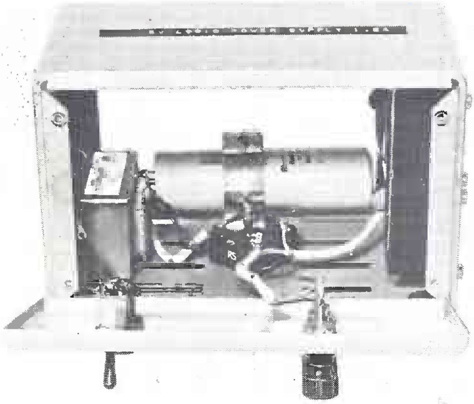
RADIO & ELECTRONICS CONSTRUCTOR

Vol. 26 No. 8 MARCH 1973 20p



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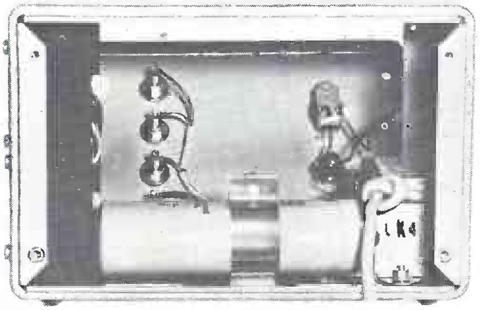

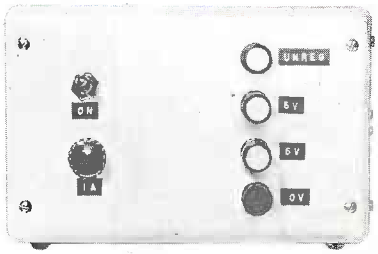

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6 way **2p** Single **1p**

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R.S. 12 way standard plug and shell	**50p**

SWITCHES

Pole	*Way*	*Type*	
4	2	Sub. Min. Slide	**10p**
6	4	Wafer Rotary	**12p each**
1	11		
4	3		
3	7		
2	5		
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ECC82	**36p**	EY86	**46p**	PY82	**42p**
ECC83	**36p**	EZ80	**30p**	PY88	**52p**
ECH81	**44p**	PCC84	**50p**	UABC80	**58p**
EABC80	**46p**	PCC89	**62p**	UCL82	**50p**
EBF89	**44p**	PCF80	**38p**	UL84	**50p**
ECL82	**44p**	PCF82	**50p**	UY85	**42p**
ECL86	**56p**	PCL82	**38p**	UM84	**32p**
EF80	**36p**	PCL84	**50p**	UCH81	**44p**
EF85	**44p**	PCL85	**64p**	6BA6	**26p**
EF86	**44p**	PCL86	**56p**	12EI	**£2.50**
EF91	**52p**	PL36	**78p**	SIIE12	**£5.00**
EF183	**40p**	PL81	**72p**	MANY OTHERS	
EF184	**44p**	PL83	**56p**		

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MODEL 4436-159-989

6–14 volt, 6 digit, illuminated, fully enclosed. **£2.50**

RESISTORS

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

SKELETON PRESETS

5K or 500K **3p**

SAFETY PINS

Standard size, 10 for **4p**

THORN PTO2E 10-6s CHASSIS SOCKET 40p

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

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VA1040
VA1055
VA1066
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10p each

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

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6 volt, 2 pole c/o heavy duty contacts **50p**

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

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

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

CONDENSERS

MFD	*Volt*	
0.005	500	**2p each**
0.001	1,250	
3.3PF	500	
500 PF	500	
2,200PF	500	
3,300PF	500	
0.1	350	**3p each**
0.1	500	
0.25	150	
0.056	5% 350V	
0.061		
0.066		
0.069		
0.075		
0.08		
0.1	1,500	**4p each**
0.25	350	
0.5	350	**5p**
0.22	250	**5p**
0.25	500	**5p**

TUNING GANG

100PF, 50PF, 33PF
20p each

TRIMMERS

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

1MFD 350 volt	**10p**
5MFD 150 volt	**40p**
10MFD 150 volt	**50p**
0.03 12 volt	**2p**
470PF 500 volt	**2p**

8MFD 800 volt electrolytic **75p**

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

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

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

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

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

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Style 154 high conductivity **5p**

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

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type **20p**

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

AC127	10p	AF180	45p	BSV64	40p
AC187	14p	AF239	35p	2N706	8p
AC188	14p	BC107/8/9	7p	2N2219	19p
AD149	35p	BCY40	25p	2N2401	15p
AD161	27p	BD131	40p	2N2904	17p
AD162	27p	BD132	50p	2N2905	21p
Matched pair	50p	BD135	35p	2N2907	18p
AF116	12p	BFY52	15p	2N3055	35p
AF117	12p	BFX88	20p	2N3053	15p
AF178	40p				

BRIDGE RECTIFIERS

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

Plastic types

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

Encapsulated with built-in heat sink 15p

1 AMP RECTIFIERS

IN4002	100 volt	4p
IN4003	200 volt	5p
IN4004	400 volt	7p
IN4005	600 volt	9p
IN4006	800 volt	10p
IN4007	1,000 volt	15p

HIGH POWER RECTIFIERS

	Amp	*Volt*	
BYX38-600	2.5	600	25p
BYX38-300	2.5	300	20p
BYX38-900	2.5	900	28p
BYX38-1200	2.5	1,200	30p
BYX49-600	2.5	600	25p
BYX48-300	6	300	27p
BYX48-900	6	900	40p
BYX48-1200	6	1,200	60p
BYX72-300R	10	300	35p
BYX72-500R	10	500	43p
BYX42-300	10	300	40p
BYX42-600	10	600	45p
BYX42-900	10	900	65p
BYX42-1200	10	1,200	75p
BYX46-300*	15	300	2.50
BYX46-400*	15	400	£2.90
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BYX20-200	25	200	35p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.25

**Avalanche type*

N50 ohm free plug (UG21D/U)	50p
N50 ohm square socket (UG58A/U)	50p
1″ Terryclips, black plastic coated, or chrome finish . .	4p
Cinch 10-way terminal block	15p
Pair of LA2407 Ferrox cores with adjuster	25p
Chrome Car Radio facia . .	15p
Rubber Car Radio gasket . .	10p
DLI Pal Delayline	£2.00
Relay socket . . Take miniature 2PCO relay	12p
B9A valve can	2p
0–30 in ·5 segments, black pvc, 360° dial, silver digits, self adhesive, 4¼″ dia.	15p

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

Diodes

BPX29 Photo transistor 80p

CQ11B Infra red transmitter £4

THYRISTORS

Amp	*Volt*		
1	400	CRS1/40	30p
1	240	BTX18-200	30p
1	240	BTX30-200	30p
5 6	700	BT106	85p
6.5	300	BT102-300R	42p
6.5	500	BT102-500R	60p
6.5	500	BT107	90p
6.5	500	BT108	90p
6.5	500	BT101-500R	68p
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£12

TRIACS

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

DIAC BRI00 . . . . 30p

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BPX66 PNPN 10 amp £1

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BFW10	40p
BSV79	90p
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N. Channel

BSV81 M.O.S.T. . . £1

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

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150 Ohm, 250 Ohm 5K
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12 volt red or mains neon amber, push fit round, chrome bezel
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300 ohm moving coil insert 4103D 1¾″ diameter. Make ideal mike or speaker for communication work . .	25p

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ACY17-20	8p	OC71	6p
BC179	10p	OC72	6p
BCY30-34	10p	OC200-5	6p
BY127	8p	2N2926	5p
BZY88 series	6p	Germanium diode	3p
OA200-5	6p		

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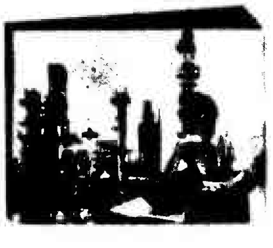

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2.2 µF:	±5% 50p;	±2% 60p;	±1% 75p
4.7 µF:	±5% 70p;	±2% 90p;	±1% 115p
6.8 µF:	±5% 95p;	±2% 115p;	±1% 150p
10.0 µF:	±5% 110p;	±2% 140p;	±1% 180p
15.0 µF:	±5% 160p;	±2% 210p;	±1% 270p

NEW! — TANTALUM BEAD CAPACITORS

Values available .1, .22, .47, 1.0, 2.2, 4.7, 6.8µF at 35V, 10µF 25V, 15µF 20V, 22µF 15V, 33µF 10V, 47µF 6V, 100µF 3V. All at 9p each; 6 for 50p; 14 for £1.00. Special pack, 6 off each value (78 capacitors) for £5.00.

TRANSISTORS: BC107; BC108; BC109 all at **9p** each. 6 for **50p; 14** for **£1.00; AF178** at **42p** each or **3** for **£1.00**. All brand new and marked.

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RESISTORS: Carbon film 5% ½w at 40°c, ¼w at 70°c. Range 2.2Ω-2.2MΩ. E12. series i.e. 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, and their decades. All at 1p each. 8p for 10; 70p for 100 of any one value. Special pack 10 off each value 2.2Ω to 2.2MΩ (730 resistors) for £5.00.

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1.0 µF: Size 2" × ¾", 45p each
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Suitable for use on C.D. ignition, 250V A.C. motors, etc.

