RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1975 30p

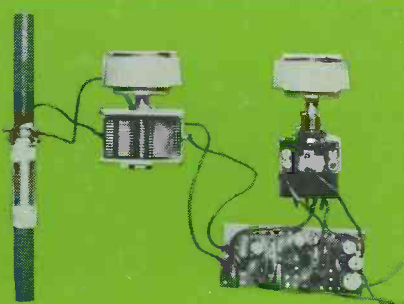
IN THIS ISSUE

VEROBOARD PROJECT ONE

VERSATILE LIGHT ALARM

VEROBOARD PROJECT TWO

BROADCAST BAND RECEIVER



NEW TRANSISTORISED OSCILLOSCOPE

PART 2 (3 PARTS)

FREE PIECE OF VEROBOARD INSIDE

RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1975
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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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

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CONTENTS

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COMPONENTS

HOBBYIST - PROFESSIONAL - DOMESTIC - SURPLUS - INDUSTRIAL
JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON OTHER REQUIREMENTS. PAY US A VISIT. OVER 90% OF STOCK BELOW QUANTITY WHOLESALE PRICE. RETURN POSTAL SERVICE UNLESS CHEQUE.

Goods sent at customer's risk, unless sufficient payment for insurance included (2p per £1 Min 5p) U.K. only.

VALVE BASES

Printed circuit B9A – B7G 2p
Chassis B7 – B9G – B7G 4p
Shrouded chassis B7G – B9A .. 6p
B8A – B9A chassis – B12A tube .. 6p

TO3 or TO66
Mica Washer .. 2p
18 volt 4 amp charger, bridge rectifier 50p
GC10/4B £3.00

Speaker, 6″ x 4″, 5 ohm, ideal for car radio etc. £1

Telescopic aerial
Closed 9½″, open 38½″
Fitted right angle TV plug, 50p

TAG STRIP – 6 way 3p
9 way 5p Single 1p

VHF Radio Tuner Head
Takes ECC 85 80p

1¼ glass fuses— 250 m/a or 3 amp (box of 12) 18p
3″ tape spools 8p 1 Terryclips chrome finish 4p
Brand new Boxed 6K7G 25p 1.5m, log edge pot .. 8p
PVC or metal clip on M.E.S. bulb holder 5p
Geared Knob, Inner to Outer Ratio 8:1 .. .. 60p
Bulgin, 5mm Jack plug and switched socket (pair) 30p
12 volt solenoid and plunger 30p
250 RPM 50 c/s locked frequency miniature mains motor .. 50p
200 OHM coil, 2¼″ long, hollow centre 10p
Belling Lee white plastic surface coax outlet Box 30p
R.S. 12 way standard plug and shell 20p

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	18p
6	2	Slide	20p
4	2	Lever Slide	15p
2	2	Slide	10p
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	24p
1	2	Toggle	10p

Wafer Rotary, all types 30p
S.P.S.T. 10 amp 240v. white rocker switch with neon. 1″ square flush panel fitting 30p

RESISTORS

⅛–¼–½ watt .. 1p
1 watt 2p
Up to 5 watt wire 10p
10 watt wire wound 12p
15 watt 14p

Philips transformer, safety fused. In 200-220-240v. Out 240v 60ma + 6.3v 1a approx 2″ x 2¼″ x 2½″ £1.50

1½ METER AUDIO LEAD

5 pin din plug 180° both ends 68p

POTS

Log or Lin carbon 13p
Switched 25p
Dual Pots 38p
Dual & switch 50p
Lin wirewound 25p
Slider Pot 25p
Dual Slider 35p

COMPUTER AND AUDIO BOARDS

VARYING PANELS WITH ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.
3lb for 85p + 60p post and packing
7lb for £1.75 + 80p post and packing

Skeleton Presets
Slider, horizontal or vertical standard or submin. 5p

Clear Plastic Boxes
For component storage or projects, sliding lid. 1¾″ x 1½″ x 1″ 10p

THERMISTORS

VA1008, VA1034, VA1039, VA1040, VA1055, VA1066, VA1082, VA1100 } 10p
VA1077, VA1005, VA1026 } 15p

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW WITH POINTER AND SILVER CENTRE 8p EACH.
1″ DIAM. WITH 1½″ SKIRT SPUN ALUMINIUM GRUB SCREW FIXING, ¼″ 30p EACH.

RELAYS

12 volt S.P.C.O octal mercury wetted high speed 75p
P.O. 3000 type, 1,000 OHM coil, 4 pole c/o 60p
Mains or 12v d.p.c.o. heavy duty octal 60p

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2·5M/A £1.50

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989
6-14 volt, 6 digit, illuminated, fully enclosed. £2.50

Ferric Chloride, Anhydrous mil. spec. 1lb. bag 50p

Boxed GEC KT88 valve £2

JAP 4 gang min. sealed tuning condensers New 25p
Ex-eqpt. 2 or 4 gang 15p

ELECTROLYTICS MFD/VOLT. Many others in stock

MFD	Up to 10V	25V	50V	70–75V	100V	200–250V	300–350V	450–500V
10	4p	5p	6p	8p	8p	12p	16p	20p
25	4p	5p	6p	8p	8p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	17p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

As total number of values are too numerous to list, use this price guide to work out cost of your actual value requirements, i.e. 2MFD, 30V would be 5p, or 330MFD, 50V would be 14p, etc. etc.
8/20, 10/20, 12/20 **Tubular tantalum 15p each**
16–32/275, 32–32/275, 100–100/150, 100–100/275 50–50/300 .. .. 20p each
50/50–385 .. .. .. 30p
12,000/12, 32–32–50/300, 700/200 100–100–100–150–150/320 .. .. 50p each
20–20–20/350 .. .. 40p each

INDICATORS

Bulgin D676 red, takes M.E.S. bulb 20p
12 volt red, small pushfit 20p
Mains neon, red, pushfit 20p

CAPACITOR GUIDE – maximum 500V

Up to .01 ceramic **2p**. Up to .01 poly **3p**. Up to 1000PF silver mica **5p**. 1,200PF up to .01 silver mica **10p**. .013 up to .25 poly etc. **4p**. .27 up to .68 poly etc. **6p**
Over 500 volt order from above guide and few others listed below.
6p. .1/600: **10p**. .01/1000, 1/350, 8/20, .1/900, .22/900, 4/16. .25/250 AC (600vDC) .1/1500 **40p**. 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 20p each

100PF Ceramic, 30PF Beehive, 12PF PTFE 2500PF 750 volt, 33PF MIN. AIR SPACED 5PF, MIN. AIR SPACED, 50PF CERAMIC.

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. 3p each

Strong grey plastic box same design as die cast ali 4⅜″ x 2⅜″ x 1¼″ 40p

1″ or 1⅜″ or ¾″ CAN CLIPS .. 2p

MAINS DROPPERS

36+79 ohm 15p
66+66+158 ohm, 66+66+137 ohm
17+14+6 ohm, 266+14+193 ohm 20p
50+40+1k5 ohm
285+575+148+35 ohm } 30p
25+35+97+59+30 ohm

5¼″ x 2¾″ Speaker, ex-equipment 3 ohm 30p
2 Amp Suppression Choke 5p
3 x 2½ x 1/16″ } PAXOLINE .. 2p
4⅝ x ½ x ⅛″, } .. .. .. 2 for 1p
220K & 100 ohm 3 watt resistors .. 4p
VALVE RETAINER CLIP, adjustable 2p

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type .. 25p
Valve type, centre tapped or straight 40p

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday – Also Sunday afternoons
Telephone: 01-223 5016

3 pin din to open end, 1½yd twin screened lead 35p
Whiteley Stentorian 3 ohm constant impedance volume control way below trade at 80p
Drive Cord 1p per yd.

SEMICONDUCTORS

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

AC107	12p	BC179B ..	11p	BF180/1/2/3 ..	20p
AC128	5p	BC184C ..	9p	BF184/5 ..	15p
AC176 ..	10p	BC186/7 ..	13p	BF194/5/6/7 ..	5p
ACY28	18p	BC213L/214B ..	9p	BF194A/195C ..	12p
AD149	40p	BC261B ..	10p	BF200	10p
AD161/2 matched pr.	69p	BC327 ..	12p	BF258	24p
AF116/7 ..	12p	BC328 ..	10p	BF262/3 ..	23p
AF124/6/7 ..	20p	BC337/8 ..	14p	BF336	25p
AF139/178 ..	30p	BC547/558A ..	7p	BFS28 Dual Mosfet	92p
AF239	20p	BC548 ..	9p	BFW10/11 F.E.T.	26p
ASY27/73 ..	25p	BCX32/36 ..	12p	BFW30 ..	£1.35
BC107A or B ..	9p	BCY40	60p	BFW57/58 ..	20p
BC107/8/9 ..	7p	BCY70/1/2 ..	9p	BFX12	20p
BC108A/B/109B/C	10p	BD112/3/5/6 ..	40p	BFX29/30/84/88	16p
BC147/8/9 ..	6p	BD131/2/3/5 ..	30p	BFY50/1/2 ..	12p
BC147A/B ..	8p	BD201/2/3/4 ..	£1.00	BFY90	50p
BC148A/B, 9B/C/S	8p	BD232/4/5 ..	46p	BR101 (Programmable Uni Junction)	30p
BC157/8/9 ..	6p	BDX77 ..	£1.40	BRY39 (Programmable Uni Junction)	31p
BC158A/B ..	11p	BF115	12p	BRY56 (Programmable Uni Junction)	34p
BC159B/C, 157A	11p	BF167/173 ..	15p	BSV64	40p
BC178A/B ..	12p	BF178/9 ..	20p	BSV79/80 F.E.T.s	£1

BSV81 Mosfet ..	90p
BSX20/21 ..	13p
BSY40	28p
BU105-01 ..	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111 ..	40p
OC35	32½p
ON222 ..	30p
TIP30 ..	52p
TIP3055 ..	50p
TIS88A FET ..	23p
ZTX300 ..	8p
2N393/MA393 ..	30p
2N706	8p
2N929	14p
2N987	35p
2N1507/2219 ..	17p
2N2401/2412/2483	25p
2N2904/5/6/7 ..	13p
2N2907A ..	15p
2N3053 ..	13p
2N3054/3055 (or equiv)	35p
2N3133 ..	18p
2N3704 ..	10p
2N4037 ..	35p
2N5036 ..	60p
2SA141/2/360 ..	31p
2SB135/6/457 ..	20p
40250	60p

OTHER DIODES

IN916	6p
IN4148	2.5p
BA145/148 ..	12p
Centercel ..	10p
BZY61	10p
BB103/110 Varicap	18p
BA182	18p
OA5/7/10 ..	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt ..	16p
BR100 Diac. ..	19p

INTEGRATED CIRCUITS

741 8 pin d.i.l. op. Amp	20p
TAD100 AMRF	£1.00
CA3001 R. F. Amp	£1.00
TAA300 1wt Amp	£1.25
NE555v Timer	42p
TAA550 Y or G	31p
TAA263 Amp	65p
ZN414 RX	95p
7400/2/10/20/30	13p
7404	14p
7414 ..	60p
7438/74/86 ..	27p
7483	80p
LM300, 2-20 volt	50p
74154 ..	£1.50

BRIDGE RECTIFIERS

Amp	Volt			Amp	Volt		
½	1,600	BYX10	30p	2	30	LT120 type	30p
1	140	OSH01-200	30p	0.6	110	EC433	15p
1.4	42	BY164	28p	5	400	Texas	75p

RECTIFIERS

	Amp	Volt	
IN4004	1	400	4p
IN4005	1	600	4p
IN4006	1	800	4p
IN4007	1	1,000	4p
BY103	1	1,500	15p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	40p
BYX38-300R	2.5	300	36p
BYX38-900	2.5	900	45p
BYX38-1200	2.5	1,200	50p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£1.00
BYX46-400*	15	400	£1.50
BYX46-500*	15	500	£1.75
BYX46-600*	15	600	£2.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

TRIACS

Amp	Volt		
6	400	Plastic ..	74p
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00

12-0-12 50M/A Min. Txfmr. 90p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia .. 15p
Rubber Car Radio gasket .. 5p

DLI Pal Delayline 50p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can .. 2p

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

OPTO ELECTRONICS

ORP12	44p
BPX40	65p
BPX42	£1.00
BPY10 (VOLTIAC)	£1.00
BPY68 / BPY69 / BPY77 Diodes	£1.00

Photo transistor

BPX29	£1.00
OCP71	30p

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

RED	14p
ORANGE / GREEN / YELLOW	16p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

THYRISTORS

Amp	Volt		
1	240	BTX18-200	50p
1	400	BTX18-300	65p
1	240	BTX30-200	40p
6.5	500	BT102-500R	75p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	75p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated ..	£8.00
30	1000	28T10 (Less Nut)	£3.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment 65p

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

Wire ended glass neons 5p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p
Holdersorpads 50pper100

PAPER BLOCK CONDENSER

0.25MFD	800 volt ..	30p
1MFD	250 volt ..	15p
2MFD	250 volt ..	20p
10MFD	500 volt ..	80p
4MFD	250 volt ..	20p
15MFD	150 volt ..	50p

METAL CHASSIS SOCKETS

Car Aerial .. ..
Coax .. ..
5 or 6 pin 240° din
Speaker din switched
3.5mm Switched Socket
9p

SOLDER

Multicore - 2½p foot

ENAM. COPPER WIRE

SWG.	PER YD.
18	3p
20-24	2p
26-42	1p

GARRARD

GCS23T Crystal Stereo Cartridge £1.00

HANDLES

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

Philips Iron Thermostat ... 15p
Bulgin 2-pin flat plug and socket 10p
McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK
Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 20p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	10p
ASZ21	15p	TIC44	24p
BC186	11p	2G240	2-50
BCY30-34	10p	2G302	6p
BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	7p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
L78/9	2p	Germ. diode	1p
M3	10p	GET120 (AC128 in 1" sq. heat sink)	20p
OA81	2p		
OA47	2p		
OA200-2	3p	GET872	12p
OC23	20p	2S3230	30p

8 way Cinch standard 0.15 pitch edge socket 20p

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

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

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

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

3.5mm STEREO PLUG Metal screened 35p

Philips electronic engineer kits add on series E1004 £1.00 each

RG4-1250 Mercury vapour rectifier £5.00

14 D.I.L. socket, gold plated contacts, NOT cheap type 13p

Miniature Axial Lead Ferrite Choke formers 2p

DEE PLUG

McMurdo DA15P 15 way chassis plug 10p

Fairway 18009 Coax. socket 3p

TIE CLIPS

Nylon self locking 7" or 3½" 2p

CINCH 150

12 way edge socket 10p

1lb Mixed nuts, bolts, washers etc. 35p

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE
LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.
TOTAL GOODS PLUS CARRIAGE, ADD V.A.T.

MAIL ORDER CUSTOMERS ONLY ADD 8% V.A.T.

BI-PAK SEMICONDUCTORS

TRANSISTORS

BRAND NEW FULLY GUARANTEED

Type	Price
AC107	0·20
AC113	0·19
AC115	0·20
AC117K	0·30
AC122	0·12
AC125	0·18
AC126	0·18
AC127	0·19
AC128	0·19
AC132	0·15
AC134	0·15
AC137	0·15
AC141	0·19
AC141K	0·30
AC142	0·19
AC142K	0·26
AC151	0·16
AC154	0·20
AC155	0·20
AC156	0·20
AC157	0·25
AC165	0·20
AC166	0·20
AC167	0·20
AC168	0·25
AC169	0·15
AC176	0·20
AC177	0·25
AC178	0·29
AC179	0·29
AC180	0·20
AC180K	0·30
AC181	0·20
AC181K	0·30
AC187	0·22
AC187K	0·23
AC188	0·22
AC188K	0·23
ACY17	0·26
ACY18	0·20
ACY19	0·20
ACY20	0·20
ACY21	0·20
ACY22	0·17
ACY27	0·19
ACY28	0·19
ACY29	0·36
ACY30	0·29
ACY31	0·29
ACY34	0·21
BC173	0·15
BC174	0·15
BC175	0·22
BC177	0·19
BC178	0·19
BC179	0·19
BC180	0·26
BC181	0·25
BC182	0·15
BC182L	0·15
BC183	0·15
BC183L	0·15
BC184	0·20
BC184L	0·20
BC186	0·29
BC187	0·29
BC207	0·11
BC208	0·11
BC209	0·12
BC212L	0·13
BC213L	0·13
BC214L	0·17
BC225	0·26
BC226	0·36
BC301	0·28
BC302	0·25
BC303	0·31
BC304	0·37
BC440	0·31
BC460	0·37
BCY30	0·25
BCY31	0·27
BCY32	0·31
BCY33	0·22
BCY34	0·26
BCY70	0·15
BCY71	0·20
BCY72	0·15
BCZ10	0·20
BCZ11	0·26
BCZ12	0·26
BD115	0·63
BD116	0·81
BD121	0·81
BD123	0·67
BD124	0·70
BD131	0·51
BD132	0·61
BD133	0·67
BD135	0·41
BFY53	0·18
BSX19	0·16
BSX20	0·16
BSY25	0·16
BSY26	0·16
BSY27	0·16
BSY28	0·16
BSY29	0·16
BSY38	0·19
BSY39	0·19

Type	Price
BSY40	0·29
BSY41	0·29
BSY95	0·13
BSY95A	0·13
BU105	£2·04
C111E	0·51
C400	0·31
C407	0·26
C424	0·26
C425	0·51
C426	0·36
C428	0·20
C441	0·31
C442	0·31
C444	0·36
C450	0·22
MAT100	0·19
MAT101	0·20
MAT120	0·19
MAT121	0·20
MJE521	0·56
MJE2955	0·88
MJE3055	0·57
MJE3440	0·51
MPF102	0·43
MPF104	0·38
MPF105	0·38
OC19	0·36
OC20	0·65
OC22	0·47
OC23	0·49
OC24	0·57
OC25	0·39
OC26	0·30
OC28	0·51
OC29	0·51
OC35	0·43
OC36	0·51
OC41	0·20
OC42	0·25
2N918	0·31
2N929	0·21
2N930	0·21
2N1131	0·20
2N1132	0·22
2N1302	0·15
2N1303	0·15
2N1304	0·18
2N1305	0·18
2N1306	0·21
2N1307	0·21
2N1308	0·24
2N1309	0·24
2N1613	0·20
2N1711	0·20
2N1889	0·32
2N1890	0·46
2N1893	0·38
2N2147	0·73
2N2148	0·58
2N2192	0·36
2N2193	0·36
2N2194	0·36
2N2217	0·22
2N2218	0·20
2N2219	0·20
2N2220	0·22
2N2221	0·20
2N2222	0·20
2N2368	0·18
2N2369	0·15
2N2369A	0·15
2N2411	0·25
2N2412	0·25
2N2646	0·48
2N2711	0·21
2N2712	0·21
2N2714	0·21
2N2904	0·18
2N2904A	0·21
2N2905	0·21
2N2905A	0·21
2N2906	0·16
2N2906A	0·19
2N2907	0·20
2N2907A	0·22
2N2923	0·15
2N2924	0·15
2N2925	0·15
ACY35	0·21
ACY36	0·29
ACY40	0·18
ACY41	0·19
ACY44	0·36
AD130	0·39
AD140	0·49
AD142	0·49
AD143	0·39
AD149	0·51
AD161	0·36
AD162	0·36
AD161 & AD162(MP)	0·89
ADT140	0·51
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·25

Type	Price
AF118	0·36
AF124	0·31
AF125	0·31
AF126	0·29
AF127	0·29
AF139	0·31
AF178	0·51
AF179	0·51
AF180	0·51
AF181	0·51
AF186	0·51
AF239	0·38
AL102	0·68
AL103	0·68
ASY26	0·26
ASY27	0·31
ASY28	0·26
ASY29	0·26
ASY50	0·26
ASY51	0·26
ASY52	0·26
ASY54	0·26
ASY55	0·26
ASY56	0·26
ASY57	0·26
ASY58	0·26
ASY73	0·26
ASZ21	0·41
BC107	0·08
BC108	0·08
BC109	0·08
BD136	0·41
BD137	0·46
BD138	0·51
BD139	0·56
BD140	0·61
BD155	0·81
BD175	0·61
BD176	0·61
BD177	0·67
BD178	0·67
BD179	0·71
BD180	0·71
BD185	0·67
BD186	0·67
BD187	0·71
BD188	0·71
BD189	0·77
BD190	0·77
BD195	0·87
BD196	0·87
BD197	0·92
BD198	0·92
BD199	0·98
BD200	0·98
BD205	0·81
BD206	0·81
BD207	0·98
BD208	0·98
BDY20	£1·02
BF115	0·25
BF117	0·46
BF118	0·71
BF119	0·71
BF121	0·46
BF123	0·51
BF125	0·46
BF127	0·51
BF152	0·56
BF153	0·46
BF154	0·46
BF155	0·71
BF156	0·49
BF157	0·56
BF158	0·56
BF159	0·61
BF160	0·41
BF162	0·41
BF163	0·41
BF164	0·41
BF165	0·41
OC44	0·16
OC45	0·13
OC70	0·10
OC71	0·10
OC72	0·15
OC74	0·15
OC75	0·16
OC76	0·16
OC77	0·26
OC81	0·16
OC81D	0·16
OC82	0·16
OC82D	0·16
OC83	0·20
OC139	0·20
OC140	0·20
OC169	0·26
OC170	0·26
OC171	0·26
OC200	0·26
OC201	0·29
OC202	0·29
OC203	0·26
OC204	0·26
OC205	0·36
OC309	0·41
OCP71	0·44*
ORP12	0·44*
ORP60	0·41*

Type	Price
ORP61	0·41*
P20	0·51*
P346A	0·20
P397	0·43
ST140	0·13
ST141	0·18
TIP29	0·44
TIP30	0·52
TIP31A	0·56
TIP32A	0·68
TIP41A	0·68
TIP42A	0·81
TI843	0·31*
UT46	0·28*
ZN414	1·11
2G301	0·19
2G302	0·19
2G303	0·19
2G304	0·25
2G306	0·41
2G308	0·36
2N2926 G	0·13
2N2926 Y	0·11
2N2926 O	0·10
2N2926 R	0·10
2N2926 B	0·10
2N3010	0·71
2N3011	0·15
2N3053	0·18
2N3054	0·47
2N3055	0·42
2N3319	0·15
2N3391 A	0·17
2N3392	0·15
2N3393	0·15
2N3394	0·15
2N3395	0·18
2N3402	0·21
2N3403	0·21
2N3404	0·29
2N3405	0·43
2N3414	0·16
2N3415	0·16
2N3416	0·29
2N3417	0·29
2N3525	0·77*
2N3614	0·69
2N3615	0·76
2N3616	0·76
2N3646	0·09
2N3702	0·12
2N3703	0·12
2N3704	0·13
2N3705	0·12
2N3706	0·12
2N3707	0·13
2N3708	0·08
2N3709	0·09
2N3710	0·09
2N3711	0·09
2N3819	0·29
2N3820	0·51
2N3821	0·36
2N3823	0·29
2N3903	0·29
2N3904	0·31
2N3905	0·29
2N3906	0·28
2N4058	0·12
2N4059	0·10
2N4060	0·12
BC113	0·10
BC114	0·16
BC115	0·16
BC116	0·16
BC117	0·19
BC118	0·10
BC119	0·31
BC120	0·81
BC125	0·12
BC126	0·19
BC132	0·12
BC134	0·19
BC135	0·12
BC136	0·16
BC137	0·16
BC139	0·41
BC140	0·31
BC141	0·31
BC142	0·31
BC143	0·31
BC145	0·46
BC147	0·10
BC148	0·10
BC149	0·12
BC150	0·19
BC151	0·20
BC152	0·18
BC153	0·29
BC154	0·31
BC157	0·19
BC158	0·12
BC159	0·12
BC160	0·46
BC161	0·51
BC167	0·12
BC168	0·12
BC169	0·12
BC170	0·12
BC171	0·15

Type	Price
BC172	0·15
BF167	0·22
BF173	0·22
BF176	0·36
BF177	0·36
BF178	0·31
BF179	0·31
BF180	0·31
BF181	0·31
BF182	0·41
BF183	0·41
BF184	0·26
BF185	0·31
BF187	0·28
BF188	0·41
BF194	0·12
BF195	0·12
BF196	0·15
BF197	0·15
BF200	0·46
BF222	0·98
BF257	0·46
BF258	0·61
BF259	0·87
BF262	0·56
BF263	0·56
BF270	0·36
BF271	0·31
BF272	0·81
BF273	0·36
BF274	0·36
BFW20	0·61
BFX29	0·28
BFX84	0·22
BFX85	0·31
BFX86	0·22
BFX87	0·25
BFX88	0·22
BFY50	0·20
BFY51	0·20
BFY52	0·20
2G309	0·37
2G339	0·20
2G339A	0·17
2G344	0·19
2G345	0·17
2G371	0·17
2G371B	0·12
2G373	0·18
2G374	0·18
2G377	0·31
2G378	0·17
2G381	0·17
2G382	0·17
2G401	0·31
2G414	0·31
2G417	0·26
2N388	0·36
2N388A	0·56
2N404	0·20
2N404A	0·29
2N524	0·43
2N527	0·50
2N598	0·43
2N599	0·46
2N696	0·13
2N697	0·14
2N698	0·25
2N699	0·36
2N706	0·08
2N706A	0·09
2N708	0·12
2N711	0·31
2N717	0·36
2N718	0·25
2N718A	0·51
2N726	0·29
2N727	0·29
2N743	0·20
2N744	0·20
2N914	0·15
2N4061	0·12
2N4062	0·12
2N4284	0·18
2N4285	0·18
2N4286	0·18
2N4287	0·18
2N4288	0·18
2N4289	0·18
2N4290	0·18
2N4291	0·18
2N4292	0·18
2N4293	0·18
2N5172	0·12
2N5194	0·56
2N5294	0·56
2N5296	0·56
2N5457	0·32
2N5458	0·32
2N5459	0·41
2N6122	0·69
2S301	0·51
2S302A	0·43
2S302	0·43
2S303	0·56
2S304	0·71
2S305	0·80
2S306	0·80
2S307	0·80
2S321	0·75

* 74 SERIES T.T.L. I.C's

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. AD FAMOUS MANUFACTURERS..

Type	Quantities 1	25	100+
7400	0·14	0·13	0·12
7401	0·14	0·13	0·12
7402	0·14	0·13	0·12
7403	0·14	0·13	0·12
7404	0·14	0·13	0·12
7405	0·14	0·13	0·12
7406	0·36	0·31	0·29
7407	0·36	0·31	0·29
7408	0·23	0·22	0·21
7409	0·23	0·22	0·21
7410	0·14	0·13	0·12
7411	0·23	0·22	0·21
7412	0·26	0·25	0·24
7413	0·30	0·29	0·28
7416	0·28	0·27	0·26
7417	0·28	0·27	0·26
7420	0·14	0·13	0·12
7422	0·28	0·27	0·28
7423	0·37	0·36	0·35
7425	0·37	0·36	0·35
7426	0·37	0·35	0·33
1427	0·37	0·35	0·33
7428	0·42	0·39	0·37
7430	0·14	0·13	0·12
7432	0·37	0·35	0·33
7433	0·39	0·37	0·35
7437	0·32	0·30	0·28
7438	0·32	0·30	0·28
7440	0·14	0·13	0·12
7441	0·69	0·66	0·59
7442	0·69	0·66	0·59
7443	£1·11	£1·06	£1·02
7444	£1·11	£1·06	£1·02
7445	£1·48	£1·44	£1·39
7446	£1·11	£1·06	£1·02
7447	£1·02	0·99	0·97

Type	Quantities 1	25	100+
7448	£1·02	0·99	0·97
7450	0·14	0·13	0·12
7451	0·14	0·13	0·12
7453	0·14	0·13	0·12
7454	0·14	0·13	0·12
7460	0·14	0·13	0·12
7470	0·30	0·27	0·25
7472	0·30	0·27	0·25
7473	0·38	0·36	0·32
7474	0·38	0·36	0·32
7475	0·56	0·54	0·52
7476	0·41	0·40	0·39
7480	0·56	0·54	0·51
7481	1·02	0·97	0·93
7482	0·83	0·79	0·74
7483	£1·11	£1·06	0·97
7484	0·93	0·90	0·88
7485	£1·48	£1·44	£1·39
7486	0·32	0·31	0·30
7489	£3·70	£3·47	£3·24
7490	0·60	0·58	0·56
7491	£1·02	0·97	0·93
7492	0·69	0·66	0·59
7493	0·69	0·66	0·59
7494	0·79	0·76	0·69
7495	0·79	0·76	0·69
7496	0·89	0·86	0·80
74100	£1·39	£1·34	£1·30
74104	0·56	0·54	0·51
74105	0·56	0·54	0·51
74107	0·41	0·39	0·37
74110	0·56	0·51	0·46
74111	0·83	0·81	0·78
74118	0·93	0·88	0·83
74119	£1·39	£1·30	£1·20
74121	0·46	0·44	0·41

Type	Quantities 1	25	100+
74122	0·65	0·63	0·6
74123	0·69	0·68	0·6
74141	0·79	0·76	0·7
74145	£1·20	£1·16	£1·1
74150	£1·39	£1·30	£1·2
74151	£1·02	0·97	0·9
74153	0·93	0·88	0·8
74154	£1·57	£1·43	£1·4
74155	£1·11	£1·06	£1·0
74156	£1·11	£1·06	£1·0
74157	0·93	0·88	0·8
74160	£1·30	£1·25	£1·2
74161	£1·30	£1·25	£1·2
74162	£1·30	£1·25	£1·2
74163	£1·30	£1·25	£1·2
74164	£1·67	£1·62	£1·5
74165	£1·67	£1·62	£1·5
74166	£1·48	£1·44	£1·3
74174	£1·48	£1·44	£1·3
74175	£1·02	0·97	0·9
74176	£1·16	£1·11	£1·0
74177	£1·16	£1·11	£1·0
74180	£1·16	£1·11	£1 0
74181	£3·66	£3·56	£3·4
74182	£1·16	£1·11	£1·0
74184	£1·67	£1·62	£1·5
74190	£1·81	£1·76	£1·7
74191	£1·81	£1·76	£1·7
74192	£1·81	£1·76	£1·7
74193	£1·81	£1·76	£1·7
74194	£1·20	£1·16	£1·1
74195	£1·02	0·97	0·9
74196	£1·11	£1·06	£1·0
74197	£1·11	£1·06	£1·0
74190	£2·55	£2·50	£2·4
74199	£2·31	£2·21	£2·1

Devices may be mixed to qualify for quantity price. (TTL 74 series only) data is available f the above series of I.C's in booklet form. PRICE 35p.

