# RADIO & ELECTRONICS CONSTRUCTOR

Vol. 26 No. 12 JULY 1973 20p


## MINIATURE 3 CHANNEL MIXER


**ALSO FEATURED**

CASSETTE RECORDER MAINS UNIT

INDEX VOLUME 26 August 1972 - July 1973

# BI-PRE-PAK

## SUPPLIERS OF SEMI-CONDUCTORS TO THE WORLD

**COMPLETE TELEPHONES**

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### TESTED AND GUARANTEED PAKS

| | | | |
|---|---|---|---|
| B79 | 4 | IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic | 55p |
| B81 | 10 | Reed Switches. 1" long. ⅛" dia. High speed P.O. type | 55p |
| B99 | 200 | Mixed Capacitors. Approx. quantity, counted by weight | 55p |
| H4 | 250 | Mixed Resistors. Approx. quantity counted by weight | 55p |
| H7 | 40 | Wirewound Resistors, Mixed types and values. | 55p |
| H9 | 2 | OCP71 Light Sensitive Photo Transistor | 55p |
| H28 | 20 | OC200/1/2/3 PNP Silicon uncoded TO-5 can | 55p |
| H30 | 20 | 1 Watt Zener Diodes. Mixed Voltages 6.8–43V. | 55p |
| H35 | 100 | Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked. | 55p |
| H38 | 30 | Short lead Transistors. NPN Silicon Planar types. | 55p |
| H39 | 10 | Integrated Circuits. 6 Gates BMC 962, 4 Flip Flops BMC 945 | 55p |
| H40 | 20 | BFY50/2. 2N696, 2N1613 NPN Silicon uncoded TO-5 | 55p |
| H41 | 2 | Sil Power transistors comp pair BD131 132 | 55p |

### UNMARKED UNTESTED PAKS

| | | | |
|---|---|---|---|
| B66 | 150 | Germanium Diodes Min. glass type | 55p |
| B83 | 200 | Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ. | 55p |
| B84 | 100 | Silicon Diodes DO-7 glass equiv. to OA200, OA202 | 55p |
| B86 | 100 | Sil. Diodes sub. min. IN914 and IN916 types | 55p |
| B88 | 50 | Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc. | 55p |
| B1 | 50 | Germanium Transistors PNP, AF and RF | 55p |
| H6 | 40 | 250mW. Zener Diodes DO-7 Min. Glass Type | 55p |
| H17 | 20 | 3 amp. Silicon Stud Rectifiers mixed volts | 55p |
| H15 | 30 | Top Hat Silicon Rectifiers. 750mA. Mixed volts | 55p |
| H16 | 15 | Experimenters' Pak of Integrated Circuits. Data supplied | 55p |
| H20 | 20 | BY126/7 Type Silicon Rectifiers 1 amp plastic. Mixed volts. | 55p |
| H34 | 15 | Power Transistors, PNP, Germ. NPN Silicon TO-3 Can. | 55p |

### MAKE A REV COUNTER FOR YOUR CAR

The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

**£1.10 each**

OVER

## 1,000,000

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We hold a very large range of fully marked. tested and guaranteed transistors, power transistors, diodes and rectifiers at very competitive prices. Please send for free catalogue.

**600,000** Silicon planar plastic transistors. Unmarked, untested, factory clearance. A random sampling showed these to be of remarkably high quality.

Audio PNP, similar to ZTX500, 2N3702 3, BCY70 etc.
Audio NPN, similar to ZTX300, 2N3708/9, BC107 8 9, BC168 9 etc.
Please state Audio NPN or Audio PNP when ordering.
ALL AT 500 for £3.30; 1,000 for £5.50, 10,000 for £44
P. & P. 11p 1,000

### OUR VERY POPULAR 4p TRANSISTORS

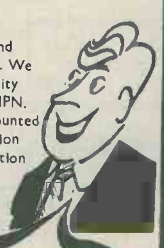
TYPE "A" PNP Silicon alloy, TO-5 can.
TYPE "B" PNP Silicon, plastic encapsulation.
TYPE "E" PNP Germanium AF or RF.
TYPE "F" NPN Silicon plastic encapsulation.
TYPE "G" NPN Silicon similar ZTX 300 range
TYPE "H" PNP Silicon similar ZTX 500 range

**8** RELAYS FOR VARIOUS TYPES P & P 27½p **£1.10**

**Our famous PI Pak is still leading in value for money.**

Full of Short Lead Semiconductors and Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN. and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

Please ask for Pak P.1. Only 55p
11p P & P on this Pak.



### A CROSS HATCH GENERATOR FOR £3.85 ! ! !

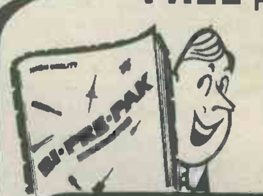
YES, a complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. This is a project in the September edition of Television.

*This complete kit of parts costs £3.85, post paid.*

A MUST for Colour T.V. Alignment.

### STEREO DECODER £4.95

A ready built unit, ready for connection to the I.F. stages of your existing FM Radio or Tuner Unit. A tell-tale light can be connected to show the presence of a Stereo transmission and correct operation of the Unit.
The Unit is in the form of a small printed circuit, and no further alignment is necessary, as all preset adjustments have already been carried out at the factory.
It is recommended that a L.E.D. is used as the indicating light and a suitable device is available from us at 36½p.
Supplied with necessary instructions and written guarantee.





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TRANSISTORS, RECTIFIERS, DIODES, INTEGRATED CIRCUITS, FULL PRE-PAK LISTS

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Plastic Power Transistors in stock, more on way!

### NOW IN TWO RANGES

There are 40W and 90W Silicon Plastic Power. Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

Range 1. VCE. Min. 15. HFE Min 15.

| | 1–12 | 13–25 | 26–50 |
|---|---|---|---|
| 40 Watt | 22p | 20p | 18p |
| 90 Watt | 26½p | 24½p | 22p |

Range 2. VCE. Min 40. HFE Min 40.

| | 1–12 | 13–25 | 26–50 |
|---|---|---|---|
| 40 Watt | 33p | 31p | 29p |
| 90 Watt | 38½p | 36½p | 33p |

Complementary pairs matched for gain at 3 amps. 11p extra per pair. Please state NPN or PNP on order.

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We stock a large range of I.Cs at very competitive prices (from 11p each). These are all listed in our FREE Catalogue, see coupon below.

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## SEMICONDUCTORS

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

| | | | | | |
|---|---|---|---|---|---|
| AC127 | 10p | BC149 | 8p | BFX30 | 25p |
| AC187/8 | 14p | BC157 | 12p | BFX88 | 20p |
| AD149 | 35p | BC158 | 8p | BSV64 | 40p |
| AD161 | 27p | BC159 | 12p | BU105/01 | £1.75 |
| AD162 | 27p | BCY40 | 25p | OC35 | 28p |
| Matched pair | 50p | BCY70 | 14p | 2N706 | 8p |
| AF116 | 12p | BCY71 | 18p | 2N2219 | 19p |
| AF117 | 12p | BD131 | 40p | 2N2401 (ASY26-27) | 15p |
| AF139 | 28p | BD132 | 50p | 2N2904 | 17p |
| AF178 | 40p | BD135 | 26p | 2N2905 | 21p |
| AF180 | 45p | BF115 | 23p | 2N2906 | 15p |
| AF239 | 30p | BF179 | 30p | 2N2907 | 18p |
| BC107/8/9 | 7p | BFY51 | 10p | 2N3055 | 35p |
| BC147 | 8p | BFY52 | 12p | 2N3053 | 15p |
| BC148 | 8p | BFX29 | 25p | | |

### 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 |

### 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

### OTHER DIODES

| | |
|---|---|
| Centercel | 5p |
| IN916 | 6p |
| BA145 | 14p |

### 1 AMP RECTIFIERS

| | | |
|---|---|---|
| IN4002 | 100 volt | 4p |
| IN4003 | 200 volt | 5p |
| IN4004 | 400 volt | 7p |
| IN4005 | 600 volt | 9p |
| IN4006 | 800 volt | 10p |
| IN4007 | 1,000 volt | 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

### TRIACS

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

DIAC BR100 30p

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

### HIGH POWER RECTIFIERS

| | Amp | Volt | |
|---|---|---|---|
| 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*

### PHOTO SILICON CONTROLLED SWITCH

BPX66 PNPN 10 amp .. £1

### 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 |

### PAPER BLOCK CONDENSER

| | | |
|---|---|---|
| 0.25MFD | 800 volt | 30p |
| 1MFD | 400 volt | 15p |
| 2MFD | 250 volt | 20p |
| 2MFD | 1.5 kv | 50p |
| 15MFD | 150 volt | 25p |

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### WIREWOUND SLIDER

150 Ohm, 250 Ohm 5K 4p each

### INDICATORS

12 volt red or mains neon amber, push fit round, chrome bezel 15p each

Rotor with neon indicator, as used in Seafarer, Pacific, Fairway depth finders 20p each

100MFD 250/275V electrolytic can 20p

### DEE PLUG

McMurdo DA15P 15 way chassis plug 20p

Fairway 18009 Coax. socket .. 5p

### TIE CLIPS

Nylon self locking 3½" 1p; 7" 2p

### CINCH 150

12 way edge socket 10p

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

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 .. 20p

U.E.C.L. 20 way pin connector 2A60000A1P20 30p

U.E.C.L. 10 way pin socket 2B606001R10 20p

U.E.C.L. 20 way pin socket B260800A1R20 30p

BELLING LEE L1354 TV Aerial diplexer 10p

### TESTED UNMARKED OR MARKED AMPLE LEAD EX NEW EQUIPMENT

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

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

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE
LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.
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# THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

*Cut these 3 pages out and keep for reference*

## BRAND NEW FULLY GUARANTEED DEVICES

| | |
|---|---|
| AC 107 | 22p |
| AC 113 | 22p |
| AC 115 | 25½p |
| AC 117K | 22p |
| AC 122 | 13p |
| AC 125 | 18½p |
| AC 126 | 18½p |
| AC 127 | 18½p |
| AC 128 | 18½p |
| AC 132 | 15½p |
| AC 134 | 15½p |
| AC 137 | 15½p |
| AC 141 | 15½p |
| AC 141K | 18½p |
| AC 142 | 15½p |
| AC 142K | 18½p |
| AC 151 | 16½p |
| AC 154 | 22p |
| AC 155 | 22p |
| AC 156 | 22p |
| AC 157 | 26½p |
| AC 165 | 22p |
| AC 166 | 22p |
| AC 167 | 22p |
| AC 168 | 26½p |
| AC 169 | 15½p |
| AC 176 | 22p |
| AC 177 | 26½p |
| AC 178 | 31p |
| AC 179 | 31p |
| AC 180 | 18½p |
| AC 180K | 22p |
| AC 181 | 18½p |
| AC 181K | 22p |
| AC 187 | 24p |
| AC 187K | 22p |
| AC 188 | 24p |
| AC 188K | 22p |
| ACY 17 | 27½p |
| ACY 18 | 22p |
| ACY 19 | 22p |
| ACY 20 | 22p |
| ACY 21 | 22p |
| ACY 22 | 17½p |
| ACY 27 | 19½p |
| ACY 28 | 21p |
| ACY 29 | 38½p |
| ACY 30 | 31p |
| ACY 31 | 31p |
| ACY 34 | 23p |
| ACY 35 | 23p |
| ACY 36 | 31p |
| ACY 40 | 18½p |
| ACY 41 | 19½p |
| ACY 44 | 38½p |
| AD 130 | 42p |
| AD 140 | 53p |
| AD 142 | 53p |
| AD 143 | 42p |

| | |
|---|---|
| AD 149 | 55p |
| AD 161 | 36½p |
| AD 162 | 36½p |
| AD 161 and | |
| AD 162(MP) | 60½p |
| ADT 140 | 55p |
| AF 114 | 26½p |
| AF 115 | 26½p |
| AF 116 | 26½p |
| AF 117 | 26½p |
| AF 118 | 38½p |
| AF 124 | 33p |
| AF 125 | 27½p |
| AF 126 | 31p |
| AF 127 | 31p |
| AF 139 | 33p |
| AF 178 | 55p |
| AF 179 | 55p |
| AF 180 | 55p |
| AF 181 | 49½p |
| AF 186 | 49½p |
| AF 239 | 40½p |
| AL 102 | 71½p |
| AL 103 | 71½p |
| ASY 26 | 27½p |
| ASY 27 | 33p |
| ASY 28 | 27½p |
| ASY 29 | 27½p |
| ASY 50 | 27½p |
| ASY 51 | 27½p |
| ASY 52 | 27½p |
| ASY 54 | 27½p |
| ASY 55 | 27½p |
| ASY 56 | 27½p |
| ASY 57 | 27½p |
| ASY 58 | 27½p |
| ASZ 21 | 44p |
| BC 107 | 10p |
| BC 108 | 10p |
| BC 109 | 11p |
| BC 113 | 11p |
| BC 114 | 16½p |
| BC 115 | 16½p |
| BC 116 | 16½p |
| BC 117 | 16½p |
| BC 118 | 11p |
| BC 119 | 33p |
| BC 120 | 88p |
| BC 125 | 13p |
| BC 126 | 20p |
| BC 132 | 13p |
| BC 134 | 20p |
| BC 135 | 13p |
| BC 136 | 16½p |
| BC 137 | 16½p |
| BC 139 | 44p |
| BC 140 | 33p |
| BC 141 | 33p |
| BC 142 | 33p |

| | |
|---|---|
| BC 143 | 33p |
| BC 145 | 49½p |
| BC 147 | 11p |
| BC 148 | 11p |
| BC 149 | 13p |
| BC 150 | 20p |
| BC 151 | 22p |
| BC 152 | 18½p |
| BC 153 | 31p |
| BC 154 | 33p |
| BC 157 | 20p |
| BC 158 | 13p |
| BC 159 | 13p |
| BC 160 | 49½p |
| BC 161 | 55p |
| BC 167 | 13p |
| BC 168 | 13p |
| BC 169 | 13p |
| BC 170 | 13p |
| BC 171 | 15½p |
| BC 172 | 15½p |
| BC 173 | 15½p |
| BC 174 | 15½p |
| BC 175 | 24p |
| BC 177 | 21p |
| BC 178 | 21p |
| BC 179 | 21p |
| BC 180 | 26½p |
| BC 181 | 26½p |
| BC 182 | 11p |
| BC 182L | 11p |
| BC 183 | 11p |
| BC 183L | 11p |
| BC 184 | 13p |
| BC 184L | 13p |
| BC 186 | 31p |
| BC 187 | 31p |
| BC 207 | 12p |
| BC 208 | 12p |
| BC 209 | 13p |
| BC 212L | 12p |
| BC 213L | 12p |
| BC 214L | 15½p |
| BC 225 | 27½p |
| BC 226 | 38½p |
| BCY 30 | 26½p |
| BCY 31 | 28½p |
| BCY 32 | 33p |
| BCY 33 | 24p |
| BCY 34 | 27½p |
| BCY 70 | 15½p |
| BCY 71 | 20p |
| BCY 72 | 15½p |
| BCZ 10 | 22p |
| BCZ 11 | 27½p |
| BCZ 12 | 27½p |
| BD 121 | 66p |
| BD 123 | 71½p |
| BD 124 | 66p |

| | |
|---|---|
| BD 131 | 55p |
| BD 132 | 66p |
| BD 133 | 71½p |
| BD 135 | 44p |
| BD 136 | 44p |
| BD 137 | 49½p |
| BD 138 | 55p |
| BD 139 | 60½p |
| BD 140 | 66p |
| BD 155 | 88p |
| BD 175 | 66p |
| BD 176 | 66p |
| BD 177 | 71½p |
| BD 178 | 71½p |
| BD 179 | 77p |
| BD 180 | 77p |
| BD 185 | 71½p |
| BD 186 | 71½p |
| BD 187 | 77p |
| BD 188 | 77p |
| BD 189 | 82½p |
| BD 190 | 82½p |
| BD 195 | 93½p |
| BD 196 | 93½p |
| BD 197 | 99p |
| BD 198 | 99p |
| BD 199 | £1.04½ |
| BD 200 | £1.04½ |
| BD 205 | 88p |
| BD 206 | 88p |
| BD 207 | £1.04½ |
| BD 208 | £1.04½ |
| BDY 20 | £1.10 |
| BF 115 | 26½p |
| BF 117 | 49½p |
| BF 118 | 77p |
| BF 119 | 77p |
| BF 121 | 49½p |
| BF 123 | 55p |
| BF 125 | 49½p |
| BF 127 | 55p |
| BF 152 | 60½p |
| BF 153 | 49½p |
| BF 154 | 49½p |
| BF 155 | 77p |
| BF 156 | 53p |
| BF 157 | 60½p |
| BF 158 | 60½p |
| BF 159 | 66p |
| BF 160 | 44p |
| BF 162 | 44p |
| BF 163 | 44p |
| BF 164 | 44p |
| BF 165 | 44p |
| BF 167 | 24p |
| BF 173 | 24p |
| BF 176 | 38½p |
| BF 177 | 38½p |
| BF 178 | 33p |

| | |
|---|---|
| BF 179 | 33p |
| BF 180 | 33p |
| BF 181 | 33p |
| BF 182 | 44p |
| BF 183 | 44p |
| BF 184 | 27½p |
| BF 185 | 33p |
| BF 188 | 44p |
| BF 194 | 13p |
| BF 195 | 13p |
| BF 196 | 15½p |
| BF 197 | 15½p |
| BF 200 | 49½p |
| BF 222 | £1.04½ |
| BF 257 | 49½p |
| BF 258 | 66p |
| BF 259 | 93½p |
| BF 262 | 60½p |
| BF 263 | 60½p |
| BF 270 | 38½p |
| BF 271 | 33p |
| BF 272 | 88p |
| BF 273 | 38½p |
| BF 274 | 38½p |
| BFW 10 | 66p |
| BFX 29 | 30p |
| BFX 84 | 24p |
| BFX 85 | 33p |
| BFX 86 | 24p |
| BFX 87 | 26½p |
| BFX 88 | 24p |
| BFY 50 | 22p |
| BFY 51 | 22p |
| BFY 52 | 22p |
| BFY 53 | 18½p |
| BPX 25 | 93½p |
| BSX 19 | 16½p |
| BSX 20 | 16½p |
| BSY 25 | 16½p |
| BSY 26 | 16½p |
| BSY 27 | 16½p |
| BSY 28 | 16½p |
| BSY 29 | 16½p |
| BSY 38 | 20p |
| BSY 39 | 20p |
| BSY 40 | 31p |
| BSY 41 | 31p |
| BSY 95 | 14p |
| BSY 95A | 14p |
| Bu 105 | £2.20 |
| C 111E | 55p |
| C 400 | 33p |
| C 407 | 27½p |
| C 424 | 22p |
| C 425 | 55p |
| C 426 | 38½p |
| C 428 | 22p |
| C 441 | 33p |
| C 442 | 33p |

| | |
|---|---|
| C 444 | 38½p |
| C 450 | 24p |
| MAT 100 | 21p |
| MAT 101 | 22p |
| MAT 120 | 21p |
| MAT 121 | 22p |
| MPF 102 | 46p |
| MPF 104 | 40½p |
| MPF 105 | 40½p |
| OC 19 | 38½p |
| OC 20 | 69½p |
| OC 22 | 42p |
| OC 23 | 46p |
| OC 24 | 61½p |
| OC 25 | 42p |
| OC 26 | 27½p |
| OC 28 | 55p |
| OC 29 | 55p |
| OC 35 | 46p |
| OC 36 | 55p |
| OC 41 | 22p |
| OC 42 | 26½p |
| OC 44 | 16½p |
| OC 45 | 14p |
| OC 70 | 11p |
| OC 71 | 11p |
| OC 72 | 15½p |
| OC 74 | 15½p |
| OC 75 | 16½p |
| OC 76 | 16½p |
| OC 77 | 27½p |
| OC 81 | 16½p |
| OC 81D | 16½p |
| OC 82 | 16½p |
| OC 82D | 16½p |
| OC 83 | 22p |
| OC 84 | 22p |
| OC 139 | 22p |
| OC 140 | 22p |
| OC 169 | 27½p |
| OC 170 | 27½p |
| OC 171 | 27½p |
| OC 200 | 27½p |
| OC 201 | 31p |
| OC 202 | 31p |
| OC 203 | 27½p |
| OC 204 | 27½p |
| OC 205 | 38½p |
| OC 309 | 44p |
| P 346A | 47½p |
| P 397 | 47½p |
| OCP 71 | 44p |
| ORP 12 | 44p |
| ORP 60 | 22p |
| ORP 61 | 46p |
| ST 140 | 14p |
| ST 141 | 18½p |
| TIS 43 | 33p |
| UT 46 | 30p |

| | |
|---|---|
| 2G 301 | 21p |
| 2G 302 | 21p |
| 2G 303 | 21p |
| 2G 304 | 26½p |
| 2G 306 | 44p |
| 2G 308 | 38½p |
| 2G 309 | 38½p |
| 2G 339 | 22p |
| 2G 339A | 17½p |
| 2G 344 | 20p |
| 2G 345 | 17½p |
| 2G 371 | 17½p |
| 2G 371B | 13p |
| 2G 373 | 18½p |
| 2G 374 | 18½p |
| 2G 377 | 33p |
| 2G 378 | 17½p |
| 2G 381 | 17½p |
| 2G 382 | 17½p |
| 2G 401 | 33p |
| 2G 414 | 33p |
| 2G 417 | 27½p |
| 2N 388 | 38½p |
| 2N 388A | 60½p |
| 2N 404 | 22p |
| 2N 404A | 31p |
| 2N 524 | 46p |
| 2N 527 | 54p |
| 2N 598 | 46p |
| 2N 599 | 49½p |
| 2N 696 | 14p |
| 2N 697 | 14½p |
| 2N 698 | 26½p |
| 2N 699 | 38½p |
| 2N 706 | 9p |
| 2N 706A | 10p |
| 2N 708 | 13p |
| 2N 711 | 33p |
| 2N 717 | 38½p |
| 2N 718 | 26½p |
| 2N 718A | 55p |
| 2N 726 | 31p |
| 2N 727 | 31p |
| 2N 743 | 22p |
| 2N 744 | 22p |
| 2N 914 | 15½p |
| 2N 918 | 33p |
| 2N 929 | 23p |
| 2N 930 | 23p |
| 2N 1131 | 22p |
| 2N 1132 | 24p |
| 2N 1302 | 15½p |
| 2N 1303 | 15½p |
| 2N 1304 | 18½p |
| 2N 1305 | 18½p |
| 2N 1306 | 23p |
| 2N 1307 | 23p |
| 2N 1308 | 25½p |
| 2N 1309 | 25½p |

| | |
|---|---|
| 2N 1613 | 22p |
| 2N 1711 | 22p |
| 2N 1889 | 35p |
| 2N 1890 | 49½p |
| 2N 1893 | 40½p |
| 2N 2147 | 79p |
| 2N 2148 | 62½p |
| 2N 2160 | 66p |
| 2N 2192 | 38½p |
| 2N 2193 | 38½p |
| 2N 2194 | 38½p |
| 2N 2217 | 24p |
| 2N 2218 | 22p |
| 2N 2219 | 22p |
| 2N 2220 | 24p |
| 2N 2221 | 22p |
| 2N 2222 | 22p |
| 2N 2368 | 18½p |
| 2N 2369 | 15½p |
| 2N 2369A | 15½p |
| 2N 2411 | 26½p |
| 2N 2412 | 26½p |
| 2N 2646 | 51½p |
| 2N 2711 | 23p |
| 2N 2712 | 23p |
| 2N 2714 | 23p |
| 2N 2904 | 18½p |
| 2N 2904A | 23p |
| 2N 2905 | 23p |
| 2N 2905A | 23p |
| 2N 2906 | 16½p |
| 2N 2906A | 20p |
| 2N 2907 | 22p |
| 2N 2907A | 24p |
| 2N 2923 | 15½p |
| 2N 2924 | 15½p |
| 2N 2925 | 15½p |
| 2N 2926(G) | 14p |
| 2N 2926(Y) | 12p |
| 2N 2926(O) | 11p |

| | |
|---|---|
| 2N 2926(R) | 11p |
| 2N 2926(B) | 11p |
| 2N 3010 | 77p |
| 2N 3011 | 15½p |
| 2N 3053 | 18½p |
| 2N 3054 | 50½p |
| 2N 3055 | 55p |
| 2N 3391 | 15½p |
| 2N 3391A | 17½p |
| 2N 3392 | 15½p |
| 2N 3395 | 15½p |
| 2N 3394 | 15½p |
| 2N 3395 | 18½p |
| 2N 3402 | 23p |
| 2N 3403 | 23p |
| 2N 3404 | 31p |
| 2N 3405 | 46p |
| 2N 3414 | 16½p |
| 2N 3415 | 16½p |
| 2N 3416 | 31p |
| 2N 3417 | 10p |
| 2N 3525 | 82½p |
| 2N 3646 | 10p |
| 2N 3702 | 11p |
| 2N 3703 | 11p |
| 2N 3704 | 12p |
| 2N 3705 | 11p |
| 2N 3706 | 10p |
| 2N 3707 | 12p |
| 2N 3708 | 7½p |
| 2N 3709 | 10p |
| 2N 3710 | 10p |
| 2N 3711 | 10p |
| 2N 3819 | 31p |
| 2N 3820 | 55p |
| 2N 3821 | 38½p |
| 2N 3823 | 31p |
| 2N 3903 | 31p |
| 2N 3904 | 33p |
| 2N 3905 | 31p |

| | |
|---|---|
| 2N 3906 | 30p |
| 2N 4058 | 13p |
| 2N 4059 | 11p |
| 2N 4060 | 13p |
| 2N 4061 | 13p |
| 2N 4062 | 13p |
| 2N 4284 | 18½p |
| 2N 4285 | 18½p |
| 2N 4286 | 18½p |
| 2N 4287 | 18½p |
| 2N 4288 | 18½p |
| 2N 4289 | 18½p |
| 2N 4290 | 18½p |
| 2N 4291 | 18½p |
| 2N 4292 | 18½p |
| 2N 4293 | 18½p |
| 2N 5172 | 13p |
| 2N 5457 | 35p |
| 2N 5458 | 35p |
| 2N 5459 | 44p |
| 2S 301 | 55p |
| 2S 302A | 46p |
| 2S 302 | 46p |
| 2S 303 | 60½p |
| 2S 304 | 77p |
| 2S 305 | 92½p |
| 2S 306 | 92½p |
| 2S 307 | 92½p |
| 2S 321 | 61½p |
| 2S 322 | 46p |
| 2S 322A | 46p |
| 2S 323 | 61½p |
| 2S 324 | 77p |
| 2S 325 | 77p |
| 2S 326 | 77p |
| 2S 327 | 77p |
| 2S 701 | 46p |
| 40361 | 44p |
| 40362 | 49½p |

## DIODES & RECTIFIERS

| | |
|---|---|
| AA 119 | 9p |
| AA 120 | 9p |
| AA 129 | 9p |
| AAY 30 | 10p |
| AAZ 13 | 11p |
| BA 100 | 11p |
| BA 116 | 23p |
| BA 126 | 24p |
| BA 148 | 15½p |
| BA 154 | 13p |
| BA 155 | 15½p |
| BA 156 | 14½p |
| BY 100 | 16½p |
| BY 101 | 13p |
| BY 105 | 18½p |
| BY 114 | 13p |
| BY 126 | 15½p |
| BY 127 | 16½p |
| BY 128 | 16½p |

| | |
|---|---|
| BY 130 | 17½p |
| BY 133 | 23p |
| BY 164 | 55p |
| BYX 38.30 | 46p |
| BYZ 10 | 38½p |
| BYZ 11 | 33p |
| BYZ 12 | 33p |
| BYZ 13 | 27½p |
| BYZ 16 | 44p |
| BYZ 17 | 38½p |
| BYZ 18 | 38½p |
| BYZ 19 | 31p |
| CG 62 | |
| (Eq) OA 91 | 5½p |
| CG 651 (Eq) | |
| OA 70–OA79 | 6½p |
| OA 5 | 38½p |
| OA 5SL | 23p |
| OA 10 | 38½p |

| | |
|---|---|
| OA 47 | 7½p |
| OA 70 | 7½p |
| OA 79 | 7½p |
| OA 81 | 7½p |
| OA 85 | 10p |
| OA 90 | 6½p |
| OA 91 | 6½p |
| OA 95 | 7½p |
| OA 200 | 6½p |
| OA 202 | 7½p |
| SD 10 | 5½p |
| SD 19 | 5½p |
| IN 34 | 7½p |
| IN 34A | 7½p |
| IN 914 | 6½p |
| IN 916 | 6½p |
| IN 414B | 6½p |
| IS 021 | 11p |
| 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"×7" | 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

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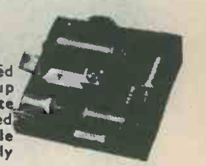
**ONLY 83p each**

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE **Guar. 3 Watts RMS. Module Tested and Guaranteed.**
Qty. 1–9 £2.89 ; 10–25 £2.51. Price each.
Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each module or available separately at 11p each.



