

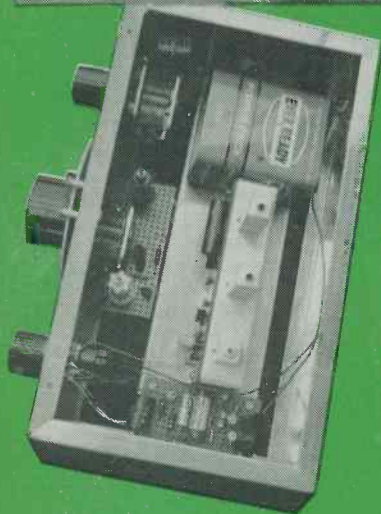
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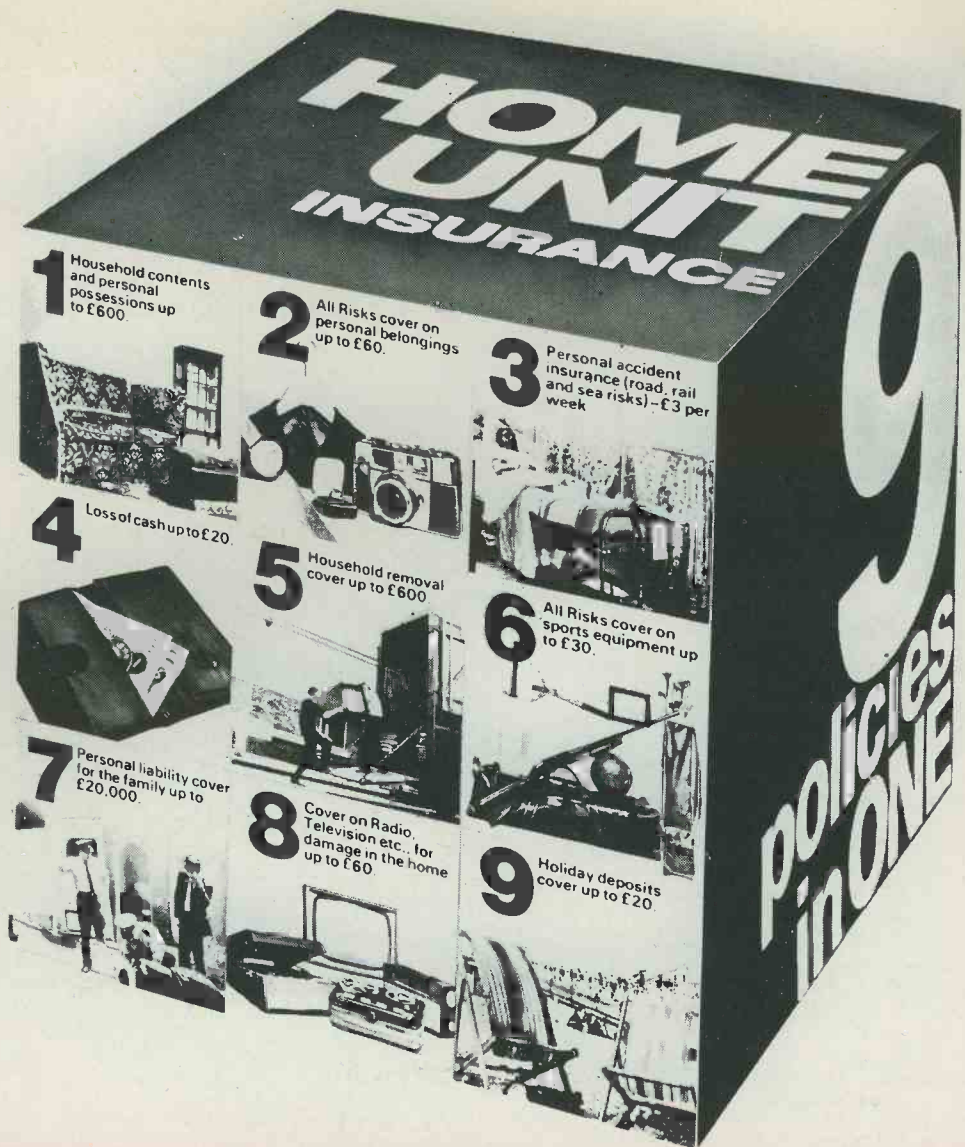
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10	4p	5p	6p	8p	8p	12p	16p	20p
25	4p	5p	6p	8p	8p	15p	18p	20p
50	4p	5p	6p	9p	13p	18p	25p	—
100	5p	6p	10p	12p	19p	20p	—	—
250	9p	10p	11p	17p	28p	—	85p	£1
500	10p	11p	17p	24p	45p	—	—	—
1000	13p	17p	40p	75p	—	£1.50	—	—
2000	23p	37p	45p	—	—	—	—	—

As total values are too numerous to list, use this price guide to work out your actual requirements
 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

RS 100-0-100 micro amp null indicator
 Approx. 2" x 3/4" x 3/4" £1.50

INDICATORS
 Bulgin D676 red, takes M.E.S. bulb 20p
 12 volt or Mains neon, red pushfit 18p
 R.S. Scale Print, pressure transfer sheet 10p

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, 5 x 50PF, 2 x 220PF, 50PF CERAMIC.

CONNECTOR STRIP
 Belling Lee L1469, 4 way polythene. 3p each
 1 1/2 glass fuses 250 ma/a or 3 amp (box of 12) 18p
 Bulgin, 5mm Jack plug and switched socket (pair) 30p
 1" or 1 1/2" or 2" or 3/4" 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 }
 5 1/2" x 2 3/4" Speaker, ex-equipment 3 ohm 30p
 2 Amp Suppression Choke 5p
 3 x 2 1/2 x 1 1/8" } PAXOLINE 2p
 4 3/8 x 1/2 x 1/8" } 2 for 1p
 PCV or metal clip on MES bulb Holder .5p
 VALVE RETAINER CLIP, adjustable 2p

OUTPUT TRANSFORMERS
 Sub-miniature Transistor Type 25p
 Valve type, centre tapped or straight 40p
 12 volt 250M/A or 6 volt 1/2 A Transformers £1
 Whiteley Stentorian 3 ohm constant impedance volume control way below trade at 80p
 Drive Cord 1p per yd.

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AC107	12p	BC184C/LC	9p	BF180/1/2/3	15p
AC128	5p	BC186/7	13p	BF184/5	15p
AC176	9p	BC213L/214B	9p	BF194/5/6/7	4p
ACY28	18p	BC261B	10p	BF194A/195C/200	10p
AD149	40p	BC327/8	10p	BF258/262/263	20p
AD161/2 matched pr.	69p	BC337/8	11p	BF336	25p
AF116	12p	BC547/558A	7p	BF28 Dual Mosfet	92p
AF124/6/7	20p	BC548/557	9p	BFW10/11 F.E.T.	26p
AF139/178/180/181	30p	BC548/A/557/559	9p	BFW30	£1.35
AF239	20p	BCX32/36	12p	BFW57/58	20p
ASY27/73	25p	BCY40	60p	BFX12	20p
BC107A or B	9p	BCY70/1/2	9p	BFX29/30/84/88	16p
BC107/8/9	6p	BD112/3/5/6	40p	BFX89	35p
BC108A/B/109B/C	10p	BD131/2/3/5/7/9	30p	BFY50/1/2	12p
BC147/8/9	6p	BD142	45p	BFY90	50p
BC147A/B	8p	BD201/2/3/4	£1.00	BR101	30p
BC148A/B/C, 9B/C/S/8	6p	BD232/4/5	46p	BRY39	Programmable Unj Junction 31p
BC157/8/9	6p	BDX77	£1.40	BRYS6	34p
BC158A/B	11p	BF115	10p	BSV64	40p
BC159B/C, 157A	11p	BF167/173	10p	BSV79/80 F.E.T.s	£1
BC178A/B/179B	10p	BF178/9	20p	BSV81 Mosfet	90p

BRIDGE RECTIFIERS

Amp	Volt		Amp	Volt	
1/2	1,600	BYX10	2	30	LT120 type
1	140	OSH01-200	0.6	110	EC433
1.4	42	BY164	5	400	Texas

RECTIFIERS

	Amp	Volt	
IN4004	1	400	3p
IN4005	1	600	4p
IN4006	1	800	
IN4007	1	1,000	
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

Amp	Volt	TRIACS	
6	800	Plastic RCA	90p
25	900	BTX94-900	£4.00
25	1200	BTX94-1200	£6.00
12-0-12 50M/A Min. Txmfr. 90p			
RS 2mm Terminals			
Blue & Black 5 for 40p			
Chrome Car Radio facia 16p			
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, 4 3/4" dia. 10p			

OPTO ELECTRONICS

BPX40	65p	Photo transistor	
BPX42	£1.00	BPX29	£1.00
BPY10	£1.00	OCF71	30p
(VOLTAGE)			
BPY68	} £1.00	BIG L.E.D. 0.2"	
BPY69		2v 50m/A max.	
BPY77		RED	13p
		ORANGE	} 15p
	GREEN		
	YELLOW		
		CLIP	2p
Diodes			
PHOTO SILICON CONTROLLED SWITCH BPX66 PNP 10 amp £1.00			

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

COY11B 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

Holders or pads 50pper100

Philips Iron Thermostat 15p

Bulgin 2-pin flat plug and socket 10p

McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK

Europelec 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)	
OA81	2p		
OA47	2p		
OA200-2	3p	GET872	12p
OC23	20p	2S3230	30p

BSX20/21	13p
BSY40	28p
BSY95A	9p
BU105-01	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111	40p
OC35	32 1/2p
ON222	30p
TIP30	43p
TIP3055	50p
TIS88A FET	23p
ZTX300	5p
ZTX341	15p
2N393/MA393	30p
2N706	6p
2N929	14p
2N987	35p
2N1507/2219	14p
2N2401/2412/2483	25p
2N2904/5/6/7	10p
2N2907A	13p
2N3053	13p
2N3054/3055 (or equiv)	35p
2N3133	18p
2N3704	9p
2N4037	35p
2N5036	60p
2SA141/2/360	31p
2SB135/6/457	20p
40250	60p

OTHER DIODES

1N916	6p
1N4148	1-5p
BA145/148	11p
Central	10p
BZY61	10p
BB103/110 Varicap	18p
BB113 Triple Varicap	37p
BA182	18p
OA5/7/10	10p
BZY88 Up to 33 volt	6p
BZX61 11 volt	16p
BR100 Diac.	19p

INTEGRATED CIRCUITS

TAA700	£2.95
723 reg.	45p
741 8 pin d.i.l. op. Amp	18p
TAD100 AMRF	£1.00
CA3001 R. F. Amp	50p
TAA300 1wt Amp	£1.25
NE555v Timer	40p
TAA550 Y or G	31p
TAA263 Amp	62p
7400	8p
7402/4/10/20/30	10p
7414	45p
7438/74/86	25p
7483	80p
LM300, 2-20 volt	50p
74154	67p

THYRISTORS

Amp	Volt		
1	240	BTX18-200	23p
1	400	BTX18-300	25p
1	240	BTX30-200	23p
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

Multicore Solder 18SWG 3p per foot

ENAM. COPPER WIRE SWG. PER YD.

20-24 2p

26-42 1p

GARRARD GCS23T or GP93/1 Crystal Stereo Cartridge £1.00

HANDLES Rigid light blue nylon 6 1/2" with secret fitting screws 5p

Belling Lee white plastic surface coax outlet box 30p

Miniature Axial Lead Ferrite Choke formers 2p

RS 10 Turn Pot 1% 250, 500 Ω; 1, 50, 100K £1.50

Copper coated board 10" x 9" approx. 32p

TIE CLIPS Nylon self locking 7" or 3 1/2" 2p

Gear Knob 8-1 ratio 1 1/8" diam, black 60p

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0.25MFD 800 volt 30p

1MFD 250 volt 15p

2MFD 250 volt 20p

10MFD 500 volt 80p

4MFD 250 volt 20p

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Car Aerial

Coax

5 or 6 pin 240° din

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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 2B60800A1R20 20p

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RS Yellow Wander Plug Box of 12, 25p

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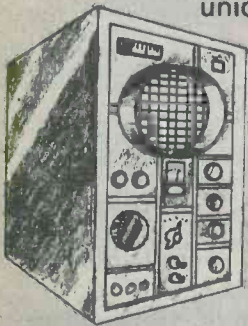
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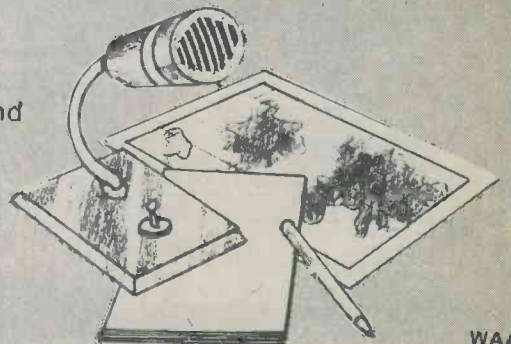
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8/350V 22p	1000/100/275v 65p	32+32/450V 75p
16/350V 30p	150+200/275V 70p	100+50+50/350V 85p
32/500V 50p	8+8/450V 50p	32+32+32/350 75p
25/25V 10p	8+16/450V 50p	900MFD/350V 95p
50/50V 10p	16+16/450V 50p	4700/63V 95p
100/25V 10p	32+32/350V 50p	

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 22, 25, 68, 100, 150, 200, 220, 330, 470, 680, 1000, 1500, 2200, mfd all 10 volt 10n ea.
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 1 2 4 5 8 16 25 30 50 100 200mF 15V 10p.
 500mF 12V 15p. 25V 20p. 50V 30p.
 1000mF 12V 20p. 25V 35p. 50V 47p. 100V 70p.
 2000mF 6V 25p. 25V 42p. 50V 57p. 4700/63V 95p.
 2500mF 5V 82p. 3000mF 25V 47p. 50V 65p.
 5000mF 6V 25p. 12V 42p. 25V 75p. 35V 85p. 50V 95p.
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 CERAMIC 1pF to 0.01mF. 5p. Silver Mica 2 to 5000pF. 5p.
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80 Ohm Coax 8p yd.

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E.M.I. 13 1/2 x 8 in.

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 8 or 15 ohm



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Fluted wood front 16 x 10 x 9in. Teak Veneer Post 75p

R.C.S. 10 WATT AMPLIFIER KIT



This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. A mono kit or a stereo kit. The mono kit uses 13 semiconductor. The stereo kit uses 22 semiconductor with printed front panel and volume knob and treble controls. Spec. 10 watts output into 8 ohm, 7 watts into 15 ohm. Response 20 cps to 30K/c/s. Input 100 mV high imp. Size 9 1/2" x 3 1/2" x 2 1/2".
 Mono kit **£12.50** Stereo kit **£20** Post 45p

LOUDSPEAKERS P.M. 3 ohms, 7 x 4in. £1.25; 6in. £1.50; 8 x 5in. £1.60; 8in. £1.75; 10 x 6in. £1.90; 10in. £2.00. SPECIAL OFFER LOUDSPEAKERS! All Brand New. 3 ohm, 2 1/2in. 3 1/2in. 5in. 8 ohm, 2 1/2in; 2 1/2in; 5 x 3in; 5in. 15 ohm, 3 1/2in. 5in. 6 x 4in; 5 x 3in; 7 x 4in; 8 x 5in. 25 ohm, 2 1/2in; 3in. 5 x 3in. 35 ohm, 3in; 5in. 80 ohm, 2 1/2in, 2 1/2in. 120 ohm, 3in. **£1.25 EACH**

LOUDSPEAKER VOLUME CONTROL 15 ohm 10 watt with 1in long threaded bush for wood panel mounting **75p**

RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. diameter 4W £2.50, 10in. diameter 5W £2.95; Post 25p. 12in. diameter, 6W £3.50, 3 or 8 or 15 ohm models. SPEAKER COVERING MATERIALS. Samples Large S.A.E. Horn Tweeters 2-16Kc/s, 10W 8 ohm or 16 ohm £3.60. De Luxe Horn Tweeters 2-18 Kc/s, 15W, 8 ohm £4.00. TWO WAY 3,000 cps CROSS OVERS 3, 8 or 15 ohm £1.90. 3 WAY CROSSOVER 850 cps and 3,000 cps (25 watt) £2.20

GOODMANS CONE TWEETER

18,000 cps. 25 watts. 8 ohm. Price **£3.60**

ELECTRO MAGNETIC PENDULUM MECHANISM

1.5v d.c. operation over 250 hrs continuous on SP2 battery, fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome, strobe etc. 95p. Post 20p

WEYRAT TYPE COILS

P50/1AC 60p	RA2W 85p	1 twin Gang	£1.50
P50/2CC 40p	OPT1 65p	Printed Circuit	
P50/3CC 40p	LFD74 65p		85p

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES SURFACE MOUNTING 25p. BALANCED TWIN RIBBON FEEDER 300 ohms, 7p yd. JACK SOCKET Std. open-circuit 15p. closed circuit 23p. Chrome Lead Socket 45p. Phone Plugs 10p. Phone Socket 8p. JACK PLUGS Std. Chrome 20p. 3-5mm Chrome 15p. DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p. DIN SOCKETS Lead 3-pin 18p. 5-pin 15p. DIN PLUGS 3-pin 18p. 5-pin 25p. VALVE HOLDERS 5p. CERAMIC 10p. CANS 5p.

R.C.S. 100 WATT VALVE AMPLIFIER CHASSIS



Professional model. Four inputs. Treble. Bass. Master Volume Controls. Ideal disco, P.A. or groups. S.A.E. for details. 5 speaker **£85** plus £1.50 carr. outputs, very robust job.

NEW 'DISCO 100 WATT'

ALL PURPOSE AMPLIFIER CHASSIS **£55**
 4 inputs, 4 outputs separate volume treble and bass controls. Ideal disco or slave amplifier chassis. Carr £1

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Components Lists 10p.

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SEMI-CONDUCTORS

TRANSISTORS

BRAND NEW

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC117K	*0.30	AF127	*0.26	BC160	*0.46	BC303	*0.31	BD199	*0.98	BF274	0.36	OC28	*0.60	TIP32A	*0.60	2N1308	*0.24	2N2925	0.15
AC126	*0.18	AF139	*0.31	BC161	*0.51	BC304	*0.37	BD200	*0.98	BFX29	*0.25	OC29	*0.60	TIP41A	*0.65	2N1309	*0.24	2N2926G	0.09
AC126	*0.14	AF178	*0.51	BC167	0.10	BC227	0.12	BD205	*0.81	BFX84	*0.19	OC35	*0.45	TIP42*	*0.72	2N1613	0.16	2N2926Y	0.09
AC127	*0.11	AF179	*0.51	BC168	0.10	BC238	0.12	HD206	*0.81	BFX85	*0.25	OC36	*0.51	TIS43	*0.25	2N1711	0.15	2N2926D	0.08
AC128	*0.11	AF180	*0.51	BC169	0.10	BC337	0.12	BD207	*0.98	BFX86	*0.22	OC41	*0.20	UT46	*0.20	2N1247	*0.73	2N2926R	0.07
AC128K	*0.26	AF181	*0.51	BC169C	0.10	BC338	0.12	BD208	*0.98	BFX87	*0.22	OC42	*0.25	ZTX107	0.07	2N1248	0.58	2N2926B	0.07
AC141	*0.19	AF186	*0.51	BC170	0.09	BC440	*0.31	BDY20	*1.02	BFX88	*0.22	OC44	*0.16	ZTX108	0.07	2N2218	0.18	2N3053	*0.15
AC141K	*0.80	AF239	*0.38	BC171	0.09	BC460	*0.37	BF115	*0.15	BFY50	*0.13	OC45	*0.13	ZTX109	0.07	2N2218A	*0.19	2N3054	*0.40
AC142	*0.19	AL102	*0.75	BC172	0.09	BD115	*0.93	BF117	*0.46	BFY51	*0.13	OC70	*0.10	ZTX300	0.07	2N2219	*0.18	2N3055	*0.40
AC142K	*0.28	AL103	*0.75	BC173	0.09	BD116	*0.81	BF118	*0.71	BFY52	*0.13	OC71	*0.10	ZX1750	0.09	2N2219A	*0.19	2N3402	*0.21
AC153K	*0.24	BC107	*0.08	BC174	0.15	BD121	*0.61	BF119	*0.71	BFY53	*0.13	OC72	*0.15	2N696	*0.10	2N2220	*0.22	2N3403	*0.21
AC176	*0.11	BC108	*0.08	BC175	*0.22	BD123	*0.87	BF152	0.58	BFY19	*0.16	OC74	*0.15	2N697	*0.11	2N2221	*0.22	2N3404	*0.29
AC176K	*0.26	BC109	*0.08	BC177	*0.16	BD124	*0.70	BF153	0.46	BSX20	*0.16	OC75	*0.16	2N698	*0.20	2N2222	*0.18	2N3405	*0.43
AC180	*0.20	BC113	0.10	BC178	0.18	BD131	*0.36	BF154	0.46	BSY25	*0.16	OC76	*0.16	2N699	*0.38	2N2388	*0.18	2N3614	*0.69
AC180K	*0.38	BC114	0.16	BC179	*0.16	BD132	*0.40	BF155	*0.71	BSY26	*0.16	OC77	*0.26	2N706	*0.08	2N2389	*0.12	2N3615	*0.76
AC181	*0.20	BC115	0.18	BC180	*0.25	BD133	*0.47	BF156	*0.48	BSY27	*0.16	OC81	*0.18	2N706A	*0.09	2N2464	0.12	2N3616	0.09
AC181K	*0.30	BC116	0.16	BC181	0.25	BD135	*0.61	BF157	*0.58	BSY28	*0.16	OC81D	*0.18	2N708	*0.11	2N2646	*0.34	2N3646	0.78
AC187	*0.17	BC117	0.19	BC182	0.09	BD136	*0.41	BF158	0.58	BSY29	*0.16	OC82	*0.18	2N914	*0.15	2N2904	*0.14	2N3702	0.09
AC187K	*0.23	BC118	0.09	BC182L	0.09	BD137	0.46	BF159	0.61	BSY38	*0.19	OC82D	*0.16	2N918	*0.81	2N2904A	*0.18	2N3703	0.09
AC188	*0.19	BC119	*0.31	BC183	0.09	BD138	0.61	BF173	*0.15	BSY39	*0.19	OC83	*0.20	2N1311	*0.18	2N2905	*0.18	2N3704	0.08
AC188K	*0.23	BC120	*0.81	BC183L	0.08	BD139	0.58	BF165	*0.71	BSY40	*0.28	OC199	*0.20	2N1312	*0.18	2N2905A	*0.18	2N3705	0.08
AD140	*0.49	BC137	0.16	BC184	0.09	BD140	0.61	BF179	*0.31	BSY41	*0.29	OC140	*0.23	2N1302	*0.15	2N2096	*0.12	2N3706	0.08
AD142	*0.55	BC139	*0.41	BC184L	0.09	BD155	*0.81	BF180	*0.31	BSY95	*0.13	OC169	*0.28	2N1303	*0.15	2N2906A	*0.14	2N3707	0.08
AD143	*0.49	BC140	*0.31	BC186	*0.29	BD175	*0.61	BF181	*0.31	BSY95A	*0.13	OC170	*0.28	2N1304	*0.18	2N2907	*0.15	2N3708	0.08
AD149	*0.45	BC141	*0.31	BC187	*0.29	BD176	*0.61	BF184	0.10	BU105	*1.90	OC171	*0.26	2N1305	*0.18	2N2907A	*0.18	2N3709	0.08
AD150	*0.45	BC142	*0.31	BC207	0.11	BD177	*0.67	BF195	0.10	MJ1521	*0.58	OC200	*0.28	2N1306	*0.21	2N2908	0.15	2N3710	0.09
AD161	*0.38	BC143	*0.31	BC208	0.11	BD178	*0.67	BF196	0.92	MJ2355	*0.88	OC201	*0.29	2N1307	*0.21	2N2924	0.15	2N3711	0.09
AD162	*0.36	BC145	0.46	BC209	0.12	BD179	*0.71	BF197	0.12	MJE3055	*0.57	OC202	*0.29						
AD161 & AD162 (MP)		BC147	0.09	BC212	0.10	BD180	*0.71	BF198	0.12	MJE3440	*0.51	OC203	*0.28						
		BC148	0.09	BC221L	0.10	BD185	*0.67	BF199	0.12	MPP102	*0.28	OC204	*0.28						
		BC149	0.09	BC213	0.09	BD186	*0.67	BF257	*0.28	MPP104	*0.28	OC205	*0.38						
AF114	*0.89	BC150	*0.92	BC213L	0.10	BD187	*0.71	BF258	*0.38	MJ1525	*0.28	OC206	*0.44						
AF115	*0.22	BC151	0.20	BC214	0.10	BD188	*0.71	BF259	*0.48	OC19	*0.38	ORP12/							
AF116	*0.22	BC152	0.18	BC214L	0.10	BD189	*0.77	BF262	0.56	OC20	*0.80	NSL4931	*0.48						
AF117	*0.22	BC153	0.29	BC225	0.26	BD190	*0.77	BF263	0.56	OC22	*0.47	ORP60	*0.41						
AF118	*0.32	BC154	0.20	BC226	0.38	BD195	*0.87	BF270	*0.36	OC23	*0.49	ORP61	*0.41						
AF124	*0.28	BC157	0.11	BC251	0.10	BD156	*0.87	BF271	*0.31	OC24	*0.57	TIP29	*0.40						
AF125	*0.28	BC158	0.11	BC301	*0.28	BD197	*0.92	BF272	*0.81	OC25	*0.39	TIP30	*0.45						
AF126	*0.26	BC159	0.11	BC302	*0.25	BD198	*0.92	BF273	0.38	OC26	*0.38	TIP31A	*0.52						

V.A.T. CHART

Please add 8% to prices marked *. Remainder add 25%. Do not add V.A.T. to prices marked +.

SUPER UNTESTED PAKS

Pak No.	Description	Price
U 1	120 Glass Sub-min. General purpose Germ. diodes	0.60
U 4	30 Germanium transistors like OC81, AC128	0.80
U 5	60 200mA sub-min. silicon diodes	0.60
U15	20 NPN Sil. planar trans. TO-5 like 2N132, 2N2904	0.60
U19	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	0.60
U19	20 Silicon NPN transistors like BC108	0.60
U26	30 Fast switching silicon diodes like 1N914 Micro-Min.	0.60
U29	10 1 Amp SCR's TO-5 can. up to 600 CRS/25-600	*1.20
U32	25 Zener diodes 400mW DO-7 case 3-33 volts mixed	0.60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	0.60
U45	7 3A SCR. TO66 up to 600 PIV	*1.20
U46	20 Unijunction transistors similar to TIS43	0.60
U48	9 NPN Sil. power transistors like 2N3055	*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 untested.

* SIL. G.P. DIODES

300mW 40 PIV (min) SUB-MIN FULLY TESTED
Ideal for Organ builders
30 for \$50, 100 for £1.50, 500 for £5, 1000 for £9.