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AC 113	20p	AD 161	33p	BC 145	45p	BD 132	60p	BF 180	30p	C 450	22p	2G 302	19p
AC 115	23p	AD 162	33p	BC 147	10p	BD 133	65p	BF 181	30p	MAT 100	19p	2G 303	19p
AC 117K	20p	AD 161 and		BC 148	10p	BD 135	40p	BF 182	40p	MAT 101	20p	2G 304	24p
AC 122	12p	AD 162(MP)	55p	BC 149	12p	BD 136	40p	BF 183	40p	MAT 120	19p	2G 306	40p
AC 125	17p	ADT 140	50p	BC 150	18p	BD 137	45p	BF 184	25p	MAT 121	20p	2G 308	35p
AC 126	17p	AF 114	24p	BC 151	20p	BD 138	50p	BF 185	30p	MPF 102	42p	2G 309	35p
AC 127	17p	AF 115	24p	BC 152	17p	BD 139	55p	BF 188	40p	MPF 104	37p	2G 339	20p
AC 128	17p	AF 116	24p	BC 153	28p	BD 140	60p	BF 194	12p	MPF 105	37p	2G 339A	16p
AC 132	14p	AF 117	24p	BC 154	30p	BD 155	80p	BF 195	12p	OC 19	35p	2G 344	18p
AC 134	14p	AF 118	35p	BC 157	18p	BD 175	60p	BF 196	14p	OC 20	63p	2G 345	16p
AC 137	14p	AF 124	30p	BC 158	12p	BD 176	60p	BF 197	14p	OC 22	38p	2G 371	16p
AC 141	14p	AF 125	25p	BC 159	12p	BD 177	65p	BF 200	45p	OC 23	42p	2G 371B	12p
AC 141K	17p	AF 126	28p	BC 160	45p	BD 178	65p	BF 222	95p	OC 24	56p	2G 373	17p
AC 142	14p	AF 127	28p	BC 161	50p	BD 179	70p	BF 257	45p	OC 25	38p	2G 374	17p
AC 142K	17p	AF 139	30p	BC 167	12p	BD 180	70p	BF 258	60p	OC 26	25p	2G 377	30p
AC 151	15p	AF 178	50p	BC 168	12p	BD 185	65p	BF 259	85p	OC 28	50p	2G 378	16p
AC 154	20p	AF 179	50p	BC 169	12p	BD 186	65p	BF 262	55p	OC 29	50p	2G 381	16p
AC 155	20p	AF 180	50p	BC 170	12p	BD 187	70p	BF 263	55p	OC 35	42p	2G 382	16p
AC 156	20p	AF 181	45p	BC 171	14p	BD 188	70p	BF 270	35p	OC 36	50p	2G 401	30p
AC 157	24p	AF 186	45p	BC 172	14p	BD 189	75p	BF 271	30p	OC 41	20p	2G 414	30p
AC 165	20p	AF 239	37p	BC 173	14p	BD 190	75p	BF 272	80p	OC 42	24p	2G 417	25p
AC 166	20p	AL 102	65p	BC 174	14p	BD 195	85p	BF 273	35p	OC 44	15p	2N 388	35p
AC 167	20p	AL 103	65p	BC 175	22p	BD 196	85p	BF 274	35p	OC 45	12p	2N 388A	55p
AC 168	24p	ASY 26	25p	BC 177	19p	BD 197	90p	BFW 10	60p	OC 70	10p	2N 404	20p
AC 169	14p	ASY 27	30p	BC 178	19p	BD 198	90p	BFX 29	27p	OC 71	10p	2N 404A	28p
AC 176	20p	ASY 28	25p	BC 179	19p	BD 199	95p	BFX 84	22p	OC 72	14p	2N 524	42p
AC 177	24p	ASY 29	25p	BC 180	24p	BD 200	95p	BFX 85	30p	OC 74	14p	2N 527	49p
AC 178	28p	ASY 50	25p	BC 181	24p	BD 205	80p	BFX 86	22p	OC 75	15p	2N 598	42p
AC 179	28p	ASY 51	25p	BC 182	10p	BD 206	80p	BFX 87	24p	OC 76	15p	2N 599	45p
AC 180	17p	ASY 52	25p	BC 182L	10p	BD 207	95p	BFX 88	22p	OC 77	25p	2N 696	12p
AC 180K	20p	ASY 54	25p	BC 183	10p	BD 208	95p	BFY 50	20p	OC 81	15p	2N 697	13p
AC 181	17p	ASY 55	25p	BC 183L	10p	BDY 20	£1.00	BFY 51	20p	OC 81D	15p	2N 698	24p
AC 181K	20p	ASY 56	25p	BC 184	12p	BF 115	24p	BFY 52	20p	OC 82	15p	2N 699	35p
AC 187	22p	ASY 57	25p	BC 184L	12p	BF 117	45p	BFY 53	17p	OC 82D	15p	2N 706	8p
AC 187K	20p	ASY 58	25p	BC 186	28p	BF 118	70p	BPX 25	85p	OC 83	20p	2N 706A	9p
AC 188	22p	ASZ 21	40p	BC 187	28p	BF 119	70p	BSX 19	15p	OC 84	20p	2N 708	12p
AC 188K	20p	BC 107	9p	BC 207	11p	BF 121	45p	BSX 20	15p	OC 139	20p	2N 711	30p
ACY 17	25p	BC 108	9p	BC 208	11p	BF 123	50p	BSY 25	15p	OC 140	20p	2N 717	35p
ACY 18	20p	BC 109	10p	BC 209	12p	BF 125	45p	BSY 26	15p	OC 169	25p	2N 718	24p
ACY 19	20p	BC 113	10p	BC 212L	11p	BF 127	50p	BSY 27	15p	OC 170	25p	2N 718A	50p
ACY 20	20p	BC 114	15p	BC 213L	11p	BF 152	55p	BSY 28	15p	OC 171	25p	2N 726	28p
ACY 21	28p	BC 115	15p	BC 214L	14p	BF 153	45p	BSY 29	15p	OC 200	25p	2N 727	28p
ACY 22	16p	BC 116	15p	BC 225	25p	BF 154	45p	BSY 38	18p	OC 201	28p	2N 743	20p
ACY 27	18p	BC 117	15p	BC 226	35p	BF 155	70p	BSY 39	18p	OC 202	28p	2N 744	20p
ACY 28	19p	BC 118	10p	BCY 30	24p	BF 156	40p	BSY 40	28p	OC 203	25p	2N 914	14p
ACY 29	35p	BC 119	30p	BCY 31	26p	BF 157	55p	BSY 41	28p	OC 204	25p	2N 918	30p
ACY 30	28p	BC 120	80p	BCY 32	30p	BF 158	55p	BSY 95	12p	OC 205	35p	2N 929	21p
ACY 31	28p	BC 125	12p	BCY 33	22p	BF 159	60p	BSY 95A	12p	OC 309	40p	2N 930	21p
ACY 34	21p	BC 126	10p	BCY 34	25p	BF 160	40p	Bu 105	£2.00	P 346A	20p	2N 1131	20p
ACY 35	21p	BC 132	12p	BCY 70	14p	BF 162	40p	C 111E	50p	P 397	42p	2N 1132	22p
ACY 36	28p	BC 134	10p	BCY 71	18p	BF 163	40p	C 400	30p	OCP 71	43p	2N 1302	14p
ACY 40	17p	BC 135	12p	BCY 72	14p	BF 164	40p	C 407	25p	ORP 12	43p	2N 1303	14p
ACY 41	18p	BC 136	15p	BCZ 10	20p	BF 165	40p	C 424	20p	ORP 60	40p	2N 1304	17p
ACY 44	35p	BC 137	15p	BCZ 11	25p	BF 167	22p	C 425	50p	ORP 61	40p	2N 1305	17p
AD 130	30p	BC 139	40p	BCZ 12	25p	BF 173	22p	C 426	35p	ST 140	12p	2N 1306	21p
AD 140	40p	BC 140	30p	BD 121	60p	BF 176	35p	C 428	20p	ST 141	17p	2N 1307	21p
AD 142	40p	BC 141	30p	BD 123	65p	BF 177	35p	C 441	30p	TIS 43	30p	2N 1308	23p
AD 143	30p	BC 142	30p	BD 124	60p	BF 178	30p	C 442	30p	UT 46	27p	2N 1309	23p

2N 1613	20p	2N 2926(R)	10p	2N 3906	27p		
2N 1711	20p	2N 2926(B)	10p	2N 4058	12p		
2N 1889	32p	2N 3010	70p	2N 4059	10p		
2N 1890	45p	2N 3011	14p	2N 4060	12p		
2N 1893	37p	2N 3053	17p	2N 4061	12p		
2N 2147	72p	2N 3054	44p	2N 4062	12p		
2N 2148	57p	2N 3055	50p	2N 4284	17p		
2N 2160	60p	2N 3391	14p	2N 4285	17p		
2N 2192	35p	2N 3391A	16p	2N 4286	17p		
2N 2193	35p	2N 3392	14p	2N 4287	17p		
2N 2194	35p	2N 3395	14p	2N 4288	17p		
2N 2217	22p	2N 3394	14p	2N 4289	17p		
2N 2218	20p	2N 3395	17p	2N 4290	17p		
2N 2219	20p	2N 3402	21p	2N 4291	17p		
2N 2220	22p	2N 3403	21p	2N 4292	17p		
2N 2221	20p	2N 3404	28p	2N 4293	17p		
2N 2222	20p	2N 3405	42p	2N 5172	12p		
2N 2368	17p	2N 3414	15p	2N 5457	32p		
2N 2369	14p	2N 3415	15p	2N 5458	32p		
2N 2369A	14p	2N 3416	28p	2N 5459	40p		
2N 2411	24p	2N 3417	28p	2S 301	50p		
2N 2412	24p	2N 3525	75p	2S 302A	42p		
2N 2646	47p	2N 3646	9p	2S 302	42p		
2N 2711	21p	2N 3702	10p	2S 303	55p		
2N 2712	21p	2N 3703	10p	2S 304	70p		
2N 2714	21p	2N 3704	11p	2S 305	84p		
2N 2904	17p	2N 3705	10p	2S 306	84p		
2N 2904A	21p	2N 3706	9p	2S 307	84p		
2N 2905	21p	2N 3707	11p	2S 321	56p		
2N 2905A	21p	2N 3708	7p	2S 322	42p		
2N 2906	15p	2N 3709	9p	2S 322A	42p		
2N 2906A	18p	2N 3710	9p	2S 323	56p		
2N 2907	20p	2N 3711	9p	2S 324	70p		
2N 2907A	22p	2N 3819	28p	2S 325	70p		
2N 2923	14p	2N 3820	50p	2S 326	70p		
2N 2924	14p	2N 3821	35p	2S 327	70p		
2N 2925	14p	2N 3823	28p	2S 701	42p		
2N 2926(G)	12p	2N 3903	28p	40361	40p		
2N 2926(Y)	11p	2N 3904	30p	40362	45p		
2N 2926(O)	10p	2N 3905	28p				

DIODES & RECTIFIERS

AA 119	8p	BY 130	16p	OA 47	7p
AA 120	8p	BY 133	21p	OA 70	7p
AA 129	8p	BY 164	50p	OA 79	7p
AAY 30	9p	BYX 38 30	42p	OA 81	7p
AAZ 13	10p	BYZ 10	35p	OA 85	9p
BA 100	10p	BYZ 11	30p	OA 90	6p
BA 116	21p	BYZ 12	30p	OA 91	6p
BA 126	22p	BYZ 13	25p	OA 95	7p
BA 148	14p	BYZ 16	40p	OA 200	6p
BA 154	12p	BYZ 17	35p	OA 202	7p
BA 155	14p	BYZ 18	35p	SD 10	5p
BA 156	13p	BYZ 19	28p	SD 19	5p
BY 100	15p	CG 62		IN 34	7p
BY 101	12p	(Eq) OA 91	5p	IN 34A	7p
BY 105	17p	CG 651 (Eq)		IN 914	6p
BY 114	12p	OA 70—OA79	6p	IN 916	6p
BY 126	14p	OA 5	35p	IN 414B	6p
BY 127	15p	OA 5SL	21p	IS 021	10p
BY 128	15p	OA 10	35p	IS 951	6p

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0.50
C 2	200	Capacitors mixed values approx. count by weight	0.50
C 3	50	Precision Resistors .1%, .01% mixed values	0.50
C 4	75	⅛th W Resistors mixed preferred values	0.50
C 5	5	Pieces assorted Ferrite Rods	0.50
C 6	2	Tuning Gangs, MW/LW VHF	0.50
C 7	1	Pack Wire 50 meters assorted colours	0.50
C 8	10	Reed Switches	0.50
C 9	3	Micro Switches	0.50
C10	15	Assorted Pots & Pre-Sets	0.50
C11	5	Jack Sockets 3—3.5m 2 — Standard Switch Types	0.50
C12	40	Paper Condensers preferred types mixed values	0.50
C13	20	Electrolytics Trans. types	0.50
C14	1	Pack assorted Hardware – Nuts/Bolts, Gromets, etc.	0.50
C15	4	Mains Toggle Switches, 2 Amp D/P	0.50
C16	20	Assorted Tag Strips & Panels	0.50
C17	10	Assorted Control Knobs	0.50
C18	4	Rotary Wave Change Switches	0.50
C19	3	Relays 6 – 24V Operating	0.50
C20	4	Sheets Copper Laminate approx. 10″×7″	0.50

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

Component Lists for mail order available on request.

JUMBO COMPONENT PAKS

MIXED ELECTRONIC COMPONENTS

Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1.50 only

BRAND NEW POST OFFICE TYPE TELEPHONE DIALS

ONLY 35p each

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

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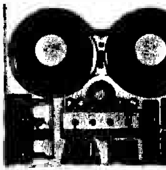
SYSTEM 12 STEREO

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



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PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0.20	0.25	0.25	0.25	0.47	0.50	0.53	£1.15
100	0.25	0.35	0.47	0.47	0.50	0.50	0.60	£1.40
200	0.25	0.37	0.40	0.40	0.57	0.61	0.75	£1.60
400	0.42	0.47	0.55	0.55	0.67	0.75	0.90	£1.75
600	0.55	0.57	0.66	0.66	0.77	0.97	£1.25	—
800	0.65	0.70	0.80	0.80	0.90	£1.30	£1.50	£4.00

SILICON RECTIFIERS—TESTED

PIV	300mA £p	750mA £p	1A £p	1.5A £p	3A £p	10A £p	30A £p
50	0.04	0.05	0.05	0.07	0.14	0.21	0.60
100	0.04	0.06	0.05	0.13	0.16	0.25	0.75
200	0.05	0.09	0.05	0.14	0.20	0.34	1.00
400	0.06	0.13	0.07	0.20	0.27	0.37	1.25
600	0.07	0.10	0.10	0.22	0.34	0.45	1.35
800	0.10	0.17	0.11	0.25	0.37	0.55	2.00
1000	0.11	0.25	0.14	0.30	0.45	0.62	2.50
1200	—	0.33	—	0.35	0.57	0.75	—

TRIACS

VBOM	2A TO-1 £p	6A TO-66 £p	10A TO-66 £p
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200	50	60	90
400	70	75	1-10

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

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FOR USE WITH TRIACS
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10 amp POTTED BRIDGE RECTIFIER on heat sink. 100 PIV. 90p each.

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Plastic encapsulated 2 amp Bridge Rects.

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100 v RMS 37p each
400 v RMS 46p each

Size 15 mm x 6 mm

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BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT
T1	8	2G371B	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 50p each pak

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ORP12 40p
ORP60, ORP61 40p each

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 25p each.

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

£p			
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50 For	1.00	500 For	7.50
		1000 For	13.00

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO.5 N.P.N. 25 up 15p each.