## 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

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| 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 | 0.64 | 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 | £4.40 |

## SILICON RECTIFIERS—TESTED

| PIV | 300mA (DO 7) £ | 750mA (SO 16) £ | 1A Plastic £ | 1.5A (SO 16) £ | 3A (SO 10) £ | 10A (SO 10) £ | 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 | 0.40½ | 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 | 0.50½ | 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

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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

**UNIJUNCTION**

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**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

### CADMIUM CELLS

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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|---|---|---|
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| U3 | 75 Germanium Gold Bonded Sub-Min. like OA5, OA47 | 55p |
| U4 | 40 Germanium Transistors like OC81, AC128 | 55p |
| 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 |
| U11 | 25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904 | 55p |
| U12 | 12 Silicon Rectifiers Epoxy 500mA up to 800 PIV | 55p |
| U13 | 30 PNP-NPN Sil. Transistors OC200 and 2S 104 | 55p |
| U14 | 150 Mixed Silicon and Germanium Diodes | 55p |
| U15 | 25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697 | 55p |
| U16 | 10 3Amp Silicon Rectifiers Stud Type up to 1.000 PIV | 55p |
| U17 | 30 Germanium PNP AF Transistors TO-5 like ACY 17-22 | 55p |
| U18 | 8 6Amp Silicon Rectifiers BYZ13 Type up to 600 PIV | 55p |
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| U31 | 20 Sil. Planar Plastic NPN Trans. Low Noise Amp 2N3707 | 55p |
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| U36 | 25 Silicon Planar NPN Transistors TO–5 BFY50/51/52 | 55p |
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| 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.

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| Qty. | 1-24 | 25-99 | 100 up |
|---|---|---|---|
| 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 |
| MPF105 | 40½p |

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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A. 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30–170.

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|---|---|---|---|
| | 52p each | 44p each | 41p each |

**SILICON High Voltage 250V NPN** TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
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**115 WATT SIL. POWER NPN**
55p EACH

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BIP 20 PNP. Brand new.

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| Q5 | 4 OC 75 transistors | 55p |
| Q6 | 5 OC 72 transistors | 55p |
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| Q8 | 4 AC 126 transistors PNP | 55p |
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|---|---|
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| | | | |
|---|---|---|---|
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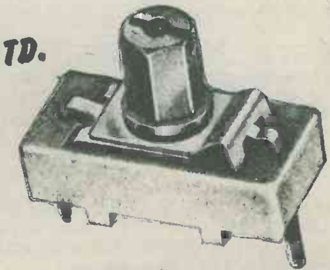

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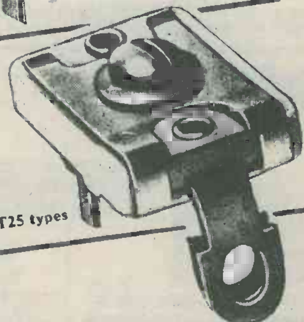
| VC29Q | TP4 | | 20—250 pF | 11p |
| VC29R | TP12 | | 50—450 pF | 14p |
| VC29RB | TP11 | | 150—750 pF | 17p |
| VC29S | TP7 | | 300—1000 pF | 18p |
| VC29SA | TP10 | | 400—1250 pF | 19p |
| VC29SB | TP29 | | 500—2000 pF | 22p |

MT31A types



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**AUGUST ISSUE WILL BE PUBLISHED ON AUGUST 1st**

# CASSETTE RECORDER MAINS UNIT

**by S. ESSEX**

**A simple stabilized power unit suitable for use with battery operated cassette recorders requiring supplies of 6, 7.5 or 9 volts.**

MANY HOMES NOW POSSESS A CASSETTE TAPE RECORDER or musicassette player, and a large proportion of these are powered by ordinary dry cells such as the type U11 or U2. The use of batteries gives the recorder the advantage of portability, but this advantage soon proves to be expensive as the cost of running the recorder can work out at several pence per hour. The writer realised that a mains supply unit would be useful for operating the recorder at home over long periods of time, and that this would reduce the running costs to less than one-hundredth of a penny per hour. Quite a saving!

*The unit coupled to a cassette recorder*

## CHOICE OF CIRCUIT

After having decided on a mains supply unit, the next question was to choose between the alternatives of a stabilized or an unstablized circuit. Although the latter has the advantages of smaller size and lower cost, its disadvantages, namely that its output voltage varies with load current and that it will in most instances have a higher ripple content in the output, make the stabilized form more suitable for the present application. Ripple is reduced by the stabilization action, which ensures that the output voltage remains constant within close limits whatever load is applied. This results in the supplied recorder working consistently at its best.

The circuit employed is shown in Fig. 1. The mains input is applied, via fuse F1, to the primary of the mains transformer T1. There is no on-off switch, the unit coming into operation as soon as its input supply lead is plugged into the mains. The transformer provides a secondary voltage of 13 volts r.m.s., which is rectified by the bridge rectifier given by D1 to D4. Capacitor C1 functions as a reservoir capacitor, ensuring that the rectified voltage across it remains at a high level between the half-cycle peaks when the diodes conduct. The voltage on the negative terminal of C1 is applied to the collector of transistor TR1.

This transistor functions as an emitter follower, the voltage at its emitter being slightly lower, due to the small drop across the emitter-base junction, than the voltage on its base. The base voltage is held steady by zener diode ZD1, which is kept at its zener voltage level by the current flowing through R1 and R2. A second electrolytic capacitor, C2, provides smoothing for the voltage appearing at the junction of R1 and R2 and this, together with the low slope resistance of the zener diode, results in a relatively ripple-free voltage of TR1 base. Capacitor C3 provides further smoothing and ensures a low impedance output. Fuse F2 provides protection against output overload.

The author's power supply unit is employed with a Ferguson Model 3240 battery cassette recorder, which requires a voltage of 7.5 volts at about 100mA. In

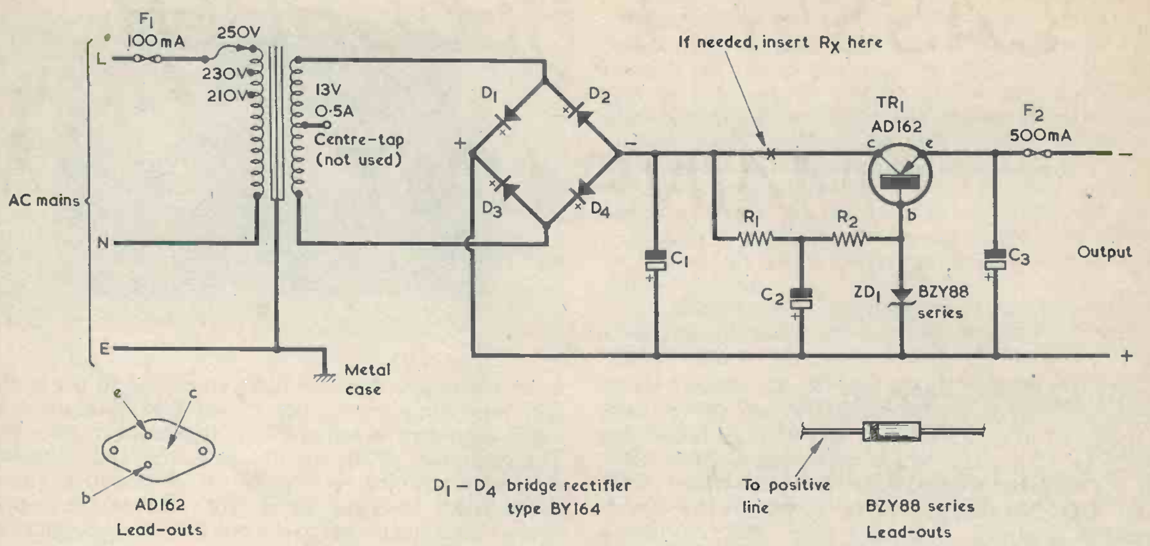



*Fig. 1. The circuit of the recorder mains supply unit. The zener diode type depends upon the output voltage required*

## COMPONENTS

*Resistors*

R1 — 330Ω, $\frac{1}{2}$ watt, 5% (6V version)
270Ω, $\frac{1}{2}$ watt, 5% (7.5V version)
180Ω, $\frac{1}{2}$ watt, 5% (9V version)

R2 — 330Ω, $\frac{1}{2}$ watt, 5% (6V version)
220Ω, $\frac{1}{2}$ watt, 5% (7.5V version)
180Ω, $\frac{1}{2}$ watt, 5% (9V version)

Rx — 12Ω, 3 watt, 10% (6V version)
8.2Ω, $2\frac{1}{2}$ watt, 10% (7.5V version)
5.6Ω, 2 watt, 10% (9V version)

*Capacitors*
(All capacitors Mullard Miniature Electrolytic)

C1 — 640µF, 25V
C2 — 200µF, 10V
C3 — 125µF, 16V

*Transformer*

T1 — Mains transformer, secondary 13 volts centre-tapped at 0.5 amp (R.S. Components – see text)

*Semiconductors*

TR1 — AD162 (complete with mica washer and insulating bushes)
D1–D4 — Silicon bridge rectifier type BY164
ZD1 — BZY88C6V2 (6V version)
BZY88C7V5 (7.5V version)
BZY88C9V1 (9V version)

*Fuses*

F1 — 100mA 20mm. fuse
F2 — 500mA 20mm. fuse

*Miscellaneous*

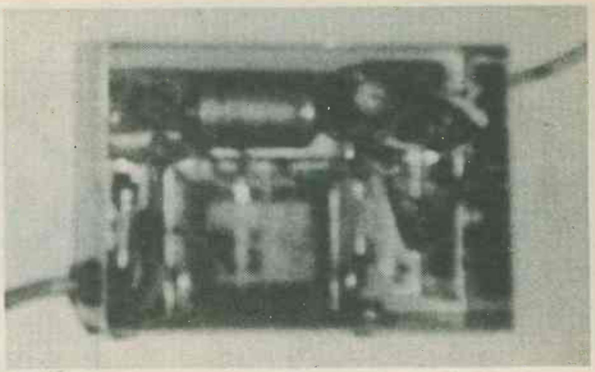
Metal case type AB9 (see text)
2 fuseholders, 20mm. chassis-mounting
2 grommets (to suit input and output leads)
2 plastic cable clips (to suit input and output leads)
Perforated board or plain Veroboard (0.15 in. pitch)
Nuts, bolts, solder tags, etc.

consequence, ZD1 in the prototype was a 7.5 volt type. The actual output voltage given in this particular instance was 7.6 volts. There will be a slight difference in output voltage for different zener diodes which are rated at a nominal 7.5 volts, because of variations within tolerance of their actual zener voltages. The circuit may also be employed to give outputs of 6 volts or 9 volts by using different zener diodes and different values for R1 and R2. These alternatives are shown in the Components List.

The resistor Rx is discussed later.

## COMPONENTS

The components are all standard types. Transformer T1 is an R.S. Components 'Standard Filament' transformer having a centre-tapped secondary giving 13 volts at 0.5 amp. No connection is made to the centre tap. This transformer is available from suppliers of R.S. Components parts such as Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN. It is also available from Home Radio under Cat. No. TH5D. Diodes D1 to D4 are given by a silicon bridge rectifier



*A view of the unit with the cover removed*

type BY164 (Home Radio and Radio Shack) which contains all four diodes in a single module. All the parts are mounted in an aluminium box with lid measuring 4 by 2¾ by 1½ in., and which is retailed as 'type AB9'. This is available from Electrovalue or from Home Radio (Cat. No. Z239). As the layout in this box is somewhat compact, beginners may prefer to use a slightly larger case. Before use, ventilation holes are cut in the bottom of the case as will be described shortly.

For safety the box must be reliably earthed via the earth lead of a 3-core mains lead which is properly terminated in a 3-pin plug. Also, the mains lead should pass through a grommet in the side of the box and be securely clamped with a plastic clip. A grommet and plastic clip should be similarly provided for the output lead.

A suitable general layout is shown in Fig. 2. Here it can be seen that the mains transformer is bolted to one side of the box. If the secondary tags are uppermost this enables a good proportion of the mains wiring to be hidden, where it cannot be touched accidentally. When this method of mounting is employed the inside bottom of the box, apart from the ventilation holes and the area which is in contact with the transistor heat sink, should be covered with self-adhesive plastic sheet to minimise the risk of short-circuits. A number of strips of p.v.c. insulating tape may be used here in the absence of other materials. The two fuses employed in the prototype were 20mm. types, being located in chassis-mounting fuse holders on either side of the mains transformer. The remainder of the circuit, apart from the transistor, may be assembled on a piece of perforated insulated board, such as plain Veroboard without the copper strips, this being bolted to the box bottom and separated from it by spacers or pillars.

The heat sink for the transistor consisted of a piece of aluminium about $\frac{3}{32}$ in. thick having a surface area of 1⅜ by 2½ in., with a bent-over section ½ in. wide. See Fig. 3. This was bolted direct to the bottom of the box, the self-adhesive plastic being removed over the area where the heat sink and case metal are in contact. Thus, further heat sinking is provided by the case. The transistor is insulated from the heat sink by the usual mica washer and insulating bushes. The mica washer will be helpful for marking out the holes required for the transistor, but it must be handled with care to prevent the mica fracturing. Temperature rise in the box can be reduced by cutting large ventilation holes in the lid, these holes and those in the bottom being covered on the outside by perforated board or plain Veroboard to prevent prying fingers from touching the live mains points.

The output lead may be terminated in a manner suitable for the cassette recorder with which the unit is

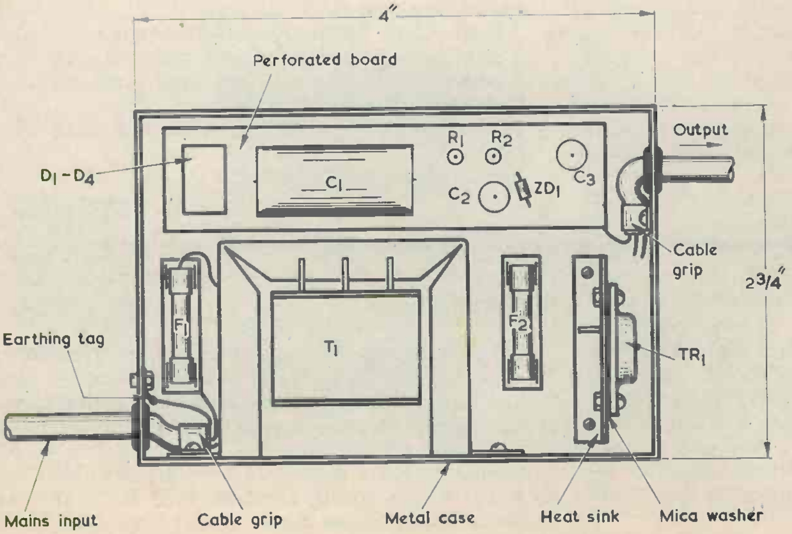



*Fig. 2. Layout of components inside the metal case. The case must be reliably connected to the mains earth*

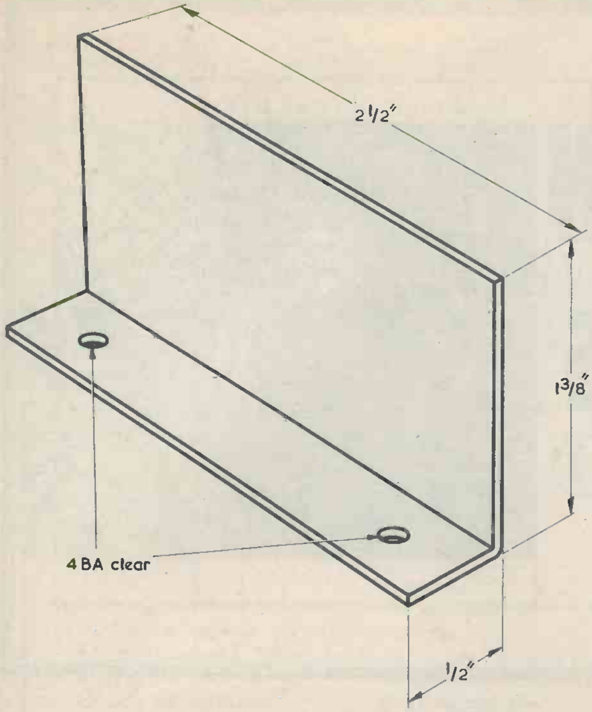


*Fig. 3. Dimensions of the heat sink*

to be used. Note that neither of the output leads is earthed.

**TESTING**

After wiring has been completed and checked, the unit may be tested. It should *not* be connected to the cassette recorder at this stage. With the mains connected and no load on the output of the unit a voltage of about 18 volts should appear across C1. The output voltage is next checked, and this should be close to the nominal zener voltage of the zener diode used. If the voltage is low, at less than 1 volt, a possible fault is that the zener diode has been connected wrong way round.

If all is satisfactory, the output of the unit may then be coupled to the recorder, taking great care to ensure correct polarity.

No problem with overheating of the transistor was observed with the prototype unit despite long periods of use. If, due to higher load currents or the use of too small a heat sink, the temperature rises excessively, a resistor may be inserted between the negative terminal of C1 and the collector of the transistor at the point indicated in Fig. 1. This resistor is Rx, and it dissipates some of the power which is handled by the transistor. Suitable values for Rx, should it be needed, are given in the Components List. The temperature of the transistor can be observed by touching it with a finger, taking care to avoid touching any live mains points.

The mains should not be applied with the recorder connected and switched on, as the resulting charging surge in C1 will probably blow fuse F1. This drawback could, if desired, be overcome by using an anti-surge fuse of around 80mA for F1, since such a fuse will pass the occasional surge but still blow on overload. If the simple precaution of not applying the mains with the recorder connected and switched on is observed, the unit will give good service for many years to come. ■

# BOOK REVIEW

★ ★ ★

**SUN EARTH and RADIO** By J. A. Ratcliffe
256 pages, 5½ x 7½ in. Published by The World University Library. Price £1.75p.

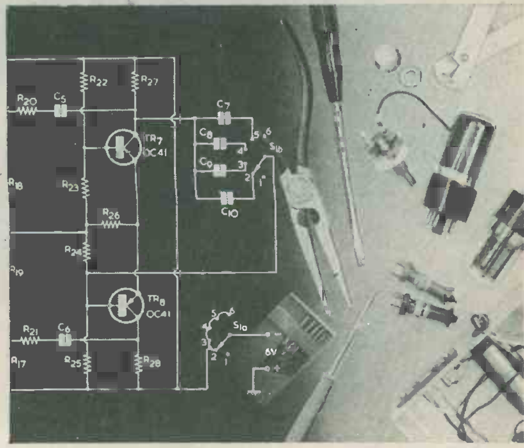
The behaviour of radio waves is of interest to those who are shortwave listeners in particular; to radio amateurs especially and to everyone who wants to understand the vagaries of radio reception, be it only in relation to the daily radio programmes received on their domestic radio receivers.

An understanding of the processes involved in their propagation necessitates a consideration of the nature of the radio waves themselves as well as the media through which they pass. This book covers these aspects of the matter very thoroughly and in a clear, readable manner, and it illustrates very well the great progress made in understanding these phenomena in recent years. For those whose knowledge of this topic has been somewhat 'basic' it is surprising to learn what strides have been made recently in this branch of science.

Introductory chapters describe how radio waves have been used to investigate the magnetosphere and the ionosphere – the two layers of charged particles in the upper atmosphere, which determine the behaviour of radio waves. The electron structure of the ionosphere and the effect of solar radiations upon it are then fully considered and the nature of the ionising radiations is considered in some detail. The ionosphere and its relationship to radio communication is specifically considered and the book ends with recent advances in this branch of science.

This is a book which can be recommended to the reader who wants a better understanding of this topic than is available in the usual section on this subject to be found in the conventional amateur radio handbooks.

# UNIJUNCTION METRONOME




by G. A. FRENCH

ELECTRONIC METRONOMES INCORporating unijunction transistor relaxation oscillators are by no means new devices and a number of designs for these have been published in the technical press from time to time. In those designs which the writer has seen the audible output is somewhat low. The present article sets out to describe a unit which offers a relatively high output.

The reason for the popularity of the unijunction transistor in electronic metronomes is that it can be connected up in a very simple relaxation oscillator circuit whose frequency is capable of being varied by means of a single potentiometer. The unijunction oscillator produces a series of sharp regularly spaced pulses which can be amplified and fed to a speaker, whereupon they become reproduced as "clicks". Unfortunately, the sound energy in a "click" is relatively low and it is for this reason that it becomes difficult to achieve high acoustic output. The metronome design to be described here tackles this problem by means of a "brute force" approach and the circuit, when switched to its highest output level, causes current pulses of the order of 1 amp to be passed through the coil of a 3Ω loudspeaker. The resulting "clicks" are in consequence reproduced at quite a high level and should be adequate for most purposes. The displacement of the loudspeaker cone during the "clicks" is, so far as can be determined visually, of the same order as is given when a 3 volt battery is connected to the speaker.

## THE CIRCUIT

The circuit of the electronic metronome appears in Fig. 1. In this diagram TR1, a 2N2646, is the unijunction transistor and it is connected in a conventional unijunction relaxation oscillator arrangement. After the on-off switch, S2, has been closed, C2 commences to charge by way of VR1 and R1. The voltage on the emitter of TR1 rises. When this voltage reaches triggering level, the unijunction transistor exhibits negative resistance and C2 discharges rapidly into whatever resistance is present between the base 1 of the transistor and the negative supply rail. The unijunction transistor reverts to normal operation when C2 is nearly fully discharged, whereupon C2 commences to charge once more and a further cycle commences. The rate of charge in C2, and hence the frequency of oscillation, is controllable by means of VR1. The capacitor charges more quickly, and frequency increases, when the resistance inserted into circuit by VR1 decreases.

During the negative resistance period when C2 discharges, a voltage pulse appears at the base 1 of the unijunction transistor. This pulse has the shape shown in Fig. 2. The discharge current from C2 flows through R3 and (ignoring the small current flow in VR2) through the base-emitter junction of TR2. Component values are such that TR2 is turned hard on for at least part of the period of the pulse, thereby applying nearly the full 9 volts from the supply across the loudspeaker and whichever of R4 to R6 has been selected by S1. If S1 is in position 3 this voltage is applied across the speaker and the 5Ω resistor R6, whereupon a current of the order of 1 amp can be expected to flow through the speaker coil. Positions 1 and 2 of S1 select higher values of series resistor and produce lower audible outputs from the metronome. It is necessary to use a switch to control volume rather than have a series wire-wound potentiometer, since the latter would require wire in its track which was capable of passing 1 amp and would, in consequence, be a very bulky component.

Between pulses, the silicon material in TR1 between base 2 and base 1 functions as a resistor. The resistance offered between the two bases of a 2N2646 lies between 4.7 and 9.1kΩ, and VR2 is adjusted such that, in the absence of pulses, the base of TR2 is just below the level at which this transistor commences to conduct. Thus, the transistor is fully cut off in the absence of pulses and is hard on in the presence of pulses. Circuit operation is, therefore, at its most efficient. A very low impedance across the supply rails is provided by C1, and this allows a high pulse current to flow in the speaker even when the battery, in ageing, offers a relatively high internal resistance.

TR2 is a silicon power transistor type BD124. A silicon device is used here because a silicon transistor does not turn on until its base is some 0.6 volts higher in potential than its emitter. This ensures that it can be reliably taken into cut-off, between

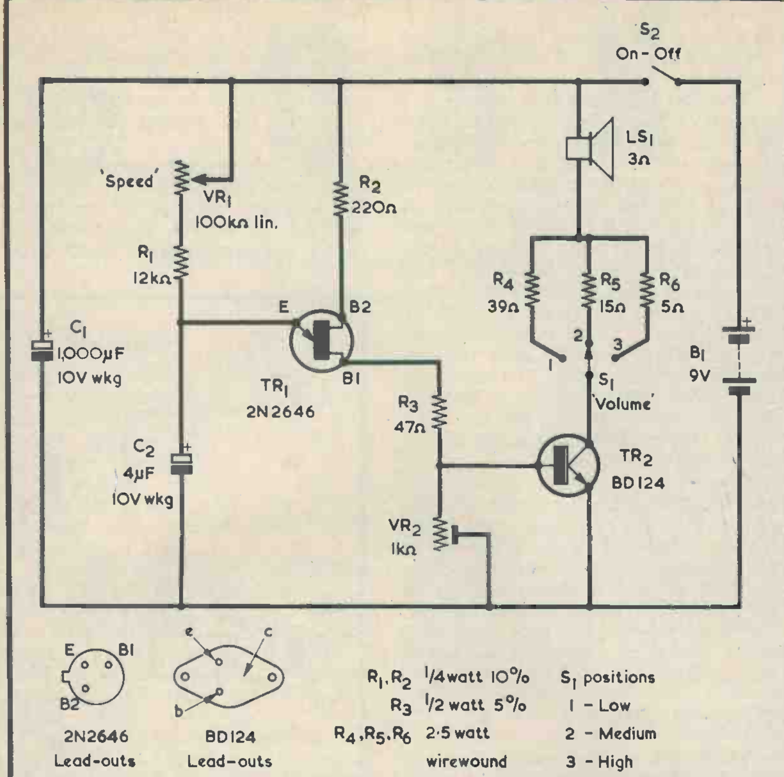



*Fig. 1. The circuit of the unijunction metronome. When S1 is in position 3, pulses of the order of 1 amp flow in the loudspeaker. The value of R3 may require adjustment, as is explained in the text*

pulses, by the appropriate adjustment in VR2. A power type is employed simply because it is capable of passing the fairly heavy collector currents involved. As the pulses of current in the collector circuit are of very short duration, dissipation in TR2 is low and it does not need to be mounted on a heat sink.

Dissipation in the three series resistors, R4 to R6, is also low, but they still have to pass pulses of relatively high current. It is for this reason that they are specified as wire-wound types. The value of R3 may need to be altered and this point is discussed shortly.

The loudspeaker should be a type which is capable of handling at least 3 watts of audio power, and its audible output is increased if it is mounted in a cabinet to provide a baffle effect. *Miniature low-power speakers must on no account be used in this circuit as they may be damaged by the pulse currents.*

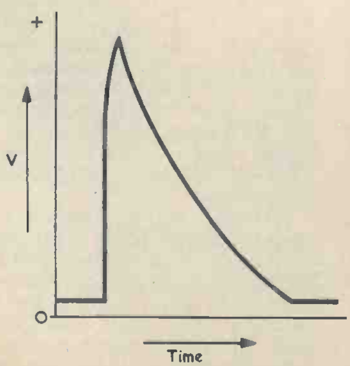



*Fig. 2. The shape of the pulse appearing at the base 1 of the unijunction transistor*

The frequency range offered by VR1 with the prototype was approximately 1 pulse per second when VR1 was set to insert full resistance and approximately 7 pulses per second when this potentiometer was adjusted for minimum resistance. If it is desired to use the device as a photographer's metronome giving one pulse per second, R1 and VR1 may be changed accordingly. R1 could be increased to 47kΩ and VR1 made a pre-set potentiometer which is adjusted for a speed of 1 pulse per second.

Unfortunately, pulse frequency varies somewhat with battery voltage. For most applications this should not be a disadvantage, and the battery can be discarded when its voltage has fallen to some 8 volts, in which case changes in frequency will not be great. If a high level of frequency stability is required the unit, or at least the emitter and base circuits of TR1, must be powered by a stabilized supply.

The current consumption from the battery in the prototype with R3 at 47Ω was less than 4mA at the slowest speed, and was approximately 30mA at the highest speed.

## COMPONENTS

The two transistors used in the circuit are commonly encountered types which are readily available. VR1 is a panel-mounting potentiometer whilst VR2 is a skeleton pre-set type. Both the capacitors should be good-quality components. In the prototype, C2 was a Mullard Miniature electrolytic. The 9 volt battery should be a reasonably large type, such as the Every Ready PP9.

S1 is a rotary switch. It would be best to avoid using one of the popular miniature rotary switches that are currently available and to employ instead a standard size wafer switch whose moving contact passes between two fixed contacts at each position. Such a switch would be more capable of passing the currents involved. S2 can be a standard toggle switch.

As was just mentioned, the value of R3 may need to be changed. The value of 47Ω specified in the circuit diagram takes up the case where TR2 is at the bottom of its hFE spread. It was found, in the prototype, that the peak value of the pulse appearing at the base 1 of TR1 was a little higher than 3 volts. This means that, allowing for base-emitter voltage drop in TR2, the voltage appearing across R3 in the presence of pulses is about 2.5 volts. At the same time, the minimum hFE quoted for the BD124 (at a collector current of 2 amps) is 25, with the consequence that a bottom-limit BD-124 requires a base current of 40mA if it is to pass a collector current of 1 amp. By giving R3 a value of 47Ω, a base current of about 50mA becomes available. This ensures that TR2 is taken fully into conduction at the peak of the pulse shown in Fig. 2, and that it is at or near full conduction for the upper part of the pulse near the peak.

The 2N2646 is capable of a base 1 current of 50mA, but there is no point in having a semiconductor device pass a greater current than is necessary. Since it is doubtful in practice that the gain of TR2 will be anywhere near its bottom limit it is probable that there will be, in most units built up to the circuit of Fig. 1, no significant loss in output if R3 is increased in value to 100Ω, thereby halving the base 1 current in TR1. This point has to be checked experimentally after the circuit has been assembled. An intriguing feature of this situation is that increasing the value of R3 to 100Ω causes the rate of discharge in C2 when TR1 triggers to be halved, whereupon the pulse waveform of Fig. 2 becomes twice as wide. In consequence, if TR2 is a high-gain specimen the increase in the value of R3 may result in TR2 becoming fully conductive over a higher section of the pulse; but, compensating for this, the widening of the pulse will still allow TR2 to be conductive for nearly the same amount of time.

