxation oscillator*

"The snag," replied Smithy, "is that the emitter potential at which the device triggers depends upon the physical positioning of the p-type emitter along the n-type base material. Before triggering takes place the latter acts like a resistive potential divider, so that the voltage at the point where the emitter is located must obviously depend upon its physical position. Unfortunately, it is difficult to manufacture unijunction transistors with precise positioning of the emitter, with the result that different unijunction transistors of the same type number can have varying trigger voltages."

"I see," said Dick thoughtfully. "I should imagine that this could be a nuisance with mass-produced assemblies incorporating unijunction transistors."

"Exactly," concurred Smithy. "And this is where the p.u.t. scores. It's used in a relaxation oscillator circuit which is nearly as simple as that for the unijunction transistor."

He smoothed over the sand once more, and traced out another circuit. (Fig. 8.)

"There we are," he remarked. "As you can see, the circuit symbol for a p.u.t. is that for a diode plus a sloping gate line which, this time, comes out of the anode section. Now, we said just now that we turn the p.u.t. on by causing the gate to go negative with respect to the anode. When the p.u.t. is used in a relaxation oscillator we cause it to turn on by keeping the gate at a fixed potential and taking the anode *positive* of the gate. This is, of course, the same thing expressed in a different way. In this oscillator circuit, the gate potential is decided by the two resistors which couple it between the positive and negative supply rails. The capacitor is discharged until the supply is switched on, after which it commences to charge, taking the anode of the p.u.t. positive. When the anode passes the potential of the gate a gate current commences to flow, and when this is high enough the device becomes triggered and turns on, causing the

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capacitor to discharge into the resistor between the cathode and the negative rail. When the voltage across the capacitor is sufficiently low the device turns off again, allowing the capacitor to charge and another cycle to commence. A series of positive-going pulses is then given across the cathode resistor."

"That's knobby," said Dick. "I suppose you can fix the gate voltage at any level you like within reason by giving suitable values to the two resistors which connect to it."

"That's correct," stated Smithy, "and that's where the p.u.t. has the edge over the unijunction transistor. Since the gate and the anode form a silicon junction the device fires when the anode is about 0.6 volt positive of the gate. The minimum gate current required to cause firing, the 'peak-point current' as it is called, is of the order of microamps only. In consequence it becomes possible to have a relaxation oscillator circuit which gives virtually the same frequency with any p.u.t. of the correct type number, since the triggering level is 'programmed' externally by the values of the two gate resistors. You couldn't have the same consistency of performance with unijunction transistors."

"What sort of supply voltages are required by p.u.t.'s?"

"Anything from about 4 to 40 volts," replied Smithy. "The p.u.t. is not very fussy in this respect. In the relaxation oscillator circuit I've just shown you, the anode resistor and the two gate resistors could all be 100kΩ each, and the cathode resistor could be 100Ω. The capacitor could have a value of around 0.05μF, this being altered for different frequencies of oscillation. A supply of 9 volts would be suitable."

"I don't," remarked Dick, "seem to have seen many p.u.t.'s on the home-constructor market yet."

"That's because they're fairly new," replied Smithy. "But they should be appearing in some profusion pretty soon, whereupon you'll be well primed up on how they work."

## VISITING CARD

The sounds from the bathers in the sea were very close now. The dog nuzzled his nose into Smithy's side and gave a little whine.

"We haven't forgotten you," chuckled Smithy. "Here, let's see what else we can find for you."

He fished into the hold-all bag and produced another paper bag. He extracted two sausage rolls and passed them to the dog, who devoured them almost instantly.

"Corluvaduk," fumed Dick as Smithy lay back again. "Those sausage rolls were *mine*. That blasted mutt has eaten pretty well all my lunch!"

The dog, sensing perhaps that the chance of further offerings was low, rose to its feet and shook himself vigorously to get rid of the sand on his body. Smithy turned over to face his infuriated assistant. The latter scowled thunderously at him then, for no apparent reason, his expression changed first to wonderment and then to almost hysterical jubilation.

Smithy felt a warm stream flowing down his back.

He sat up abruptly and the dog, once more in a state of equilibrium with all its four paws properly on the ground, scampered away out of sight across the beach.

"Well, that's gratitude for you, I must say," snorted Smithy angrily. "After all the scoff I gave him, too!"

"He's left a marker on you for the benefit of his mates," chortled Dick, almost delirious with laughter. "It's like those signs that tramps leave outside houses where they're given cups of tea. As soon as any of his mates have a sniff at you they'll say to themselves: 'Ah, here's a right generous twit so far as scrounging food is concerned'."