SIL. G.P. DIODES £p

300mW	30	0.50
40PIV(Min.)	100	1.50
Sub-Min.	500	5.00
Full Tested	1,000	9.00

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U1	120 Glass Sub-Min. General Purpose Germanium Diodes	50p
U2	60 Mixed Germanium Transistors AF/RF	50p
U3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	50p
U4	40 Germanium Transistors like OC81, AC128	50p
U5	60 200mA Sub-Min. Silicon Diodes	50p
U6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	50p
U7	16 Sil. Rectifiers Top-Hat 750mA Vltg. Range up to 1,000	50p
U8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	50p
U9	20 Mixed Voltages, 1 Watt Zener Diodes	50p
U10	20 BAY50 charge storage Diodes DO-7 Glass	50p
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	50p
U12	12 Silicon Rectifiers Epoxy 500 mA up to 800 PIV	50p
U13	30 PNP-NPN Sil. Transistors OC200 and 2S 104	50p
U14	150 Mixed Silicon and Germanium Diodes	50p
U15	25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	50p
U16	10 3Amp Silicon Rectifiers Stud Type up to 1,000 PIV	50p
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	50p
U18	8 6Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	50p
U19	25 Silicon NPN Transistors like BC108	50p
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U23	30 MADT's like MHz Series PNP Transistors	50p
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	50p
U25	25 300 MHz NPN Silicon Transistors 2N708, BSY27	50p
U26	30 Fast Switching Silicon Diodes like 1N914 Micro-Min.	50p
U27	12 NPN Germanium AF Transistors TO-1 like AC127	50p
U29	10 1Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	£1.00
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U31	20 Sil. Planar Plastic NPN Trans. Low Noise Amp 2N3707	50p
U32	25 Zener Diodes 400mW DO-7 case 3-18 volts mixed	50p
U33	15 Plastic Case 1 Amp Silicon Rectifiers 1N4000 Series	50p
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	50p
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	50p
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	50p
U37	30 Silicon Alloy Transistors SO-2 PNP OC200, 2S322	50p
U38	20 Fast Switching Silicon Trans. NPN 400 MHz 2N3011	50p
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	50p
U40	10 Dual Transistors 6 lead TO-5 2N2060	50p
U41	25 RF Germanium Transistors TO-1, OC45, NKT72	50p
U42	10 VHF Germanium PNP Transistors TO-1 NKT667, AF117	50p
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	50p
U44	20 Sil. Trans. Plastic TO-5 BC115/NPN	50p
U45	7 3A SCR. TO66 up to 600 PIV	£1.00

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

QUALITY TESTED SEMICONDUCTORS

Pack	Description	Price £
Q1	20 Red spot transistors PNP	50p
Q2	16 White spot R.F. transistors PNP	50p
Q3	4 OC 77 type transistors	50p
Q4	6 Matched transistors OC44/45/81/81D	50p
Q5	4 OC 75 transistors	50p
Q6	5 OC 72 transistors	50p
Q7	4 AC 128 transistors PNP high gain.	50p
Q8	4 AC 126 transistors PNP	50p
Q9	7 OC 81 type transistors	50p
Q10	7 OC 71 type transistors	50p
Q11	2 AC 127/128 Comp. pairs PNP/NPN	50p
Q12	3 AF 116 type transistors	50p
Q13	3 AF 117 type transistors	50p
Q14	3 OC 171 H.F. type transistors	50p
Q15	7 2N2926 Sil. Epoxy trans. mixed colours	50p
Q16	2 GET880 low noise Germ. trans.	50p
Q17	5 NPN 2 x ST.141. and 3 x ST. 140	50p
Q18	4 MADT's 2 x MAT 100 & 2 x MAT 120	50p
Q19	3 MADT's 2 x MAT 101 & 1 x MAT 121	50p
Q20	4 OC 44 Germanium transistors A.F.	50p
Q21	4 AC 127 NPN Germanium transistors	50p
Q22	20 NKT transistors A.F. R.F. coded	50p
Q23	10 OA 202 Silicon diodes sub-min.	50p
Q24	8 OA 81 diodes	50p
Q25	15 1N914 Silicon diodes 75PIV 75mA	50p
Q26	8 OA95 Germanium diodes sub-min 1N69	50p
Q27	2 10A 600 PIV Sil. rectifiers 1S425R	50p
Q28	2 Silicon power rectifiers BYZ 13	50p
Q29	4 Silicon trans. 2 x 2N696, 1 x 2N697, 1 x 2N698	50p
Q30	7 Sil. switch transistors 2N706 NPN	50p
Q31	6 Sil. switch transistors 2N708 NPN	50p
Q32	3 PNP Sil. trans. 2x2N1131, 1x2N1132	50p
Q33	3 Silicon NPN transistors 2N1711	50p
Q34	7 Sil. NPN trans. 2N2369, 500MHz (code P397)	50p
Q35	3 Sil. PNP TO-5, 2x2N2904 & 1x2N2905	50p
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	50p
Q37	3 2N3053 NPN Silicon transistors	50p
Q38	7 PNP trans. 4 x 2N3703, 3 x 2N3702	50p
Q39	7 NPN trans. 4 x 2N3704, 3 x 2N3705	50p
Q40	7 NPN trans. 4x 2N3707, 3 x 2N3708	50p
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2. Radio, Tuner	35 mV into 50KΩ
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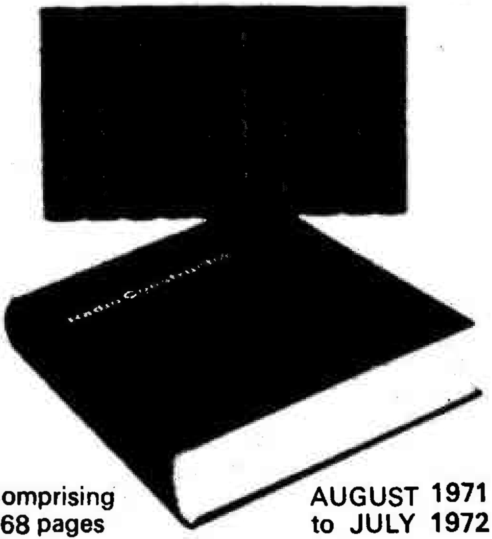

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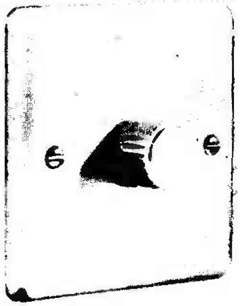

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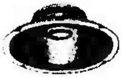

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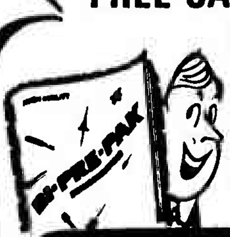

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Hex. Inverter	BMC935	12p	11p	10p
Hex. Inverter	BMC936	12p	11p	10p
Hex. Inverter	BMC937	12p	11p	10p
Hex. Inverter	BMC940	12p	11p	10p
Hex. Inverter	BMC941	12p	11p	10p
Type D Flip Flop	BMC942	20p	18p	16p
Ex. 2/4-input Power	BMC944	12p	11p	10p
Clocked Flip Flop	BMC945	20p	18p	16p
4/2 Input Nand Gate	BMC946	11p	10p	9p
Clocked Flip Flop	BMC948	20p	18p	16p
4/2 Input Nand Gate	BMC949	12p	11p	10p
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Monostable Multivib.	BMC951	25p	23p	21p
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Dual J/K Flip Flop	BMC955	20p	18p	16p
Dual J/K Flip Flop	BMC956	20p	18p	16p
Quad. 2-input Power	BMC958	12p	11p	10p
2/4-input Gate	BMC961	12p	11p	10p
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3/3-input NAND Gate	BMC963	12p	11p	10p
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RADIO & ELECTRONICS CONSTRUCTOR

MARCH 1973

Vol. 26 No. 8

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141
Telegrams Databux, London

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Annual Subscription: £2.70 (U.S.A. and Canada $7.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

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Production.—Web Offset.

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

The *Radio & Electronics Constructor* is printed by Carlisle Web Offset.

APRIL ISSUE WILL BE PUBLISHED ON APRIL 2nd

THE SCHMITT TRIGGER

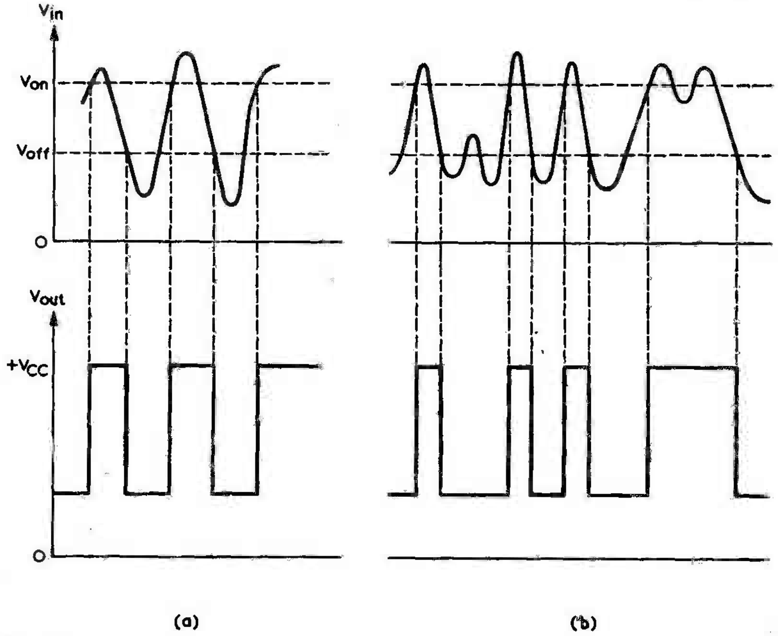
by

A. Foord

Our contributor describes the basic functioning of the Schmitt trigger, then proceeds to examples which illustrate its operation for different applications.

THE SCHMITT TRIGGER IS A BISTABLE CIRCUIT WHICH is a variation on the familiar cross-coupled arrangement. One collector is coupled to the opposite base in the usual way, but the second interconnection is through the transistor emitters. The original circuit used valves in 1938.

The action of the circuit is shown in Figs. 1(a) and (b). Fig. 1(a) shows how an irregular waveform with slow rise and fall times is converted into sharp output transitions as the Von and Voff levels are crossed.



(a)

(b)

Fig. 1 (a). The Schmitt trigger converts an irregular waveform into sharp output transitions as the Von and Voff levels are crossed
(b). Another example of Schmitt trigger operation. Note that the input must pass the Von or Voff level, as applicable, to promote triggering

Fig. 1(b) shows how a noisy waveform is converted into clean noise-free pulses. Input pulses below Von in amplitude are discriminated against while signals exceeding Von become sharp unambiguous transitions. Since both Von and Voff must be traversed to produce an output the double peak is not resolved. If suitable switching levels are chosen, then noise and other undesirable signals can be rejected. The Schmitt trigger circuit can perform a number of functions in waveshaping, logic level restoring, squaring, amplitude discriminating, and sensing.

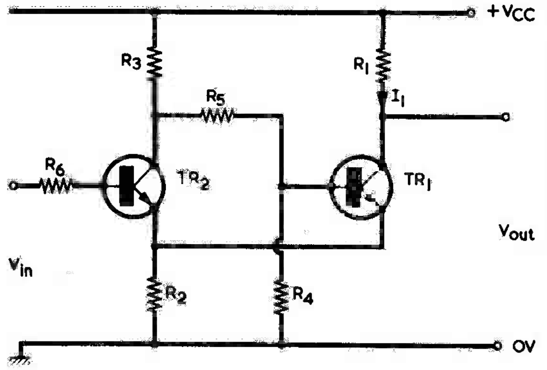


Fig. 2. The basic circuit for a Schmitt trigger

BASIC CIRCUIT

The basic circuit is shown in Fig. 2. We can initially assume that Vin is low enough for TR2 to be cut off. When TR2 is cut off its collector voltage is high and TR1 will be saturated. The current through TR1 causes a voltage to be dropped across R2 which sets the emitter potential of TR2. The output potential Vout will be given by:

$$\text{Vout} = \text{I1 R2} + \text{VCE (sat)}$$

If the input voltage rises a potential will be reached which causes TR2 to start to conduct. The decreased potential at TR2 collector turns TR1 off. This further decreases the current through R2, lowering TR2 emitter potential.

This regenerative (positive feedback) cycle rapidly completes the switching transition until TR2 is saturated and TR1 is cut off. The output voltage for this state is +Vcc. The input voltage required for this transition is Von.

If the input voltage now decreases it eventually becomes low enough to bring TR2 out of saturation. TR2 collector voltage increases, causing TR1 to conduct and increase the emitter potential. This regenerative action rapidly turns TR2 off and TR1 on. The input voltage required for this transition is Voff.

The difference between Von and Voff is called the 'hysteresis' voltage or 'dead zone'. Some hysteresis is essential to the operation of the circuit, and is usually achieved by making R3 greater than R1 and by using the potential divider action of R4 and R5 in level setting. It can be reduced by making R3 equal to R1 and removing R4. Reducing the hysteresis increases the rise and fall times of the circuit and makes the triggering more sensitive.

THREE TYPICAL CIRCUITS

Three typical circuits are shown. Fig. 3 uses high gain germanium transistors and switches in about 2μS. Figs. 4 and 5 are designed to interface with TTL circuits. Fig. 5 uses a 12V supply with the collector voltages clamped at around 5V. (There is a forward voltage drop in the 1N914 diodes of about 0.7V.) This collector clamping reduces the rise and fall times of the circuit and enables the output level to be maintained at 5V for load currents up to 5mA. The rise and fall times for this circuit were about 30 nS and the maximum p.r.f. was 5 MHz.