TRIACS

Case	100V	200V	400V
2 Amp	T05 *0.31	*0.51	*0.71
6 Amp	T066 *0.51	*0.81	*0.77
10 Amp	T048 *0.77	*0.92	*1.12

GP300

115 WATT SILICON TO3 METAL CASE
Vceo 100V. Vceo 60V. IC. 15A. Hfe. 20-100 suitable replacement for 2N3055 BDY11 or BDY20.
1-34 25-99 100
*50p *48p *46p

HANDBOOKS

TRANSISTOR DATA BOOK
DTE 1 227 Pages packed with information on European Transistors. Full specification including outlines. Price £2.95 each

TRANSISTOR EQUIVALENT BOOK
BPE 75 256 Pages of cross references and equivalents for European, American and Japanese Transistors. This is the most comprehensive equivalents book on the market today and has an introduction in 13 languages. Price £2.68 each

DIODE EQUIVALENT BOOK
DE 74 144 Pages of cross references and equivalents for European, American and Japanese diodes, Zeners, Thyristors, Triacs, Diacs and L.E.D.'s. Price £1.98 each

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Type	Price	Type	Price	Type	Price	Type	Price
BA100	*0.19	BB104	*0.15	OA10	*0.14	QA91	*0.07
BA116	*0.21	BY100	*0.16	OA47	*0.07	QA95	*0.07
BA126	*0.22	BY126	*0.16	OA70	*0.07	QA200	*0.07
BA148	*0.15	BY128	*0.18	OA79	*0.07	QA202	*0.07
BA154	*0.12	BY164	*0.51	OA81	*0.07	IN914	0.08
BA156	*0.14	BYX		OA85	*0.09	IN916	0.06
BA173	*0.15	38/50	*0.43	OA90	*0.07	IN418	*0.06

GP Switching Trans

TO18 SIM. to 2N706/8 BSY27/28/95A
All usable devices. No open and shorts.
ALSO AVAILABLE IN PNP similar to 2N2906, BCY 70
20 for *50p, 50 for *£1, 100 for *£1.80, 500 for *£8, 1000 for *£14.
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JUMBO SEMICONDUCTOR PAK
Transistors-Germ. and Silicon. Rectifiers-Diodes Triacs-Thyristors-I.C.'s and Zeners. ALL NEW AND CODED.
APPROX 100 PIECES ONLY *£1.85

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FULL RANGE IN STOCK
400 mw 8p 2-33 Volts 1.5 w 17p 10 w *30p

SILICON RECTIFIERS

PIV	300mA (DO7)	750mA (SO 16)	(Amp Plastic)	1.5 Amp (SO 16)	3 Amp (SO 10)	10 Amp (SO 10)	30 Amp (TO 48)
50	*0.05	*0.06	IN4001	*0.05	*0.07	*0.14	1-0.56
100	*0.05	*0.07	IN4002	*0.06	*0.09	*0.16	*0.69
200	*0.08	*0.09	IN4003	*0.07	*0.12	*0.20	*1.25
400	*0.07	*0.14	IN4004	*0.08	*0.14	*0.28	*1.25
600	*0.08	*0.16	IN4005	*0.09	*0.15	*0.33	*1.76
800	*0.11	*0.18	IN4006	*0.10	*0.18	*0.35	*1.84
1000	*0.13	*0.28	IN4007	*0.11	*0.23	*0.44	*2.31
1200		*0.32		*0.11	*0.28	*0.54	*2.88



Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00.

BI-PAK

P.O. BOX 6 WARE HERTS

COMPONENTS

ANTEX Equipment

SOLDERING IRONS	
X25. 25 watt	★£2.45
Model G. 18 watt	★£2.70
CCN 240. 15 watt	★£2.90
SK2. Soldering Kit	★£3.90

BITS	
102 for model CCN240	★42p
104 for model CCN240	★42p
106 for model CCN240	★42p
1100 for model CCN240	★42p
1101 for model CCN240	★42p
1102 for model CCN240	★42p
1020 for model G240	★42p
1021 for model G240	★42p
50 for model G240	★42p
50 for model X25	★44p
51 for model X25	★44p
52 for model X25	★44p

ELEMENTS	
Model ECN 240	★£1.10
Model EG 240	★£1.35
Model ECCN 240	★£1.50
Model EX 25	★£1.65

SOLDERING IRON STAND	
ST3 Suitable for all models	★£1.10
Antex heat shunt	★10p

PLUGS & SOCKETS

PLUGS		Price
PS 1 D.I.N. 2 Pin (Speaker)		0.10
PS 2 D.I.N. 3 Pin		0.10
PS 3 D.I.N. 4 Pin		0.10
PS 4 D.I.N. 5 Pin 180°		0.16
PS 5 D.I.N. 5 Pin 240°		0.15
PS 6 D.I.N. 6 Pin		0.16
PS 7 D.I.N. 7 Pin		0.17
PS 8 Jack 2.5mm Screened		0.17
PS 9 Jack 3.5mm Screened		0.17
PS 10 Jack 3.5mm Screened		0.17
PS 11 Jack 1" Plastic		0.14
PS 12 Jack 1" Screened		0.20
PS 13 Jack Stereo Screened		0.33
PS 14 Phono		0.09
PS 15 Car Axial		0.14
PS 16 Co-Axial		0.14

INLINE SOCKETS

PS 21 D.I.N. 2 Pin (Speaker)	0.13
PS 22 D.I.N. 3 Pin	0.19
PS 23 D.I.N. 5 Pin 180°	0.19
PS 24 D.I.N. 5 Pin 240°	0.19
PS 25 Jack 2.5mm Plastic	0.16
PS 26 Jack 3.5mm Plastic	0.16
PS 27 Jack 1" Plastic	0.28
PS 28 Jack 1" Screened	0.32
PS 29 Jack Stereo Plastic	0.28
PS 30 Jack Stereo Screened	0.35
PS 31 Phono Screened	0.17
PS 32 Car Axial	0.20
PS 33 Co-Axial	0.20

SOCKETS

PS 35 D.I.N. 2 Pin (Speaker)	0.07
PS 36 D.I.N. 3 Pin	0.09
PS 37 D.I.N. 5 Pin 180°	0.09
PS 38 D.I.N. 5 Pin 240°	0.10
PS 39 Jack 2.5mm Switched	0.11
PS 40 Jack 3.5mm Switched	0.11
PS 41 Jack 1" Switched	0.18
PS 42 Jack Stereo Switched	0.07
PS 43 Phono Single	0.28
PS 44 Phono Double	0.09
PS 46 Co-Axial Surface	0.09
PS 47 Co-Axial Flush	0.19

INSTRUMENT CASES

(In 2 sections, Black Vinyl covered top and sides and bezel)

No.	Length	Width	Height	Price
BV1	8" x 5 1/2" x 2"			★£1.25
BV2	11" x 6" x 2"			★£1.62
BV3	6" x 4" x 1 1/2"			★£0.92
BV4	9" x 5 1/2" x 2 1/2"			★£1.39

AUDIO ACCESSORIES

CROSSOVER NETWORK

K4007 1/P Impedance 8 ohms. Insertion 2-way Loss 3dB. Crossover Frequency 3KHz

PRICE: £1.12

ALUMINIUM BOXES

No.	Length	Width	Height	Price
BA1	5 1/2"	4"	2 1/2"	★0.45
BA2	4"	4"	2 1/2"	★0.45
BA3	4"	4"	1 1/2"	★0.45
BA4	5 1/2"	4"	1 1/2"	★0.54
BA5	4"	4"	1 1/2"	★0.45
BA6	3"	2 1/2"	1"	★0.39
BA7	7"	5"	2 1/2"	★0.79
BA8	8"	6"	3"	★1.02
BA9	6"	4"	2"	★0.66

(Each complete with 1/2" deep lid & screws)
PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX

COMPONENTS

CARBON RESISTOR PAKS

These Paks contain a range of Carbon Resistors, assorted into the following groups:

R1	50 Mixed 100 ohms-820 ohms	0.60
	1/8th W	
R2	50 Mixed 1K ohms-8.2K ohms	0.60
	1/8th W	
R3	50 Mixed 10K ohms-82K ohms	0.60
	1/8th W	
R4	50 Mixed 100K ohms-820K ohms	0.60
	1/8th W	
R5	30 Mixed 100 ohms-820 ohms	0.60
	1/8 W	
R6	30 Mixed 1K ohms-8.2K ohms	0.60
	1/8 W	
R7	30 Mixed 10K ohms-82K ohms	0.60
	1/8 W	
R8	30 Mixed 100K ohms-820K ohms	0.60
	1/8 W	

THESE ARE UNREPEATABLE PRICES

REPANCO CHOKES & COILS

RF Chokes	CH1	2.5mH	0.27
	CH3	7.5mH	0.29
	CH5	1.5mH	0.28
	CH2	5.0mH	0.28
	CH4	10mH	0.31

COILS DRX1	Crystal set	0.29	Dual
	range		0.42

CARBON POTENTIOMETERS

Log and Lin		
4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 2.		
VC1	10K Less Switch	0.20
VC2	Single D.P. Switch	0.40
VC3	Tandem Less Switch	0.80
VC4	1K Less Switch	0.20
VC5	100K Log anti-Log	0.60

HORIZONTAL CARBON PRESETS

0.1 Watt	0.09 each
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.	

REPANCO TRANSFORMERS

240V. Primary. Secondary voltages available from selected tapings. Up to 50V and 25V-0-25V.

Type	Amps	Price	p & p
MT/50/1	1	£3.00	0.45p
MT/50/1 1/2	1 1/2	£4.00	0.48p
MT/50/2	2	£5.00	0.50p

COILS FORMERS & CORES

NORMAN 1/2" Cores & Formers	0.07p
1/2" Cores & Formers	0.09p

SWITCHES

DP/DT Toggle	0.28p
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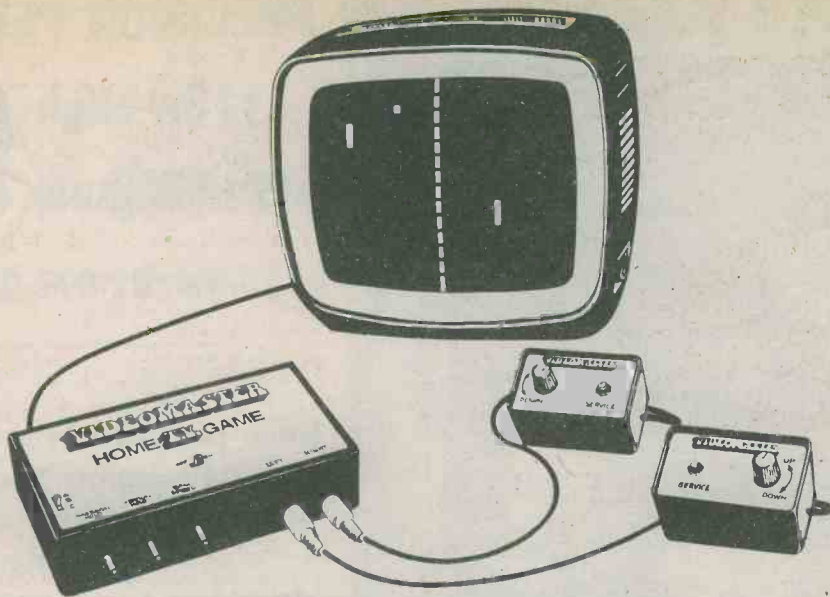
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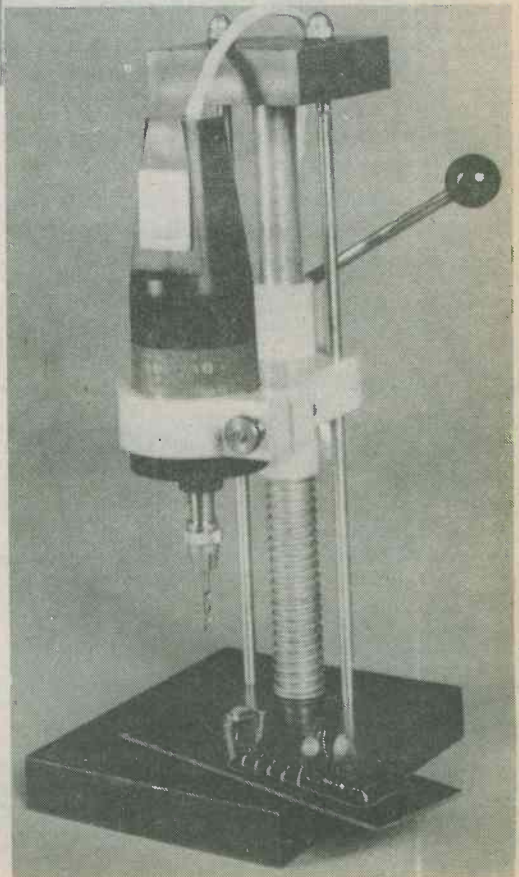
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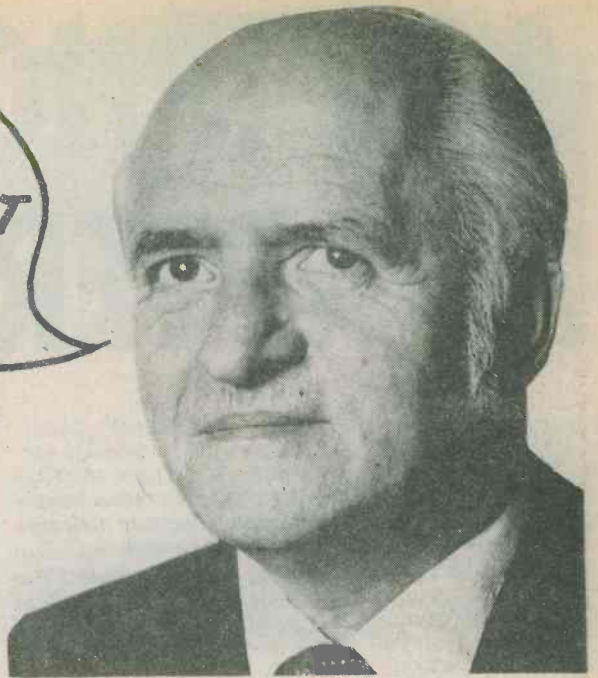
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AMBIPHONIC ADAPTER

Part 1

By R. A. Penfold

The adapter described here and in next month's concluding article extracts the difference signal from a stereo system and produces from this two rear channels in anti-phase, each with its own volume and bass and treble tone controls. The result is an added ambience which adds richness of sound to many stereo recordings.

Although two channel stereo has been the standard form of high fidelity audio reproduction for many years now, its replacement by four channel reproduction, or 'quadrophonics' as it is usually called, seems inevitable. There are several four channel systems currently being marketed, ranging from the RCA CD-4 system, which provides four discrete channels, to inexpensive ambiphonic systems which in their most basic form merely consist of an ordinary stereo system with an extra pair of speakers connected across the positive (i.e. non-earthly) output terminals.

For anyone wishing to get started with simple low cost four channel equipment, ambiphonic equipment provides the obvious starting point. This type of equipment will synthesize four channel operation from any stereo programme. In the writer's opinion it also gives a superior performance when used with four channel SQ matrix encoded material, such as a CBS SQ disc.

PRINCIPLE OF OPERATION

The simplest set-up for ambiphonic listening is shown in Fig. 1. The stereo outputs are fed to the left and right hand front speakers in the usual fashion. Two extra speakers are positioned in the rear corners of the room and are connected across the positive outputs of the amplifier with the phasing shown. (The plus and minus signs at the speakers indicate phasing; the cone of any speaker moves in the same direction relative to its magnet when the signal voltage at the terminal with the plus sign is positive.)

This arrangement forms the basis of much of the four channel audio equipment which is available at the time of writing. The present article will describe an adapter which, together with an extra pair of speakers, will convert any existing two channel stereo system to four channel ambiphonic operation.

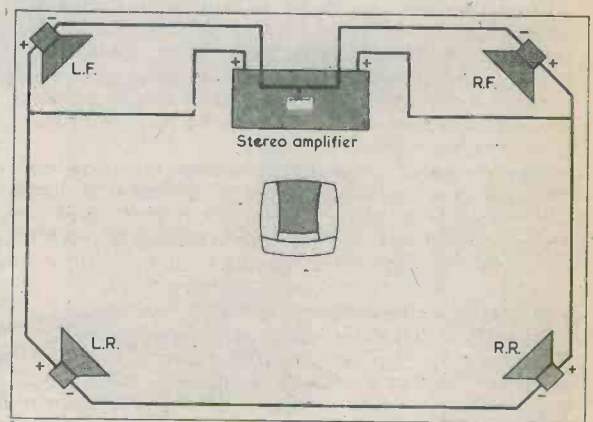


Fig. 1. A basic ambiphonic arrangement incorporating a standard stereo amplifying system

As with ordinary stereo, speaker phasing is very important. The right front speaker is in phase with the right rear one, and the left front speaker is in phase with the left rear one.

To elaborate this point, consider a signal from the amplifier right hand output only. As the positive left hand output is conveying no signal it will act as an earth for the rear speakers. Both right hand speakers have their positive terminals connected to the positive right hand amplifier output, and are therefore driven in phase. The left rear speaker is connected in the opposite phase, and is driven out of phase with the other two speakers.

The use of a ready made case gives the completed ambiphonic adapter an attractive and striking appearance



With a signal being supplied from the left hand channel output only, the two left hand speakers will be driven in phase and the right rear speaker in anti-phase.

The signal developed across the two rear speakers is known as the 'difference signal', since it is equal to the difference between the two amplitude levels at the positive outputs. Thus, if at a given instant the left hand output is at +6 volts and the right hand output is at +4 volts, 2 volts are developed across the rear speakers.

If, on the other hand, the left hand output is at -6 volts and the right hand output is at +4 volts, 10 volts are developed across the rear speakers. This is an important point to bear in mind, as it shows how out-of-phase signals at the outputs cause a large amplitude signal to be developed across the rear speakers.

If identical in-phase signals are produced at the amplifier outputs, then no signal is developed across the rear speakers as, obviously, the difference in the two output amplitudes is zero.

In a practical situation the signal appearing across the rear speakers is quite simple to visualise. Signals which appear in the middle of the stereo sound stage are produced by feeding in-phase signals of equal amplitude to both front speakers. These will cancel out as far as the rear speakers are concerned, and so will not be reproduced at the rear.

Sounds which are to one side of the sound stage are produced by feeding in-phase signals to the front speakers, but at a greater amplitude on the side to which the sound is to be offset. The further the sound is offset, the greater the inequality in favour of the side from which the sound must seem to originate. Therefore, the further a signal is offset to one side, the louder it appears in the rear speakers.

AMBIENCE SIGNALS

The effectiveness of the system is mainly due to what are often termed 'ambience signals'. Ambience signals are not signals travelling direct from the source of sound to the recording microphones but are random sounds produced by reflections from the walls, ceiling and objects in the concert hall or studio, these then returning to the recording area where they are picked up by the microphones.

The ambience sounds can often be heard quite clearly when a recording is played in mono or stereo, but they do not sound very convincing as they come from the front, along with the main signal. When listening in a concert hall, these sounds would be

mainly heard coming from the rear, sides and above the listener. It must be emphasised that the ambience signals are not so delayed as to appear as distinct echoes of the main sound; they are delayed only fractionally and are detected subconsciously rather than by the conscious mind.

Ambience signals give a good concert hall a very rich sound which is lacking when a two channel stereo or mono recording is played in a room of normal domestic dimensions. Some of this richness of sound can be recovered by using four channels. In the ambiphonic arrangement (sometimes called the Haffler configuration after its originator) the ambience signals will be reproduced by both the front and the rear speakers. These signals will, of course, be phased quite randomly. Some will be in phase to some degree in both channels, and will contribute only a small signal for the rear speakers. But other signals will be out of phase, and will be reproduced more loudly from the rear. This can give a very realistic effect, and is what enables the system to work as well as it does.

As is to be expected, the simple arrangement of Fig. 1 has limitations. The most obvious one is that there is a tendency to have the front speaker volume at the normal stereo setting, augmented by the rear speakers. There is therefore increased loading on the amplifier, which can cause problems unless the equipment is normally used well within its maximum ratings. Again, unless one amplifier output connection is common to both channels, the arrangement will not work at all!

Another drawback is the lack of individual level controls for the front and rear speakers, as the stereo amplifier volume control will govern both front and rear volume levels. There is no means of balancing the rear speakers, either. Thus, any differences in the efficiencies of the front and rear speakers, and between the two rear speakers, will result in unbalanced reproduction.

Simple resistive volume controls consisting of low value variable resistors in series with the rear speakers and, possibly, the front speakers are feasible but not attractive. Amongst other things, they can reduce speaker damping by the low output impedance of the amplifier and introduce losses in efficiency.

All these disadvantages can be overcome by using four power amplifiers, one for each speaker, and by obtaining the difference signal at a low power level. Volume and even tone controls for the rear channels then present no problems whatsoever.

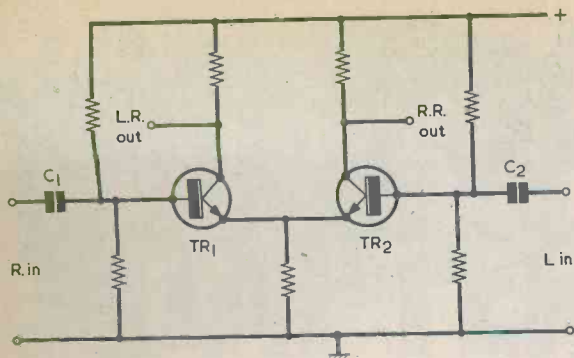


Fig. 2. A differential amplifier, as here, can be employed to produce difference signals for the rear speaker channels

DIFFERENTIAL AMPLIFIER

An obvious method of obtaining out-of-phase difference signals is to use a differential amplifier. Fig. 2 shows the basic circuit diagram for an amplifier of this type.

The two transistors are normally biased so that they have equal collector currents under quiescent conditions. If a signal is fed to TR1 base via C1, TR1 will operate as a common emitter amplifier, and an amplified and inverted signal will appear at its collector. Its emitter will also follow the input signal voltage, and will be in phase with the input signal. The signal at TR1 emitter is applied to the emitter of TR2, causing TR2 to operate in the common base mode. A common base amplifier does not invert the signal it handles, and so the input signal at TR1 base appears amplified and in phase at TR2 collector.

A similar process takes place if an input signal is applied to TR2 base via C2. In this case an amplified inverted signal will appear at TR2 collector and an amplified in-phase signal at TR1 collector.

If identical in-phase signals are fed to the bases of both transistors, there will be no variation in the collector current of either. This is because the two emitters will follow the signals and will maintain the same base-emitter current in both transistors. The two in-phase inputs thus cancel each other out and produce no output signals at the collectors.

Equal out-of-phase input signals will produce an exactly opposite effect. The input at TR1 base will appear inverted at its collector and that of TR2 base inverted at TR2 collector. Furthermore, the signal amplitude at each collector will be double the amplitude given if the signal had been applied to only one base.

The same phase relationships as occur in the ambiphonic arrangement of Fig. 1 are given if the left rear signal is taken from the transistor to which the right hand input signal is applied, and the right rear signal is taken from the transistor to which the left hand input signal is applied. The difference signals are, this time, obtained at a low power level and are then fed to the rear speakers via power amplifiers.

PRACTICAL CIRCUIT

The practical circuit of the ambiphonic adapter is given in Fig. 3. In this, TR1 and TR2 form the differential amplifier, and the input signals, obtained from a stereo amplifier, are applied to their bases via the pre-set potentiometers VR1 and VR2. These potentiometers are adjusted to balance the input signal levels.

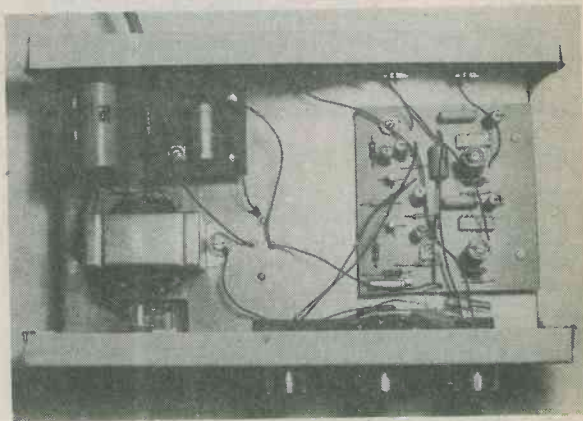
R6 and R7 form a potential divider which provides base bias for TR1 via R1 and for TR2 via R5. This method of base bias supply offers more reliable results than does the use of a separate bias network for each transistor. The junction of R6 and R7 is bypassed to chassis by way of C2.

There is no need to use matched transistors for TR1 and TR2, but they should be from the same gain group. Transistors from the highest gain group (BC108C) are to be preferred as these will give the lowest noise and distortion figures.

The signal at TR2 collector couples via C4 and volume control VR3 to the left rear channel amplifier. That at TR1 collector passes to an identical circuit for the right rear channel. Only the left rear amplifier is illustrated in Fig. 3.

The signal at the slider of VR3 passes next to the passive tone control network around VR4 and VR5, which provide bass and treble cut and lift. The output from the tone control network is then fed to IC1, an LM380N integrated circuit a.f. amplifier in 14 pin dual-in-line. This particular i.c. requires few external discrete components to make up a working amplifier. C9 and C12 are the input and output d.c. blocking capacitors respectively. C10 decouples the supply to the pre-amplifier section of the i.c. whilst C11 and R11 ensure stable output loading. C13 is the main supply bypass capacitor for both channels.

A maximum output power of about 3 watts r.m.s. per channel is possible, but the i.c.'s, as used in the present design, are only provided with sufficient heat-sinking to sustain a continuous output of about 2 watts r.m.s. There is little risk of the i.c.'s being damaged through overheating, however, as the LM380N has internal thermal shutdown circuitry. It also has output short-circuit protection. In a practical situation the integrated circuits will not, in any case, be called upon to handle continuous high amplitude sine waves.