* D.T.L. 930 SERIES

Type	Quantities 1	25	100+
BP930	0·14	0·13	0·12
BP932	0·15	0·14	0·13
BP933	0·15	0·14	0·13
BP935	0·15	0·14	0·13
BP936	0·15	0·14	0·13
BP944	0·15	0·14	0·13
BP945	0·28	0·26	0·23
BP946	0·14	0·13	0·12
BP948	0·28	0·26	0·23
BP951	0·65	0·60	0·56
BP962	0·14	0·13	0·1
BP9093	0·42	0·40	0·3
BP9094	0·42	0·40	0·3
BP9097	0·42	0·40	0·3
BP9099	0·42	0·40	0·3

* TRIACS

	Case	100V	200V	400V
2 Amp	TO5	0·31	0·51	0·71
6 Amp	TO66	0·51	0·61	0·77
10 Amp	TO48	0·77	0·92	£1·12

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* D.I.L. SOCKETS

	1	25	100+
TSO14 14 pin type	0·31	0·28	0·25
TSO16 16 pin type	0·35	0·32	0·30
TSO24 24 pin type	0·69	0·64	0·62
BPS 8 8 pin type (low cost)	0·14	0·12	0·10
BPS14 14 pin type (low cost)	0·15	0·13	0·11
BPS16 16 pin type (low cost)	0·16	0·14	0·12

LINEAR I.C's

Type	Quantities 1	25	100+
72702	0·46	0·44	0·42
72709	0·23	0·21	0·19
72709P	0·19	0·18	0·17
72710	0·32	0·31	0·28
72741	0·28	0·27	0·26
72741C	0·26	0·25	0·24
72741P	0·28	0·27	0·26
72747	0·79	0·74	0·61
72748P	0·35	0·33	0·31
SL201C	0·46	0·42	0·37

Type	Quantities 1	25	100+
SL701C	0·46	0·42	0·37
SL702C	0·46	0·42	0·37
TAA263	0·74	0·65	0·56
TAA293	0·93	0·88	0·83
TAA350A	£1·71	£1·67	£1·57
uA703C	0·26	0·24	0·22
uA709C	0·19	0·18	0·17
uA711C	0·32	0·31	0·28
uA712C	0·32	0·31	0·28

Type	Quantities 1	25	100+
uA723C	0·45	0·43	0·40
76003	£1·39	£1·34	£1·30
76023	£1·39	£1·34	£1·30
76660	0·88	0·86	0·83
LM380	0·93	0·90	0·88
NE555	0·45	0·43	0·40
NE556	0·88	0·86	0·83
TBA800	£1·39	£1·34	£1·30
ZN414	£1·11	—	—

SILICON RECTIFIERS

PIV	300mA (DO 7)	750mA (SO 16)	1 Amp Plastic		1·5Amp (SO 16)	3Amp (SO 10)	10Amp (SO 10)	30Amp (TO 48)
50	0·05	0·06	1N4001	0·05	0·07	0·14	0·19*	0·56*
100	0·05	0·07	1N4002	0·06	0·09	0·16	0·21*	0·69*
200	0·06	0·09	1N4003	0·07	0·12	0·20	0·23*	0·93*
400	0·07	0·14	1N4004	0·08	0·14	0·28	0·35*	£1·25*
600	0·08	0·16	1N4005	0·09	0·16	0·33	0·42*	£1·78*
800	0·11	0·18	1N4006	0·10	0·18	0·35	0·51*	£1·94*
1000	0·13	0·28	1N4007	0·11	0·23	0·44	0·60*	£2·31*
1200	—	0·32			0·28	0·54	0·69*	£2·88*

PO BOX 6 WARE HERTS

SUPER UNTESTED PAKS

Pak No.	Description	Price £p
U1	120 Glass Sub-min. General purpose Germ. diodes	0·60
U2	50 Mixed Germanium transistors AF/RF	0·60
U3	75 Germanium gold bonded sub-min. like OA5, OA47	0·60
U4	30 Germanium transistors like OC81, AC128	0·60
U5	60 200mA sub-min. silicon diodes	0·60
U6	30 Sil. Planar trans. NPN like BSY95A, 2N706	0·60
U7	16 Sil. rect. TOP-HAT 750mA VLTG. RANGE up to 100	0·60
U8	50 Sil. planar diodes DO-7 glass 250mA like OA200/202	0·60
U9	20 Mixed voltages, 1 Watt Zener Diodes	0·60
U10	20 BAY50 charge storage diodes DO-7 glass	0·60
U11	20 PNP Sil. planar trans. TO-5 like 2N1132, 2N2904	0·60
U13	30 PNP-NPN Sil. transistors OC200 & 28104	0·60
U14	150 Mixed silicon and germanium diodes	0·60
U15	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	0·60
U16	10 3Amp sil. rectifiers stud type up to 1000 PIV	0·60
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0·60
U18	8 6 Amp sil. rectifiers BYZ13 type up to 600 PIV	0·60
U19	20 Silicon NPN transistors like BC 108	0·60
U20	12 1·5 Amp sil. rectifiers top hat up to 1000 PIV	0·60
U21	30 AF. Germ. alloy transistors 2G300 series & OC71	0·60
U23	25 MADT's like MHz series PNP transistors	0·60
U24	20 Germ. 1 Amp rectifiers GJM series up to 300 PIV	0·60
U25	25 300 MHz NPN silicon transistors 2N708, BSY27	0·60
U26	30 Fast switching silicon diodes like IN914 Micro-Min	0·60
U29	10 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	£1·20*
U32	25 Zener diodes 400 mW DO-7 case 3-33 volts mixed	0·60
U33	15 Plastic case 1 Amp sil. rectifiers IN4000 series	0·60
U34	30 Silicon PNP alloy trans. TO-5 BCY26 28302/4	0·60
U35	25 Silicon planar transistors PNP TO-18 2N2906	0·60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	0·60
U37	30 Silicon alloy transistors SO-2 PNP OC200, S2322	0·60
U38	20 Fast switching silicon trans. NPN 400 MHz 2N3011	0·60
U39	30 RF. Ger. PNP transistors 2N1303/5 TO-5	0·60
U40	10 Dual transistors 6 lead TO-5 2N2060	0·60
U43	25 Silicon trans. plastic TO-18 A.F. BC113/114	0·60
U44	20 Silicon trans. plastic TO-5 BC115	0·60
U45	7 3A SCR. TO66 up to 600 PIV	£1·20*
U46	20 Unijunction transistors similar to TIS43	0·60*
U47	10 TO220AB plastic triacs 50V 6A	£1·20*
U48	9 NPN Sil. power transistors like 2N3055	£1·20
U49	12 NPN Sil. plastic power trans. 60W like 2n5294/5296	£1·20

Code No's 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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uA.7812/L130 12V (Equiv. to MVR12V) £1·25p
uA.7815/L131 15V (Equiv. to MVR15V) £1·25p
uA.7818 18V (Equiv. to MVR18V) £1·25p

* THYRISTORS

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	0·13	0·15	—	—	—	—	—	—	—	—
20	0·15	0·18	—	—	—	—	—	—	—	—
30	0·19	0·22	—	—	—	—	—	—	—	—
50	0·22	0·28	0·20	0·25	0·36	0·36	0·48	0·51	0·54	£1·18
100	0·25	0·30	0·25	0·25	0·48	0·48	0·51	0·57	0·58	£1·43
150	0·31	0·38	—	—	—	—	—	—	—	—
200	0·38	0·44	0·25	0·30	0·50	0·50	0·57	0·62	0·62	£1·63
400	—	—	0·30	0·39	0·55	0·57	0·62	0·71	0·77	£1·79
600	—	—	0·39	0·48	0·69	0·69	0·78	0·99	0·90	—
800	—	—	0·58	0·65	0·81	0·81	0·92	£1·22	£1·39	£4·07

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA119	0·08	BY101	0·12	BYZ16	0·41	OA85	0·09
AA120	0·08	BY105	0·18	BYZ17	0·36	OA90	0·07
AA129	0·08	BY114	0·12	BYZ18	0·36	OA91	0·07
AAY30	0·09	BY124	0·12	BYZ19	0·28	OA95	0·07
AAZ13	0·10	BY126	0·15	CG62		OA200	0·07
BA100	0·10	BY127	0·16	(OA91Eq)	0·06	OA202	0·07
BA116	0·21	BY128	0·16	CG651 (OA70-		SD10	0·06
BA126	0·22	BY130	0·17	OA79)	0·07	SD19	0·06
BA148	0·15	BY133	0·21	OA5 Short		1N34	0·07
BA154	0·12	BY164	0·51	Leads	0·21	1N34A	0·07
BA155	0·15	BYX38/300	·43	OA10	0·14	1N914	0·06
BA156	0·14	BYZ10	0·36	OA47	0·07	1N916	0·06
BA173	0·15	BYZ11	0·31	OA70	0·07	1N4148	0·06
BB104	0·15	BYZ12	0·31	OA79	0·07	1S021	0·10
BY100	0·16	BYZ13	0·26	OA81	0·07	1S951	0·70

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Q5	4 OC 75 transistors	0·60
Q6	5 OC 72 transistors	0·60
Q7	4 AC 128 transistors PNP high gain	0·60
Q8	4 AC 126 transistors PNP	0·60
Q9	7 OC 81 type transistors	0·60
Q10	7 OC 71 type transistors	0·60
Q11	2 AC 127/128 Complementary pairs PNP/NPN	0·60
Q12	3 AF 116 type transistors	0·60
Q13	3 AF 117 type transistors	0·60
Q14	3 OC 171 H.F. type transistors	0·60
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Q17	5 NPN 2 × ST.141 & 3 × ST.140	0·60
Q18	4 MADT'S 2 × MAT 100 & 2 × MAT 120	0·60
Q19	3 MADT'S 2 × MAT 101 & 1 × MAT 121	0·60
Q20	4 OC 44 Germanium transistors A.F.	0·60
Q21	4 AC 127 NPN Germanium transistors	0·60
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Q24	8 OA 81 diodes	0·60
Q25	15 IN 914 Silicon diodes 75PIV 75mA	0·60
Q26	8 OA95 Germanium diodes sub-min 1N69	0·60
Q27	2 10A 600 PIV Silicon rectifiers IS425R	0·60*
Q28	2 Silicon power rectifiers BYZ 13	0·60
Q29	4 Sil. transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·60
Q30	7 Silicon switch transistors 2N706 NPN	0·60
Q31	6 Silicon switch transistors 2N708 NPN	0·60
Q32	3 PNP Sil. trans. 2 × 2N1131, 1 × 2N1132	0·60
Q33	3 Silicon NPN transistors 2N1711	0·60
Q34	7 Sil. NPN trans. 2N2369, 500MHz (code P397)	0·60
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Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0·60
Q37	3 2N3053 NPN Silicon transistors	0·60
Q38	5 PNP transistors 3 × 2N3703, 2 × 2N3702	0·60
Q39	5 NPN transistors 3 × 2N3704, 2 × 2N3705	0·60
Q40	5 NPN transistors 3 × 2N3707, 2 × 2N3708	0·60
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UIC05 =	12 × 7405	0·60	UIC80 =	5 × 7480	0·60
UIC06 =	8 × 7406	0·60	UIC81 =	5 × 7481	0·60
UIC07 =	8 × 7407	0·60	UIC82 =	5 × 7482	0·60
UIC10 =	12 × 7410	0·60	UIC83 =	5 × 7483	0·60
UIC13 =	8 × 7413	0·60	UIC86 =	5 × 7486	0·60
UIC20 =	12 × 7420	0·60	UIC90 =	5 × 7490	0·60
UIC30 =	12 × 7430	0·60	UIC91 =	5 × 7491	0·60
UIC40 =	12 × 7440	0·60	UIC92 =	5 × 7492	0·60
UIC41 =	5 × 7441	0·60	UIC93 =	5 × 7493	0·60
UIC42 =	5 × 7442	0·60	UIC94 =	5 × 7494	0·60
UIC43 =	5 × 7443	0·60	UIC95 =	5 × 7495	0·60
UIC44 ×	5 × 7444	0·60	UIC96 =	5 × 7496	0·60
UIC45 =	5 × 7445	0·60	UIC100 =	5 × 74100	0·60
UIC46 =	5 × 7446	0·60	UIC121 =	5 × 74121	0·60
UIC47 =	5 × 7447	0·60	UIC141 =	5 × 74141	0·60
UIC48 =	5 × 7448	0·60	UIC151 =	5 × 74151	0·60
UIC50 =	12 × 7450	0·60	UIC154 =	5 × 74154	0·60
UIC51 =	12 × 7451	0·60	UIC193 =	5 × 74193	0·60
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UIC54 =	12 × 7454	0·60	UIC X1	25 Assorted 74's	£1·50
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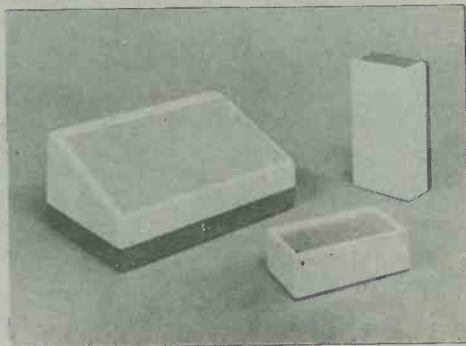

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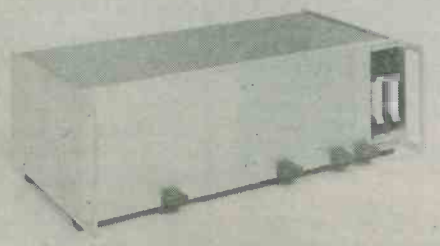

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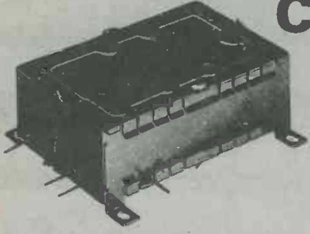

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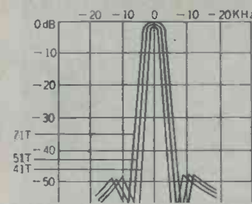

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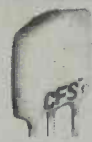

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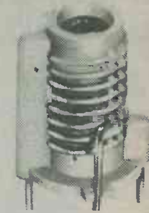

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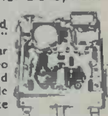

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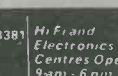

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VERSATILE LIGHT ALARM

By J. R. Davies

This device turns itself on automatically at a certain light level, then produces an a.f. tone whose frequency varies with light intensity. It can be readily assembled on the piece of Veroboard which is given free with this month's issue.

In this issue we are presenting a free Veroboard for the use of readers. The Veroboard is of 0.15in. matrix and has 7 copper strips each with 16 holes. The board can be employed for quite intricate circuits and, doubtless, many readers will wish to assemble their own designs on it. For those who prefer to work to published designs, we are describing two projects in this issue which can be assembled on the Veroboard. The first of these projects appears in the present article.

The majority of constructors will nowadays have had experience in handling Veroboard, and they will be aware of the usefulness of this material. The copper strips can be cut at any hole, with the aid of a Vero spot face cutter or a twist drill of suitable size, in order to set up the particular circuit pattern required. Component lead-outs are passed through the holes in the board and can then be readily soldered to the strips. A small soldering iron of around 15 to 20 watts rating is preferred, and it is essential to use a radio-type resin-cored solder such as Ersin Multicore or Savbit. A paste or liquid flux must *never* be used, as it will leave a harmful residue.

LIGHT ALARM CIRCUIT

The circuit of the light alarm which forms the first Veroboard project appears in Fig. 1. This employs a photoconductive cell type ORP12, the resistance of which changes according to the light incident on it. In total darkness the ORP12 resistance is 10MΩ or more, and when fully illuminated the resistance drops to a figure of some 75 to 300Ω. Thus, the resistance of the ORP12 decreases as the light falling on it increases.

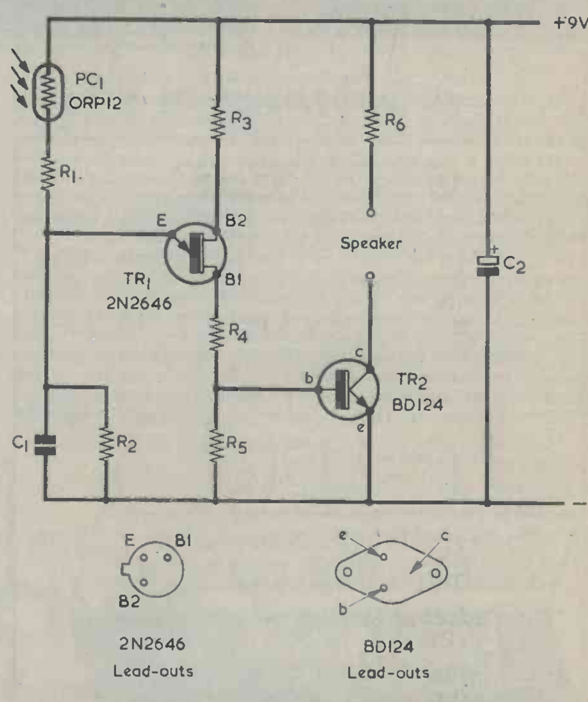


Fig. 1. The circuit of the light alarm. This produces an audible tone whose frequency varies with illumination of the ORP12. It also turns off automatically when the illumination falls below a certain level

The ORP12, in series with R1, couples to the emitter of the unijunction transistor, TR1. This acts as an audio oscillator in the following manner. Assuming for the moment that R2 is not in circuit, C1 charges via the ORP12 and R1 until the voltage on its upper plate reaches the emitter triggering level of TR1. At this level the transistor gives a negative resistance effect which causes the capacitor to discharge rapidly into R4, R5 and the base-emitter junction of TR2. After this discharge, C1 commences to charge again until the voltage across it reaches the emitter triggering level once more. Again it discharges, and then once more it starts to charge. This process repeats continuously, causing a series of pulses to be given at the base 1 of the transistor. The repetition frequency of these pulses depends on the resistance of the ORP12 and R1 and on the capacitance of C1. Both R1 and C1 are fixed, whilst the resistance of the ORP12 changes with light intensity. In consequence the pulse frequency increases as the intensity of the light incident on the ORP12 increases.

This is because the resistance of the ORP12 then decreases, and C1 charges more quickly.

Between pulses, a small standing current of about 1 to 2mA flows between the base 2 and base 1 of the transistor.

Transistor TR2 is a silicon power transistor which becomes conductive when its base is taken positive of its emitter by approximately 0.6 volt. Between the pulses from TR1, the base of TR2 is at a lower potential than 0.6 volt and so it passes no collector current. On the other hand, the pulses from TR1 take the base of TR2 up to the potential needed for the transistor to turn on, and it passes a heavy collector current when the pulses are present. If a 3Ω speaker is connected to the "Speaker" terminals, the amplified pulses from TR2 flow through it, the series resistor R6 limiting

COMPONENTS

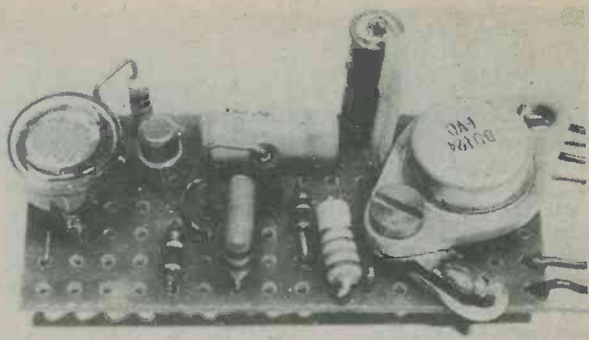
Resistors
(All $\frac{1}{4}$ watt miniature 10% unless otherwise stated)
- R1 10kΩ
- R2 100kΩ
- R3 470Ω
- R4 100Ω
- R5 180Ω
- R6 10Ω wire-wound, $2\frac{1}{2}$ or 3 watt

Capacitors
- C1 0.1μF, type C280 (Mullard)
- C2 100μF electrolytic, 10V Wkg., subminiature (Mullard)

Semiconductors
- TR1 2N2646
- TR2 BD124

Photoconductive Cell
- PC1 ORP12

Miscellaneous
- Veroboard, 0.15in. matrix, 7 strips by 16 holes
- 3 Ω speaker
- 9 volt battery
- Battery connector clips
- 4BA solder tag
- 4BA nut and bolt
- Wire, sleeving, etc.



Mounting the light alarm components on the Veroboard results in a neat and functional final assembly

their amplitude to about 0.6 amp. The speaker then produces an audible tone having the same frequency as the pulses from TR1.

As has been noted, TR2 passes no current between pulses. As a result the average dissipation in this transistor is low. A power transistor is specified nevertheless, in order that the relatively high collector current pulses may be passed, but it does not need to be mounted on a heat sink. Similarly, resistor R6 is specified as a $2\frac{1}{2}$ to 3 watt wire-wound component because of the high level of the current pulses it passes. As with TR2, the average dissipation in R6 is small.

Up to now, design functioning has been considered with the assumption that R2 is not in circuit. If we now take this resistor into consideration, there is an added effect on circuit operation. The ORP12, R1 and R2 form a potential divider, and if the ORP12 presents a high resistance the potential at the junction of R1 and R2 will be lower than the emitter triggering level of TR1, whereupon C1 cannot charge up to that level. In consequence TR1 does not produce any pulses and TR2 is continually turned off. If the resistance of the ORP12 is reduced (by allowing more light to fall upon it) the potential at the junction of R1 and R2 will rise above triggering level and TR1 will then commence to oscillate. Thus, below a certain level of illumination of the ORP12 the circuit is completely turned off, the only current drawn from the 9 volt supply being the 1 to 2mA standing base 2 to base 1 current in TR1 together with the much smaller current flowing through the ORP12, R1 and R2. Should the level of illumination of the ORP12 be increased, the circuit will commence to oscillate, the frequency rising with increasing light intensity.

With the component values shown, the circuit will be turned off in a fairly dark room but will at once commence to produce an audible tone if the room light is switched on or if a torch is shone on the ORP12. The circuit may, in consequence, be employed as an intruder alarm. It can also be used as a morning alarm. If positioned near a window it will cause a tone to be generated as the outside light increases at the start of the day. Other applications, mainly of a novelty nature, will readily suggest themselves to the reader.

The tone emitted by a 3Ω speaker coupled to the device is at a high volume level. If the ORP12 is illuminated by a 100 watt lamp some 8ft. away, the frequency of oscillation is of the order of 1kHz. At this frequency, current consumption from the 9 volt supply is approximately 18mA. The consumption reduces as frequency reduces; and it increases, to a maximum of some 23mA, when the ORP12 is highly illuminated.

The function of capacitor C2 is to ensure that a low impedance is always present across the supply rails. If this capacitor were omitted, the audible output of the circuit would reduce due to increasing internal resistance in the 9 volt supply battery as it ages. In Fig. 1, the two transistor lead-out insets show the transistors with their lead-outs pointing towards the reader. The metal case of the BD124 provides its collector connection.

CONSTRUCTION

A good idea of the general assembly can be gained from the accompanying photographs. As may be noted, both the ORP12 and TR2 are mounted by their lead-outs with their bodies above the surface of the Veroboard. The component and copper sides of the board are illustrated in Fig. 2, in which diagram the holes are given letter and number references to assist in explanation.

First, take up the Veroboard and cut the strips at holes B11, C3, D7, E3, E10 and F6. Fit and solder bare wire links between G1 and E1, and between C1 and B1. Similarly, fit and solder insulated wire links between E6 and C6, and between E11 and A11. The link between E6 and C6 should be curved slightly, to leave hole D6 clear.

Components are next fitted, each component lead-out being soldered to the appropriate copper strip after it has been inserted and the component set to its final position. Also, excessive leads projecting under the board are snipped off after soldering. Fit R2 between C5 and A5, C1 between C7 and A7, R1 between E9 and B9, R5 between D10 and A10, and R6 between G6 and F10. The four resistors are all fitted

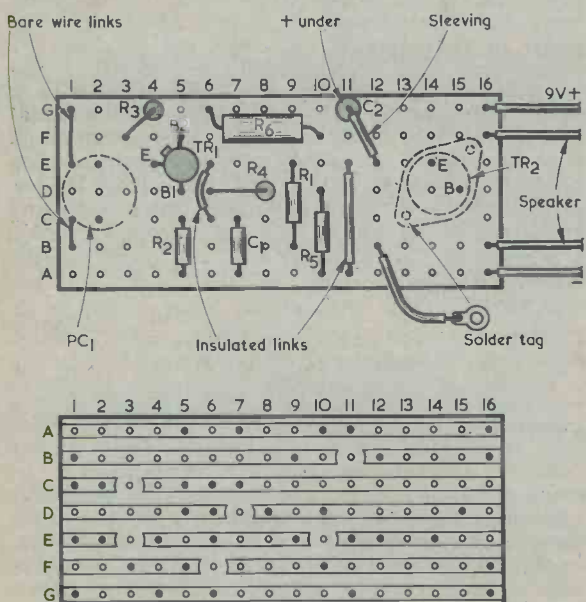
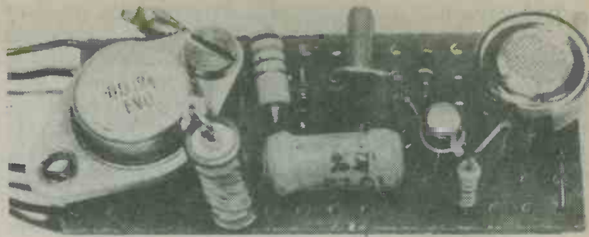


Fig. 2. The component and copper sides of the Veroboard assembly. The holes are given letter and number references to assist in describing construction



The light alarm board, as seen from the other side

flat, i.e. their bodies are horizontal. Capacitor C1 is mounted by its side wires. Next fit R3 between G4 and F3, with its body vertical, as shown. Similarly fit R4 between D8 and D6 with its body vertical. Take a piece of thin flexible insulated wire about 1in. long and solder one end to a 4BA solder tag. Solder its other end at B12.

Take up the 2N2646 unijunction transistor, gently splay out its lead-outs and put the base 2 lead-out through F5, the emitter lead-out through E4 and the base 1 lead-out through D5., Solder these three lead-outs. Pass the two ORP12 lead-outs through E2 and C2, and position the ORP12 so that it is spaced away from the board by about $\frac{3}{8}$in. Solder its two lead-outs.

Prepare four thin insulated flexible wires, each about 1ft. long. These are for connection to the 9 volt battery and the speaker. Longer leads may be employed, should this be desired. Solder these wires to G16, F16, B16 and A16 respectively.

Take up the BD124, and identify its emitter and base lead-outs from the inset in Fig. 1. Using a short 4BA bolt and nut, affix the solder tag from hole B12 to the mounting hole of the transistor which is further away from the emitter and base lead-outs. Then pass the emitter lead-out through E14 and the base lead-out through D15. Position the BD124 so that it is spaced from the board by about $\frac{1}{4}$in. then solder its emitter and base lead-outs.

Take up C2 and pass a length of sleeving $\frac{3}{4}$in. long over its negative lead-out. (This lead-out is common with the capacitor can). The capacitor is mounted vertically between G11 and E12 as illustrated, with its positive lead-out at G11. First bend over the negative lead-out and then fit the capacitor. The purpose of the sleeving is to insulate its negative lead-out from the metal case of TR2.

OPERATION

The assembly of the light alarm is now complete. Make a careful check to ensure that all parts have been fitted correctly and that all solder joints are of good quality. Make certain that no two adjacent copper strips have been short-circuited together by stray "blobs" of solder.

If all is well, connect the leads from F16 and B16 to a 3Ω speaker. Connect the lead from A16 to the negative terminal of the 9 volt battery, and that from G16 to the battery positive terminal. A loud tone should at once be audible from the speaker. Pass a hand over the ORP12. The frequency of the tone should change as the light intensity on the ORP12 varies. Unless the room is very brightly lit, it should be possible to cause the oscillation to cease by cupping the hand over the ORP12 without touching it.

The light alarm is now complete and ready for use. After a little experience, the constructor will soon be able to assess the conditions of light and darkness which are required for reliable operation. ■

RECENT PUBLICATIONS

RADIO CONSTRUCTION FOR AMATEURS. By R. H. Warring. 128 pages, 220 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by Pitman Publishing Ltd. Price £2.00

This book is intended for the real beginner and it deals largely with simple a.m. receivers and a.f. amplifiers. After introductory chapters describing the basics of a.m. transmission and reception, and technical terms and component symbols, the book carries on to simple crystal sets. Tuned circuits are next dealt with, and further chapters are devoted to amplifiers, a.f. output stages, transistor biasing, t.r.f. receivers, regenerative and reflex receivers, and superhets. A relatively long and useful chapter discussing components follows, together with two final chapters covering circuit construction, field effect transistors and integrated circuits.

PRINCIPLES OF TRANSISTOR CIRCUITS, 5th Edition. By **S.** W. Amos, B.Sc., C.ENG., M.I.E.E. 328 pages, 220 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$ in.) Published by Newnes-Butterworths. Price £3.20.

This is the 5th edition of ***Principles of Transistor Circuits,*** the 4th edition having appeared in 1969. The book has been kept up to date by the inclusion of more information on circuits using f.e.t.'s and the expansion of the treatment of switching circuits. Various small changes have also been made to eliminate dated information or to simplify and clarify the text.

The book starts with semiconductor physics and the basic principles of transistor operation. The main body of the book then deals in depth with transistor circuit design in amplifiers, oscillators, detectors, frequency changers, pulse and sawtooth generators, and digital applications.

Since the appearance of the first edition in 1959 the book has been adopted by many technical colleges as a standard course text. It has appeared in special editions in America and other countries, and in languages other than English. This present edition brings a work which has thus already been widely accepted fully up to the present time.

BEGINNER'S GUIDE TO COMPUTER LOGIC. By Gerald F. Stapleton. 196 pages, 220 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by Foulsham-Tab Ltd. Price £1.60.

This title comprises an American text with an introductory chapter for English readers. The book is divided into two parts, the first of which deals with the understanding of computer logic whilst the second describes logic projects which can be built by the amateur constructor.

Binary notation, logic operations, electronic logic circuits and logic applications are all dealt with in Part 1, which gives a clear and well illustrated explanation of its subject. An unusual technique is the provision in the text of 'key' paragraphs printed inside a heavy black border to draw attention, each paragraph giving a condensed summary of the concept being dealt with. This approach is useful in allowing pre-digestion of the matters being described as well as offering quick reviews when referring back to earlier points.

The projects described in Part 2 range from simple to quite complex circuits, and they are used to demonstrate specific logic operations. The first circuits to be described employ discrete components, the second employ r.t.l. integrated circuits and the third d.t.l. circuits. The projects allow a large number of experimental logic operations to be carried out including, for example, those for shift register and serial adder.

GETTING THE MOST OUT OF YOUR ELECTRONIC CALCULATOR. By William L. Hunter. 208 pages, 220 x 135mm. ($8\frac{1}{2}$ x $5\frac{1}{4}$in.) Published by Foulsham-Tab Ltd. Price £1.85.