The capacitors shown in the diagrams are 'speed-up' capacitors which increase the switching speed of the circuit.

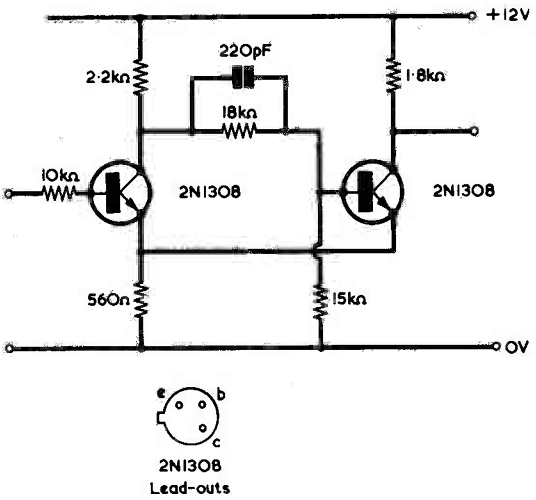


Fig. 3. Circuit using high gain germanium transistors

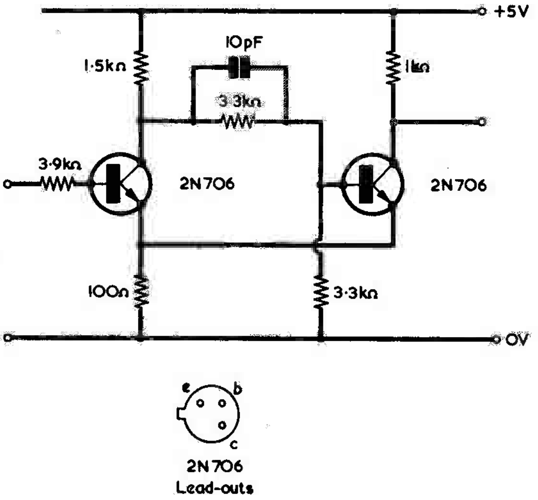


Fig. 4. Simple circuit employing 2N706 transistors

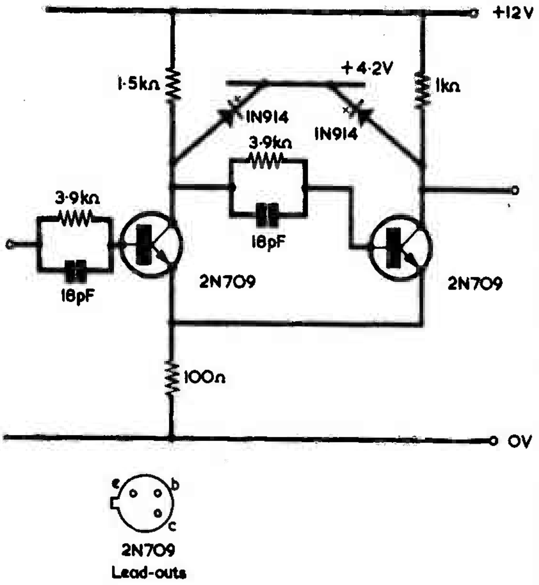


Fig. 5. Circuit with collector clamping to increase speed

HIGH INPUT IMPEDANCE CIRCUIT

The input impedance of the conventional Schmitt trigger can be increased by making the input stage differential, as shown in Fig. 6. This also tends to keep the trip point and hysteresis constant with changes in ambient temperature.

If TR1 is off then TR2 will be on and TR3 is maintained conducting. The output will be at –18V and D1 is reverse biased and the hysteresis resistor R1 will be out of circuit. The bias voltage for TR2 is fixed by the potentiometer chain. When the input voltage reaches or becomes more negative than this reference voltage then TR1 is turned on and TR3 and TR2 turn off.

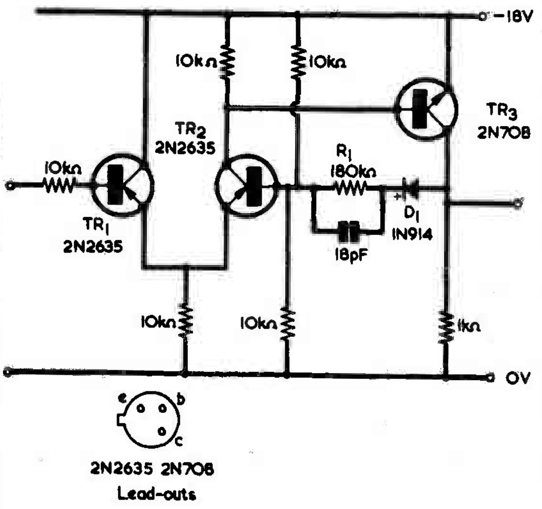


Fig. 6. High input impedance circuit

As TR3 turns off the output level drops to zero, forward biasing D1 and bringing the base of TR2 nearer to earth potential. The positive feedback around the TR2 and TR3 path regeneratively increases the switching speed, while the action of D1 provides the hysteresis.

When the signal drops below the new reference voltage at TR2 base then TR1 will turn off and TR2 come on. This allows TR3 to conduct and the output rises to –18V and the cycle is completed.

The circuit speed depends mainly on TR3 because TR1 and TR2 form a fast current mode switch, and is typically 20 nS for the transistors shown.

TR1 and TR2 are shown as 2N2635 in Fig. 6. If this type is difficult to obtain, any small p.n.p. transistor (germanium or silicon) with a current gain greater than 30 and a high fT may be employed in its place. A suitable type is the 2N1132, which has the same lead-out layout as the 2N2635.

SN7413 SCHMITT TRIGGER

Although the discrete component versions previously discussed can be designed to interface with TTL waveforms a Schmitt trigger is available in the SN7400 series. This is the SN7413 and it may be used where it is required to interface with other circuits of the TTL family. It has a typical hysteresis of 0.8V with the positive going threshold at 1.7V and the negative going threshold at 0.9V.

For TTL input levels it can be used directly, as in Fig. 7. For non-TTL inputs where the levels are not well defined the circuit of Fig. 8 may be used. This is

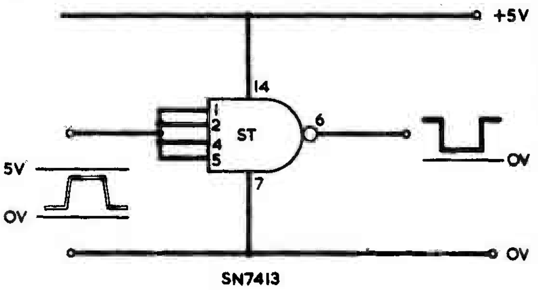


Fig. 7. Simple circuit using SN7413, for logic level inputs

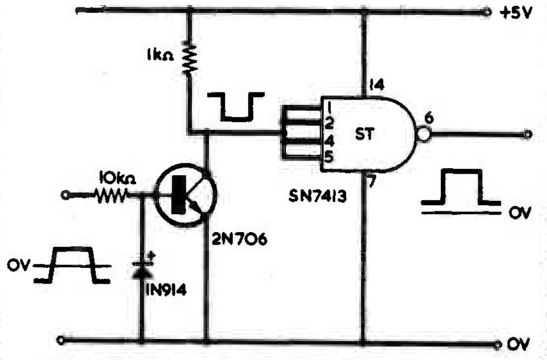


Fig. 8. Circuit employing SN7413 and transistor, for use when input levels are not well defined

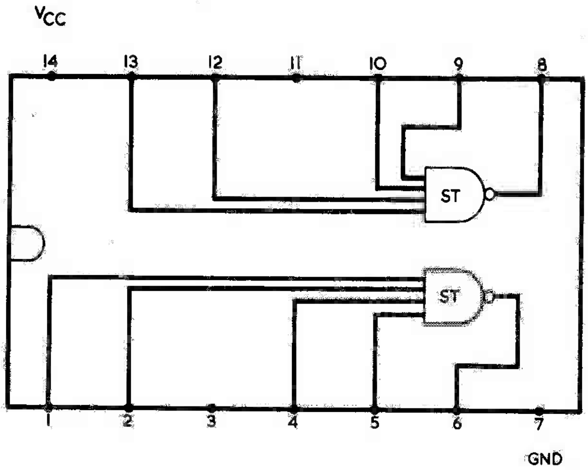


Fig. 9. Top view of the SN7413, illustrating pin layout and functions

suitable for many waveforms and there is no danger of the input logic levels for the SN7413 being exceeded.

When, in Fig. 8, the transistor is turned on its collector is pulled down to 0V, producing a 1 level at the Schmitt trigger output. It is preferable to use a Schmitt trigger i.c. rather than a normal SN7400 gate in this position because a gate can act as a linear amplifier with a high gain as it passes through the linear region of its input/output characteristic. Various feedback paths exist within the gate which can cause instability and consequent false outputs if the SN7400 input rise and fall times are longer than 1 µS or so. The SN7413 introduces hysteresis to the input/output characteristic and avoids this problem even if the input waveform is very slow.

It should be mentioned that the SN7413 is a *dual* NAND Schmitt trigger. Fig. 9 gives a top view of the package. ■

RECENT PUBLICATIONS

SEMICONDUCTOR DIODE LASERS. By Ralph W. Campbell and Forrest M. Mims.
198 pages, 5½ x 8½ in. Published by W. Foulsham & Co., Ltd. Price £1.90.

Semiconductor Diode Lasers is a title in the Foulsham-Sams Technical Books series and it has an American text with a special introductory section for the English reader.

The book deals with its subject at a level which will appeal in particular to the experimenter. So far as the reviewer is aware, not a great deal of amateur work on laser devices has been carried out in the U.K., and probably the most attractive application here is given by the use of laser diodes to provide communication by light beam. With a laser beam transmitter employing pulse frequency modulation, one of the authors, Ralph W. Campbell, has achieved one-way voice communication over a range of 3½ miles.

The first chapter in the book deals briefly with the principles of light and then gives a simplified description of laser theory. Succeeding chapters discuss the properties of lasers, methods of manufacture, commercially made devices and laser driving arrangements, including pulse generators and modulators. Three final chapters cover light detectors, modulated light receivers, optical and viewing devices, and laser applications. Subsequent appendices deal with safety precautions, communication system range equations and the addresses of manufacturers. The last are, of course, all based in the U.S.

The book will, notably, be helpful in introducing English electronics enthusiasts to a new field of experimentation as well as giving design engineers a general background on diode laser techniques.

THE HANDBOOK OF BASIC ELECTRONIC EQUIPMENT. By W. Oliver.
110 pages, 5½ x 8½ in. Published by W. Foulsham & Co., Ltd. Price £1.75.

This book covers an extensive range of electronic subjects, dealing with these in alphabetical order and devoting an average of about one and a half pages to each. No subject is dealt with at great depth, but sufficient information is given to enable a newcomer to electronics, or the reader for whom electronics is a side interest, to pick up a general idea of what is involved.

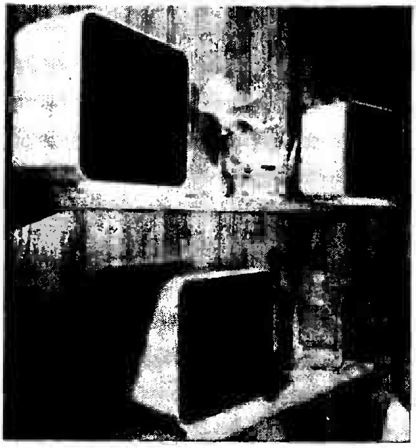
Topics dealt with include capacitors, resistors, dial lamps, control knobs, headphones, relays, printed circuit boards, cathode ray tubes, and pick-ups and styli. Any mathematical material which appears does not go further than the equations for capacitors in series, resistors in parallel and for resistor wattage dissipation.

The book includes a number of photographs of components and high fidelity equipment. There are also some 46 diagrams illustrating component assembly or circuit diagrams.

The Handbook of Basic Electronic Equipment refers, where applicable, to manufacturers of individual items and lists the addresses of suppliers who are most likely to be useful to the budding constructor. By no means all aspects of electronics are covered, but the subjects selected are representative of those most likely to be encountered.

NEWS . . . AND .

RECEIVER SYSTEM FOR BBC RADIO BROADCASTS



Now that there is more stereo time than ever on BBC radio, especially Radio 2, an increasing number of Eagle International's FM model SC-720 stereo receiver systems are to be seen in the shops. Eagle have taken the truly fashion-conscious approach with the design of this system, which comprises a tuner-amplifier and twin speakers. These are almost identical in size and very compact, which suits the well-organised, modern living room.

The finish of all three cabinets is a handsome matt white. This is offset by a dark grille cloth, in the case of the speakers, and a matching, smoke-black fascia on the tuner-amplifier. Behind the fascia is an illuminated, circular tuning scale, and a tuning indicator which glows when an FM stereo transmission is being received. There are inputs for tape recorder and turntable; and an output socket for stereo headphones.

At £62.20 complete, this is an economical buy.