The layout of the printed boards on the chassis inside the case

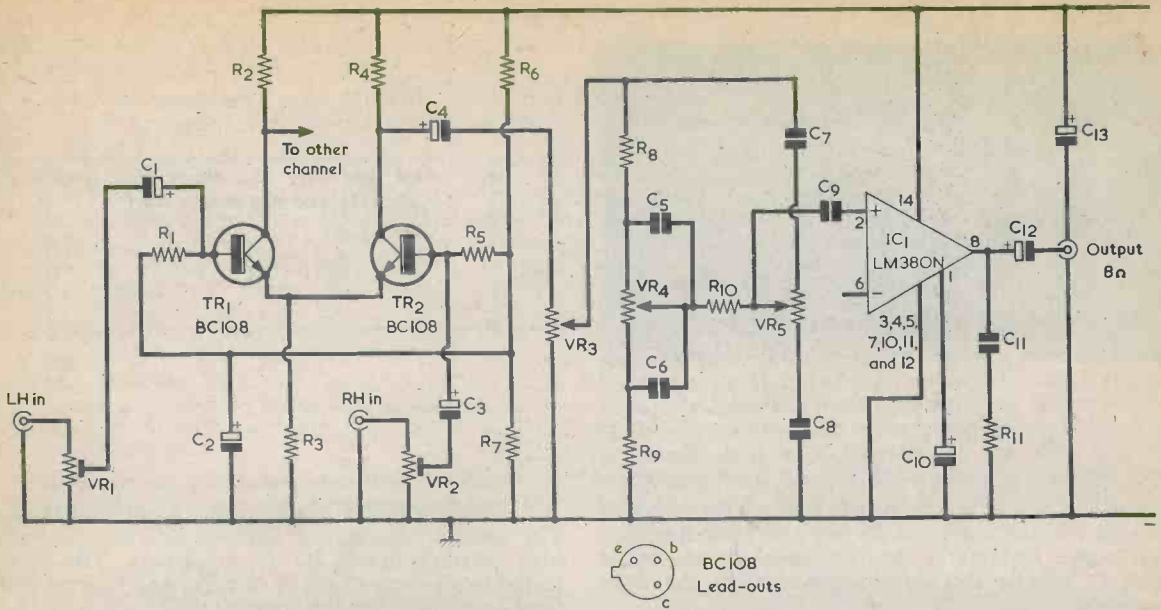


Fig. 3. The circuit of the ambiphonic adapter. The two inputs for the differential amplifier are taken from a stereo amplifier. The volume control, tone control and amplifying circuit for the other channel is identical to that shown here

COMPONENTS

Resistors

(All fixed values 1/4 watt 5%)

- R1 39kΩ
- R2 5.6kΩ
- R3 3.3kΩ
- R4 5.6kΩ
- R5 39kΩ
- R6 39kΩ
- R7 27kΩ
- R8, R8a 15k
- R9, R9a 1.5kΩ
- R10, R10a 6.8kΩ
- R11, R11a 10Ω
- R12 2.2kΩ
- VR1 22kΩ pre-set potentiometer, 0.1 watt horizontal (see text)
- VR2 22kΩ pre-set potentiometer, 0.1 watt horizontal (see text)
- VR3, VR3a 47kΩ potentiometer, log
- VR4, VR4a 47kΩ potentiometer, linear
- VR5, VR5a 47kΩ potentiometer, linear
- VR6 2.2kΩ pre-set potentiometer, 0.1 watt horizontal (see text)

Capacitors

- C1 10μF electrolytic, 16 V. Wkg.
- C2 10μF electrolytic, 16 V. Wkg.
- C3 10μF electrolytic, 16 V. Wkg.
- C4, C4a 10μF electrolytic, 16 V. Wkg.
- C5, C5a 0.01μF plastic foil
- C6, C6a 0.1μF plastic foil
- C7, C7a 0.0022μF plastic foil
- C8, C8a 0.022μF plastic foil
- C9, C9a 0.47μF type C280 (Mullard)
- C10, C10a 10μF electrolytic, 16 V. Wkg.
- C11, C11a 0.068μF type C280 (Mullard)
- C12, C12a 1,000μF electrolytic, 10 V. Wkg.

- C13 100μF electrolytic, 25 V. Wkg.
- C14 2,200μF electrolytic, 25 V. Wkg.
- C15 150pF polystyrene
- C16 1,000μF electrolytic, 25 V. Wkg.

Transformer

T1 Mains transformer, Douglas type MT112 (see text)

Semiconductors

- IC1, IC1a, LM380N
- IC2 723C
- TR1 BC108 (see text)
- TR2 BC108 (see text)
- TR3 2N3055
- D1 1N4002
- D2 1N4002

Switch

S1 (a) (b) d.p.s.t. rocker (see text)

Neon

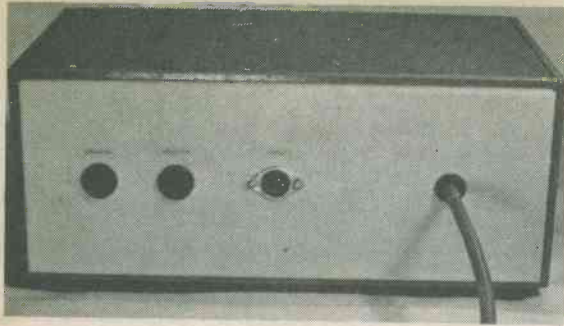
NE1 Panel mounting neon assembly, 240V a.c.

Sockets

- 5-way DIN socket
- 2-off 2-way DIN speaker sockets

Miscellaneous

- Case, Contil MOD-2 size C (Doram)
- 6-off control knobs
- TO-3 insulating kit (for TR3)
- Mains lead and plug
- Materials for printed circuit boards
- Grommet, wire, nuts, bolts, etc.



Rear view, showing the input and output sockets and the mains lead

A power output of 2 watts per channel for each rear speaker is quite adequate for use with most domestic hi-fi stereo systems as the rear speakers are called upon to handle less output power than the front speakers.

The unweighted noise level is better than -60dB , and distortion is only about 1% with an output of 2 watts r.m.s. into an 8Ω speaker, as measured at 1kHz.

It will be evident that some of the components in Fig. 3 are duplicated in the amplifier for the right rear channel. These components are identified in the Components List and layout diagrams by the addition of the suffix 'a'. Thus, the right rear volume control is designated VR3a.

POWER SUPPLY

A regulated mains power supply is employed for both channels, and the circuit for this is given in Fig. 4. The centre-tapped secondary of transformer T1 connects to the full-wave rectifier given by D1 and D2, with C14 functioning as reservoir and smoothing capacitor. The voltage across C14 is then applied to

IC2, which is a 723C regulator in 14 pin dual-in-line. The external transistor, TR3, passes the relatively high currents drawn by the amplifiers. VR6 is adjusted to give an output of 16 volts, and C16 provides final smoothing for the supply.

A very well smoothed and regulated supply results, the hum content on the output being extremely low.

The mains transformer is a Douglas type MT112. This has a 0.5 amp secondary with the following connections: 0V, 12V, 15V, 20V, 24V and 30V. The centre-tap connection in Fig. 4 is made to the 15V tap, and the 0V and 30V taps connect to D1 and D2. No connections are made to the unused taps, which are not shown in the diagram. The transformer may be obtained from A.S.P. Ltd., Simmonds Road, Wincheap, Canterbury, Kent. The neon indicator, NE1, is a neon assembly, complete with integral series resistor, which is intended for operation at 240 volts a.c. The mains on-off switch, S1 (a) (b), is a d.p.s.t. rocker switch (non-illuminated) which is retailed by Doram Electronics.

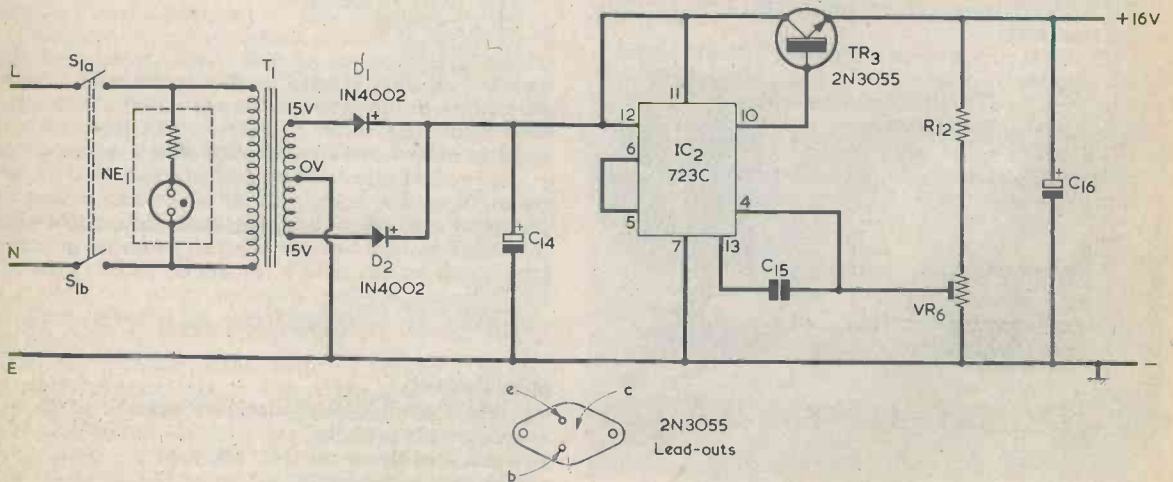


Fig. 4. The power supply section of the adapter unit. This employs a standard i.c. voltage regulator circuit

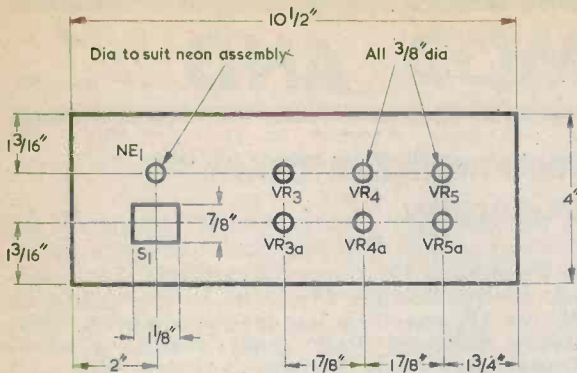
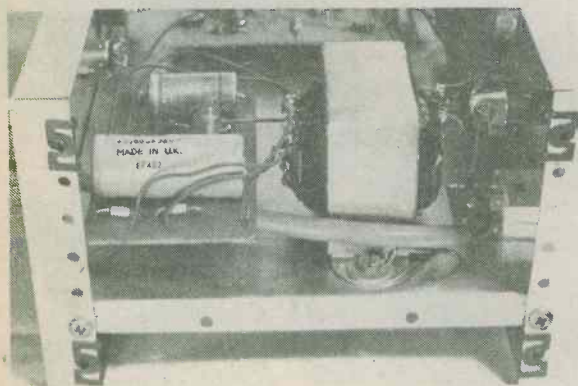


Fig. 5. Drilling and cutting details for the front panel. The two outside dimensions are approximate

CASE

The adapter is made up in a ready made case. This is a Contil MOD-2 case, size C, and is also available from Doram Electronics. It is supplied complete with an aluminium chassis.

The drilling and cutting out required on the front panel is shown in Fig. 5. This is quite straightforward apart from the aperture required for S1. The dimensions needed here are shown in inches in the diagram, and it may be noted that Doram Specify 28.2 by 22.3mm. As can be seen from the photograph of the front of the unit, the longer dimension is horizontal. The aperture can be cut out by means of a fretsaw or a miniature round file, and the panel, being p.v.c.



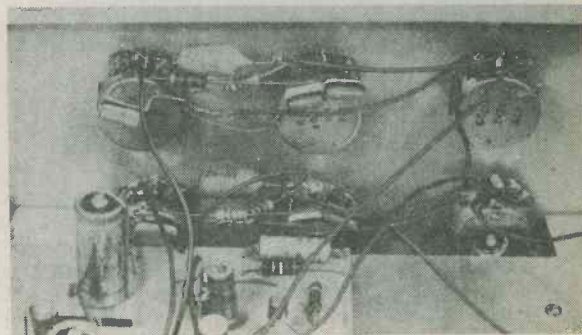
The chassis is fitted at the lowest level available

covered aluminium, is quite easy to cut. The cut-out should be made to just less than the required dimensions, and it is then carefully filed out to precisely the correct size. The switch clips into the cut-out and so it is essential that the latter be accurately dimensioned.

There is a choice of five levels at which the chassis can be mounted. For this project it is mounted at the lowest level.

Before fitting the chassis, two rectangular cut-outs need to be made along its front edge, one to give clearance for VR3a, VR4a and VR5a, and the other to give clearance for S1. The dimensions can be taken from the components themselves. The four short edges of the cut-outs, at right angles to the chassis front edge, are made with a hacksaw. The cut-out edge lines parallel to the front edge are then deeply scored in the aluminium with a sharp modelling knife. The two metal sections to be removed are next, in turn, repeatedly bent up and down along the scored lines until the metal fatigues and the sections break off.

Four holes are required in the rear panel for the



Part of the front of the chassis is cut away to give clearance for the control potentiometers

sockets and the grommet for the mains lead. Looking directly at the rear panel the holes take, from left to right, the right rear speaker socket, the left rear speaker socket, the input socket and the mains lead grommet. The speaker sockets are 2-way DIN, and the input socket 5-way DIN. The socket bodies, and the mains lead, should be just above the surface of the chassis. The positions of the holes can be adjudged from the photograph of the adapter rear.

NEXT MONTH

Constructional details will be completed in next month's concluding article. The full Components List accompanies the present article, and any outstanding points about the parts employed will be dealt with next month.

(To be concluded)

VEROWIRE

Vero Electronics Limited announce the introduction of a further addition to their range of systems for breadboarding and prototype work.

The new system has been designed for the inter-connection of components on a very high density. The basis of the system is a self-fluxing polyurethane



coated wire which is housed in a special pen dispenser and used to connect from one position on a circuit board to another. The wire thickness is 38 AWG with an insulation thickness of .0005mm giving a proof voltage of 600 Volts DC.

The wire which is used to make the interconnections is held neatly in position on the circuit board by the use of moulded wiring combs. These not only retain the wire, but are also used in routing from one point to another.

The principle of use is to mount all components on to the circuit board deforming the individual legs of I.Cs through 120° with a special deforming tool. This more positively enables the wire to be wrapped around them. All wiring is then carried out, the wire being held in position by wrapping one or two turns of it around the component. The wires are then soldered permanently in position without the necessity for the insulation to be pre-stripped merely by using a temperature controlled miniature soldering iron.

The photograph illustrates the component parts of an introductory kit which is now available for approximately £15. It consists of a wiring pen, a number of spools of wire, wiring combs and terminal pins together with a lead deformation tool, inspection glasses and cutters.

TELEPHONE CENTENARY EXHIBITION

A Telephone Centenary Exhibition was opened, at the Science Museum, to the public on March 10, exactly a hundred years after Alexander Graham Bell shouted into a crude transmitter "Mr. Watson — come here — I want to see you", and Mr. Watson obeyed.

The first part of the exhibition deals with Bell's early life and how he came to make his invention. The establishment of the telephone in Britain is then shown and the final section of the exhibition shows some of the major technological developments in telephony. Historical exhibits include part of the radio transmitter that provided the first transatlantic telephone link.

JONELLE CASSETTE TAPES

Department Stores of the John Lewis Partnership have now introduced their own brand Jonelle cassette blank tapes at competitive prices.

The Jonelle C60 costs 39p and lasts 2 x 30 minutes approximately; and the Jonelle C90 costs 49p and lasts 2 x 45 minutes approximately.

Both are supplied in snap-back cases and are complete with an index card.

The cassettes are made in England using tape made by a large West German manufacturer.



COMMENT

WHEATSTONE—THE VERSATILE INVENTOR

In the article "The Wheatstone Telegraph" by D. P. Newton which appeared in our June 1975 issue, our contributor pointed out that Wheatstone did not invent the Wheatstone Bridge, for which he is mostly remembered nowadays, although he popularized its practical effect.

Another of our contributors, George Short, made the same point in a BBC science programme when describing some of the ingenious experiments Wheatstone conducted.

If you had been in London in 1821, you might have come across a strange demonstration, in a musical instrument maker's shop in Pall Mall, said George Short. From the ceiling was suspended a Greek lyre. It emitted, as if by magic, the sounds of music.

The demonstration was a trick, of course. The music was in reality played by musicians in the room above. But it was a scientific trick, based on observations of the efficiency with which sound vibrations can be conducted from one place to another through something metallic — in this case, through the brass wire hanging from the ceiling, which really went *through* the ceiling to the sounding board of a piano upstairs. The 'lyre' was a sort of loudspeaker.

Wheatstone, in his teens, had repeated experiments on sound vibration made originally by the German, Chladni, and improved on them, devising a technique which demonstrated how instruments emitting the same note can nevertheless have a different timbre.

Unknown to Wheatstone, the Danish physicist Oersted had already done this. The two men met when Oersted came to London and heard about the "Enchanted Lyre." They became friends, and Oersted publicised Wheatstone's work in lectures in Paris. Other friendships came, too, notably with Michael Faraday, and it is not entirely surprising that Wheatstone, at the age of 32, became professor of science at London University.

He had passed the intervening years in amateur research into acoustics, devising an experiment to measure the speed of electricity, and inventing various musical instruments, including one which became popular — the concertina.

CASSETTE IN HUMBER BRIDGE FOUNDATIONS



Derek Ratcliffe, BBC Radio Humber-side producer, with the cannister containing the Scotch High Energy cassette which has been placed 150 feet down in the foundations of the Humber Bridge, the world's longest single-span structure. 3M's cassette contains a recording about the bridge produced in 1972 by BBC Radio Humberside.

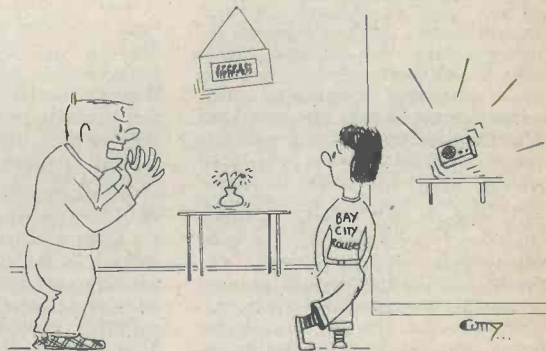
JOHNSONS RADIO

Messrs. Johnsons Radio, of 17 Solitaire Avenue, Worcester, formerly of Shaw Street, Worcester, wish to express their apologies to those of our readers who were inconvenienced in the latter part of last year by delays in executing orders.

The delays were due to exceptional circumstances quite outside their control. We understand that orders are now processed normally.

4 Channel Stereo Mixer

In the Veroboard layout diagram for this design, appearing on page 411 of the last February issue, the negative leads of C11 and C11a should connect to X2 and X15. Due to R1, R4, R7 and R10, the pre-amplifiers are susceptible to noise on the positive supply rail; should hum be troublesome C14 may be increased to 2,000uF and C15 to 1,000uF.



"I said the volume is too High."

NOVEL TRANSISTOR GAIN METER

By G. A. French

It is helpful, especially when dealing with batches of surplus or ex-equipment transistors, to have a means of measuring common emitter current gain, or HFE. Ideally, a device for measuring HFE requires a meter to indicate base current and a second meter to indicate the consequent collector current. The collector current divided by the base current then gives the HFE figure at the particular conditions under which the measurements are made.

It is possible to dispense with the meter which indicates base current if the supply potential is constant. The base current is passed via a series resistor and, when the value of this is known, the base current flowing though it can be readily calculated. A meter to indicate collector current is still nevertheless required. Typically, the collector current meter may consist of a 0-10mA movement but such instruments are nowadays becoming more and more expensive when purchased new.

The current gain meter to be described employs a novel approach which dispenses with a current indicating meter in the collector circuit of the transistor under test, replacing it with a relatively inexpensive relay. The base current of the test transistor is gradually increased by advancing a variable resistor until the relay energises. The HFE of the transistor being checked may then be read from a scale fitted to the variable resistor. The overall accuracy of the gain readings thus obtained can be of the order of 10%, which is sufficient for most home-constructor applications.

The use of a relay as a collector current monitor is admittedly unusual, and it might be considered that most relays could not be relied upon to energise always at a specific coil current. However, the particular relay model recommended for the circuit

has an extremely simple construction with an almost friction-free pivot for the armature, whereupon the current at which it energises becomes a function of the air gap between the armature and the core prior to operation and the tension imparted by the armature retaining spring. These two factors are unlikely to alter in the short term and should remain constant over long periods if the relay is enclosed in a case which prevents the ingress of dust and dirt. Practical checks by the author have shown that the relay always energises at a precise current and that there is no change in the value of the energising current if its direction is reversed after a period during which the relay has been held energised. There would appear in consequence to be little remanent magnetism in the relay armature, yoke or core, and the relay can be employed to monitor the collector current of both n.p.n. and p.n.p. transistors without polarity switching for its coil.

BASIC CIRCUIT

The basic circuit for the transistor gain meter is illustrated in Fig. 1. Here, a variable resistor is connected between the upper supply rail and the base of the test transistor, and it inserts a resistance R. The voltage across the variable resistor is equal to the supply voltage minus the voltage dropped in the base-emitter junction of the transistor, and we shall refer to this as VR. The collector of the test transistor couples to the upper supply rail via the coil of the relay, which has a resistance of 500Ω. We shall call the voltage across the coil which is just sufficiently high to operate the relay VO. We know VR by measurement of the supply rail voltage, and we know VO as a result of a previous measurement.

The value of R is gradually reduced by adjustment of the variable resistor

until the relay just operates. Since the release current for the relay is lower than its energising current, the relay stays firmly in the operated condition. The HFE of the test transistor under these conditions is equal to the current flowing in the relay coil divided by the current flowing in the variable resistor. From Ohm's Law the current in the relay coil is equal to VO divided by 500Ω. Similarly, the current in the variable resistor is equal to VR divided by R. HFE then becomes equal to:

$$\frac{VO}{500} \times \frac{R}{VR}$$

where R is in ohms. The corresponding expression for R in kilohms is:

$$\frac{VO}{0.5} \times \frac{R}{VR}$$

This gives us an equation for R in kilohms which reads:

$$R = \text{HFE} \times \frac{0.5VR}{VO}$$

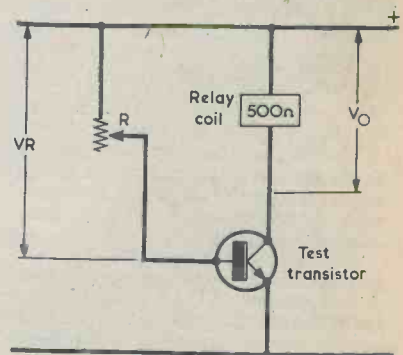


Fig. 1. Basic operating circuit of the transistor gain meter. An n.p.n. transistor is assumed

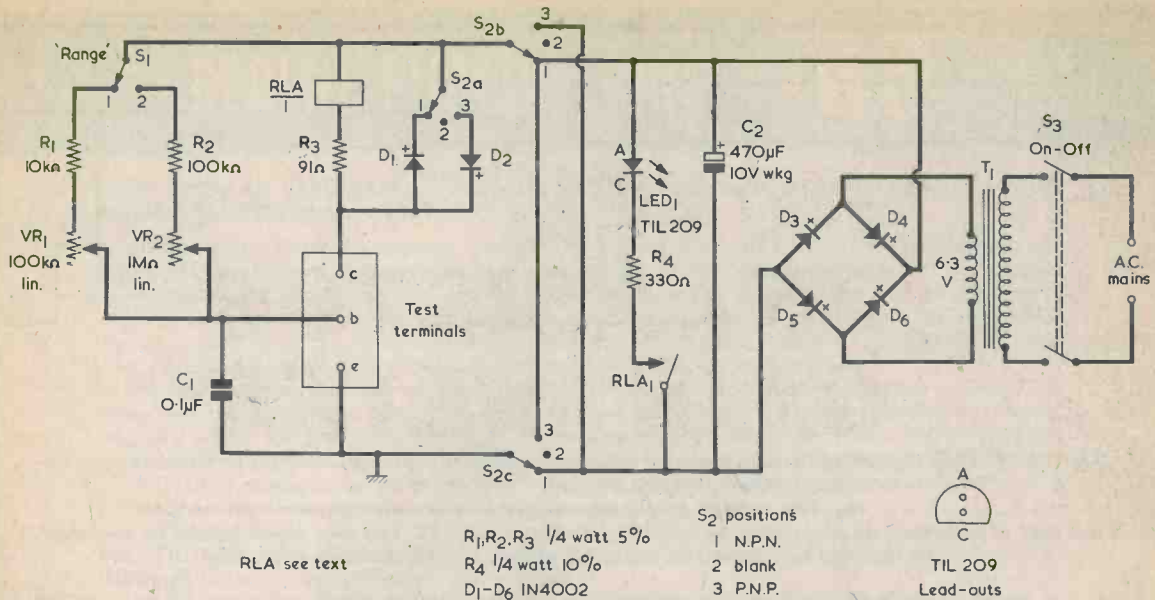


Fig. 2. The complete circuit of the transistor gain meter

FULL CIRCUIT

The full circuit of the gain meter appears in Fig. 2. In this, S₂(a)(b)(c) is the transistor polarity switch and, in the diagram, is shown in the n.p.n. position. For the time being we shall assume that the gain meter is intended to check silicon transistors only.

The relay coil is represented by the rectangle designated RLA/1, and its single contact set, shown in the de-energised condition, as RLA1. When the relay energises the contact set completes a supply circuit to the light-emitting diode LED1, causing this to be illuminated. The relay is a 'Miniature Open P.C. Relay' with a 410Ω coil, available from Doram Electronics. The nominal operating voltage range of the relay is specified as 4.8 to 35 volts, and it will be found that the coil voltage which just causes it to operate is lower than 4.8 volts.

The 91Ω resistor, R₃, in series with the relay coil brings the total resistance in the transistor collector circuit closely equal to 500Ω. Collector circuit conditions are thus virtually the same as in Fig. 1. If desired, R₃ can be a 1% or 2% 90Ω resistor instead of the 5% component indicated in Fig. 2. Alternatively, R₃ could have a value which causes the measured resistance across it and the relay coil to be exactly 500Ω.

A simple mains supply is employed and no attempt at voltage stabilization is incorporated. T₁ is any mains heater transformer with a 6.3 volt secondary rated at 1 amp or more. This feeds into a bridge rectifier coupled to the high value reservoir capacitor C₂, with the result that at the low current consumption given when the relay just operates the supply voltage is very nearly equal to the peak rectified output of the

bridge rectifier. Voltage stabilization is, in consequence, governed by the voltage stabilization of the mains supply and it is felt, for a simple instrument of this nature, that such a level of stabilization is adequate. A voltage stabilizing circuit would, of course, be essential if a battery were used instead of the mains supply.

The variable resistor of Fig. 1 is replaced by either R₁ and VR₁, or R₂ and VR₂, according to the setting of the Range switch S₁. Range 1 is used for the measurement of HFE from about 10 to 100, and Range 2 for HFE figures from about 100 to 1,000.

As already stated, S₂ controls polarity and is shown in the n.p.n. position. S₂(b) and (c) then allow the upper supply rail to be positive and the lower supply rail to be negative. In the p.n.p. position S₂(b) and (c) cause the upper rail to be negative and the lower rail to be positive. D₁ or D₂ prevents the formation of a high back-e.m.f. on release of the relay, and these are switched in as required by S₂(a). S₂ has a central blank position. This enables an inexpensive 4-pole 3-way make-before-break rotary switch to be used, with no connections made to one of the poles. The central blank position ensures that the rectified voltage across C₂ is not short-circuited when changing from one polarity to the other.

Capacitor C₁ is included to provide a level of bypassing between the test transistor base and emitter for any hum voltages which may be picked up by the base wiring. With a high gain transistor these could cause trembling of the relay armature when the voltage across the coil is close to operating level. Such armature trembling may still occur, despite the presence of C₁,

if a finger is applied to the base of the test transistor. Because of this effect, the test terminals should not be touched when evaluating the gain of a transistor.

CIRCUIT VOLTAGES

In order to calibrate VR₁ and VR₂, it is first necessary to find the values of VR and VO in the equation given earlier. This is quite a simple process and merely involves the measurement of two voltages.

The circuit should be assembled with all components except for LED1. A transistor is connected to the test terminals and S₂ adjusted for the required polarity. A testmeter switched to an appropriate voltage range is then connected across RLA/1 and R₃, as illustrated in Fig. 3(a). S₁ is set to Range 2, and VR₁ and VR₂ adjusted to insert maximum resistance into circuit. The resistance inserted by VR₂ is then gradually reduced until the relay, as observed visually, just operates. If the relay does not operate within the range offered by VR₂, S₁ is set to Range 1 and the resistance inserted by VR₁ is gradually reduced until the relay operates. The voltage appearing across the relay coil and R₃ at which the relay just operates is then noted. This is VO. Without disturbing the setting of VR₂ (or VR₁ as appropriate) the voltage across the supply rails is measured as in Fig. 3(b). Following the assumption that the gain meter will be employed only for checking silicon transistors, VR is then equal to the voltage across the supply rails minus 0.6 volt. The 0.6 volt figure is the typical forward voltage drop across the base and emitter of a silicon transistor.