Now that pocket electronic calculators with their fantastic l.s.i. chips are becoming continually less expensive, any reliable information on their use is of value. The present volume, another book in the Foulsham-Tab list, deals with the use of calculators in an interesting and helpful manner. The book is concerned entirely with the operation of calculators and not with the functioning of the electronics inside.

Procedures for a very wide range of types of calculation are described including working with fractions, sales tax problems and conversion of metric to U.S. standards. The final chapter deals with American income tax calculations and has an academic interest only for the English reader.

The book is written in a comfortable style and offers an easy read, especially for those who are interested in numbers and problems with numbers.

SUGGESTED CIRCUIT 299

The 'Tantaliser' — an electronic game

By G. A. French

Electronic games can offer quite a good deal of amusement, particularly where a contender has to exercise skill in winning. The game to be described in this month's "Suggested Circuit" falls into this category, and it presents simple operating rules without any element of chance.

On the front panel of the case housing the game circuitry are an on-off toggle switch, a push-button, a light-emitting diode and a meter. After the unit has been switched on the l.e.d. commences to become illuminated at regular intervals. If the push-button is pressed when the l.e.d. is extinguished a capacitor inside the unit starts to charge and the needle of the meter, which monitors the voltage across the capacitor, moves at a readily visible rate from zero towards the full-scale deflection end of its scale. Should the button be released, the meter needle remains at the position it held at the instant of release. If, however, the button is pressed when the l.e.d. is alight the capacitor discharges at a markedly higher rate than that at which it previously charged. The object of the game is to take the meter needle up to or beyond f.s.d. as quickly as possible, i.e. for the lowest number of flashes in the light-emitting diode.

This calls for two qualities on the part of the contender. If he is to charge the capacitor rapidly he must have a quick reaction time so that he presses the button as soon as possible after the l.e.d. has extinguished. The second quality is a good sense of timing, allowing the button to be released just before the l.e.d. becomes illuminated again. With a good sense of timing the contender can cause the capacitor to acquire a high level of charge during each period that the l.e.d. is extinguished. But if at any time he releases the button just fractionally too late the l.e.d. will light up whilst the button is pressed, the capacitor will discharge at a rapid rate, and the contender will have lost much of the ground he has so far achieved.

This is one of the tantalising elements which give rise to the title of the game. A second tantalising feature is that the movement of the needle towards f.s.d. is slower as the f.s.d. level is approached. Needle movement is still readily perceptible but its reduced speed makes the f.s.d. point tantalisingly more difficult to achieve. When f.s.d. has been reached, the meter needle will remain in this position provided the push-button is not inadvertently pressed again while the l.e.d. is alight. Switching the unit off and then on again discharges the capacitor and allows another game to commence. The meter sensitivity can be pre-set to vary the possible time in which f.s.d. can be reached. What is probably the most attractive adjustment is one which allows a reasonably skilled operator to obtain the f.s.d. reading after pressing the button about 10 times, but this figure is not mandatory and the circuit can be set up for successful completion at any number of button closures from about 6 to 14.

THE CIRCUIT

The circuit employed in the game appears in Fig. 1. The first point to observe is that transistor TR2 and zener diode ZD1 allow a stabilized voltage of about 9 volts to be available for the remainder of the components.

IC1 is a 555 timer, and it is connected up in a standard astable multivibrator circuit. The timer output is given at pin 3 and this output is high when C1 charges via R1 and R2, and is low when C1 discharges via R2 on its own. Thus, during the cycle, the time when the output is high is longer than that when it is low. The output connects via current limiting resistor R3 to the light-emitting diode LED1. This is extinguished when the timer output is high, and lights up when the timer output is low.

The output of IC1 also connects to the push-button S1, the contacts of which close when it is pressed. The capacitor which becomes successively more and more charged as the game procceeds is C2. If S1 is pressed when the timer output is high, a charging current flows into C2 via R4, with diode D1 being reverse-biased. If, on the other hand, the button is pressed when the timer output is low, diode D1 becomes conductive and provides a rapid discharge path, in parallel with R4, via R5. For D1 to conduct, the capacitor has to have a voltage across its plates which exceeds the 0.6 volt forward voltage drop across D1 plus the small voltage at the timer output in the low condition, but in practice C2 very soon acquires this potential.

The situation as so far described can now be summed up. When the timer output is high the l.e.d. is extinguished. If S1 is pressed, a charging current flows into C2 via R4. When the timer output is low the l.e.d. is illuminated, and closure of S1 contacts causes C2 to be rapidly discharged via D1 and R5. This meets the basic game requirements described at the start of the article. It has also been shown that, during the cycle, the l.e.d. is alight for a shorter period than that during which it is extinguished. This factor is psychologically attractive, since the charge ("good") condition is longer than the discharge ("bad") condition.

The voltage across the capacitor is monitored by the voltmeter given by TR1, R6, R7 and meter M1. TR1 functions as an emitter follower and its base presents a very high resistance to C2. If this capacitor is a good quality modern component with a low leakage current it should be found that the voltage across it remains constant, or very nearly constant, for a long period after S1 has opened. Thus, the meter reading remains unaltered, or at worst substantially unaltered, after S1 has been released. The capacitor employed by the author in the prototype circuit was a Mullard type C437, and there was no significant shift in voltmeter reading after the button had been released. The voltage across the

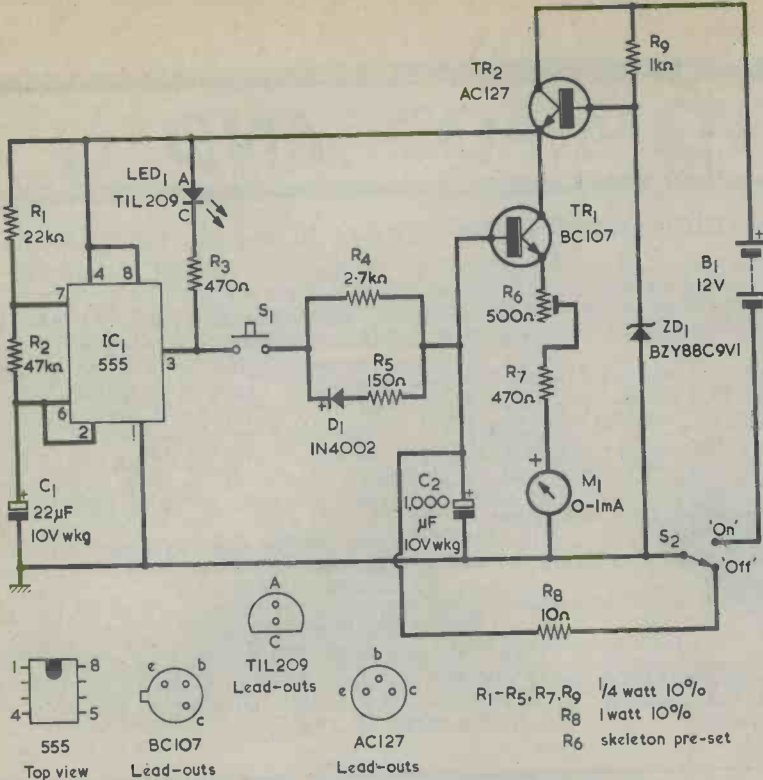


Fig. 1. The circuit of the "Tantaliser". The aim is to press S1 during the periods when LED1 is extinguished and thus charge capacitor C2 in the shortest period of time

capacitor at which meter M1 gives an f.s.d. reading should be of the order of 7 volts. A precise voltage cannot be specified here because of tolerances in the circuit, including tolerance on voltage in ZD1, and the degree of difficulty it is desired to impart to the game. For these reasons the pre-set variable resistor, R6, is included in series with the meter. It is an easy matter to set up R6, and the process is described later.

Due to the forward base-emitter voltage drop of about 0.6 volt in TR1, the meter does not give an indication until the voltage across C2 rises above this figure. This voltage delay matches the forward voltage drop of 0.6 volt in D1 which was just mentioned. Initial closure of S1 with the l.e.d. extinguished takes C2 quickly above the 0.6 volt level, after which the meter reads approximately zero when the capacitor is discharged to the lowest level of which the circuit is capable.

EXPONENTIAL CURVE

The rate of charge in C2 decreases as the voltage across its plates rises. This is to be expected as the capacitor charge follows the familiar exponential curve shown in Fig. 2, which represents charge time against voltage for a capacitor charging from a fixed direct voltage via a resistor. With the present circuit, the effect is that the voltage across the capacitor increases more slowly when S1 is pressed with the l.e.d. extinguished as the meter needle approaches full-scale deflection.

When switch S2 is in the "On" position it causes the negative terminal of the battery to be connected to the lower supply rail, and the unit is thus switched on. When S2 is set to "Off" it disconnects the battery and connects R8 across C2, thereby rapidly discharging C2. R8 is a current limiting resistor whose function is to prevent current surges at the switch contacts. S2 is a standard s.p.d.t. toggle switch.

The voltage stabilizing circuit given by ZD1, TR2 and R9 follows conventional practice. ZD1 is taken up to its zener voltage by way of the current flowing through R9, and TR2 acts as an emitter follower through which most of the current required by the remainder of the circuit flows. R9 can have a relatively high value as the zener diode specified goes into zener conduction at a very low current level, and the current drawn by TR2 base is extremely small. TR2 is a germanium rather than a silicon transistor since a germanium transistor has a lower base-emitter voltage drop and thereby allows a slightly higher voltage to be made available for the rest of the circuit. This advantage is admittedly of a very marginal nature, but since the transistor specified for TR2 is in the general range of low cost transistors its use can be justified. The circuit offers an acceptable level of stabilization for battery voltages down to some 10.5 volts.

The battery can consist of two 6 volt batteries in series or any other combination which produces a total of 12 volts. The current drawn from the battery varies according to the state of IC1 and whether or not S1 is pressed. The average consumption is of the order of 12mA.

The length of the period when the timer output is low and the l.e.d. is illuminated is approximately equal (in seconds) to 0.7 times the product of R2 and C1 (in megohms and microfarads. This works out at about 0.7 second. The period during which the timer output is high is approximately equal to 0.7 times C1 multiplied by the sum of R1 and R2, and this is about 1 second. These periods appear, subjectively, to offer a good choice for operation of the game. The period lengths will vary slightly, in different versions of the circuit, because of tolerances on value in R1, R2 and C1.

When the unit has been assembled and checked out, R6 may be set to insert maximum resistance and a little practice obtained in operating S1. It will be found that the first period of non-illumination in the l.e.d., given immediately after switching on, is longer than the subsequent periods, and this enables C2 to be given an encouragingly high initial charge. S1 can, indeed, be held closed when S2 is set to the "On" position.

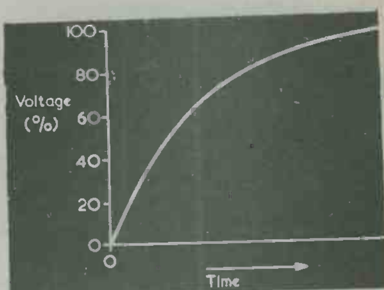
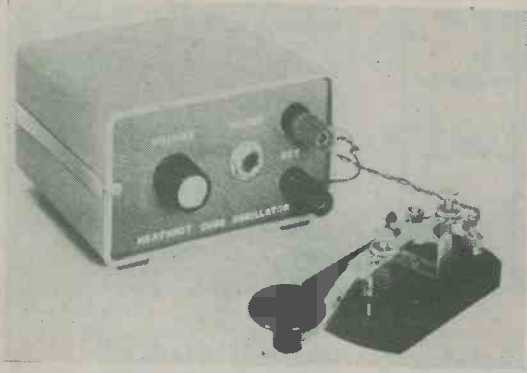


Fig. 2. Exponential capacitor charging curve showing that the rate of charge of a capacitor connected to a fixed voltage via a resistor decreases as the voltage across the capacitor increases. This last voltage is indicated as a percentage of the fixed voltage

A decision is next made concerning the number of closures in S1 which represent the target figure for the game. If the number chosen is 10, which in the writer's opinion is the best choice, one or more runs are attempted to produce as high a meter reading as is possible after this number of switch closures. On completion of a satisfactory run, S1 is left open and R6 adjusted for f.s.d. in the meter. The game is then set up and ready for use. ■

NEWS . . . AND .

HEATHKIT CODE PRACTICE OSCILLATOR KIT



The Heathkit HD-1416 Code Practise Oscillator is as much fun to build as it is to use — and it also makes a great starter kit for a beginning CW operator.

Safe, portable, and reliable. The HD-1416 is designed in the Heath tradition of top quality and value. Most components mount on a single circuit board for easy assembly. The unit operates from a single inexpensive 9-volt transistor battery (not supplied) and is complete with telegraph key and phone jack. The oscillator, with built-in speaker, has a separate control for volume on the front panel — as well as a tone control accessible from the back of the cabinet.

The HD-1416 can also be used as a side tone oscillator with any transmitter using grid block keying — such as the Heathkit DX-60B.

Kit K/HD-1416, £7.00 including 8% VAT and delivery within the United Kingdom.

Free Catalogue with full details of the new HD-1416 and the complete range of Heathkit Electronic Kits, available from: Heath (Gloucester) Ltd., Bristol Road, Gloucester GL2 6EE.

NEW RADIO SHOW FOR BIRMINGHAM EXHIBITION CENTRE — SOUND & VISION '76

Sound & Vision '76 will be the title of next year's TV and audio show to be held at the National Exhibition Centre, Birmingham (May 28th to 31st).

The show follows on from HEDA — the first International Home Electronics and Domestic Appliances Exhibition — a five day trade show sponsored by the Association of Manufacturers of Domestic Electrical Appliances (AMDEA) and the British Radio Equipment Manufacturers' Association (BREMA) which opens on May 23rd.

With the exception of the first day of the public show, when the doors will open at noon, the TV and audio show will be open from 10 am to 10 pm daily including the Spring Bank Holiday Monday.

The HEDA trade show, which opens from 10 am to 7 pm, features for the first time the entire range of domestic electrical appliances, TV and audio under one roof.

Bookings have already topped the 13,000 square metres mark and the domestic appliances show has exceeded by 1,500 square metres the Electric Living Fair it replaces.

COMBINATION GRINDER AND POLISHER

This new top quality machine is attractively styled, very robustly constructed and designed to give long, trouble free service. It is particularly suitable for production and "Do it Yourself" Workshop use. Powered by a ½ H.P. single or three phase motor with condenser starting. Fitted with 8" x ¾" grinding wheel and a 6" polishing mop. Controlled by safety pull/push on/off switch. Approximate overall size: length 21", height 11", width 6". Weight approximately 67 lbs. Finish Grey Enamel. Supplied complete with fixing bolts and delivered in a strong wooden crate.

Price £55 plus £3.50 packing and carriage plus VAT. Supplied on 14 days satisfaction money refund guarantee.

Details from Hadley Sales Services, 112 Gilbert Road, Smethwick, Warley, West Midlands B66 4PZ.

. . . COMMENT

CEEFAX AT SCIENCE MUSEUM

The BBC's CEEFAX system is on view at the Science Museum until November, CEEFAX is the BBC's dial-a-page information; at the touch of a button the viewer can switch from the conventional programme to any of a wide range of written pages of news, sport, travel, weather and numerous other subjects.

CEEFAX receivers provide all that a conventional television set does but in addition they have a decoder which picks out coded CEEFAX pulses "hidden" on a few spare lines of the television picture and converts them into the words and figures on the screen.

Concurrently with the development of CEEFAX, the IBA has developed a similar system called ORACLE.

CEEFAX is carried on the 625-line uhf service of BBC-1, and is available in most parts of the United Kingdom.

At present, CEEFAX carries 50 pages of news and information but gradually the service will expand.

So at the Science Museum you can see a service that could in a few years' time be commonplace in our homes.

The CEEFAX exhibit will be in the Radio Room on the 3rd Floor. It will be shown at all times except when the Museum's Radio Station is being demonstrated (i.e. 11.30 and 16.00 Monday to Friday and most Sunday afternoons).

NEW BOARD APPOINTMENT

Mr. Chable newly appointed Director of Doram Electronics Ltd.

Ron Marler, Chairman of Electrocomponents, Britain's biggest electronic component distribution Group has announced the appointment of Frank Chable to the Board of their mail-order component distribution subsidiary Doram Electronics Ltd, of Wellington Road Industrial Estate, Leeds.

Mr. Chable has had a long association with the Electrocomponents Group. He joined RS Components Ltd., in 1966, having spent twelve years as a Radio Communications Instructor with the Royal Air Force.

In June 1974, he was, together with Ron Marler and Don Turner, both of whom are Main Board Directors, instrumental in the launch of Doram and subsequently became General Manager of the Company.

IN BRIEF

■ West Midlands Readers will be interested to learn that Henry's Radio have opened an electronic components store at 94/96 Upper Parliament Street, Nottingham.

Stocks of their full catalogue range of components and equipment are maintained.

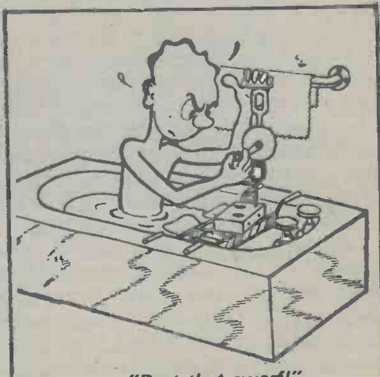
■ The British Amateur Electronics Club report that their tenth Exhibition, held at Penarth, Glamorgan, was again a great success and a record donation of nearly £550 was made to the Cancer Research Campaign.

Details of membership of B.A.E.C. may be obtained from J. G. Margetts, 11 Hazelbury Drive, Warmley, Bristol.

■ Amateur Radio Classes are being held at:– Glasgow College of Nautical Studies, 2 Thistle Street, Glasgow, C.5. Tuesdays and Thursdays from 7.00 pm to 9.30 pm. Gosforth Secondary School, Gosforth, Newcastle-upon-Tyne, Tuesdays from 7.00pm to 9.00 pm. Candidates may sit the R.A.E. at the school.

■ 2 short courses of lectures are to be held at South London College, Knight's Hill, London, SE27 0TX.

1. Electronic Calculators. Tuesday evenings commencing 7th October.
2. Integrated Circuits. Thursday evenings commencing 9th October.



"Drat that swarf!"

PRE-PUBLICATION OFFER

We are informed that publication of *Linear I.C. Circuit Applications* by G. Clayton has been postponed to mid-November.

We regret any inconvenience caused to readers by the delay. However it does mean that we can extend the offer until 31st October — see our advertisement pages.

Ten tips with insulating tape

By K. Harker

The humble reel of plastic insulating tape can be put to a surprising number of useful applications.

There are a number of minor problems which are liable to confront the constructor and which can be solved by using ordinary plastic insulating tape. This is not to claim that insulating tape is an electronic cure-all, but it does lend itself to many versatile applications.

Let's begin with its electrical insulating uses. This may sound as self-evident as saying a resistor resists; but simple precautions can be all too easily overlooked in the absorption of trouble-shooting and setting-up procedures.

1: INSULATING WIRES

Wrapping insulating tape round bare wire seems as easy as losing an 8BA washer; but let's remind ourselves of the whens and wheres.

When fault-finding around a chassis the ends of some leads may have to be disconnected. It is safer to insulate an unsoldered end than to leave it dangling bare where it might short-circuit against metalwork and wreck a few components. Remember, too, that the wire may make accidental contact with *you*, and this is not a pleasant way of driving home the insulation moral if high voltages are involved.

The same applies to fitting in temporary leads as, for example, when connecting a milliammeter in circuit. Whether you solder the leads, twist the ends or use crocodile clips will depend mainly on how long the check will take and whether the connections are likely to be disturbed. But nothing is lost by adding a turn or two of tape. It is so easy to forget temporary connections, dangling somewhere in mid-air, when you are concentrating on meter readings.

Furthermore, a wire linked at both ends — as opposed to a free-hanging wire with one end detached — is probably more easily prone to accidental tugging. And even a temporary wrap-round of tape might be abraded if it chafes on, say, the sharp corner of a transformer tag, giving dire results. So make sure the insulation you add is thick enough to be suitable wherever it happens to be. Preferably, rearrange the leads so that any joints hang well clear of trouble spots. Also, of course, extra turns of tape will themselves strengthen a joint, particularly if this is a twisted-wire type.

What counts is a cautious approach with two points in mind: protection of components and your own and other people's safety.

2: INSULATING SURFACES

In effect, insulating surfaces is the same as insulating wires, except that it is sometimes more convenient to stick tape to, say, a metal chassis than around component wires. Strips of tape can be affixed to the underside of a metal equipment case lid wherever there is a risk of components touching it when the lid is fastened home. A further instance occurs in the screening can of a tuning coil, as in Fig. 1,

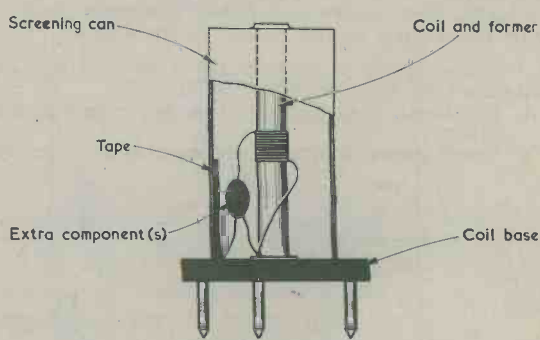


Fig. 1. When extra components are crowded inside a coil can, cover the adjacent internal surface with tape.

where resistors or capacitors which are also included in the can leave little space for individual insulation.

If you've just soldered in extra components dangerously close to the metalwork of a chassis, you'll have to poke a strip of insulating tape in with the components already in position. Tweezers or fine-nosed pliers can help to initially locate the strip. Once you've got a corner anchored, the flat of a broad-bladed screwdriver is useful for pressing the strip down on to the surface.

3: COLOUR CODING

Wrap a turn of tape round a wire (even though this is already insulated) for easy identification. For greatest benefit you'll need tapes of several colours. There are plenty of colours available.

This procedure can help if you ever find yourself using plain twisted 2-way flex with a meter. First check the leads for continuity, then mark both ends of one. Or for polarity identification you can mark *both* leads. An obvious combination is red positive and black negative or, should you wish to be in keeping with the revised mains lead coding, brown and blue respectively for "live" and "neutral".

If you are proposing to wire up a chassis which is complex enough to require several different colours of insulated wire for lead-tracing purposes, you can aid matters by colour coding the ends with a wrap-round of tape which is a different colour from the wire insulation. Thus, with five wire insulation colours and five colours of tape you have twenty possible combinations of *different* colours, as a glance at Fig. 2 will show. There are also five combinations of the *same* colour. In these cases, there is probably little point in adding the tape, since the wire insulation alone serves the same identification purpose. The same-colour combinations are represented by the diagonal of squares from top left to bottom right.

If you rough out such a table, you can put crosses in the squares as you proceed with the wiring up. These will guide you on which colour combinations you have already used.

Insulating tape colour

Wire insulation colour	red	orange	yellow	green	blue
red		X	X	X	X
orange	X		X	X	X
yellow	X	X		X	X
green	X	X	X		X
blue	X	X	X	X	

Fig. 2. Table showing combinations of different colours (the crossed squares) obtainable with five basic colours of tape and wire insulation

4: LABELLING

Sometimes you might want to label wires for improved identification. For instance, when there are linking wires between two separate chassis, A and B, you can mark the wire ends to correspond with point numbers on the circuit diagram. Labels can be quickly made with a single wrap-round of tape, pressing the two ends together to form a writing surface about $\frac{1}{2}$in. square. Use a ballpoint pen of different colour from the tape to write on the connecting point numbers, such as, say, "A6 to B9". See Fig. 3. The other end of the lead would carry a label marked "B9 to A6". Write on both sides of the labels for easy viewing. You could be glad of these labels in later fault-finding if you have to detach wires and then solder them back in the right places.

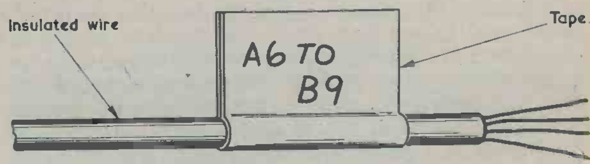


Fig. 3. Tape showing connecting points can be used to label a wire link

Components which need adjustment during setting-up procedures can be identified with small cut-out squares of similarly marked tape. With coils, such as "L2" if an i.f. strip, the label can be stuck to one side of the screening can. With pre-set variable resistors on printed circuit boards, labels are more conveniently stuck to an adjacent part of the board. As many such components are probably out of sight except during adjustment, neat hand-written labels serve adequately.

5: AIDING CONSTRUCTION

Occasionally, in assembly work, the positioning of nuts and bolts with the fingers becomes an impossibility; but you may be able to use insulating tape to anchor a nut over the appropriate hole in, say, a component baseplate before the plate is placed in its final awkward corner. As the bolt is screwed through it pushes the tape free of the nut. As is shown in Fig. 4(a), it helps if one end of the tape was originally

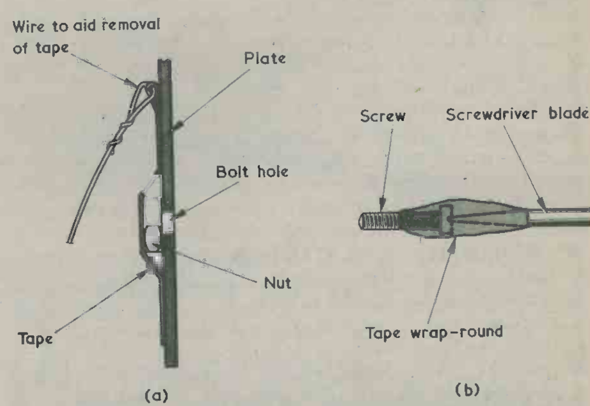


Fig. 4(a). Positioning a nut in an "awkward" place (b). How a screw may be temporarily secured to a screwdriver wrapped round a length of spare wire. The tape can then be fished out of the difficult position by means of this "fishing-line."

Tightening the nut is another story but, if you can't get a spanner in, any long thin gadget pressed up against a side of the nut will usually hold it while the bolt is turned with a screwdriver.

The counterpart to this is fitting a screw through an inaccessible hole. A turn or two of tape can serve here to temporarily attach the screw to a suitably long screwdriver, with the blade already fitted into the screw head slot. Fig. 4(b) illustrates the idea. It is then a simple matter to push the screw through the hole and rotate it.

6: ANCHORING LEADS

You can often guard against the dangling leads snag mentioned in the first tip by temporarily taping insulated wires to an adjacent surface. The same applies when holding wires aside to give access for test prods, etc. You can also make more permanent fixtures where several wires run alongside each other by binding them in a group with tape at, say, 6in. intervals. Again, several wrap-rounds can help to fill up free space in any cleat or grommet through which the bundle runs, thereby holding it more securely.

In the more delicate task of coil winding, fine strips of tape can temporarily attach an enamel covered wire to the coil former before the bared end of the wire is permanently soldered into the base. After winding, the other end of the wire can be similarly anchored before snipping off the excess. A third strip laid along the coil can further help in fixing the coil turns. See Fig. 5. You can leave all such strips in position, even if you also intend to daub the turns with polystyrene cement to finally secure them.

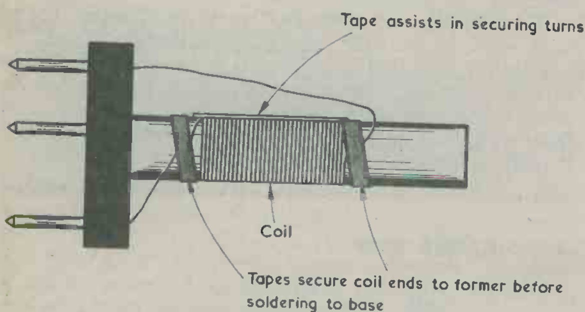


Fig. 5. Tape is a useful accessory in coil winding

7: GUIDING COIL TURNS

If you are winding a multi-layer coil and wish to contain the turns over a short length of the former you can built up two "bobbin ends" by first winding on two thin longish strips of insulating tape, as in Fig. 6. You will probably need quite a few turns in each to give sufficient depth to the coil zone in between. It may then be necessary to nick a slot or two in the tape nearer the coil former base to allow the coil ends to be led directly down to their tags.

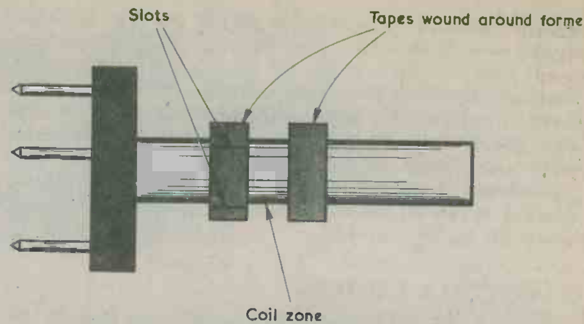


Fig. 6. "Bobbin ends" can be built up with tape to contain a multi-layer coil over a short length of former

8: INDICATING CONTROL SETTINGS

Should you be using a potentiometer without an indicator knob, and with no flat or screwdriver slot on the shaft, it is anybody's guess how far round you have set the wiper. A thin strip of tape can serve as a marker here.

With the three tags nearest you and the potentiometer set fully anticlockwise, attach the tape strip down the side of the shaft alongside the left hand tag. The strip should continue over the spindle end, as shown in Fig. 7(a). This continuation of the strip

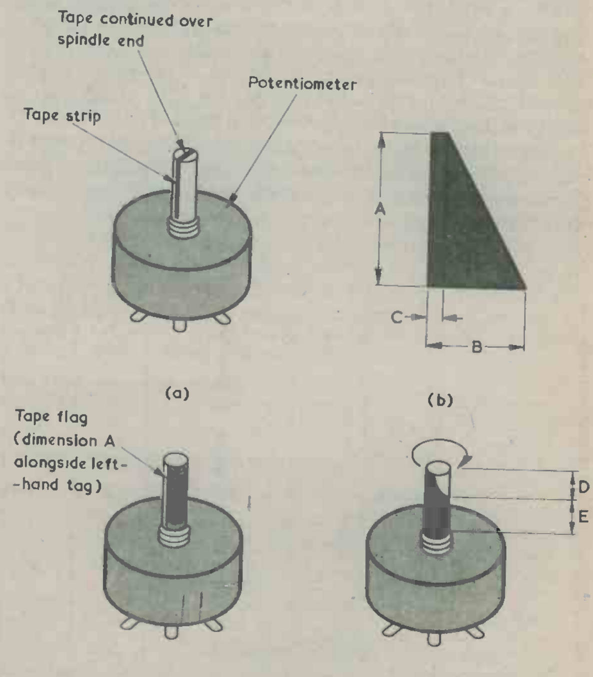


Fig. 7(a). Fixing a thin strip of tape to a potentiometer shaft to provide a marker (b). Alternatively, a "flag" of tape can be cut out, as here (c). The "flag" is wrapped around the potentiometer shaft (d). The ratio of D to E indicates amount of shaft rotation provides a useful way of keeping it in view, to indicate wiper angle, when the rest of the strip becomes hidden round the back of the shaft.