## CONSTRUCTION

The circuit may be assembled in any convenient manner, and layout is not important. As was stated earlier, the speaker should be fitted in a cabinet. This cabinet could house the parts, with VR1, S1 and S2 mounted on the front panel. The connection between R3 and base 1 of TR1 should be of a temporary nature during construction.

When completed, VR2 should be adjusted to insert minimum resistance into circuit and the metronome switched on by means of S2. The resistance inserted by VR2 should then be increased slowly until pulses are heard at good amplitude with S1 set to position 3. VR2 should not be advanced any further than this at the present stage, and the operation of VR1 and S1 should then be checked.

Next, set VR1 to insert maximum resistance, set S1 to position 3 and switch off at S2. Connect a meter switched to read 100mA full-scale in series with the positive battery lead and ensure that C1 is reliably in circuit (as, otherwise, the meter may be damaged by the pulses of loudspeaker current). Switch on at S2. The meter needle will give a kick at switch-on as C1 charges, after which it will read the current drawn by the metronome. Set VR2 to insert minimum resistance into circuit once more, thereby stopping the pulses being reproduced by the loudspeaker. Slowly advance VR2 so as to insert more resistance into circuit. As VR2 advances, the pulses will become audible again. The meter needle will kick up to some 10 to 20mA at the pulses, falling to a value very near zero between them. When VR2 slider passes a certain point the current between pulses will noticeably increase. The final position for VR2 is just before the point at which the current between pulses commences to increase. This setting is not very critical.

After this process, switch off at S2 again and insert a 47Ω ½ watt 5 or 10% resistor between R3 and base 1 of TR1, as in Fig. 3(a). Switch on again and temporarily short-circuit

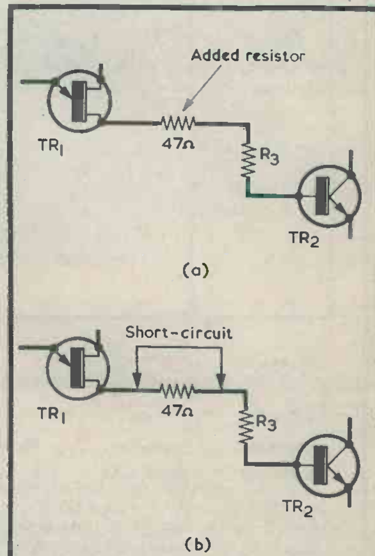



*Fig. 3 (a) When assembly is complete, a 47Ω resistor is temporarily inserted as shown here*
*(b) The effect of short-circuiting the added resistor is then investigated*

this resistor with a piece of wire, as illustrated in Fig. 3(b). S1 should be in position 3 for this check and it is helpful to adjust VR1 for a fairly high pulse frequency. If the audible level is higher with the added resistor short-circuited, then the correct value for R3 is 47Ω. If there is no significant alteration in audible level when the added resistor is short-circuited then R3 can be changed to 100Ω ½ watt, 5 or 10%. The added resistor is removed and R3 (either as 47Ω or as 100Ω) finally wired in. If R3 is changed to 100Ω the setting of VR2 should be re-checked.

VR1 may be fitted with a pointer knob and a scale which is calibrated in terms of pulses per minute. For all but the highest speeds the calibration may be made by counting the pulses whilst observing a watch with a sweep second hand. Such a calibration should be quite adequate for most applications where a metronome is used. ■

# QSX

**By FRANK A. BALDWIN**

**(All Times GMT)**

The subject of clandestine radio stations is always of interest to many short wave listeners. Some of the less well known clandestines were mentioned in the last issue of this magazine – see under 'Short Wave News for DX Listeners' – and to commence with here we report reception of another under-cover transmitter.

On **9555** the Iranian Revolutionaries Radio was heard opening at 1858 with slogans and propaganda in Farsi (Persian) which went turgidly on to sudden sign-off at 1957. A short interlude of military music at 1901 was the only light relief!

Radio Pathet Lao is another pro-communist clandestine that should prove of interest to the DX hunter. Try **7310** around 2300 or 1530.

## ● LATIN AMERICA

Two recent late night sessions have produced a few Latin Americans although, at the time of writing, the 'season' for reception of these stations had not by any means got into its stride.

**4679 0250** HCWE1 Radio Nacional Espejo, Quito, Ecuador, with light orchestral music, YL in Spanish and identification. This one has a 24 hour schedule, 5kW (64.11m).

**4755 0302** Radio Difusora de Maranhao, Sao Luis, Brazil, announcements in Portuguese, National Anthem and sign-off. Schedule is from 0800 to 0300, 5kW (63.09m)

**4820 0231** HRVC La Voz Evangelica, Tegucigalpa, Honduras Republic, with hymns accompanied by the piano. Schedule 1000 to 0430, 5kW (62.24m).

**4832 2315** TIHB Radio Capital, San Jose, Costa Rica, Latin American music and identification. Has a 24 hour schedule, 1kW (62.08m).

**4905 0154** ZYZ20 Radio Relogio, Rio de Janeiro, Brazil, two short pips and one tone every minute as time checks, with ticks every second superimposed over OM in Portuguese, identification at 0200. ZYZ20 has a 24 hour schedule, 5kW (61.16m).

**4915 0400** HJSG Radio Guatapuri, Valledupar, Colombia, with a newscast in Spanish after identification. Schedule 1100 to 0500, 1kW (61.03m).

**4923.5 0219** HCRQ1 Radio Quito, Ecuador, with Latin American songs after station identification. Schedule is from 1045 to 0430, 3kW (60.94m).

**5035 0330** ZYW22 Radio Anhanguera, Goiania, Brazil, with songs, music and identification. Schedule 0900 to 0400, 1kW (59.58m).

**5045 0345** CP38 Radio Altiplano, La Paz, Bolivia, plaintive Andean music heard from 0335, then identification. CP38 has a 24 hour schedule, 5 kW (59.46m).

**11925 2148** ZYR78 Radio Bandeirantes, Sao Paulo, Brazil, sports commentary in Portuguese. Schedule 2100 to 0530, 10kW (25.16m).

## ● AUSTRALIA

**6055 2100** Darwin with the world news in English after 6 'pips' and station identification.

**9570 0846** Shepparton with a programme in English about the Australian cricket scene.

The above are transmitters of the Overseas Service. From the DX point of view, an interesting outlet of the Domestic Service is that of Brisbane on the 60 metre band. Logged here in early May on:

**4920 1952** VLM4 Brisbane, opening with dance music records, good morning greetings, 'Waltzing Matilda', 6 'pips' and time-check for 6 a.m. (at 2000 GMT) followed by the world news. Schedule 2000 (Sundays 2030) to 1402, 10kW (60.98m).

## ● INDONESIA

**4805 2154** YDF4 Jakarta, Indonesia, series of six musical chimes repeated until announcements and news in Indonesian at 2200 lasting to 2209.

## ● WINDWARD ISLANDS

**5015 2304** WIBS Grenada, world news in English (relay of BBC World Service).

## ● CAMEROON

**4972 2049** Radio Yaounde, African drums and chants, ideal material for those with tape recorders.

## ● ANGOLA

**4793.5 2110** CR6RG Radio Commercial de Angola, Sa da Bandeira, with YL in Portuguese songs under hetro (listed 4795).

**4937 2037** CR6RS Radio Clube do Lobito, Portuguese songs, announcements and music.

**4985 2000** CR6RB Radio Ecclesia, Luanda, with identification in Portuguese after music programme.

**5060 1919** CR6RD Radio Clube do Huambo, with a programme of light orchestral music and announcements in Portuguese.

## ● MALAYSIA

**4845 2200** Kajang, Radio Malaysia opening with 6 'pips', National Anthem and newscast in Tamil.

## ● KENYA

**4805 2100** Nairobi, station identification, newscast in English and sign-off at 2108.

## ● CHINA

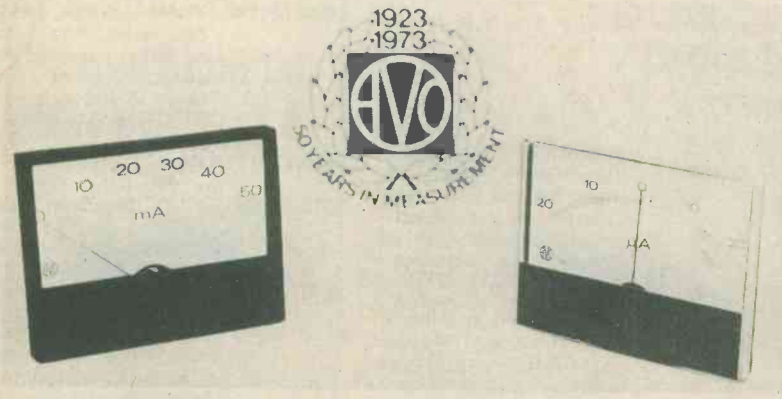
**4380 2010** PLA Fukien, with Chinese songs and music, announcements by YL.

**4864.5 2155** Lanchow, talk in Chinese by OM, some CW QRM on channel.

**4905 2034** Radio Peking, Chinese orchestral music, YL with songs.

# NEWS . . . AND .

## AVO'S FIRST PANEL METERS




*First panel meter from Avo Limited, the Dinline Fifty range of eight matching models with two alternative presentations.*

AVO celebrated their Golden Jubilee with the introduction of their first-ever range of panel mounting meters – the new Dinline Fifty range.

These new AVO panel meters were launched at the International Electronic Components Exhibition.

The range is available in a matching series of eight models with two alternative presentations, one moulded in tough ABS material with matt black finish and glass window, the other moulded in clear Macralon giving a clearview appearance and ensuring entirely shadow-free readings. This second presentation is available with either a matt black escutcheon or a range of colours to customer requirements. A low arc line is offered as standard and all models combine the well-known AVO reputation for reliability with compact modern styling and clear readability to meet virtually all requirements.

Standard features include comprehensive preferred ranges, accuracy to BS 89/70 Part 1 and a sensitivity of 1000Ω/V. Many other special features are available including optional stud positioning, enabling customers to up-date their equipment without alteration to existing panel cut-outs, non-standard accuracies, higher sensitivities, mirror scales, off-set or centre zero and special scaling to customer requirements.

Enquiries for Dinline Fifty panel meters, from equipment manufacturers, should, in the first instance, be made direct to Avo Limited, Archcliffe Road, Dover, Kent.


## GRILLE MATERIAL

**Expamet expanded aluminium with colour anodised finish is an attractive material for making all types of grilles for speakers and ventilation openings in equipment and hi-fi cabinets. Used for many years by leading electronics companies it is now available to the hi-fi, electronics and radio amateur. It is sold by many d.i.y. retailers and meshes may be selected from a display stand containing four different patterns packed in colourful sleeves.**

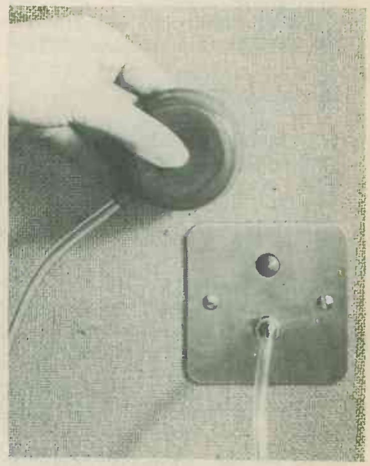
## NEW PNEUMATIC CALL UNIT

Nelson Tansley's Pneumatic Call Units are now available in a number of forms, with either a squeeze bulb on a flexible tube or a wall-mounted push-pad as the call component.

In principle the pneumatic system comprises the call component coupled by tubing to a sensitive bellows unit which operates a sealed spark-free microswitch.

The pneumatic units are particularly suitable for applications where direct switching, even at low voltages constitutes a hazard. Such applications occur, for example, in geriatric wards, bathrooms and shower cubicles where the electric-shock danger is particularly acute.

An important feature of the pneumatic call units are their complete freedom from fire risk. They are,



Call Unit with flexible air tube.

therefore, ideally suited for use in oxygen tents.

They also offer obvious advantages for operating theatres, where a spark from an open switch could ignite highly inflammable gases to cause an explosion; and the waterproof construction also permits direct hosing without risk of damage.

An outstanding feature of the pneumatic system is the ease with which a call can be made, even by a weak or severely handicapped person, using the hand, elbow or foot. The sensitivity of the units can be preset to meet such requirements.

# . . . COMMENT

## OSCAR BEING WELL USED

At the time of writing, the Amateur Radio Satellite, OSCAR 6, has completed over two thousand five hundred orbits. That it is being well used for communication by radio amateurs is well shown by the reports steadily coming in of the many contacts made throughout the world via OSCAR 6.

The American Amateur Radio League, is now offering a special certificate for contacts via OSCAR. Points are awarded on a contact-country-continent basis, and certificates are awarded to those stations accumulating 1,000 points. The first 'G' station to be awarded this Certificate is Pat Gowen, G3IOR, of Norwich, who to date has worked a total of 174 amateur radio stations – 137 in 24 European countries, 26 in U.S.A., 9 in Russia and 2 in Canada. A pretty impressive log! And he has done this with quite modest equipment, viz., a three element Yagi at 50 feet on the 10 metre receiving side, with a good home built 10 metre receiver, and 12 watts to a 6 over 6 slot fed antenna for transmitting on the 2 metre circuit, tilted 7 degrees to the horizon, 30 feet high.

OSCAR 6 is now turned off during part of the week to give the solar cells adequate time to recharge the batteries. It is fully functional on Thursdays, Saturdays, and Mondays, at the time of writing.

## IN PARLIAMENT

In a written parliamentary answer to a question by Mr. John Hannam, M.P., asking what action he proposed to take following representations made to him to restore regional broadcasting on medium frequencies in the South West, Sir John Eden, Minister of Posts and Telecommunications, stated:

> "I have authorised the BBC to install low-power transmitters at Exeter, Barnstaple, Torbay, Plymouth and Redruth to broadcast on medium frequencies the programmes carried on the VHF transmissions of Radio 4, which include regional items."

## IN BRIEF

● Sales office of ITT Components Group's Thermistor Division, formerly in Harlow, has moved to Stephen Street, Taunton, Somerset. It is now at the same location as the factory.

● Special Event Station: GB3MKB – Ballycastle, Co. Antrim, June 30–July 7, operated by Belfast YMCA ARC for local Marconi-Kemp 75th Anniversary. Specially printed postal covers (Ballycastle or Rathlin Is. postmark) a, regional stamp 15p or 3 IRC's; b, Marconi-Kemp 9p stamp 20p or 4 IRC.s, Postmark on separate covers – a, 25p or 5 IRC's; b, 35p or 7 IRC's; apply UDC Office, Ballycastle, Co. Antrim. All bands operation, contacts count towards GI6YM Golden Jubilee Award.

● Lindair House in Tottenham Court Road is Europe's first department store devoted to hi-fi, audio and video equipment and, according to Chairman, Bennie Linden, its 23,000 square feet of space, coupled with its stock of more than £1m worth of hi-fi equipment, establishes Lindair House as the biggest specialist outlet of its kind in the world.

● Four new Fellowships have been awarded by The Royal Television Society. The new Fellows are: Walter Anderson, Ivan James, Charles Marshall and Peter Rainger.

● The British Amateur Electronics Club's Exhibition is being held at the Shelter, Esplanade, Penarth, Glam., from 21st to 28th July.

● AMF Potter and Brumfield have received from Swift Hardman Ltd., an order for no less than fifty-five thousand relays. This is believed to be the largest single order ever placed by a distributor with any manufacturer in the United Kingdom.

## EASY-CARRY PACKS FOR RECORDING TAPE

**Improved handling, identification and storage of EMI professional recording tape should follow the introduction of the new easy-carry packs with handles.**

**The first pack size to be introduced accommodates 2 in. tape on 10½ in. diameter reels. Emitape 815 and 816 professional recording tape on this size of reel is in extensive use in studios. A 10½ in. reel of two inch tape weighs about 9 lb. (4 kg.).**

**Packs for reels of 1 in. and ½ in. multi-track tape will be introduced during the summer.**

**A valuable feature of the new pack, is the provision of white panels on one edge of the pack to carry identification on the library shelf and a large panel on the rear carrying a form on which to enter data about the recordings on the tape.**

# MODIFYING THE GC1U RECEIVER. Part 1.

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

**This is the first of two articles describing modifications which have been successfully carried out on the Heathkit 'Mohican' Communications Receiver Model GC-1U. The concluding article will appear next month.**

**Editor's Note**

*The modifications described in this and next month's articles should be carried out only by the experienced constructor who fully understands the principles involved. We have been asked by Heath (Gloucester) Limited to point out that the GC-1U is no longer a current Heathkit model and is therefore no longer available, and that Heath cannot supply any of the parts needed for the modifications nor can they enter into any correspondence concerning them. Further, under their general terms Heath (Gloucester) Limited cannot accept equipment for service which has been modified in any way.*

THIS TWO-PART SERIES DESCRIBES SOME MODIFICATIONS to the popular GC-1U communications receiver which should provide improved performance, stability and s.s.b. reception. The two principal points discussed are the inclusion of an internal regulated mains power unit to replace the existing UBE-1 eliminator unit normally used with this receiver and the addition of a simple internal product detector for improved s.s.b. reception. Whilst the circuits described relate principally to the GC-1U receiver, the product detector could be applied to many receivers which lack this facility. The power unit, with minor changes, could also be used to supply most transistor receivers from the domestic mains supply. The circuits therefore offer some scope to the practical experimenter as, with minor modifications, they could be applied to many receivers other than the type specifically mentioned here. These points will be discussed next month.

The GC-1U is essentially a good general purpose receiver, being found in a great many amateur and s.w.l. stations throughout the world. It is however a little 'dated', having been one of the first all-transistor communications receivers to appear on the amateur market. It was designed for battery operation with the choice of the UBE-1 eliminator as an optional extra for mains operation, this unit fitting into the receiver internal battery box. Compact size, good sensitivity and reasonable selectivity, together with wide frequency coverage and excellent bandspread features, are included among its better points. Its performance on s.s.b. is not particularly good, however, and both short term and long term frequency drift, particularly on the h.f. bands, is sometimes noticeable. This is particularly so when the dial light switch on the front panel is operated. This switch is provided in the interests of power economy when using batteries.

## NEW POWER SUPPLY

The first necessity was considered to be a stable power supply. The load characteristic of the UBE-1 eliminator as checked by the author is shown in Fig. 1. As can be seen, taking the extremes of load variation with and without dial lights (indicated in the diagram as 'maximum load change'), the d.c. supply variation was 3.8 volts. The d.c. output was also directly proportional to changes in mains voltage. The output of the alternative power supply, which will next be described, is also shown in Fig. 1 for comparison.

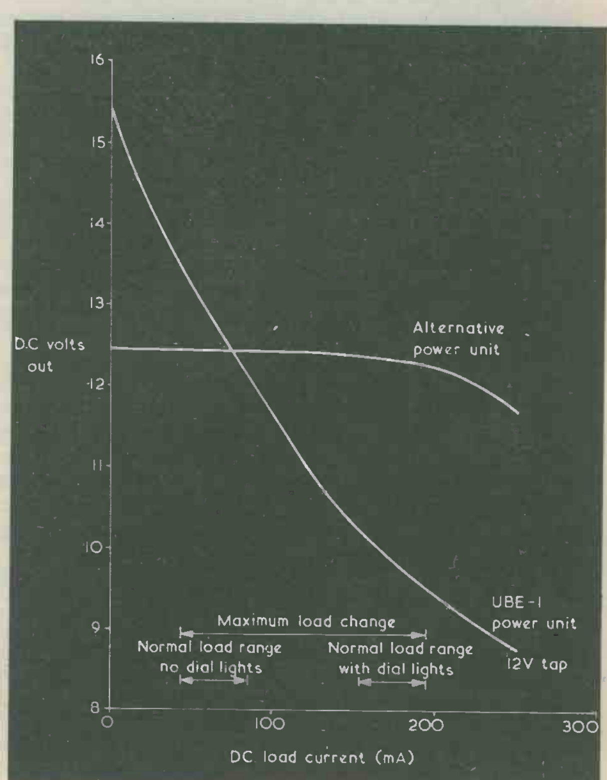
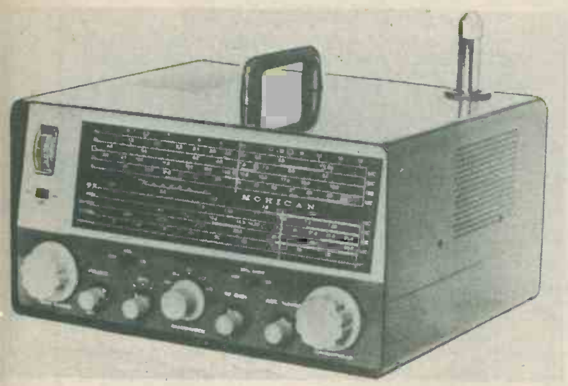



*Fig. 1. Regulation curves obtained by the author with the original mains unit and the alternative unit*




The circuit diagram of the alternative power unit is given in Fig. 2(b) with the original circuit, for comparison, in Fig. 2 (a). As can be seen from the curve in Fig. 1, the maximum voltage change with the new supply unit is only 0.2 volt, a regulation improvement of almost 20 times. The ripple factor is similarly improved, being 0.1% as against 0.35% at 100mA. The receiver power circuits are also simplified, as can be seen in the 'before and after' circuit diagrams of Figs. 2 (a) and (b). All components designated in the receiver circuits relate to those in the published circuit diagram and receiver handbook.

The alternative power unit is quite conventional and uses standard components. It is designed to fit into the receiver internal battery box. The secondary output from a small mains transformer, T1, is fed into an encapsulated diode bridge, this providing full-wave rectification. T1 is an R.S. Components 'filament transformer' offering 16.3 volts at 0.3 amp centre-tapped (Home Radio Cat. No.TH5A) whilst the diode bridge is a Mullard BY164 (available in the Home Radio semiconductor list under the same number). Smoothing is provided by the filter circuit consisting of C1, R1 and C2, R1 also providing current limiting for the zener diode D5, which stabilizes the 12 volt d.c. output. This diode is of the stud-mounting variety and is mounted on a 1¼ in. square aluminium plate which acts as a small heat sink. The output is fed via the Internal-External switch to the receiver circuits. The muting link is left in the positive line, whilst C22 is retained to decouple the supply line at radio frequencies. An additional smoothing capacitor, C3, is added in the receiver to further reduce ripple and ensure negligible

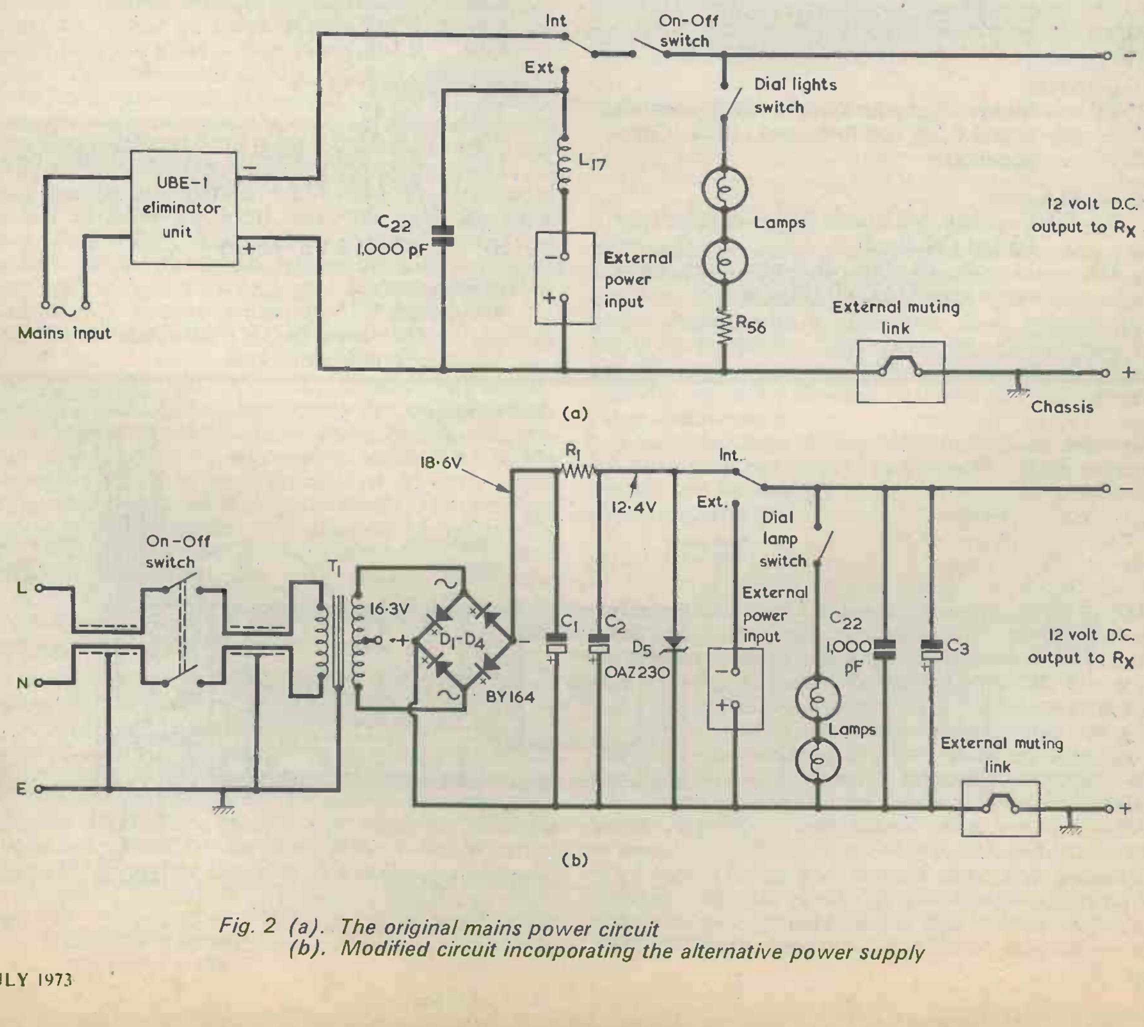



*Fig. 2 (a). The original mains power circuit*
*(b). Modified circuit incorporating the alternative power supply*

hum even at maximum volume. The dial lights and light switch are connected directly across the 12 volt receiver supply. Economy resistor R56 and r.f. choke L17 can be omitted.

One further disadvantage with the original circuit was that no mains switch was incorporated in the UBE-1 eliminator, the on–off receiver switch on the a.f. volume control being in the 12 volt d.c. line. This meant that the mains transformer primary was permanently energised, even with the receiver switched off. In the alternative circuit the switch is taken out of the d.c. line and put into the mains supply to T1 primary. The double-pole switch required is already on the rear of the a.f. volume control and can be safely used for this purpose, being rated at 250 volts 1 amp a.c. Insulated twin screened cable is used to take the mains supply both to and from this switch, and this prevents hum pick-up in the adjacent circuits on the receiver printed board. The mains wiring is terminated at a 6-way tagstrip fixed to the side of the battery box, as shown in Fig 3.