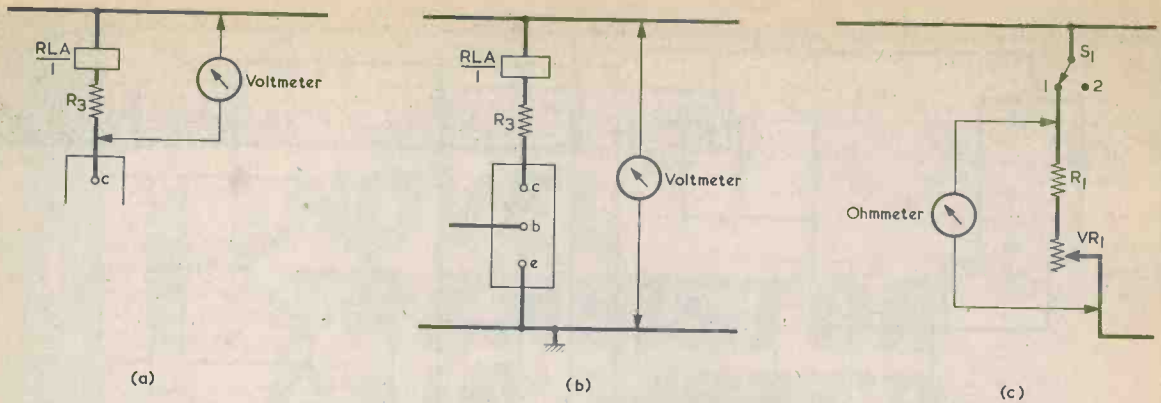


Fig. 3(a). Finding the voltage across the relay coil and R3 when the relay just energises. Voltmeter polarity depends upon whether the test transistor is n.p.n. or p.n.p.
(b). The voltage across the supply rails is next checked
(c). VR1 is calibrated by measuring its resistance in series with R1. The gain meter should be switched off and the test transistor removed whilst carrying out this operation

As a practical example of the figures to be expected, VO in the author's circuit was 3.8 volts, whilst the voltage across the supply rails was 7.8 volts, giving a VR of 7.2 volts. Substituting in the equation given earlier,

$$R = \text{HFE} \times 0.5 \times 1.9 \\ = \text{HFE} \times 0.95.$$

VR1 is then calibrated by connecting an ohmmeter across R1 and VR1, as in Fig. 3(c). VR1 is calibrated for a gain figure of 20 when the value of R1 plus VR1 equals 0.95 times 20, or 19kΩ. Resistance values corresponding to gains of 30 and 40 are 28.5kΩ and 38kΩ respectively, and calibration may be continued up to the highest figure offered by VR1. VR2 is calibrated in the same way by connecting the ohmmeter across R2 and VR2 in series and using the formula for R and HFE. In practice it will be difficult to measure resistance very closely with the ohms ranges of the average testmeter, but a reasonable approximation should be possible.

The calibration of other gain meters made up to the circuit is carried out in the same manner. The values of VO and VR are initially found, after which they are substituted in the equation for R and HFE.

After the values of VO and VR have been established the light-emitting diode is connected into circuit. To use the gain meter, VR2 and VR1 are set to insert maximum resistance, S2 is put to the requisite polarity and the test transistor is connected to the test terminals. VR2, or if necessary VR1, is then reduced in value until the light-emitting diode becomes illuminated, whereupon the HFE of the transistor is read directly from the scale of the appropriate potentiometer. This will be, judging from the writer's experience, at a collector current of approximately

8mA. If the transistor is connected to the test terminals incorrectly, the maximum current which can flow is limited by R3 and the relay coil to about 16mA. The flow of such a current in a modern transistor junction should not cause damage, but it would be preferable to ensure that earlier transistors, such as the OC44, are connected properly.

GERMANIUM TRANSISTORS

As described, the gain meter is calibrated for silicon test transistors having a base-emitter voltage drop of approximately 0.6 volt. It may also be used to check germanium transistors which have a base-emitter voltage drop of about 0.1 volt, but the readings given will be about 6% high.

This fact can be accepted or, alternatively, the discrepancy can be reduced by fitting a switching circuit between the emitter test terminal and the lower supply rail, as illustrated in Fig. 4. The switch shown here as S4 connects the emitter test terminal directly to the lower supply rail when checking silicon transistors, so that the overall circuit is then the same as in Fig. 2. When S4 is set for checking germanium transistors, the two silicon diodes D7 and D8 are inserted between the emitter test terminal and the lower supply rail. These will give a forward voltage drop of 0.6 volt both for n.p.n. and p.n.p. germanium test transistors, whereupon the total forward voltage drop between the base and the lower supply rail will be about 0.7 volt. This is sufficiently close to the situation given when checking silicon transistors for the calibration of VR1 and VR2 to be employed for both types of transistor.

The complete gain meter can be

housed in a metal or insulated case with the switches, the test terminals, VR1, VR2 and LED1 mounted on the front panel. A metal case should be made common with the lower supply rail, as indicated by the chassis symbol in Fig. 2. The case should also be connected to the mains earth. No chassis

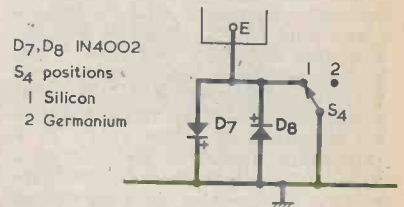


Fig. 4. If desired, a switching circuit can be incorporated which permits the same calibration to apply for germanium as well as silicon transistors

connection is needed with an insulated case. With either type of case the usual precautions must be taken to ensure that there is no risk of accidental shock from the mains supply.

It may be found that there is an occasional tendency for the relay armature to tremble when, after operation, either VR1 or VR2 is taken back to the point where the relay releases again. This is a characteristic of the relay design and has no bearing on the energise function, which is sharp and abrupt.

RECENT PUBLICATIONS



HOW TO BUILD ELECTRONIC KITS. By Vivian Capel. 95 pages, 215 x 130mm. (8½ x 5¼ in.) Published by Argus Books Limited. Price £1.75.

Intended primarily for the beginner in home-construction, this book sets out to give a practical explanation of the various components that may be encountered and the simple skills that are required for the successful completion of a project. Whilst the book title refers to kits, the contents apply almost equally well to the building of designs published in the constructional press. The work could also be instructive for the somewhat more experienced electronics hobbyist, as each subject is dealt with at quite a high level of detail commensurate with the size of the book.

The first two chapters give an introduction to components and to semiconductor devices. The following chapters then get down to the basics of construction, dealing with the questions of connecting up a circuit, the use of the soldering iron, general assembly and fault-finding. Further chapters are devoted to testmeters and their uses, the construction of cases and, finally, the choice of battery.

The book is helpful and down to earth, and will be of value to anyone embarking on the rewarding hobby of amateur electronics.

ELECTRONIC TEST EQUIPMENT. By Harry T. Kitchen. 207 pages, 215 x 135mm. (8½ x 5½ in.) Published by Argus Books Limited. Price £4.50.

"All branches of engineering require measuring instruments, but nowhere is the field so diverse or so complex as in electronics." This, the opening sentence in the preface to this comprehensive book, aptly sets the scene for an interesting and instructive text.

Commencing, inevitably, with voltage, current and resistance measurements, the book proceeds to electronic meters, audio frequency oscillators, radio frequency oscillators, and attenuators. Then follows a long chapter on oscilloscopes which includes more than a dozen clear illustrations of traces photographed direct from the screen and demonstrating sweep non-linearity, attenuator compensation and a.f. amplifier performance under different conditions. Also included are photographs of commercial test equipment and of equipment which has been constructed by the author.

The treatment is mainly descriptive with the inclusion of a little simple mathematics, where necessary. The author obviously has a special inclination towards electronic measurements and measuring instruments, and this has been exemplified in articles under his name which have appeared in earlier issues of *Radio & Electronics Constructor*. It is a pleasure to record that one of our contributors has produced a book as meritorious as "Electronic Test Equipment".

FOUNDATIONS OF WIRELESS AND ELECTRONICS, 9th Edition. by M. G. Scroggie, B.Sc., C. Eng., F.I.E.E. 551 pages, 215 x 130mm (8¼ x 5¼ in.) Published by Newnes Technical Books. Price £3.75.

First introduced in 1936 under the title "Foundations of Wireless", this best-selling book has now sold nearly 250,000 copies. Entering its ninth edition, it offers an authoritative text on virtually all aspects of electronics.

The book starts almost "before the beginning", as it were, because Chapter 1 is preceded by a 14 page section explaining algebraic symbols, graphs and circuit diagrams. Chapter 1 then gives a general view of a radio system, after which successive chapters deal with electronics at a continually increasing depth.

M. G. Scroggie is well-known for his clear and often humorous style and he has made many contributions to the journal *Wireless World* under his own name and as "Cathode Ray". Purchasers of the book can rest assured that they are obtaining what has now become a classic work in terms of lucidity, accuracy and painstaking detail.

SERVICING WITH THE OSCILLOSCOPE, 2nd Edition. By Gordon J. King, T.Eng. (C.E.I.), R.Tech. Eng., A.M.I.E.R.E., F.I.S.T.C., F.S.C.T.E., M.I.P.R.E., M.A.E.S. 216 pages, 215 x 135mm. (8½ x 5½ in.) Published by Newnes-Butterworths. Price £4.50.

A valuable diagnostic tool for servicing work is provided by the oscilloscope, this being especially true when fault finding in colour television receivers, which have many more programme and processing signals than appear in less complex entertainment equipment.

In this second edition of a work which originally appeared in 1969, the author has expanded and updated the text to take in recent developments in colour television and audio amplifiers, as well as providing more details on the design and operation of the oscilloscope itself.

The text is liberally augmented by clear photographs of oscilloscope traces and off-screen television pictures, and the book will be of particular interest and worth for the service engineer who deals with present-day domestic electronic equipment.

POWER SUPPLY WITH ELECTRONIC FUSE

This little power supply, intended primarily for test and design work with battery powered equipment, automatically shuts itself off when the output current exceeds a pre-determined level.

By A. P. Roberts

Most modern low voltage power supplies incorporate some form of short-circuit protection. In many instances, however, this is primarily intended for the protection of the components in the power supply itself rather than for the protection of those in the circuit being supplied. Typically, the overload protection employs a form of current limiting which merely ensures that the power supply output current cannot exceed a certain level under short-circuit conditions.

As the limited short-circuit output current may lie between a hundred milliamps and several amps, expensive components in the powered circuit are afforded little protection against what may be fatally high current flows.

A different approach is used in some modern integrated circuit voltage regulators such as those in the TBA 625 series. These incorporate what is referred to as "foldback limiting" and were described by J. B. Dance in the article "Foldback Limiting Voltage Regulators", published in the October 1975 issue of this journal. With these regulators the output voltage is stabilized at currents up to the maximum level, but as soon as this level is exceeded the output voltage falls to a low level and the available output current reduces to a fraction of the previous value. Thus, a low short-circuit current flows and a considerable degree of protection is given to both the power supply and the powered circuit.

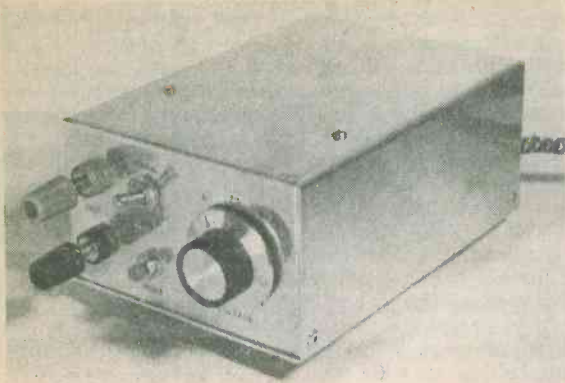
ELECTRONIC FUSE

It is possible to take the protection process a stage further by incorporating a so-called "electronic fuse" in the power supply. With such a circuit the output of the supply cuts off completely whenever the output current reaches a pre-determined trigger level. The supply voltage is restored by merely operating a reset switch.

When compared with ordinary fusing arrangements, the electronic fuse circuit has the advantage that there is no waste of time and money in replacing blown fuses. Also, and perhaps of greater importance, the electronic fuse, unlike the conventional type, is virtually instantaneous in operation. It therefore gives the maximum possible protection to the supplied circuit as well as to the power supply itself.

This article describes a simple small mains power unit which incorporates an electronic fuse. It has switched output voltages of 6, 7.5 and 9 volts nominal. The maximum current that can be drawn is approximately 200mA, and this can be altered if desired by changing the value of one resistor. The unit is particularly useful for test or design work on small battery powered equipment.

The author has been using power supply units with electronic cut-outs for a number of years now, and has never yet damaged a semiconductor device whilst employing such a power source.



THE CIRCUIT

The circuit of the power supply unit is given in Fig. 1. Here, the mains supply is applied to transformer T1, whose low voltage secondary couples to rectifiers D1 and D2, and thence to the reservoir capacitor C1, in a standard full-wave rectifier arrangement.

R7 and zener diode D3 form a simple voltage stabilizing circuit in which the stabilized voltage appears across D3. Either the full stabilized voltage or a suitable proportion is selected by S2 and passed to the input base of the emitter follower Darlington pair, TR4 and TR5. The output voltage at TR5 emitter is equal to the voltage at TR4 base minus slightly more than a volt dropped across the two base-emitter junctions.

When S2 is set to select 9 volts output, the full 10 volts across the zener diode is applied to TR4 base. About 9 volts is therefore present at the output. The voltage at the junction of R8 and R9 is such as to cause approximately 7.5 volts to be present at the output when S2 is in its central position. Similarly, the voltage at the junction of R9 and R10 allows an output of about 6 volts to be given when S2 is set for this voltage.

The output impedance at TR5 emitter is extremely low and the maximum output current of 200mA can be supplied with only a very small increase in the voltage drop across TR5. The output voltage of the prototype varies by only about 250mV between zero and maximum load.

TR4 and TR5 cannot function adequately at very low currents in TR5 emitter circuit. In consequence, R11 is connected across the output terminals to ensure that, even at zero loading, a small current is still drawn through TR5.

The electronic fuse is based on a bistable circuit incorporating TR1 and TR2. When the supply is initially turned on, TR2 becomes biased hard on by the base current flowing through R4. Its collector voltage is consequently very low and no base bias current flows into TR3, which is therefore cut off. Similarly, TR1 receives no base bias current via R2 and is also cut off.

Now, when an output current is drawn from the supply unit it passes through the low-value resistor R1, flowing in a direction which causes the voltage across the resistor to be negative at the junction with C1 and positive at the connection to the bottom earth rail. This voltage is applied to the emitter and base of TR1, with R3 in series with the base connection.

If output current increases so also does the voltage

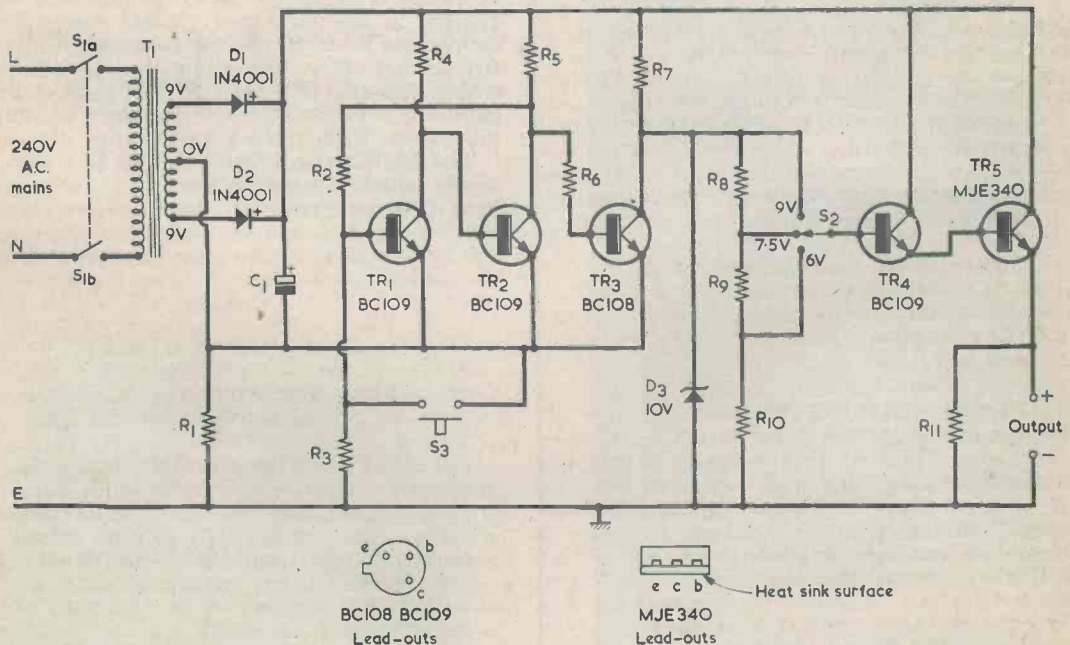
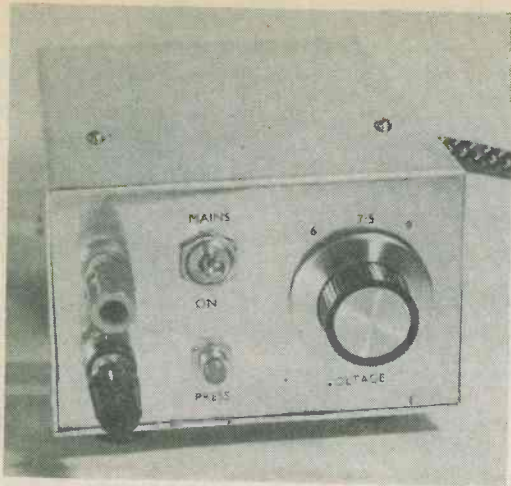


Fig. 1. The circuit of the power supply with electronic fuse. In this, TR1 and TR2 form a bistable which changes state when an excessive output current is drawn



There are three controls on the front panel, these being the mains on-off switch, the output voltage selector switch and the reset press-button

COMPONENTS

Resistors

(All $\frac{1}{4}$ watt 10% unless otherwise stated)

R1 3.3 Ω	R7 1.8k Ω
R2 12k Ω	R8 1.2k Ω 2%
R3 1k Ω	R9 1.2k Ω 2%
R4 27k Ω	R10 5.6k Ω 2%
R5 3.9k Ω	R11 8.2k Ω
R6 27k Ω	

Capacitor

C1 1,500 μ F electrolytic, 16V Wkg.

Transformer

T1 Mains transformer, secondary 9-0-9V at 1A (see text)

Semiconductors

TR1 BC109	D1 1N4001
TR2 BC109	D2 1N4001
TR3 BC108	D3 BZY88C10V
TR4 BC109	
TR5 MJE340	

Switches

S1(a)(b) d.p.s.t. toggle
 S2 1-pole 3-way, rotary (see text)
 S3 Press-button, push to make

Miscellaneous

Aluminium chassis with base plate, 152 x 102 x 64mm. (see text)
 Insulated terminal, red
 Insulated terminal, black
 Knob
 Veroboard, 0.15in. matrix
 4 rubber feet
 3-core mains lead
 Grommet for mains lead
 Bolts, nuts, etc.

dropped across R1. When the current approaches 200mA the voltage across R1 passes above 0.6 volt and this voltage, across the base and emitter of TR1, is sufficient to turn this transistor on. Its collector voltage then falls to a low level, whereupon no base current is available for TR2, which cuts off. Whereas, previously, TR2 was on and TR1 was off, TR1 is now on and TR2 off. The circuit remains stable in this state even if the voltage across R1 falls below 0.6 volt, because a base bias current is now provided for TR1 via R5 and R2.

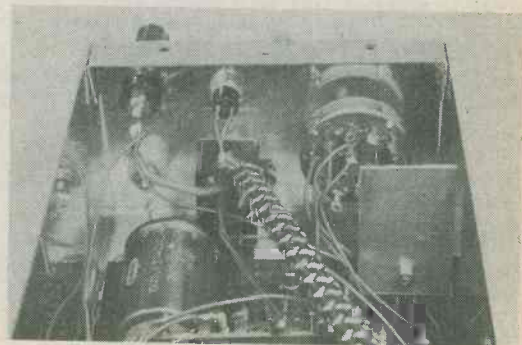
As soon as TR2 turns off a base bias current, flowing through R5 and R6, is passed to TR3. This transistor turns hard on and its collector causes the voltage across the zener diode to be taken down to a very low level. As a result, the output of the power supply falls to zero.

SWIFT ACTION

In practice the action just described takes place over a very short period of time. As soon as the output current reaches trigger level the supply shuts off and stays off. It can be turned on again by pressing the Reset button, S3. This short-circuits the base and emitter of TR1 and causes this transistor to turn off. TR2 at once turns on again and the fuse circuit reverts to its previous condition, with TR1 and TR3 off. Naturally, S3 must not be pressed until the load which has caused the excessive output current to flow has been disconnected from the power supply.

Since TR1 and TR2 form a bistable it might be thought that either of the two transistors could be the one which turns on after the power supply has been switched on by S1(a)(b). With the prototype, however, it has been found that, of the two, it is always TR2 which turns on after switch-on. This state of affairs is probably due to the fact that TR1 base couples to the earth rail via R3 whilst TR2 base couples via R4 to the positive supply rail only. To confirm circuit action, the author has checked operation with a high gain BC109 in the TR1 position and a low gain BC109 in the TR2 position, and it was still found that it was TR2 which always turned on.

The MJE340 specified for TR5 is a high voltage device which is used well within its voltage ratings here. It is a conveniently sized power transistor and meets present circuit requirements very adequately. The current level at which the electronic fuse triggers



A view from the rear of the case showing the components inside the case

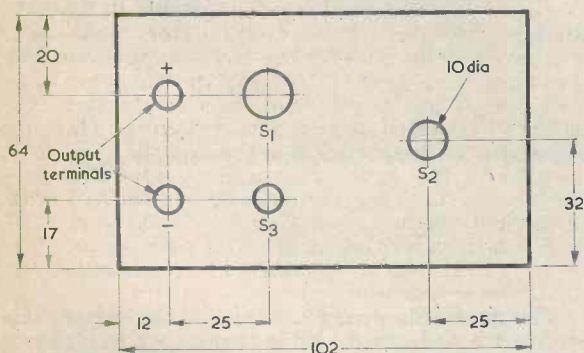
may be altered by choosing a different value for R1, this being equal in ohms to 0.66 divided by the desired trigger current in amps. The trigger current chosen should not, however, be greater than 300mA as it would then cause excessive dissipation in TR5. The mains transformer employed in the prototype is an Osmabet type MT9V (available from Home Radio) which has a secondary current rating of 1 amp. A mains transformer having a 9-0-9 volt secondary with a current rating lower than 1 amp but equal to or greater than the trigger current may alternatively be employed, provided it is small enough to fit in the space available in the power supply unit case.

Switch S2 is a single pole 3-way rotary component. The author employed a miniature 4-pole 3-way rotary switch with no connections made to the unused poles.

CASE

The unit can be built in any convenient case of adequate proportions. The author used an 18 s.w.g. aluminium chassis with base plate measuring 152 by 102 by 64mm. (6 by 4 by 2.5in.). These were obtained from Radio Component Specialists, 337 Whitehorse Road, Croydon. The base plate is at the bottom of the assembly and is fitted with four rubber feet.

One of the 102 by 64mm. chassis sides is used as the front panel, and this is drilled out as indicated in Fig. 2. The holes for the two insulated output terminals



All dimensions in mm

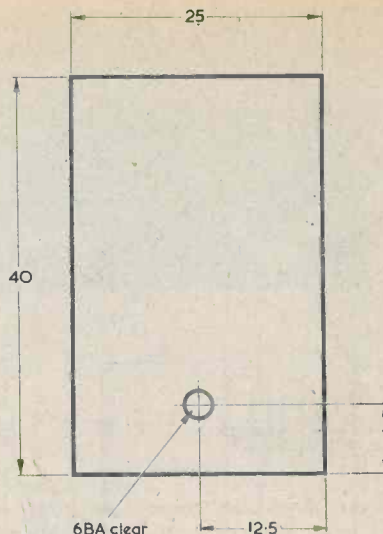
Fig. 2. Drilling details for the front panel of the supply

and for S1(a)(b) and S3 should be cut out with diameters to suit the particular components employed.

T1 is mounted centrally on the rear of the case using a couple of short 4BA bolts and nuts. A solder tag is secured under one of the nuts. A hole is also required near one of the top rear corners for the mains lead. This hole is fitted with a grommet.

Fig. 3 shows the heat sink for TR3. This is simply a flat piece of aluminium of around 20 s.w.g. which is made up to the dimensions shown.

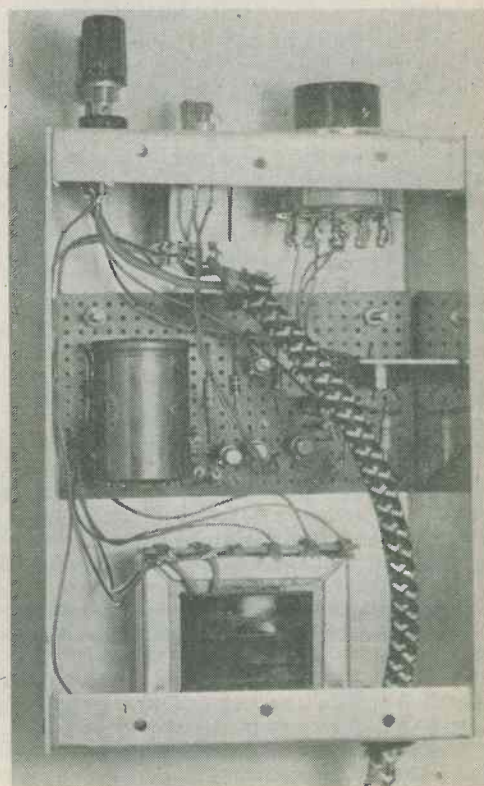
The small components are wired up on a Veroboard panel of 0.15in. matrix having 25 holes by 14 strips. Complete details of this are given in Fig. 4. Before mounting components it is necessary to drill the two



Material: 20 swg aluminium

All dimensions in mm

Fig. 3. The heat sink for TR5



Looking down into the inside of the case

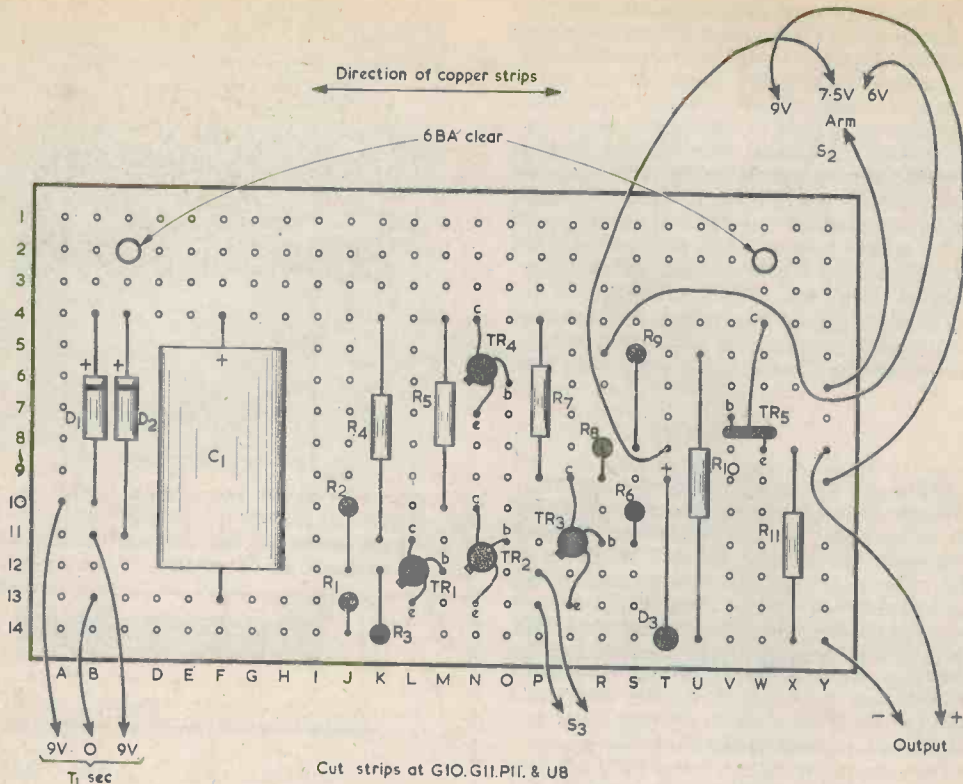


Fig. 4. Illustrating the manner in which the small components are assembled on the Veroboard panel

6BA clear holes and cut the strips at the points indicated.