An alternative way, possibly best used on shorter shafts, is to cut the tape to form a "flag", as in Fig. 7(b). Make dimension A the same as the length of the shaft, and B the same as the circumference. For ¼in. shafts, B will be about 0.8in. Dimension C should correspond roughly to the portion of circumference lying between the end stops, perhaps to about 40°. This makes C about 0.1in. The dimension B minus C (0.7in.) then corresponds to the approximate angle through which the potentiometer shaft can turn.

Again, with the tags nearest you and the wiper set fully anticlockwise, stick the flag to the shaft with its left hand edge alongside the left hand tag, as illustrated in Fig. 7(c). The tapering edge will thus be wrapped around the back. On adjusting the potentiometer the proportion of "exposed" shaft opposite the right hand tag, viewed directly from the front, will indicate the approximate proportion of full travel from the anticlockwise end. See Fig. 7(d). This is given as the ratio D to E of the dimensions shown.

9: MARKING A TUNING TOOL

Tape offers a similar aid when adjusting iron-dust or ferrite cores in higher frequency coils. In television i.f. alignment work, for example, a fraction of a turn can be critical; so it's of advantage to know how far you have turned a tuning slug in case you want to return it to its original position. You can't very well do this by noting the position of the slot in the end of the core if you want to keep the tuning tool in position!

All you need to indicate the angle which has been turned through is a thin strip of tape attached along one side on the tuning tool. Should this be a home made tool such as a cut-down plastic knitting needle with one end reshaped like a screwdriver blade, file a 1in. length at the other end to a square cross-section. Then stick the tape along one of the flats, as in Fig. 8. The square shape helps you to "feel" the position in quarter-turns, a very useful feature if you are watching a meter or television test card.

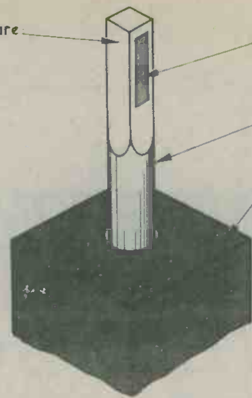


Fig. 8. Mark one side of a trimming tool with tape as a guide to fine adjustment of coil cores

The strip of tape gives visual confirmation of the number of quarter-turns made.

A commercially made trimming tool with a hexagonal end can have the square cross-section filed out on the wider part of its body.

10: SEALING OFF ADJUSTMENTS

Finally, if you are lining up a chassis which has a number of coils, each to be adjusted at a specified frequency, it's as well to know which ones you've already set up (or should not even touch at all). To make sure you don't accidentally tamper with them again the simple answer is to stick a square of insulating tape over the access-hole at the top of the screening can.

This may sound a negative sort of tip, but it's a good way of ensuring positive results in getting your tuning problems taped. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Codar CR45 – J. Edmundson, 60 Lime Tree Place, Stowmarket, P14 1BT – Instruction Book and Circuit Diagram – Borrow or purchase.

"Air Machines" by Wiston Reynolds – H. H. Seymoor 74 Harold Estate, Pages Walk, London, SE1 4HW – Borrow or purchase.

Lafayette Model HE30 – J. Morgan, 43 September Road, Anfield, Liverpool 6 – Circuit and Servicing information required.

Radio Constructor and **Radio Amateur** – J. H. Luxton, Bergheim; Battery Hill; Fairlight Cove, Hastings, Sussex – Early 1950 issues of "Constructor" and issues before 1950 of "Amateur" wanted.

NEW TRANSISTORISED OSCILLOSCOPE

Part 2 By R. A. Penfold

In last month's issue, details were given of metal-work and the power supply section of the oscilloscope. Most of the constructional work is described this month, including the assembly of the X and Y amplifiers, and the timebase and sync amplifier. The flyback blanking amplifier and other final points will be dealt with in next month's concluding article.

In the first part of this series, published last month, the overall functioning of the oscilloscope was described. Also given were constructional details of the power supply section, together with the full Components List.

We now proceed to the display section.

DISPLAY SECTION

Fig. 8 gives the circuit diagram of the display section. This is quite conventional, but has been modified slightly from the earlier design, mentioned last month, to use fewer components.

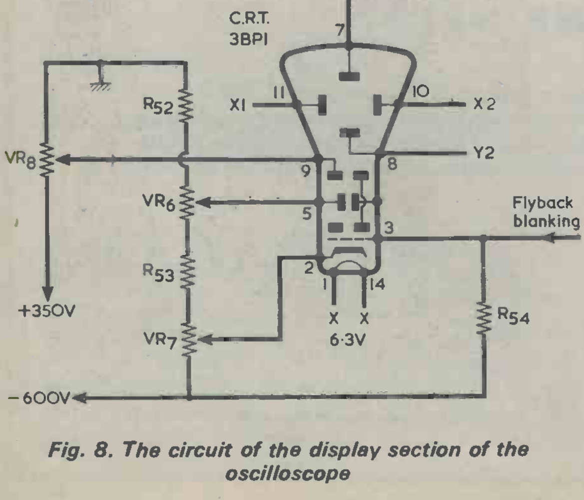


Fig. 8. The circuit of the display section of the oscilloscope

The astigmatism control, VR8, is required to ensure that the beam spot remains correctly focused at all parts of the screen. It is now powered from a 350 volt supply instead of the 124 volt supply, as in the previous oscilloscope, to give increased control.

A point to point wiring system is used in the assembly of the display section. There is no internal connection to pin 6 of the tube, and so R54 can conveniently be connected between pins 3 and 6 on the c.r.t. holder. VR8 is mounted on the rear c.r.t. bracket, and not on the front panel.

The 3BP1 tube is intended to operate with an e.h.t. supply of 1,500 volts, but it works perfectly satisfactorily with a 600 volt supply. The only effects of using this reduced voltage are a slight loss of trace brightness and an increase in deflection sensitivity.

To check that the display section is working properly, first earth the X and Y deflection plates temporarily to chassis and then switch the unit on. Check that VR7 controls the brightness of the spot and that VR6 enables the spot to be focused to a diameter of about 1mm. only. The spot should appear at about the centre of the screen.

The astigmatism control cannot be properly adjusted until the oscilloscope has been completed and its slider should be left at the centre of its track at this stage.

X AMPLIFIER

An extremely simple X amplifier is used, and the circuit diagram of this is shown in Fig. 9.

The input stage uses a 2N3819 field-effect transistor, TR3, in the source follower mode, this being the f.e.t. equivalent of the emitter and cathode follower circuits. TR3 is biased by R9, R10 and R11, while R12 is its source load resistor. VR1 operates as the X

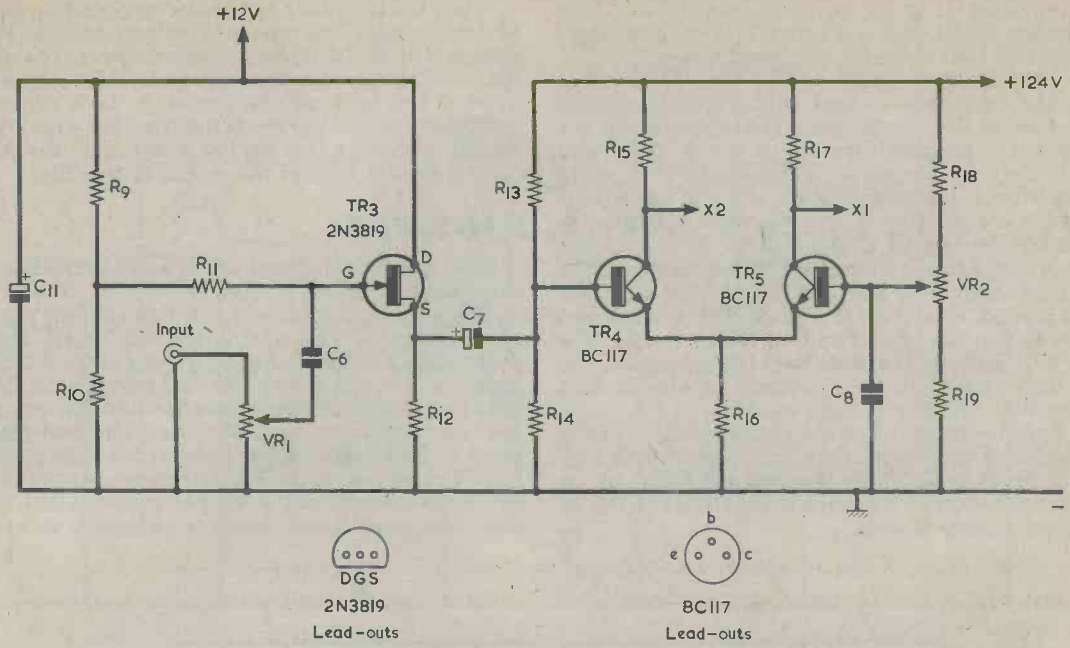


Fig. 9. The oscilloscope has a simple X amplifier in which voltage gain is governed by load resistor values

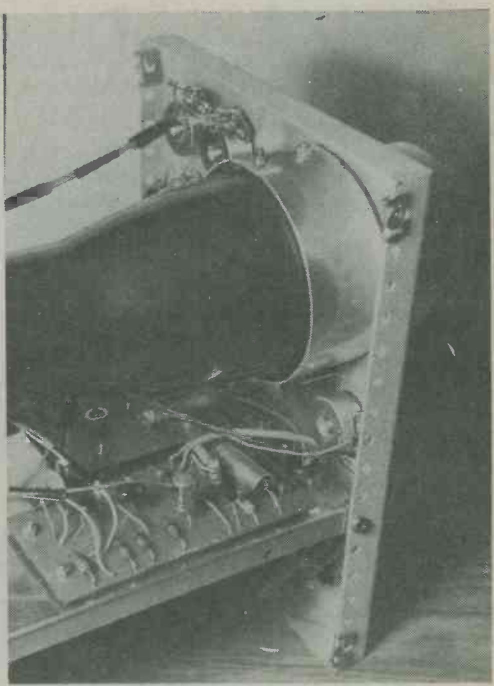
gain control and C6 provides d.c. blocking. The voltage gain of the input stage is slightly less than unity, and it is mainly used as a buffer stage to provide a high input impedance. The input impedance is 500kΩ shunted by about 20pF.

C7 couples the output of TR3 to the input of the differential amplifier formed by TR4 and TR5. This type of amplifier has one input and two anti-phase outputs. TR4 and TR5 do not have to be matched as it is the resistor values which determine the static voltages and gains in the circuit and not the individual current gains of the transistors. For this reason, R13 to R17 are close tolerance components. One advantage of this circuit over that in the previous design is that no pre-set potentiometers are used, and so no setting up of the completed circuit is required.

The operation of the output stage is quite simple. R13 and R14 produce about 4.6 volts at the base of TR4, and in consequence about 4 volts are developed across R16, allowing for a voltage drop of approximately 0.6 volt in the base-emitter junction of TR4. If VR2, which is the X shift control, is adjusted to produce exactly the same voltage across R16, the circuit will be balanced. Of the 4mA flowing through R16, 2mA will flow through TR4 collector-emitter and R15, while the other 2mA will flow through TR5 collector-emitter and R17.

Obviously the voltages present at the outputs, i.e. TR4 and TR5 collectors, will be the same, and the spot will appear at the centre of the c.r.t. screen.

If a positive-going input signal is applied to TR4 base, this transistor will pass an increased collector-emitter current, and as a result the voltage at its collector will drop. The increased voltage across R16 will cause TR5 to pass a reduced collector-emitter current, and the voltage at its collector must therefore increase.



The X amplifier board is mounted at the front left of the chassis, partly below the cathode ray tube

An input signal of the opposite polarity will have the opposite effect, and will cause TR4 collector to go positive and TR5 collector to go negative.

The principal advantage of this type of circuit is that it enables a peak-to-peak output voltage of up to about 130 to be developed. The outputs of the amplifier are coupled directly to the X deflection plates of the tube. Capacitor C8 boosts the response of the amplifier at high frequencies, where it has a comparatively low reactance and provides a bypass to chassis for the base of TR5.

The X amplifier is assembled on a printed circuit board measuring 4 by 2in., and the etching and component layouts are shown in Fig. 10. These are shown full size so that the copper pattern can be traced. The letters X-X indicate the same edge in both views. The input lead from VR1 is screened, as also is that between VR1 and the X input socket.

The board is mounted on the chassis in the position indicated in Fig. 3 (published last month) with C11 near the front panel. It is secured and takes up its chassis connection in the same manner as was the 12 volt power supply board.

When the amplifier has been completed and checked for mistakes, the unit may be switched on. By adjusting VR2 it should be possible to centre the spot on the screen, and VR2 should provide sufficient control to send the spot off the screen in both directions. Touching the non-earthy X input socket with a finger should produce a line on the screen, and the X gain control should control the length of this line.

Y AMPLIFIER

The circuit diagram of the Y amplifier and attenuator is shown in Fig. 11.

There are two inputs to the Y amplifier; one connects direct to VR3 and is the d.c. input, and the other, the a.c. input, connects by way of the d.c. blocking capacitor, C9. VR3 is the fine gain control. R20 to R24 form a simple step attenuator and also act as the gate bias resistance for TR6. The attenuator resistors must be high stability low-noise types, and must also have a close tolerance. The attenuator is not frequency compensated, but a simple modification, to be described next month, enables frequency compensa-

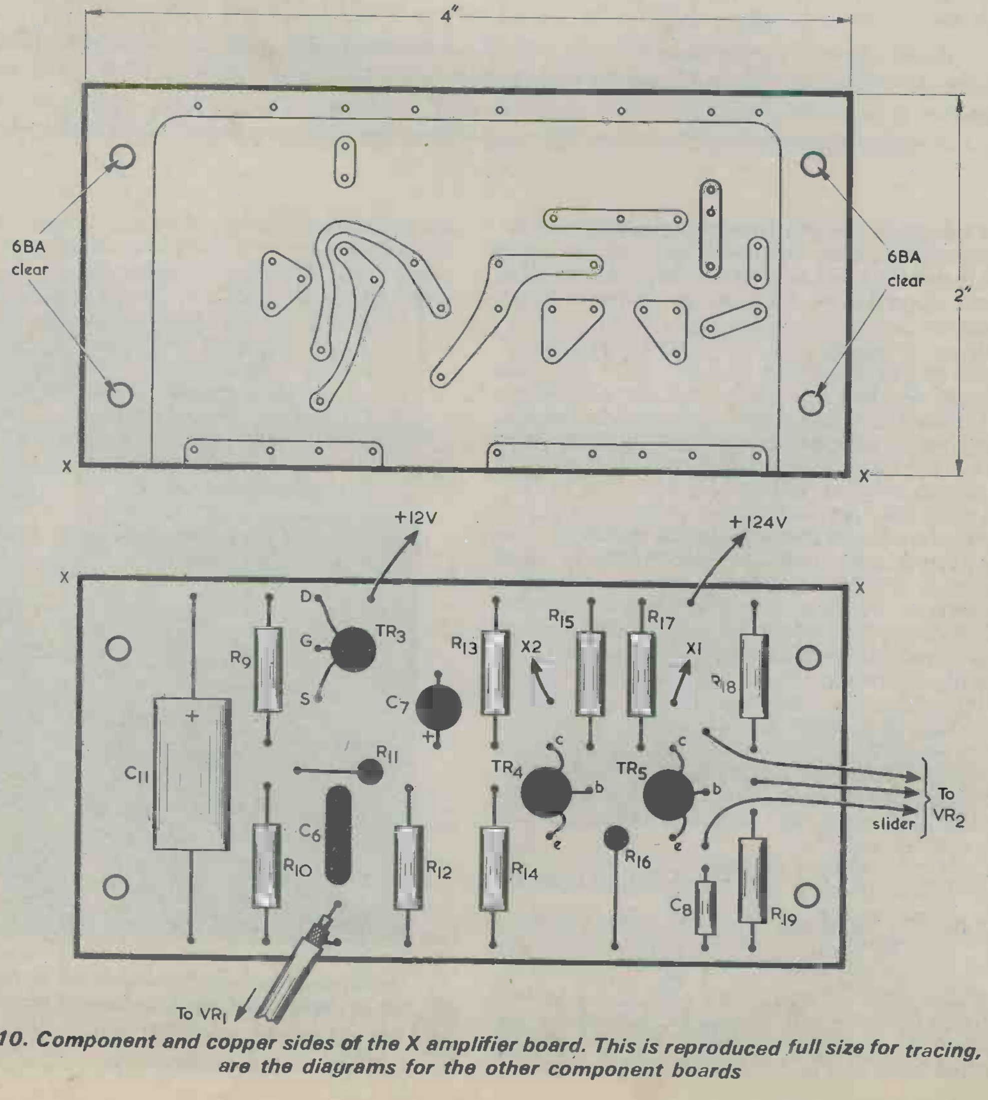


Fig. 10. Component and copper sides of the X amplifier board. This is reproduced full size for tracing, as are the diagrams for the other component boards

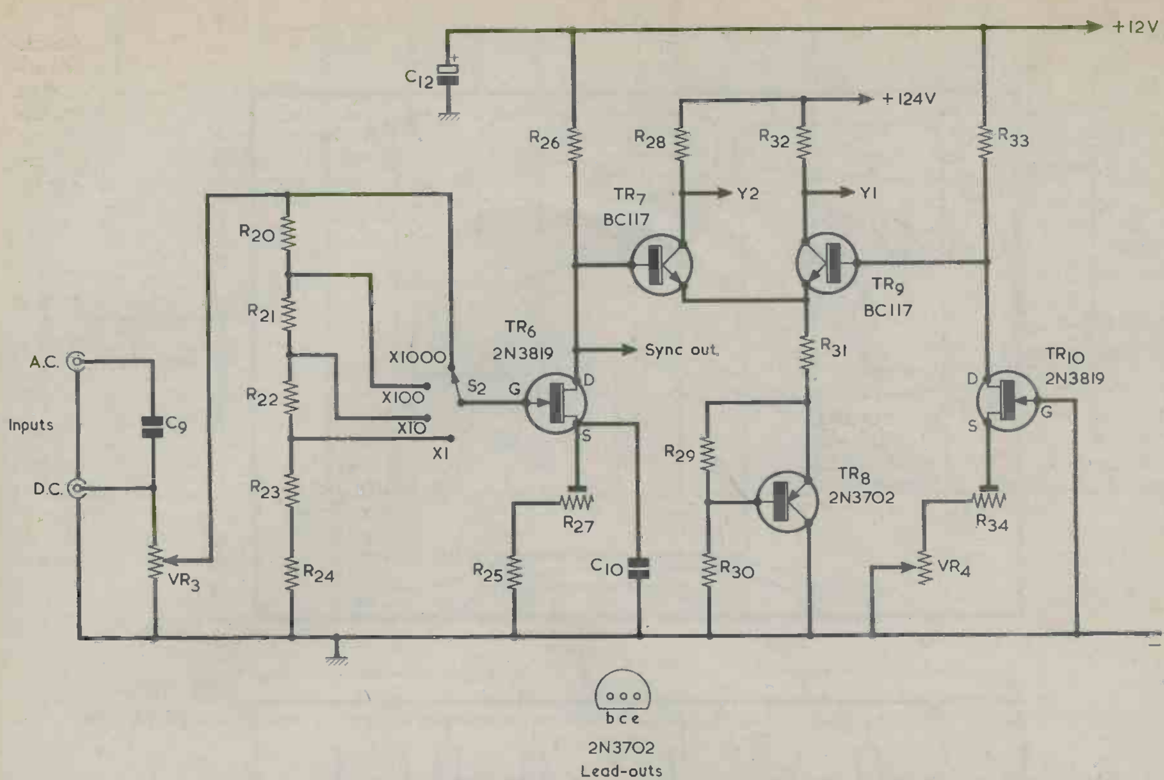


Fig. 11. The circuit of the Y amplifier and its input attenuator

tion to be incorporated if desired.

TR6 is used as a common source amplifier, and has R26 as its drain load resistor, and R27 together with R25 as its source bias resistor. C10 bypasses the source bias resistance at high frequencies and so provides high frequency boost.

TR7 and TR9 form a differential amplifier similar to that employed in the output of the X amplifier. The maximum output swing at TR6 drain in the negative direction provides a voltage which is rather high above chassis potential, and so TR8 is interposed between chassis and R31. TR8 functions as an 'amplified diode' and raises the lower end of R31 about 1 volt above chassis. It is not possible to increase the negative output swing of TR6, and so TR8 is used to increase the minimum input voltage requirement of the differential amplifier.

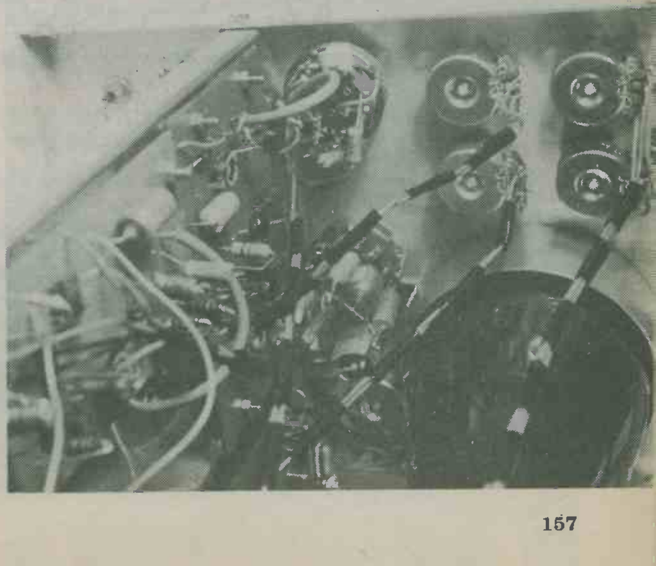
The base of TR9 is fed from a second common source f.e.t. circuit, rather than from a simple potential divider. This is necessary in order to provide temperature compensation. Any change in the voltage at TR6 drain caused by a change in ambient temperature is matched by a similar change at the drain of TR10. The circuit will thus remain balanced and the position of the trace on the screen will be unaltered.

VR4 is the Y shift control.

The Y amplifier is assembled on a printed circuit board which has dimensions of 4 by $2\frac{3}{4}$in. Etching details of this are shown full size in Fig. 12 together with the component layout. The board is mounted on the chassis in the position shown in Fig. 3 with the edge marked X-X in Fig. 12 nearer the front panel.

Screened leads are used for the input wiring and these should be kept as short as possible to keep the input capacitance low. The attenuator resistors are mounted on S2. This is a 3-pole 4-way rotary switch with two of the poles unused. (They are brought into use if the attenuator is modified for frequency compensation.) C9 is positioned between the a.c. and d.c. input sockets. Nothing connects to the sync output of the printed circuit board at this stage.

Wiring behind the panel above the Y amplifier board



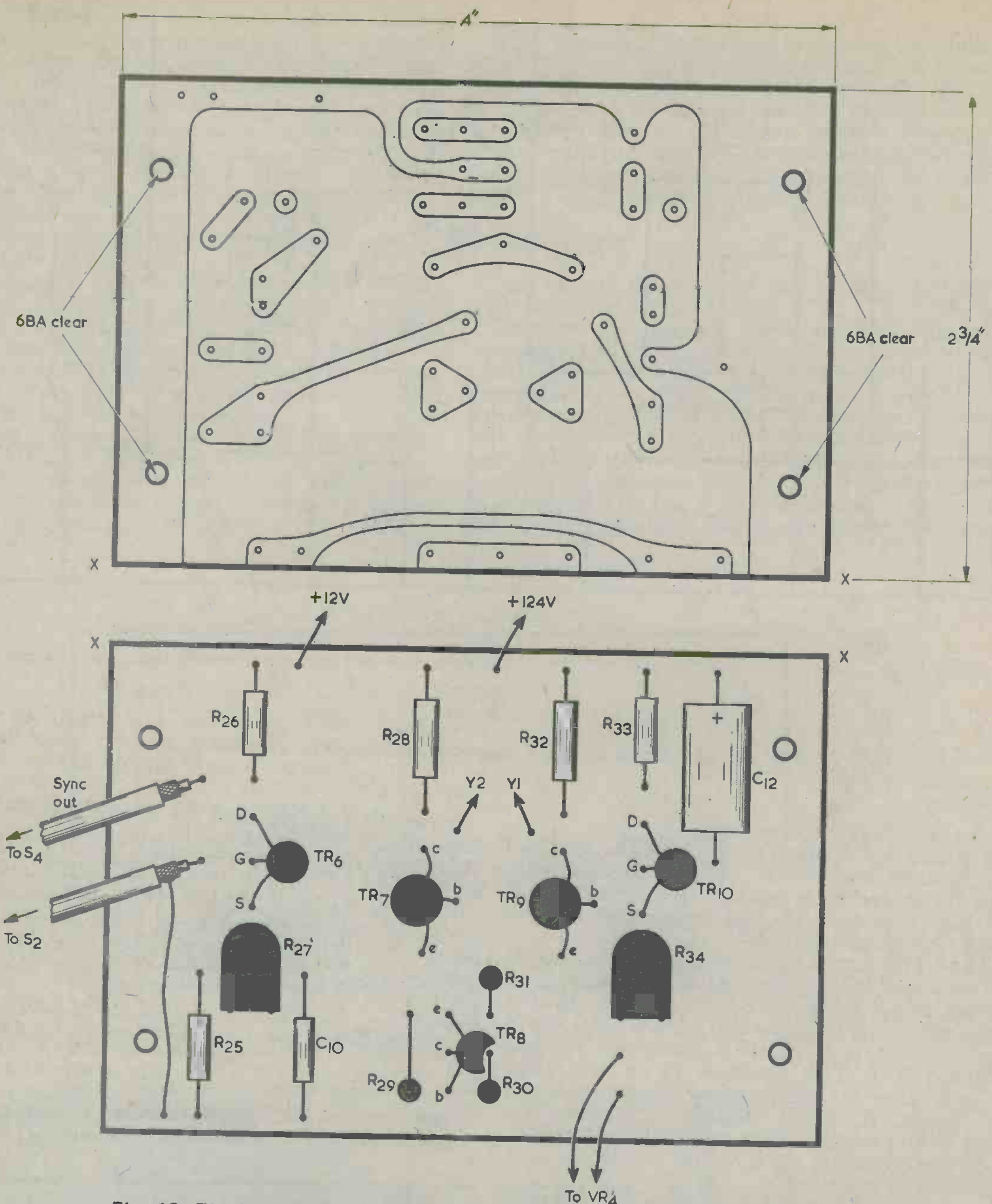


Fig. 12. The Y amplifier board after it has been etched and assembled

When the board has been checked for mistakes and installed on the chassis, set R27, R34 and VR4 to insert approximately half maximum resistance into circuit. Then switch the unit on.

Connect a 20,000Ω per volt multimeter set to read 10 volts f.s.d. between TR6 drain and chassis, the negative test lead connecting to chassis. Adjust R27 to give a reading of 6.5 volts in the meter. Then adjust R34 to bring the spot to the centre of the screen. Check that the Y shift control can shift the spot off the screen at both the top and the bottom. Connecting a 9 volt battery to the d.c. Y input should shift the spot by a little less than 1cm. with the attenuator in the 'X1' position and the fine gain control at maximum.

TIMEBASE AND SYNC

The timebase circuit employs the popular NE555V integrated circuit or any of its equivalents. The circuit of the timebase generator and sync amplifier is given in Fig. 13. A detailed description of the NE555V will not be given as this has been the subject of many articles.

The timebase signal is generated across whichever of the capacitors is switched into circuit by S3(b). In position 0 of this switch the timebase is disconnected from the X amplifier input by S3(a), whilst S3(b) short-circuits TR12 collector to chassis to prevent stray capacitances allowing the timebase to oscillate.

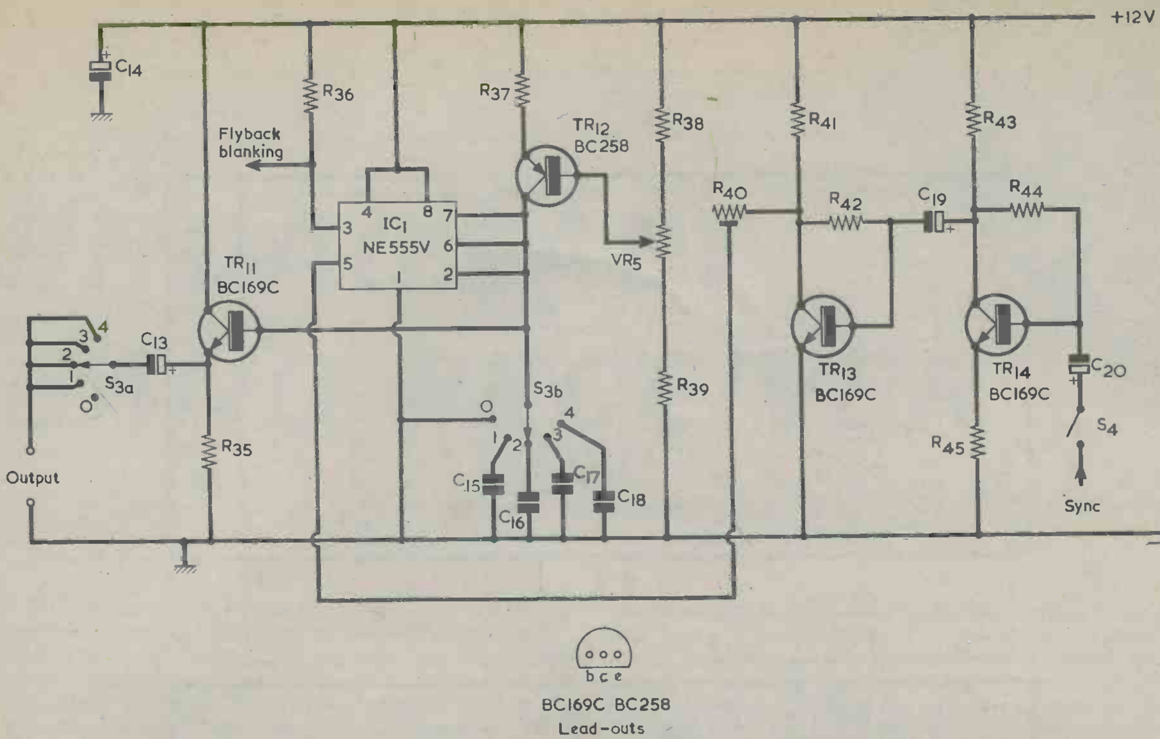


Fig. 13. The timebase section incorporates an NE555V timer with a constant current capacitor charging source

TR12 is connected as a constant current generator, the actual current which it produces being governed by the setting of VR5, which is the timebase fine frequency control. When the supply is applied the capacitor selected by S3(b) will begin to charge up via the constant current generator. Being fed from a constant current source, the capacitor will charge at a linear rate.