MULLARD IN PEKING

Mullard Ltd., are taking part in the Exhibition of British Industrial Techniques in Peking during this month, components made by the latest techniques will be displayed.

Prominent among new integrated circuits will be types of random-access memory with capacities of up to 1024 bits. These are intended for use in computers and control systems where small size is important. Six new low-threshold, silicon-gate, shift registers with capacities ranging from 64 to 1024 bits will also be shown.

GI6YM GOLDEN JUBILEE AWARD

This year is the Golden Jubilee of the City of Belfast YMCA Radio Club GI6YM, Northern Ireland, and the members are planning to celebrate the occasion with a number of special activities.

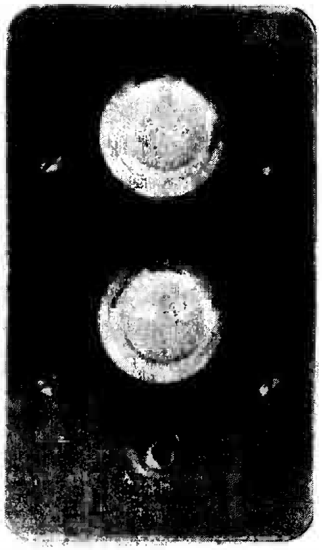
This club jubilee also happily coincides with the 75th anniversary of the wireless tests carried out by Marconi and Kemp, on behalf of Lloyd's, between Ballycastle (Co. Antrim) and Rathlin Island off the north Irish coast, to report ships passing the N.E. corner of Ireland.

These tests were successful and established the "first public service" of wireless in the year 1898.

To commemorate both these milestones the Belfast YMCA Club are to issue an award certificate (only the second such award ever to be offered by GI radio amateurs).

Further details will appear shortly.

RADIO PROGRAMME SELECTOR UNITS



Nelson Tansley now offer independent radio-programme selector units in their Series 259 range of nurse-call products. Two basically similar wall-mounted units are available carrying a six-channel rotary selector switch and a volume control.

One of these units, Catalogue No. 25957, also carries a Stetotube output transducer, and is intended for personal use in situations where it is desirable to separate the radio selection from the full bed-head facilities (i.e., nurse-call and light-switching) or where the other bed-head facilities are not required. The other unit, Catalogue No. 25958, has no Stetotube output, being intended for loudspeaker control in day rooms, common rooms, etc.

Each of these units is mounted on a 3⅜ x 5¾ins. satin finish stainless steel panel, fitted in a standard conduit box of either the flush-mounting type or surface mounting for upgrading. In common with all other Series 259 products, these units utilise printed circuit techniques for all internal connections, with the Nelson Tansley patented plug-and-socket system for termination of incoming wiring. This system permits termination of all incoming wiring into free socket connectors, which mate with fixed plugs on the unit's printed-circuit wiring board, final assembly can then be made shortly before commissioning.

• • • COMMENT

CHECK-OUT STAGE FOR GRANADA COLOUR TV CAMERAS

Part of a £200,000 television equipment contract for Granada Television, this EMI '2005' three-tube colour camera is seen here during final check-out at the company's Hayes, Middlesex, plant. The camera is one of five which EMI Sound & Vision Equipment Ltd. is supplying under an order to equip a new 5,175 sq. ft. colour production studio at Granada's Manchester Television Centre. Also included in the contract are colour and monochrome picture monitors, video and pulse equipment and talk-back communications system. EMI will also carry out all installation work and commissioning of the studio equipment.

One of the EMI 19″ type '3119' colour monitors for Granada is pictured in the photograph, being used in conjunction with the '2005' camera on test. Renowned for its simple, stable and reliable performance, the EMI '2005' camera channel is equipped as standard with a self-contained auto-centering unit. Apart from automatically and continuously maintaining centering to a very high degree of accuracy, this unit significantly reduces channel set-up time.

IN BRIEF

- ● After 49 years production of high quality medium priced valve receivers, Eddystone Radio has announced that the world-famous 830 general purpose receiver is to be phased out of production.
- ● The United Kingdom Association of Professional Engineers (UKAPE) and the Association of Supervisory and Executive Engineers (ASEE) are holding talks to explore the possibility of a closer alliance.
- ● Although the BBC has no plans for regular quadraphonic broadcasting there will, within the next few months, be one experimental programme which will use Radio 2 and Radio 3 transmitters simultaneously.
- ● Vero Electronics announce their appointment as the exclusive UK agent and distributors for the American E. F. Johnson Company range of components.
- ● A further substantial reduction in the number of TV licence evaders is forecast by the Ministry of Posts and Telecommunications in a statement on the computerisation of TV licence records.

BROADCASTING FORECASTS

Britain's entry into the Common Market does not mean that the BBC is going to shift its emphasis to the European audiences at the expense of audiences in other parts of the world.

Mr. Gerard Mansell, managing director, BBC External Broadcasting, made this clear in a broadcast in the BBC World Service programme *Outlook* to mark the 40th anniversary of overseas broadcasting by the BBC. He predicted that ground-based short wave and medium wave transmitters would remain a means of transmission for the next 10 to 15 years.

There was the eventual prospect of international television – a form of transmitting television similar to short wave radio. A signal starting from the United Kingdom would be directly received on television sets in India, in the Soviet Union, even possibly in China – and certainly in the United States. But there were many difficulties to overcome before that point was reached.

"Good morning, this is a recorded message."

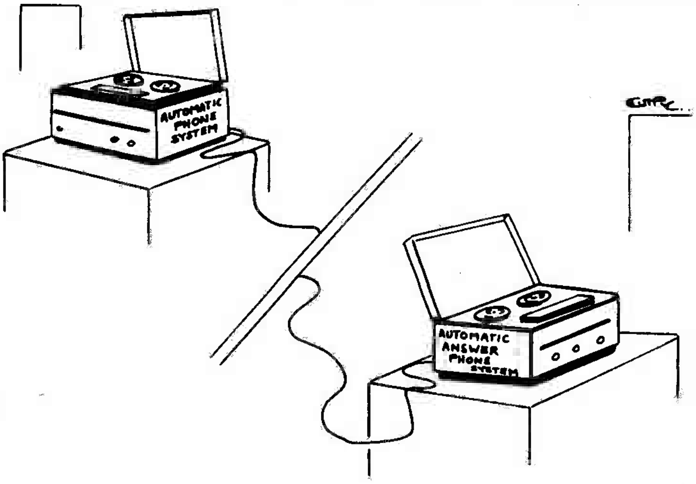
"Good morning, your message is being recorded."

"Good morning, this is a recorded message."

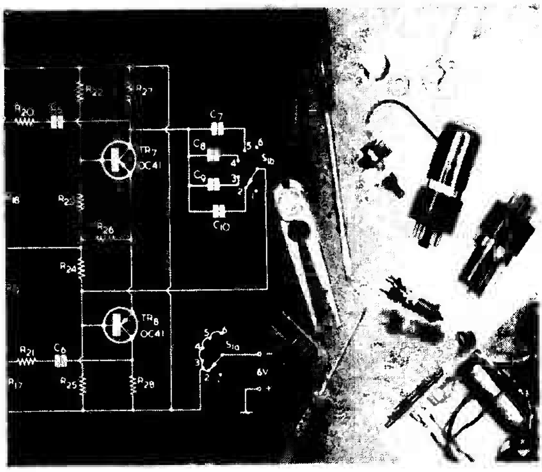
"Good morning, your message is being recorded."

"Good morning, this is a recorded message."

"Good morning, your message is . . . ."



LIGHT-EMITTING DIODE CIRCUITS



by G. A. FRENCH

A SEMICONDUCTOR DEVICE WHICH offers a number of interesting applications to both the home-constructor and the experimenter is the light-emitting diode. Current versions of the light-emitting diode have the basic appearance shown in Fig. 1(a). A circular base incorporates a flat p.n. junction which constitutes the diode. Above this is a roughly hemispherical dome made of clear or red tinted epoxy resin. This dome functions partly as a lens and partly to provide a non-reflective outer surface which allows the maximum amount of light generated in the junction to be passed through to the outside air. The diameter of the base is less than quarter of an inch, the actual dimensions varying according to type number.

The most common junction material is gallium arsenide phosphide and this produces a red light near the low wavelength end of the visible spectrum. The diode is provided with two or three lead-outs. In the latter case, connection is made to two of the lead-outs only. The light-emitting diode is referred to, in abbreviated form, as an l.e.d. or LED. Since some versions of the diode emit infra-red waves, the term 'visible light-emitting diode' may also be encountered, this being abbreviated to v.l.e.d. or VLED. A common circuit symbol for the light-emitting diode (which in this article is the term we shall use for the type which emits visible red light) is given in Fig. 1(b). Note that, in common with normal diode practice, the end at which the plus sign appears is referred to as the cathode (C or K) of the device. The other terminal is the anode (A).

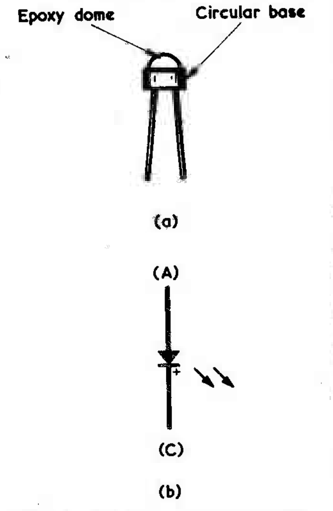


Fig. 1. (a) Typical light-emitting diode construction
(b) Circuit symbol for the light-emitting diode

ELECTRICAL PERFORMANCE

The light-emitting diode produces light when a current is passed through it in the forward direction. The forward voltage dropped across the diode is nominally around 1.5 volt, but the spread with practical diodes and the variance between diodes of different type numbers appears to be such that forward voltages up to 2 volts or so can be obtained. Maximum reverse voltage ratings for typical devices are low, being of the order of 3 volts.

The light is generated in the diode by electroluminescence, this being a phenomenon which appears also in laser diodes. Electrons at the junction are raised in energy level to the conduction band by the forward current, after which they fall to the valence band, producing photons of light in the process. Light intensity increases in an approximately linear manner with increasing forward current. However, the subjective impression of increase at higher levels may be less than that at low levels since the eye has a logarithmic response.

Light-emitting diodes do not provide sufficient light for illumination of other objects, and they are intended to function as indicator lights, for which purpose their light output is more than adequate. They have a number of advantages over filament lamps in this application, these being that they function at low voltages and currents, have long life, do not have a low cold resistance, do not have fragile filaments, and do not generate heat. At the time of writing, the l.e.d.'s available on the home-constructor components market are, unfortunately, somewhat more expensive than filament lamps, but there is little doubt that their price will drop as more devices become available.

This article describes several simple applications for l.e.d.'s, these having been checked out in practice by the author with the aid of the l.e.d. type NKT7011. This l.e.d. is available from Electrovalue Limited, 28 St. Judes

Road, Englefield Green, Egham, Surrey. The l.e.d. type NKT7011 is rated at a maximum forward current of 50mA and a maximum power dissipation of 100mW. It is very probable that other l.e.d.'s having the basic construction shown in Fig. 1(a) and having approximately the same maximum forward current rating will give a similar performance, but the author cannot vouch for this as he has checked the circuits with the NKT7011 only. It should be added that some earlier l.e.d.'s had maximum forward current rating figures which were considerably in excess of 50mA and these would not be suitable for the purposes to be described.

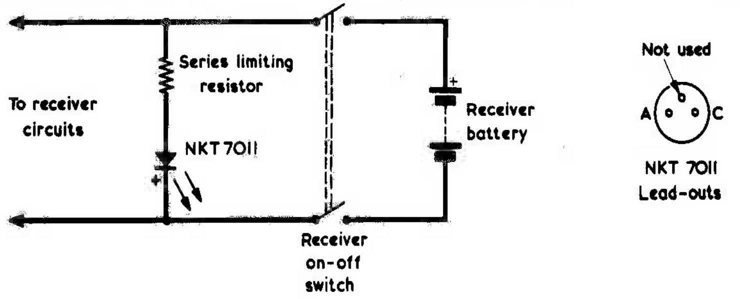


Fig. 2. Adding an l.e.d. and series current limiting resistor to a transistor radio to indicate when the latter is switched on. The l.e.d. and resistor are connected across the supply rails after the on-off switch

CIRCUIT APPLICATIONS

An l.e.d. should not be connected directly to a source of voltage without a resistor in series. This is because the l.e.d. forward slope resistance when the diode conducts is low and without a series resistor heavy currents could flow, causing damage to the diode. The diode should be connected to a voltage which is in excess of the forward voltage, a series resistor being inserted to limit forward current to a desirable level. The diode must be connected into circuit correct way round as it otherwise will not function and, because of its low maximum reverse voltage rating, might suffer damage. The supply voltage must be direct, of course, and not alternating.