## COMPONENTS

*Power Supply*

*Resistor*

| | |
|---|---|
| R1 | 25Ω 5 watts wire-wound |

*Capacitors*

| | |
|---|---|
| C1 | 1,000μF electrolytic, 25 V.Wkg |
| C2 | 1,000μF electrolytic, 15 V.Wkg |
| C3 | 2,500μF electrolytic, 15 V.Wkg |

*Transformer*

| | |
|---|---|
| T1 | Mains 'filament transformer', secondary 16.3V 0.3A centre-tapped. (R.S. Components) |

*Semiconductors*

| | |
|---|---|
| D1–D4 | Encapsulated silicon bridge rectifier type BY164 (Mullard) |
| D5 | 12 volt, 10 watt, stud-mounting zener diode type OAZ230 (Mullard) |

*Miscellaneous*

6-way tagstrip (see Fig. 3)

## COMPONENTS

*Product Detector*

*Resistors*

(All fixed values ¼ watt 10%. R47 and R54 are new values for existing resistors.)

| | |
|---|---|
| R1 | 100kΩ |
| R2 | 5.6kΩ |
| R3 | 220Ω |
| R4 | 3.3kΩ |
| R5 | 6.8kΩ |
| R6 | 330kΩ |
| R7 | 3.3kΩ |
| R8 | 2.2kΩ |
| R9 | 220Ω |
| R10 | 470Ω |
| R11 | 470Ω |
| R12 | 750Ω |
| R47 | 1kΩ potentiometer, linear wire-wound |
| R54 | 2.2kΩ |

*Capacitors*

| | |
|---|---|
| C1 | 100pF silvered mica |
| C2 | 100pF silvered mica |
| C3 | 0.1μF plastic foil |
| C4 | 680pF silvered mica |
| C5 | 0.0068μF plastic foil |
| C6 | 0.1μF plastic foil |
| C7 | 1μF plastic foil |
| C8 | 0.47μF plastic foil (see text) |
| C9 | 0.1μF plastic foil |
| C10 | 0.1μF plastic foil |

*Semiconductors*

| | |
|---|---|
| TR1 | OC45 |
| TR2 | OC45 |
| D1 | 6.8 volt 400mW zener diode type BZY88C6V8 (Mullard) |

*Switch*

| | |
|---|---|
| S1 | 2-pole 3-way rotary |

*Miscellaneous*

Veroboard, 0.15 in. matrix, approx. 2 by 2⅛ in. (12 strips by 13 holes) Aluminium for mounting brackets

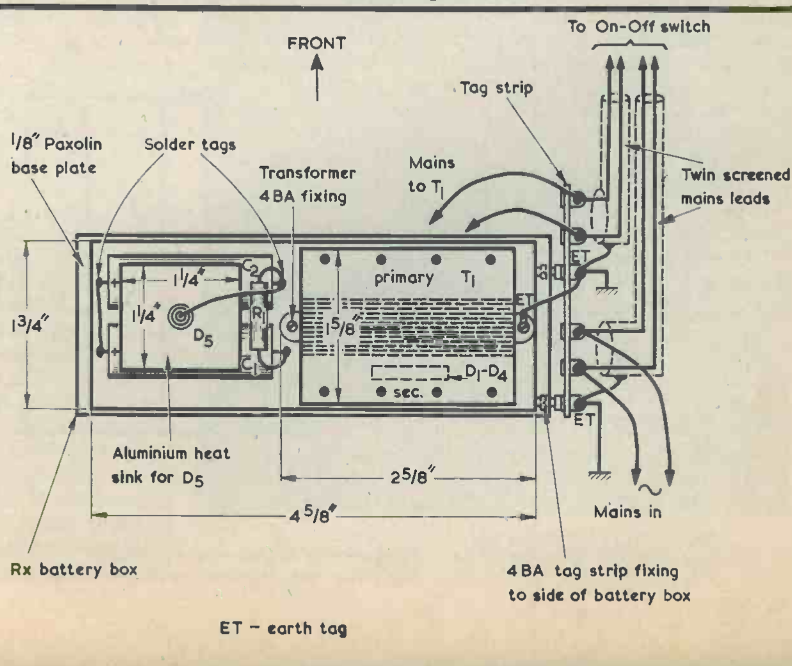



*Fig. 3. Layout of the components in the new mains supply unit*

## POWER UNIT CONSTRUCTION

The construction of the power unit should offer no problems. The components are mounted on an ⅛ in. Paxolin board resting on the bottom of the battery box, the capacitors and resistor being mounted between solder or turret tags mounted in the board. Add an insulating strip of Paxolin to ensure that the bottoms of these tags do not short-circuit against the metal base of the battery box. The zener diode, D5, is mounted, as already mentioned, on a 1¼ in. square heat sink, and it is soldered between the appropriate tags by means of 18 s.w.g. wire so that it becomes self-supporting. The encapsulated diode bridge is beneath T1 top plate, being wired directly to the appropriate secondary tags.

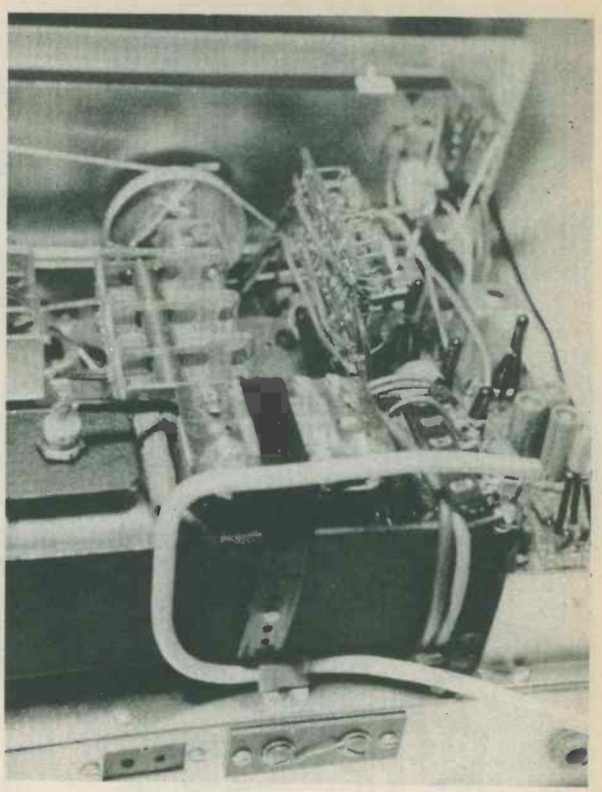
A general view of the power unit, together with relevant dimensions, is given in Fig. 3 and a list of the additional parts required appears in the accompanying Components List. A small grommet can be let into the back of the receiver cabinet to allow for the outgoing mains lead. The extra smoothing capacitor, C3, is positioned under the i.f.-a.f. printed board, being fastened to the underside plate of the chassis by means of an insulated spring clip secured by a 6BA countersunk screw. As the can will normally be common to the negative lead of the capacitor it must be insulated from the chassis which is, of course, positive. Hence the use of an insulated clip. The mains cables going to and from the power switch are held in place along the top edge of the printed board by small clips, these being fixed to the chassis by means of the existing 6BA screws which already hold the printed board in place.

When the new power unit is completed the receiver can be tried out with it. If desired, voltage and current checks may be made, and the readings obtained should be approximately equal to those indicated in Figs. 1 and 2 (b). An improvement in overall stability should be noted, particularly on the h.f. bands. The frequency stability of both the local oscillator and the b.f.o. should be virtually unaffected by the operation of the dial light switch, by normal changes in mains voltage or by changes in the r.f. and a.f. gain control settings.

## RESISTOR SUBSTITUTION

Before dealing with the product detector, two further points of a more general nature may first be mentioned. After completing and testing the power unit, a complete check and if necessary, a complete realignment of the receiver, is worth-while. This assumes, of course, that the necessary signal generator is available. The complete alignment procedure for both i.f. and r.f. sections is fully described in the receiver handbook. Whilst a complete realignment can take several hours, the writer found it well worth-while in terms of increased sensitivity and selectivity and accurate local oscillator tracking.

The second point refers to the replacing of all existing carbon resistors by high stability metal oxide types. This gives a much improved performance with regard to noise. The older type of standard carbon resistor tends to be rather noisy, whilst the new 5% metal oxide resistor has a much superior noise and long-term stability factor. The r.f. and frequency changer circuits are particularly sensitive to this form of noise. Besides reducing the noise level by a noticeable amount, the long-term stability of the overall circuits is much improved by changing to this type of resistor. While again this task is rather time-consuming, and metal oxide resistors are more expensive than carbon types, the writer considers the results worth the extra time and expense. This modification can be recommended for any older receiver with a high noise level, whether it be valve or transistor. The writer has carried out this modification on several older receivers and has always found it extremely effective in improving the signal-to-noise performance.



*A view of the new power supply unit fitted in the battery box*

The replacement of the older type paper capacitors by new polyester types, particularly in r.f. and i.f. bypass and decoupling circuits, also helps to improve overall receiver performance and stability.

## S.S.B RECEPTION

The inclusion of a product detector for s.s.b. reception was considered necessary for improved s.s.b. performance. With the original circuit s.s.b. reception was achieved by the earlier method of switching on the b.f.o., tuning in the required s.s.b. signal, reducing the r.f. gain as much as possible and readjusting the b.f.o. control for final tuning, the a.m. detector being left to resolve the signal. Such a method has several disadvantages. Any drift in the local oscillator frequency or b.f.o. frequency is sufficient to cause severe distortion or even a completely unreadable signal. Sudden changes in r.f. signal strength or changes in r.f. gain setting can produce a similar effect. To a certain extent, all these problems can be overcome by the inclusion of a well stabilized supply and a simple product detector.

The existing third i.f. stage and b.f.o. stage are shown in Figs. 4 (a) and (b) respectively. Fig. 5 shows the added product detector circuitry and its interconnection into the two stages illustrated in Figs. 4 (a) and (b). Also shown is the added function switch S1 (a) (b). The circuit is designed so as to keep the number of modifications to the receiver to a minimum.

The circuit in Fig. 5 shows a simple product detector TR1, the circuit functioning on a non-linear characteristic. The b.f.o. output is fed via C2 into TR1 base, this signal being mixed with the i.f. output taken from transistor X6 emitter via C1. (The previous b.f.o. coupling capacitor, C60, is now removed.) The resultant product of these two signals is developed in amplified

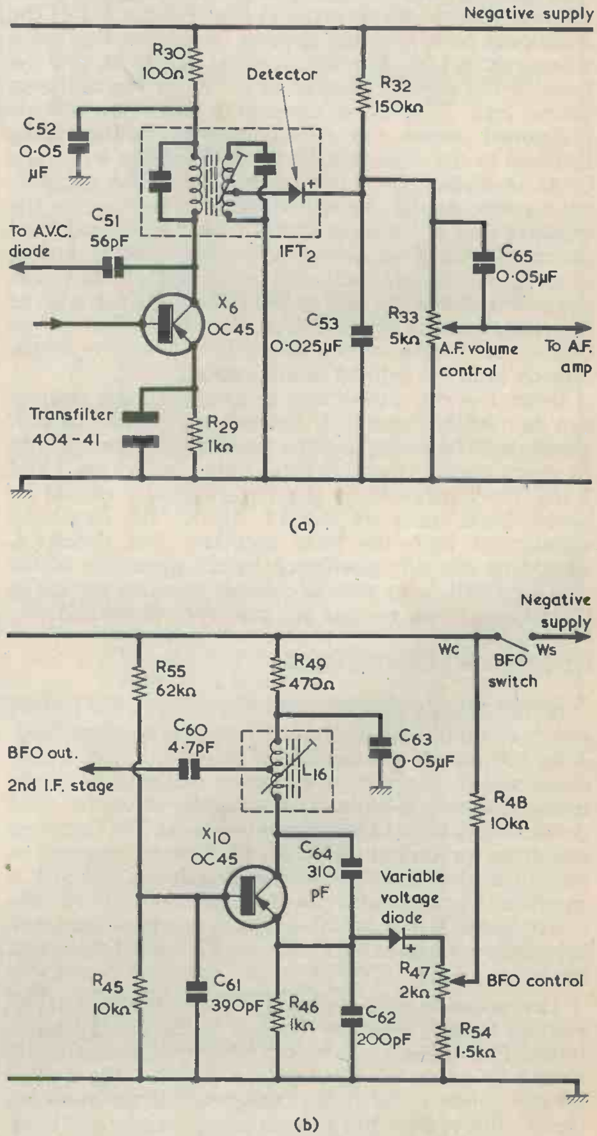



*Fig. 4 (a). The third i.f. stage of the receiver in unmodified form*
*(b). The unmodified b.f.o. stage.*

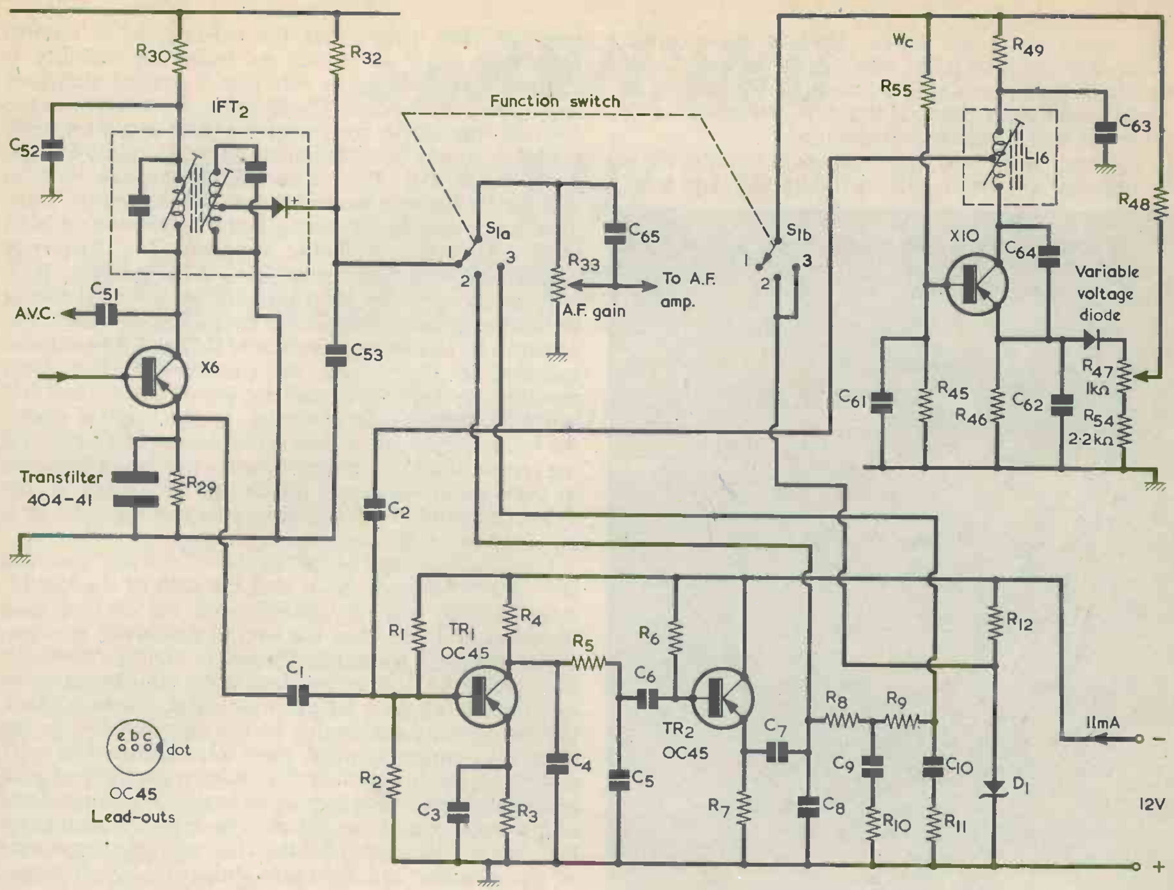



*Fig. 5. The added product detector circuit, including the interconnections to the third i.f. and b.f.o. stages*

form across load resistor R4 and fed into the filter circuit C4, R5, C5. The characteristics of this filter help give the resultant output the correct shape and frequency bandpass, the insertion loss involved being catered for by the signal gain achieved in TR1.

The filter output is fed via coupling capacitor C6 to the emitter follower TR2, the final output signal being developed across emitter load resistor R7. The purpose of TR2 is to give isolation between detector TR1 and the audio output circuits and also to provide a low impedance output for easy matching into the audio input circuit. The final output is taken via blocking capacitor C7, through the function switch S1, to the receiver first audio stage.

An optional extra audio filter circuit is also connected, via isolating resistor R8, to the output. This filter is formed by R9, R10, R11, C9 and C10 and it is a simple low-pass circuit which can be switched in by the function switch to give a narrow audio acceptance band. Such a facility can prove useful in both s.s.b. and c.w. modes. It would normally only be used under crowded band conditions and in effect it helps to improve selectivity. The filter can, however, be omitted if required. C8 forms a capacitor divider in conjunction with C7 and provides simple top cut. It clips overall upper bandwidth limits to an acceptable level, though it does tend to reduce sensitivity slightly. Its value can be altered to suit individual receivers.

Function switch S1 (a) (b) allows selection of a.m., s.s.b./c.w., and narrow band s.s.b./c.w. on positions 1, 2 and 3 respectively, and section (a) is inserted between the last i.f. stage and the a.f. input. In position 1 the output from the a.m. detector is taken directly, via S1 (a) to the a.f. input. In positions 2 and 3 the outputs from the product detector are taken to the a.f. input while the a.m. detector is left out of circuit. At the same time the supply to the b.f.o. is switched in by S1 (b). It will be noticed that the i.f. output is taken from the emitter of X6. This was done to avoid having to break into the I.F.T.2 circuit, with the resultant damping which would result due to the loading effect of the product detector. The point selected has a much lower impedance and is much less prone to the effects of external loading. In practice the a.m. performance of the receiver was completely unchanged.

In common with most simple product detectors it is still necessary to carry out final tuning with the b.f.o. control. This meant that the existing b.f.o. control required a little attention. As frequency stability is extremely critical it was felt that a special stabilized supply was warranted. The existing zener diode in the receiver was left to cope with the local oscillator only, the b.f.o. supply being taken via S1 (b) from the 6.8 volt zener diode D1. This is connected through limiting resistor R12 across the stabilized 12 volt supply. Thus, in effect, a double stabilizing factor is present on both local and b.f.o. oscillator supplies. The frequency variation covered by the existing b.f.o. control, R47, was found to be too great, making incremental tuning somewhat difficult. A smaller frequency coverage was obtained by changing the values of R47 and R54 to those specified in Fig. 5 and the Components List. This modification kept the overall d.c. conditions correct and provided greater ease of tuning. In the original circuit the b.f.o. supply was turned on by means of a switch on the rear of the b.f.o. potentiometer, this being operated by pulling out the centre spindle. As the supply is now switched on by S1 (a) (b), this control is replaced by a standard potentiometer.

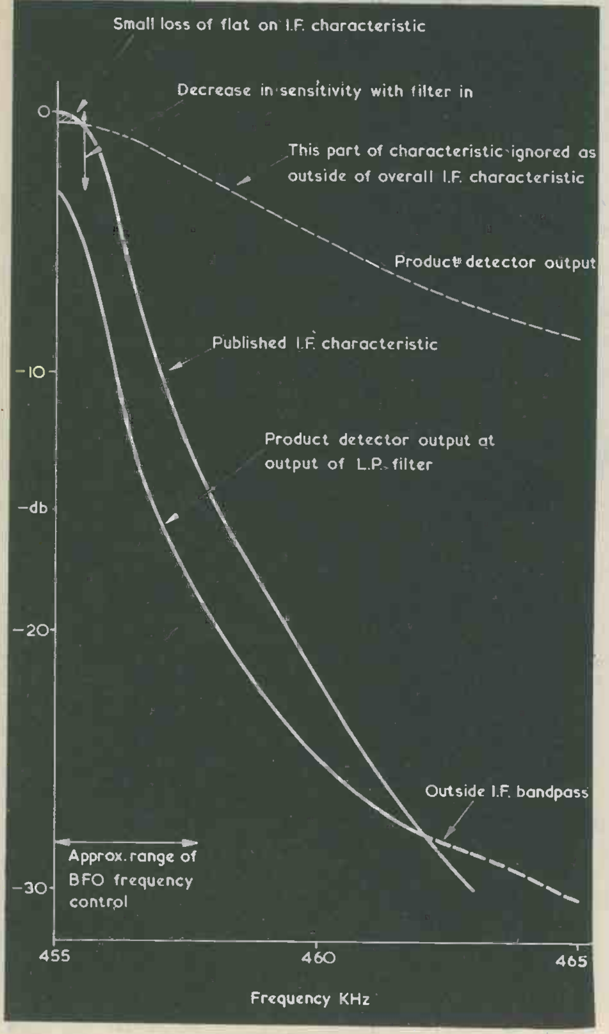



*Fig. 6. The relative differences in sensitivity between the product detector output and published i.f. output. The measured characteristics are static only*

One disadvantage of taking the i.f. output from the emitter of transistor X6 is that the gain of the last i.f. stage is lost. This is compensated for by the gain obtained in TR1. Thus the overall sensitivity is maintained although the selectivity suffers slightly. When the low pass audio filter is switched in (S1 (a) (b) in position 3) an apparent drop in sensitivity is of course noticed, this being unavoidable due to the insertion loss in the filter. As, under crowded band conditions, sensitivity is often of less importance than selectivity, this loss is of negligible importance in most instances. When measured under static signal conditions, the apparent sensitivity loss was in the order of 3db. The static characteristics of the detector and filter are shown in Fig. 6 superimposed over the published i.f. characteristic of the receiver. It can be seen that negligible flat loss occurs with the product detector in circuit. The choice of germanium OC45 transistors was simply in order to keep the modifications in line with the existing receiver circuit, this type already being used both for the i.f. stages and the b.f.o. The additional circuits will be virtually unaffected by normal temperature changes met with in practice.

Constructional details for adding the product detector circuit will be given next month. More precise details of the Veroboard and the brackets required for its mounting, as included in the Components List, will also be provided next month. The relatively large value capacitors specified for C7 and C8 are available from several suppliers, including Marco Trading, The Maltings Station Road, Wem, Salop. As will be explained in the next article, C8 may required adjustment in value.

(*To be concluded*)

## BACK NUMBERS

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

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 6p postage.

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

We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

# SERVICING THE TRANSISTOR PORTABLE

## Part 2 by Vivian Capel

**In this concluding article of our 2-part series the problem of low sensitivity is dealt with. Also described is the procedure of alignment using received signals**

THE COMMON CAUSES OF NO-SIGNAL AND DISTORTION faults were dealt with in the first article, published last month. Low sensitivity is another trouble that is often encountered. As with other faults, the battery voltage should be checked first; whilst a low battery voltage normally produces distortion, many modern circuits allow the battery voltage to fall appreciably before distortion takes place, and in these cases low volume or sensitivity can be the first symptom of a failing battery.

Almost any stage can give rise to low sensitivity, but not often the output stage as troubles here usually produce distortion. A quick check as to whether the trouble exists before or after the detector is to detune and turn the volume up. A strong background hiss suggests that the audio circuits are in order and that the trouble is in the earlier stages.

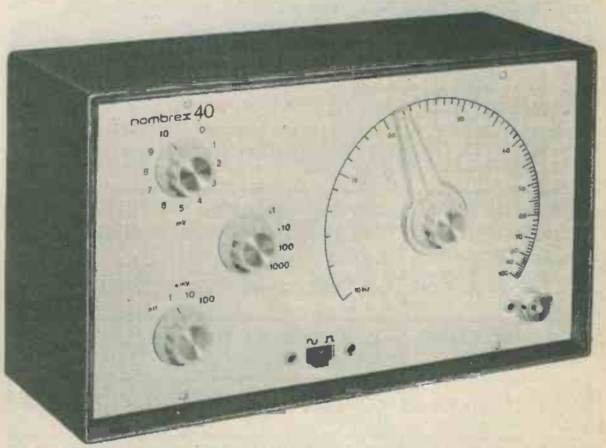
### MECHANICAL DAMAGE

As with the other faults dealt with last month, mechanical damage is responsible for many low-sensitivity troubles. A very frequent cause is a broken ferrite aerial rod; the ferrite material is very brittle and is usually the first thing to suffer in a fall. Sometimes the effect of a broken rod is not too great, although there is bound to be some loss of signal and the rod will still, of course, have to be replaced. Also, the coils may become misplaced, thereby upsetting the r.f. alignment and there may even be a broken wire. The coils can become loose without the rod being broken and so this should be one of the first things to check.

When obtaining a replacement rod make sure that the diameter is correct as well as the length. Most rods are standard sizes which can be readily obtained from the component firms.

Sometimes, when a rod breaks, the coils are damaged by impact against some sharp component or object. The long-wave coil, being usually wave-wound, often suffers, with damage penetrating to several layers. This may cause a complete open-circuit or short-circuit of several turns. Do not be misled by the fact that both wavebands are affected, short-circuited turns will affect any other coil on the rod just as short-circuited turns on a transformer winding affect the whole transformer.

Faulty transistors are also fairly common, and these can be diagnosed in the same way as with the other faults, by voltage readings and by shunting a replacement across the suspected transistor. A signal tracer or injector can be useful for comparing the gain along the r.f. and i.f. stages and thus localizing the defective stage. A check on the i.f. stages can be made by detuning each i.f. transformer in turn. There should be a sharp tuning peak in each case with the possible exception of the final transformer, which will be damped by the detector diode. If it is possible to rotate the core by more than a turn or so without any drop in volume, the associated




*A wide range of test equipment is manufactured by Nombrex (1969) Ltd., Exmouth, Devon. Shown here is the Nombrex Model 40 low frequency signal generator which offers outputs from 10Hz to 100kHz in four switched decade ranges* stage would appear to be faulty. Sometimes a stage may be completely inoperative, yet low-volume results can still be obtained due to stray coupling from the preceding stage. Thus the signal 'jumps' the offending stage. Where a good peak is obtained there is unlikely to be a fault in that part of the circuit. Return each core to its optimum position before passing to the next.

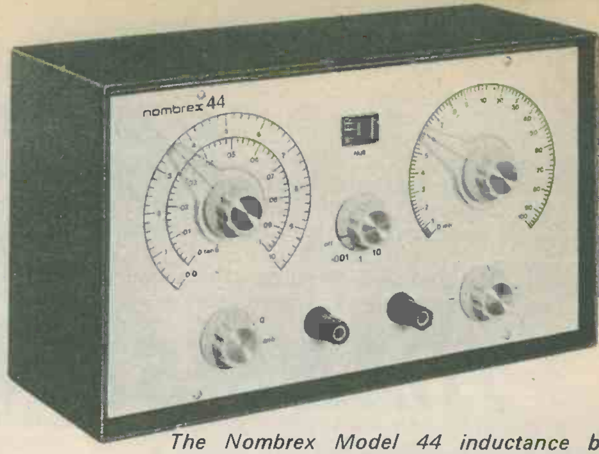
## ALIGNMENT

Now we come to the matter of alignment. Knocks and jolts can loosen cores and coils and throw the alignment out, but more commonly it is the owner who, when performance falls due to some other cause such as the battery, catches sight of the trimmers and proceeds to screw them all up tight! Whatever the cause though, and even with a set which is working tolerably well, an alignment will often bring a marked improvement.

Conventional alignment procedure calls for the use of a signal generator, an output meter and the maker's alignment instructions. However, this is not at all necessary with the simple circuits encountered in receivers of the type being discussed, and in fact the time involved in setting up the equipment would make the job uneconomic. Few professional engineers align these receivers by any other means except by ear and broadcast transmissions, using test equipment only with the more sophisticated sets and those with an f.m. band.

Firstly the i.f. transformers are aligned. A radio transmission should be chosen that is weak in order to avoid a.g.c. action, yet which is steady and not subject to fading. One of the more distant B.B.C. medium wave stations will usually serve the purpose. Volume is kept low as the ear is more sensitive to volume changes at the lower end of the range.

It can be assumed that the i.f. transformers are already near their correct frequency. Exact frequency is not important (some new sets of the same model have been received from the makers aligned to slightly different i.f. frequencies) as long as they are all tuned to the same one. Staggered tuning is not often en-




*The Nombrex Model 44 inductance bridge, which is capable of measuring inductances from 1µH to 100H. This incorporates two measuring processes, allowing readings to be taken with air-cored and iron-cored inductors*

countered with this class of receiver. All then that needs to be done is to tune each transformer, starting from the last one, for maximum volume, repeating the procedure at least once. If a weak station is used there will be a background hiss from the local oscillator, and it is sometimes easier to listen to this when making adjustments as this is steady whereas the programme content is varying. Always use the correct trimming tool for adjusting the transformer cores.

Next comes the oscillator. Circuits differ somewhat here, and the differences affect alignment considerably. Most circuits use a single oscillator coil for both wavebands, an additional parallel fixed capacitor being switched into circuit on long waves. In some cases, however, a long wave oscillator trimmer is switched in as well, and the alignment procedure depends on whether this trimmer is present or not.

First of all, then, look for a trimmer apart from those across the two sections of the tuning capacitor. Those sets having a bandspread medium wave band in addition to the normal medium wave range will have extra trimmers and these will have to be identified. This can be done by giving each trimmer a slight turn back and fourth and noting which waveband is affected. Oscillator

**Table I**

*Alignment of receivers with separate oscillator long wave trimmer*

| Tune to: | Adjust: |
|---|---|
| Weak medium wave station | 3rd i.f. transformer for max. volume<br>2nd i.f. transformer for max. volume<br>1st i.f. transformer for max. volume<br>Repeat |
| Radio 3, 464 metres station near 200 metres, or Radio 1, 247 metres | Osc. coil for correct dial setting<br>Osc. gang trimmer for correct dial setting<br>Repeat |
| Radio 2, 1,500 metres | Long wave osc. trimmer for correct dial setting |
| Weak long wave station | Long wave aerial coil for max. volume |
| Radio 3, 464 metres, or nearby weak station. Weak station near 200 metres | Medium wave aerial coil for max. volume<br>Aerial gang trimmer for max. volume<br>Repeat |

**Table II**

*Alignment of receivers without oscillator long wave trimmer*

| Tune to: | Adjust: |
|---|---|
| Weak medium wave station | 3rd i.f. transformer for max. volume<br>2nd i.f. transformer for max. volume<br>1st i.f. transformer for max. volume<br>Repeat |
| Radio 2, 1,500 metres, and Radio 3, 464 metres. Station near 200 metres, or Radio 1, 247 metres | Osc. coil for compromise dial setting<br>Osc. gang trimmer for correct dial setting<br>Repeat |
| Weak long wave station | Long wave aerial coil for max. volume |
| Radio 3, 464 metres or nearby weak station. Weak station near 200 metres | Medium wave aerial coil for max. volume<br>Aerial gang trimmer for max. volume<br>Repeat |

trimmers tune sharply and have the effect of tuning the entire receiver, whilst aerial trimmers are more flat.

## SEPARATE TRIMMER

If we have a straightforward two-waveband receiver with a separate long wave oscillator trimmer, we start with the medium wave band. Tune in a station near the low frequency end of the scale (i.e. with the 2-gang capacitor near maximum), Radio 3 on 464 metres being suitable. Adjust the oscillator coil core to bring the station to the correct point on the station scale. Now tune to the other end of the band and tune in a suitable station; a station near 200 metres or Radio 1 on 247 metres will do. Adjust the oscillator trimmer on the 2-gang capacitor to bring the station onto the correct point on the scale. Repeat both adjustments for optimum accuracy.