The heat sink for TR5 is bolted to the metal side of the panel with a short 6BA bolt and nut in the manner illustrated in the photograph of the board. The transistor lead-outs are soldered to the Veroboard strips at the points indicated in Fig. 4 and no further support for the heat sink is required.

Two 6BA clear holes are required in the top of the case for mounting the board, and these may be marked out with the aid of the board itself. The board is positioned in the space between T1 and the components on the front panel, with the two 6BA clear holes nearer the front. Care must be taken to ensure that there is no risk of TR5 heat sink, which is common with the collector, touching any wiring or the metal case. In the latter instance, plastic insulating tape may be applied to the inside surface of the case side over the area closest to the heat sink. Before mounting the panel complete the connections to S2, S3, T1 secondary and the output terminals. In Fig. 4, the leads to S2 fixed contacts are identified by the voltages selected. The Veroboard panel is then bolted to the top of the case, using 6BA spacing washers to provide clearance from the metal underside.

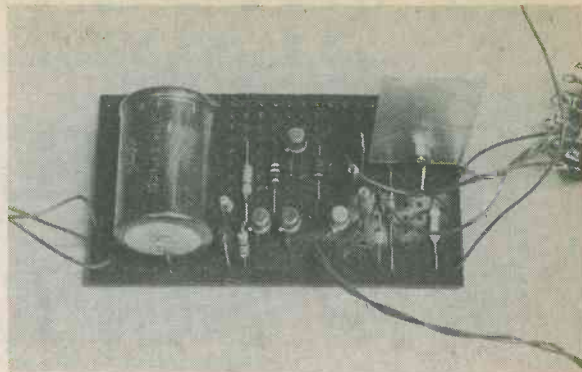
The remaining wiring can then be completed. The mains live and neutral leads connect via S1(a)(b) to the transformer primary, as in the circuit diagram of Fig. 1. The mains earth lead connects to the negative output terminal, and another lead from this terminal connects to the solder tag under the mounting nut of T1, thereby earthing the case.

TESTING

After wiring has been completed there should be a thorough check for mistakes and any apparent errors should be rectified. The supply unit may then be connected to the mains and turned on. If a voltmeter is available this can be used to check that the three output voltages are approximately correct. The exact voltages obtained will vary somewhat from their nominal values due to tolerances on zener diode voltage and, to a lesser extent, tolerances in R8, R9 and R10. The output voltages should be within 10% of the nominal values and in most instances will be closer than this.

To test the electronic fuse, switch the unit to give an output of 9 volts and, if the trigger level is 200mA,

The Veroboard component assembly



temporarily apply a 33Ω $\frac{1}{2}$ watt or 1 watt resistor across the output terminals. This should cause the cut-out to operate immediately and, once the resistor has been removed from the supply terminals, it should be possible to restore the output supply by pressing S3. Should the electronic fuse fail to operate due, say, to a wiring error, the use of a resistor across the output terminals will prevent the power supply unit from being damaged. The 33Ω resistor will, however, overheat if it is maintained across the output terminals under these conditions as the continual dissipation in it will be in excess of 1 watt.

If R1 has been given a value other than 3.3Ω the resistor connected across the output terminals for test

purposes should have a value which causes the flow of a temporary current about 20% to 30% higher than the trigger value.

It should always be borne in mind that while S3 is pressed no form of overload protection is present in the circuit. If the cut-out is triggered, immediately pressing S3 would be the same as replacing an ordinary fuse with a piece of heavy gauge wire. When the cut-out comes into operation S3 should not be pressed until the cause of the overload has been found and removed. If it cannot be readily located, a resistor can be inserted in series with the output to limit the current to a safe level.

If desired, an l.e.d. panel indicator can be added, this being connected across the output of the supply via a $2.2k\Omega$ series resistor, as shown in Fig. 5. The l.e.d. and resistor are not included in the Components List. The l.e.d. will show the presence of a voltage at the output and will indicate, by extinguishing, that the cut-out has operated.

If the output is applied to an item of equipment having a large value electrolytic capacitor across its supply rails, the sudden charging current for the capacitor may trip the fuse. This difficulty may be overcome by connecting the equipment to the output terminals with S1(a)(b) turned off. When S1(a)(b) is then turned on, the charging current to the electrolytic capacitor rises at a slower rate and there is much less risk of the cut-out being triggered. ■

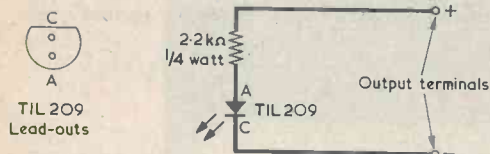


Fig. 5. If desired, an l.e.d. may be added to the power supply unit. The circuit employed is shown here

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 11p 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.

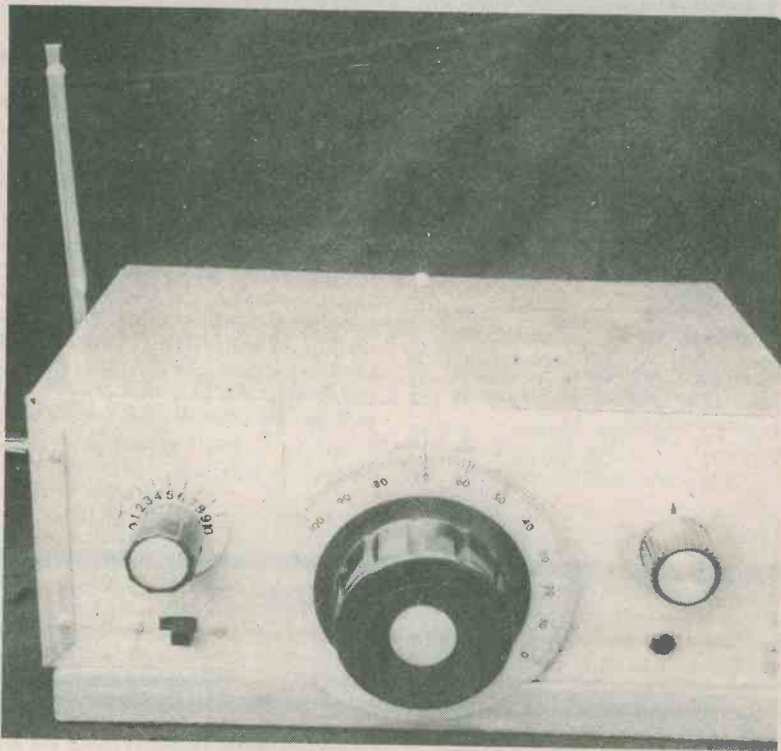
We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

SINGLE RANGE OSCILLATOR SUPERHET

Part 1

By F. G. Rayer

By the use of techniques common in transceiver circuits, this receiver employs a single oscillator tuning range to obtain reception from 700kHz to 18MHz with a small gap only at 2.6 to 3.6MHz. The only band switching is given by a 2-way switch coupled to the aerial coil. A description of circuit operation and some of the constructional details are given in this issue, and these will be completed in next month's concluding article.



The completed superhet receiver. The controls consist of the aerial tuning capacitor, the oscillator tuning capacitor, the volume control and the 2-way aerial range switch

By making use of techniques similar to those employed in most present-day transceivers, considerable simplifications in tuning arrangements can be made in equipment intended for reception only. The low frequency, or l.f., band of this receiver tunes from slightly below 700kHz to 2.6MHz, or about 425 to 115 metres, while the high frequency or h.f. band covers 3.6 to 18MHz, or about 85 to 17 metres. This is achieved with a single oscillator coil and a single 2-band aerial coil, considerably simplifying switching and wiring.

In most receivers, three pairs of coils (aerial and oscillator) would normally be needed for a coverage of this nature. In the present circuit, frequency coverage is extended at the high frequency end because no parallel trimmers are present across the tuned circuits, while oscillator coverage with a single coil is increased at the low frequency end by omitting a series padder capacitor. (Trimmers and padder capacitors

are required with conventional ganged tuning for alignment and tracking purposes.) As a result, one inductance gives extended frequency coverage.

The relatively high intermediate frequency of 1.6MHz is also used. Apart from giving better second channel rejection, this allows reception down to 700kHz, without the oscillator having to tune lower than 2.3MHz. This, with the extended oscillator frequency range, means that no oscillator switching is necessary.

A separate variable capacitor is employed for aerial tuning, and this can be likened to the use of a transceiver power amplifier tank coil for aerial tuning during reception. The separate aerial capacitor avoids any ganging difficulties; it is merely peaked for best reception and can compensate for changes to the aerial or aerial coupling.

In this way an efficient receiver having wide coverage is obtained, and also one with the minimum of switching.

COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 5%)

R1 18k Ω	R12 27k Ω
R2 15k Ω	R13 120 Ω
R3 2.7k Ω	R14 4.7k Ω
R4 180 Ω	R15 2.2M Ω
R5 39 Ω	R16 10k Ω
R6 120k Ω	R17 2.7k Ω
R7 47k Ω	R18 1M Ω
R8 4.7k Ω	R19 47 Ω
R9 330k Ω	R20 1k Ω
R10 330k Ω	R21 3.3 Ω
R11 390 Ω	R22 3.3 Ω

VR1 10k Ω potentiometer, log, with switch S2

Capacitors

C1 0.01 μ F plastic foil
C2 0.0033 μ F paper or plastic foil
C3 6 μ F electrolytic, 6 V. Wkg.
C4 0.0047 μ F paper or plastic foil
C5 0.0047 μ F paper or plastic foil
C6 0.1 μ F plastic foil
C7 0.25 μ F plastic foil
C8 0.01 μ F plastic foil
C9 0.25 μ F plastic foil
C10 100 μ F electrolytic, 10 V. Wkg.
C11 4 μ F electrolytic, 6 V. Wkg.
C12 200 μ F electrolytic 10 V. Wkg.
C13 500 μ F electrolytic, 10 V. Wkg.
VC1 365pF variable, Jackson type 01 (see text)
VC2 365pF variable, Jackson type 01
TC1 60pF mica trimmer

Inductors

L1-L6 Miniature Transistor Tuning Coil, Red, Range 2T, modified (Denco)
L7 Miniature Transistor Tuning Coil, White, Range 3T (Denco)
I FT1 I.F. transformer type I FT18/1.6MHz
I FT2 I.F. transformer type I FT18/1.6MHz
I FT3 I.F. transformer type I FT17/1.6MHz

Semiconductors

TR1 BF194
TR2 BF195
TR3 BF194
TR4 BF194
TR5 BC108
TR6 BC109
TR7 AC127
TR8 AC128
D1 OA81

Switches

S1 slide switch
S2 s.p.s.t. toggle, part of VR1

Jack Socket

JK1 3.5mm. jack socket, insulated

Metalwork

(All Home Radio 'Universal Chassis' parts)
1-off 8x1in. flanged side
1-off 10x3in. flanged side
2-off 10x4in. flanged side
2-off 6x4in. flanged side
2-off 10x6in. plate (1 optional — see text)
1-off Hardware Kit

Miscellaneous

PP9 battery (Ever Ready)
Veroboard, plain, 0.15in. matrix
Slow motion drive type 4489 (Jackson)
Telescopic aerial
Battery connectors
3 insulated sockets
2 knobs
1 $\frac{1}{2}$ in. scale, (Home Radio)
Wood, 10x $\frac{3}{4}$ x $\frac{3}{4}$ in. (or rubber feet)

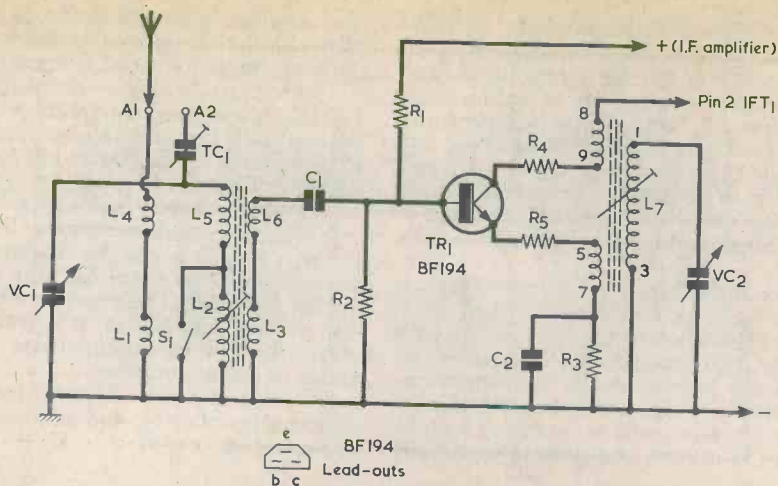


Fig. 1. The circuit of the mixer stage. There is only one oscillator coil, and aerial signal ranges are switched by the s.p.s.t. switch S1

MIXER CIRCUIT

Fig. 1 shows the circuit of the mixer stage. Its simplicity stems from the points just outlined, and the fact that the oscillator may operate either above or below the aerial circuit frequency.

Socket A1 is for an aerial of normal length, and socket A2 is for a short or telescopic aerial. The 2-band coil is tuned by VC1. L5 on its own tunes the h.f. band, and L5 and L2 in series, with S1 opened, tune the l.f. band. All windings are on a common former, and only the single pole switch S1 is needed for range selection. With S1 open the l.f. range is about 2.6MHz to 700kHz. With S1 closed, the h.f. range of approximately 18 to 3.6MHz is tuned.

The oscillator coil, L7, is tuned by VC2. This has no parallel trimmer or series padder, and as a result it tunes from approximately 2.3 to 10MHz. As VC2 is the more important tuning capacitor, it has a large dial and ball drive. R4 and R5 are included to obtain reliable oscillator operation at all frequencies.

The manner in which reception is obtained on various frequencies should be noted, though in use it is only necessary to tune in a signal with VC2 and peak it up with VC1, S1 being open for l.f. and closed for h.f. bands.

When L7 is tuned from 2.3MHz to 10MHz and is above the aerial signal frequency, the possible aerial signal frequencies range from 2.3MHz minus 1.6MHz to 10MHz minus 1.6MHz, or 700kHz to 8.4MHz. When the oscillator is below the aerial signal frequency, reception is from 2.3MHz plus 1.6MHz to 10MHz plus 1.6MHz, or 3.9 to 11.6MHz. This method of having the oscillator frequency either above or below the reception frequency is usual in transceivers, in which it avoids the necessity of unessential oscillator ranges. In addition, some commercial receivers employ second harmonic mixing. With this, the highest frequency oscillator coil may be similar to one used for signals at half the frequency. In the present circuit, the second harmonic of the oscillator covers 4.6 to 20MHz. This extends reception to up to 18.4MHz, with the se-

cond harmonic being above the aerial signal frequency.

These tuning arrangements may appear unusual to those who are more accustomed to the normal method of employing separate aerial and oscillator coils for each band, but they offer wide coverage with a minimum of components.

The optional aerial inputs allow best results with a variety of aerials. A short wire or telescopic aerial will bring in many signals, but a longer aerial naturally increases range and may be helpful, for instance, with 160 metre Amateur or other weak signals.

In the receiver the mixer circuit is constructed on its own board, its output passing to the 1.6MHz i.f. amplifier.

I.F. AMPLIFIER

The circuit of the i.f. amplifier is given in Fig. 2. This has two double-tuned i.f. transformers and a single-tuned i.f. transformer feeding the diode D1. Transistor TR2 has an untuned coupling to TR3, and the latter is useful in raising the strength of weak signals. The output from the mixer is taken from pin 8 of the oscillator coil and applied to pin 2 of IFT1.

Diode D1 provides detection and, also, a negative-going a.g.c. voltage. This is applied back to the base of TR2 via R12, R7 and the secondary of IFT1. The detected audio output is obtained from volume control VR1.

The i.f. transformers are pre-aligned by the manufacturer, with the result that the i.f. amplifier should function satisfactorily as soon as it has been assembled. In fact, the transformer cores should not be moved until reasonable results are obtained from the receiver, as such adjustments will very probably cause unnecessary misalignment.

Apart from VR1, which is mounted on the front panel of the receiver, the i.f. amplifier is built as a separate complete unit. It is stable if constructed in the manner to be described. Audio signals are taken from the slider of VR1 to the audio amplifier board.

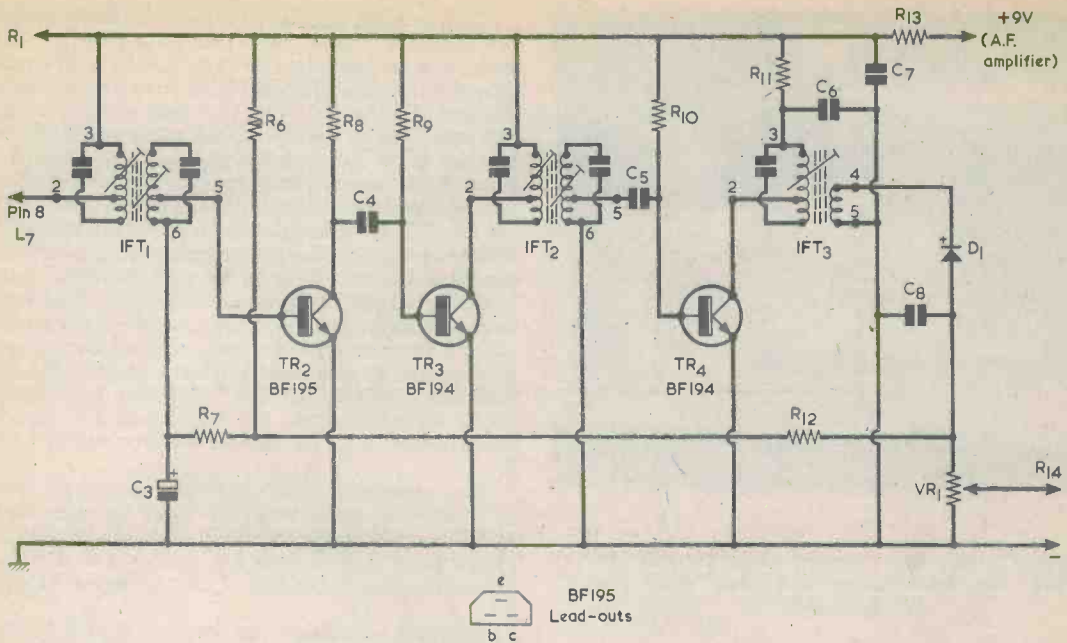


Fig. 2. The i.f. amplifier. This has three transistors and five tuned circuits for good gain and selectivity

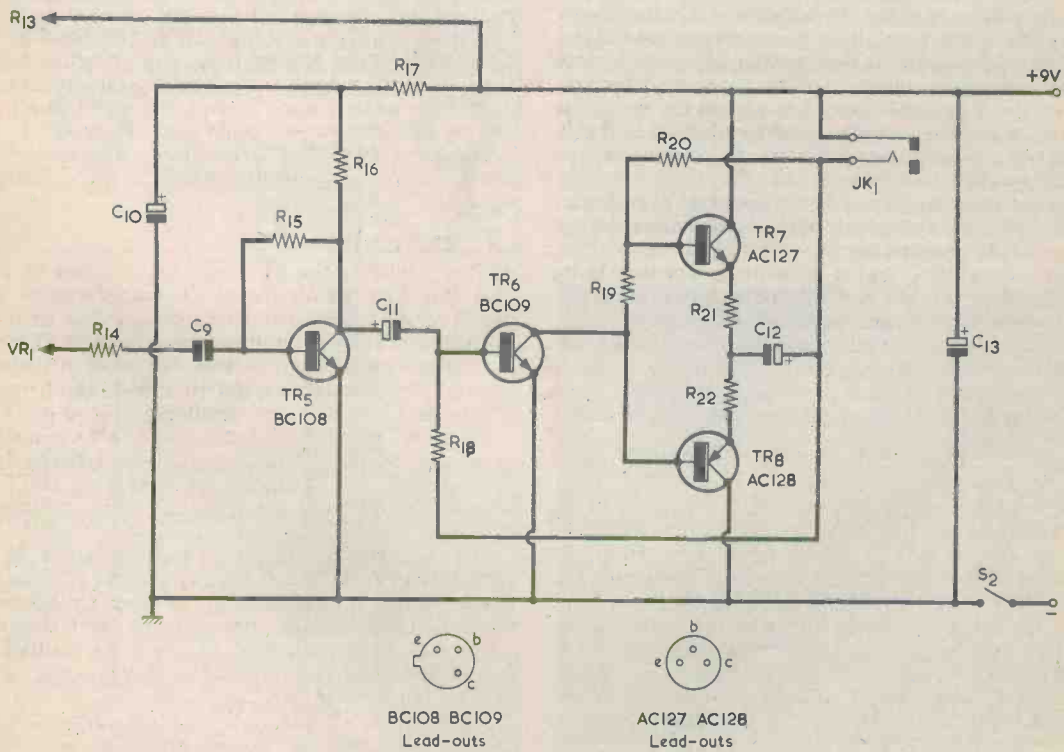
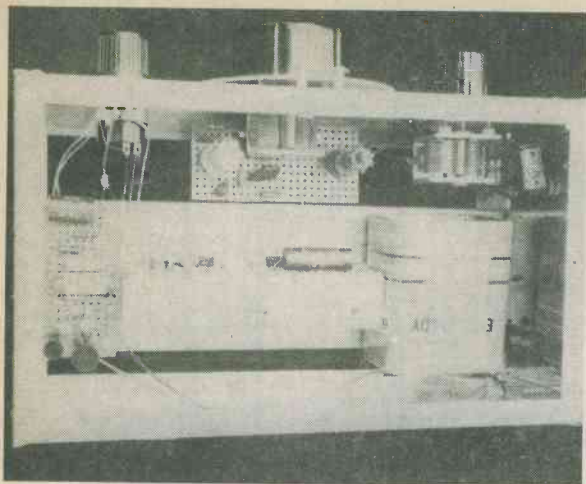


Fig. 3. The audio amplifier. This will provide a satisfactory output both for a loudspeaker or for headphones



Layout inside the receiver case. Despite its wide frequency range only two coils are employed.

AUDIO AMPLIFIER

The audio amplifier, whose circuit appears in Fig. 3, also provides a high level of gain, and it comprises a pre-amplifier, a driver and a complementary output stage. It is of quite simple design but gives good results and can feed any output load of 8Ω or more. The output is coupled to a 3.5mm. jack socket on the front panel and normally a speaker will be plugged into this as most signals will be reproduced at ample speaker level. However, headphones can alternatively be plugged in if circumstances cause personal listening to be preferred. Since one terminal of the jack socket is common to the positive supply rail it needs to be of insulated construction, and a suitable socket is sold by Home Radio.

The audio amplifier is assembled on a small circuit board and is afterwards mounted near the i.f. amplifier on the receiver chassis.

AERIAL COIL

The aerial coil consists of a modified Denco Red Range 2T coil. This is designed for oscillator use but the inductance of its tuned winding makes it suitable for the aerial coil of the present receiver. Modification is carried out in three stages, referring to Fig. 4. Soldered connections made to the coil pins during the modification should be carried out very quickly as the plastic coil former material melts readily with heat. If desired, the coil can be temporarily plugged into a B9A valveholder whilst the modification is being carried out; this will hold the pins in position and provide a small level of heat sinking.

In Fig. 4, L1, L2 and L3 are the existing windings whilst L4, L5 and L6 are the new windings. The turns on L1 and L2 are not modified, but L3 has $2\frac{1}{2}$ turns removed in the manner to be described. The numbers in the diagram refer to the pins.

Tuned windings. Screw down the insulated nut on the threaded part of the former. Starting immediately below the nut, wind on 25 turns of 28 s.w.g. enamelled wire side by side to form L5. Secure the coil ends with touches of adhesive. Note that this winding must be in the same 'sense' as the existing wave-wound coil L2, so that their inductances are mutually aiding when they are in series. The upper end of L5 does not connect to a coil pin but will pass direct to the fixed vanes tag of VC1 at a later stage of receiver construction. The lower end of L5 connects to pin 1 after the new aerial and base windings have been added.

Aerial windings. Disconnect the end of L1 from pin 9. Solder a length of 36 s.w.g. cotton or rayon covered wire to the winding end removed from pin 9. Keep the solder joint on the unused central part of the former, and wind on 4 additional turns side by side for L4, about one-third from the bottom of L5, and in the same direction as L1. Solder the free end of L4 to pin 9.

Base windings. Disconnect the end of L3 from pin 5. Unwind $2\frac{1}{2}$ turns from L3. Take the wire up to the middle of L5, and wind on 2 turns side by side for L6, in the same direction as L3. Solder a short length of thin extra wire to the end of L6 and connect this to pin 5.

The new windings can receive a few touches of adhesive to keep them in place, but the turns should not be completely painted or covered with adhesive. Set the core so that about 20 threads of the 6BA screw project. This should give the wanted coverage with a little to spare. If not, the core may be moved a turn or two later to give the required range. Due to the position of the core, taking it out of L2 brings it near L5. The actual coverage of the coil in the receiver is 700kHz to 2.6MHz and 3.6MHz to 18MHz with a little to spare. It is felt that the gap of 2.6 to 3.6MHz does not contain many signals of interest.