The NKT7011's checked by the writer exhibited illumination at very low forward current, this increasing to an intense glow at around 30mA. There is, in the writer's view, little point in taking the NKT7011 to currents higher than around 30mA as the light intensity at this level is more than adequately high. At 3mA the glow given by the NKT7011 is noticeable, although not sufficiently high to be attention-catching in a brightly lit room. Nevertheless, the visible indication at this current is enough to make the idea of adding an l.e.d. to a transistor radio to indicate that the latter is switched on worth entertaining, since the low current drawn by the device from the radio battery is not excessively high. The circuit required is shown in Fig. 2. If it did nothing else, the l.e.d. would at least help to ensure that a bedside radio was switched off after turning off the bedroom light, since the l.e.d. glow given with the set switched on would be quite marked in the ensuing darkness. The value of the series resistor may be calculated on the assumption that approximately 1.7 volt is dropped across the light-emitting diode. If the receiver has a 9 volt battery, the series resister has to drop 9 minus 1.7, or 7.3 volts, at 3mA, which works out at 2.43kΩ. A 2.4kΩ or 2.2kΩ 10% resistor would be staisfactory in practice. For a 6 volt supply the series resistor can be 10% 1.5kΩ. In both cases the resistor rating may be $\frac{1}{4}$ watt, $\frac{1}{8}$ watt or 1/10 watt, as the wattage dissipation is very low. Since some constructors may feel that the light output given by the l.e.d. at 3mA is insufficient for this particular application, it is suggested that the circuit be checked out experimentally first before permanently installing the l.e.d. in the case of the radio. The constructor may decide for himself from the experimental circuit whether or not the l.e.d. light output is adequate for the proposed purpose.

The question of the adequacy of the light output does not arise at l.e.d. current of 15mA or more, where the l.e.d. brightness is quite sufficient for normal purposes. The l.e.d. can be used at such currents to indicate whether any item of equipment is switched on, the only proviso being the ability of the equipment to furnish the necessary direct current. Several l.e.d.'s can also, provided the requisite current is available, be used to indicate which of a number of facilities has been selected. Thus, in a sine wave-square wave signal generator, additional contacts on the function switch can allow one l.e.d. to be illuminated for sine wave output and another for square wave output.

An interesting optical illusion is given when l.e.d. current is of the order of 25mA or more. At these brightness levels the area of the light producing surface appears to be greater than the area of the base of the dome at the top of the device. This is due to the brightness of the small spot of light which is actually given at the diode junction.

USE WITH T.T.L.

A particularly intriguing feature of l.e.d. devices of the type being discussed here is that, to use the current jargon, they can 'interface' readily with t.t.l. circuitry. This means that an l.e.d. can be coupled directly to the output of many types of t.t.l. gate, whereupon it can indicate whether the gate output is at 1 or at 0.

To understand what is involved here it is first of all necessary to quickly examine a typical t.t.l. gate, and Fig. 3 shows the internal circuitry of one of the four NAND gates which comprise the t.t.l. integrated circuit type 7400. This gate circuit has appeared several times in recent issues

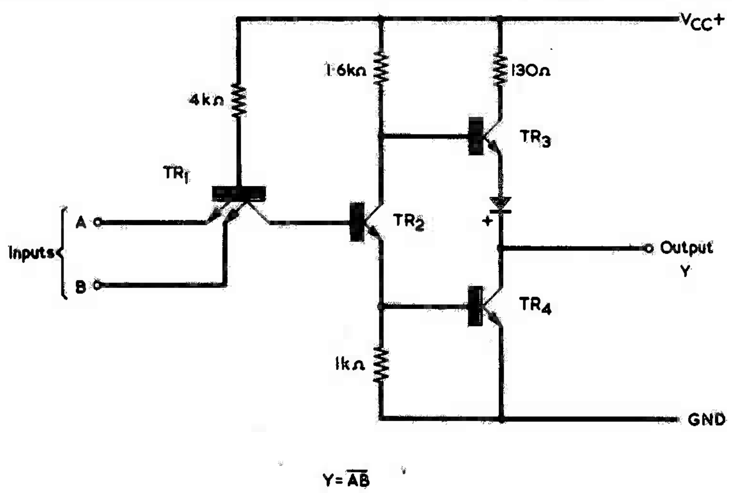


Fig. 3. The internal circuitry of a 7400 NAND gate

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BLOCK LETTERS PLEASE

of *Radio & Electronics Constructor* including, in particular, the last December issue, in which the 7400 was dealt with in detail by Dick and Smithy of 'In Your Workshop' fame. We shall, here, deal very briefly with the circuit, and only to the extent in which its method of operation is involved in the present discussion.

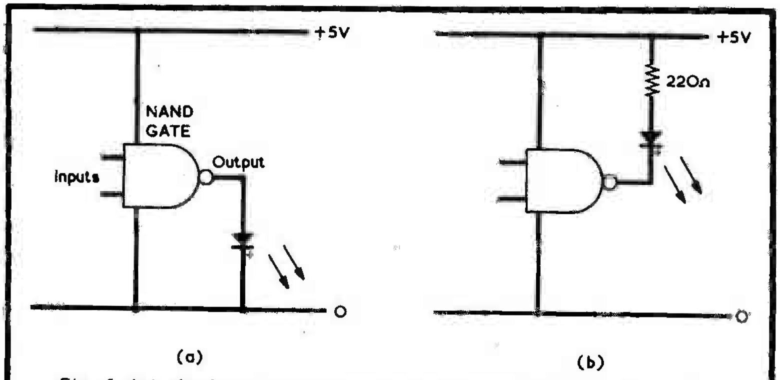
The NAND gate of Fig. 3 gives the same performance as an AND gate followed by an inverter. In an AND gate the output is 1 only when all inputs are 1. The addition of an inverter gives the result that the output of the NAND gate is 0 only when all inputs are 1. If one or more inputs is taken to 0 the output changes to 1. The 7400 NAND gate uses positive logic, in which 1 is represented by a high positive voltage and 0 by a low positive voltage. Holding down either of the two emitters of TR1 at a low potential, as is given by an input of 0, similarly holds down the base of TR1. Both emitters have to be taken to the high positive potential which corresponds to 1 before the base of TR1 can similarly rise and change over the gate output to 0. A relatively high current (up to 1.6mA) has to flow in each input emitter to keep its potential low. If an input emitter is left open-circuit no emitter current can flow in it and the emitter will have the same effect on gate operation as if it were connected to the high positive level. Thus, the gate will also give an output 0 if both input emitters are open-circuit. (It is recommended that, for optimum results, unused inputs in a NAND gate should be held at a positive voltage of 2.4 to 3.5 volts, be paralleled with used inputs, or be returned to the positive supply rail via a 1kΩ resistor. However, for simple applications in low noise circuits no difficulties are caused by open-circuit input emitters.)

We turn next to the output of the 7400 gate. When this is at 0 transistor TR4 is hard on, and the output is lower than 0.4 volt above ground. When the gate output is at 1, transistor TR4 is cut off and TR3 is on. This time the positive rail voltage is applied to the output via the 130Ω resistor, TR3 and the diode below TR3.

Light-emitting diodes of the type being dealt with here may be connected directly to the output of a 7400 NAND gate as shown in Fig. 4(a). When the output in this diagram is at 0 the l.e.d. is extinguished because negligible voltage is applied to it. Conversely, the l.e.d. becomes brightly illuminated when the output changes to 1. This is because the positive supply rail voltage is now applied to it via TR3 of Fig. 3 and the diode below TR3, the necessary series resistance being the 130Ω resistor in the integrated circuit itself. It is an easy matter to calculate the current which then flows in the light-emitting diode. There will be some 1.7 volt drop in the l.e.d. and about 0.8 volt drop in TR3 and the diode below it in the i.c., leaving approximately 2.5 volts across the 130Ω resistor. This corresponds to a current flow in the 130Ω resistor (and, in consequence, in TR3, the i.c. diode and the l.e.d.) of some 19mA. Such a current is more than sufficient to energise the l.e.d.

In Fig. 4(a) the l.e.d. lights up when the gate output is at 1. The circuit of Fig. 4(b) is used when it is desired to have the l.e.d. illuminated when the gate output is 0. Since, in this instance, TR4 of Fig. 3 is now hard on, it is necessary to insert a physical external resistor in series with the l.e.d. to limit its current. Its value can be 5% 220Ω with a rating of ¼ or ⅛ watt. This resistor allows slightly less than 16mA (the maximum output current for a 7400 NAND gate at 0 output) to flow in the l.e.d.

The circuits of Figs. 4(a) and (b) are very useful since they enable light producing devices to be directly operated by any t.t.l. gates which, like the 7400 NAND gates, have 'totem-pole' output circuits. No intermediary driver transistors are required, as normally occurs when filament lamp output state indicators are employed.



(a) (b)

Fig. 4. (a) An l.e.d. may be connected directly between the output of a t.t.l. NAND gate and the ground line. It becomes illuminated when the output is 1
(b) With this circuit the l.e.d. becomes illuminated when the gate output is 0

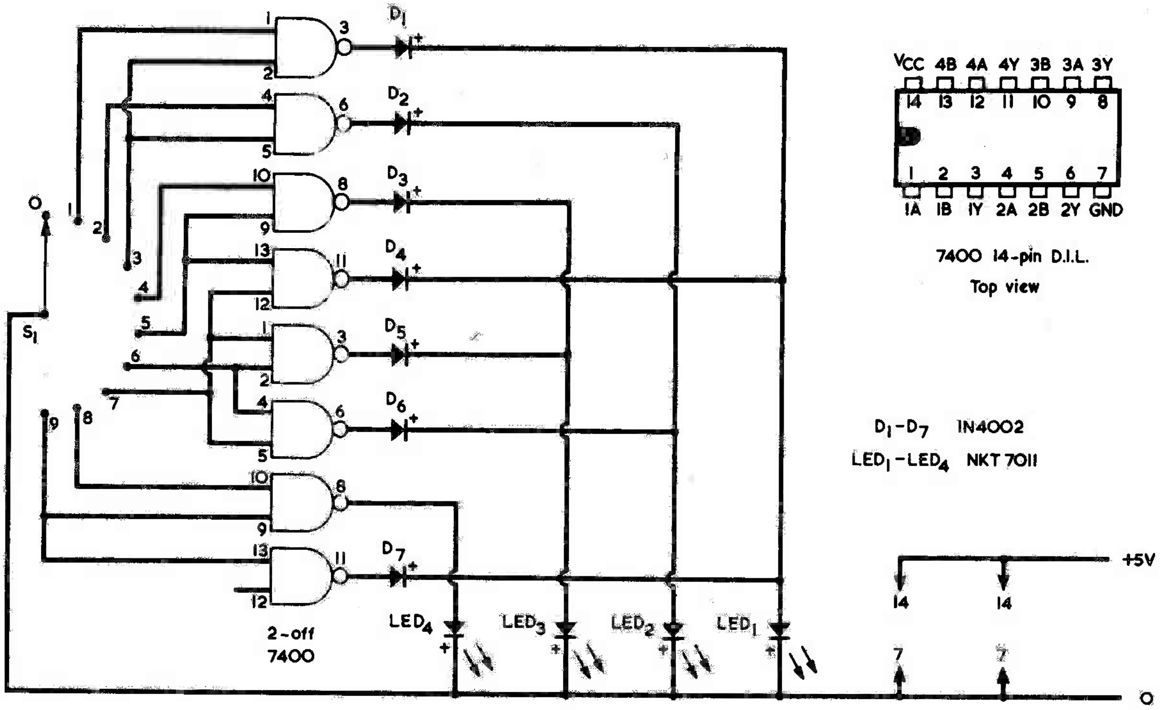


Fig. 5. A circuit which demonstrates the use of light-emitting diodes in conjunction with t.t.l. elements. The four light-emitting diodes indicate the binary equivalents of the decimal numbers selected by S1

DEMONSTRATION CIRCUIT

Finally, a demonstration circuit which illustrates the capabilities of t.t.l. and l.e.d. combinations is given in Fig. 5. This circuit allows four l.e.d.'s to represent the binary equivalents of the decimal numbers 1 to 9 each l.e.d. standing for a binary 1, when illuminated, and a binary 0 when extinguished. It is appreciated that there are easier methods of switching light indicating devices to represent binary equivalents of decimal numbers, but the circuit of Fig. 5 does demonstrate very clearly how light-emitting diodes can be incorporated in simple logic circuits. For reference, a table showing the decimal and binary equivalents is given in Fig. 6.

The circuit of Fig. 5 employs two 7400 i.c.'s, thereby providing eight 2-input NAND gates. As we have already seen, the output of a NAND gate is at 0 when all inputs are open-circuit. If either one input or more is taken to a low voltage corresponding to 0 the gate output rises to 1. When S1 is at position 0, all gate inputs are open-circuit and all gate outputs are at 0. Moving S1 to position 1 couples one input of the top gate to a low voltage (actually zero volts). Its output rises to 1, whereupon LED1 becomes illuminated. This l.e.d. is coupled to the gate output in the same manner as was the l.e.d. in Fig. 4 (a), with the exception that the silicon diode D1 is now in series. Diodes D1 to D7 are included in circuit to isolate gate outputs which couple to the same l.e.d. The diodes prevent current flow between two outputs if one is at 1 and the other at 0.