With pins 2, 6 and 7 of the NE555V connected together the capacitor will be allowed to charge to two-thirds of the supply potential. The capacitor will then be rapidly discharged by the i.c. until one-third of the supply potential appears across it. The i.c. then allows the capacitor to charge once more until two-thirds of the supply voltage is once again developed across it, whereupon it will again be quickly discharged to one-third of the supply potential.

This oscillation will continue, a 4 volt peak-to-peak linear sawtooth waveform being produced across the capacitor in the process. This signal is at a rather high impedance and is fed to the X amplifier via an emitter follower buffer stage, TR11. S3 functions as the timebase coarse frequency control.

During the short period when the capacitor is discharging the voltage at pin 3 of the i.c. goes low, and this pulse is amplified and used as the flyback blanking signal.

The sync signal from the Y amplifier is amplified by two common emitter amplifiers, TR13 and TR14. The amplified signal is fed to pin 5 of the i.c., where it modulates its triggering voltage and so locks the timebase frequency to a factor of the input frequency. This arrangement gives a stationary trace.

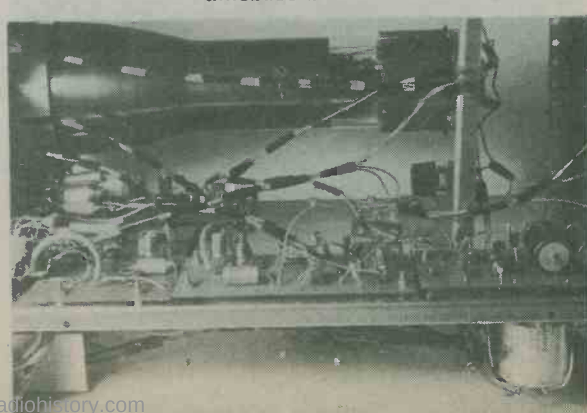
One problem with the sync circuit in the earlier oscilloscope was that adjusting the Y gain control altered the level of sync. this had the effect of shortening the trace and could even result in the number of cycles displayed being reduced or increased as the Y gain was adjusted. The limiting action brought about by the use of an extra stage of gain in this circuit virtually elminates that problem.

S4 is the sync on-off switch, and R40 is the sync pre-set level control.

The four timebase capacitors, C15 to C18, should preferably be close tolerance as this will enable the frequency ranges to ascend in multiples of approximately 10 times. They are listed as 5% plastic foil in the Components List, but it may be found easier to use a close tolerance silvered mica capacitor for C18. Capacitors with a tolerance of 10% can of course be employed, at a sacrifice of the relationship between ranges. The switch employed for S3 is a miniature 2-pole 6-way component with adjustable end stop set up for 5 ways. This is available from Henry's Radio, Ltd.

The timebase and sync circuits are assembled on a single printed circuit board which measures 4½ by 2in.

Side view giving details of the Y amplifier and timebase boards



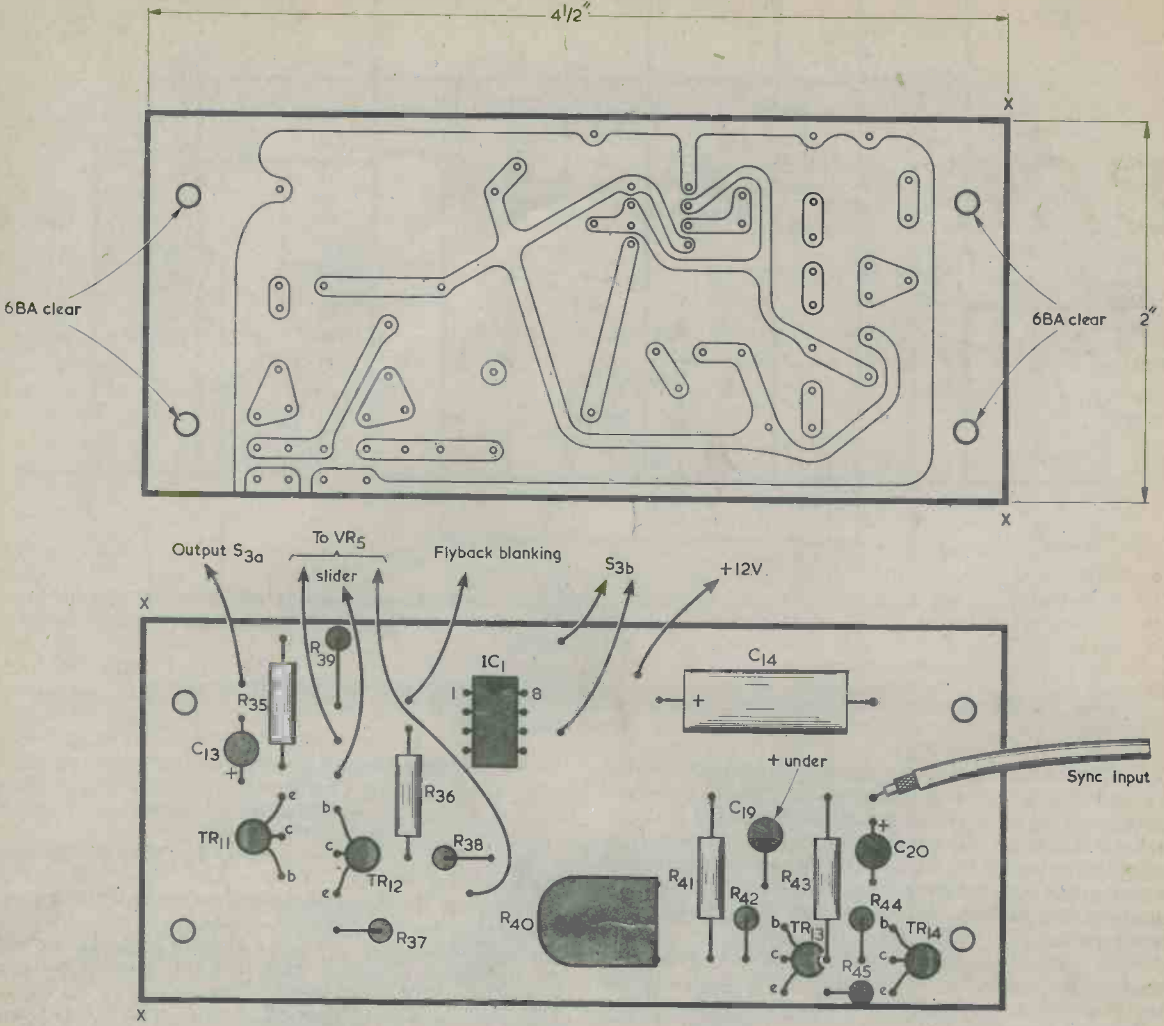


Fig. 14. The timebase component board in its completed form

Details of the etching of this are reproduced actual size in Fig. 14, which also shows the component layout.

The lead from the sync output on the Y amplifier to S4 is screened, as also is the lead from S4 to the timebase and sync board. The screened lead braiding may be earthed to chassis at any convenient point. The output from the timebase and sync board to S3(a) is not screened, but that from S3(a) to the X input is screened. C15 and C18 are soldered to the appropriate tags of S3(b). Note that R40 is slightly larger in physical size than R27 and R34 of Fig. 12. The smaller miniature size could be used for R40 as well, if desired, by slightly altering the copper pattern.

The timebase and sync board is mounted to the chassis in the position shown in Fig. 3, with TR14 near the front panel.

To test the timebase, first set S4 to the Off position, adjust R40 to insert about half maximumn resistance into circuit and switch S3 to position 0. Turn the oscilloscope on and allow a minute or two for it to warm up. It should be working exactly as before until S2 is switched to position 1. A line should then appear across the screen, and it should be possible to control the length of the line by adjusting the X gain control.

If the Y attenuator and fine gain controls are set at maximum and one of the Y input sockets is touched with a finger, a number of cycles should appear on the screen. VR5 should control the number of cycles produced. Then switch S4 to the On position and check that this synchronises the timebase properly. The sync gives a wide pull-in range, which can be adjusted to suit individual requirements by altering the setting of R40. If only a low level of sync is required R40 can be increased in value, say to 500kΩ.

NEXT MONTH

The only component board which has not yet been discussed is that for the flyback blanking amplifier. This will be described in next month's concluding article, which will also deal with adjustments and frequency compensation, including the provision of a frequency compensated input attenuator.

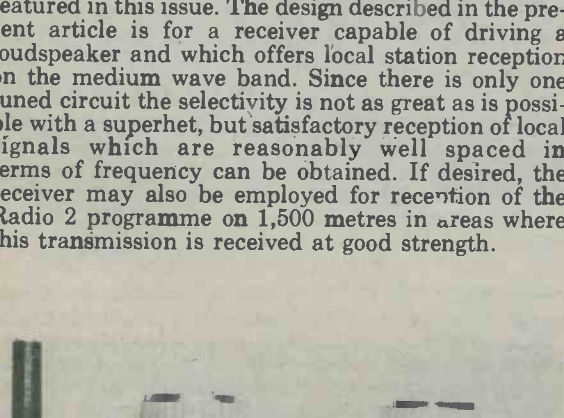
(To be concluded)

BROADCAST BAND RECEIVER

By J. R. Davies

This is the second of the two projects which can be assembled on the Veroboard presented free to readers in this month's issue. The receiver described here gives loudspeaker reception of local stations on the medium wave band. It may also be employed on long waves in areas where the Radio 2 signal on 1,500 metres is received at good strength.

The piece of Veroboard presented to readers this month is in a matrix of 0.15in. and has 7 strips by 16 holes. Methods of dealing with Veroboard are discussed at the start of the other Veroboard project article featured in this issue. The design described in the present article is for a receiver capable of driving a loudspeaker and which offers local station reception on the medium wave band. Since there is only one tuned circuit the selectivity is not as great as is possible with a superhet, but satisfactory reception of local signals which are reasonably well spaced in terms of frequency can be obtained. If desired, the receiver may also be employed for reception of the Radio 2 programme on 1,500 metres in areas where this transmission is received at good strength.



The Veroboard assembly wired up to VR1, S1, VC1 and a medium wave ferrite aerial

The circuit incorporates a ZN414 integrated circuit, this being followed by a 4-transistor a.f. amplifier which has been specifically designed to incorporate a very low quantity of components. A current-reading meter capable of measuring currents around 20mA is required for a test which is carried out after construction is complete. As a result of this test it may be necessary to alter the value of one resistor in the receiver, but the possibility of such a change being required is low.

CIRCUIT DESIGN

The circuit of the receiver appears in Fig. 1. The power for the receiver is provided by two 1.5 volt cells, these being switched into circuit by the on-off switch S1 (a) (b). This switch is ganged with the volume control VR1.

L1 is a ferrite rod aerial coil, and is tuned by the variable capacitor VC1. Further details of these two components are given later. They couple to the input of IC1, a ZN414 integrated circuit which functions both as an r.f. amplifier and as an a.m. detector. The ZN414 appears in a standard circuit with a 1.5 volt supply being applied to it from cell BY2. R2 is the output load resistor for the i.c., whilst C2, R3 and C3 are r.f. decoupling components. A detected a.m. signal free of r.f. content is thus applied to C4, and thence to the a.f. amplifier incorporating TR1 to TR4.

TR1 functions as an emitter follower feeding into the common emitter transistor TR2. The collector of TR2 couples directly to the bases of the output transistors, TR3 and TR4, and these provide a Class B output stage. Negative feedback, both at d.c. and a.c. is given via VR1 and R4.

Dealing first with the d.c. feedback, the purpose of this is to cause the output emitters, in the absence of signal, to take up a potential which is nearly equal to half the 3 volt supply potential. The base bias current for TR1 is taken from the output emitters via VR1 and R4, with the result that, should the output emitters go slightly positive in potential for any reason, an increased bias current flows into the base of TR1. The emitter current of this transistor increases proportionately, producing a higher base current and consequently a greater collector current in TR2. This increased collector current causes the output transistor bases to go negative. thereby

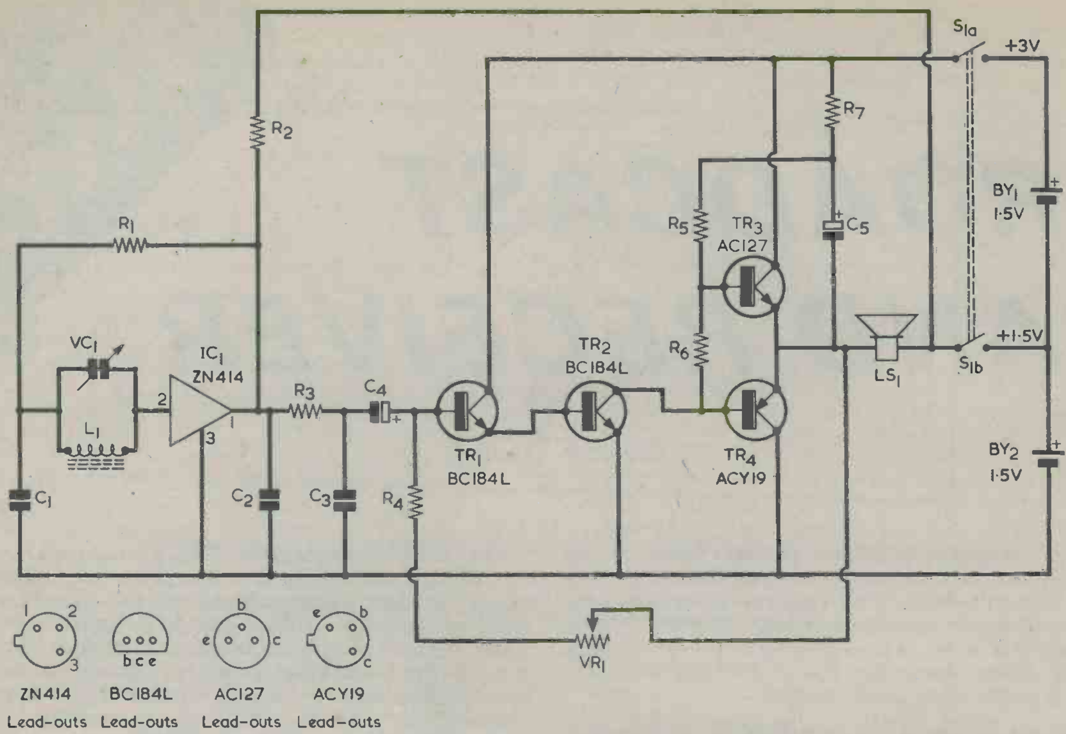


Fig. 1. The circuit of the broadcast band receiver. The low supply voltage enables the a.f. amplifier section to have a simple circuit with few components

COMPONENTS

Resistors
(All fixed values miniature ¼ watt 10% unless otherwise stated)
R1 100k Ω
R2 1k Ω
R3 680 Ω
R4 180 Ω
R5 68 Ω 5%
R6 18 Ω 5% (see text)
R7 15 Ω 5%
VR1 100kΩ potentiometer, log track, with S1 (a) (b)

Capacitors
C1 0.1 μF type C280 (Mullard)
C2 0.1 μF type C280 (Mullard)
C3 0.01 μF type C280 (Mullard)
C4 4 μF electrolytic, 4 to 10V Wkg., subminiature (Mullard)
C5 100 μF electrolytic, 6.4 to 10V Wkg., subminiature (Mullard)
VC1 Variable air-spaced, value to suit ferrite aerial (see text)

Inductor
L1 Medium wave, or medium and long wave, ferrite aerial (see text)

Semiconductors
IC1 ZN414
TR1 BC184L
TR2 BC184L
TR3 AC127
TR4 ACY19

Switch
S1(a) (b) d.p.s.t. toggle (part of VR1)

Speaker
LS1 3 Ω speaker

Battery
BY1 1.5 volt cell
BY2 1.5 volt cell

Miscellaneous
Veroboard, 0.15in. matrix, 7 strips by 16 holes
2 knobs
Wire, sleeving, etc.

counteracting the initial positive voltage shift at the output emitters. The bias current required at TR1 base is very low, and the overall effect is that the circuit takes up a state of equilibrium in which the potential at the output emitters is very slightly positive of the voltage needed at TR1 base to maintain collector current in this transistor. Both TR1 and TR2 are silicon transistors with a typical voltage drop across their base-emitter junctions of some 0.7 volt, whereupon the output emitters take up a potential under no-signal conditions which is approximately 1.4 volts positive of the lower supply rail. Because of the low bias current requirement at TR1 base, the output emitters maintain this potential for all settings of VR1.

Under a.c. conditions, the voltage gain of the overall amplifier is approximately equal to the series resistance of VR1 and R4 divided by the impedance presented to the base of TR1 by the preceding circuitry. The impedance consists of R3 in series with the parallel combination of R2 and the output impedance of the ZN414. As a result, the a.f. amplifier section offers nearly the full voltage gain of which it is capable when VR1 inserts maximum resistance into circuit. The voltage gain falls continuously as VR1 is adjusted to insert reducing resistance, and it reaches a very low level when VR1 is set to insert minimum resistance. In consequence, VR1 controls the overall gain of the amplifier and functions as a volume control. It gives smooth control in practice and the circuit has the advantages of providing both d.c. and a.c. negative feedback as well as a volume control with two components, VR1 and R4, only. R4 is included to ensure that the resistance in the feedback path cannot be made lower than its own value. Without R4, the amplifier could break into supersonic oscillation when VR1 inserts minimum resistance.

SPEAKER COUPLING

Since the output emitters, under quiescent conditions, are very nearly at 1.5 volts above the lower rail, the speaker is connected directly between them and the junction of the two 1.5 volt cells. This method of connection renders unnecessary the high value electrolytic capacitor which would otherwise be required for speaker coupling. A relatively low value electrolytic capacitor, C5, couples the output emitters to the bootstrapping circuit given by R7 and R5. Since the upper end of R5 goes positive and negative in sympathy with the positive and negative signal excursions at the output transistor bases it presents a resistance to TR2 collector which is much higher than its actual physical value. The bootstrapping also provides an adequate source of collector current for TR2 when, in the presence of signal, the output bases go highly positive.

Because of the low supply potential, both TR3 and TR4 are germanium transistors with a consequent low voltage drop between their bases and emitters. Also the usual series emitter resistors, whose function is to limit thermal runaway current in the output transistors, have been omitted. Such resistors, if fitted, would seriously reduce the signal voltage available for the 3Ω speaker. The common bias resistor, R6, has been given a value which allows a voltage of 0.32 volt to appear across it under quiescent conditions, and this voltage is just sufficient to bring most specimens of the AC127 and ACY19 used in the output circuit to the start of passing collector current. Because of the lack of protection against thermal runaway it is desirable to keep quiescent current at a low level, even at the cost of a little crossover distortion. Such distortion will, in any case, only be apparent at high volume settings in VR1 whereupon the output signal will be at a high level with crossover distortion proportionately less noticeable. At lower volume settings in VR1, the increased negative feedback around the amplifier will itself reduce crossover distortion, if present. The author would add that he has operated the amplifier for considerable periods of time at both high and low output levels, and there has been no evidence of any tendency in the output transistors to even run warm.

Nevertheless, it is sensible to check the output transistor quiescent current after the receiver has been assembled, and this check consists of a simple measurement of overall receiver current. In the unlikely event that this indicates an excessively high quiescent current in TR3 and TR4 then the value of R6 can be reduced.

The use of a 3 volt supply instead of the more usual 6 or 9 volt battery is mainly concerned with the provision of a receiver circuit having a small number of components. The maximum output power which can be delivered to the speaker is of the order of several hundred milliwatts, and the current drawn from the 3 volt supply varies from a standing level of around 18mA to nearly 100mA on high output peaks. At medium volume settings the average current is around 30mA. The additional current drawn from BY2 by the ZN414 circuit is negligibly low, being only 0.3 to 0.5mA.

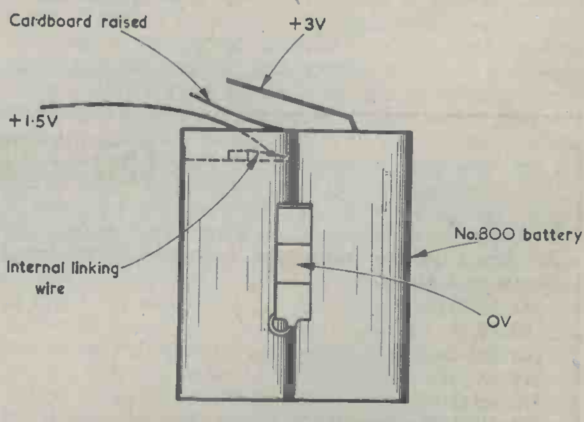


Fig. 2. An economical source of supply is given by a No. 800 cycle lamp battery. A connection to the internal wire linking its two cells provides the 1.5 volt supply point

The two 1.5 volt cells can consist of torch cells such as the HP2, but a more economical source of supply is given by a 2 cell cycle lamp battery, such as the Ever Ready No. 800. Access to the internal wire coupling the two cells together in this battery is obtained by raising the cardboard cover, and a lead can easily be soldered to this internal wire to provide the positive 1.5 volt supply point needed by the receiver. See Fig. 2.

FERRITE AERIAL

Before assembling the components on the Veroboard panel it is desirable to prepare a suitable ferrite rod aerial coil for L1. This has not been quoted as a specific part in the Components List because a number of options are available here.

Ready-wound manufactured medium wave, or medium and long wave, ferrite aerial assemblies are available from some component retailers, who usually state the value of tuning capacitor which should be employed with the assemblies. VC1 can then be given that value, or one which is slightly higher, should the latter be available.

If it is intended that the receiver be employed for medium wave reception only then all that is required is a medium wave ferrite aerial assembly. For adequate sensitivity the ferrite rod should not be shorter than 5in. If manufactured, the medium wave ferrite aerial coil will very probably have, in addition to the tuned winding, a second winding with a few turns for coupling to a low impedance transistor base input circuit. This coupling winding can be ignored and no connection is made to it. Should a manufactured ferrite aerial assembly also have a long wave winding on it, this is removed if it is intended to receive medium waves only. It is necessary to remove the long wave winding because such windings are frequently resonant, with their own self-capacitance, at frequencies in the medium wave band, and if left on the rod can cause unwanted absorption effects.

Should it be intended to have medium and long wave reception, the required wave band switching circuit is that shown in Fig. 3(a). As can be seen, the long wave winding is short-circuited on medium waves. The two windings should be connected so that they are series aiding, i.e. both windings are wound in the same direction and the inductance of the medium wave winding adds to that of the long wave winding when the long wave band is selected. As with the medium wave winding, any low impedance coupling winding on the long wave tuned winding should be ignored.

For constructors who wish to wind their own ferrite aerial, details are given for a medium wave version in Fig. 3(b). A medium and long wave home-wound coil assembly, together with the requisite wave band switching, is illustrated in Fig. 3 (c). The letter and number references in Figs. 3(a), (b) and (c) apply to the holes in the Veroboard receiver panel at which they will connect. In both Figs. 3(b) and (c) the tuning capacitor may have a value between 250 and 310pF. Due to varying permeability between different ferrite rods it may be necessary to add or take off a few turns on the medium wave winding to enable it to cover the medium wave band precisely, and this can be done after the receiver has been assembled and checked out.

As already stated, the receiver is recommended for long wave reception only in areas where the Radio 2 transmission on 1,500 metres is at good strength. It is in any case easier to start initially with a medium wave aerial only, and then add a long wave winding and the appropriate switch after some experience with the completed receiver has been obtained.

Before carrying on to constructional details, a few words concerning components are required. The two electrolytic capacitors, C4 and C5, are specified as Mullard sub-miniature with a working voltage, for C4, between 4 and 10 volts, and a working voltage, for C5, between 6.4 and 10 volts. This choice of working

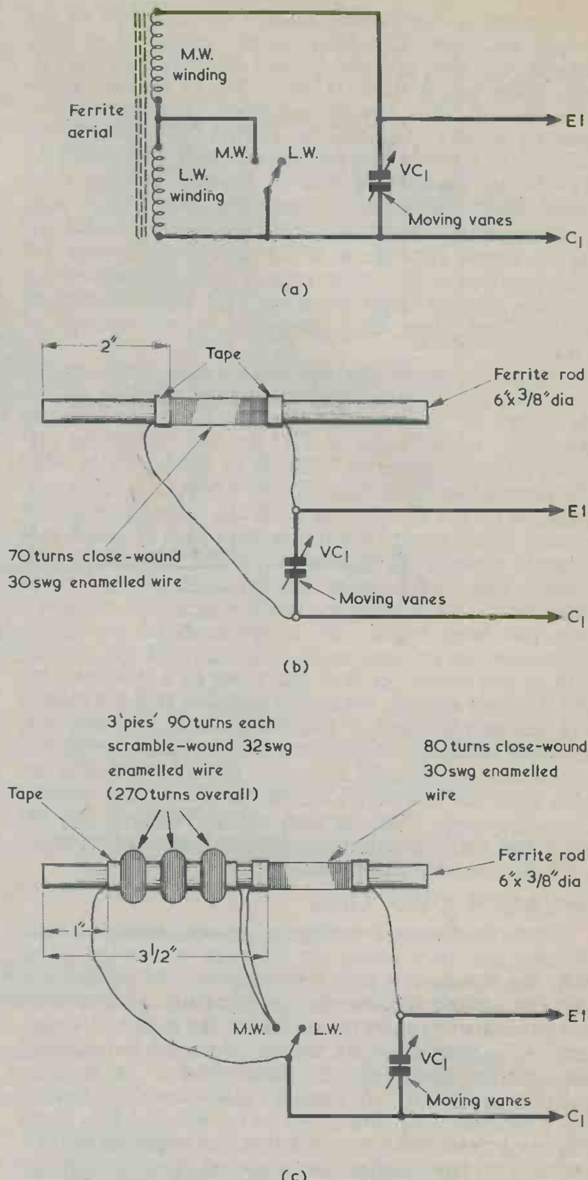


Fig. 3(a). A suitable wave band switching circuit if a ready wound medium and long wave ferrite aerial is used
(b). Winding details for a home-wound medium wave ferrite aerial
(c). A home-wound medium and long wave ferrite aerial assembly, and its wave band switching circuit

voltages takes in Mullard capacitors which are variously referred to as "type C426" or as being in the "015-016-017 range". C5 should have a diameter of 6.7mm. and a length of 18.5 to 20mm.

LS1 can be any 3Ω speaker. It will need to be mounted on a baffle or in an enclosure. For initial tests a suitable temporary baffle for a small speaker can consist of a piece of cardboard about a foot square with a hole in the centre having approximately the

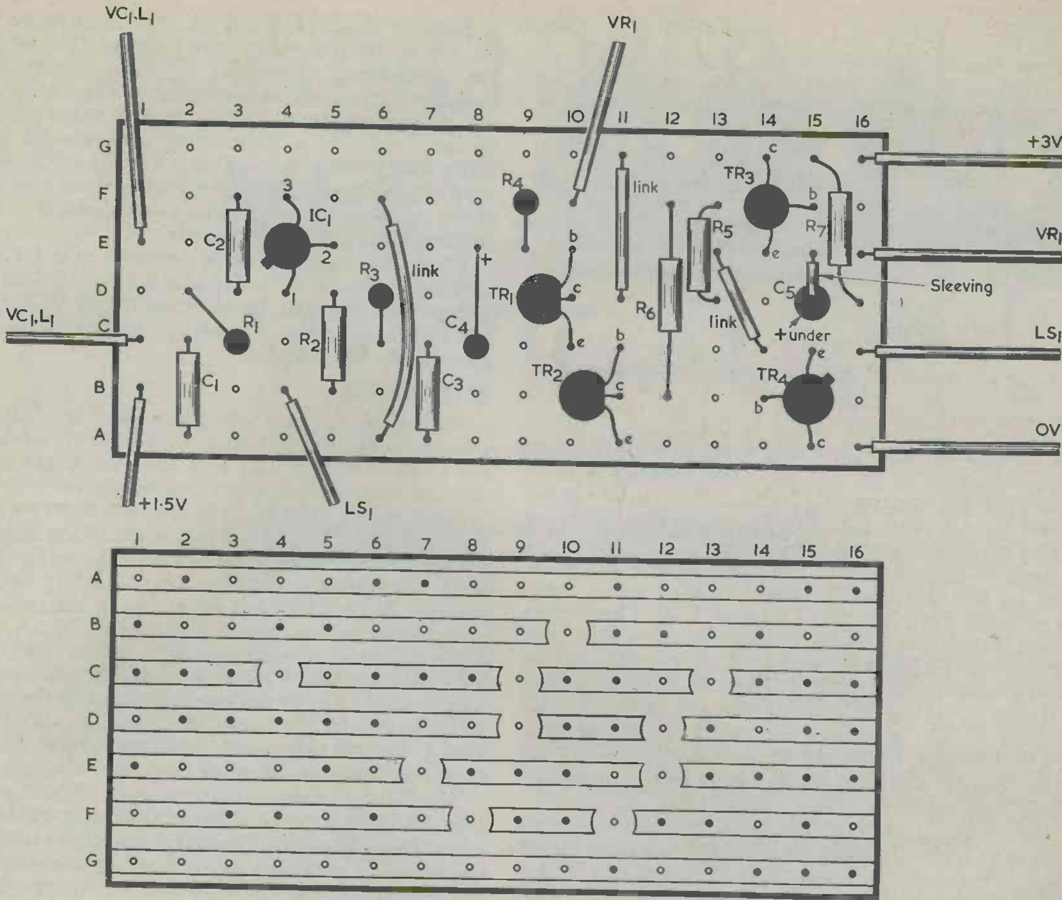


Fig. 4. Component and copper sides of the Veroboard panel

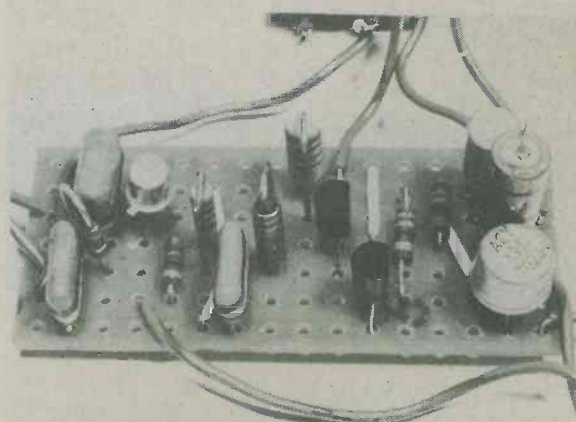
same dimensions as the speaker cone. The speaker is then simply stood on the bench with its cone upwards and the cardboard baffle placed over it. An elementary baffle of this nature makes a surprising improvement in audible volume and response.

ASSEMBLY

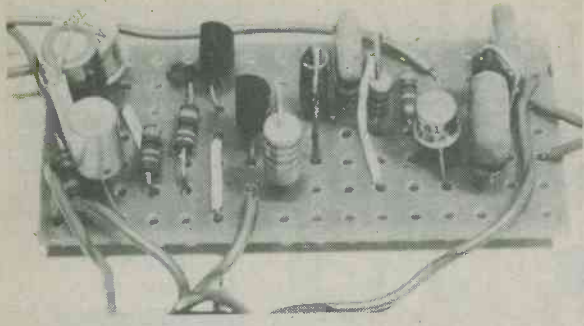
Having satisfied the points just discussed, assembly on the Verboard panel may commence. Fig. 4 shows the component and copper sides of the panel with letter and number references to assist in the description of construction.