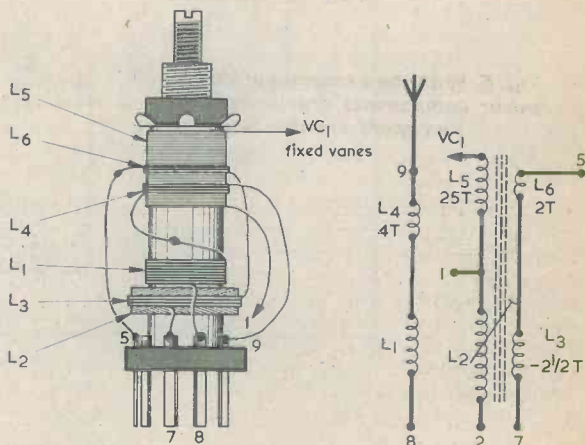


Fig. 4. Details of the modification to the aerial coil

MIXER BOARD

The components in the mixer circuit, with the exception of VC1 and TC1, are assembled on a piece of plain Veroboard of 0.15in. matrix having 10 by 23 holes.

First drill out holes in the board to take the coil pins, as shown in Fig. 5. Next take up VC2 and examine its underside. This should have a 4BA tapped hole. Drill out a corresponding 4BA clear hole in the board to enable the two to be assembled together by a single 4BA bolt in the manner illustrated in the diagram. The bolt should be short and should not project into the capacitor further than the thickness of the capacitor bottom plate as it may then touch or damage the vanes. If necessary, fit a spacing washer between the board and the capacitor frame to give clearance for ceramic insulators, etc., on the

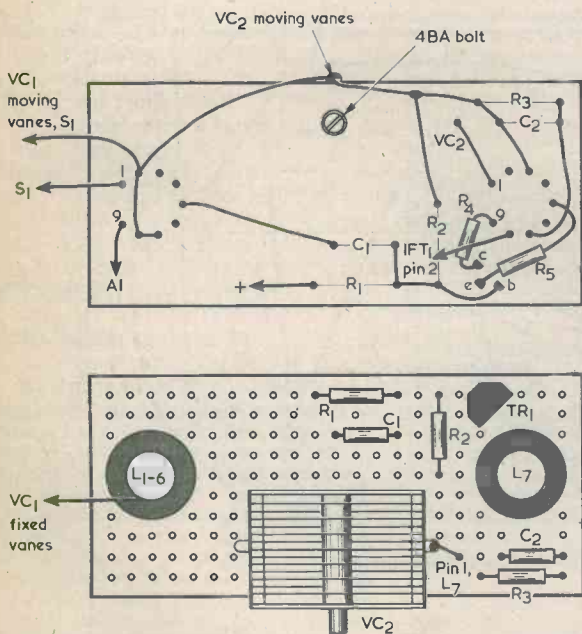


Fig. 5. With the exception of VC1 and TC1, the mixer components are assembled on a plain Veroboard panel as shown here

capacitor. The 4BA tapped hole on the capacitor underside is not part of its general specification but it is normally provided in capacitors of this nature. Should it be absent a simple metal bracket may be devised to hold the capacitor and Veroboard together. At a later stage in construction the capacitor is mounted to the front panel of the receiver, whereupon the mixer board is held in position below it.

Next wire up the components as shown. In most cases the component lead-outs will themselves reach the points at which they are soldered. Other leads can consist of 22 s.w.g. tinned copper wire with sleeving where necessary. Flying leads from the underside of the board are provided for later connection to aerial socket A1, to VC1 moving vanes, to S1, the positive supply and IFT1.

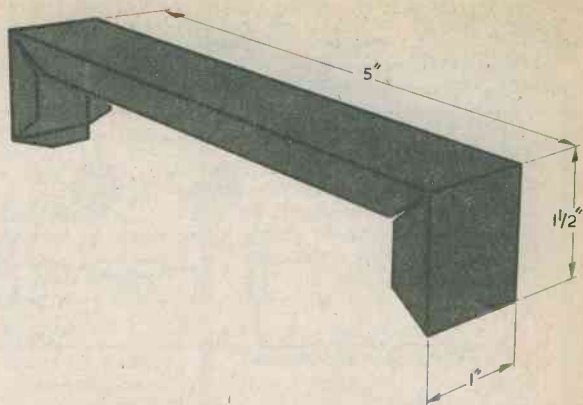


Fig. 6. The i.f. amplifier is built on a 'Universal Chassis' member bent to the shape shown here

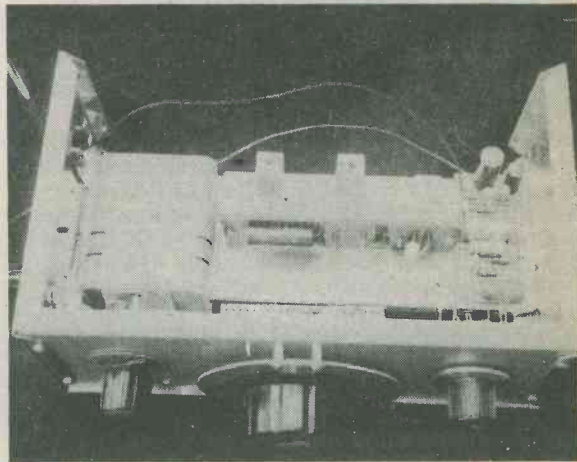
The 6BA core screw of L7 is set so that about 15 threads project. This is later adjusted, if necessary, for the required oscillator coverage and is then locked with a 6BA nut.

I.F. AMPLIFIER ASSEMBLY

The wiring and construction of the i.f. amplifier is illustrated in Fig. 7, and it will be helpful here to examine the photographs of the receiver interior to see how this section of the receiver is made up.

First of all, a 'Universal Chassis' 8 by 1 in. flanged member has four 90° V-cuts made in the flanges 1½ in. from the ends. The ends are then bent in through 90° to form a box-shaped member measuring 5 by 1½ by 1 in., as illustrated in Fig. 6. The i.f. transformers are mounted on the top 5 by 1 in. surface.

A piece of plain 0.15in. Veroboard, measuring 5 by 1½ in. is secured by two 6BA bolts to two end flanges so that it takes up the position shown in the upper view in Fig. 7. Component bodies then appear on the outside of the board as is illustrated here and in the



Another view of the receiver interior. This illustrates the manner in which the i.f. amplifier is assembled

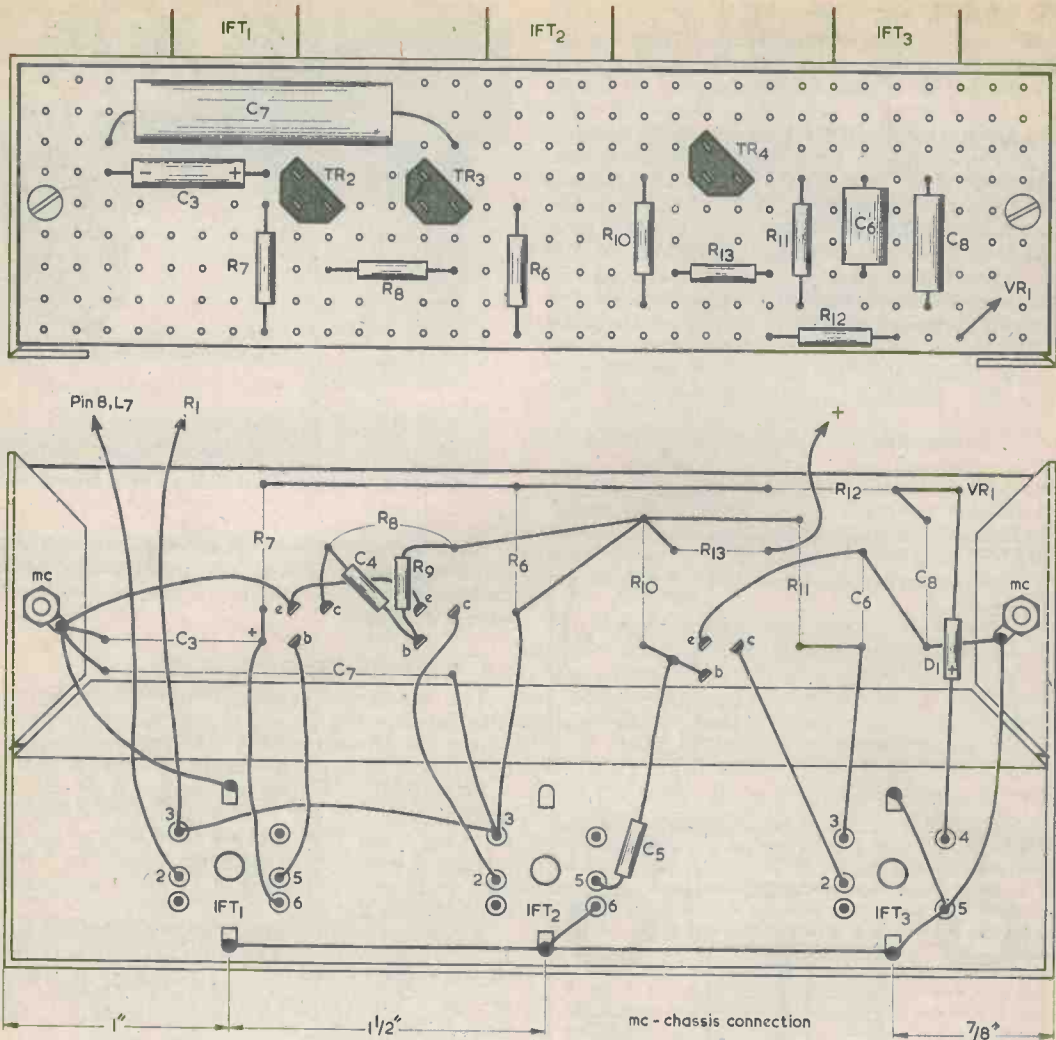


Fig. 7. Layout and wiring of components in the i.f. amplifier

photographs.

Before fitting the Veroboard, first cut out holes in the 5 by 1 in. surface for the i.f. transformers. These should include central holes to allow access to the transformer cores. Then fit the transformers, making sure that there is no contact between their pins and the metal. Short pieces of insulated sleeving on the pins will ensure that fragments of metal or solder do not cause short-circuits here.

Then mount the Veroboard with two 6BA bolts and nuts, fitting solder tags on the nuts inside the assembly. These two solder tags are those indicated as 'MC' in the lower view of Fig. 7. In this view the 5 by 1 in. metal surface has been rotated through 90° to enable the i.f. transformer wiring to be seen. Also, the remainder of the folded metal member is omitted.

Wiring is then carried out as illustrated in Fig. 7. Chassis wiring connections are made to the i.f. transformer can lugs to avoid possible poor contact to

the metal on which the transformers are mounted. C4, C5, R9 and D1 are positioned behind the Veroboard, as shown. Flying leads are provided from R13 and from the junction of C8 and D1 to the volume control. The positive supply lead from the mixer board and the lead to pin 2 of IFT1 are wired in just before the i.f. amplifier assembly is secured to the receiver chassis.

NEXT MONTH

In next month's concluding article constructional details will be given for the i.f. amplifier board and the complete receiver chassis. The Components List is given this month for completeness, but some items in this, including in particular VC1 and the 'Universal Chassis' parts for the case, will be discussed in next month's issue.

(to be concluded)

LETTERS

RESISTANCE BRIDGE

Allow me to thank you for the most useful Resistance Bridge described in 'In Your Workshop' article in October's magazine.

I managed to construct the bridge inside a 10p soap dish, obtainable at selfservice stores. As it worked so well on all ranges up to 1MΩ it occurred to me to try the effect of leaving a 1MΩ resistance in place of paralleling it with other MΩ resistances. This works excellently — all you need is a chart of parallel resistances (or a pocket calculator!) I mention this as I have had trouble obtaining high value resistors making voltmeters where you often need them for the input.

Wishing you and your excellent publication every success.

W. E. Jones,

Westcliff-on-Sea,
Essex.

CONSERVING THE OSCARS

As AMSAT-OSCAR 7 enters its second year of continuous operation, it is becoming more and more apparent that there are an increasing number of stations using Mode B who are using much more than the recommended 100 watts e.r.p. The result of this over-powering is that the AGC circuit of the transponder is being swamped and when this occurs, an excessive amount of current is being drawn from the on-board power source. In maximum sunlight, the solar panels can supply approximately one ampere of current. If more than that amount of current is required, the battery must supply the rest. The red line lower limit of battery discharge current is about 1.2 amps. When excessive power is run by Mode B users, the current drawn from the battery at times exceeds 2 amps, when AO7 is in sunlight and over 3 amps is drawn when the satellite is in darkness. Needless to say, this heavy discharging of the spacecraft's battery has caused the voltage to drop at times to the point where the under voltage protection circuits have taken over. These were designed to place OSCAR 7 in Mode D, the recharge mode, with both transponders OFF when a low of 12.1 volts is reached. Switches to Mode D have already occurred as well as some unexpected switches to Mode A. Telemetry readings point to high power offenders being located in the European and North American regions for the most part.

They may tell you that they are running only 100 watts output, but 100 watts into a single KLM, Tilton, K2RJW, W0EYE or similar Yagi antenna, with about 13db gain over a dipole produce an effective radiated power of two thousand watts which is far too much power to run for Mode B work. The sad thing is that many EME stations on 432MHz are using not 100 watts, but their KW finals.

As Amsat-Oscar 6 enters its fourth year of operation, its battery continues to show signs of age by not holding a charge as well as in its earlier days. Because of this it is imperative that command stations keep an eye on channel 3A of the telemetry for signs of low battery voltage. If the count on 3A falls to 55, 54 or 53 during a sheduled "ON" orbit, the transponder must be turned off.

Another problem expected to confront us shortly is that of overheating of the AO-6 battery. Because of the type of orbit which OSCAR is in, it will be in sunlight a greater percentage of the time in upcoming months, causing the battery to charge more than in previous months. This charging will help the low voltage problem, but will cause another one to occur. Since the internal resistance of the battery is increasing with age, the greater amount of recharging time being encountered is going to cause the internal temperature of the AO6 battery to rise once again to a dangerously high level as it did earlier last year.

Richard Zwirko,

Vice President of AMSAT.

WATER LEVEL SENSOR

Some time ago I made a device similar to the "Water Level Sensor" described in the February issue of *Radio & Electronics Constructor*.

This also used wire probes but the wire eventually corroded right up to and inside the p.v.c. covering.

I then used a spark plug but this failed too, the centre contact disappearing up inside the ceramic.

Next I took a battery to pieces and used the carbon rods as the contacts which sensed the water level. Reliability is now 100%. The battery was a farmer's fencing battery with carbon rods 7in. long and ¼in. diameter.

R. J. Leeves,

Umberleigh,
Devon.

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TIME BASE GENERATOR

By P. R. Arthur

In last month's issue we described a very simple wobulator which is capable of operating with an oscilloscope offering a timebase output. The circuit described here enables the wobulator to be employed with oscilloscopes which do not have the requisite timebase output.

The unit described in the article "Low Cost Wobulator", which appeared in last month's issue, can be used on its own with an oscilloscope having a suitable timebase output, the latter being coupled to the variable capacitance diodes in the wobulator. The combination of wobulator and oscilloscope then allows the response curve of an a.m. receiver to be displayed on the cathode ray tube of the oscilloscope.

It is also possible to use the unit with an oscilloscope not having a timebase output, and this is achieved by employing a separate timebase generator for the wobulator. The oscilloscope timebase then sweeps the spot across the face of the cathode ray tube while the additional timebase sweeps the wobulator frequency across the receiver passband.

The timebase for the wobulator also produces a positive pulse at the start of the flyback period and the pulse can be employed to synchronise the timebase of the oscilloscope when this has a triggered sweep mode. Using the trigger pulse to synchronise the two timebases is not essential, but it does ensure a stable trace. The author has obtained excellent results with this synchronising technique using a Russian C1-16 double beam oscilloscope, which is completely devoid of any form of timebase output.

RELAXATION OSCILLATOR

The timebase generator is based on a unijunction transistor relaxation oscillator. The circuit appears in Fig. 1.

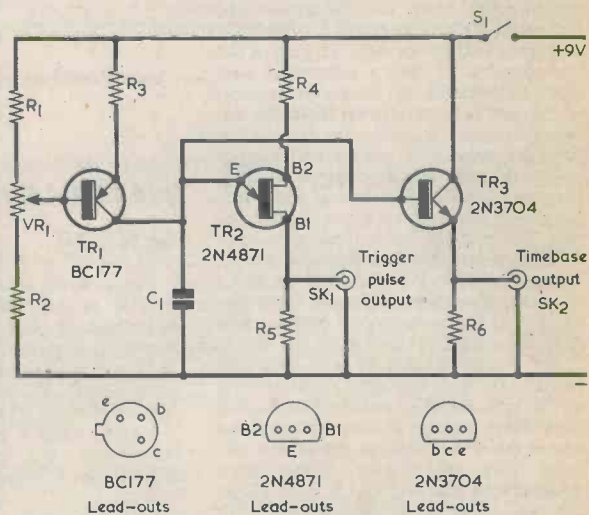


Fig. 1. The timebase generator incorporates a constant current source charging a capacitor, and produces a linear sawtooth at low output impedance

As soon as on-off switch S1 is closed, C1 commences to charge via transistor TR1. TR1 functions as a constant current source, whereupon the voltage across C1 rises in a linear manner with time. When the voltage across C1 reaches the emitter triggering level in the unijunction transistor, TR2, it discharges rapidly via the emitter and base 1 of the device into R5. It then commences to charge once more via TR1. Potentiometer VR1 controls the current passed by TR1 and therefore controls the rate at which C1 charges. In consequence VR1 operates as the timebase frequency control.

A linear sawtooth waveform is produced at the emitter of TR2, but this is at a fairly high impedance, particularly when the circuit is operating at slow sweep speeds. The waveform at the emitter is, accordingly, coupled to the base of the emitter follower, TR3. This offers a low output impedance at the timebase output socket whilst ensuring a very low level of loading on the waveform shaping circuit. The timebase output socket connects directly to the timebase input socket of the wobblator via screened cable.

A positive-going pulse is developed across R5 during the discharge period of C1, and this may be used to trigger the timebase of the oscilloscope. The sweep frequency is continually variable from a few Hertz to several hundred Hertz, the exact range being dependent upon tolerances in the values of R1, R2, VR1 and C1, and in the triggering voltage of TR2.

Power is obtained from a PP3 9 volt battery, current consumption ranging from about 2 to 5mA according

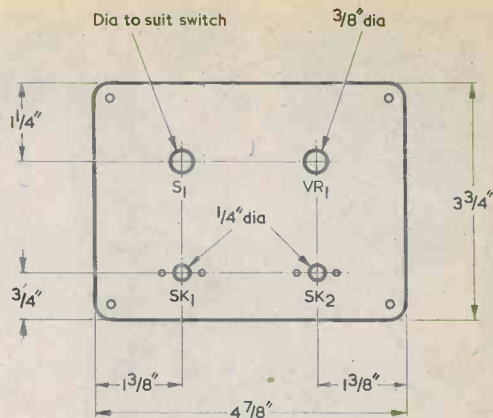


Fig. 2. The front panel is drilled out in the manner shown here

to the setting of VR1. The 2N4871 specified for TR2 is available from Henry's Radio, Ltd.

CONSTRUCTION

The prototype is housed in an "A.B.S." case type M3, obtainable from Doram Electronics, Ltd. This is a plastic case with metal front panel and measures 130 by 100 by 50mm. Fig. 2 shows the holes required in the front panel. The two small mounting holes for each coaxial socket are marked out with the aid of the socket itself. They are drilled 6BA clear with a No. 31 twist drill. A solder tag is fitted under the inner securing nut of the timebase output socket, SK2, to provide a chassis connection.

All the small components are mounted on a Veroboard panel of 0.1in. matrix, this having 13 holes by 15 copper strips. There are no breaks in the strips.

COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 5%)

R1 3.3k Ω

R2 47k Ω

R3 390 Ω

R4 390 Ω

R5 220 Ω

R6 8.2k Ω

VR1 5k Ω potentiometer, linear

Capacitor

C1 0.47 μ F plastic foil, type C280 (Mullard)

Semiconductors

TR1 BC177

TR2 2N4871

TR3 2N3704

Switch

S1 s.p.s.t. toggle

Sockets

SK1, SK2 coaxial sockets

Miscellaneous

Case, "A.B.S." type M3, 130 x 100 x 50mm.

(Doram)

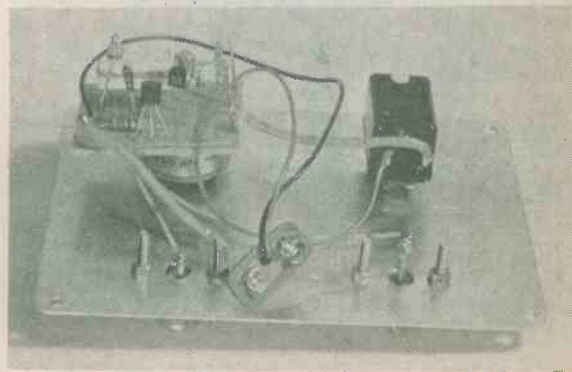
PP3 battery (Ever Ready)

Battery connector

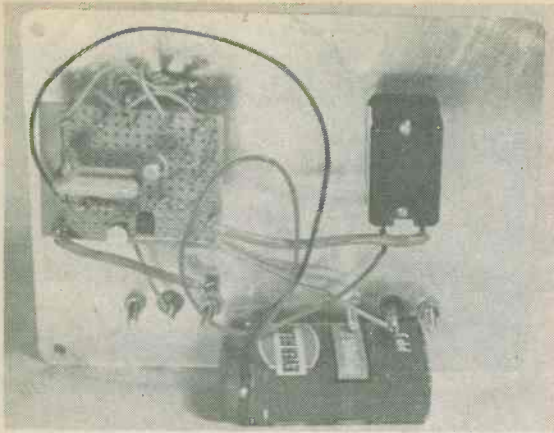
Knob

Veroboard, 0.1in. matrix

Veropins, 0.1in.



The small components are all assembled on a Veroboard panel positioned behind the sweep speed potentiometer



Another view illustrating the internal layout

The component layout on the panel is illustrated in Fig. 3. Veropins suitable for 0.1 in. Veroboard are used for the points where external connections are made to VR1 and the sockets, etc. The two connections to VR1 track are designated "A" and "B". The lead marked "A" connects to the potentiometer tag corresponding to maximum clockwise rotation of its spindle. The lead indicated as "B" connects to the other track tag.

The component panel is positioned behind VR1 with its copper side facing the front panel, and with the Veropins which connect to the potentiometer at the top. Short single strand wires connect the panel to the rest of the circuit, and these provide the panel with a mounting of adequate rigidity.

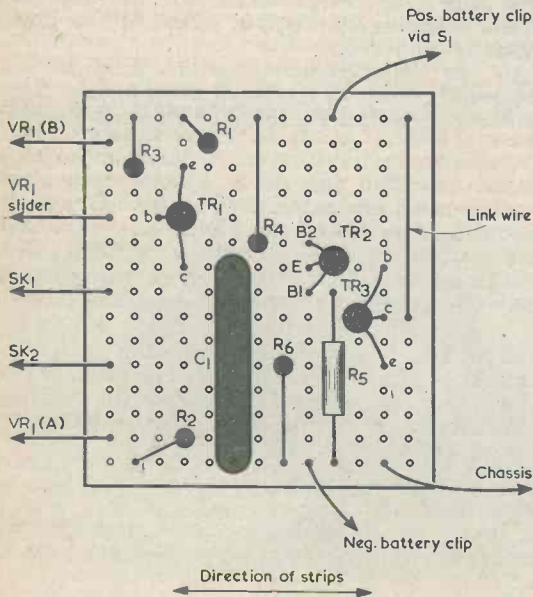


Fig. 3. Component layout on the Veroboard panel. There are no breaks in the copper strips

There is plenty of space for the battery at the bottom of the case. It can be held in place with a simple clamp affixed to the front panel. Alternatively, a piece of foam rubber or plastic glued to the rear of the panel can retain it in position.



The front panel is marked up with legends taken from Panel-Signs Set No. 4, available from Data Publications, Ltd.

USING THE GENERATOR

As already mentioned, the timebase output connects to the timebase input of the wobulator. The trigger pulse output connects, where applicable, to the trigger input of the oscilloscope. The equipment is then set up in much the same way as with the wobulator on its own, except that it is now also necessary to adjust the frequency control of the additional timebase. The frequency is set up such that one complete picture of the displayed receiver passband fills, or nearly fills, the oscilloscope screen from side to side. ■

SHORT WAVE NEWS

FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT

Frequencies = kHz

In January of this year the International Short Wave League commenced celebrating the 25th year of their monthly journal *Monitor*, of which the writer was the founder and first editor.

The survival of *Monitor* from its beginning to the present day is undoubtedly due firstly to the enthusiastic efforts of many League members who have, over the years, devoted their time on a purely voluntary basis to contributing and editing the written material freely submitted by members; secondly to the format which has always consisted of information and news rather than constructional articles.

The contents of the journal are well balanced between the various interests of the membership both amateur and broadcast band listeners being catered for in addition to the transmitting members, those interested in VHF, QSL card collecting and the like, League affairs, details of contests, news, queries, letters, etc.

The January issue consisted of 36 pages plus cover, the latter being attractively designed especially for the 25th year of publication. The present editorial staff are to be congratulated for their sterling work in producing such an excellent journal on a part-time basis.

Year after year *Monitor* comes tumbling through my letter box once a month, always being eagerly scanned for its packed content of news and views, keeping me in touch with events and the doings of others having like interests. I only hope it will never cease to land on the hall mat, a future without *Monitor* would be unthinkable!

CURRENT SCHEDULES

All published short wave schedules are liable to change at short notice, those published here are correct at the time of writing.

● SOUTH AFRICA

"Radio RSA" — the Voice of South Africa", Johannesburg, has an External Service in English to Europe and West Africa from 2100 to 2150 on **7270, 9525, 11900** and on **15155**. The English Service to North America is from 2230 to 2320 on **9525, 11900, 11970** and on **15155**. The programme in English for Central and East Africa can also be heard here in the

U.K. and this is from 1100 to 1200 on **11900, 15220** and on **21535**.

● CZECHOSLOVAKIA

"Radio Prague", Prague, operates an External Service in English directed to the U.K. and Eire from 1630 to 1700 on **5930** and **7345**; from 1900 to 1930 on **5930, 7245** and on **7345**; from 2000 to 2030 on **5930** and **7345** and from 2130 to 2200 on **6055**.

An "Inter-Programme" for Europe in English is radiated from 0745 to 0800, 0845 to 0900, 0945 to 1000, 1045 to 1100 and from 1145 to 1200 on **6055** and **9505**.

● EAST GERMANY

"Radio Berlin International — the Voice of the GDR", Berlin, presents an External Service in English to Europe from 1830 to 1915 on **6080, 6115, 7185, 7300** and on **9730**; from 2115 to 2200 on **7260**.

● PAKISTAN

"Radio Pakistan", Karachi, beams its World Service to the U.K. in Urdu from 0830 to 1100 on **15110** and **17665**; from 1915 to 2145 in Urdu, Sylheti and English on **6235** and **7085**. A newscast in English read at slow speed is radiated to West Europe from 1100 to 1115 on **15110** and **17665** and to the Middle East from 1630 to 1645 on **9462** and **11885**. A word of warning however, variations in frequency can vary from day to day as much as plus or minus 5kHz.

● ITALY

"RAI — Italian Radio and Television", Rome, schedules a programme in English to the U.K. in the External Service from 1935 to 1955 on **6010, 7275** and on **7290**.