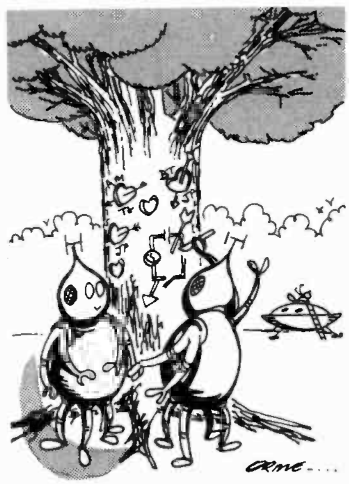
Dick subsided into helpless giggles which abruptly changed to a smothered gasp when the pair of them were soaked by an outsize wave from the hitherto unnoticed incoming sea.

"Quick," yelled Smithy, "get the clothes!"

They picked up their clothes and rushed further up the beach where, panting, they watched the advancing sea. They were on a relatively flat section of the bay and the water moved in at a correspondingly swift rate. It was then that Smithy noticed that they had forgotten the hold-all bag with the food and the precious containers of tea.

Smithy strode into the water and reclaimed the bag which, apart from the thermos flasks, contained food that was completely soaked and uneatable. After which he walked back into the sea again for a very long and fully immersed bathe.

In the circumstances there wasn't much else he could profitably do. ■



# Radio Topics

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THERE CAN BE FEW PURSUITS WHICH offer such a wide variety of techniques and end-results as does the construction of radio and electronic equipment. Let's just have a look at the fantastic range which is at our disposal.

### TECHNIQUES

The methods of construction themselves are quite diverse. We can, for instance, build all our projects on sturdy metal chassis, using tagboards and tagstrips for connections. Or we can make up our own printed circuit boards and mount our components on these. Or we can use Veroboard. Or we can use plain perforated board with turret tags. Or, for temporary items, we can use S-DeC. So far as metalwork is involved this can be as extensive as we care to make it, or it can be reduced to the minimum by employing Lektrokit and any of the many ready-made metal boxes that are nowadays available in various sizes.

Projects? Here, receivers and amplifiers are among the most popular. Making one's own test gear is another favourite with many constructors. So far as gadgets and electronic devices are concerned, the field is wide open indeed. Simple logic circuits form an engrossing subject, as also do devices which function in relation to time, such as metronomes, process timers and units which switch a piece of equipment on or off after a long delay. Light-operated circuits can offer both amusement and practical usage, as also can sound-operated units. Electronic musical instruments can be completely absorbing, as also can items of equipment which modify musical sound signals. And we haven't yet caught up with tape recording, for which the constructor may make up simple accessories or, even, complete recorder units.

Interested in short wave listening? Then you can build your own receiver or, if using one that is ready-made, knock up aerial tuning units and other ancillary gear in addition to playing around with the aerial system itself. Or you can indulge in hi-fi and the pleasures of music that is really well reproduced. Then, again, there are such interests as radio control of models, amateur transmitting, power supply design and electronic robots.

### ACTIVE COMPONENTS

When we come to think of active components we once more encounter a very wide choice. It is instructive here to look upon these from the historical point of view.

The older amongst us bit our constructional teeth on valves. Cumbersome as they are, both with regards to size and power requirements, you can do no end of things with valves. Valves have the advantage of *simplicity:* you apply a voltage change to a high impedance grid and get a corresponding current change at the valve anode. I know that transistors are simple, too, but transistors don't seem to have the almost baby-faced type of simplicity that valves have. Quite a few constructors still like to make up valve equipment and there is no reason why they shouldn't continue to do so with complete success. The only real snags with valves are the heating-up time, the relatively heavy current requirements, the bulk and the fact that they are not as long-lived as transistors.

Another old-timer which won't lie down is the relay. Making up relay circuits is quite an art in itself, as anyone who has had experience of these will at once agree. The relay has the exceptional advantage that the current which operates it is completely remote from the circuits into which its contact set or contact sets connect. Relays have been doing logic operations for very many years now, and they still continue to do so. In its most modern form the relay appears, of course, in the form of the dry reed relay, which has its contacts hermetically sealed to prevent oxidation.

Whereupon we next come to the transistor. Nobody can say that there isn't a wide variety here! The transistor types available from the different manufacturers run into many tens of thousands. And from these we can select a.f. transistors, r.f. transistors, power transistors, switching transistors f.e.t.'s, m.o.s.f.e.t.'s and so on. Further semiconductor devices, such as light-emitting diodes, varactors, thyristors, triacs, and many more, continue to come to mind. After which we pass on to integrated circuits . . . .