First take up the panel and, with a Vero spot face cutter or a twist drill of suitable size, cut the copper strips at holes B10, C4, C9, C13, D9, D12, E7, E12, F8 and F11. Next fit and solder thin insulated wire links between F6 and A6, between G11 and D11, and between E13 and C14. The link between F6 and A6 curves slightly to the right, as illustrated, to allow access to holes D6 and C6.

All components referred to next are soldered to the appropriate copper strips as they are fitted. There is no necessity to bend over any of the component leads excessively on the copper side of the board, and excess wire can be snipped off after soldering. Some resistors are fitted horizontally with their bodies parallel to the board surface, and some are fitted vertically in the manner indicated in the diagram. Fit R7 horizontally, positioning its body so that access is available to holes F15 and E16. Fit R5 horizontally, spacing this a little way off the board so that its body is clear of the link wire at E13. Fit R6 horizontally, spacing this away from the board by about $\frac{1}{4}$in. so that it can be easily removed later, if necessary. Fit R2 horizontally. Fit R1, R3 and R4 vertically in the positions illustrated.



A closer look at the components on the Veroboard



Another view of the completed Veroboard assembly

Fit C1 and C3 with their side wires passing through the holes indicated. Fit IC1, with its three leads passing through the appropriate holes. Fit C2 in the same manner as C1 and C3. Fit C4 vertically with its positive lead-out passing through E8. The polarity of the leads of this capacitor (and of C5) can be determined by the fact that the negative lead-out is common with the can. Next fit TR1 and TR2. The bodies of these transistors are above the holes through which their lead-outs pass, and not to one side as shown, for ease of presentation, in Fig. 4. Take up TR3 and identify its lead-outs with the aid of the inset in Fig. 1. The lead-outs of this transistor are rather close together and a little care is necessary in their location. Fit TR3 to the board with its body positioned centrally between hole rows G and E.

Take up C5, pass a ¾in. length of thin sleeving over its negative lead-out and then bend this lead-out down alongside the capacitor body. Fit C5 vertically in the position shown, with its positive lead-out at D15. The purpose of the sleeving is to insulate the negative lead-out from the can of TR3 and thereby prevent possible crackles in the receiver output.

Fit a thin flexible insulated wire about 2ft. long to hole C16. This is one of the loudspeaker leads. Fit another similar wire, also about 2ft. long, to B4. This is the other loudspeaker lead. Both these leads may be shortened later, if desired. Fit a third wire, about 9in. long, to A16. This last wire connects to the negative terminal of BY2. Fit TR4 as indicated. It does not matter if the body of TR4 touches the insulating sleeve over the can of C5.

All the components are now fitted to the board. Next to be connected are leads passing to VR1/S1, and to L1 and VC1. VR1/S1 is positioned away from the board near the G row of holes. VC1 is positioned near the left hand end of the board, and the ferrite rod can be in any convenient position which does not too closely approach the board. Precise positioning of external components is not critical provided that the loudspeaker lead from hole C16 is kept away from L1, VC1 and the wiring to these. All the leads to the external components employ thin flexible insulated wire.

Fit a 2in. length of wire between E16 and the slider of VR1. Fit another 2in. wire between F10 and the zero volume end of VR1 track, so that the resistance inserted into circuit by VR1 increases as the spindle is turned clockwise. With an ohmmeter or continuity tester identify the tags corresponding to the two poles of S1(a), S1(b). It is important to ensure that the correct supply voltages, as indicated in Fig. 4, are applied to the board. If the 3 volt supply is inadvertently applied to the ZN414 circuit, this i.c. may be damaged. Fit a 1½in. length of wire between G16 and one of the switch sections on VR1. Fit a 9in. length of wire to the other tag of this switch section. This is the positive 3 volt battery lead, but it is not connected to the battery yet. Fit a 2½in. wire between B1 and the remaining switch section on VR1. Fit a 9in. length of wire to the other tag of this second switch section. This is the positive 1.5 volt battery lead, and it is also not connected to the battery cells yet.

Fit a 4in. length of wire between hole C1 and the moving vanes of VC1. Fit another 4in. length of wire between E1 and the fixed vanes tag of VC1. Connect the ferrite aerial winding across VC1, using reasonably short leads.

CHECKING

Wiring up is now complete, and a visual check should be carried out to ensure that all solder joints are correct and sound, and that there are no short-circuits between adjacent copper strips.

Next ensure that S1 is turned off, then connect the zero volt and positive 1.5 volt leads to the appropriate points on the battery or two cells forming BY1 and BY2. Connect the positive 3 volt battery lead to the positive 3 volt battery point via a current-reading meter switched to read 0-50mA or 0-100mA. Connect the speaker to the loudspeaker leads. Switch on at VR1/S1, keeping VR1 close to the minimum volume position, and check the reading given by the meter. In all probability, this will lie between about 18 and 23mA. Should this be the case, no further checking is required, and the receiver is ready for use.

Should the current be in excess of 23mA, short circuit R6 with a piece of insulated wire having bared ends. The current indicated by the meter may remain unaltered or decrease. If the reading is unaltered, or if the decrease is 5mA or less, then no further checks are required and the receiver is ready to be used. Should the decrease in current be greater than 5mA then the value of R6 is too high and it needs to be reduced. Note the current reading in the meter with R6 short-circuited, then reduce the value of R6 until the current is less than 5mA greater than this short-circuit value. Reduction of the value of R6 is achieved by temporarily applying external resistors across it. If the desired lower current is given when 100 Ω is applied across R6, then its reduced value should be 15 Ω. Parallel resistors of 36 Ω and 22 Ω across R6 correspond to 12 Ω and 10 Ω respectively. When the required new value in R6 has been found, the existing resistor is carefully removed and the new value is fitted in its place.

As was stated earlier, it is very doubtful whether it will be necessary to replace R6 with a lower value component. The procedure just described is included for the sake of completeness of information.

Once the current check has been satisfactorily completed, the current-reading meter may be removed and a permanent connection made to the positive 3 volt point on the battery or cells. The receiver is then ready for use. The ZN414 is sensitive to supply voltage variations around 1.5 volts. If a brand-new battery offering terminal voltages higher than the nominal values is employed there may be oscillation and whistles between transmissions, these clearing when a strong signal is tuned in. This effect does not upset local station reception, and it disappears when the battery voltage has settled down to its nominal value. ■

ANOTHER VERSATILE VERTICAL

By V. S. Evans

How to tune an external Top Band loaded vertical aerial from the comfort of the shack.

This article is, to some extent, a follow-on from 'Versatile Vertical For Top Band' which appeared in the May, 1975 issue of *Radio & Electronics Constructor*. In the previous article the author described a loaded vertical aerial for the 160 metre amateur band which was primarily intended to be fitted to a car for mobile transmission and reception. The aerial employed aluminium alloy tubing with an adjustable section at the top for tuning together with a central loading coil.

Loaded vertical aerials of this nature can also be used at fixed locations, although there will then be difficulty in tuning if the aerial is mounted in an inaccessible place such as on a roof or at the top of a wooden pole. Series capacitive tuning is an accepted method of altering the resonant frequency of an aerial of this type, but the variable capacitance must be located at the base of the aerial.

REMOTE CONTROL

This article describes a remote control switching method which allows the operator to switch into use any one of four segments of Top Band for transmission and reception. A weatherproof unit at the base of the vertical loaded aerial contains two reed relay switches, the contacts of which are mounted inside hermetically sealed glass tubes, whereupon they are impervious to tarnish or corrosion. The glass tubes containing the switch reeds are each fitted within a solenoid, and the reeds are operated electromagnetically by passing a current through one or both of the solenoids from the shack. The unit also contains two pre-set trimmer capacitors which are taken in or out of circuit by the reed switches.

Fig. 1 shows the basic circuit and it will be seen that two trimmers, C1 and C2, are in series with the feed to the aerial. The reed switches are connected across the capacitors and their solenoids are coupled to switch S1(a)(b) in the shack. When this switch is in position 1 both solenoids are energised, both reed switches are closed and both trimmers are short-circuited. With the switch in position 2, C2 is short-circuited and C1 is in series with the aerial. Position 3 of the switch causes C1 to be short-circuited and C2 to be in circuit, whilst setting the switch to position 4 brings both trimmers in series with the feed to the aerial.

A common earth connection to the solenoids is carried by the outer conductor of the coaxial cable between the transmitter or receiver and the aerial. This means that in addition to the normal coaxial feed there is also required a lightweight twin plastic cable which may be taped to the coaxial line.

SWITCH UNIT

A piece of Perspex or s.r.b.p. ('Paxolin') measuring $2\frac{1}{2}$ by $4\frac{1}{2}$in., together with a strip of the same material 1in. wide mounted at one end at right angles, will accommodate all the components required at the base of

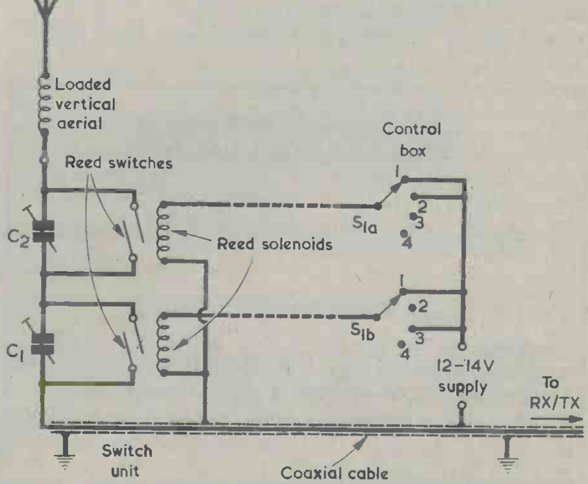


Fig. 1. The circuit used for remote tuning of the aerial. The control box is situated at the operating position.

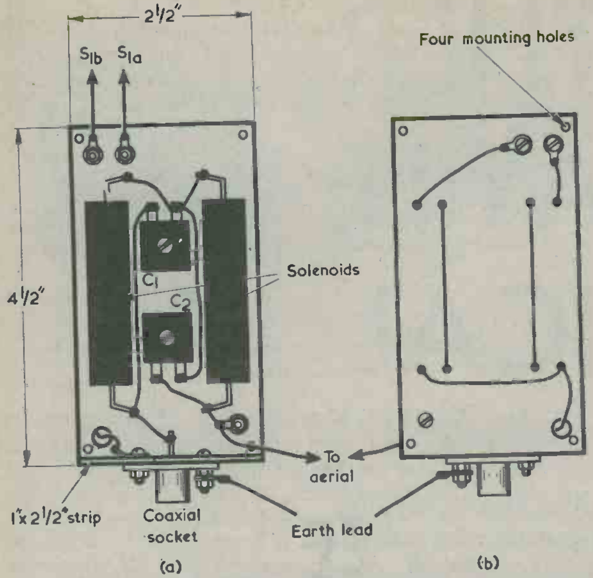


Fig. 2(a). Layout of components in the switch unit. The strip at the bottom is secured to the main panel by a small angle bracket. (b). The panel underside, showing the wiring to the solenoids.

the aerial. Fig. 2(a) shows layout and wiring. The glass reed switches should be treated with care as rough usage or overheating during soldering will break the glass. Fig. 2(b) shows the rear side of the panel and the wiring to the solenoids. The solenoids have two windings, which are connected in series for the present application. This explains why four connections are shown for each solenoid. Soldering to the solenoid pins should be carried out quickly, otherwise the former material will soften and the pins become loose.

Fig. 3 shows the switch unit contained in a suitable metal weatherproof box, which must be positioned close to the base of the aerial. The lead from the box to the aerial should be stranded copper with thick walled insulation, and must not be more than 12in. long.

COMPONENTS

Capacitors
C1 500pF mica trimmer (see text)
C2 250pF mica trimmer

Switch
S1(a)(b) 2-pole 4-way rotary

Reed Relays
2-off reed switches type 7-RSR-A (R.S. Components)
2-off solenoids, coils type 1 (R.S. Components)

Miscellaneous
Knob with pointer
Coaxial plug and socket
Perspex or s.r.b.p. panel
Weatherproof metal box
Nuts, bolts, solder tags, grommets, etc.

CONTROL BOX

The rotary switch can be mounted in a small box, being fitted with a knob and pointer. A white fascia showing the switch positions may then be glued behind the pointer. Four terminals are required at the rear of the box, these connecting to the two wires which couple to the reed switch solenoids, to earth and to a d.c. energising source of 12 to 14 volts. The energising voltage may be obtained from batteries, from a small mains power unit, or from the power supplies in either the transmitter or the receiver. In the last instance, the outer conductor of the coaxial cable will normally be common with the chassis of the transmitter or receiver. The energising source can be either positive or negative of earth. The two windings of each solenoid have a resistance of 800Ω, giving a total of 1,600Ω for each coil. The corresponding current is slightly under 10mA for each coil.

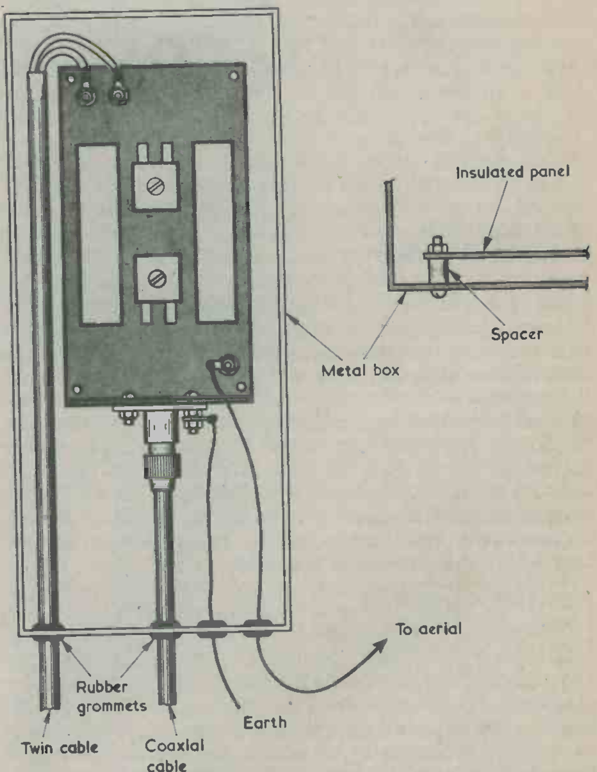


Fig. 3. The switch unit is fitted in a weatherproof box with wires entering through grommets at the bottom.

The two reed switches specified are rated at 2 amps. The two trimmer capacitors should be robust mica types and suitable components are type D4 or D5 from Henry's Radio, or type TP from Home Radio or Doram Electronics. The 500pF value specified for C1 is nominal and the nearest actual values available here are 120-750pF (Henry's Radio), 50-450pF or 150-750pF (Home Radio) and 100-580pF (Doram Electronics).

SETTING UP

The aerial and the switch unit may be mounted at a reasonably accessible position for adjustment and tuning. They should be well away from surrounding objects and a few feet off the ground. The coaxial and twin cables should be cut to the length that will be required for the final positioning of the aerial.

With the rotary switch in position 1 both trimmers are short-circuited, and the system should be tuned to a low part of the band, say 1.825MHz, by adjusting the telescopic top of the aerial. The switch is next set to position 2, whereupon C1 comes into circuit. This can be adjusted to tune to the next higher frequency point required. Setting the switch to position 3 brings in C2 on its own, and this should be tuned to a still higher frequency, as required. With the switch in position 4 both trimmers are in circuit, and the resonant frequency depends upon the previous adjustments and cannot be altered without affecting the previously set points.

It will be seen that there is a considerable variation permitted in the choice of band segments to suit the operator.

Some thought should be given to making the aerial loading coil waterproof in a permanent installation. Waterproofing compound, rather like plasticine, is obtainable from motor accessory shops. Alternatively, heavy greasing or tape could be employed to prevent the ingress of rain-water. ■

AMATEUR RADIO TELEPRINTER SPEED STANDARDS

By Arthur C. Gee

One of the most controversial topics in the world of amateur radio RTTY has been that of the speed at which the teleprinter should run. Ever since RTTY started in the UK this matter has constantly come up for consideration. Basically the difficulty arose from the fact that in this country the standard speed for commercial teleprinters is 50 bauds, whereas in America the commercial standard favoured at the start of RTTY was 45 bauds. The only source of teleprinters for the amateur has been surplus obsolete equipment sold cheaply by the commercial concerns, which meant that almost all the teleprinters coming on to the market in the UK were for 50 bauds. In America, and in those parts of the world where American equipment had been used extensively, the printers were for 45 bauds.

At first there was not too much difficulty. Most RTTY enthusiasts were happy to make QSO's with others in their own country, so here and to a certain extent in Europe 50 bauds became adopted as the standard. However, as the "art" developed it became quite commonplace to work Dx, and contacts across the Atlantic to American stations became the accepted thing. This of course brought into the open the question of what speed should be used — 45 or 50 bauds? The machines in this country usually had governed motors whose speed could be altered by a few simple adjustments, and these could be changed to the 45 baud speed without too much difficulty. In America the machines had synchronous motors whose speeds could not be altered. So those who wanted to work Dx with the US had to change their speeds to 45 bauds. On the other hand, those who only wanted to work "local" stations on v.h.f. or, say, 80 metres continued to leave their machines at 50 bauds. So the two speeds remained in use.

Intercontinental RTTY contacts are at present almost commonplace. Nowadays, you can call CQ-RTTY on 20 metres almost any time of the day, any day of the week, and get a reply. But most of the Continental stations are also interested in Dx, so they now use 45 bauds. In order to sort things out, BARTG via the RSGB presented a paper to the recent Region 1 IARU Conference at Warsaw, setting out the problem and making suggestions for resolving it.

BARTG proposed that the standard be 50 bauds. It must be said that they presented a very good case for retaining this speed, and produced a well prepared and technically sound paper. However, their proposal found no support whatsoever amongst other delegates, and the Conference voted massively for the adoption of 45 bauds as the standard speed for all future forms of amateur RTTY. So maybe, at last, this vexed question has been resolved. ■

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 8p postage.

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

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.

FOLDBACK LIMITING VOLTAGE REGULATORS

By J. B. Dance

Small integrated circuit voltage regulators can provide a stable output voltage having low ripple together with foldback current limiting to prevent accidental damage.

The SGS-Ates TBA 625 series of voltage regulator integrated circuits are encapsulated in small TO-5 transistor cases and provide maximum output currents of about 140mA. They are particularly suitable for use on individual circuit boards.

REASONS FOR USE

The reader who has never used an integrated circuit voltage regulator may well ask why he should consider using one now, since in most cases the amateur experimenter does not require particularly well regulated power supplies. There are three main advantages, and these will next be discussed.

First, the use of a suitable voltage regulator of the type under discussion enables the hum ripple at a power supply output to be reduced to about 1mV with very simple circuits. The regulator devices are smaller and cheaper than the large value electrolytic capacitors which might otherwise be required to provide the same level of smoothing.

Secondly, the writer uses the TBA 625B or the TBA 625C to provide power supplies with a very low hum level from which the supply for the varicap diodes of an f.m. tuner can be derived. Some form of regulator circuit is almost essential in this application and it is easier to employ an integrated circuit regulator than to build one with discrete components. In addition, the use of a regulated supply ensures that the tuning scale remains unaffected by mains voltage variations.

Finally, constructors who use many integrated circuits for experimental work may destroy appreciable numbers of these by accidentally short-circuiting some of their connections during experiments and thus allowing large currents to flow. The output current "folds back" in the devices being considered to about 30 to 45mA when the output is accidentally short-circuited. Such a current is unlikely to damage any normal device and the use of these voltage regulators in power supplies therefore offers almost complete protection to the circuits being supplied with power.

The writer now almost always employs power supplies containing one of these regulators provided that they can supply enough current to the circuit concerned; they have been especially useful when he has been experimenting with pre-production samples of very new devices which are often irreplaceable. He has never had any device fail when this type of power supply has been employed.

The devices are particularly suitable for use on individual circuit boards where a number of these are operated from a single supply, since they eliminate the problems of unwanted coupling between boards. Although the output current is limited to about 140mA, methods of obtaining higher currents are available.

REGULATOR TYPES

The regulators are available in four different types, the main difference between them being their output voltages. The values of these output voltages and various other data are shown in the Table. The connections to all of the four types of device are shown in Fig. 1.

TABLE
The TBA 625 series of Regulators

	TBA 625A	TBA 435	TBA 625B	TBA 625C
Output voltage	5V	8.5V	12V	15V
Max. input voltage	20V	20V	27V	27V
Ripple rejection (Iout = 5mA 100Hz)	60db	57db	54db	51db
Short-circuit current	45mA	40mA	35mA	30mA
Output noise voltage, 10Hz to 100kHz	70μV	100μV	150μV	200μV

Fig. 1 Lead-outs for the TBA 625 series of voltage regulators

A typical circuit for providing a regulated positive output is shown in Fig. 2; the simplicity of this circuit is very striking. It is important that the 10μF capacitor C2 connected across the output should be soldered as close to the regulator as possible in order to ensure stability. The value of the reservoir capacitor C1 on the input side is determined by the value of the output current required and by the maximum permissible output ripple voltage.

As an example, one may consider the case of a TBA 625A used with C1 at 500μF and an output current of 100mA. If the ripple voltage across C1 at 100Hz is about 2V peak-to-peak, the output ripple is typically 4mV peak-to-peak.

CURRENT FOLDBACK

In order to protect the devices against excessive thermal dissipation under short-circuiting of the output, current limiting under these conditions must take place at a lower current than the normal maximum output current. The devices are therefore designed so that the current "folds back" when the resistance of the load falls below a certain value; this current foldback is shown in Fig. 3 for the four devices. The output voltage is guaranteed to be regulated to within 1% for output currents at least up to 100mA.

The maximum current and the short-circuit current both fall with increasing chip temperature; this further reduces the possibility of excessive thermal dissipation. The quiescent current is the input current when the output current is zero; it is about 9mA for the TBA 625A and TBA 435 at the maximum permissible input voltage of 20V for these devices and about 10mA for the TBA 625B and the TBA 625C at the maximum permissible input voltage of 27V.

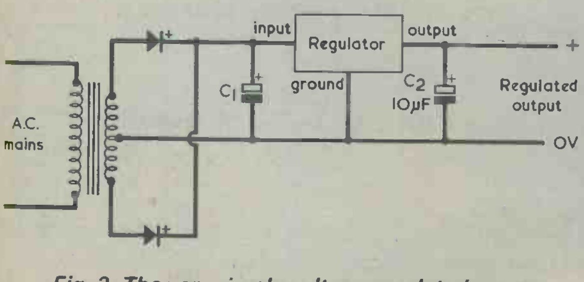


Fig. 2. The very simple voltage regulated power supply circuit which the regulators make possible

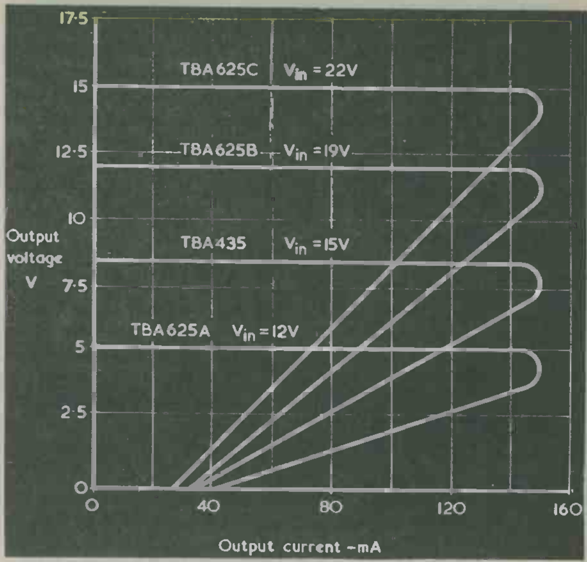


Fig. 3. Voltage, output current and foldback characteristics of the regulators

The ripple rejections fall to about 6db below the values shown in the Table as the output current rises to 140mA. The minimum amount by which the input voltage across C1 of Fig. 2 must exceed the output voltage across C2 for 1% regulation is shown in Fig. 4.

The quiescent power dissipation is equal to the input voltage multiplied by the quiescent current, but when an output current is drawn the dissipation is increased by an amount equal to the output current multiplied by the difference between the input and output voltages. Each device can dissipate up to about 0.7W at ambient temperatures up to 25°C, but if a

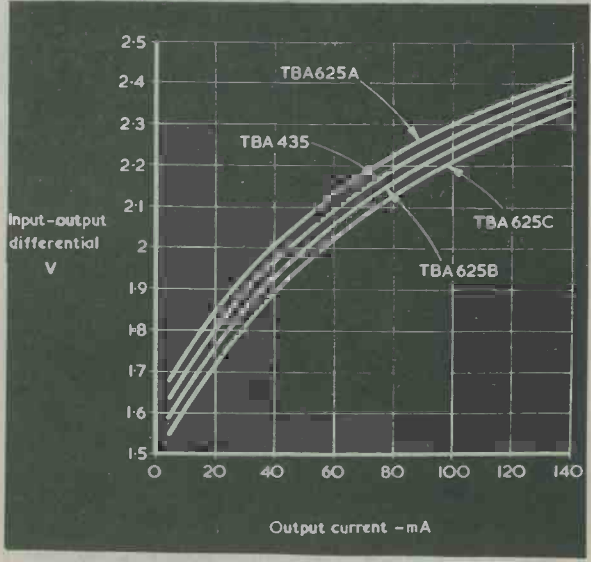
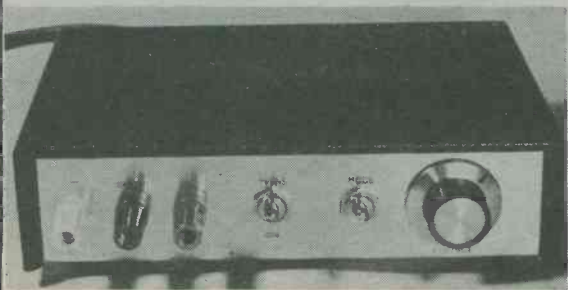


Fig. 4. Minimum input — output voltage requirements for 1% regulation



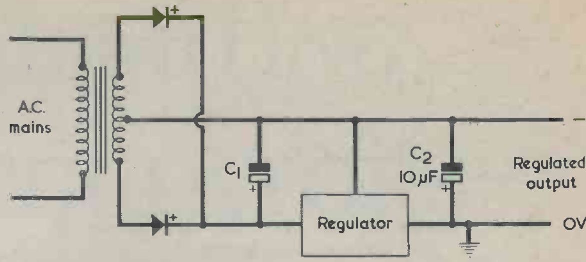


Fig. 5. Using a regulator to obtain a negative supply voltage

heat sink of thermal resistance 37°C/W is fitted, the dissipation can be increased to 2W. The writer often uses Jermyn type 2215 TO-5 heat sinks with these devices, but in many cases no heat sink is required. For example, the TBA 625A can be used with a 12V input supply at output currents of up to 70mA without any heat sink even if the ambient temperature reaches 70°C. (It may be noted that the type H1 TO-5 heat sink listed by Henry's radio is rated at 10°C/W).

OTHER CIRCUITS

The devices may be used in the circuit of Fig. 5 when a negative regulated supply line is required. The performance is the same as that of Fig. 2.

A small increase in the output voltage can be obtained by inserting a resistor between the regulator device and ground, as shown in Fig. 6. The increase in the output voltage is equal to the value of this resistor multiplied by the quiescent current, the latter being indicated as IG. The maximum value of the resistor which can be employed (about 200Ω) produces an increase in the output voltage of about 2V; higher values of this resistor may result in blocking of the device with zero output voltage across it. If desired, the resistor of Fig. 6 can be made variable.

The circuit of Fig. 6 retains the foldback current characteristics on short-circuit; indeed, the short-circuit current is less than in the case of Fig. 2. The other features of the circuit of Fig. 2 are also retained.

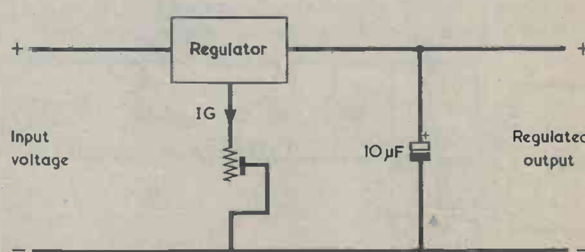


Fig. 6. The regulator output voltage can be increased by inserting a resistor in the manner shown here

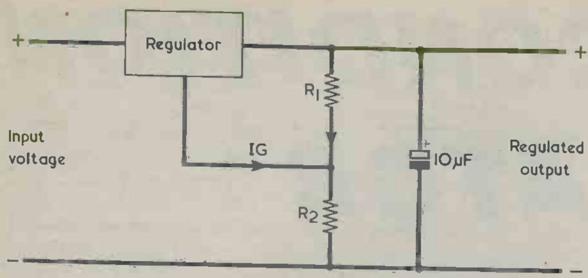


Fig. 7. Another method of obtaining an increased output voltage

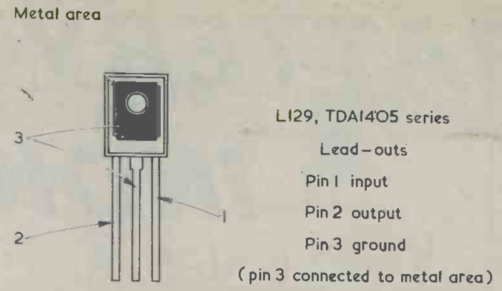


Fig. 9. The lead-outs of the higher current regulators discussed in the text

Somewhat larger increases in the output voltage may be obtained by the use of the circuit shown in Fig. 7. The current flowing through R1 increases the total current flowing through R2 above the quiescent current, IG. R2 may be fixed or variable. As shown in Fig. 8, the foldback current characteristics are retained in the circuit of Fig. 7.

HIGHER CURRENTS

Various circuits have been published in which these regulators are used with one or more transistors to provide greater current outputs. Outputs of several amps are easily obtained with foldback to about 0.5A on short-circuiting of the output.

However, a simpler way of obtaining somewhat higher currents involves the use of another type of regulator in a TO-126 power transistor package of the type which can be fixed to a heat sink with a single bolt. The SGS-Ates L129 and TDA 1405 devices provide an output voltage of 5V at currents up to at least 600mA, the L130 and TDA 1412 devices provide currents of at least 500mA at 12V, and the L131 and TDA 1415 devices provide currents up to at least 450mA at 15V. Typical values of the maximum output currents are rather higher than the minimum values quoted, being namely 820mA, 720mA and 600mA for the respective types. The lead-out connections are shown in Fig. 9.