● BULGARIA

"Radio Sofia", Sofia, radiates programmes in English for the U.K. from 1930 to 2000 and from 2130 to 2200 on **6070** and on **9700**.

● NETHERLAND

"Radio Nederland", Hilversum, presents programmes in English for Europe from 0930 to 1050 on **5995, 6045, 7210** and **7240**; to Europe, the Far

East, South and Southeast Asia from 1400 to 1520 on 5995, 6045, 15260, 15415, 17810 and from the Madagascar transmitter on 11740; to Africa and Europe from 1830 to 1950 on 11740 from Madagascar and on 17830 from the Bonaire transmitter; to West Europe from 2000 to 2120 on 11730 from Madagascar.

● ROMANIA

"Radio Bucharest", Bucharest, amongst its External Services lists the following transmissions for Europe in English. From 1300 to 1330 on 7195, 9690 and 11940; from 1930 to 2030 on 6150 and 7195 and from 2100 to 2130 on 5990 and on 7195.

● WEST GERMANY

"Deutsche Welle — The Voice of Germany", Cologne, broadcasts in English to Central and East Africa from 0430 to 0515 on 5990, 7150 from Cologne and on 7225 and 9565 from the relay transmitter at Kigali, Rwanda; to West Africa from 0600 to 0630 on 9615, 9700, 11765, 11905 and on 15275; to Central and East Africa from 1045 to 1115 on 11785 and 15410 from the relay transmitter at Kigali and on 17765, 17875, 21500 and 21600 from Cologne; to West Africa from 1200 to 1245 on 15410 and 17765 from Kigali and on 17875 and on 21600 from Cologne. There are no transmissions in English directed to the U.K. on short waves.

● SWEDEN

"Radio Sweden", Stockholm, offers a service in English to Europe and Africa from 1100 to 1130 on 9630 and 21690; to Europe and the Middle East from 1600 to 1630 on 6065, 9665 and 11735; to Europe and Africa from 1830 to 1900 on 6065, 9625 and 11780; to Europe, Africa and the Middle East from 2030 to 2100 on 6065, 9605 and 9685 and to Europe and North America from 2300 to 2330 on 6035, 6045 and on 9605.

● SYRIA

"Syrian Arab Republic Radio", Damascus, has a Western/Turkish Programme which is part of the Domestic Services. The Western/Turkish Programme is intended in part for listeners in Europe, the English transmissions being from 0700 to 0730 on 7105 and from 2030 to 2200 on 9655.

● CHINA

"Radio Peking", Peking, beams an External Service in English to Europe from 2030 to 2130 on 6270, 6410, 6860 and on 7590; from 2130 to 2230 on 6270, 6860 and on 9030.

● CUBA

"Radio Havana", Havana, presents a programme in English to Europe from 2010 to 2140 on 11715.

AROUND THE DIAL

● ISRAEL

Jerusalem on a measured 7462 with the Home Service from 1800 through to 2304 sign-off with the National Anthem.

● SWAZILAND

Trans-World Radio on 4760 from 1830 through to 1900 sign-off. In Portuguese prior to sign-off the announcement is "The concluding programme was in Portuguese, this is Trans-World Radio, Swaziland", then follows some musical chimes.

● CHINA—1

Urumchi, Sinkiang Provincial Service on a measured 5062 at 0055 in parallel with the listed 4220 channel.

The above three loggings were submitted by B. Walsh of Romford who incidentally maintains a card index system of short wave stations amounting to some 2100 cards in frequency order and additionally a further 1200 cards containing station information. It was Brian who some two years ago assisted me in identifying the clandestine "Voice of the Thai People" transmitter operating on 9422.5 where it may still be heard from around 1500 onwards to 1615 sign-off (variable).

TOGO

Lama-Kara on 3222 at 1858, OM with a talk in French then into a programme of pops in the same language. The best time to hear this one however is around 0600 through to 0630.

● VIETNAM

Hanoi on 3999 at 1536, YL in Vietnamese then local-style orchestral music. This transmission is part of the 1st Network directed to the former South Vietnam, the schedule on this channel being from 1400 to 1715 and from 2115 to 0000. Also in parallel on 4930, 6450, 7374 and 10060.

● ECUADOR

Radio Nac. Espejo, Quito, on 4679 at 0120, an excited full-blooded drama production in Spanish!

● CHINA—2

Radio Peking on 3390 at 1956 when signing-off with the "Internationale" after a programme in a U.S.S.R. dialect. This channel is scheduled to carry the Foreign Service from October to April from 1630 to 2130 and from 2230 to 2300; from May to August from 1730 to 1800 and from 1900 to 2000. Obviously some amendment to this schedule has taken place recently.

● GHANA

Ejura on 3350 at 2145, recordings of church organ music in the Network 1 programme.

Accra on 3366 at 0548, church service with hymns and sermon in English.

● BRAZIL

Radio Ribamar on 4785 at 0021, LA music, OM in Portuguese, slogans and identification.

Radio Dif. Teresina on 4835 at 0028, YL with songs, slogans with echo-effect, OM in Portuguese.

Radio Brazil Central on 4985 at 0150, OM with songs in Portuguese, light music.

Radio Clube do Para on 4855 at 0132, guitar recital after identification.

● VENEZUELA

Radio Bolivar on 4770 at 0033, OM with sports commentary in Spanish.

Radio Continente on 5030 at 0318, OM with world news in Spanish after identification.

● PAPUA

Port Moresby on 3925 at 1945, opening with military music complete with a marching chorus. Evening schedule is from 1945 to 2230 and the power is 10kW. The best chance of hearing Port Moresby is probably on the 4890 channel where sign-on is at 2000.

WORKSHOP AIDS

TWO NEW HACKSAWS

Paramo Tools have produced two new hacksaws, a senior and junior frame.

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The Junior frame utilises an attractively finished hardwood handle, with chrome plated steel ferrule and parts screwing into a solid chromed steel frame. Tensioning a junior blade becomes a difficulty of the



past. The blade pins are fitted into the accurately machined slots, and by turning the handle can be tensioned as required. No more cut fingers and broken blades with the Paramo JF2 Junior frame. Priced at 95p, plus V.A.T., it should be available from Paramo Tool stockists everywhere.



'EASYDRIVER' SYSTEM

The unique 'Easydriver' Ratchet Ball, which drives from one side and reverses from the other, is the heart of this tool system. Because of its shape the turning power is twice that of a normal screwdriver to make jobs faster and easier.

The system is flexible and versatile with three different lengths of drive shaft which accept a variety of insert bits to fit most types of screw head. There are two socket adaptors for driving $\frac{1}{4}$ in. and $\frac{3}{8}$ in. sockets, and for yet more torque a special handle fits over the Ratchet Ball.

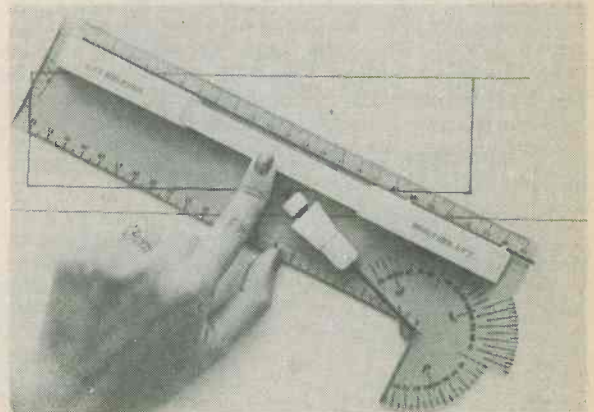
The 'Easydriver' System can be bought in various packs, or the individual pieces separately.

Enquiries to Thunder Screw Anchors Ltd., Industrial Estate, Southwater, Horsham, Sussex.

THE 'MULTIDRAFT'

The 'Multidraft' compact drafting instrument can be used to draw sets of parallels quickly and easily, rotate to give any angular setting, and draw perspective lines with a minimum of inconvenience. A special 18 in. extending ruler foot makes the instrument even more adaptable.

'Multidraft' features a 10-inch drafting arm and a 4 in. rotary protractor. It is available in both metric and imperial calibrations. Construction consists of a single moulded amber-coloured body with firmly attached housings which contain special roller and pivot pin assemblies, controlled by a simple magnetic clutch system. The instrument therefore always lies flat on the paper, and can be moved into position literally by the touch of two fingertips.



The 'Multidraft', compact drafting instrument, now available from Northgate Instruments Limited, of 19 London Road, Gloucester

DIODE POLARITY INDICATOR

By N. R. Wilson

This instrument is completely portable and may be employed for finding the polarity of all silicon or germanium diodes, including rectifiers and small signal types.

There are numerous silicon and germanium rectifiers and signal diodes on the home-constructor market at present, and many of these do not have their polarity reliably indicated. The instrument to be described in this article offers a very simple means of determining the polarity of a diode, and is particularly helpful when large batches of diodes have to be checked.

The basic method of operation is similar to that employed in other diode polarity indicating devices: a low alternating voltage (which in other designs is usually derived from the a.c. mains) is applied to the diode under test, and its polarity is then indicated by the illumination of one of two lamps. In the present circuit the alternating voltage is generated in the unit itself, and two transistors are added to enable the forward current in the test diode to be kept at a low level. These facilities incur a slightly increased complexity in the circuit, but give the advantages that the unit is completely portable and independent of the mains and that small signal diodes may be checked at low forward currents.

555 TIMER

The circuit of the unit appears in Fig. 1, and it will be seen that this incorporates a 555 timer. The 555 runs as an astable multivibrator offering an output at its pin 3 which is close to a square wave.

The multivibrator circuit is quite standard. During one period of each cycle C1 charges via R1 and R2 in series, whilst in the remaining period it discharges via R2 on its own. Thus, the discharge period is shorter than the charge period. However, the value of R2 is much larger than that of R1, causing the discrepancy between the two periods to be small and ensuring that the output from the i.c. is very nearly a 50:50 square wave. The frequency of oscillation is approximately 67Hz.

The i.c. is powered by the 12 volts given by BY1 and BY2 in series. During the charge period in C1 the potential at pin 3 is high and approaches that on the upper positive rail. During the discharge period the output potential is nearly equal to that on the lower negative rail. In relation to the junction of the two 6 volt batteries, pin 3 alternates positive and negative by some 5 to 6 volts. This constitutes the alternating voltage employed for determining test diode polarity.

Pin 3 connects to test terminal No. 1, whilst test terminal No. 2 couples to the battery junction via R3 and R6. The direction of current flow in these two resistors is sensed by TR1 and TR2, whereupon either LED1

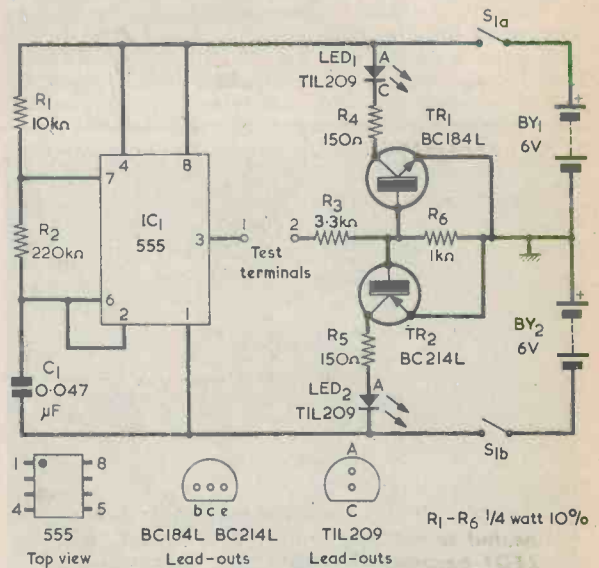


Fig. 1. The circuit of the diode polarity indicator

or LED2 becomes illuminated.

Fig. 2(a) illustrates the instance where a diode is connected to the test terminals with its cathode at terminal No. 2. It will be assumed that current flows from positive to negative.

During the periods when pin 3 of the i.c. is negative of the battery junction the test diode is reverse biased and no current flows in R3 and R6. In consequence, both TR1 and TR2 are cut off. When pin 3 of the i.c. is positive of the battery junction the test diode passes forward current through R3 and R6, whereupon the base of the n.p.n. transistor TR1 is taken positive of its emitter. This transistor turns on. At the same time the base of the p.n.p. transistor TR2 is also positive of its emitter, causing its emitter-base junction to be reverse biased. In consequence, TR2 remains off.

Since TR1 has been turned on it passes a collector current through LED1 and R4, causing the light-emitting diode to glow. The l.e.d. only glows during the periods when pin 3 of IC1 is positive, but persistence of vision gives the impression that it is continually illuminated.

Fig. 2(b) illustrates the situation where the test

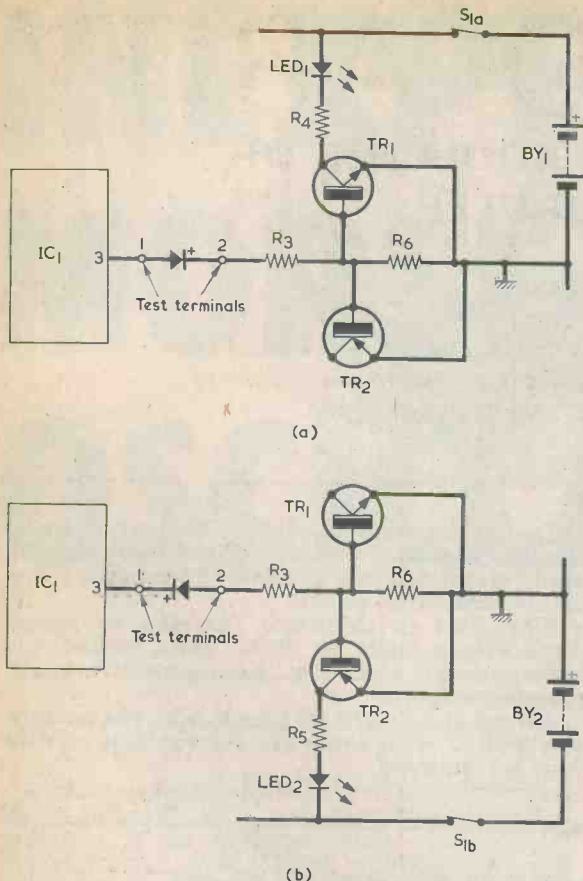


Fig. 2(a). If the diode being checked is connected to the test terminals as shown here, LED1 becomes illuminated (b). Reversing the test diode causes LED2 to light up

diode has its cathode connected to test terminal No. 1. This time current only flows when pin 3 of the i.c. is negative and it causes the base of TR2 to be taken negative of its emitter. TR2 now turns on, whilst TR1 remains cut off. LED2 is thus illuminated during the periods when pin 3 of the i.c. is negative, and the visual impression is one of continual illumination.

To sum up, LED1 lights up when the cathode of the diode under test connects to test terminal No. 2, and LED2 lights up when the cathode of the test diode connects to terminal No. 1. Two further indications are possible. If both i.e.d.'s light up the test diode is short-circuit, and if neither lights up the test diode is open-circuit.

CURRENT VALUES

Resistor R3 limits forward current in the test diode, whilst R6 ensures that indications are not given by low test currents. Both TR1 and TR2 are silicon transistors requiring a forward voltage of about 0.6 volt between base and emitter before they become conductive, with the result that at least 0.6mA has to pass

through the 1kΩ resistor, R6, before either transistor can turn on. When the test diode is conductive, the forward current which then flows is limited by R3 to some 1 to 1.5mA.

Since a forward current of at least 0.6mA has to pass through the test terminals before any indications are given it does not matter if the terminals are touched by the fingers, as the relatively low current which then flows by way of the hand is well below 0.6mA. In consequence, diodes having awkwardly situated lead-outs or terminations can be held directly against the test terminals by the fingers.

The current drawn from the two 6 volt batteries when no test diode is connected is of the order of 8mA. Applying a test diode causes an extra drain of around 15mA from either BY1 or BY2, according to which i.e.d. is illuminated.

The two batteries can each consist of four 1.5 volt cells mounted in a 4-cell holder or any other convenient combination which offers the required voltage. Two 9 volt batteries must not be used as the maximum permissible supply voltage which may be applied to the 555 is 16 volts only. On-off switch S1(a)(b) is a standard double-pole toggle type.

As battery voltage falls with use (and assuming that both batteries have the same voltage) it will be found that the first effect of too low a supply voltage is that LED1 fails to light up whilst LED2 still gives a satisfactory indication. The reason for this is that the positive voltage excursion of pin 3 of the 555 is less than its negative excursion.

The components can be housed in a small case with S1(a)(b), the two test terminals and the two i.e.d.'s mounted on the front panel. LED1 should be positioned alongside test terminal No. 2 and LED2 alongside test terminal No. 1, as illustrated in Fig. 3. The il-

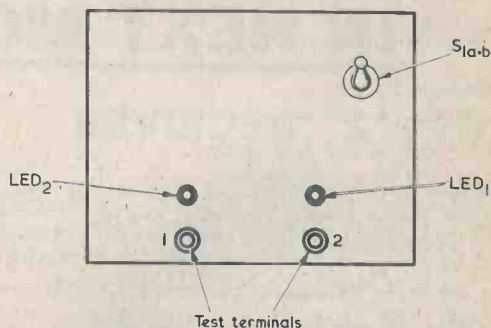


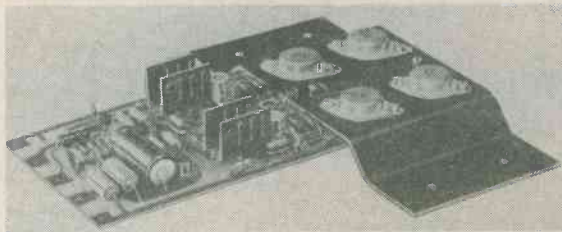
Fig. 3. A Suitable front panel layout for the polarity indicator

luminated i.e.d. then indicates the terminal to which the test diode cathode has been connected, the red i.e.d. glow giving a psychological association with 'positive.'

Quite a high level of radio interference is generated by the wiring around C1, and the multivibrator tone can be picked up by a medium or long wave receiver several feet away. If this effect is considered to be a nuisance, the components may be housed in a metal case which will then provide screening. The metal case should be common with the junction of the two batteries, as indicated by the chassis symbol in Fig. 1. If the interference effect is to be ignored, the parts can be assembled in a plastic or home-made wooden case.

TRADE NOTE

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output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.

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IN NEXT MONTH'S ISSUE

"I.C. + 2" RECEIVER

A simple design offering reception on the medium wave band. Battery supply demands are very modest and the receiver offers an output to an earphone or to its own loudspeaker at a low level for bedside listening

DUAL METRONOME

This electronic metronome employs a very simple circuit and has the unusual feature of providing visual flashes in synchronism with the audible pulses

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INEXPENSIVE MORSE OSCILLATOR

By D. Snaitth

An inexpensive unijunction oscillator
with variable frequency control.

A morse oscillator is a useful item for the enthusiast who is preparing for his amateur transmitting examination. It can, of course, consist of any a.f. oscillator coupled to a speaker or headphones, and which has some means of keying the tone that is produced.

ON-OFF KEY

In the design described here the morse key is also the on-off switch for the oscillator, whereupon no power is consumed from the battery when the key is up. The current consumption is of the order of 2mA only when the key is down, whereupon the life of the battery powering the oscillator should be very long.

Since continual listening to morse at one audio frequency can be tiring, the frequency of the oscillator is made variable over a fairly wide range. The oscillator drives a loudspeaker at an adequate volume level for use in quiet surroundings. Alternatively, the oscillator can be coupled to a standard medium or medium and long wave transistor radio for reproduction of the tone at a higher level.

A low cost circuit which enables these various facilities to be achieved is given by a unijunction transistor oscillator. Since, in an oscillator of this type, oscillation is given by successive discharges of a capacitor into a load there is no need for an a.f. bypass capacitor across the oscillator supply rails. This allows the morse key to be inserted directly in series with the battery which powers the oscillator, and the circuit immediately controlled by the key can be regarded as being completely resistive. The start and cessation of oscillation is instantaneous, a factor which would be difficult to achieve if there were a bypass capacitance across the supply rails after the key.

The circuit of the unit is shown in Fig. 1, and it will be seen that, basically, it is a standard unijunction arrangement. If there is no plug inserted in the jack socket, the base 1 of the transistor connects directly,

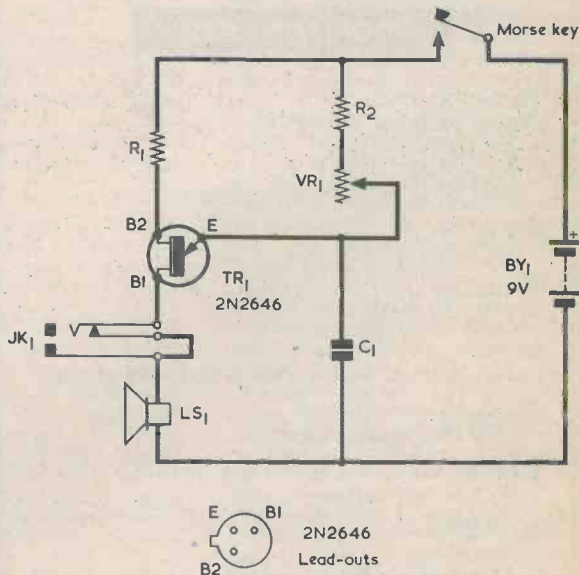


Fig. 1. The simple circuit employed for the morse oscillator. The frequency of the a.f. tone this produces is varied by VR1

via the jack socket break contact, to the loudspeaker. When the morse key is pressed capacitor C1 continually charges, via R2 and VR1, and then discharges into the speaker via the emitter and base 1 of the transistor, thereby producing a series of current pulses in the speaker. The repetition frequency of the pulses is in the audio range, producing an audible tone from the speaker. The frequency of oscillation can be varied by adjusting VR1. When this potentiometer inserts minimum resistance into circuit the capacitor charges at its fastest rate and the frequency of oscillation is at its highest. The frequency falls when VR1 is adjusted to insert increasing resistance, since the rate of charge in C1 is then reduced. The range of audio frequencies will vary somewhat with individual unijunction transistors due to spread in emitter triggering voltage levels, and also because of tolerances in R2, VR1 and C1. With the author's unit the tone frequency was approximately 600Hz when VR1 inserted minimum resistance and was approximately 300Hz when the potentiometer inserted maximum resistance.

SPEAKER

The speaker may be a small component with an impedance of 15Ω. Speakers having a lower impedance should not be used. The volume of the tone is adequate for single persons or small training groups, and it is helpful to mount the speaker in an enclosed housing with the speaker aperture at the front. The other components in Fig. 1, apart from the morse key, may also be fitted in this case.

When a louder tone is required the radiating coil shown in Fig. 2, is plugged into the jack socket, whereupon it becomes connected in series with the speaker, and the pulses from the base 1 of the unijunction transistor pass through it as well as through the speaker.

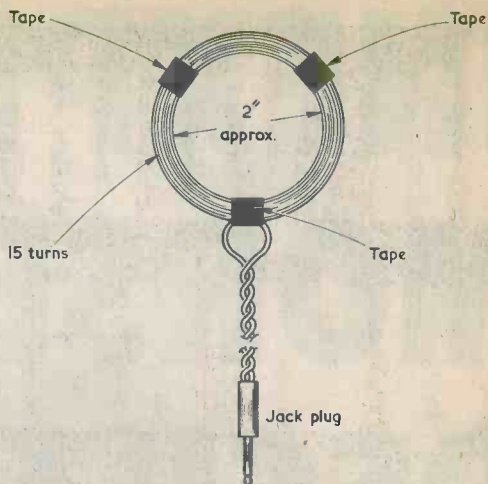


Fig. 2. The radiating coil. This allows the oscillator output to be reproduced via a transistor radio

The coil is self-supporting and simply consists of 15 turns of thin insulated flexible connecting wire random wound and secured at three points by p.v.c. insulating tape. The coil can be wound on one hand and then slipped off, as its exact diameter is not critical. The two coil ends protrude on either side of one of the pieces of insulating tape. They are then twisted together to form a length of 2-way flex about 18 inches long, this being terminated in the jack plug.

The radiating coil, when plugged into the oscillator unit, is held in line with the ferrite aerial rod of the transistor radio with which it is to be used. Initially, the radio is switched on and tuned to a section of the medium or long wave band which is relatively free of transmissions, after which the radiating coil is moved around its cabinet until a position of maximum coupling is found with the unijunction oscillator tone being reproduced by way of the radio speaker. The pick-up of the tone by the radio is due to the fact that the pulses of current in the radiating coil contain r.f. harmonics which extend well above the medium wave range of frequencies, and these harmonics are modulated at the oscillator frequency.

After ensuring that the receiver can pick up the oscillator frequency, the coupling between the radiating coil and the receiver ferrite aerial rod is reduced by moving the coil away from the receiver. Optimum results are given by having the receiver volume control at or near its maximum setting, with the radiating coil positioned just close enough to the receiver to allow the latter to reproduce the tone at the volume level desired. This method of operation will ensure that the receiver a.g.c. circuit is only slightly affected, if at all, by the r.f. signal from the radiating coil, with the result that the morse characters are reproduced cleanly.

The current consumption of the author's oscillator unit was 2.4mA when VR1 was adjusted for the highest tone, and was 1.8mA when VR1 was adjusted for the lowest tone.

COMPONENTS

Resistors

(Fixed values ¼ watt 10%)

R1 330Ω

R2 4.7kΩ

VR1 5kΩ potentiometer, linear

Capacitor

C1 0.2μF plastic foil

Transistor

TR1 2N2646

Socket

JK1 3.5mm. jack socket with break contact

Speaker

LS1 15Ω loudspeaker

Battery

BY1 9 volt battery

Miscellaneous

Morse key


3.5mm jack plug

Knob

Connecting wire

Case

In your workshop



"March winds," sang Dick, "and April showers!"

Cheerfully, he carried the small 14 inch black and white mains-battery television receiver over to his bench. He cleared an area by pushing to one side a pile of odd components, lengths of wire and short pieces of solder, then placed the set on the bench surface. He took up the u.h.f. aerial lead and plugged it into the receiver aerial socket.

"March winds," he intoned, as he inserted the receiver mains plug into a socket at the back of his bench, "and April showers!"

He switched on the receiver, whereupon the sound channel of one of the local transmissions at once became audible from the speaker. He waited for the tube to warm up. Eventually a picture having a markedly low contrast level appeared on the screen.

LOW CONTRAST

Dick frowned and tuned the set to another local transmission. Again, the sound channel was reproduced at good strength and again the picture on the tube was of low contrast.

"March winds," he sang thoughtfully, "and April showers!"

A groan of exasperation rose up from Smithy's bench on the other side of the Workshop. The Serviceman bent further over the hybrid valve and transistor TV on which he was working.

Dick looked at the front of the receiver but no contrast control was available here. He turned the receiver half-way round and examined the rear. A row of holes denoted access to pre-set controls and, picking up a small insulated screwdriver, Dick passed this through a hole designated

"Contrast". He felt its blade enter a recessed slot, and he turned it clockwise experimentally. There was no change in picture contrast level. Dick continued to turn the screwdriver until he realised that he had rotated it through more than a complete circle.

Satisfied that he had found an obvious fault right at the start of his work on the receiver, Dick removed the screwdriver and switched off the receiver. Whistling, he applied the screwdriver to the screws which secured the back of the set.