Switch next to long waves and adjust the long wave oscillator trimmer to bring the Radio 2 programme in at 1,500 metres. This will not affect the medium-wave alignment.

If the set does not have a long wave oscillator trimmer a different procedure must be adopted because adjustments will affect both wavebands. First, switch to long waves and adjust the oscillator coil core to bring in the Radio 2 programme at 1,500 metres. Now switch to medium waves and check that the Radio 3 programme or a similar station at the low frequency end of the band comes in at the right point on the dial. If it does not, the oscillator core must be re-adjusted to effect this. It may now be found that the Radio 2 programme is off calibration, so a compromise must be reached between the two. As the long wave stations are broader tuned than those of the medium wave, it is usually better to arrange for the larger error to be on the long wave band. Next, tune to the high frequency end of the medium wave band and bring in a station near 200 metres or Radio 1 in the correct place by the oscillator trimmer on the 2-gang capacitor. As this will affect the other settings, the three adjustments may have to be repeated several times to bring about a satisfactory compromise.

Finally there are the aerial circuits. Weak stations should be used for aerial alignment. For the long wave band all that is needed is to slide the long wave coil (the larger one) along the ferrite rod for best results. A weak long wave station can be chosen for this in preference to the Radio 2 programme, and adjustment is made for maximum volume.

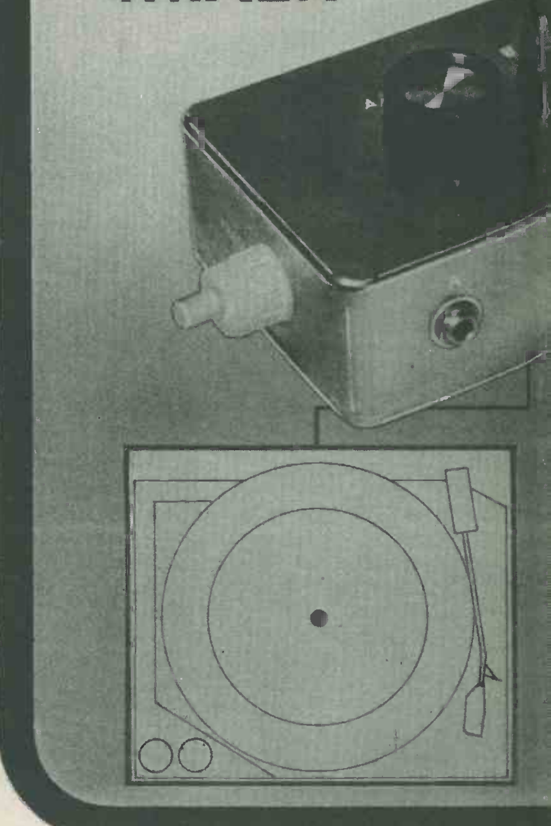
Then switch to medium waves. The low frequency end of the medium wave band is set up by moving the medium wave aerial coil along the ferrite rod followed by an adjustment of the aerial trimmer on the 2-gang capacitor at the high frequency end. These two adjustments may need to be repeated to find the optimum settings. If no means of ensuring that the aerial coils remain steady in their new positions is provided, melt some wax over the coil ends to secure them to the ferrite rod.

In the case of sets with a separate long wave trimmer, both oscillator and aerial circuits can be adjusted before passing to the long wave band. However, with those without such a trimmer all oscillator adjustments must be carried out first because of their interdependence.

By following the hints and tips, as used in dealers' workshops, which have been given here and in last month's issue, speedy and economical repairs are possible in a large number of cases. ■

*Cover Feature*

# MINIATURE 3 MIXER



A completely self-c
audio mixer which
input impedances
1MΩ. An integral
po

THIS MIXER IS ASSEMBLED IN A BOX WHICH MEASURES only 4½ by 2¼ by 1 in. deep, yet it is completely self-contained, power being obtained from an internal 9 volt battery. Three inputs are provided at nominal input impedances of 50kΩ, 500kΩ and 1MΩ, but other combinations of these impedances can be used according to the constructor's requirements. Individual volume controls are provided for each channel.

Five inexpensive silicon transistors are employed in the circuit. Current consumption from the PP3 battery is approximately 4mA, giving a very reasonable battery life.

## PASSIVE MIXER CIRCUIT

Before proceeding to a description of the mixer unit it will be of interest to examine a passive mixer circuit. A typical example is given in Fig. 1 and this represents the basis of a large number of mixers. It is really a simple voltage adding circuit.

In Fig. 1, VR1, VR2 and VR3 are the volume controls for their respective channels. The fixed resistors R1, R2 and R3 between the potentiometer sliders and the output are required to provide a certain degree of isolation between the volume controls. If these resistors were omitted, adjustment to any one control could seriously affect the level of the other two channels.

Operation of the circuit is fairly obvious. The voltage at the output is the sum of the three input voltages divided by the degree of attentuation inherent in the circuit. The attenuation will depend upon the setting of the volume controls and the impedance into which the output of the circuit is coupled.

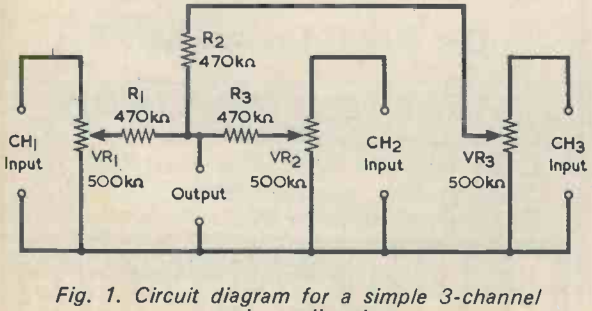
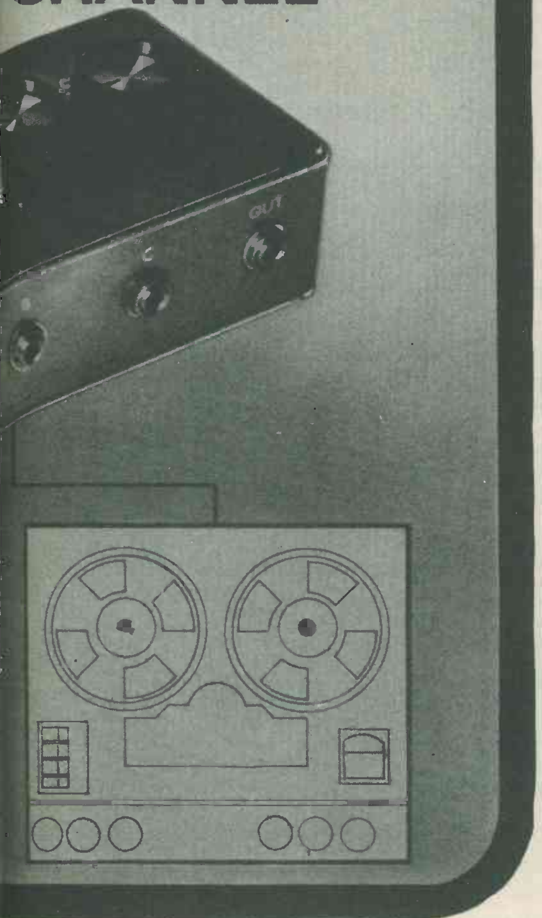



*Fig. 1. Circuit diagram for a simple 3-channel passive audio mixer*

# CHANNEL




by R. A. Penfold

contained 3 channel
h provides nominal
of 50kΩ, 500kΩ and
amplifier is incor-
ted.

## COMPONENTS

*Resistors*
(All fixed values $\frac{1}{4}$ or $\frac{1}{8}$ watt miniature, 10%)

| | |
|---|---|
| R1 | 100kΩ |
| R2 | 100kΩ |
| R3 | 1MΩ |
| R4 | 560kΩ |
| R5 | 1MΩ |
| R6 | 39kΩ |
| R7 | 39kΩ |
| R8 | 39kΩ |
| R9 | 100Ω |
| R10 | 2.2kΩ |
| R11 | 2.2kΩ |
| R12 | 1.5MΩ |
| R13 | 1kΩ |
| VR1 | 5kΩ potentiometer, log |
| VR2 | 5kΩ potentiometer, log |
| VR3 | 5kΩ potentiometer, log |

*Capacitors*
(All miniature – see text)

| | |
|---|---|
| C1 | 1µF electrolytic, 10 V.Wkg |
| C2 | 0.47µF plastic foil |
| C3 | 0.22µF plastic foil |
| C4 | 10µF electrolytic, 10 V.Wkg |
| C5 | 10µF electrolytic, 10 V.Wkg |
| C6 | 100µF electrolytic, 10 V.Wkg |
| C7 | 10µF electrolytic, 10 V.Wkg |
| C8 | 220pF ceramic wafer |

*Transistors*

| | |
|---|---|
| TR1 | 2N3702 |
| TR2 | 2N3702 |
| TR3 | 2N3702 |
| TR4 | 2N2926, Y or G |
| TR5 | 2N2926, Y or G |

*Switch*
S1 S.P.S.T. switch (see text)

*Battery*
B1 9 volt battery type PP3 (Ever Ready)

*Miscellaneous*
4-off 3.5mm. jack sockets
Veroboard panel, 0.1 in. matrix, 9 strips by 15 holes
Battery connector clips
Diecast box type 7134P (Eddystone)
3 control knobs

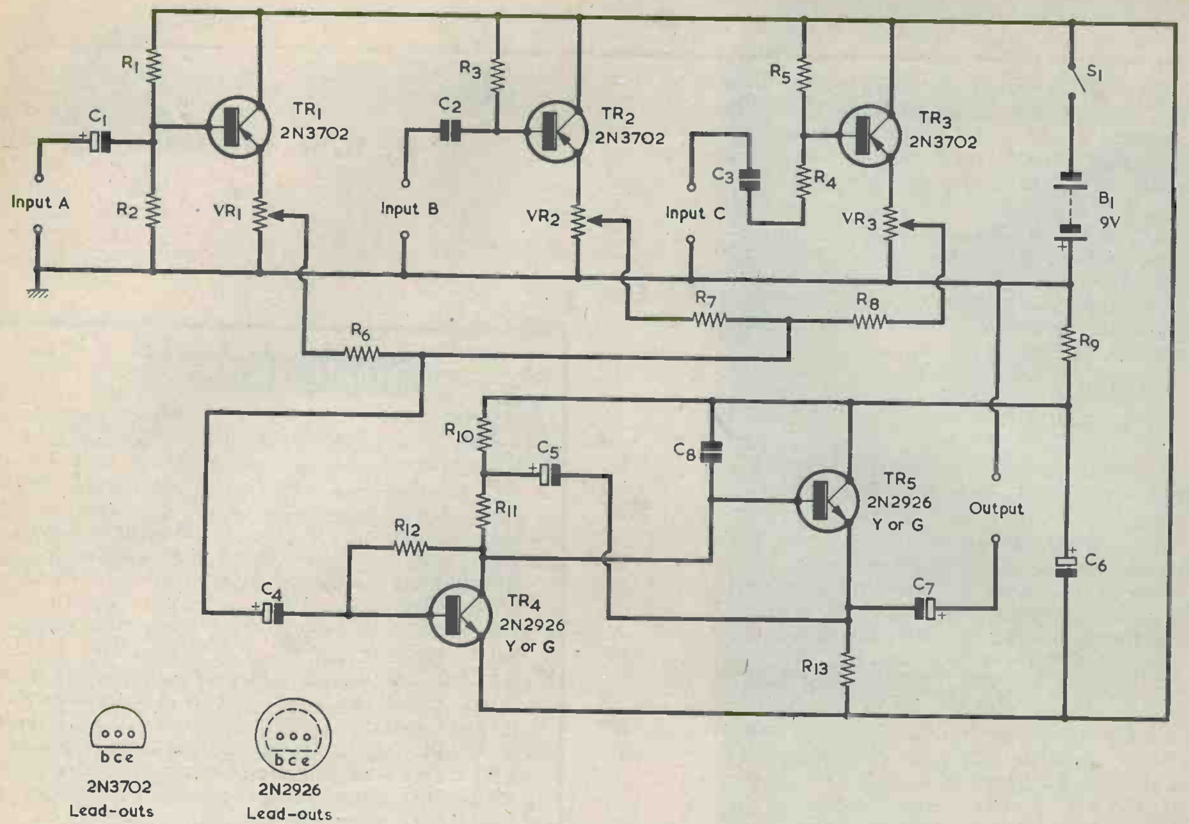



*Fig. 2. The circuit of the 3-channel mixer with integral amplifier which is described in this article. The three inputs and the output are connected to jack sockets*

## ACTIVE MIXER

Whilst circuits of the type shown in Fig. 1 are adequate, they have two main disadvantages. Firstly, there is the fact that there is a substantial loss between each input and the output, even with the volume controls set at maximum. Secondly, the input impedance of each channel varies considerably with the settings of the volume controls. If more channels were to be added to the circuit, the situation would be worsened. This state of affairs can be improved by raising the values of the fixed resistors, but this would result in an increase in the attenuation given by the circuit.

In an active mixer, an amplifier is used to boost the output of a passive mixer and thus overcome the attentuation problem. The circuit diagram of the active mixer constructed by the author is shown in Fig. 2.

The mixing section of this circuit is given by VR1, VR2, VR3, R6, R7 and R8. It will be seen that, when compared with the circuit of Fig. 1, the value of the fixed resistors has been greatly increased in proportion to that of the potentiometers.

An emitter follower is used at each input. An emitter follower has slightly less than unity voltage gain, but it offers a high input impedance and a low output impedance. The input impedance is approximately equal to the emitter load resistance multiplied by the current gain of the transistor, this impedance being shunted by the base bias resistor or resistors.

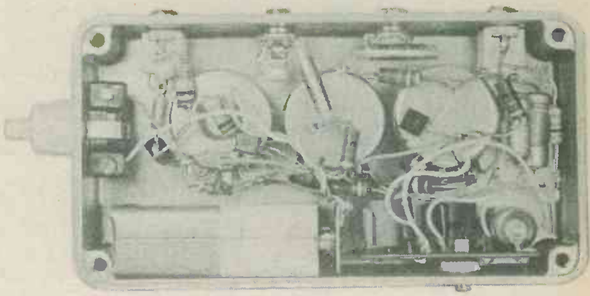
Channel A has purposely been given values of biasing resistor which shunt the input heavily. This is done to give an input impedance of slightly less than 50kΩ, and is suitable for moving coil microphones having matching transformers intended for this impedance. Channel B has an input impedance of approximately 500kΩ and can take a signal from a tape recorder, etc. Channel C has basically the same circuit as Channel B, but the input impedance has been raised to approximately 1MΩ by the addition of the series resistor R4. In consequence, the sensitivity of this input is only about half that of the other two. It can take the output from a crystal microphone or ceramic pickup, etc.

Should the constructor feel that a different combination of input impedances would suit his purposes better, there is no reason why the input circuits should not be changed around to accommodate these needs. For instance, if the unit was required as a microphone mixer for three 50kΩ moving-coil microphones, then the input circuit for Channel A (comprising C1, R1 and R2) could be repeated at the inputs for Channels B and C.

Transistors TR4 and TR5 function as voltage amplifier and emitter follower output stages respectively.

TR4 is biased by R12, which is connected to its collector. This collector couples directly to the base of TR5, the signal at TR5 emitter appearing across the output load resistor R13 and being fed back, also, to the junction of R10 and R11 via C5. This bootstrapping technique offers an increase in the voltage gain provided by TR4.

The bootstrapping process operates in the following manner. If an input signal causes an increase in the voltage at the collector of TR4 there will be a similar and nearly equal increase at the emitter of TR5. The latter increase is coupled to the junction of R10 and R11, with the result that any increase in the voltage at the lower end of R11 is matched by a similar and nearly equal increase at its upper end. There is therefore an almost constant voltage across R11 and it offers what is effectively a very high resistance to a.c. signals. This apparently high resistance causes TR4 to give a very high voltage gain.



*The wiring and component layout inside the case*

## CONSTRUCTION

The components are housed in an Eddystone diecast box type 7134P. This is available from Home Radio under Cat. No. E896. All the fixed resistors and capacitors should be miniature types. The electrolytic capacitors are specified as 10V.Wkg but it will be in order to employ capacitors with higher working voltages if these enable available miniature types to be used. If, for instance, the capacitors are all Mullard Miniature Electrolytic types, C1 may be 40V.Wkg, and C4, C5 and C7 may be 16V.Wkg. An alternative for C6 is the 125μF 10V.Wkg capacitor in the Mullard Miniature Electrolytic range, and this may be used if a suitable 100μF capacitor cannot be obtained. The Home Radio Cat. Nos. for the capacitors just mentioned are 2CH05 (1μF), 2CH23 (10μF) and 2CH60 (125μF). C8 may be any small miniature capacitor, such as ceramic wafer (Home Radio Cat. No. C87N). The components employed in the prototype for C2 and C3 are not standard types, but Mullard Miniature Foil capacitors Type C280 will fit in here. The 0.4μF capacitor is listed under Home Radio Cat. No. 2EH58 and the 0.22μF capacitor under Home Radio Cat. No. 2EH53. The three potentiometers are small modern types having a body diameter of ⅞ in. or less. The on–off switch used in the author's unit is a push-on push-off switch obtained from Woolworth's stores. A small slide switch could be fitted in its place, if desired.

Since there is not a great deal of space inside the case, point-to-point wiring, in which some junctions are not anchored at individual tags, is used in the assembly of the three input emitter follower circuits. Fig. 3 shows much of this wiring, part of it having been omitted for reasons of clarity. The omitted wiring consists of the following. First, an insulated wire connects together the three transistor collectors and then continues to one side of the on–off switch. A flexible insulated wire terminated in the battery negative clip is connected to the other side of the switch. An insulated wire joins

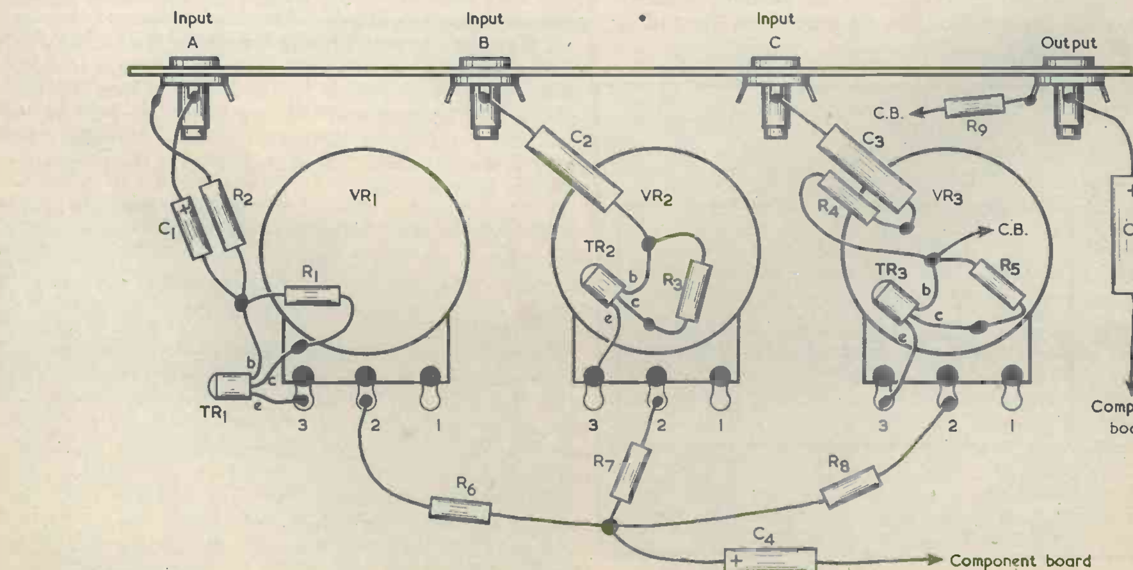



*Fig. 3. The main wiring around the jack sockets*

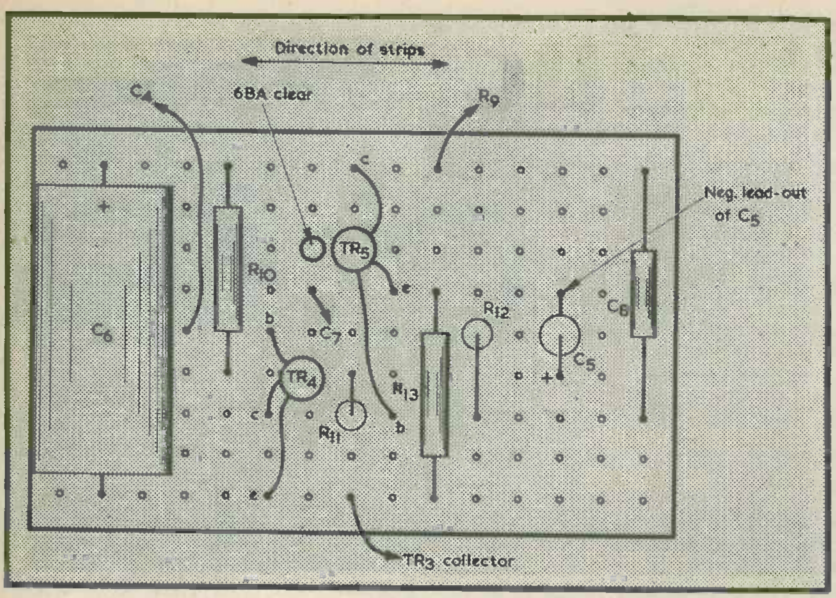



*Fig. 4. The Veroboard assembly, seen from the components side*

together the tags 1 on the three potentiometers and then connects to the earthy tag of input jack A. A flexible insulated lead terminated in the positive battery clip connects to the earth tag of input jack B. It will be found helpful not to fit R9, C4 and C7 at this stage.

A small Veroboard panel, of 0.1 in. matrix and having 9 strips, each with 15 holes, is used for the amplifier assembly. None of the strips is cut, but a 6BA clear hole is drilled out as indicated in Fig. 4, which shows the component side of the board. As can be seen from the photograph illustrating the interior of the unit, this board is mounted to the box side opposite jack C and the output jack, with C6 near the end of the case. The corresponding 6BA clear mounting hole in the box side may be marked out with the aid of the Veroboard panel after this has been drilled. Its distance from the end is indicated in Fig. 5.

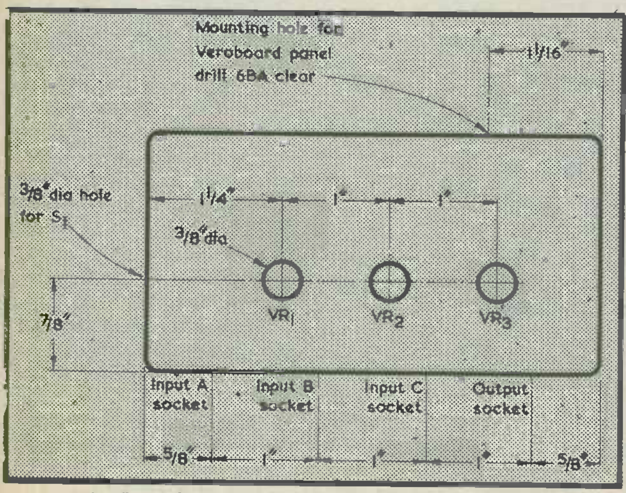



*Fig. 5. Drilling details for the case. The positions of the 6BA clear hole and the holes for the on–off switch and jack sockets are discussed in the text*

To prevent the strips on the copper side of the Veroboard from short-circuiting against the inside surface of the case, and also to prevent the board edge from fouling the locating ridge on the case cover, a few washers made from an insulating material should be passed over the 6BA mounting bolt to space off the Veroboard panel. There should be sufficient washers to space the Veroboard away from the case inside surface by ⅛ in.

It will be noted from Fig. 4 that a lead passes from the board to TR3 collector. This lead picks up the negative supply for the amplifier. There are connections also from the board to C4, C7 and R9. The requisite leads are fitted to the board before it is mounted. They may then be cut to the correct length, the appropriate components fitted and final connections made up.

A diagram showing drilling details for the front panel of the case is given in Fig. 5. The view here is looking down on the front panel. The holes in the side and end for the jack sockets and the switch are all ⅜ in. down from the front panel surface. The hole diameters for the jack sockets should be such as to suit the particular make of sockets used.

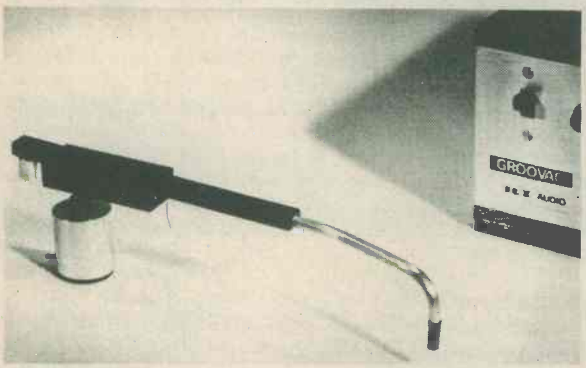
It is possible that the inside surface of the case cover could touch one or more parts of the point-to-point wiring when the cover is fitted. Should this risk exist, strips of adhesive p.v.c. insulating tape should be applied to the inside surface of the cover at the appropriate positions.

The case cover, when bolted down, should hold the battery firmly in position. If the battery is found to be at all loose, a pad of foam rubber or plastic may be affixed to the back of the front panel over the area occupied by the battery, and another pad, similarly positioned, to the inside of the cover.

To complete the unit, the case should either be cleaned and then painted, or polished to give a bright natural finish. Legends to indicate control and jack functions may then be applied to the front and sides, these legends being taken from 'Panel Signs' Set No. 3. 'Panel Signs' are available from the publishers of this journal. ■

# New Products

## VACUUM RECORD CLEANER




**R.I. Audio, claim that their new "Groovac" record cleaner is the only unit available which removes dust from records by vacuum cleaning.**

**The suction method is available for the effective removal of the fine dust particles which collect inside record grooves and which are responsible for record and stylus wear. A tracking force of only 0.7 gram has been achieved by using a lightweight design with lubricated-for-life bearings throughout.**

**The Groovac consists of a precision lightweight arm, and a suction unit which is acoustically isolated in a special enclosure. The suction unit has been designed to be inaudible at a distance of 2 metres; it has a mains switch and indicator, and is attractively finished in teak. It mounts by means of an extremely convenient magnetic base, and its height is adjustable to suit different turntables. When not in use it is simply rotated outwards and lowered onto its integral rest.**

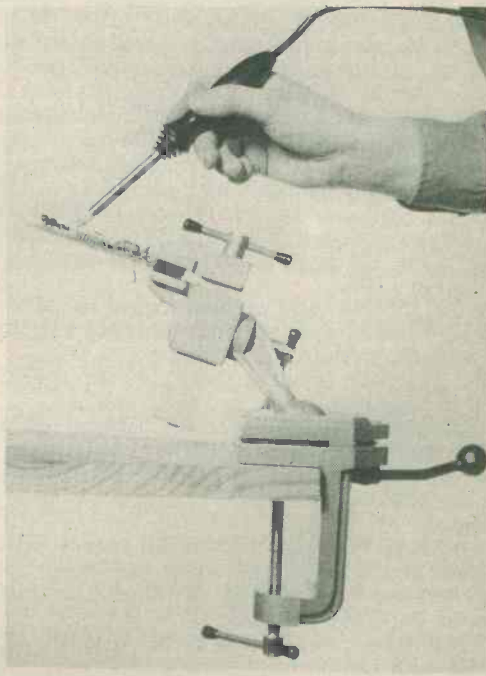
**Price £6.90 plus VAT. Further details from R.I. Audio, Kernick Road, Penryn, Cornwall.**

## ADJUSTABLE BENCH VICE

A new model of the Oryx adjustable bench vice is available from W. Greenwood Electronic Limited, 21 Germain Street, Chesham, Bucks. HP5 1LL. The vice has been restyled to present a completely versatile laboratory tool. The new model now comprises four parts: the bench clamp, steel ball joint so that the whole unit above the bench can be easily moved, a rotating head and the miniature adjustable vice.

Each of the parts is adjusted to suit the position of the component in the jaws and to give complete rigidity. The clamp will fix onto surfaces up to 85mm thick and the jaws open to a maximum distance of 47mm. The fibre faced jaws have replaceable pads and will hold the most delicate components without damage.

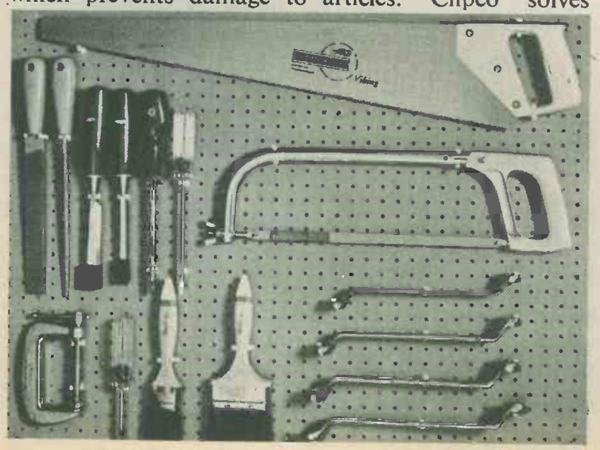
The new bench vice is available at £13.15 from W. Greenwood and the distributors Electroplan Limited, PO Box 19, Orchard Road, Royston, Herts. SG8 5HH.