These power regulators can be used in exactly the same type of circuit as that of Fig. 2. The output capacitor may be 10μF, but in some cases a fairly high value of input capacitor may be required to supply the larger current to these devices. The L129, L130 and L131 devices can operate at room temperatures down to −20°C, whilst the TDA 1405, TDA 1412 and TDA 1415 devices have a minimum recommended operating temperature of 0°C.

For high levels of dissipation a heat sink measuring about 2in. square should be adequate. The maximum permissable dissipation without a heat sink is 1.25W.

Current foldback occurs when the output is short-circuited, the value of the short-circuit current being typically 200mA, 100mA and 85mA for the 5, 12 and 15V devices respectively. These regulators therefore provide a substantial amount of protection to any circuits they are feeding, but the protection against accidental short-circuits is obviously less than with the TBA 625 series of regulators.

Readers may wish to use these power regulators to supply current to integrated circuit power amplifiers which are not themselves short-circuit protected during the initial experimental period. The power regulators should provide ample protection for this purpose.

All the regulators referred to in this article, with the exception of the TBA 435, are listed by Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN.

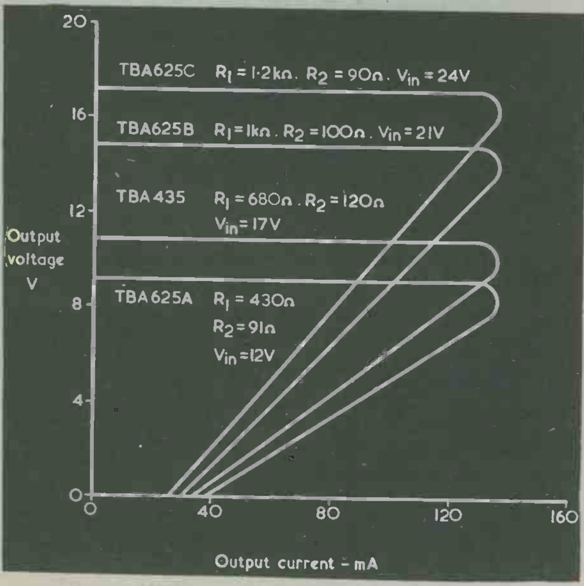


Fig. 8. Typical voltage and current characteristics for the circuit of Fig. 7

CONCLUSION

In conclusion, the writer hopes that he has conveyed to readers his enthusiasm for the use of integrated circuit regulators in circuits where the regulation they provide may not be required but where the protection they give to other integrated circuits combined with their hum rejection is most valuable. ■

BATTERY CONDITION INDICATOR

By P. R. Arthur

A neat comparator circuit which can be fitted to battery operated equipment to maintain a check on battery voltage.

This simple little device makes a very useful addition to many pieces of test equipment as well as other types of electronic apparatus. The unit incorporates an indicator light which comes on when the supply voltage falls below a certain pre-set level. This triggering threshold can lie anywhere between 6 and 15 volts.

BATTERY CURRENT

One reason for including the device in an electronic equipment is that if the equipment draws a very low level of battery current the voltage drop caused by the increase in the internal resistance of the battery as it runs down will be relatively small. The equipment may therefore function properly even though the battery may be virtually exhausted. There is in consequence a very real risk that the battery electrolyte may begin to leak while the battery is still inside the equipment. Quite expensive damage can be caused in this way, as the author has found to his cost.

The risk can be avoided by using the battery condition indicator described here, as this can be set to indicate a dangerously low battery voltage which need not be much lower than the ordinary working voltage of the battery. The battery can then be changed in time, even though the main equipment may have shown no signs of a failing battery.

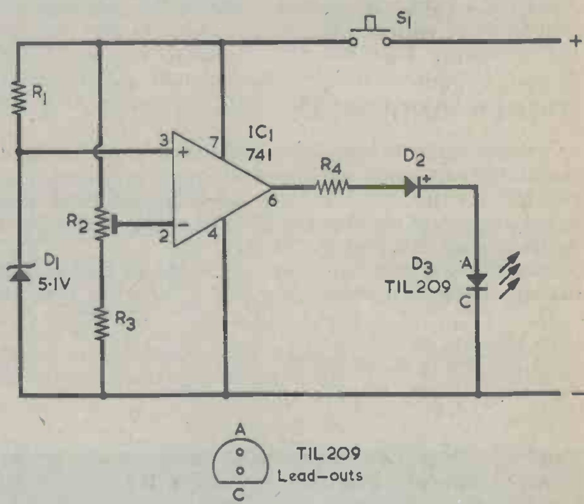
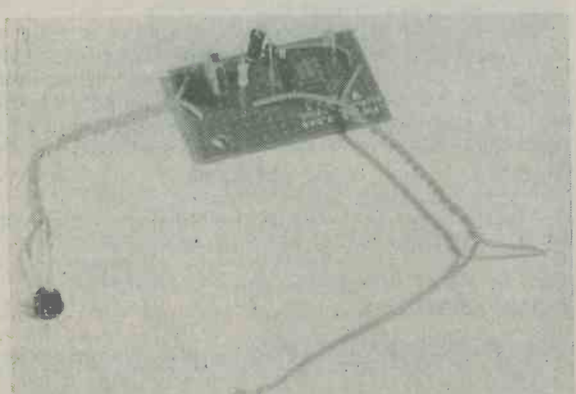


Fig. 1. The circuit of the battery condition indicator. The output of the 741 integrated circuit goes abruptly positive and lights the l.e.d. when the supply voltage falls below a preset threshold level



The battery condition indicator is wired up on a Veroboard panel. The l.e.d. couples to this via a 2-way flexible lead

The prototype has been included in a short wave converter which falls into the category just described, and it has proved to be very successful in use.

The device can also be used to advantage in equipment having a zener diode voltage stabilizing circuit with no means of monitoring the zener voltage. Many items of test equipment whose accuracy depends upon the provision of a constant stabilized supply voltage fall into this class. It is quite possible for the battery voltage to fall to a level which is too low to allow the zener diode to exert control, and the test equipment may then give misleading indications. Such a possibility can be eliminated by the fitting of the battery condition indicator.

CIRCUIT OPERATION

A 741 operational amplifier forms the basis of the unit, as can be seen in the circuit diagram given in Fig. 1. The 741 is employed as a voltage comparator.

The non-inverting input of the 741 is connected to the zener reference source given by zener diode D1. The diode is coupled to the positive rail via R1. The inverting input of the 741 is fed from a potential divider connected across the supply rails. A light-emitting diode, D3, is coupled to the output of the i.c. by way of current limiting resistor R4 and diode D2.

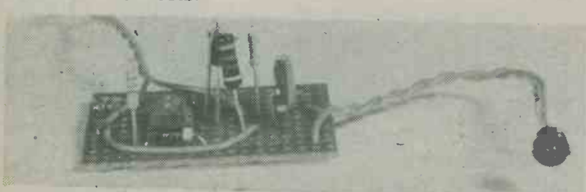
To give an example of circuit operation, let us assume that the device is to be set to indicate a fall in voltage to 10.2 volts and that the reference voltage given by D1 is exactly 5.1 volts. For this, R2 would be adjusted so that the voltage at the inverting input of the 741 is half the supply voltage. The output voltage of the i.c. is equal to the potential difference across its two inputs multiplied by its voltage gain. The 741 has a voltage gain of many thousands, and so a potential difference of less than a millivolt is required across the inputs to result in the output swinging either fully positive or fully negative.

When the supply voltage is higher than 10.2 volts the inverting input will be positive of the non-inverting input. The i.c. output will therefore be swung fully negative and the l.e.d. will not light. When the supply falls just fractionally below the 10.2 volt level the i.c. inverting input will be slightly negative of the non-inverting input, and the output of the i.c. will swing fully positive. In consequence the l.e.d will light, so indicating that the supply voltage has fallen to the pre-set threshold level. The l.e.d. can, of course, be made to light at other pre-set voltages by making the requisite adjustment to R2.

D2 is included in the circuit as the voltage from the i.c. when the output is fully negative is approximately 2 volts. This is sufficient to cause the l.e.d. to become lit. The voltage drop of about 0.6 volt across D2 reduces this output level to a voltage which is just too low to light the l.e.d. D2 may be any silicon diode or small silicon rectifier capable of passing some 20mA forward current. The author used a BAY31 in the prototype.

Although the current drain of the battery condition indicator is not excessive, it is nevertheless shown as being connected to the supply via a push-button switch. Thus, no current at all is consumed unless the switch is depressed. The battery can conveniently be tested before and after each session during which the supplied equipment is employed.

The indicator can, alternatively, be connected permanently across the supply lines if preferred. The current consumption with the l.e.d. not lit is approximately 0.5mA at 6 volts, rising to about 1.5mA at 15 volts. When the l.e.d. is lit the current consumption becomes about 4.5mA at 6 volts rising to some 14mA at 15 volts.



Another view of the battery condition indicator. As may be seen, construction is simple and few components are required

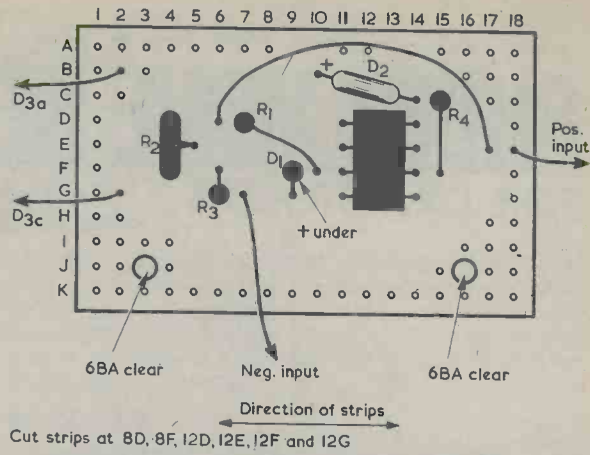


Fig. 2. The components are assembled on a small piece of Veroboard as shown here

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 8.2kΩ
R2 1MΩ pre-set potentiometer, miniature skeleton, vertical
R3 470kΩ
R4 680Ω

Semiconductors
IC1 741 in 8 pin d.i.l. package
D1 BZY88C5V1
D2 BAY31 or similar (see text)
D3 TIL209, with panel holder

Switch
S1 push-button, press to close (see text)

Miscellaneous
0.1in. pitch Veroboard, 18 holes by 11 strips
Connecting leads, etc.

CONSTRUCTION

With the exception of S1 and D3, the components are assembled on a 0.1in. pitch Veroboard having 18 holes by 11 copper strips. Complete details of this panel are shown in Fig. 2.

Commence construction by cutting out a panel of the specified size and then make the six breaks in the copper strips. Drill the two 6BA clear mounting holes with a No. 31 twist drill. The various components and the link wire can then be soldered in, leaving the i.c. until last. No socket for the i.c. was used on the prototype, although one can be employed if desired. No connections are made to pins 1, 5 and 8.

Finally, connect the l.e.d. and the leads which couple to the monitored supply lines.

SETTING UP

The only adjustment that is required is to give R2 a setting which causes the l.e.d. to light up at the required threshold voltage. The simplest way of achieving this is to connect the unit to a voltage which is equal to that at which it is desired the l.e.d. should turn on. Then R2 is adjusted as far in an anticlockwise direction (when viewed from the side at which the l.e.d. connections are taken) as is possible without D3 becoming extinguished. ■

SHORT WAVE NEWS
FOR DX LISTENERS

Times = GMT   *Frequencies* = kHz

By Frank A. Baldwin

In the August issue of this magazine readers of this feature will have read of the 90 metre band Dx that may be heard and have noted some of the stations currently being reported in the SWL press. It was pointed out that, although the 60 metre band is the favourite hunting ground of many broadcast band Dxers, others produce very good results on the aforementioned band despite the increased commercial interference. However, Dx transmissions may be heard on other bands and therefore the attention of followers of this monthly series is now directed on the next band up the dial — the 6MHz band.

6MHz DX

This band (49 metres) extends from **5950** to **6200**kHz and within these limits, especially during late night and early morning sessions, many exciting transmissions may be logged. Recently, for instance, we heard Sierra Leone Broadcasting Service at Freetown on **5980** with a newscast in English and sign-off with the National Anthem at 2330.

Some of the stations reported are Radio Cultural, Guatemala on **5955** around 0430; R.TV Dominicana on **5970** at 0130; Radio Reloj, Costa Rica on **6006** at 0030; La Voz del Tolima, Colombia on **6040** at 0130; Radio Nacional, Buenos Aires on **6060** at 0100; La Voz del Llano, Colombia on **6115** at 0100; Radio Union, Lima on **6115** at 0130 and Radio Suyapa, Honduras on **6125** at 0130.

More convenient times would probably be 1630 RRI Jakarta, Indonesia on **6045** or 1900 Mozambique on **6050.**

CURRENT SCHEDULES

The schedules published here are correct at the time of writing but sudden changes are sometimes made, the details of which cannot be included in some cases owing to the printing schedule of the magazine. Every effort is made to ensure that the information given is reliable, both from published schedules issued by various organisations and from our own observations. Where practicable, schedules are confirmed during listening sessions but obviously this is not possible with some of them.

● EGYPT

From Cairo, the Arab Republic of Egypt Broadcasting Corporation radiates an Overseas Service in English to Europe from 2145 to 2300 on **9805.** Other broadcasts in English are as follows — from 0200 to 0330 to North America on **9475;** to South East Asia from 1315 to 1430 on **17920;** to East, Central and South Africa from 1515 to 1600 on **17725;** to Central and South Africa from 1715 to 1830 on **17890** and to East, Central and South Africa from 2030 to 2200 on **17725.** the broadcasts to Africa are announced as "The Voice of Africa".

● IRAQ

"Radio Baghdad" has an external Service in English to Europe from 1930 to 2020 on **9745.**

● CUBA

"Radio Havana" offers an External Service in English to Europe from 2010 to 2140 on **11715.**

● HUNGARY

"Radio Budapest" is in English to Europe from 1200 to 1240 Mondays to Fridays on **6025, 7155, 7220, 9585, 11910, 15160** and on **17780;** from 2130 to 2200 on **5965, 7180, 9655, 9833, 11910, 15125** and on **17780.** The Dx programme in English is from 1515 to 1530 on Tuesdays and Fridays on **6025, 7155, 9595, 9833, 11910, 15125** and on **17780.**

● CZECHOSLAVAKIA

"Radio Prague" presents programmes in English to the UK from 1630 to 1700 on **5930** and **7345;** to the UK and the Middle East from 1900 to 1930 on **5930, 7245** and on **7345;** from 2000 to 2030 to the UK on **5930** and **7345** and from 2130 to 2200 on **6055.**

The Radio Prague "Inter-Programme" in English to Europe may be heard from 0745 to 0800; 0845 to 0900; 0945 to 1000; 1045 to 1100 and from 1145 to 1200 all on **6055** and **9505.** The "Inter-Programme" to Europe and North America may be heard from 0030 to 0100 on **6055** and **9740.**

● SWITZERLAND

The "Overseas Service of S.B.C.", Berne, offers programmes in English as follows — from 0700 to 0730 to Australasia, Far East, South and Southeast Asia and Europe on **3985, 6165, 9535, 9590, 11775, 15305** and on **17840;** from 1100 to 1130 to Africa and Europe on **3985, 6165, 9535, 15140, 15305, 17830** and **21520;** from 1315 to 1345 to the Far East, Australasia, Southeast Asia, North and Central America and Europe on **3985, 6165, 9535, 11775, 15140, 15430, 17830** and **21520;** from 1530 to 1600 on **3985, 6165, 9535, 15430, 17830** and **21520;** from 2100 to 2130 to Africa and Europe on **3985, 6165, 9535, 9590, 11720, 11870** and **15305.**

● ALBANIA

"Radio Tirana" radiates programmes in English to Europe from 0630 to 0700 on **7065** and **9500;** from 1630 to 1700, 1830 to 1900, 2030 to 2100 and from 2200 to 2230 all on **7065** and **9480.**

● BULGARIA

"Radio Sofia" has English transmissions directed to the UK and Eire from 1930 to 2000 and from 2130 to 2200 on **6070** and **9700.** Other English programmes are as follows — to North America from 0001 to 0100 on **9700;** to East and Central Arica from 1930 to 2000 on **15310** and **17825** and to Africa from 2105 to 2130 on **11730, 11765, 15310** and on **17825.**

● EAST GERMANY

"Radio Berlin International — the Voice of the GDR", Berlin, presents an English service to Europe from 1730 to 1815 and from 2115 to 2200 on **7260;** from 1830 to 1915 on **6080, 6115, 7185, 7300** and on **9730.** Radio Berlin International is also in English from 1200 to 1245 to Southeast Asia on **11960, 15125** and **15320;** from 1315 to 1400 to Central Africa on **17800,** from 1400 to 1445 to Southeast Asia on **11960** and **15125;** from 1530 to 1610 to Southeast Asia on **11960;** from 1815 to 1900 to East and West Africa on **15170, 15255** and on **15390** and to West Africa from 2000 to 2045 on **15250** and **15390.**

● JAPAN

"Radio Japan", Tokyo, radiates in English to Europe from 0800 to 0830 on **15390** and **15430** and from 1830 to 1900 on **9735** and on **11960.**

● ROMANIA

"Radio Bucharest" maintains an External Service in English to Europe from 1300 to 1330 on **7195, 9690** and on **11940;** from 1930 to 2030 on **7225** and on **9510** and from 2100 to 2130 on **7195** and on **9690.**

● POLAND

"Radio Warsaw" operates an External Service in English for Europe from 0630 to 0700 on **7285, 9540** and **9675;** from 1200 to 1230 on **7285** and **9540;** from 1600 to 1630 on **6095, 7125, 7285** and on **9540;** from 1830 to 1900 on **6095, 7125, 7285** and on **9540;** from 2030 to 2100 on **7285** and **9540** and from 2230 to 2300 on **5995, 6135, 7285** and on **9540.**

AROUND THE DIAL

● GHANA

Ejura at 2000 on **3350,** interval signal of African drums, identification in English then time-check for "eight o'clock". This service is in both English and vernaculars, the weekday schedule being from 1600 to 2305, power is 20kW.

● GAMBIA

Banjul at 2055 on **4820,** African drums, local music, announcements and newscast in vernacular at 2100. The evening schedule of this one (weekdays) is from 1625 to 2300 and the power is 3.1kW; not an easy one to log owing to a high powered USSR transmitter on the same channel.

● NIGERIA

Lagos at 1837 on **4990,** newcast by OM in vernacular, several mentions of Kampala and Angola, musical interlude at 1840. This is the National Programme with an evening/afternoon schedule from 1500 to 2305, power is 10kW.

● ZAIRE

Lubumbashi at 1848 on **4750,** OM with a talk in vernacular interspersed with local music and drums. This is the Home Service with the scheduled afternoon/evening transmission from 1500 to 2100 (weekdays). The power is 10kW and it is not an easy one owing to the surrounding commercial QRM.

● INDIA

All India Radio, Delhi, at 1910 on **3905,** Arabic-type music, announcements by OM in Arabic, off the air suddenly at 1930, without National Anthem. This is the Home Service Arabic transmission, the power is variable from 20 to 100kW.

● SOUTH AFRICA

Johannesburg at 1900 on **3285,** OM with a newscast in English after 6 pips time-check and station identification. This is the English Service which is on this channel from May until October the evening schedule (weekdays and Sunday) being from 1620 to 2115, Saturdays from 1620 to 2205, the power being 100kW.

● CHINA

Radio Peking at 2100 on **4800,** YL in Chinese and short interludes of local music. This is the Home Service 1, the schedule being from 2000 to 0100, power variable from 120 to 240kW.

● LESOTHO

Maseru at 1854 on **4800,** OM in vernacular, Euro-style pop records, YL announcer at 1900 then into programme of local pops. Tending to be irregular, Maseru reportedly has a schedule from 0400 through to 2030 (Sundays to 2135). The power is 10kW and the channel is subject to severe commercial QRM at times.

● LIBERIA

ELWA Monrovia at 2156 on **4770,** OM with a religious programme in English.

Trade News . . .

MINI-BLOW TORCH BY FLAMINAIRE

The feature that distinguishes the Longs Mini-Blow Torch from any other similar product is its pencil point slim flame. This unique feature enables the user to concentrate the heat exactly where it is wanted and is invaluable to electronic engineers.

The 35gms butane gas cylinder has a life of 4-5 hours operating temperature up to 3,500°F. Refills are readily available.

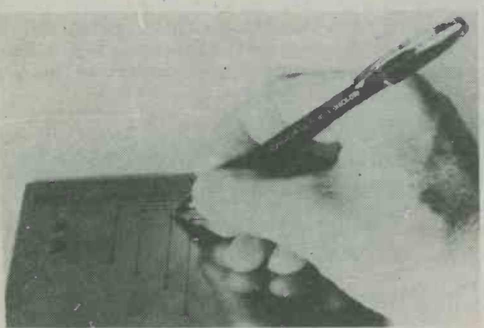
The gas burner is fitted with a brass nozzle and has special cooling fins. It is the clever engineering of this burner that produces the unique pencil point flame.

A detachable solder pencil is included in the kit and its use can be readily appreciated.

The present cost of a Longs Mini-Blow Torch is £6.25 incl. VAT and p.p.

Details from Longs Ltd., Hanworth Lane Trading Estate, Chertsey, Surrey.

QUICK-DRI ETCH-RESIST MARKING PEN



The unique Decon-Dalo 33 PC etch-resist marking pen for preparing printed circuit boards has been very well accepted by electronics engineers, both professional and amateur, since it was first offered by Decon Laboratories some three years ago. A new improved version in the form of the 33 PC Quick-Dri is now available. As the name implies, the major improvement is a newly formulated etch-resist ink with rapid drying characteristics. It is necessary simply to draw the desired printed circuit on to a copper-clad board, allowing the track to dry for just two minutes before etching in ferric chloride or any other usual etching solution. A high degree of resistance to etchants is claimed and a professional high-quality board can be prepared very simply.

The Decon-Dalo 33 PC Quick-Dri is priced at £1.08 for 1, £4.43 for 6 or £8.80 for 12 (postage and VAT included), either direct from Decon or from radio supplies retailers.

Full details are available from Decon Laboratories Ltd., at Ellen Street, Portslade, Brighton, Sussex. BN4 1EQ.

MINIATURE MAGNIFIER FOR CLOSE SCRUTINY WORK

A unique miniature magnifier for precise, close scrutiny work, has been introduced by Northgate Instruments of 19 London Road, Gloucester. The magnifier easily attaches to tweezers, probes, scrapers or scalpels and features 8X magnification. It is fully adjustable with a ¾″ diameter (20mm) pivoting lens.

The new miniature instrument complements the comprehensive Northgate range of microscopes and magnifiers, varying from a pocket microscope with 30X magnification to a robust table-top magnifier with a 2-4X magnification.

Detailed literature and price lists are available on application to: Northgate Instruments Ltd., 19 London Road, Gloucester.

In your workshop

This month we find Smithy the Serviceman on the point of completing a novel resistance measuring bridge with a range of 1Ω to 1MΩ. As always he is accompanied, for most of the time at any rate, by his able assistant, Dick.

"That's it!" called out Dick exuberantly. "Work's finished for today!"

Cheerfully, he turned off the switch that controlled all the mains outlets on his bench, divested himself of his overall coat and hung it on the hook behind the Workshop door.

"Blimey," remarked Smithy, glancing up at the clock, "you're in a hurry, aren't you? Not a nanosecond after packing-up time and you're already set for the off."

"Ah," said Dick, putting on his jacket, "I don't want to be late getting away today."

"Why's that?"

"I've got a heavy date," replied Dick happily, "and she doesn't like being kept waiting."

PRIVATE JOB

"In that case," remarked Smithy, "I'd be the last person to hold you back."

"I wonder," remarked Dick tentatively, "if you could give me a lift as far as Joe's Caff. I said I'd meet her there, and Joe's Caff is on your way home."

"Well, I would normally," said Smithy, "but I'm afraid I'll be hanging on here for quite a bit yet."

"Fair enough," said Dick carelessly "I'll walk it instead. Cheers for now, Smithy."

"Cheerio."

Dick opened the Workshop door, then turned round as a thought struck him.

"Why're you staying late?" he asked, puzzled. "We're well ahead so far as work is concerned."

"I'm not doing any more servicing," said Smithy. "What I'm going to do is put the finishing touches to a little private job for myself."

"I see," said Dick. "Well, cheers for now, then."

"Cheerio."

But Dick seemed reluctant to depart. His ever active curiosity had been aroused.

"Er, what sort of a private job, Smithy?"

"A piece of test equipment," explained Smithy, as he cleared a working space on his bench. "It's a resistance measuring bridge."

"Just a resistance measuring bridge, eh?" repeated Dick. "Well, that doesn't sound very exciting."

"It's got a few novel features in it," added Smithy. "For instance, it takes advantage of a circuit arrangement that was used recently by G. A. French in a 'Suggested Circuit'. And the null indicator incorporates an idea that originated in Australia."

"Does it, indeed?" said Dick musingly.

He glanced at the clock.

"Blow me," he exclaimed. "I really must rush now. Cheers then, Smithy."

"Cheerio."

The door closed behind his assistant, leaving Smithy alone in the now quiet Workshop. He opened the cupboard below his bench and produced a small metal case which he placed fondly on his bench. Visible on its front panel were two pointer knobs, one with a temporary paper scale behind it, a toggle switch, two light-emitting diodes and two insulated terminals. Smithy turned the case over, removed its back, then pulled a cardboard box with a few small resistors in it towards him. Contentedly, he took up one of the resistors, and started to wire it into the circuitry inside the metal case.

Just as he was returning his soldering iron to its rest, the Workshop door clattered open. Smithy turned round.

"Blimey, are *you* back?"

"I couldn't help wondering," said Dick in an irritated tone, "just exactly what those novel features in your resistance bridge were."

"Well," said Smithy, "there's a basic Wheatstone bridge set-up together with an unusual means of null indication. I'll show you what I mean. To start off with, I hardly need to tell you that a Wheatstone bridge consists basically of four resistors connected up like this."

Smithy pulled his note-pad towards him and quickly drew out a circuit. (Fig. 1(a).)

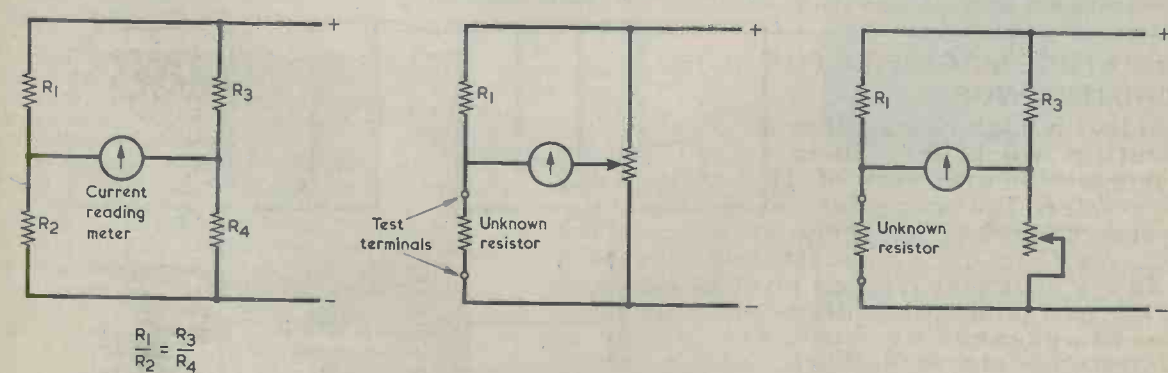


Fig. 1 (a). The Wheatstone bridge. Balance is given when the equation is satisfied

(b). Changing the two right hand resistors for a potentiometer allows the bridge to measure resistance

(c). Another version of the bridge when used for resistance measurement

"Two pairs of the resistors are connected across a d.c. supply with a null indicating device between them like I've shown here," he went on. "I've drawn a centre-zero current-reading meter as the null indicating device, and the bridge is said to be balanced when the resistance values are such that no current flows through the meter, whereupon it indicates zero. I've marked the resistors R1 to R4 and balance is given when the ratio of R1 to R2 is the same as the ratio of R3 to R4. Which is another way of saying that R1 divided by R2 equals R3 divided by R4. With this relationship between the resistors, both terminals of the meter are at the same potential and no current passes through it."

"I can see that," said Dick impatiently. "If you incorporate a potentiometer instead of having all the resistors fixed, then the circuit becomes capable of measuring resistance, doesn't it?"

"That's right," agreed Smithy. "A common approach here consists of replacing *two* of the resistors by a potentiometer. Like this."

Smithy sketched out a second circuit. (Fig. 1(b).)

"This arrangement," he continued, "has the advantages of simplicity and wide range. It is obvious that if the bridge balances when the slider of the pot is at the centre of its track, then the value of the unknown resistor is the same as R1 in my circuit. If the bridge balances when the slider of the pot is a third of the way up its track then there is twice as much track resistance above the slider than there is below it, and this will indicate that the unknown resistor has half the value of R1."

"In other words," put in Dick quickly, "there is twice as much resistance above the left hand meter terminal as there is below it."

"That's right," confirmed Smithy. "It is possible to provide a scale for the pot which is graduated in terms of the value of the unknown resistor. You connect the unknown resistor to the circuit, adjust the pot until you reach the null point where there is zero current in the meter and then read the value of the unknown resistor from the pot scale."

"That seems fair enough," said Dick. "Does that circuit have any snags?"

"The only drawback," said Smithy, "is that the pot scale is non-linear, and the readings get cramped at one end. I've used a different bridge circuit in my own little gadget. Here's the general idea."

Smithy drew another circuit. (Fig. 1(c).)

"What's the advantage here?"

"The circuit gives a linear pot scale," replied Smithy. "Let's say, for a start, that R1 and R3 in the circuit are equal in value. The bridge will then balance when the resistance inserted by the pot is equal to the unknown resistance. If the pot has a linear track the amount of resistance it inserts into circuit is proportional to spindle rotation, and so you get a linear pot scale. If, next, you give R1 a value that is 10 times the value of R3 then you can use the same pot scale as you had previously, with all the readings on the scale multiplied by 10. Got it?"

BRIDGE CIRCUIT

"Yes, yes," said Dick restlessly. "Now how about getting on to the actual bridge circuit you used yourself?"

Smithy sketched a further circuit. (Fig. 2.)

"This is the basic set-up," he stated. "As you can see, there are six ranges, and I'll start off with the highest resistance one first. This is given when the switch is set to Range 6. The right hand side of the bridge then consists of a 20kΩ fixed resistor and a 20k Ω pot, whilst the left hand side consists of a 1M Ω fixed resistor and the unknown resistor. This resistor will be connected to the two test terminals."

"Well," said Dick, gazing at the circuit, "it's obvious that the maximum unknown resistance you can measure is 1MΩ, as balance will then occur when the lider of the pot is at the top end of its track. This will give 1M Ω and 1M Ω on the left hand side of the bridge, and 20k Ω and 20k Ω on the right hand side of the bridge. What's the lowest resistance you can measure, Smithy?"