His whistling changed to song. "March winds and April showers!"

"For the love of Mike," roared out Smithy, "have you got to keep singing that tune?"

Surprised, Dick put down the screwdriver and turned to face the Serviceman.

"What tune?"

"That 'March winds and April showers' thing," replied Smithy irately. "Ever since you came in this morning you've done nothing else but sing that."

"Blimey," retorted Dick, outraged at this unexpected attack on his lawful activities, "what's wrong with singing? It's a free country, and people sing when they're happy. It so happens that I'm happy this morning."

"Perhaps people do sing," grated Smithy irritably. "But most normal people I've ever heard of sing a song all the way through. Normal people don't just sing the first line over and over again."

"Are you suggesting," returned Dick coldly, "that I'm abnormal in some respect?"

"You must be," stated Smithy dispassionately. "A normal person would sing the song right through, and not just keep repeating the first line."

Occasional minor differences of opinion are inevitable in the most amicable of relationships. Despite Smithy's irritation over some of Dick's little mannerisms, the pair are still able to trace a fault in the contrast control circuit of a single standard TV receiver.

The pair glowered at each other.

"Anyway," said Smithy decisively, "if you start singing that one line again, so help me, I'll come over and personally disembowel you. So watch it."

Smithy turned resolutely back to his bench whilst his assistant, his cheerfulness now dissipated, returned to the mains-battery television set. Silently, he removed its back and examined the small open pre-set contrast control mounted on the printed circuit board. It was obvious why he had been able to adjust it through more than 360 degrees. Its slider was distorted out of shape and was not even touching the track. Dick grunted and walked towards the filing cabinet. Shortly, he returned with a service manual, opened it out on his bench, then examined the circuit around the contrast control (Fig. 1). Frowning, he next turned to the components list in the manual. Once again he rose, this time making for the spares cupboard.

There was silence for several minutes as he looked through the contents of the cupboard. Patently, his search was fruitless.

"Hey, Smithy!"

"Hullo," came a preoccupied answer from Smithy's bench.

"Have we got a 470Ω skeleton pot knocking around? Not a miniature, just one of the normal size ones. Oh, and vertical, too."

Smithy put down his soldering iron. "I might have one or two here," he replied. "There's not much call for these pots as replacements but I did get some in a few weeks ago for a little experimental private job. I'll have a look."

He pulled open a drawer in his bench, extracted a cardboard box and poked a questing finger around its con-

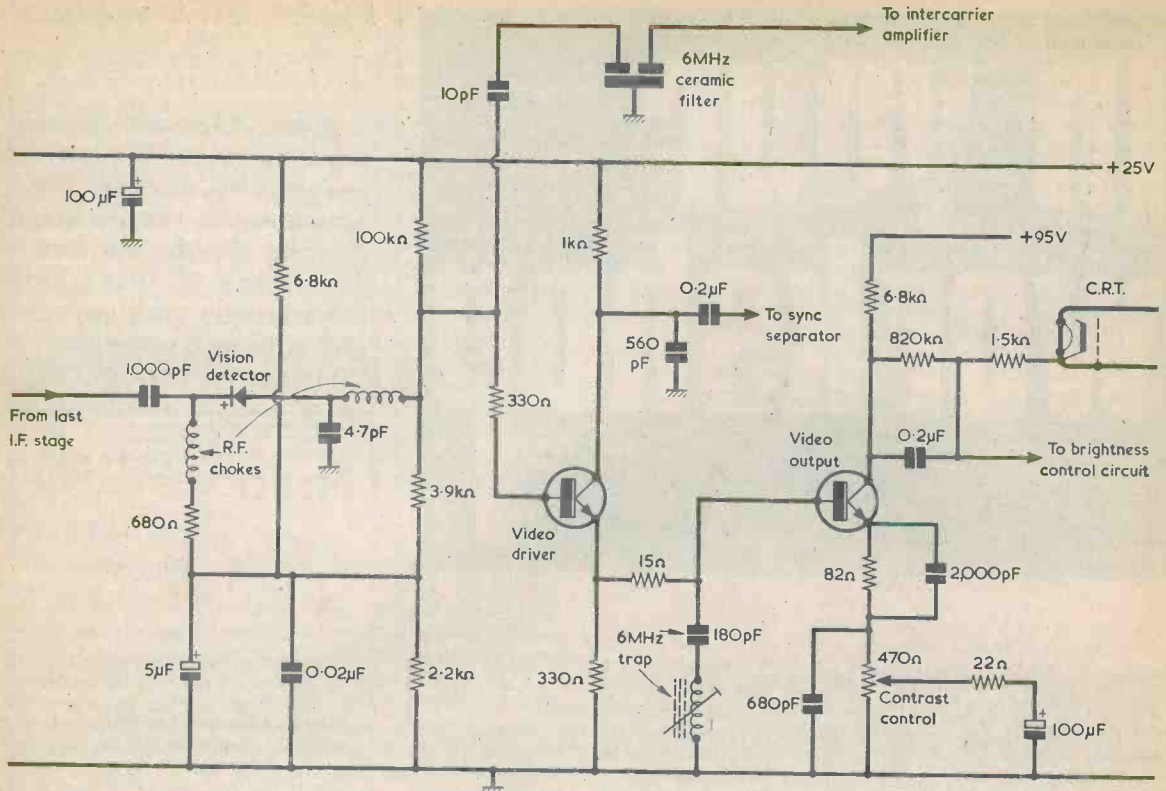


Fig. 1. The signal path in a single standard television receiver from the vision detector to the cathode of the cathode ray tube

tents.

"You're in luck," he announced, taking out a small potentiometer. "I've got several 470Ω skeletons. Incidentally, what's it for? As I said, we don't have to change these pots very often."

"Well, we'll have to change the one in this set," replied Dick. "Come and have a look at it."

Still preoccupied, Smithy got up and walked over to Dick's bench. Dick showed him the potentiometer on the printed circuit board of the television receiver.

"Dear me," remarked Smithy. "Some ham-handed Henry has certainly had a go at that one. He's forced the slider right past the end of the track. Now, I wonder why on earth he did that?"

"Perhaps we'll find out," stated Dick. "When I get the new pot in."

"The one I've got here isn't a precise physical equivalent," said Smithy, holding the potentiometer he was carrying against the component on the board. "Still, the tag spacing looks the same so you might as well fit it in."

VARYING FEEDBACK

"There's rather an unusual type of contrast control in this set," remarked Dick chattily as he pointed to the circuit in the service manual. "It's in the emitter circuit of the video output stage."

"Ah yes, so it is," remarked Smithy, examining the diagram. "It's a very neat arrangement, actually, because it varies the negative feedback in the emitter circuit without upsetting the d.c. conditions. In some of these 625 line monochrome jobs the contrast control changes the amplitude of the detected video signal in much the same way as a volume control changes the amplitude of the signal in an a.f. amplifier. But this one works in quite a different manner."

"How exactly does it work, Smithy?"

"Well," said Smithy, "let's assume for the moment that the 680pF and 2,000pF capacitors aren't there, and also that the 22Ω resistor is omitted. Under these conditions, what happens

when the slider of the pot is at the bottom of the track?" (Fig. 2(a).)

"You get an unbypassed emitter load of about 550Ω," replied Dick promptly. "Which is given by the 470Ω in the pot track and the 82Ω resistor above it."

"Good," replied Smithy. "And what do we have when the slider of the pot is at the top of the track?" (Fig. 2(b).)

"The unbypassed emitter load is 82Ω only," stated Dick. "The 470Ω in the pot track is bypassed by the 100μF electrolytic."

"Exactly," pronounced Smithy. "And that's all there is to it. There is less negative feedback in the emitter circuit when the slider is at the top of the track and so the video output transistor offers greater gain, which corresponds to increased contrast. The 680pF and 2,000pF capacitors in the complete circuit are frequency compensating components and they ensure that a good high frequency response is given when the contrast control pot is at about the correct setting. The 22Ω resistor limits the effect of the 100μF

electrolytic and helps to give smooth contrast control. A very nice little circuit."

Smithy gazed appreciatively at the service manual.

"There are quite a few other interesting points in the overall circuit," put in Dick quickly. "Right from the vision detector on, in fact."

"Ah yes," said Smithy, now completely absorbed by the circuit in the manual. "Well now, let's take the signal all the way from the vision detector to the cathode of the tube. To start off with, it's a negative modulation 625 line signal with sync pulse tips corresponding to maximum amplitude. The vision detector is connected so that the detected sync pulses are negative-going, whereupon the picture information has to be positive-going. This signal is applied to the base of the video driver transistor."

"There's a 10pF capacitor immediately after the vision detector," interrupted Dick. "It goes to the ceramic filter."

"That's right," confirmed Smithy. "The 10pF capacitor takes off the 6MHz intercarrier signal after the vision detector and applies it to the intercarrier amplifier, after which it is fed to the 6MHz sound detector and then to the a.f. amplifier and speaker. The ceramic filter is resonant at 6MHz, of course. But let's go back to the video signal at the base of the video driver transistor. This splits up in two ways. It appears inverted at the collector of the transistor, so that the sync pulse tips are positive-going, and this version of the signal is applied to the sync separator. The 560pF capacitor between the collector and chassis is merely an i.f. bypass capacitor."

"I suppose that the signal at the video driver emitter is in phase with the signal at its base."

"It is," agreed Smithy. "The emitter signal is next applied to a 6MHz trap, which removes the intercarrier signal, and it then passes to the base of the video output transistor. The 6MHz trap will also help to remove some of the i.f. present after the vision detector. We've already looked at the emitter circuit of the video output transistor, where the contrast control is, so all we need say is that the video output transistor functions as a common emitter amplifier and inverts the signal. The signal at the collector is then applied to the cathode of the tube."

"And the signal at the video output collector," chimed in Dick, "will have negative-going picture information and positive-going sync pulses."

"Exactly," stated Smithy. "And that's just the polarity the signal should have at the tube cathode."

BRIGHTNESS CONTROL

"Just a minute, though," said Dick hastily, observing that Smithy was making a move back to his own bench, "there's one bit we haven't looked at yet. There's a 100kΩ resistor from the tube cathode to the brightness control. And, blow me, it goes to the receiver on-off switch, too! What's all that about?" (Fig. 3.)

"It's quite simple," responded Smithy. "All that the brightness control does is vary the standing positive voltage on the tube cathode. During the scan period the tube grid is held at chassis potential, and the cathode is taken positive of it by the brightness control. When you switch the set off, a section of the on-off switch shorts the brightness control slider to chassis, with the result that the tube cathode is taken sufficiently negative for the tube to pass a high beam current and dis-

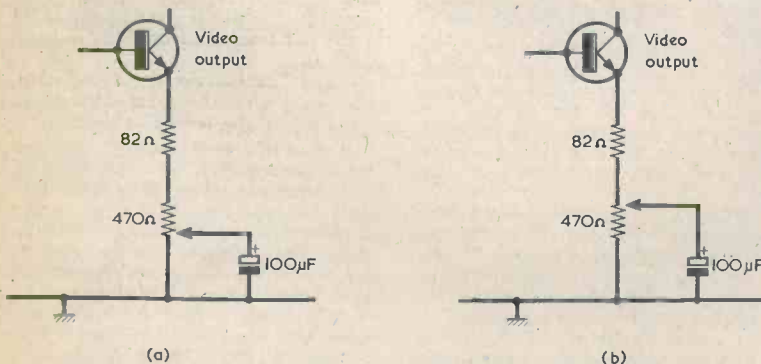


Fig. 2(a). Circuit conditions when the contrast control slider is at the earthy end of its track
(b). The conditions which exist when the slider is at the non-earthly end of the track

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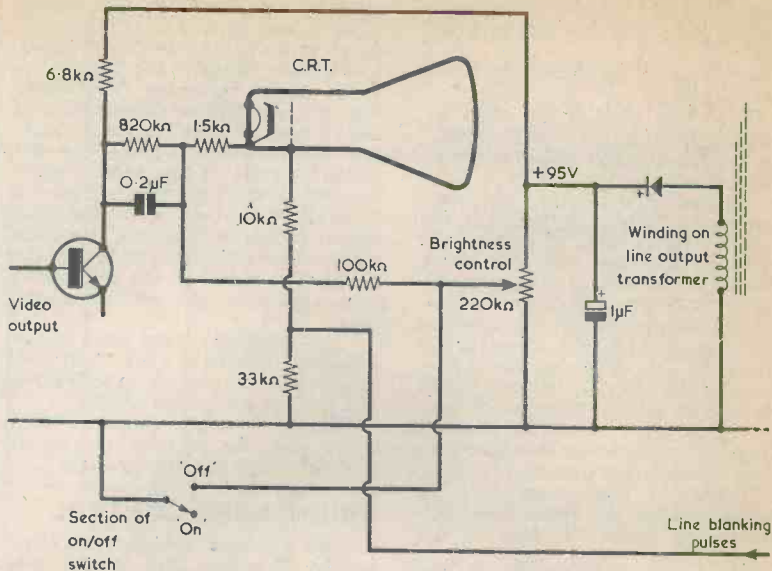


Fig. 3. The brightness control circuit. This, and the circuit of Fig. 1, are based on the appropriate stages of the Thorn Consumer Electronics 1590-1591 Series of mains-battery receivers. The line blanking pulses cut off the c.r.t. during line flyback

charge the e.h.t. reservoir capacitance."

"So you don't get a spot on the screen after switch-off?"

"That's right. And just to finalise the story, the positive voltage required by the brightness control is given by scan rectification of the waveform from a winding on the line output transformer. The scan rectification produces a direct voltage of about 95 volts which is applied also, by the way, to the collector load of the video output transistor."

Smithy glanced at his watch and sighed.

"I must," he remarked wearily, "be the most put-upon person in the world. If I'm not having to endure you singing one-line songs all out of key, I'm wasting my time explaining technical points to you. How on earth I ever get any of my own work done just beats me."

"There's just one little point I don't understand," pleaded Dick. "What's this scan rectification business?"

"It's the opposite," replied Smithy shortly, "to flyback rectification."

Dick considered this statement.

"I still don't get it."

"Look," said Smithy impatiently, "these mains-battery receivers have a main supply rail voltage which is only about 11.5 volts. Quite a few of the receiver stages, as well as the c.r.t., need voltages that are higher than this, and all these higher voltages are obtained from the line output

transformer. One obvious source of high voltage is the boosted supply voltage given by normal line output transformer operation, and this may be used to supply the i.f. stages and the video driver stage. The tube needs an e.h.t. voltage of around 12kV or so, and it is given by rectification of the waveform on the e.h.t. winding of the transformer. This is an example of flyback rectification." (Fig. 4(a).)

"In other words," said Dick brightly, "it's the high voltage flyback peaks that are rectified."

"That's it," replied Smithy. "The flyback peaks are only present for a very short part of the line output transformer waveform cycle, and so flyback rectification is only suitable for cases where the current drawn from the reservoir capacitor is low. If you want to draw a relatively high rectified current you use scan rectification. In this instance the reservoir capacitor charges from the much longer scan period of the waveform with the result that, though you get a much lower rectified voltage, its regulation is very much better." (Fig. 4(b).)

"Oh, I get it now. It's quite easy when you think about it, isn't it?"

"And may I," asked Smithy with elaborate sarcasm, "return to my own work now?"

"Pray do, Smithy. I'm most obliged to you for your information."

"Would Sir be wanting to know anything else?" went on Smithy with biting irony. "Say, for instance, how

the timebases cause the little spot on the screen to go from left to right and up and down?"

"Hey, Smithy," said Dick uneasily. "Don't be like that."

"Perhaps," continued Smithy, "I could assist you by going through all the resistors in this set, showing you how you can tell their values from their colour coding."

"Hell's teeth," complained Dick, "I've never known you carry on like this before. You're really twitter and bisted."

"Harumph," stated Smithy, turning an eagle eye on his uncomfortable assistant: "Well, just you remember it."

With which somewhat inconclusive comment Smithy turned round and walked back to his bench.

NEW CONTROL

The Workshop fell silent for an unwontedly long period as Dick and Smithy set about their various tasks.

Dick applied himself to the rather ticklish process of removing the wrecked potentiometer from the printed board of the television receiver. As he worked, his cheerfulness once more returned and he gradually forgot Smithy's irascibility. Eventually he was able to remove the faulty potentiometer without damage to the copper on the printed board. As he placed the component on his bench he hummed quietly to himself.

He picked up the new potentiometer and bent its tags slightly to ensure an easy fit into the printed circuit holes. They fitted excellently. Carefully he

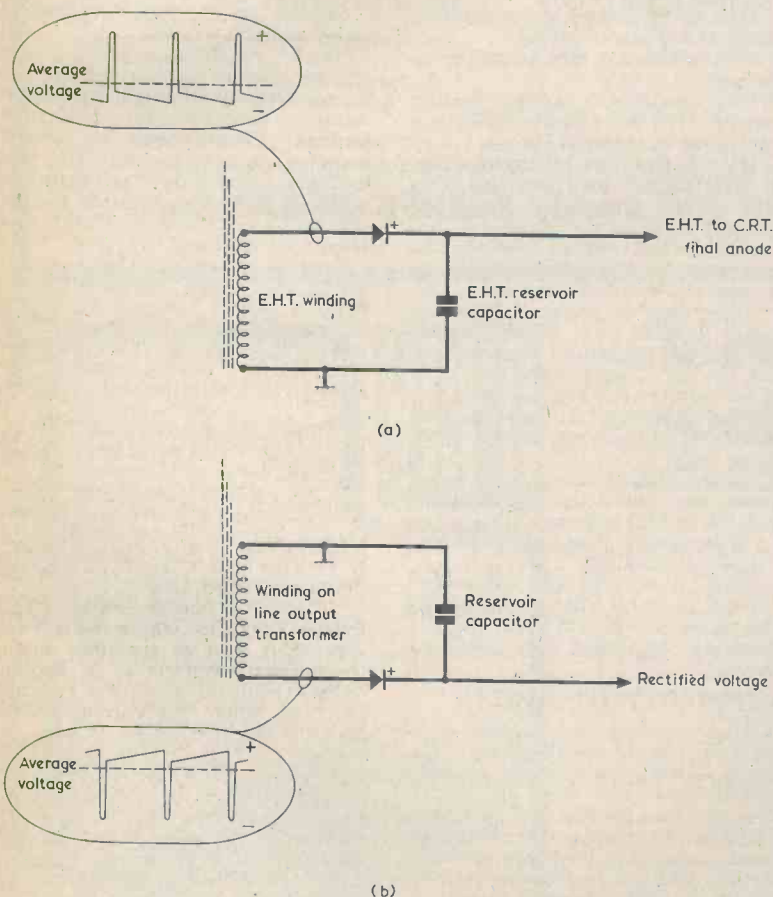


Fig. 4(a). A typical example of flyback rectification is given in the e.h.t. circuit of a television receiver. The e.h.t. reservoir capacitor is normally formed by the inside and outside graphite coatings of the cathode ray tube

(b). Scan rectification is given when a winding on the line output transformer is connected in opposite phase

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applied his soldering iron and the solder to the three tags and the copper areas surrounding them. The resulting joints were excellent, too. Dick's mood rose to one of high elation.

"March winds," he sang joyfully, "and April showers!"

Headless of the furious snarl which was at once audible from the other side of the Workshop, he switched on the television receiver. Again, the sound channel came immediately to life. As Dick waited for the tube to warm up Smithy, at his own bench, was engaged in a quite mysterious operation. The Serviceman had picked up a $400\mu\text{F}$ 275 volt electrolytic capacitor and was now connecting it temporarily by means of insulated crocodile clip leads to the chassis and h.t. positive line of the hybrid television receiver on his bench.

Dick's eyes brightened as an over-contrasted picture appeared on the screen of his set.

"March winds," he carolled exultantly, "and April showers!"

Smithy carefully removed first one and then the other crocodile clip from the $400\mu\text{F}$ 275 volt capacitor, making certain that they would not touch each other. Quietly he picked up a small tin lid with a shiny inside surface.

Dick adjusted the contrast control he had just fitted. It worked perfectly.

Smithy crept up noiselessly behind his assistant. He held the tin lid just behind Dick's left ear and slowly brought the tags of the charged capacitor towards its surface.

"March winds," began Dick, "and

The $400\mu\text{F}$ capacitor discharged into the tin lid surface with an ear-shattering crack. Dick jumped round wildly, involuntarily turning the screwdriver in the contrast control potentiometer as he did so and jerking the television chassis several inches across his bench. His right knee dislodged the lead of his soldering iron, causing it to be pulled from its rest. Still moving convulsively, he twitched his knee even further, whereupon the soldering iron traced a delicate arc in the air before clattering down to the floor. Bemused by the sudden rush of events, Dick dropped the screwdriver he was holding and grabbed unsuccessfully at the iron as it passed him, with the result that he lost his balance and fell to the floor. He lay there for a moment, staring uncomprehendingly at Smithy, then jumped up almost as quickly as he had fallen down when the smell of burning fabric and a warm sensation from his right arm revealed that the soldering iron was doing as much damage to the sleeve of his overall jacket as it was to the Workshop linoleum.

Even Smithy was slightly taken aback at the dramatic outcome of his little enterprise. He sat philosophically on Dick's stool as his stricken assistant tottered over to the Workshop sink to run a little cold water over the scorched overall sleeve and to generally

assess the damage that had been done to him. Thoughtfully, Smithy stooped down, picked up Dick's soldering iron and replaced it neatly on its rest.

Dick returned from the sink, looked at the capacitor and tin lid which Smithy was now holding in his left hand, and realised what had produced the pistol-like crack at his left ear.

"Bleeding rattlesnakes," he complained bitterly, "What on earth did you go and do that for?"

"I warned you," replied Smithy, sternly. "You can't say I didn't warn you. You've just about sent me round the twist this morning with your one-line singing, so you've only got yourself to blame."

Dick looked at the Serviceman. An expression of reluctant respect was burgeoning in his eyes.

"Blimey," he said grudgingly at last, "if you say you're going to do something you do it."

Smithy made no reply.

Dick glanced down at the scorched sleeve of his overall jacket.

"You've caused this jacket to be damaged."

"No problem," replied Smithy shortly. "It's Workshop property and can easily be replaced."

His assistant turned to the television receiver he had been repairing. This still quietly reproduced the sound channel of the local transmission, but the picture had reverted to its previous state of low contrast. Dick quickly examined the contrast control.

"Blow me," he stuttered, "the new pot is wrecked now! When you discharged that capacitor I was adjusting the pot and I must have turned its slider past the end stop as well!"

"Not to worry," returned Smithy calmly. "I can give you another of the same value."

Smithy stalked slowly back to his bench and looked through the components in his cardboard box.

"Here you are," he said, returning. "Here's another one."

"Well, it can jolly well wait a bit," snorted Dick. "It will take me a good five minutes to get rid of my tremble following the ordeal I've just been through."

INTERMITTENT FAULT

After allowing the passage of a suitable time for the steadying of his nerves, Dick removed the contrast potentiometer and fitted the second new one that Smithy had provided. The Serviceman was now working once more on his own television receiver, and the $400\mu\text{F}$ 275 volt capacitor and the tin lid (now noticeably blackened at two points on its surface) were stowed away out of sight at the back of his bench.

Dick put down his soldering iron and once more switched on the television set. After some moments the picture appeared, but in its low contrast state. Dick adjusted the new contrast control. It had no effect.

"Oh no," he moaned.

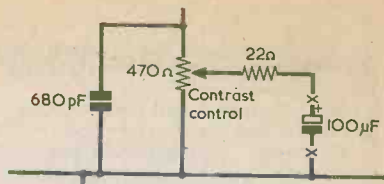


Fig. 5. Dick finally discovered an intermittent connection at the $100\mu\text{F}$ capacitor in the contrast control circuit

"What's up?" called out Smithy.

"The new pot doesn't work," replied Dick. "There's something else wrong with this darned set now."

"Is there?" remarked Smithy, a note of interest entering his voice. "Perhaps what's happened is that as well as over-adjusting that pot you gave the printed board a bit of a jolt, with the result that you brought on the real fault."

Smithy rose and once more walked to his assistant's bench.

"Now," he went on, "let's reason this out. The set came in with the pot broken because someone had turned it round too hard. Now, why should that happen? People don't go around screwing up contrast control pots just to pass the time of day. Isn't there just a chance that whoever turned the pot was trying to get more contrast but he tried a bit too hard?"

Smithy picked up Dick's screwdriver and gently tapped the components around the contrast potentiometer. Suddenly, the picture changed to a full contrast level, stayed in this condition for a few seconds, and then relapsed back to its low contrast condition.

"Blimey," exclaimed Dick. "An intermittent! What I've got to do is chase that intermittent!"

"That's it," returned Smithy. "Now, if I hadn't done you the favour of making you jerk that printed circuit board you'd have been under the impression that you'd cleared the fault, and the set would have come back in again almost immediately after it had gone out."

"If that's your idea of a favour," retorted Dick, indignantly, "I'd prefer you to do things against me. Anyway, let's sort out this intermittent."

After a little tapping Dick soon located the guilty component: none other than the $100\mu\text{F}$ capacitor which coupled to the contrast control slider via the 22Ω resistor. (Fig. 5.) Dick was not able to confirm whether the component itself or one of its connections to the board was faulty, so he took no chance and soldered in a completely new capacitor.

Dick's good spirits had now completely returned, and he hummed happily away as he tightened up the screws at the rear of the fully serviceable television receiver.

"Let's twist again," he sang, "like we did last Summer."

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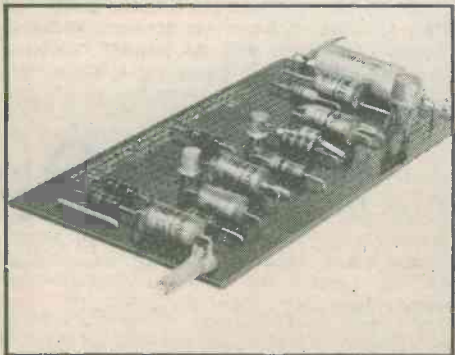
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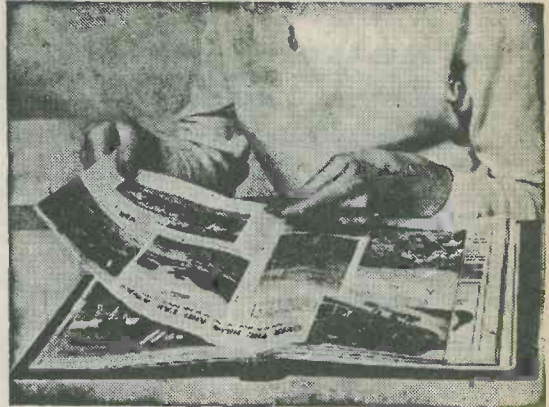
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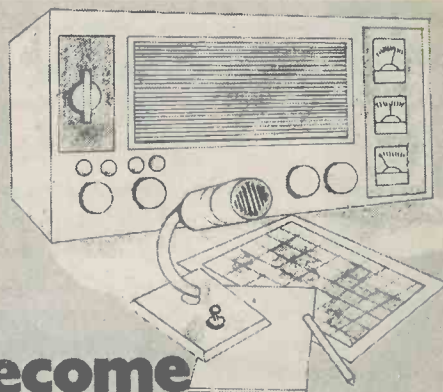
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