Setting S1 to position 2 causes the output of the first gate to drop to 0 and that of the second to rise to 1. LED1 extinguishes and LED2 lights up, to indicate binary 10. On position 3 of S1 both the top two gates have outputs of 1, causing LED2 and LED1 to light up, giving binary 11. On position 4, LED3 lights up on its own, to indicate binary 100. Position 5 causes the outputs of the third and fourth gates to rise to 1, energising LED3 and LED1. On position 6, the outputs of the fifth and sixth gates rise to 1 (LED3 and LED2 illuminated) and position 7 results in the outputs of the fourth, fifth and sixth gates becoming 1 (energising LED3, LED2 and LED1).

DECIMAL	BINARY
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

Fig. 6. Table showing the binary equivalents of decimal numbers from 1 to 9

At position 8 the seventh gate is operated, causing LED4 to light up on its own and indicate binary 1000. There is no need to insert a diode in the output circuit of this particular gate as it does not couple to the same l.e.d. as any other gate output. On position 9 the remaining input of the seventh gate is taken to the low voltage, as also is one input of the eighth gate, whereupon LED4 and LED1 are illuminated, giving binary 1001. No connection is made to the unused input of the eighth gate.

In the prototype circuit all the l.e.d.'s except LED4 passed about 13mA when illuminated. LED4 passed approximately 18mA. The higher current is due to the fact that there is no series diode (across which a forward voltage is dropped) in the supply circuit to LED4.

The circuit of Fig. 5 can be wired up quite quickly. Care must be taken to see that LED1 to LED4 are wired in with correct polarity. (The l.e.d. lead-out layout is given in Fig. 2.) Diodes D1 to D7 must also be wired into circuit with correct polarity to ensure isolation between gate outputs.

Any simple regulated 5 volt supply whose output does not fall below 4.75 volts or rise above 5.25 volts may be used to power the circuit of Fig. 5. A suitable power supply was described in the 'In Your Workshop' episode which appeared in the last December issue. ■

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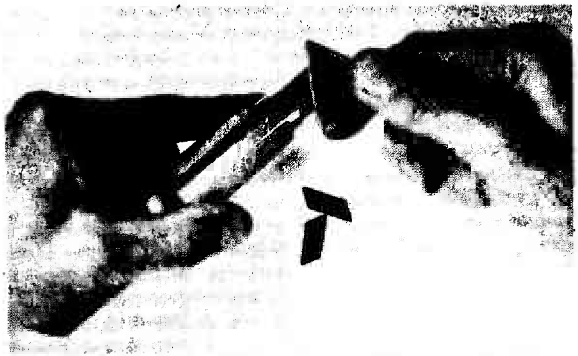
Other items in the range are a ten-blade plastic dispenser/blade snapper, plus two sizes of carded spare blades. Rexel Cutters are available from hardware and DIY shops, ironmongers, stationers and department stores. For further information contact Ofrex Group of Companies, Ofrex House, Stephen Street, London W1A 1EA.



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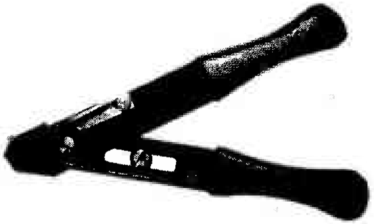

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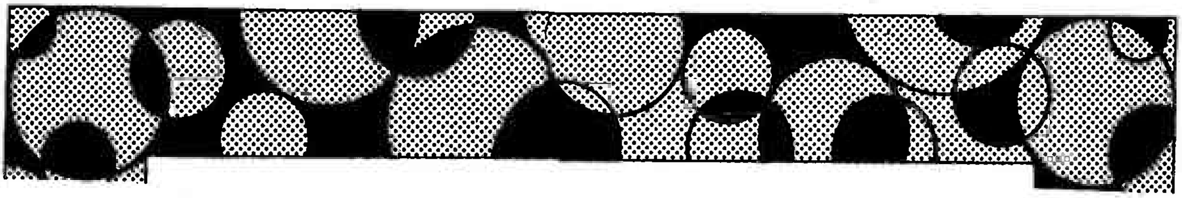
For further information, please contact: Hollands & Blair Ltd., Bensham Grove, Thornton Heath, Surrey.



SQUARE WAVE AND PULSE CONVERSION UNIT

by

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

This unit offers square wave and pulse outputs from 30Hz to 100kHz at amplitudes up to 10 volts peak. Pulse width is variable from 50mS to 1uS.

WHILE THE MAJORITY OF AMATEUR CONSTRUCTORS and experimenters include an audio or f. sine wave generator amongst their test equipment, few have the additional facility of a square wave and pulse source. Where work of an experimental nature, particularly in the audio, digital, biological fields, etc., is being carried out, the benefits of a versatile square wave and pulse signal source can be readily appreciated. Ideally a pulse generator should have several independent outputs, each providing a different basic waveform. These outputs are normally independently variable in amplitude and time with low source output impedance, high stability and wide frequency or repetition rate range. A glance at the specifications of some commercial pulse generators will indicate not only their wide range of performance but also their rather high price. In practice the writer has found that for a great deal of experimental work a simpler and more basic specification will generally meet most day-to-day requirements. The circuit to be described was designed with such requirements in mind and in practice the unit has proved extremely useful in many fields of electronic and audio work.

CIRCUIT SPECIFICATION

The circuit has the advantage that any standard audio or f. signal generator can be used as the basic signal source, the input limitations as regard frequency and amplitude being extremely wide. This method dispenses with the need for a separate generator source for pulse and square wave output. By utilising an existing generator and an additional unit for pulse and square wave conversion only, the overall circuit of the latter is greatly simplified and the cost considerably reduced. The unit described provides two basic independent outputs, these being a 1:1 square wave and a pulse output having a pulse width which is variable between very wide limits of time. Both signals are derived from the common sine wave source which can be varied over a very wide frequency range, thus providing an equally wide range of square wave frequencies and pulse repetition rates. Both output signals also have independent amplitude controls, and all output signal parameters are independent of the input signal amplitude over a very wide range. Low output impedance and fast rise times with negligible overshoot are a marked characteristic of both outputs.

The unit is supplied from any conventional d.c. power unit of suitable voltage. The use of internal zener stabilization allows considerable tolerance on the nominal d.c. supply voltage, while the overall current drain is quite small, being of the order of 46mA with a 24 volt supply. If necessary, the unit could be powered from internal or external batteries. A complete specification is given in the accompanying Table.

TABLE

Square Wave and Pulse Conversion Unit – Specification

Input:	Sine wave, 30Hz to 100kHz, 1 to 10 volts r.m.s.
Square wave output:	Frequency as input sine wave. Amplitude variable from 0 to 10 volts peak. Rise time less than 250nS.
Pulse output:	Repetition rate as input frequency. Amplitude variable from 0 to 10 volts peak. Pulse width variable from 50mS to 1µS in five switched ranges. Rise time less than 100nS.
Supply:	24 volts nominal.

The circuit of the unit is given in Fig. 1. As can be seen, the circuit uses standard components and all transistors are of the same type. The functioning of the circuit is quite straightforward. The input sine wave is fed via blocking capacitor C1, through limiting resistors R1, R2 and clipping diodes D1, D2, to the base of TR1. The design of the input is such as to allow the specified wide range of amplitude in the input signal to be accommodated. TR1 is the squaring amplifier, emitter feedback allowing for differences in gain tolerance and also helping maintain high frequency response. The output signal developed across load resistor R4 is a good square wave replica of the clipped input signal applied to the base.

This output signal is applied via C2 to the driven bistable circuit TR2, TR3. Such a circuit has two stable conditions; i.e. when TR2 is bottomed TR3 is biased off and vice versa. D.C. coupling between transistors is provided by R8 and R9, while a suitable choice of values in the resistor chains R7, R8, R10 and R11, R9, R6 between the supply lines allows for a rapid change of state between the two halves of the circuit with the application of the squared input drive signal. Speed-up capacitor C4, together with h.f. compensation by C3, helps maintain fast rise times. Such a circuit has a very rapid transition time between changes of state and provides an output square wave having very fast rise times with negligible overshoot or sag.

Before proceeding further, brief mention should be made of C3 which, at first sight, might appear to cause possible slowing of the rise in TR2 collector potential when this transistor turns off. The function of C3 is to prevent h.f. ringing on changeover in TR2 which can cause a fractionable time jitter in the leading edge of the following monostable action. It was found that capacitors in the C3 position having values from 100 to 1,000 pF satisfactorily prevented any tendency towards

COMPONENTS

Resistors
(All fixed values ½ watt 5% unless otherwise stated)

R1	1.5kΩ
R2	7.5kΩ
R3	220kΩ
R4	4.7kΩ
R5	120Ω
R6	22kΩ
R7	4.7kΩ
R8	15kΩ
R9	15kΩ
R10	22kΩ
R11	4.7kΩ
R12	10kΩ
R13	10kΩ
R14	33kΩ
R15	2.7kΩ
R16	4.7kΩ
R17	2.2kΩ
R18	2.7kΩ
R19	10kΩ
R20	47Ω 2 watts
VR1	2kΩ potentiometer, linear, wirewound
VR2	25kΩ potentiometer, linear, wirewound
VR3	2kΩ potentiometer, linear, wirewound

Capacitors

C1	1µF plastic foil
C2	0.22µF plastic foil
C3	470pF silvered mica
C4	200pF silvered mica
C5	1,000pF silvered mica
C6	4.7µF plastic foil
C7	1µF plastic foil
C8	0.1µF plastic foil
C9	0.01µF plastic foil
C10	1,000pF silvered mica

Semiconductors

TR1-TR7	BC182L
D1-D3	OA95
D4, D5	9.1 volt, 1.5 watt, zener diode type BZY96C9V1
D6	4.7 volt, 1.5 watt, zener diode type BZY96C4V7

Switches

S1	1-pole 5-way rotary
S2	d.p.s.t. toggle

Miscellaneous
Veroboard, 0.15in. matrix, 3 × 2¼in., 15 strips by 18 holes.
3 coaxial sockets
2 wander plug sockets
4 pointer knobs
2 tagstrips (see Fig. 3)
Material for panel and Veroboard bracket.
Cabinet type W, 8 × 6 × 6in. (H. L. Smith & Co. Ltd.)