"In theory, it's proportional to the lowest resistance that can be resolved by the pot. I've made an arbitary choice of 100kΩ here, which is given when the 20kΩ pot inserts 2kΩ, so that the whole range with the switch in position 6 is 1MΩ down to 100kΩ."

"It could go lower though, could'nt it?"

"Oh yes," said Smithy. "But this 10 to 1 relationship combines nicely with the next range, which is 100kΩ down to 10kΩ. Also the fact that you can adjust the pot for readings on Range 6 below 100kΩ means that you can take the pot *through* the 100kΩ setting. It's always nice to be able to go a little beyond the final setting when you're adjusting a bridge."

"But," protested Dick, "you haven't allowed for that at the maximum resistance end of the range. If the pot has a value of 20kΩ the very highest reading you can get on Range 6 is exactly 1MΩ."

"True," agreed Smithy. "But don't forget that this circuit only shows the *basic* bridge. In the practical circuit, which you'll see in a moment, I've given the pot a value that is a little higher than 20kΩ, so that you can go through the maximum resistance setting as well. Now, there's another point I want to bring out, and that concerns the voltage on the upper test terminal. If a 1MΩ resistor is connected to the test terminals on Range 6, then the voltage on the upper test terminal is half the supply voltage. The supply voltage happens to be 9 volts, and so the upper test terminal is then at 4.5 volts relative to the bottom supply rail. If a 100kΩ resistor is connected to the test terminals then the voltage on the upper terminal is one-eleventh of the supply voltage which is, near enough, 0.82 volts. So, on Range 6, the null indicator is presented with voltages ranging from 4.5 volts above the lower supply rail down to 0.82 volt. Okay?"

"Sure," said Dick, entirely absorbed in Smithy's circuit. He had, already, completely, forgotten his assignation at Joe's Caff.

"As I've just mentioned," continued Smithy, "the next range down, Range 5, gives 100kΩ to 10kΩ. This is

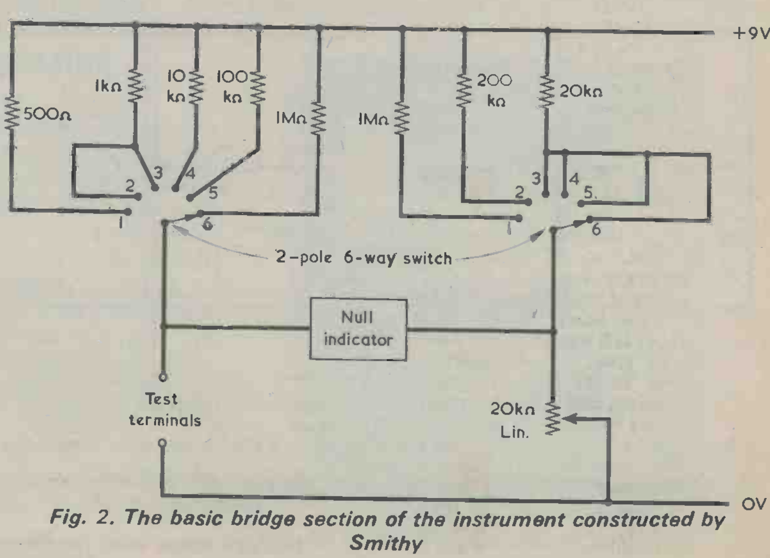


Fig. 2. The basic bridge section of the instrument constructed by Smithy

because the upper resistor on the left hand side of the bridge has been changed from 1MΩ to 100kΩ. Following from this, Range 4 gives 10kΩ to 1kΩ and Range 3 gives 1kΩ to 100 . In all these ranges, the voltage on the upper test terminal varies between 4.5 and 0.82 volts."

"Range 2," said Dick in a thoughtful tone, "is different. You've still kept the 1kΩ upper resistor on the left hand side, but you've changed the right hand upper resistor from 20kΩ to 200kΩ.

"That's right," said Smithy. "The 1kΩ upper resistor is retained on the left hand side to keep current low in the test resistance. With R2 at this value, the maximum current which can flow with the test terminals short-circuted is 9mA. Changing the upper right hand resistor from 20kΩ to 200kΩ means that the bridge balances for test resistances that are one-tenth of the corresponding resistances on Range 3. So Range 2 measures test resistances from 100Ω down to 10Ω."

Dick picked up the first of Smithy's sketches and looked critically at the equation written on it.

"Why, yes of course," he said after a moment's consideration. "Multiplying the top right hand resistance by 10 is the same as dividing the bottom left hand resistance by 10. Wait a minute, though, there's something that's just struck me."

"What's that?"

"On Ranges 3 to 6," said Dick, "the voltage on the upper test terminal varies from 4.5 to 0.82 volts. Won't the voltage variation be lower on Range 2?"

"It will be," confirmed Smithy. "If the test resistance is 100Ω the upper test terminal voltage is 0.82 volt, and if it's 10Ω the terminal voltage is approximately 0.09 volt. Now, let's move the switch on to Range 1. The upper right hand resistor is now changed to 1MΩ, and the upper left hand resistor to 500Ω. Compared with Range 2 the upper right hand resistor is multiplied by 5 and the upper left resistor is divided by 2. So the range of test resistances at which the bridge will balance is the same as those for Range 2 divided by 10, and that comes out to 10Ω down to 1Ω."

"I suppose," said Dick musingly, "you've made the upper left hand resistor 500Ω to keep test resistor current low on this range as well."

"That's right," stated Smithy. "I've put an arbitrary top limit of 1MΩ for *any* section of the bridge. If I made the upper right hand resitor 1M Ω then the upper left hand resistor has to be 500Ω to give a test resistance range of 10Ω to 1Ω . This is quite a reasonable value, and it limits current flow in the test resistor to 18mA maximum."

"What about the voltages on the upper test terminal?"

"For the test resistance of 10Ω," replied Smithy, "the upper test terminal voltage will be about 0.18 volt. If the test resistance is 1Ω the terminal voltage will be 0.018 volt only."

"Blimey," said Dick, "those voltages are pretty low, aren't they?"

VOLTAGE COMPARATOR

"They are rather," agreed Smithy. "and because of this the null indicator needs to have a high level of sensitivity. A centre-zero meter could be used, but in these days of integrated circuit op-amps, a voltage comparator is much more attractive. Because the bridge arm resistances can go up to 1M Ω , the input resistance of the comparator must be considerably higher than that value. Now, I happened to see the idea of using an op-amp comparator in a Wheatstone bridge in the Australian journal *Electronics Australia*, and all credit is due to that journal for this scheme and for a neat circuit which is used at the op-amp output. In the *Electronics Australia* circuit the two arms of a bridge go directly to the inverting and non-inverting inputs of a 741 op-amp and the output is monitored by two l.e.d.'s. In the circuit I've made up for myself the two arms of the bridge go to the op-amp inputs via silicon emitter follower transistors, which present an extremely high input resistance at their bases. And *this* idea came to me after reading a recent 'Suggested Circuit' by G. A. French in which he used an emitter follower in front of a 741 op-amp to produce a very high resistance electronic voltmeter. The 741 had its output connected back to its inverting input to make it a voltage follower, and the emitter of a BC107 coupled into its non-inverting input." (Fig. 3.)

"Ah yes," said Dick thoughtfully, "I remember that circuit. It appeared quite recently, didn't it?"

"Just a few months ago," said Smithy ruminatively. "Now, what was the date of the issue? Why yes, the date was last July."

Dick suddenly blenched and gave a strangulated groan.

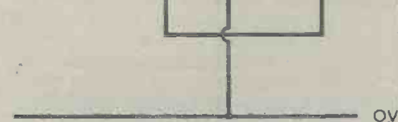


Fig. 3. Coupling a silicon transistor emitter follower to an op-amp input results in a very high input impedance. Here the transistor and the op-op-amp form a composite voltage follower

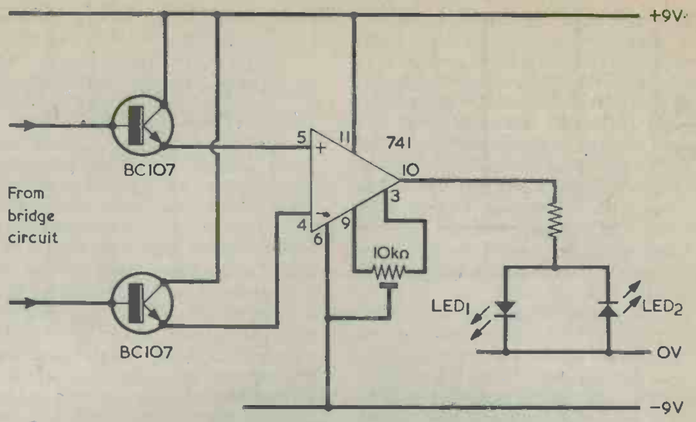


Fig. 4. The null indicator circuit. The i.c. pin numbers apply to the 14 pin encapsulation

"Date!" he repeated, standing up and rushing towards the door. "*Date!* Ye gods, she'll murder me. Cheers, Smithy!"

"Cheerio," called out Smithy to his assistant's fleeting back.

Left to himself Smithy philosophically picked up his soldering iron and proceeded to solder a further resistor in his resistance bridge. As he picked up the final resistor to be wired in, the knob of the Workshop door rattled. Smithy turned round.

"What, *again*?"

"It's no good," wailed his assistant, as he re-entered the Workshop. "I got half-way down the street and I found that I just *had* to find out how you connected those emitter followers to the op-amp."

"Well," chuckled Smithy, "I've heard of people being devoted to a subject but this is really ridiculous."

"It's my darned curiosity," complained Dick. "I get so flaming curious about electronic things that I just can't leave them till I've seen them right through to the end."

"Okay then," grinned Smithy. "I'll put you out of your misery and show you how I coupled the two emitter followers to the 741 inputs."

Smithy sketched out a further circuit. (Fig. 4.)

"As you can see," he continued, "the two inputs from the bridge go to the bases of two BC107's, and their emitters couple to the non-inverting and inverting inputs of the 741. It has been found by experience that the input resistances at the bases of the BC107's in a circuit like this are well in excess of 1MΩ, although this does involve the assumption that the transistors have lower leakage resistances than are quoted in their specificiations. The voltage at each emitter is equal to that at each base less the voltage dropped in the base-emitter junction."

OUTPUT CIRCUIT

"What's that circuit at the i.c. output? The one with two l.e.d.'s in it?"

"Those l.e.d.'s are used to indicate balance," explained Smithy. "As I said just now, this arrangement was employed in the *Electronics Australia* circuit. Let's assume for the moment that the input offset voltage for the op-amp is zero. When, under this condition, the non-inverting input of the op-amp is positive of the inverting input, the output of the op-amp swings positive and LED1 lights up. Similarly, when the non-inverting input goes negative of the inverting input the output swings negative and LED2 lights up. An interesting feature of the circuit is that the forward voltage appearing across the illuminated l.e.d. prevents the maximum reverse voltage rating of the non-illuminated l.e.d. being exceeded."

"Gosh, that's neat," said Dick. "I suppose you balance the bridge so that both l.e.d.'s are extinguished. This would occur when the op-amp output is zero."

"Adjusting for no illumination would be feasible if the pot in the bridge had very high resolution," replied Smithy. "However, there's so much gain in the op-amp that the closest you can get to this point with an ordinary pot is a setting at which an extremely slight movement of the slider causes one l.e.d. to extinguish and the other to come on. So you adjust for the point of changeover in the l.e.d.'s. If you introduce some noise in the system by, say, touching the test resistance on Range 6, you can arrive at a condition where both l.e.d.'s light up at a single setting of the pot, but all this really means is that you should keep your fingers away from the test resistor when you're measuring high values!"

"I see that you've connected a 10kΩ pot to pins 9 and 3 of the op-amp."

"Ah yes," said Smithy. "That's for offset null adjustment. In practice, we can't ignore the input offset voltage. As we saw just now, the voltages applied to the comparator circuit on Ranges 1 and 2 are very low, and an offset null

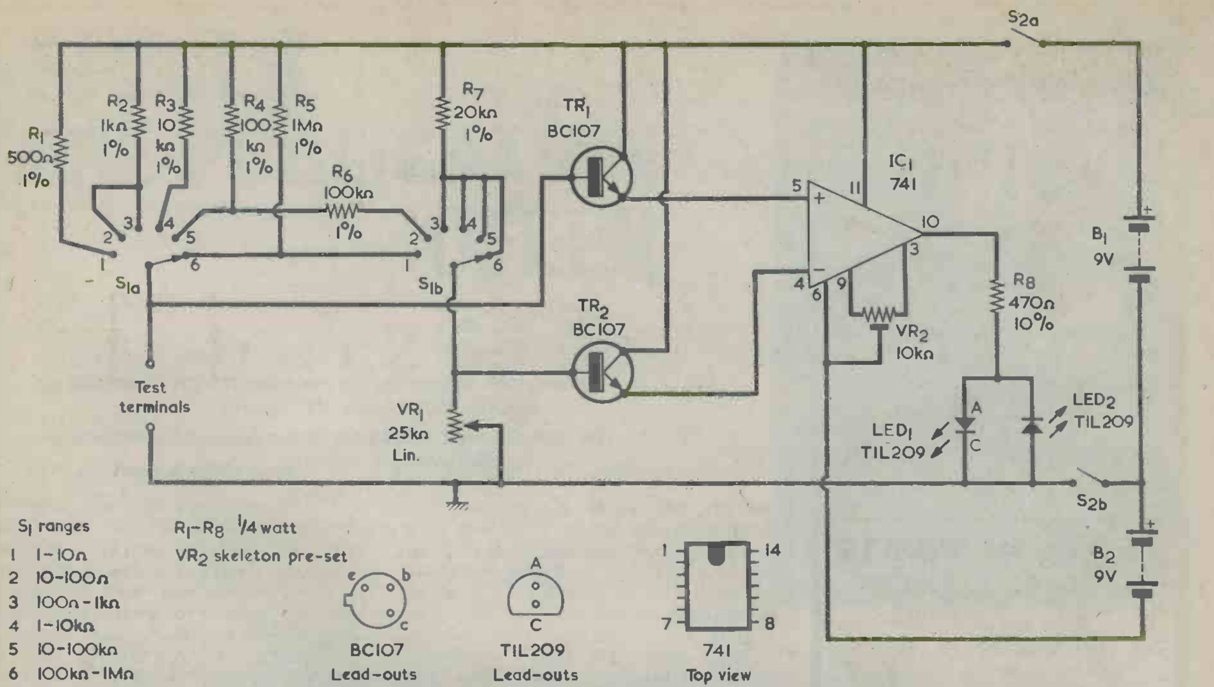


Fig. 5. Complete circuit of the bridge. The current drawn from each battery varies between about 1mA and 9mA according to which l.e.d. is illuminated. An additional current due to the bridge section is also drawn from battery B1

adjustment is essential to ensure that the op-amp output is at zero when both the transistor bases are at exactly the same potential. What we do in this case is make an offset null adjustment that takes in the two transistors as well as the op-amp."

"After all this introduction," stated Dick, "I reckon it's time I had a look at the complete circuit of the bridge."

"As you wish," said Smithy obligingly.

He reached to the back of his bench and produced a piece of paper on which a circuit had already been drawn out. (Fig. 5.)

"Here you are," he said proudly. "This is the complete circuit. It's the same as the bits I've been showing you except for some slight changes in the bridge section. I've saved one close-tolerance 1MΩ resistor by having R5 common to both Range 6 and Range 1. And the upper right hand 200kΩ resistor for Range 2 is given by R4 and R6 in series."

"Why did you do that, Smithy?"

"Partly," replied Smithy, "because it's a little easier to get hold of close-tolerance 100kΩ resistors than it is to obtain close-tolerance 200kΩ resistors. But the main reason is that R6 can be left out during initial setting up. It can be used to obtain the '1' and '10' calibration points on the pot scale, after which it's wired into the circuit."

"You've given the pot a value of 25kΩ instead of 20kΩ."

"True," confirmed Smithy. "You may remember that we said that the bridge pot ineeded a value slightly higher than 20kΩ. It's for this reason that I chose 20kΩ for the basic value in the first place, because it is possible to obtain pots in practice which have nominal values of 22kΩ or 25kΩ. Now, the normal tolerance on resistance of the usual type of low cost pot is 20%, so you're bound to get a value of 20kΩ in it if its nominal value is 25kΩ. If you're using a better class type of pot with a closer tolerance on its track resistance, you could employ one with a nominal value of 22kΩ."

"Can VR1 be an ordinary carbon track pot?"

"It can be," replied Smithy. "You'd get better long-term results, though, with a moulded track pot. Best of all would be a wire-wound pot. It should be wired up so that the resistance it inserts into circuit increases as its spindle is turned clockwise."

Smithy selected a further resistor from the cardboard box on his bench.

"Apart from R6," he announced, "this is the last resistor to go in. Do you want to stay for the setting-up operation?"

Dick looked at the clock and nodded forlornly.

"I might as well," he said glumly. "I've cooked my goose completely now so far as my date is concerned."

Smithy soon had the resistor soldered in place. He then took up a standard 470kΩ resistor, connected it to the test terminals of the bridge, selected Range 6 and switched it on. He turned the spindle of VR1 experimentally. The illumination of the l.e.d.'s changed over abruptly at a central setting of the potentiometer.

"Ah, good," he remarked, pleased. "The comparator seems to be doing its job properly. I'll do a spot of offset nulling next."

He switched off the bridge, short-circuited the test terminals with a piece of wire and connected a test lead terminated in two crocodile clips across VR1. (Fig. 6.)

"That's got the two transistor bases down to chasis potential," he remarked. "Now let's set up VR2."

He switched on again, whereupon one of the l.e.d.'s lit up. Taking up a small screwdriver he carefully adjusted VR2 until he found a point where the l.e.d. illumination changed

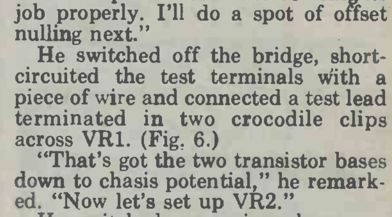


Fig. 6. The test terminals and VR1 are short-circuited for the offset null adjustment

over. He removed the two short-circuits.

"And *that* has got the offset null fixed up," he stated in a satisfied tone. "Calibration next!"

He took up the 100kΩ 1% resistor, shortly destined to become R6, and connected it to the test terminals. With the bridge still at Range 6. he next adjusted VR1 until the l.e.d.'s gave the

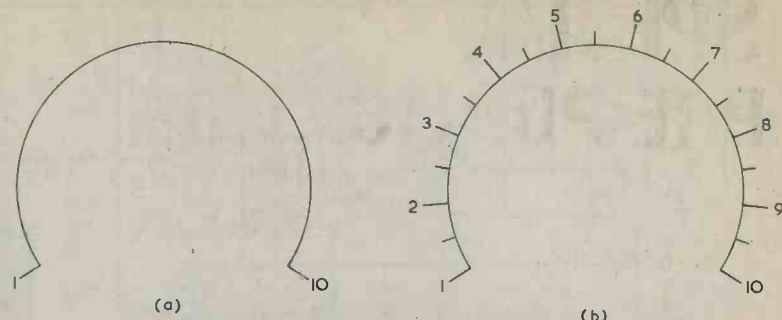


Fig. 7(a). The first step in marking up the scale for VR1 consists of finding the '1' and '10' points

(b). The scale is then filled in in linear fashion for the points between '1' and '10'

balance indication. He marked this point with the figure '1' on the temporary scale behind the knob of VR1. He then switched to Range 5 and re-adjusted VR1 for balance. This setting he marked on the scale as '10'. (Fig. 7(a).)

"And that's got the '1' and '10' points on the scale marked up," he said cheerfully. "Those two points will hold good on all the other ranges, and all I've finally got to do is mark out the intermediate values in linear fashion around the scale." (Fig. 7(b).)

A VISITOR

Smithy switched off the bridge and turned it over in order to instal the 100kΩ resistor in its final, R6, niche. There was a peremptory knock on the door. Frowning, Dick went to open it, and then gasped.

"Gosh, Jane," he stuttered. "I didn't expect to see you here."

"Well," came an indignant female voice, "you didn't think I'd spend all night chewing stale sandwiches down at Joe's, did you? They told me you were probably here, so I decided to come round and see for myself."

"Come on in," called out Smithy cheerily. "We've nearly finished."

The owner of the voice entered, to be enthusiastically appraised by the Serviceman. She had long auburn hair, and wore platform shoes, flared jeans and a gaily patterned blouse. She was obviously a member of Women's Lib, and deservedly so. Palpably, a dish.

She looked around her, then spotted the circuit of Smithy's bridge lying on his bench.

"Oh, that wouldn't interest you," said Dick condescendingly. "That's to do with electronics."

"I can see that, you twit," she replied, picking up the piece of paper. "So far as I can make out, it's the circuit of a resistance bridge."

"Hey?"

"Well, it must be," she returned decisively. "And this 741 operational amplifier and the two light emitting diodes will be for indicating balance."

His mouth sagging open, Dick gazed unbelievingly at the girl. A glint came into Smithy's eyes.

"What," she asked, "are the two emitter followers doing in front of the 741?"

"They're to increase the input resistance," explained Smithy.

"Oh, of course," she remarked.

She pointed at the metal case on Smithy's bench.

"Is that the actual bridge?"

"It is, my dear," replied Smithy in a warm paternal tone. "I'm just on the point of soldering in the last resistor now. Would you like to see it working when I've done that?"

"I'd love to," she replied enthusiastically. "What's your name?"

"They call me Smithy."

"Well, Smithy, it's really nice to have someone intelligent to talk to for a change. All Old Snodgrass here can do is just grunt and mutter inanities."

And so started a very pleasant and cosy evening. Jane and Smithy put the resistance bridge through its paces and conversed learnedly about matters electronic whilst the fuming Dick, *alias* Old Snodgrass, was relegated to the background duties of making the tea and being sent down to Joe's Caff for cakes.

We've all had them. There are times when one simply cannot win.

EDITOR'S NOTE

The Australian article referred to by Smithy was "Experimental Bridge Type Ohmmeter" by David Edwards, and it appeared in *Electronics Australia* for June 1974. The article by G. A. French in the July 1975 issue of *Radio & Electronics Constructor* was "Low Cost Electronic Voltmeter." ■

IMPROVED COURTESY LIGHT FOR CARS

In this article, which appeared on page 14 of the August 1975 issue, it is regretted that Figs. 2 and 3 were accidentally transposed.

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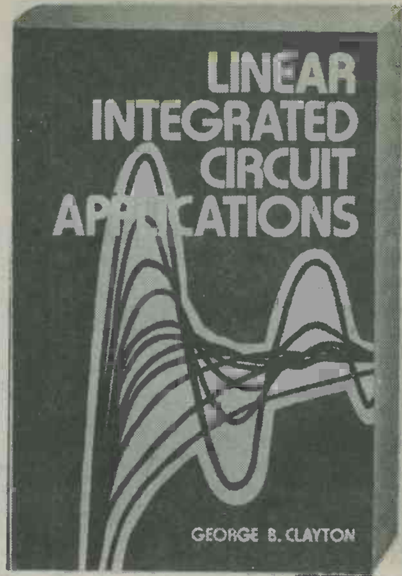

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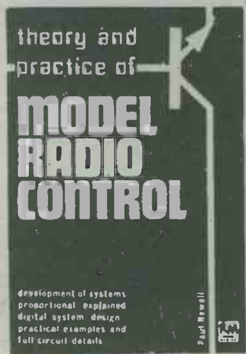

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(Continued from page 189)

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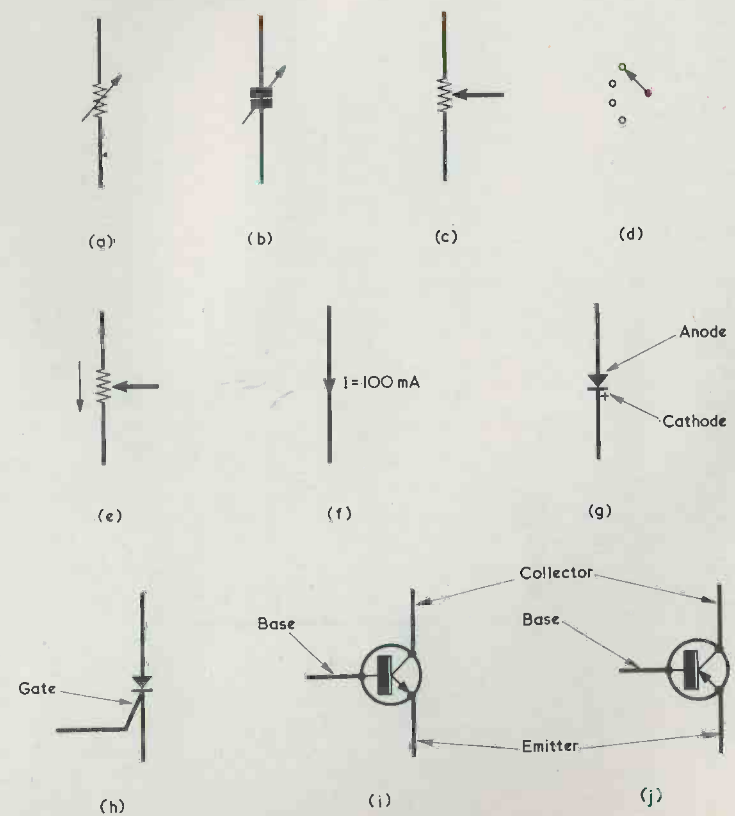
FOR THE BEGINNER

FOLLOW THE ARROWS

Arrows appear frequently in electronic circuit diagrams. An arrow drawn through a component symbol indicates that the value is variable, as with the variable resistor in (a) and the variable capacitor in (b). An arrow may indicate the slider, or wiper, of a potentiometer, as in (c), or the arm of a rotary switch, as in (d). Sometimes, an arrow is drawn alongside a potentiometer, as in (e), to indicate the direction of slider movement when the potentiometer spindle is turned clockwise.

Arrow-heads are drawn on connecting lines in a block diagram to indicate the direction of a process. They may indicate, for instance, the direction of a signal as it passes through a receiver.

When an arrow-head appears in a circuit diagram it usually indicates the direction of flow of a current, and the magnitude of the current may be printed alongside, as in (f). Normally, the arrow-head follows the convention that the current flows from positive to negative (even though the electrons which constitute the current flow from negative to positive). The symbol for a rectifier (g) is really an arrow-head with a bar at right angles, and the arrow-head indicates the current direction flow which the rectifier permits. Thus, the rectifier conducts when the anode is positive of the cathode. The arrow-head appears in other device symbols, such as that for a thyristor (h), for an n.p.n. transistor (i), and for a p.n.p. transistor (j). These arrow-heads indicate the direction of flow of current in the thyristor when it is turned on, and in the base-emitter junctions of the two transistors.



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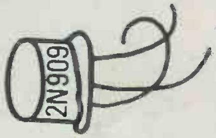

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Look at the entry for 2N909

TRANSISTOR NUMBER	PM OA LT	PACK-AGE	LEAD INFO	VCB MAX	VCE MAX	VEB MAX	I C MAX	T J MAX	P TOT	F T MIN	C OB MAX	H FE	H FE BIAS	USE	MFR	EURO EQVT	USA EQVT	ISS
2N909	NS	TO18	LO1	60V	30V	5V	200MA	175C	500MWF	50M	25P	110MN	50MA	AMG	SGI	BSX 33	2N731	0

This is what you will learn from it

TYPE NO	POL & MAT	CASE OUTLINE	LEAD IDEN TIFN	V_{CBO} MAX	V_{CEO} MAX	V_{EBO} MAX	I_C MAX	T_J MAX	P_{TOT} MAX	f_T MIN	C_{OB} MAX	h_{fe}	I_C (h_{fe} BIAS)	USE	SUP PLI ER	UK SUB	USA SUB	ISS
(EXAMPLE) 2N909	NS	TO18	LO1	60V	30V	5V	200 MA	175C	500 MWF	50M	25P	110 MN	50 MA	AMG	SG1	BSX 33	2N 731	0

- TYPE NO: NUMERO-ALPHABETIC LISTING
- POL & MAT: N = NPN, P = PNP, G = GERMANIUM, S = SILICON
- CASE OUTLINE: REFER TO CASE OUTLINES APPENDIX C
- LEAD IDENTIFN: REFER TO LEAD DETAILS — APPENDIX B
- V_{CBO}: MAXIMUM PERMISSIBLE COLLECTOR—BASE VOLTAGE WITH EMITTER OPEN-CIRCUIT
- V_{CEO}: MAXIMUM PERMISSIBLE COLLECTOR-EMITTER VOLTAGE WITH BASE OPEN-CIRCUIT
- V_{EBO}: MAXIMUM PERMISSIBLE EMITTER—BASE VOLTAGE WITH COLLECTOR OPEN-CIRCUIT
- I_C: MAXIMUM PERMISSIBLE COLLECTOR CURRENT
- T_J: MAXIMUM PERMISSIBLE JUNCTION TEMPERATURE
- P_{TOT}: MAXIMUM PERMISSIBLE DEVICE DISSIPATION — "F" = IN FREE AIR AT 25°C, "C" = WITH CASE SURFACE HELD AT 25°C, "H" = IN FREE AIR AT 25°C WITH METAL HEAT SINK ATTACHED TO DEVICE
- f_T: MINIMUM FREQUENCY CUT OFF, F_T, INDICATED IN K = KILOHERTZ M = MEGAHERTZ G = GIGAHERTZ. F_T = FREQUENCY AT WHICH COMMON-EMITTER CURRENT GAIN DROPS TO UNITY. TYPICAL F_T CAN BE TAKEN AS ROUGHLY TWICE $F_{T\,min}$
- C_{OB}: MAXIMUM COLLECTOR CAPACITANCE (TYPICAL USUALLY ½ TO ⅔ MAX) — NORMALLY EMITTER OPEN-CIRCUIT AND INDICATED BY "P" = PICOFARAD OR "N" = NANOFARAD — FOR HF DEVICES C_{re} IS GIVEN AND PICOFARADS THEN INDICATED BY "R" INSTEAD OF "P"
- h_{fe}: CURRENT GAIN, NORMALLY D.C. (BUT SOMETIMES RELATED A.C. GAIN) AT I_C BIAS SPECIFIED — WHERE MIN ("MN") ONLY IS SPECIFIED TYPICAL ("TP") CAN BE TAKEN AS TWICE MIN AND VICEVERSA
- I_C (h_{fe} BIAS): BIAS CURRENT AT WHICH CURRENT GAIN H_{fe} IS CHARACTERISED
- USE: CODE INDICATION OF APPLICATION USAGE — SEE APPENDIX A
- SUPPLIER: CODE INDICATION POSSIBLE SUPPLIER OF DEVICE — SEE "SUPPLIER" APPENDIX F
- UK SUB: SUGGESTED PROELECTRON STANDARD POSSIBLE SUBSTITUTE
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