Need I say more? All of this rich diversity undeniably makes our hobby one of the most rewarding, both in terms of interest and of achievement, that could ever have been devised.

### SOLDERING IRON TIP

Finally, a little dodge for those who like to have a soldering iron quickly available, but who may work for long periods without actually using it. The idea I'm going to describe isn't new, but I haven't seen any references to it for quite a long time and so it should be worth bringing up again.

If a soldering iron is left switched on and unused for a long time, it is liable to overheat a little. Also, it suffers a corresponding shortening of its useful life.

The dodge consists of running the iron at half-power when it is not required, whereupon it remains just below operating temperature. On being switched to full power it achieves operating temperature very quickly. The half-power condition is achieved by inserting a silicon rectifier in series with one of its leads, together with a switch across this rectifier. When the switch is open the rectifier allows only alternate half-cycles to pass to the iron, thereby giving the half-power condition. When the switch is closed, full power is applied to the iron.

The switch may be fitted on the bench near the mains socket for the iron. If a wall-mounting switch is used, there may well be sufficient room inside it to take the rectifier. The latter can be any small type capable of passing the iron current and having a p.i.v. of 400 or more. A 1N4004 would be a good choice. ■


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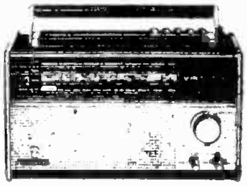

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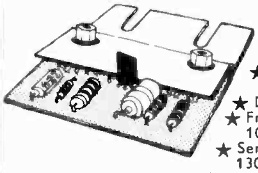

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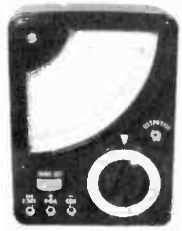

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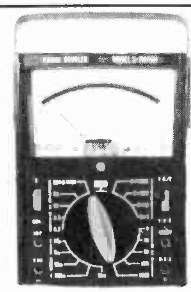

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|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7,960 | 5,030 | 3,180 | 2,520 | 1,590 | 1,010 | 796 | 503 | 318 | 159 |
| 1.5 | 6,500 | 4,110 | 2,600 | 2,050 | 1,300 | 822 | 650 | 411 | 260 | 130 |
| 2 | 5,630 | 3,560 | 2,250 | 1,780 | 1,130 | 712 | 563 | 356 | 224 | 113 |
| 2.5 | 5,030 | 3,180 | 2,010 | 1,590 | 1,010 | 637 | 503 | 318 | 201 | 101 |
| 3 | 4,600 | 2,910 | 1,840 | 1,450 | 919 | 582 | 460 | 291 | 184 | 91.9 |
| 3.5 | 4,250 | 2,690 | 1,700 | 1,350 | 851 | 538 | 425 | 269 | 170 | 85.1 |
| 4 | 3,980 | 2,520 | 1,590 | 1,260 | 796 | 503 | 398 | 252 | 159 | 79.6 |
| 4.5 | 3,750 | 2,370 | 1,500 | 1,190 | 750 | 475 | 375 | 237 | 150 | 75.1 |
| 5 | 3,560 | 2,250 | 1,420 | 1,130 | 712 | 450 | 356 | 225 | 142 | 71.2 |
| 5.5 | 3,390 | 2,150 | 1,360 | 1,070 | 679 | 429 | 339 | 215 | 136 | 67.9 |
| 6 | 3,250 | 2,010 | 1,300 | 1,000 | 650 | 402 | 325 | 201 | 130 | 65.0 |
| 6.5 | 3,120 | 1,980 | 1,250 | 988 | 625 | 395 | 312 | 198 | 125 | 62.5 |
| 7 | 3,010 | 1,900 | 1,200 | 952 | 602 | 380 | 301 | 190 | 120 | 60.2 |
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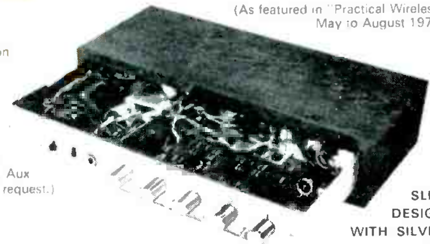

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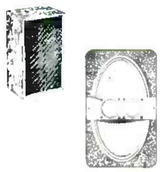

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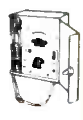

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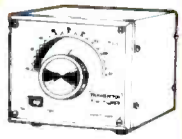

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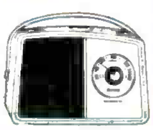

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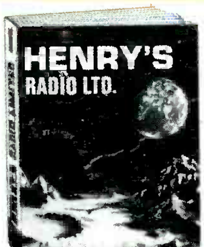


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