## REVOLUTIONARY CLIP

Herbert Terry & Sons Limited, spring manufacturers of Redditch, England, announce the launch of their revolutionary "Clipco" do-it-yourself clip.

"Clipco" is versatile, easily fixed, no screwing required, of unbreakable, resilient rust-free nylon which prevents damage to articles. "Clipco" solves many fixing problems around the home and is a specially designed dual purpose plug which ensures efficient fixing to walls, tiles, wood and pegboard. The applications include holding tools in the garage or shed, bathroom fixtures, kitchen utensils, electric wires and cables, display boards and many garden and greenhouse fixings.



"Clipco" was launched at the recent Hardware Trade Fair at Olympia, is now available from hardware stores, and do-it-yourself shops.

"Clipco" are available in three choices of visual blisters, containing 8, 9 or 10 clips, dependent on size and shape. The recommended retail price of blisters is 21p to 23p. They are also available in bulk – 100 at £2.18.

# SHORT WAVE NEWS

## FOR DX LISTENERS

**By Frank A. Baldwin**

*Times*=GMT

*Frequencies*=kHz

Like most other short wave broadcast bands, the 15MHz range offers some interesting programmes from stations around the world, not all of them easy to log by any means despite the comparatively high powers used. Some stations are not regularly reported here in the U.K. owing to the fact that they are, more often than not, 'buried' under more local and powerful transmitters and the listener must therefore await propagation conditions which favour the weaker transmission. Recently, such conditions occurred when the VOA (Voice of America) transmitter on **15225** (19.71 metres) at Greenville was 'down', allowing BED99 at Taipei, Taiwan, to be logged here in the U.K. We logged Taipei at 1832 when a programme of classical music with announcements in English was being radiated.

BED99 has also been logged by Bob Iball of Langold, Worksop, an old-timer SWL who heard the station identification at 1840 as "The Voice of Free China broadcasting from Taipei in Taiwan". Bob also heard them again on a later date at 1400 on the parallel channel of **17720** (16.93m), this being BED39.

Bob also logged on this band Radio Japan at 1100 on **15195** (19.74m), also in parallel on **17855** (16.80m); BBC Tebrau closing at 1830 on **15310** (19.60m); Kuwait at 1845 on **15415** (19.46m) and Peking on **15030** (19.96m) at 1540.

On the 15MHz band we have logged the following:

Radio Canada International on **15325** (19.58m) at 2115 with the world news in English.

BBC Ascension Island on **15400** (19.48m) at 1742 with a talk in English on crime and the criminal.

Voice of America, Monrovia, Liberia, on **15445** (19.43m) at 1904 with the world news in English.

Hanoi, North Vietnam, on **15012.5** (19.99m) at 1802 with the news, from the N. Vietnamese point of view, in English.

WIBS Radio Grenada, Windward Islands, on **15105** (19.86m) at 2025 with pop songs and music and the announcement "Advertising stimulates the economy, advertise on Radio Grenada".

ZYN32 Radio Nacional Brasilia, on **15445** (19.43m) at 2036 with station identification in French followed by guitar music.

### AROUND THE DIAL

**● ITALY**

Rome may be heard with a programme in English, directed to the U.K. on **11800** (25.42m) at 1945, at which time it was logged here.

**● FINLAND (1)**

OIX8 Pori, logged on **11755** (25.52m) at 2040 with news of Finnish affairs in English.

**● IRAQ**

Baghdad heard with station identification at 2011, in English, on **9745** (30.78m), programme in English from 2000.

**● SYRIA**

Damascus may be heard at 2000 on **9655** (31.07m) when station identification and the English programme commences.

**● IRAN**

Teheran on **9022** (33.25m) at 2015 with news of Iranian affairs in English.

**● BULGARIA**

Sofia on **9700** (30.93m) at 1930 with a programme in English for the U.K. Also on 6070 (49.92m) at 1942 with identification and an Amateur bands Dx programme.

**● ECUADOR**

HCJB Quito can be heard on **11845** (25.33m) at 2117 in German and also on **15315** (19.59m) at 2045 with identification after the English programme and into French at 2046.

For morning listeners, HCJB can be heard at 0745 on **11915** (25.18m) with a programme in English, we logged a programme about crime and punishment.

**● AUSTRALIA**

Radio Australia, Shepparton, is to be heard at 0734 on **9570** (31.35m) at which time we heard a programme about Australian internal affairs. Radio Australia can also be logged at 0643 on **11765** (25.50m) with the tuning signal "Waltzing Matilda" (musical box rendition), the "laugh" of the Kookaburra bird, station identification at 0645, musical programme and the world news at 0715.

**● ZAIRE**

Kinshasha is to be heard at 1925 on **4879** (61.48m) with announcements in French and, more often than not, African music complete with drums and other percussion instruments.

**● NIGERIA**

Benin City can often be logged around 2200 on the regular **4932** (60.83m) channel (when the teletype transmitter is silent). We heard them recently at 2304 when signing-off with the National Anthem.

**● FINLAND (2)**

OIX2 Pori may be heard at 1815 with news of Finnish affairs on **9555** (31.40m). Also at 2050 with a review of the Finnish Press on **15185** (19.76m), this being OIX4 at Pori.

**● SOUTH AFRICA**

Radio RSA from the Johannesburg transmitter has an External Service in English to Europe from 1800 to 1850 on **11970** (25.06m) and on **15175** (19.77m). On

Sundays there is a programme for the U.K. from 1000 to 1050 on **17780** (16.87m) and on **21490** (13.96m). From 2215 to 2315 (also to North America) on **9525** (31.50m), **9695** (30.94m), **11900** (25.21m) and on **11970** (25.06m).

● **NORWAY**
The Overseas Service of Radio Norway, Oslo, broadcasts a programme in English, "Norway this Week", for Europe as follows – from 0200 to 0230 on **9550** (31.41m), **11860** (25.30m) and on **15175** (19.77m); from 0400 to 0430 on **9610** (31.22m), **9645** (31.10m) and on **11860**; from 0600 to 0630 on **11850** (25.32m), **17825** (25.37m), **21655** (13.85m) and on **21730** (13.81m). From 1200 to 1230 on **6130** (48.94m), **15175, 21655, 21730** and on **25900** (11.58m); from 1800 to 1830 on **6130, 17825, 21655, 21730** and on **25900.** From 0100 to 0030 on **9550, 11860** and on **15175.**

● **SAUDI ARABIA**
From Jiddah, programmes in English are radiated from 1100 to 1250 (from 1000 on Thursdays and Fridays) on **11855** (25.31m) and from 1700 to 1955 on the same channel.

● **CANADA**
Radio Canada broadcasts to Europe in English as follows – from 0700 to 0730 on **9655** (31.07m) and on **11825** (25.37m); from 1217 to 1315 on **15325** (19.58m), **17820** (16.84m) and on **21595** (13.89m); from 1515 to 1522 (newscast) on **15325, 17820** and on **21595;** from 2115 to 2158 on the latter three channels.

● **CLANDESTINE**
In the last issue of this journal we made mention of several Clandestine stations that can be heard on the short wavebands (see also QSX this issue) and we conclude here with mention of yet another 'under-cover' station which may be logged.

On **9573** (31.33m) a powerful transmitter radiates anti-Saudi regime programmes of propaganda interspersed with music and songs. We logged the "Voice of the People from the Heart of the Arabian Peninsular" when signing-on with a march and identification repeated twice (in Arabic) until sign-off at 1900 with identification and a repeat of the march.

## CURRENT SCHEDULES

● **MALAWI**
Blantyre can sometimes be heard, if conditions are right, on **3380** (88.76m) around 2100. We logged them at 2053, when a programme of African songs and music was being radiated.

● **INDIA**
India can be heard on a multitude of channels at various times throughout the day, some of those logged recently are listed below.

Delhi on **11740** (25.55m) at 2050 with the news in English until 2105 then talk about Pakistan.

Delhi on **9525** (31.50m) at 2015 with "Radio Newsreel" in English.

Delhi on **9912** (30.27m) at 2015 with programme on Indian space probe in English.

Delhi on **7215** (41.58m) at 2030 with programme in English.

Delhi on **11620** (25.82m) at 1800 with a newscast in English after station identification.

● **SOUTH AFRICA**
Springbok Radio, one of the Internal Services of the SABC, can be heard at 0243 on **3997** (75.05m) when we listened to some English musical comedy songs on records.

● **PORTUGAL**
Sines is to be logged on **11865** (25.28m) at 1937 with a programme of music and songs in Portuguese.

● **SPAIN**
Noblejas can be heard at 1930 on **11920** (25.17m), at which time we listened to a programme of Spanish music and songs.

● **MOZAMBIQUE**
Radio Clube de Mozambique on **4855** (61.79m) can often be logged in the evenings here in the U.K. We heard them recently at 2215 when they were signing-off with the National Anthem, quite the easiest Mozambique station to log on the 60m band.

● **ANGOLA**
CR6RB Radio Ecclesia, Luanda, operates on **4985** (60.18m) where we logged them at 1927 with a talk in Portuguese under some CW QRM.

CR6RO Radio Clube do Bie, Silvo Porto, is on **4895** (61.29m) being heard at 2116 with songs in Portuguese, Latin American-type music and station announcements.

● **ISRAEL**
Kol Yisrael has an External Service from the Jerusalem transmitter, in English to Europe as follows – from 0500 to 0515 on **9009** (33.30m), **11865** (25.28m) and on **11945** (25.12m). From 1130 to 1200 on **11865, 15425** (19.45m) and on **17870** (16.82m). From 2000 to 2045 on **9009, 11705** (25.63m), **15165** (19.78m) and on **15425.**

## CLUB EVENTS

● Cornish Radio Amateurs are holding their 1973 Mobile Rally at Treviglas School, Newquay, Cornwall, on 8th July. Further information from G. Tremelling, G3FWG, Finnartmore, Oakland Park, Falmouth.

● The Barking Radio & Electronics Society will be operating at the Dagenham Town Show on the 7th and 8th July. Bands in use will be 160m to 2m inclusive. There will be a mobile talk-in station operating on 145MHz – call sign GB2DTS. Details from R. E. Clark, G8BXC, 62 Waltham Road, Woodford Bridge, Essex, IG8 8DN.

● Scarborough Amateur Radio Society annual rally at Burniston Barracks on 15th July. Details from P. B. Briscombe, G8KU, "Roseacre", Irton, Nr. Scarborough, Yorks.

● Derby and District Amateur Radio Society will be taking a stand at the National Amateur Radio and Electronics Exhibition at Leicester in October.

The theme is to be "Sixty Years of Radio" and is their contribution to the RSGB's Diamond Jubilee Celebrations.

The society's programme for July is: 4th, Surplus Sale by Auction: 11th, Mobile Operation, talk by Tom Darn, G3FGY: 18th, D.F. Practice Night: 25th, Visit from VK4KS "DXpedition to Mellish Reef in Coral Sea". Tape and Slides.

# RANDOM OUTPUT GENERATOR

**by E. F. Whitman**

**A simple and instructive device which illustrates basic logic principles.**

THE DEVICE WHICH FORMS THE SUBJECT OF THIS SHORT article can be described as a complicated method of tossing a coin! Nevertheless, it is an amusing gadget having attractive presentation, and it can be made up into a small pocket unit complete with its own battery.

The basis of the device is a generator which causes either one of two light emitting diodes to be illuminated by random selection whenever a switch is thrown. An initial examination of the circuit indicates that a true 50:50 random distribution between the two l.e.d.'s should be given as soon as the unit has been assembled, but in practice there may be a tendency for one l.e.d. to be illuminated more frequently than the other. If this tendency appears, it can be cancelled out by suitably adjusting a capacitor value in the circuit.

## CIRCUIT FUNCTIONING

The circuit of the generator appears in Fig. 1. When in this diagram S2 is closed, the multivibrator given by TR1 and TR2 runs at around 3kHz and drives a bistable consisting of two cross-coupled t.t.l. NAND gates.

The two NAND gates are part of a quadruple NAND gate type 7400, and their operation may be understood by remembering that the output of a 2-input t.t.l. NAND gate is high (corresponding to 1) when either one or both of its inputs is low (corresponding to 0). The NAND gate output goes low only when both its inputs are high.

Let us first examine the circuit at an instant in the multivibrator cycle when TR1 is off and TR2 is on. Since TR1 is off, the voltage on its collector is close to that of the positive supply rail and is, in consequence, high. On the other hand, the voltage on the collector of TR2 is close to the negative supply rail and is therefore low. Since a low voltage is thus applied to input pin 5 of the lower NAND gate its output must be high. This high output is passed to input pin 2 of the upper NAND gate, which is also obtaining a high input on its input pin 1 from the collector of TR1. As a result, the ouput of the upper NAND gate, at its pin 3, is low.

Summing up the situation so far, when TR1 is off and TR2 is on, the output of the upper NAND gate is low and the output of the lower NAND gate is high. Due to the symmetry of the circuit the reverse applies during the next half-cycle of the multivibrator. When TR1 is on and TR2 is off the output of the upper NAND gate is high and the output of the lower NAND gate is low.

Each l.e.d. becomes illuminated when the output of the NAND gate to which it connects is low. Current then flows from the positive to the negative supply rail through the series 240Ω resistor, through the l.e.d. in a forward direction, and then through the output transistor inside the t.t.l. NAND gate integrated circuit. The alternative method of connecting an l.e.d. to a t.t.l. NAND gate, i.e. directly between the output and the negative supply rail, cannot be used here as it would prohibit fan-out to the other NAND gate input.

The circuit is started by closing S1 with S2 closed. The multivibrator then runs, causing both l.e.d's to be switched on and off continually. The speed of switching is, of course, far too fast to be followed visually, and both l.e.d's appear to be continually illuminated. Switch S2 is then opened. The multivibrator ceases to run and the collector of whichever transistor was on at the instant of switching off immediately rises to the potential of the positive supply rail, causing a high input to be passed to the gate to which it couples. But that gate will already have a low input from the output of the other gate and will be unaffected, continuing to produce a high output. Thus, if the multivibrator is disabled when TR1 is off, causing the upper gate output to be low, that output will remain low after the multivibrator ceases running. Similarly, the output of the lower gate will remain high. The bistable formed by the two NAND gates has the ability to remain in its last state

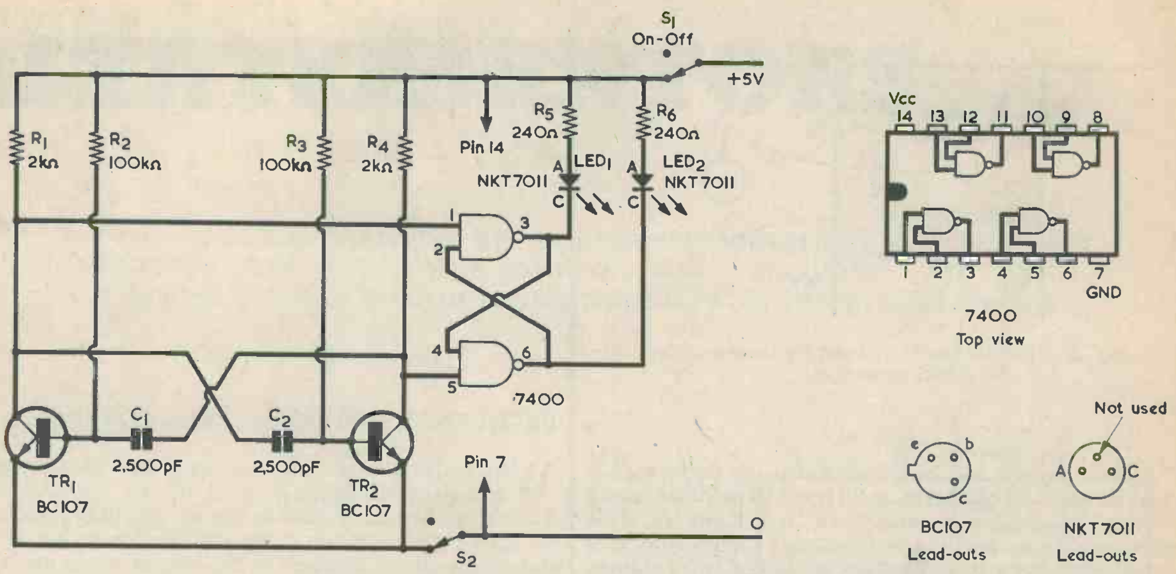



*Fig. 1. The circuit of the random output generator. Either LED1 or LED2 remains illuminated after S2 is opened*

when both its inputs go high.

It is a matter of pure chance whether TR1 or TR2 is off at the instant of switching off the multivibrator, with the result that (assuming perfect symmetry in the circuit) there is a 50:50 probability of either LED1 or LED2 remaining illuminated. Since the illuminated l.e.d. now receives a continuous current it glows at a brighter level than occurred when both the l.e.d's were lit up.

The circuit can be run again by closing S2, with the result that both l.e.d's light up once more, and then opening it again, whereupon only one of the two l.e.d's remains illuminated.

The device uses only two of the four NAND gates in the 7400 i.c., no connections being made to the other two gates. If desired, a second multivibrator could be added, this coupling to the remaing two i.c. gates .These would be similarly connected as a bistable, and their outputs would feed two further l.e.d's. S2 then becomes a double pole switch, its extra pole breaking the negative supply to the second multivibrator. This addition would produce four possible random configurations of l.e.d. illumination.

## COMPONENTS

All the components for the circuit are readily available. The light emitting diodes used by the author were Newmarket NKT7011, obtained from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. These are rated at a maximum current and power of 50mA and 100mW respectively, and it is probable that other l.e.d's with similar ratings should work equally well. The writer has, however, only checked the circuit with the NKT7011 types. It is important to ensure that they are connected into circuit with correct polarity.

The 7400 i.c. or one of its equivalents is available from virtually all suppliers of t.t.l. integrated circuits. Its Texas Instruments type number is SN7400N. The inset in Fig. 1 showing the 7400 pins is a top view, with the pins pointing away from the reader. The insets showing the transistor and l.e.d. lead-outs have the lead-outs pointing towards the reader.

For satisfactory snap action, both the switches should be toggle types. All resistors are ¼ watt and R1 and R4 may be 5%. The tolerances in R5 and R6 are discussed later.

At first sight, it would appear that a 50:50 random distribution of l.e.d. illumination would be given if R2 and R3, and C1 and C2, were closely matched, since the multivibrator would then give a true 50:50 sequence of half-cycles. Unfortunately, however, the voltage at the collector of each transistor is not a true square wave because there is slight rounding, due to the cross-coupling capacitor, on the positive-going edge. Also, since the two NAND gates may have slightly different threshold voltages for the input transition from low to high, a departure from true 50:50 operation of the bistable may result. Another factor is that each transistor, when turning on, has to draw a relatively heavy collector current through the associated NAND gate input to take the latter low, and so a further slight departure from 50:50 bistable operation is feasible if the two transistors have different gain figures.

The constructor can, because of these factors, employ one of two approaches with respect to R2, R3, C1 and C2. The first of these is to use resistors and capacitors which are matched within 1 or 2% and, if a transistor tester is available, transistors having similar gain figures. In the rather unlikely event of l.e.d. illumination distribution then not being 50:50, the biasing approach shortly to be described can be brought into use. Alternatively, the constructor may use normal wide tolerance components, being prepared to carry out the biasing process which will in this case almost certainly be required.

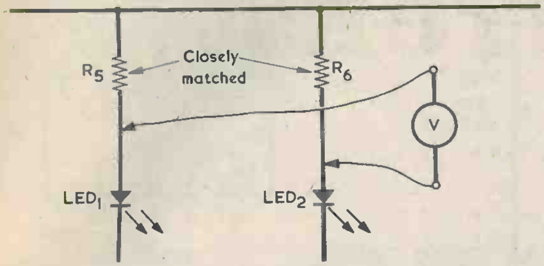



*Fig. 2. A simple method of setting up the circuit for 50:50 operation*

After the unit has been completed, its performance may be checked by operating S2 some 60 to 70 times and noting the number of times each l.e.d. lights up. This process is by no means as tedious as it sounds since it is merely necessary to put a mark in one of two columns on a sheet of paper for each operation. After this number of functions the distribution in the lamps should be 50:50, or very nearly so. If LED1 lights up more frequently then LED2, this means that TR1 may be considered as being off for a longer period in the multivibrator cycle than is TR2. The effect can be cancelled out by increasing C2 by experimentally connecting added capacitance across it, thereby increasing the off period for TR2. Similarly, if LED2 predominates, extra capacitance should be added across C1. Several counting checks should soon establish the value of capacitance finally needed.

The addition of bias capacitance may be carried out more quickly if an oscilloscope is available, since it is then merely necessary to find the added capacitance which, when S2 is closed, causes waveforms of equal duration to appear across R5 and R6. R5 and R6 may either by 5% or they may be closely matched in value. In the latter instance, a further approach for finding the required value of bias capacitance becomes possible. This consists of closing S2 and of connecting a voltmeter switched to read a low voltage across the lower ends of R5 and R6, as in Fig. 2. Voltmeter polarity is unimportant. Extra capacitance is added, across C1 or C2 as applicable, until the voltmeter reads zero. This last procedure assumes equal forward voltage drops and similar current waveforms in the two l.e.d's, but in practice it should prove quite adequate and can be finally confirmed by the 60 to 70 switch operations just mentioned.

Although the 7400 may not, for serious work, be operated at supply voltages lower than 4.75 volts, the present circuit should operate satisfactorily from a 4.5 volt battery. The prototype functioned without trouble with a battery whose voltage had dropped to as low as 4 volts. Current consumption at 4.5 volts is a little less than 20mA with S2 either open or closed.

Light emitting diodes offer an attractive and unusual form of circuit monitor. If the design of Fig. 1 is housed, with its battery, in a small box having the two diodes and the two switches on the front panel, it forms a unique little unit which can provide a considerable amount of amusement and entertainment for its user and his friends. ■

# ASTABLE

**Part 2** **by A. Foord**

## FREQUENCY AND DUTY CYCLE CONTROL

When adjustable constant current sources are added to the base sections of the conventional astable multivibrator, then frequency and duty cycle can be varied independently. The off time for each half of the astable circuit depends on the output swing and the rate at which the timing capacitor is charged. In the circuit of Fig. 7, transistor TR1 is used for the variable current source for the timing circuit associated with TR3. This current will be approximately:

$$I3 = \frac{Vcc-Ve}{R1}$$

The off time for TR3 will be:

$$t(off) = \frac{C1.V0.R1}{Vcc-Ve}$$

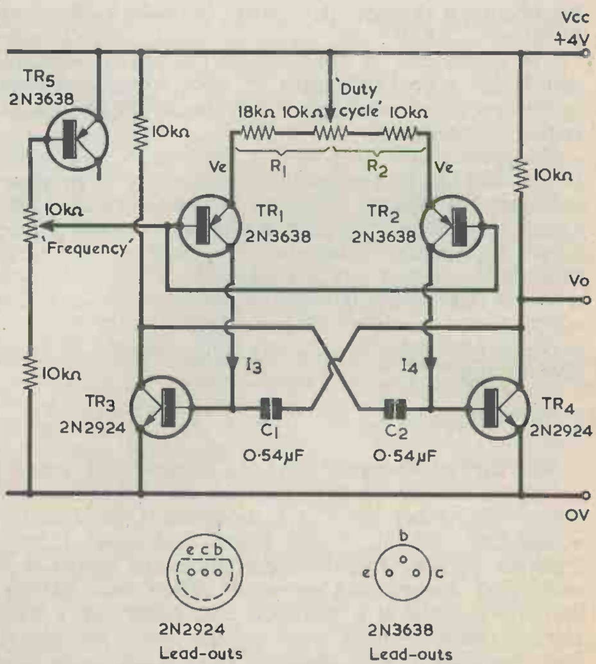



*Fig. 7. Astable multivibrator circuit with independent control of frequency and duty cycle*

# MULTIVIBRATORS

**In this concluding article our contributor describes multivibrator frequency and duty cycle control, and concludes with multivibrator circuits incorporating the SN74121 integrated circuit**

and the off time for TR4 will be:

$$t(off) = \frac{C2.VO.R2}{Vcc - Ve}$$

The duty cycle of TR3 is

$$\frac{R1}{R1+R2}$$

which is independent of frequency.

The frequency may be adjusted independently of the duty cycle by changing Ve. For the component values shown the duty cycle (when TR4 is off) can be varied between 26% and 51% while the frequency remains constant within 2%. Alternatively, the frequency can be varied between 66 and 238Hz while the duty cycle remains constant within 2%. The base-emitter junction of TR5 provides a temperature compensated voltage which tracks any changes in Vbe for TR1 and TR2 and reduces the effects of ambient temperature variations on the constant currents generated by these transistors. This arrangement is essential at the low voltages chosen for this particular circuit where the base to emitter voltage drops are significant.

The minimum constant current values should be high enough to make sure that TR3 and TR4 saturate. This is no problem with modern high gain transistors.

The 2N3638 transistors specified in Fig. 7 may be obtained from G. W. Smith & Co. (Radio) Ltd., 11–12 Paddington Green, London, W.2. However, the circuit will work with many small-signal transistors; TR1, TR2 and TR5 should be similar, as also should TR3 and TR4. Suitable alternatives would, for instance, be BC214 (p.n.p.) and BC184 (n.p.n.)

## USING SN74121 MONOSTABLES

The SN74121 is a monostable multivibrator with d.c. triggering from positive or gated negative going inputs, and with an inhibit facility. The normal Q and not-Q output pulses are available, with a fan-out of 10 and t.t.l. compatability. The basic block diagram is shown in Fig. 8.

A1 and A2 are negative edge logic trigger inputs and will trigger the monostable when either (or both) go low with B high. B is the positive edge Schmitt trigger input for slow edges or level detection, and will trigger the monostable when B goes high with either A1 or A2 in the low state.

Output pulse lengths can be varied from 40nS to 40S with suitable timing components. Where a narrow pulse is required for set/reset purposes a typical pulse length of 30nS may be achieved without external components. For this arrangement pin 9 is connected to pin 14 and pins 10 and 11 are left open-circuit. For longer pulses, timing capacitors between 10pF and 1,000μF may be connected across pins 10 and 11. When these capacitors are electrolytic the positive plate connects to pin 10. Also, external timing resistors from 2kΩ to 40kΩ may be connected. The internal limiting resistance is a nominal 2kΩ and may be used as part of the total resistance where required. For accurate repeatable pulse widths the external resistance should be connected between pins 11 and 14 with pin 9 left open-circuit. In this case the minimum resistance must be 2kΩ or more. The pulse width is given by:

$$t = 0.69\ CR\ secs.$$

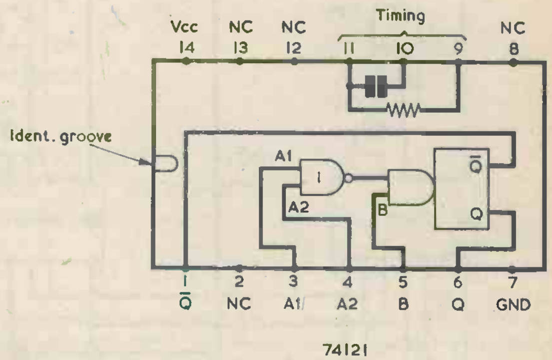



*Fig. 8. The basic SN74121 monostable multivibrator. This is a top view for 14-pin d.i.l. and gives terminal locations*

## SN74121 ASTABLE MULTIVIBRATOR

A gated astable multivibrator can be produced by using two monostables in a closed loop configuration, as in Fig. 9. If R1 and R2 are ganged then the mark-space ratio will remain constant as the total period is varied. Alternatively, the two resistors can be varied independently to give the mark-space ratio required.

The multivibrator can be released by either a negative gate at A1 and A2 or a positive gate at B. If the gate closes part of the way through the cycle the multivibrator will complete the cycle before stopping.

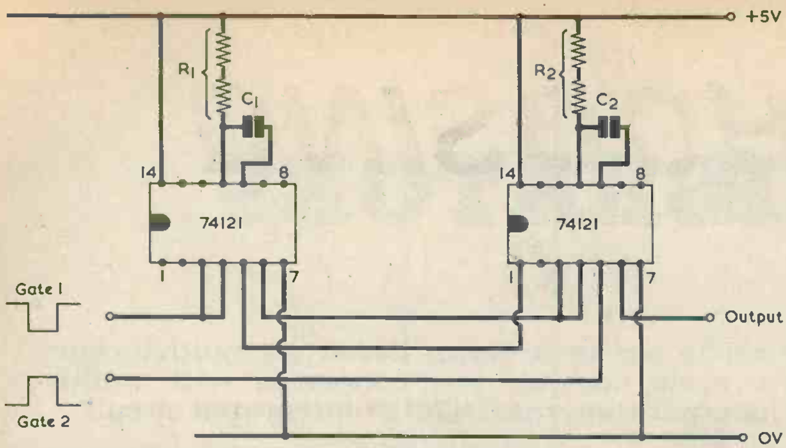



*Fig. 9. A gated astable circuit using two SN74121's*

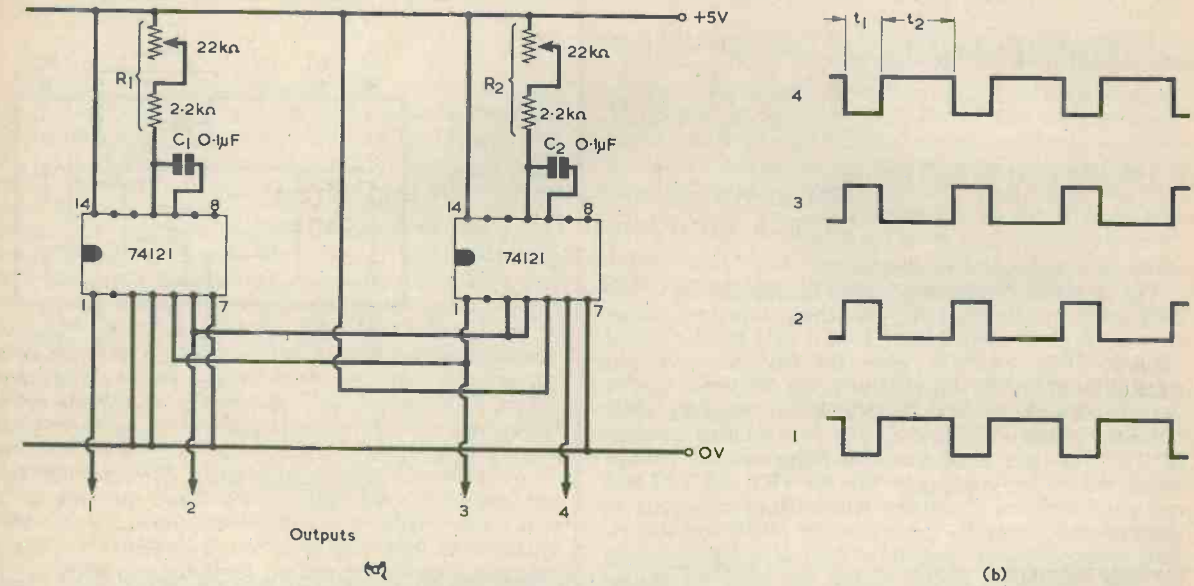
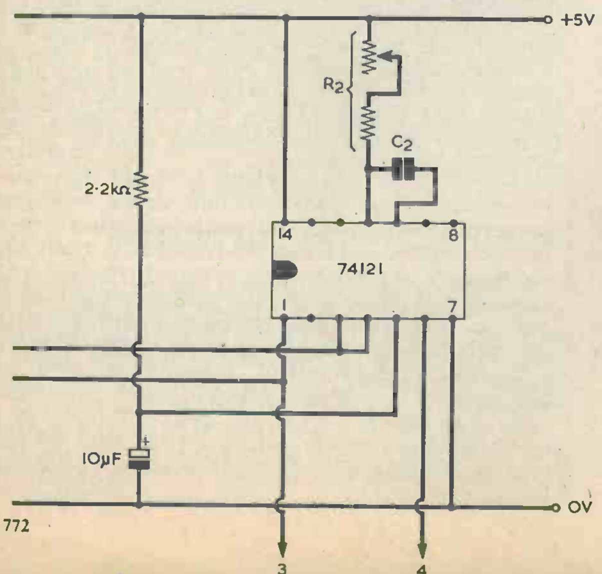



*Fig. 10 (a). A free running astable circuit incorporating two SN74121's*
*(b). The waveforms appearing at the four outputs*

*Fig. 11. The modification required if the start of the astable multivibrator is to be delayed*




For the circuit to free run, gate 1 must be taken to earth and gate 2 to the 5 volt positive rail, as in Fig. 10 (a). Since the inputs to each monostable are d.c. coupled there should be no difficulty in the circuit starting. The circuit values in Fig. 10 (a) are typical and can be varied to suit the application. If it is required that the multivibrator starts shortly after power has been applied this can be achieved by delaying the rise time of the B gate input, as shown in Fig. 11. This is useful where other logic circuits have to settle down before a clock is applied.

The timing of the outputs, as indicated in Figs. 10 (a) and (b) is:

$$t1 = 0.69 \times C1R1 \text{ secs}$$
$$t2 = 0.69 \times C2R2 \text{ secs.}$$

The total period is therefore:

$$T = 0.69\ (C1R1 + C2R2) \text{ secs,}$$

and the frequency, in hertz, is 1 divided by this period. ■

(*Concluded*)

# CHOOSING A MULTIMETER

by
P. Jefferson

**Some notes on a topic which often causes confusion for the newcomer to electronics.**

Beginners in radio and electronics soon find that a measuring instrument is virtually essential if full value is to be obtained from their hobby. There are few things so frustrating as to find that a newly constructed unit does not function and then have no means of finding where the fault lies. Without some form of testmeter it is almost impossible to carry out troubleshooting other than on a guess-work basis.

## WIDE RANGE

Having decided that a multimeter is to be obtained, the constructor will probably next consult advertisements and the catalogues of the larger mail-order houses to see what instruments are available. And this is where confusion is liable to commence because multimeters are available at prices ranging from less than £2 to around £40. What is the best model to buy?

This article cannot, of course, recommend particular makes and models of multimeter, but it will nevertheless give some general guidance lines which should assist the constructor in forming his own choice. So far as the cost of a multimeter is concerned, it is generally true that accuracy, reliability, robustness and the number of ranges offered all increase in proportion to cost. It would seem more than reasonable to assume that a £30 instrument would offer a superior performance when compared with one priced at £3, and such indeed is, of course, the case. However, the £30 meter would be more fitting in a laboratory or in a busy service workshop than in a home-constructor's den, where it is probable that only occasional measurements will be needed. An inexpensive meter, provided it is treated with reasonable care, can be an invaluable asset for constructional work.

It is possible that some constructors may prefer to build their own multimeters. This is an admirable approach, but it should be noted that the cost of the components required for a home-made multimeter can be greater than the price of a complete instrument offering a comparable performance, and the latter has the advantage of having a scale which is directly calibrated in terms of the ranges covered. Specialised test instruments for home-construction are described from time to time in this journal, but these are intended for measurements which cannot be undertaken with a standard multimeter, or they are designed to offer an exceptionally high sensitivity for voltage readings.

## VOLTAGE MEASUREMENTS

In general, multimeters are employed far more frequently for d.c. voltage measurements than for any other purpose, and the prospective purchaser should first check that the d.c. voltage ranges available in any particular multimeter will meet his requirements. When working with transistor equipment many measurements will be of direct voltages below 10 volts, and a voltage range capable of reading such voltages is necessary. There is still plenty of domestic equipment in use which employs valves (and a surprisingly large number of home-constructors still prefer to build valve units rather than their transistor equivalents), so voltage ranges capable of reading h.t. voltages between some 200 and 350 volts should also be available. A top voltage range of the order of 0-1,000 volts is, again, very desirable. Virtually all multimeters currently available can measure these voltages, the more expensive models normally having a larger number of ranges. The availability of a large number of ranges means that a range can usually be selected which enables a particular voltage to cause a relatively large deflection of the meter needle. Accuracy is likely to be higher, and meter readings easier to assess, when there is a large deflection of the needle.

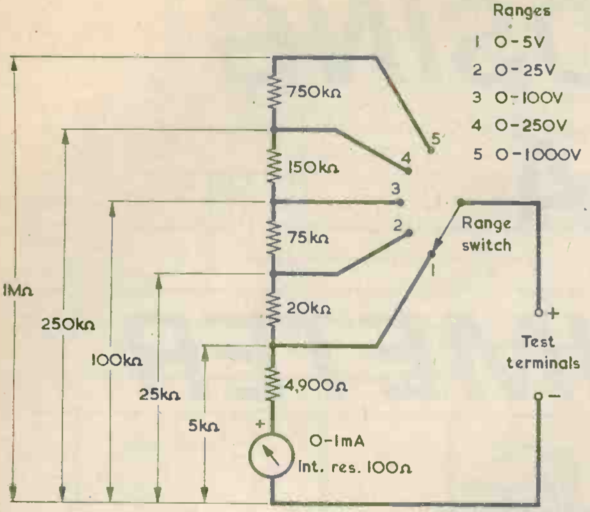



*Fig. 1. The basic form of the voltmeter section of a multimeter. Alternative voltage ranges can, of course, be provided*

Voltmeter sensitivity is an important feature. Basically, the voltmeter circuits of a multimeter take up the form shown in Fig. 1 which assumes, for purposes of illustration, voltage ranges of 0-5, 0-25, 0-100, 0-250 and 0-1,000 volts. There is a single basic meter movement, and the range switch selects different values of series resistance. It is assumed in Fig. 1 that the basic meter has a full-scale deflection (or f.s.d.) of 1mA and that it has an internal resistance (given mainly by the wire in its coil) of 100Ω. If we give the resistor which is switched into circuit on the 0-5 volt range a value of 4,900Ω then the total resistance between the test terminals for this range comes to 5kΩ. Should we apply 5 volts to the test terminals a current of exactly 1mA will flow through this 5kΩ resistance and the meter needle will travel to f.s.d., as is required. For the 0-25 volt range, we give the next series resistor a value of 20kΩ. The total resistance between the test terminals is now 20kΩ plus 4,900Ω plus 100Ω, or 25kΩ; and a current of 1mA will once again flow when a voltage of 25 volts is applied. Following similar reasoning the next resistance up is 75kΩ, giving a total resistance, on the 0-100 volt range, of 100kΩ. The final two resistors are 150kΩ and 750kΩ, giving total resistances of 250kΩ and 1MΩ respectively.

It will be seen that the resistance presented to the test terminals on any voltage range is equal to 1kΩ multiplied by the f.s.d. figure for the range. The meter of Fig. 1 can, in consequence, be described as having a sensitivity of 1kΩ per volt, or of 1,000Ω per volt. Thus, a voltmeter which consumes 1mA at full-scale deflection has a sensitivity of 1,000Ω per volt. If the basic meter in Fig. 1 gave full-scale deflection at 500μA (which is half of 1mA) all the resistance values for each range would need to be doubled and we would then say that the meter has a sensitivity of 2,000Ω per volt.

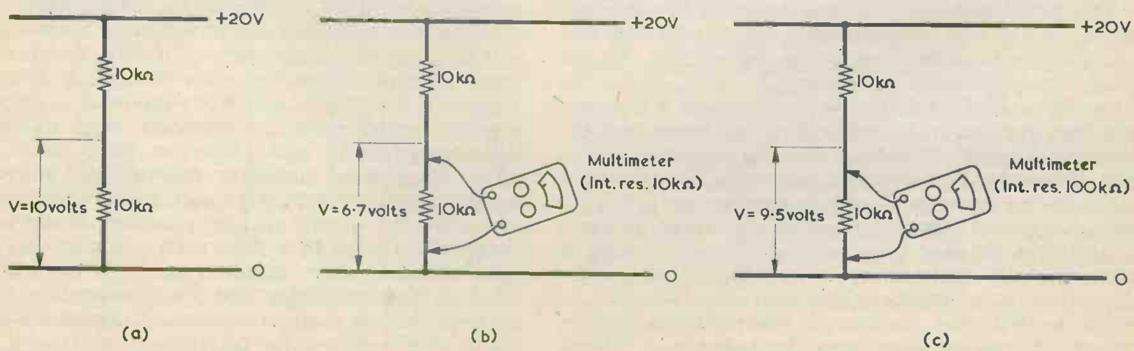



*Fig. 2. Demonstrating the effect of meter resistance on voltage readings. In (a) two 10kΩ resistors are in series. A 1,000 ohms per volt multimeter switched to a 0–10 volts range in (b) causes the voltage across the lower resistor to fall to 6.7 volts. The 10,000 ohms per volt meter in (c) indicates 9.5 volts*

Should the basic meter have an f.s.d. value of 100μA, then the resistance values in Fig. 1 would need to be 10 times greater, and the voltmeter would be said to have a sensitivity of 10,000Ω per volt. A voltmeter whose basic meter movement gave f.s.d. at 50μA would have a sensitivity of 20,000Ω per volt, and so on.

The importance of meter sensitivity is demonstrated in Figs. 2 (a), (b) and (c). In Fig. 2 (a) we have two 10kΩ resistors in series across a 20 volt supply, and we want to measure the voltage across the lower one. Common sense tells us that this voltage is 10 volts, but let us see what happens when we try to measure the voltage with a multimeter. In Fig. 2 (b) we apply a multimeter having a sensitivity of 1,000Ω per volt and switched to a 0-10 volt range. The meter presents a resistance, at its test terminals, of 10kΩ and this is effectively in parallel with the lower 10kΩ resistor, making the total lower resistance equal to 5kΩ. The voltage across the meter is now one-third of the total 20 volts available, or 6.7 volts, and *this is the voltage which the meter needle will indicate*. In Fig. 2 (c) we apply a testmeter having a sensitivity of 10,000Ω per volt and similarly switched to a 0-10 volt range across the lower resistor. The meter now applies a resistance of 100,000 ohms in parallel with the lower 10kΩ resistor, giving a total resistance which works out at 9.09kΩ. The voltage across the meter is now 9.5 volts and this is the voltage which the meter will indicate.

It can be seen that, whilst neither meter gives an accurate indication of voltage, the indication given by the more sensitive one, that with the sensitivity of 10,000Ω per volt, is closer to the required reading. Because of the fact that a multimeter inevitably consumes current when reading voltage, and thereby gives incorrect indications when measuring voltage in circuits containing series resistance, it is generally desirable to choose a model having a reasonably high sensitivity. For practical constructional work a meter with a sensitivity of 10,000 or 20,000Ω per volt will in general be quite adequate. Some relatively low-cost meters have sensitivities of 50,000Ω per volt or even 100,000Ω per volt and these will, of course, offer greater sensitivity. Despite these points, much valuable work can be carried out with the aid of a meter having a sensitivity of only 1,000Ω per volt, but it has to be remembered that its relatively low resistance can significantly alter voltages in circuits where there is series resistance. Meters having sensitivities lower than 1,000Ω per volt are best avoided unless offered at real bargain prices.

## CURRENT RANGES

The direct current ranges given by a multimeter should cover f.s.d. values of at least 1mA to 100mA, and these will cope with most requirements in valve and transistor equipment. Current ranges both above and below these two figures would, naturally, be an asset, although they may not be employed frequently in practice.

Resistance ranges tend to increase both in accuracy and the actual resistance values catered for as multimeter cost rises. In the cheaper models resistance readings can by no means approach the accuracy given by a resistance bridge, but the indications given can still be of considerable help, particularly in such applications as checking coils for continuity and the like. They can also be of help in selecting matched resistors from a batch, two resistors being chosen which give the same or very nearly the same meter indication, even if this indication differs slightly from the nominal resistance value.

The preceding remarks concerning voltage and current ranges apply to d.c. measurements. Some quite inexpensive multimeters offer a.c. voltage ranges as well, and the constructor may be undecided as to whether or not he should obtain a meter incorporating this facility. Opinions on the usefulness of a.c. voltage ranges are liable to vary from constructor to constructor but, so far as work at home is concerned, the a.c. ranges will probably only be employed for measuring mains voltages, mains transformer secondary voltages, valve heater voltages and a.f. output voltages. The alternating voltage ranges in a multimeter usually have a lower ohms per volt figure than the direct voltage ranges, but this is not normally a disadvantage as the voltages most likely to be measured are nearly always provided by components or circuits having low or negligible series resistance.

The more expensive multimeters have alternating current ranges as well. These are, however, much more likely to be used by the serious experimenter or engineer than by the home-constructor, who will rarely have occasion to employ them.

## METER MAINTENANCE

After having made his selection and purchased his multimeter, the constructor should next ensure that it is looked after correctly.

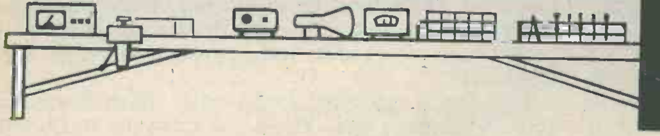
All multimeters need to be treated with respect, and they should not be subjected to knocks or similar physical misuse. In general, the cheapest meters will be the most fragile, for the obvious reason that some robustness has had to be sacrificed in the interests of keeping costs low. It may be found also that some of the inexpensive meters give their most accurate readings when they are laid flat on their backs. This is not a serious disadvantage and merely represents a factor which has to be borne in mind when using the meter.

Many of the lower cost meters have no overload protection, and great care must be taken to ensure that excessively high voltages or currents are not accidentally applied to them. The least damage that can result from an overload is a bent pointer caused by its rapid travel to the right-hand end-stop, and the worst is a burnt-out coil or coil springs, or burnt-out internal resistors. When in doubt, select a voltage or current range which is higher than that for the anticipated voltage or current to be measured. The correct range can then be selected after the indication on the higher range shows that it is safe to do so.

Never leave a multimeter switched to a current or a resistance range after work with it has finished. It is quite easy to absent-mindedly pick up the test prods later and apply them to a source of high voltage or current. The best plan is to always switch the meter to its highest voltage range before putting it away. The meter should not be left lying on the bench whilst other work is being carried out, or it will soon pick up the dirt and detritus present on nearly all benches. It is better to keep it out of the way in its own box.

Finally, on receiving the meter any instructions that come with it should be read carefully. Apart from warning against possible misuse, these instructions may also advise the constructor of applications for the meter he'd never even thought about! ■

# In your workshop



**This month Smithy the Serviceman, aided as always by his able assistant, Dick, embarks on the repair of a faulty stereo record player. In the process he is able to point out to Dick some of the more interesting and ingenious aspects of commercial design in this field.**

"NOW THIS SHOULD BE JUST THE job!"

With a smile of satisfaction, Dick selected a small stereo record player turntable unit from the "For Repair" rack and carried it over to his bench. He then returned to the rack and picked up the two speakers which were intended for use with the turntable unit, placed them at either end of his bench, and plugged them into the turntable section. He next connected this to the mains and switched on. The little turntable motor whirred into life and was just audible as it rotated busily.

Dick reached up to the shelf above his bench and took down several 45 r.p.m. discs. He placed these on the spindle of the unit, fitted the retaining arm above them and actuated the auto-change control lever. After several seconds the bottom record clattered down onto the turntable, whereupon the pick-up rose, moved over and descended upon it. A weak tinny sound of music became audible from the pick-up stylus.

## ONE CHANNEL ONLY

The turntable unit incorporated the stereo amplifier, which had independent volume controls for each channel, and Dick advanced these. At once the music on the record became audible from the right-hand speaker, reproduced at adequate volume and with acceptable quality. The left-hand speaker was silent at all settings of the left-hand volume control.

Dick switched off the record player and pulled the left-hand speaker plug from its socket at the rear. He carefully examined the wiring to this plug. It *looked* all right. He selected a low ohms range on his testmeter and applied its test prods to the two pins of the speaker plug. The meter needle moved to a low resistance reading and there was a confirmatory crackle from the speaker.

Dick returned the speaker plug to its socket and switched on again. For a second or so, the right-hand speaker gave voice to music of rapidly ascending frequency as the turntable rotation increased to full speed; after which the music was reproduced at the correct pitch. The left-hand speaker was still silent. Dick rocked its plug in the socket on the turntable unit, but to no avail. He switched off once more and stared thoughtfully at the record player.

"Having trouble?" enquired a voice in his ear.

Dick started violently then turned, glowering, towards the Serviceman.

"Hell's teeth," he snorted, "you've done it *again*!"

"Done what again?"

"Crept up on me," said Dick indignantly. "You're always doing it. Just when I'm concentrating on a job you pussy-foot up behind me and scream abuse in my lug-hole."

"I was not screaming abuse or any other such thing," replied Smithy stiffly. "I was merely venturing a polite and helpful enquiry as to whether you were having any difficulties."

"Well, perhaps you were, too," conceded Dick reluctantly. "Nevertheless, you still just about scared the living daylights out of me. As it happens I *am* having a bit of trouble. I was just pondering what to do next with this stereo record player."

"What's the snag?"

"The left-hand channel is dead. As you know, this sort of thing is often caused by something simple, like a lead broken off at the speaker plug. And so I checked that, but there's nothing wrong there."

"It looks as though you'll have to get the works out then," commented Smithy. "Still, there is a further thing you can check before you do that, and that's to see that all the connections are properly made at the pick-up cartridge. Those little spring connectors tend to come off occasionally."

Dick raised the pick-up arm and examined the cartridge connections. He replaced the pick-up on the record.

"The connections," he remarked, "are all right."

"You shouldn't move the pick-up arm of a record player around when it's half-way through a cycle of auto-change operations," said Smithy critically. "You should actuate the changer mechanism so that the arm is finally disengaged and at rest, and *then* do the moving around."

"I've moved pick-up arms in the middle of auto-change cycles before now," replied Dick defensively, "and it doesn't seem to have done any harm."

"Perhaps not," persisted Smithy, "but that's only because modern record-changers are robust and can stand up to maltreatment. Anyway, I won't keep on about it and, seeing that those cartridge connections are all right, you'll now definitely have to get that record player chassis out. Whilst you're doing that I'll see if I can find a service sheet for it. I'm beginning to get rather interested in this record player."

Whilst Smithy walked over to the filing cabinet, Dick examined the turntable unit. He removed the screws securing the front panel and found he was able to withdraw the complete amplifier chassis sufficiently far for testing purposes without disconnecting the leads which passed from it to the gram deck. Smithy returned with the required service sheet and laid it on the bench, opened out at its circuit diagram. (Fig. 1.)

## TWIN AMPLIFIERS

"Humph," he remarked, "it's a nice simple arrangement, and it shouldn't take us long to find the fault. Incident-

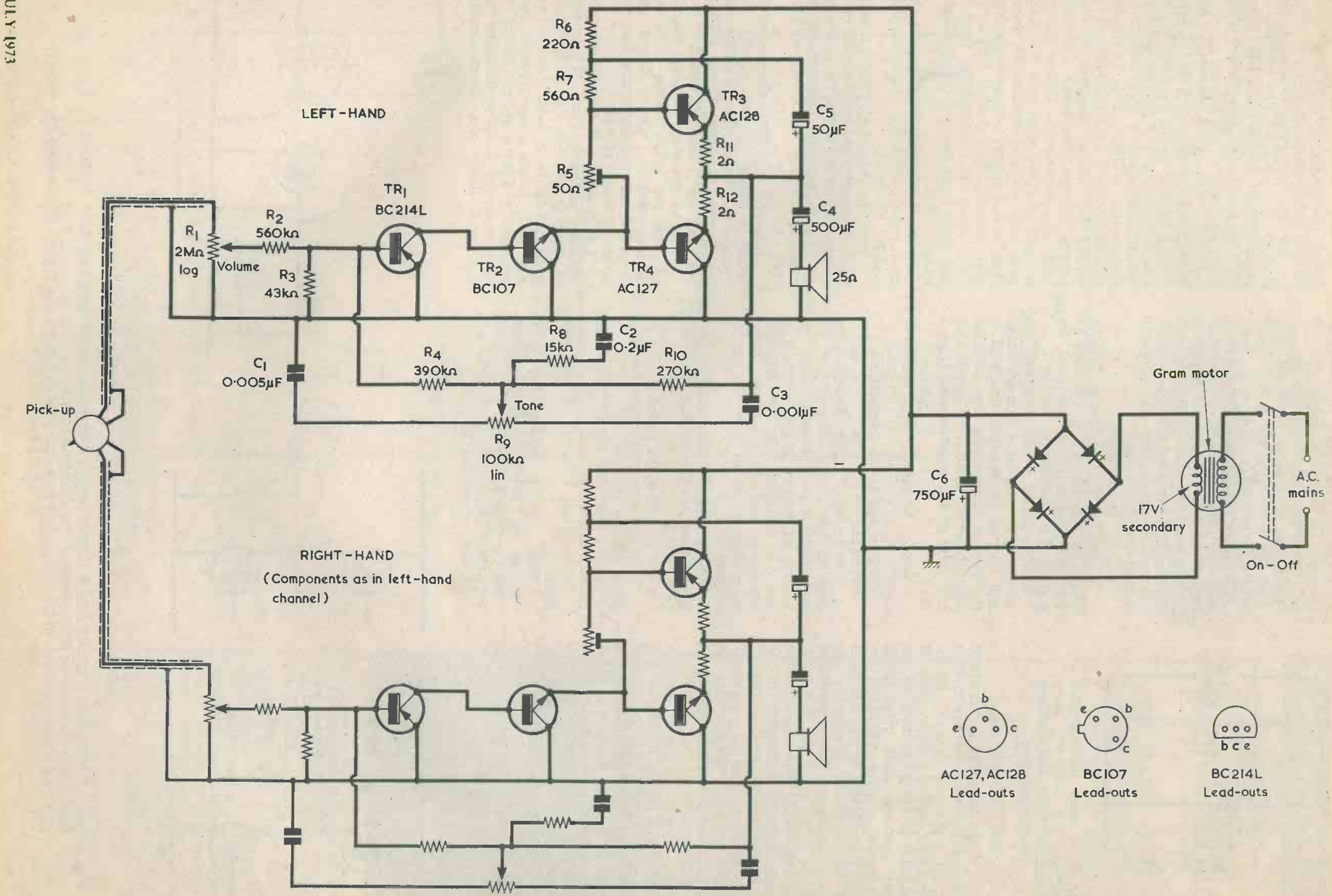



*Fig. 1. Typical small stereo record player circuit. Resistor and capacitor values are representative of commercial practice*

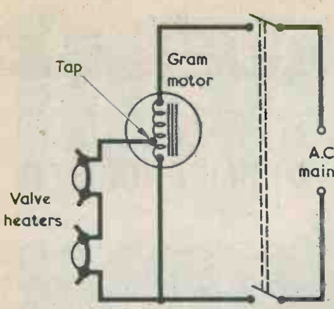



*Fig. 2. In some valve record players, the heaters were supplied by a tap in the motor winding*

ally, one of the delightful things about stereo amplifiers, so far as servicing is concerned, is that you have two identical amplifiers sitting side by side. If you've got a really sticky snag in one amplifier you can quite often get a lead towards tracing the fault by checking the voltages in various parts of the two circuits, comparing the ones you get in the faulty amplifier with those in the good one. However, we might be lucky here and find that the snag is simple enough to be traced in the faulty amplifier without having to check against the good one."

"I see," remarked Dick, "that the supply is obtained from a winding on the gram motor."

"That's right," agreed Smithy. "This is an old dodge, of course, and it enables the amplifiers to be isolated from the mains without the expense of a separate mains transformer. A similar sort of approach was used in the old valve record players. Some of these had a tap in the motor winding, and this fed the valve heaters." (Fig. 2.)

Smithy walked over to his bench, picked up his stool and returned. He sat down purposefully in front of Dick's bench.

"Now, we won't want that stack of records you've loaded on the spindle for the time being," he stated. "So could you please get them off, and then reject the one which is actually on the turntable?"

Obediently, Dick removed the stack of records, after which Smithy switched on the amplifier. The record remaining on the turntable became audible once more. Dick operated the reject lever, whereupon the pick-up arm rose and moved over to its rest.

"Okay?" he enquired.

"Okay," confirmed Smithy briskly. "Let's take a few voltage readings on this left-hand amplifier. Let's see, for a start, if it's getting any power."

Smithy pulled Dick's testmeter towards him, selected a voltage range and clipped the positive test lead to the chassis. Examining the amplifier printed circuit closely, he applied his test prod to the negative rail. (Fig. 3 (a).)

"What," he asked, "does the meter say?"

Dick peered at the testmeter.

"It's reading 22 volts."

"Fair enough," replied Smithy, glancing at the circuit diagram of the record player. "I'll now check the voltage at the two output emitters. If the d.c. conditions in this amplifier are correct the output emitters should be sitting at about half the supply voltage."

Smithy applied his negative test prod to the junction of R11 and R12. (Fig. 3(b).)

Dick looked at the meter.

"Are you sure you've got the right place on the board?"

Smithy examined the printed circuit panel closely.

"I'm certain I have," he said confidently.

"Well, you're getting the same reading as before," stated Dick. "Wait a minute, though, it isn't *quite* the same! The present reading is a wee bit lower, at around 21 volts."

"Good," said Smithy, pleased. "That means we've found something wrong first go."

"We must have found the fault, too," pronounced Dick. "If the reading on the emitter of TR3 is just a little lower than the supply rail voltage, then TR3 must be short-circuit."

"Hey, hold your horses," said Smithy, reprovingly. "It's far too early yet to start jumping to conclusions, and there are quite a few other things which could cause a high voltage on the emitter of TR3. This particular amplifier doesn't have a pre-set pot for setting the output emitters to half supply voltage, like some amplifiers with complementary output stages do, and so there must be a d.c. feedback loop which is intended to ensure that the half supply voltage is obtained automatically. Our present snag could quite easily be caused by a fault in that loop. Let's have another butcher's at the circuit."

Smithy examined the circuit in the service sheet for a few moments, then nodded his head.

"Yes," he remarked, "the d.c. feedback arrangements are pretty obvious."

He selected the lowest voltage range on Dick's testmeter and applied the negative test prod to the base of TR1. (Fig. 3(c).)

"Blimey," said Dick, glancing at the meter, "you're getting hardly any voltage at all now. The needle's indicating about 0.1 volt, if that. Perhaps it's TR1 that's short-circuited!"

"You've got short-circuited transistors on the brain today," returned Smithy shortly. "Don't forget that there *are* other components that can go short-circuit as well."

"I'm beginning to find all this a bit baffling," confessed Dick. "The emitter of TR3 is at very nearly the same potential as its collector but you say that TR3 is not short-circuited. And the base of TR1 is at very nearly the same potential as its emitter and you say that *that's* not short-circuited

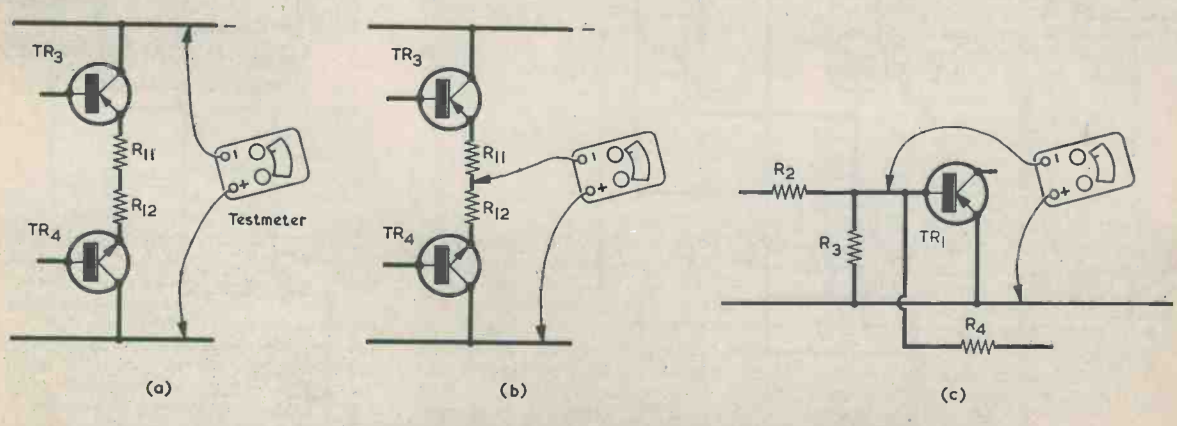



*Fig. 3 (a). Smithy first checked that a supply was available for the left-hand channel amplifier*
*(b). He next checked the voltage at the output emitters*
*(c). As a consequence of the readings he had obtained, Smithy proceeded to measure the voltage at the base of TR1*

either."

"I didn't say definitely that one or other of those transistors might *not* be short-circuit," replied Smithy testily, "but that's only because it doesn't do to be too dogmatic in the servicing game. At the same time, though, I do say that quite a few of the other components in the amplifier could be causing the symptoms we've got here. Now, that low voltage reading on TR1 base means that it's more than probable that there isn't enough bias current getting to it. Since TR1 is a silicon transistor, its base needs to be about 0.6 volt higher than its emitter, and that is certainly not happening here. The base current to TR1 flows through R10 and R4, so let's see what voltages we get at these resistors."

Smithy selected a higher voltage range on Dick's meter and placed the negative test prod on the junction of R10 and R4. (Fig. 4(a).)

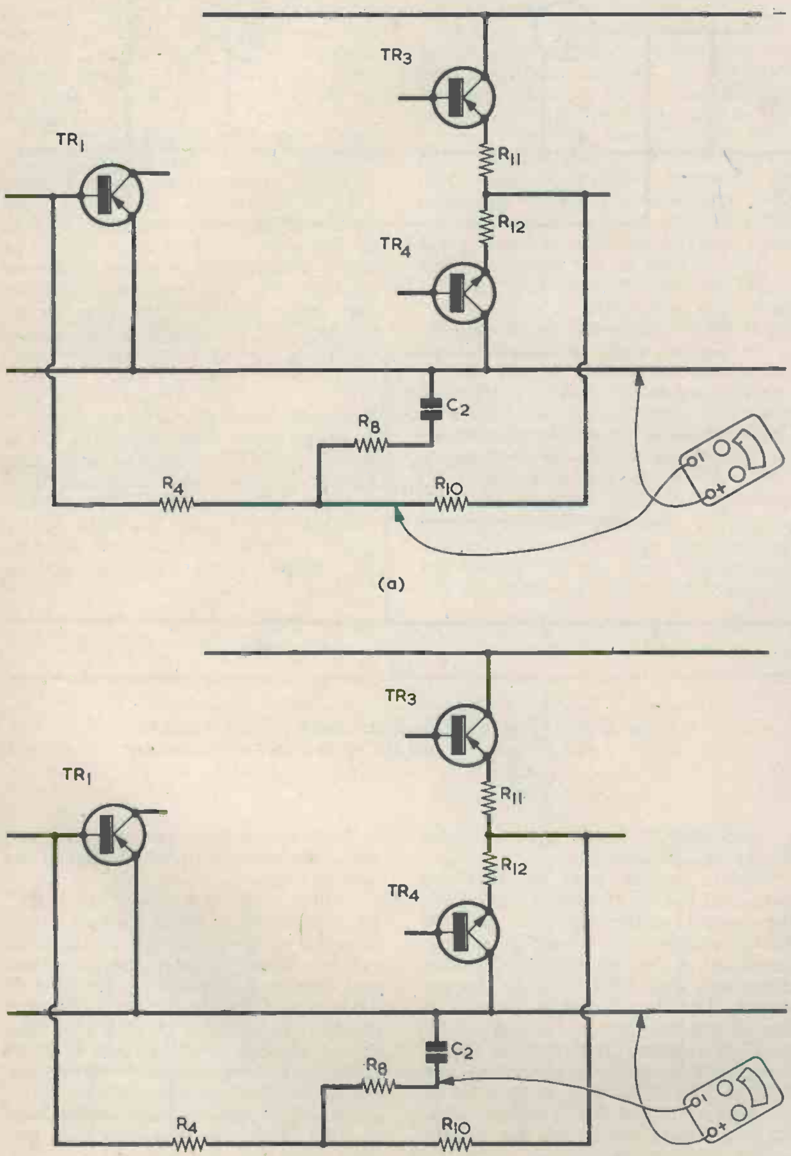



*Fig. 4 (a). Following the previous measurements, Smithy next checked the voltage at the junction of R4 and R10*
*(b). Smithy finally traced the fault by checking the voltage across C2*

"Half a mo," called out Dick. "I'll have to switch down to a lower voltage range. Ah, here, we are! The meter's reading about 1 volt."

"Is it, indeed?" remarked Smithy. "Then that means that either R10 has gone high in value or that something is dragging its junction with R4 down towards chassis. Let us undertake an exploratory prod at C2."

He applied the test prod to the junction of R8 and C2. (Fig. 4(b).)

"There's no reading in the meter at all now," announced Dick. "Not even a suspicion of one."

"Then that's it," grinned Smithy. "Either C2 is short-circuit or there's a short in the print across it. But it will almost certainly be the capacitor itself."

## FEEDBACK LOOP

Smithy rose, switched off the record-player, and let his assistant take over. After a check with his testmeter switched to an ohms range, that worthy soon established the fact that C2 was indeed short-circuit, and he quickly obtained a replacement and soldered it into circuit. He next switched on the record-player and checked the voltage at the emitter of TR3. This was now sitting sedately at the more respectable potential of 10.5 volts.

"Fine," said Smithy. "Try her out!"

Dick set up the auto-change and started it in operation. After some seconds the recorded music became audible again. But it was, this time, reproduced by both loudspeakers. The left-hand channel was now functioning as efficiently as the right-hand channel. Dick and Smithy listened contentedly until the record came to an end, and then the Serviceman switched off the record-player.

"You certainly cleared that one up pretty smartly," commented Dick. "I still can't see what was happening, though. How on earth can a shorted capacitor cause the base of one transistor to go low in voltage and the emitter of another to go high?"

"The chain of events is quite simple if you take them in stages," said Smithy in reply. "Before going any further, let's just see what each transistor in the amplifier does. TR1 is connected as a common emitter device, which means that it offers voltage amplification and that the signal on its collector is 180° out of phase with that on the base. When the base goes negative the collector goes positive, and vice versa. All the other three transistors in the amplifier are emitter followers, with the result that they offer current amplification only, with no change in phase. Thus, when the base of TR1 goes negative the emitters of TR2, TR3 and TR4 go positive, and when the base of TR1 goes positive the emitters of TR2, TR3 and TR4 go negative. All right so far?"

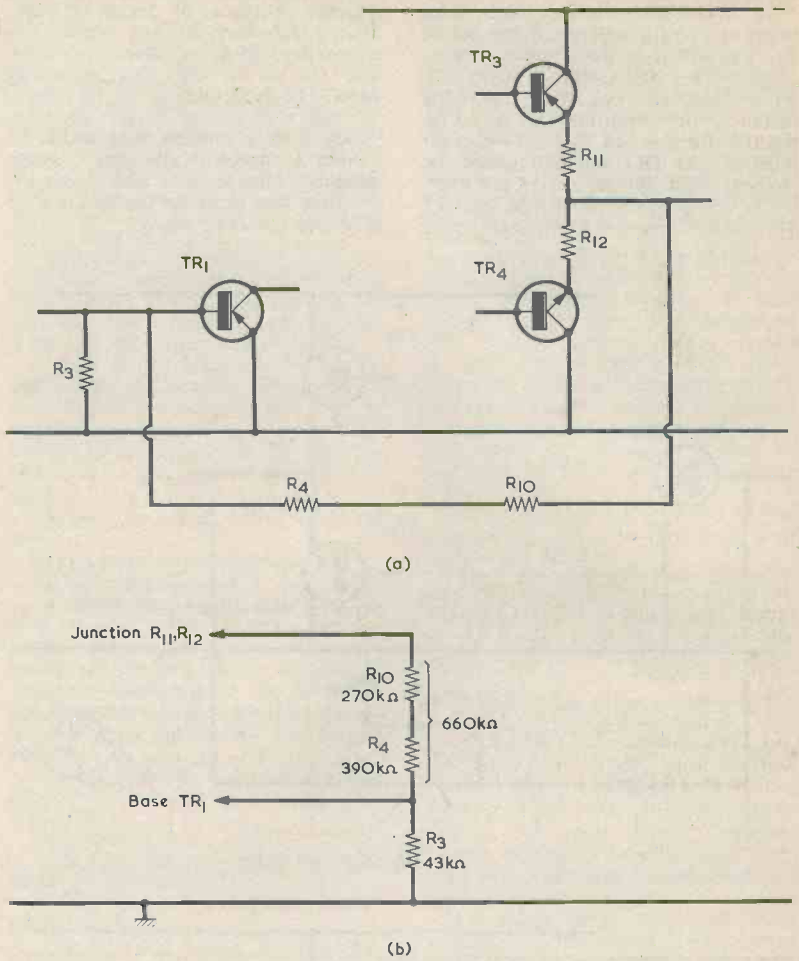



*Fig. 5 (a). The d.c. feedback path in the amplifier*
*(b). R10, R4 and R3 form a potential divider*

"Definitely," said Dick. "What comes next?"

"What comes next is that we examined the d.c. feedback path from the output emitters to the base of TR1," said Smithy. "Since we're only interested in d.c. conditions we ignore capacitors and look only at the resistors. The d.c. feedback path from the output emitters is then given by the 270kΩ resistor, R10, and the 390kΩ resistor, R4, which connects to the base of TR1. TR1 base is then taken to chassis via the 43kΩ resistor, R3. R2 and R1 are across R3, but we can ignore these as their values are much higher than that of R3."

With his finger, Smithy traced out the resistors in the feedback chain. (Fig. 5(a).)

"Now," he went on, "we have a simple potential divider here with R10 plus R4 giving the resistance above the base of TR1, and R3 the resistance below the base." (Fig. 5(b).)

Smithy took out a pen and scribbled some calculations in the margin of the service sheet.

"These resistance values are such," he continued, "that about one-fifteenth to one-sixteenth of the total voltage between the output emitters and chassis is applied to the base of TR1. Now let's assume that, for some reason, the emitters of TR3 and TR4 are at chassis potential and that we allow them to go negative. When the output emitters are at chassis potential there will be zero voltage on the base of TR1 and this transistor will not pass any collector current. As the output emitters rise towards the negative rail they will eventually reach a voltage which allows about 0.6 volt to appear between the base and the emitter of TR1. This transistor will now come on and commence to pass collector current, and the corresponding voltage at the output emitters will then be about 15.5 times 0.6, or 9.3

volts. TR1 needs a few microamps of base current to arrive at its operating point and so the voltage at the output emitters will then rise a little more to provide this. The circuit is now in a d.c. stabilized condition. If, for instance, the output emitters try to go positive the base of TR1 will also go positive and TR1 will counteract the change. And if the output emitters try to go negative, so will the base of TR1 and this transistor will once more counteract the change."

"Gosh," breathed Dick, highly impressed, "that's a really crafty bit of circuit operation. The output emitters stay at around half supply voltage simply because TR1 comes on when its base is 0.6 volt negative of its emitter."

"That's it," confirmed Smithy, "and the voltage at the output emitters depends upon the resistance values in the d.c. feedback chain back to TR1 base. I calculated the output voltage as a little more than 9.3 volts but, as we found when we measured it in the particular amplifier we are working on, it can vary slightly from this figure. This is due to the fact that the base voltage required for TR1 to come on is not *exactly* 0.6 volt, but is only approximately so."

"I can see now why the short-circuit at C2 produced such weird results," said Dick excitedly. "With C2 being short-circuited there wasn't enough voltage at TR1 base to even bring it on. Its collector went highly negative and all the other transistors, being emitter followers, went negative as well."

"Exactly," agreed Smithy. "It's an extreme instance of the case that, when TR1 base goes positive, the output emitters go negative."

## TONE CONTROL

But Dick's interest had suddenly turned to some of the other components in the circuit.

"I see that the tone control is also connected to the feedback chain," he remarked, pointing at the circuit diagram. "It's given by R9, C1 and C3." (Fig. 6.)

"Ah yes," said Smithy. "Now, when we start talking about capacitors we find ourselves looking at the a.c. feedback circuit. If, in the present design, the slider of R9 is take to the C3 end of its track, then C3 is effectively in parallel with R10. This means that feedback current increases as frequency rises. The amplifier will therefore offer reduced amplification at the higher frequencies and the result will be a treble cut or bass boost."

"Why, so it will be," exclaimed Dick. "Let's see if I can work out what happens when the slider of R9 is at the C1 end."

Dick thought for a moment as he considered the circuit in this condition.

"Well," he said, "what will take place here is that some of the feedback current will go to chassis by way of C1 instead of to the base of TR1, and that the amount of current passing through C1 will go up as frequency increases. Because of this there will be less feedback at the treble frequencies. The amplifier will offer greater ampli-

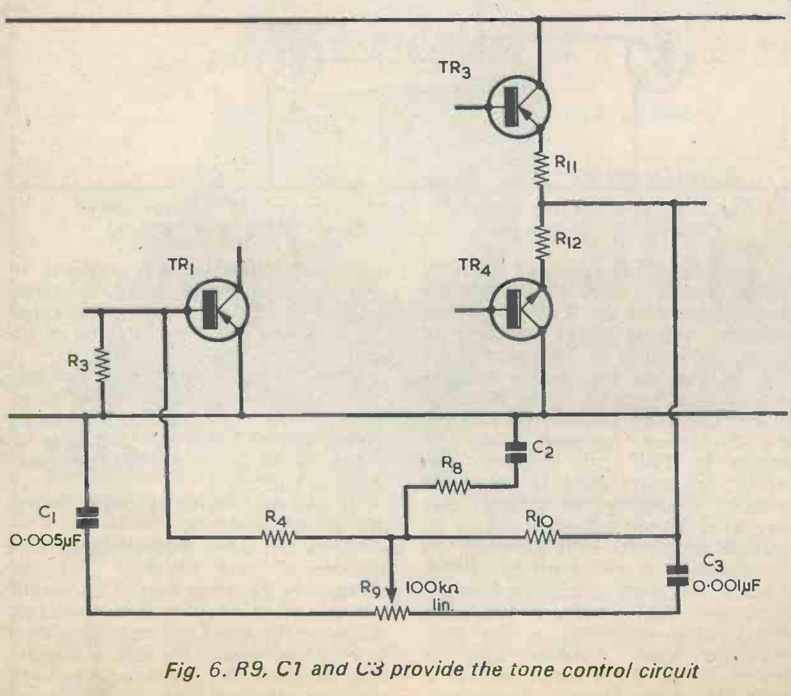



*Fig. 6. R9, C1 and C3 provide the tone control circuit*

fication at these frequencies and the result will be a treble boost."

"That's it," confirmed Smithy. "And you will get intermediate levels of cut and boost for intermediate settings of R9. R8 and C2 are also in the a.c. feedback chain and these will mainly influence the overall gain of the amplifier. If anybody wanted to build up an amplifier using a circuit of this nature they would need to experiment with the values of these two components to suit the particular pick-up they were using. The latter would need to be a crystal or ceramic type, incidentally."

"I see," remarked Dick, "that there is the usual electrolytic coupling the output emitters to the speaker. But there's another electrolytic, C5, coupling the output emitters to the junction of R6 and R7. What's that for, Smithy?" (Fig. 7.)

"It's to provide bootstrapping," explained Smithy.

"Bootstrapping?" repeated Dick dubiously. "I *think* I know what that means, but a little refresher course wouldn't come amiss!"

to TR2 and TR1."

"A *smoothing* capacitor? Come off it, Smithy, you must be joking!"

"No, I'm not," said Smithy. "As you can see, the supply circuit is of a very rudimentary nature, consisting simply of a bridge rectifier feeding directly into the reservoir capacitor, C6. There is liable to be some ripple across C6, particularly when the amplifier draws a heavy current, but this doesn't matter because TR3 is an emitter follower. TR3 acts here as a sort of electronic smoothing device, since the voltage at its emitter is dependent upon the voltage at its base regardless of changes, within reason, in collector potential. So any ripple across C6 doesn't find its way to the emitter of TR3. Or at least it doesn't provided that, on signal peaks, the troughs between ripple peaks don't take the supply voltage too close to the base voltage of TR3. However, the value of C6 should be large enough to ensure that this doesn't happen."

"I can see it all now," put in Dick. "Since TR3 causes the voltage at its base to be effectively smoothed, then

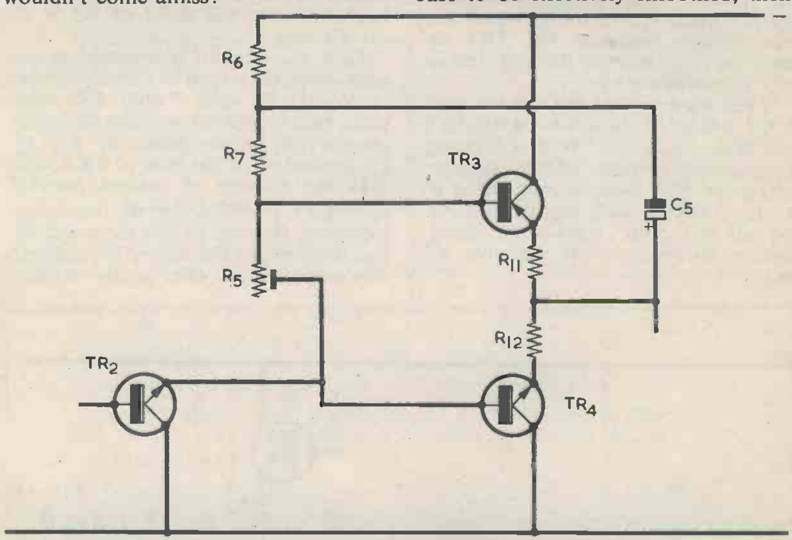



*Fig. 7. C5 couples the output of the amplifier back to the junction of R6 and R7, thereby giving both bootstrapping and smoothing*

"Fair enough," chuckled Smithy. "Well, what C5 does is to bootstrap the junction of R6 and R7 to the output emitters. When, whilst handling a signal, the emitter of TR2 goes negative, so also do the output emitters and so also, because of the presence of C5, does the junction of R6 and R7. The same happens when the emitter of TR2 goes positive. The results are that there is almost a constant voltage across R7 and that very little signal current flows in it. Because of this R7 behaves, so far as signal current is concerned, as though it has a very high value of resistance, whereupon TR2 emitter is presented with what is, effectively, a very high resistance load. Another function carried out by C5 is that it acts as a smoothing capacitor for the supply

the positive end of C5 connects to this smoothed circuit point. In consequence, it acts as a smoothing capacitor connected to the junction of R6 and R7."

"That's the idea," said Smithy. "This amplifier circuit is one of those designs which are deceptively simple on the surface but which contain quite a few subtle features when you start digging into them."

"I wonder," queried Dick, "what the output power is."

"You can work that out from first principles," said Smithy. "The rail voltage is 22 volts and the output emitters sit at about half this voltage. Allowing for small discrepancies here, it would be reasonably safe to assume that the output emitters can swing both positive and negative by about 10 volts peak. This corresponds to 7 volts r.m.s. The speaker impedance is 25Ω nominal and it would be advisable to say that the load applied to the output emitters is this figure plus a few odd ohms due to the presence of C4, R11 and R12. An output load figure of 28Ω or so would be realistic. The output power is then r.m.s. voltage squared divided by impedance, or 7 squared divided by 28."

Smithy scribbled some further figures in the margin of the service sheet.

"Ah yes," he said, "that comes out as 1.75 watts. It's always advisable to be a bit cautious with these output power figures and so it would be safe to assume an actual output power of around 1.5 watts."

"I suppose," commented Dick, "that R5 is set up in the usual way so that TR3 and TR4 pass a small current under quiescent conditions."

"That's right," agreed Smithy. "If you were starting from scratch you'd adjust R5 to put minimum resistance into circuit and insert a current reading meter between the collector of TR3 and the negative supply rail. The resistance inserted by R5 would then be increased until the meter indicated about 5mA or so under quiescent conditions. The same approach would apply for the corresponding base potentiometer in the right-hand channel."

**DON'T RING US**

"Oh well," said Dick, rising from his stool," it looks as though we've got another servicing job out of the way."

"Yes, indeed," replied Smithy, also rising. "You'd better button up this record player now and get on with the next gubbins that requires fixing."

"D'you know, Smithy," said Dick chattily, "I'm glad I went in for servicing as a career. There must be more fun in servicing than there is in any other job."

"I agree with you there," remarked Smithy. "The great thing about servicing is the special feeling of achievement you get after you've traced a really obscure fault and got a piece of equipment back into working order again."

"You're dead right there," responded Dick enthusiastically. "Hey, hang on a jiffy!"

A look of agnonised concentration spread over his face. With a sinking heart, Smithy realised that Dick was being visited, as occurred on occasion, by his Muse.

"Here, Smithy," said Dick proudly, as his brow cleared, "what do you think of this?"

He struck a pose indicative of the creative artist.

*"I could have been a bricklayer*
*Or even a window displayer,*
*But I get far more kicks*
*When I'm able to fix*
*A stereophonic gram player!"*

The shuddering Serviceman, as he sought the sanctuary of his own bench, had to admit that, in Dick, he certainly had an assistant who was totally unique. He should be so unlucky. ■

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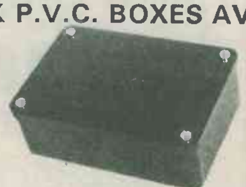

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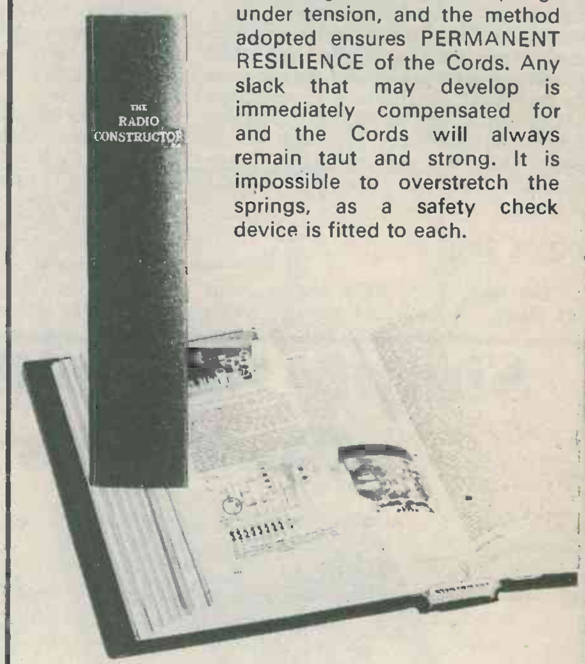


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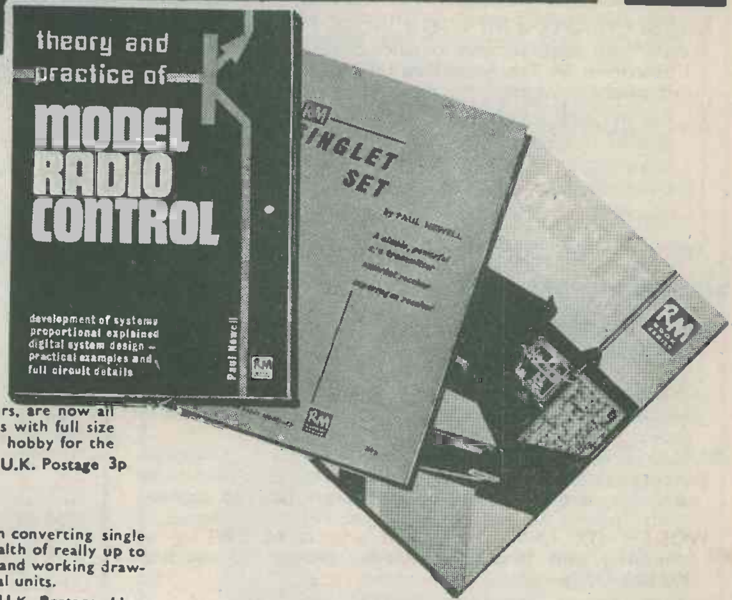


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# INDEX TO VOLUME TWENTY-SIX
## August 1972 - July 1973

# RESONANT FREQUENCIES IV

The Table gives calculated resonant frequencies, in Hz, for tuned circuits having inductances from 10 to 800mH and capacitances from 100pF to 0.1µF. Thus, 60mH and 1,000pF are resonant at 20,100Hz.

| Inductance (mH) | 100pF | 250pF | 400pF | 1,000pF | 2,500pF | 4,000pF | 0.01µF | 0.025µF | 0.04µF | 0.1µF |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 159,000 | 101,000 | 79,600 | 50,300 | 31,800 | 25,200 | 15,900 | 10,100 | 7,960 | 5,030 |
| 20 | 113,000 | 71,200 | 56,300 | 35,600 | 22,500 | 17,800 | 11,300 | 7,120 | 5,630 | 3,560 |
| 30 | 91,900 | 58,200 | 46,000 | 29,100 | 18,400 | 14,500 | 9,200 | 5,820 | 4,600 | 2,910 |
| 40 | 79,600 | 50,300 | 39,800 | 25,200 | 15,900 | 12,600 | 7,960 | 5,030 | 3,980 | 2,520 |
| 50 | 71,200 | 45,000 | 35,600 | 22,500 | 14,200 | 11,300 | 7,120 | 4,500 | 3,560 | 2,250 |
| 60 | 65,000 | 40,200 | 32,500 | 20,100 | 13,000 | 10,000 | 6,500 | 4,020 | 3,250 | 2,010 |
| 70 | 60,200 | 38,100 | 30,000 | 19,000 | 12,000 | 9,520 | 6,020 | 3,810 | 3,010 | 1,900 |
| 80 | 56,300 | 35,600 | 28,200 | 17,800 | 11,300 | 8,900 | 5,630 | 3,560 | 2,820 | 1,780 |
| 90 | 53,100 | 33,400 | 26,500 | 16,800 | 10,600 | 8,390 | 5,310 | 3,340 | 2,650 | 1,680 |
| 100 | 50,300 | 31,800 | 25,200 | 16,000 | 10,100 | 7,960 | 5,030 | 3,180 | 2,520 | 1,590 |
| 200 | 35,600 | 22,500 | 17,800 | 11,300 | 7,120 | 5,630 | 3,560 | 2,250 | 1,780 | 1,130 |
| 400 | 25,200 | 15,900 | 12,600 | 7,960 | 5,030 | 3,980 | 2,520 | 1,590 | 1,260 | 795 |
| 600 | 20,500 | 13,000 | 10,300 | 6,510 | 4,110 | 3,250 | 2,050 | 1,300 | 1,030 | 651 |
| 800 | 17,800 | 11,300 | 8,900 | 5,630 | 3,560 | 2,810 | 1,780 | 1,130 | 890 | 563 |

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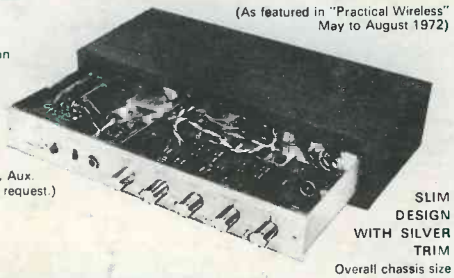

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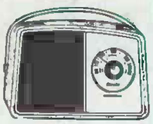

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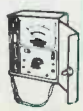

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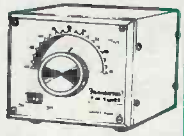

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