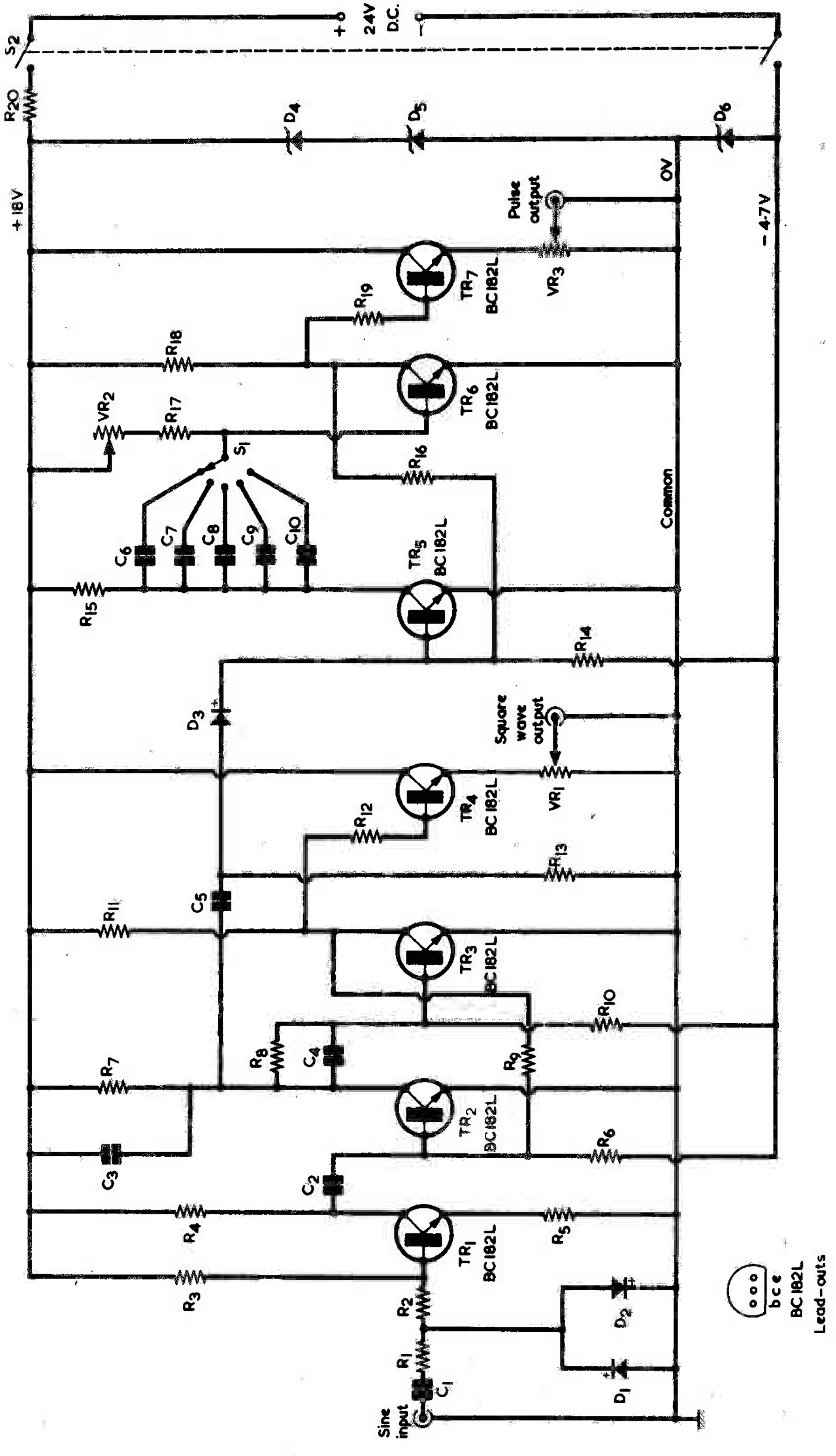
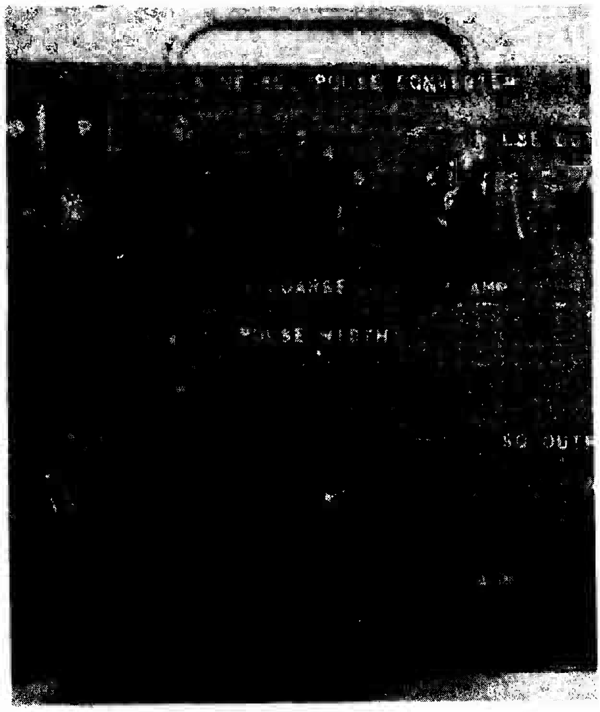


Fig. 1. The circuit diagram of the square wave and pulse conversion unit



A view of the front panel of the unit

ringing and it was felt that a final value of 470pF would give a good margin towards taking up differences in overall component tolerance. C3 has, otherwise, no noticeable effect on performance over the frequency range quoted in the specification.

The square wave output is taken from the collector of TR3 via limiting resistor R12 to the emitter follower TR4. The purpose of this stage is to provide a very low impedance variable output and also isolate the output from the switching and amplifier circuits. The final output developed across emitter load potentiometer VR1 is a d.c. coupled square wave which can be varied in amplitude between 0 and 10 volts peak.

A second square wave output is taken from the collector of TR2 for use in the pulse circuit. C5 and R13 differentiate this output square wave, the negative pulse of the differentiated signal being blocked by diode D3 while the positive pulse is applied to the base of TR5.

Transistors TR5 and TR6 form the monostable circuit just referred to in connection with C3, and they provide a pulse width control function. TR5 is normally biased off, the base being clamped to the negative supply line via R14. The short duration positive trigger pulse derived from the differentiated square wave turns this stage on and TR6 off. A.C. coupling is applied between TR5 and TR6 capacitors C6 to C10 and d.c. coupling between TR6 and TR5 via R16. Thus, the drive pulse switches the circuit into its unstable condition, given by TR6 off and TR5 on. The circuit will return to its original stable condition over a period determined principally by the time constant of C6 to C10 and R17 plus VR2. By making two of these parameters variable a very wide range of timed on/off conditions can be achieved. The resultant output developed across load resistor R18 is a pulse whose repetition rate is determined by the frequency of the initial square wave and which has a width whose time duration is determined by the time constant of the monostable circuit.

This variable output pulse is coupled via limiting resistor R19 to the pulse emitter follower output transistor TR7. The function of this transistor is similar to that already described for the square wave output transistor, TR4, and the output pulse amplitude can be varied between the same wide limits.

The d.c. power supply is obtained from an external non-critical source, internal stabilizing being achieved by means of zener diodes. These are fed via dropper resistor R20, and D4 and D5 in series provide the positive 18 volt line whilst D6 provides the negative 4.7 volt line. Mullard zener diodes in the BZY96 series are specified in the Components List, but alternative 1.5 watt 5% diodes, 9.1 volts for D4 and D5 and 4.7 volts for D6, may be employed instead. R20 has a wattage rating which enables it to cope with a wide range of supply voltage. The latter should, of course, be sufficiently high to bring the diodes into zener conduction. The use of internal stabilization not only allows a wide range of supply voltage to be accomodated but also protects against amplitudes and pulse time width changes due to variations in source supply voltage. As all transistors are of the same miniature moulded plastic case type and are of silicon planar epitaxial construction, the circuit will be unaffected by any normal temperature changes met with in practice.

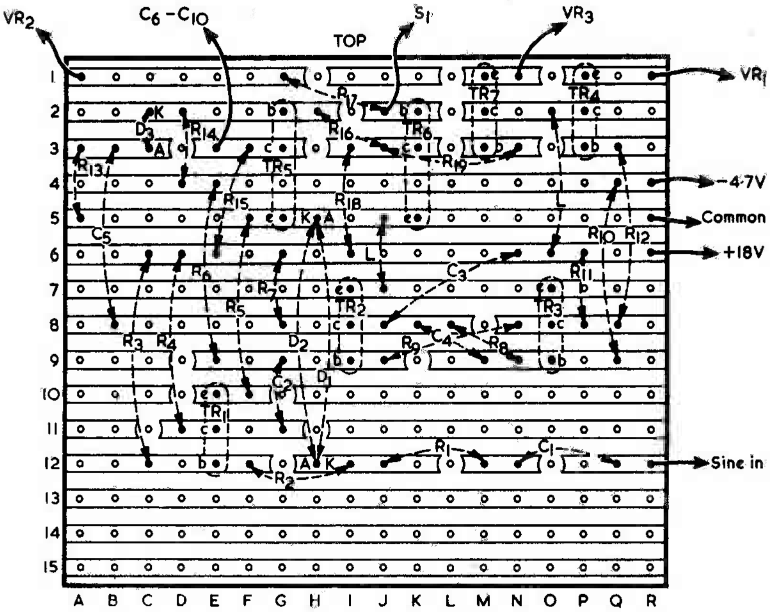
It will be noticed that both outputs are d.c. coupled to maintain symmetry of waveshape and sharp rise times. Care must be taken not to short-circuit the output sockets or leads when the slider of VR1 or VR3 is at the emitter end of the track. Such short-circuits would effectively apply short-circuit current through the transistor concerned (TR4 or TR7) and destroy it. If this should prove a problem or if it is required to block off the d.c. content of the output signals, a capacitor can be connected in series with the output, either internally or externally. The value of capacitor will depend upon the frequencies in use, the amount of droop (due to reduced l.f. performance) which can be tolerated, and the input impedance of the device or circuit to which the signals are to be applied. Generally speaking the larger the value of capacitance the better.

An alternative method of protecting TR4 and TR7 in instances where there is a risk of the outputs being accidentally short-circuited consists of inserting a 100Ω resistor between each emitter and the upper end of the corresponding 2kΩ output potentiometer. These resistors would limit short-circuit current in the transistors to a little less than their maximum rated current of 200mA, this being achieved at the cost of a 5% reduction in maximum output voltage under normal running conditions.

The components employed are generally available with the exception of the 1μF and 4.7μF capacitors. These may be obtained from V. Attwood, P.O. Box 8, Alresford, Hants, or from retailers of R.S. Components parts such as Clectron-E, P.O. Box 1, Llantwit Major, Glamorgan, CF6 9YN or Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN. The 1μF value is also available from Home Radio under Cat. No. 2EH19.

CONSTRUCTION

The construction of the unit should offer no problems, there being nothing particularly critical about the circuit. The electronic circuit, excluding potentiometers, switches, power supply components and timing capacitors, is mounted on a piece of 0.15in. matrix Veroboard measuring approximately 3in. by 2¼in. and having 15



L = link

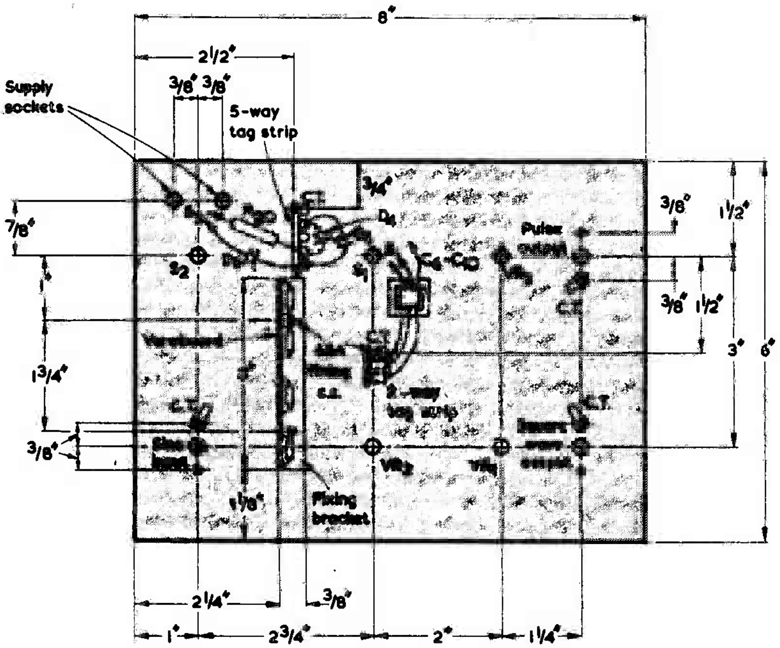
Fig. 2. The copper side of the Veroboard after completion

strips by 18 holes. The complete Veroboard layout, seen from the copper side, is shown in Fig. 2 .This board is mounted on the rear of the front panel by means of a small right angle bracket. The mounting screws are passed through 6BA clear holes drilled at convenient points in the area bounded by strips 13 and 15. No electrical connections are made to strips 13, 14 and 15.

It should be noted that diodes D1 and D2 are both terminated at holes H12 and H5. Both diode lead-outs pass through the single holes at these positions before soldering. The cathode (+) and anode ends of D1, D2 and D3 are indicated by the letters 'K' and 'A' respectively. Also sharing a common hole, at J3, are R16 and R19; and, at J2, R17 and the lead to S1.

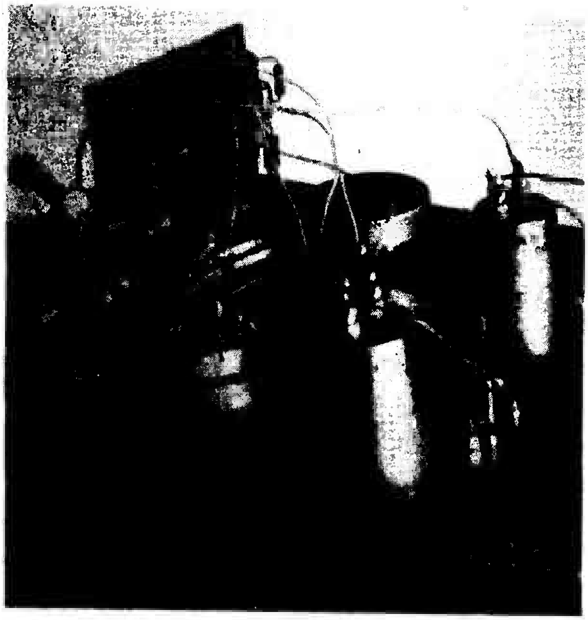
External leads from the board appear on the component side except for the lead from hole R12 to the sine input socket, which leaves the board from the copper side. A further lead on the copper side connects strip 5 to the earth tag at the sine input socket. This lead is soldered to the strip at around E5 and is not shown in Fig. 2.

The front panel layout together with relevant dimensions is illustrated in Fig. 3. When complete, the Veroboard is, as already mentioned, mounted on the rear of



C.T. - chassis tag

Fig. 3. The front panel. Components and parts shown in dotted line are mounted behind the panel



The components which are mounted on the rear of the front panel

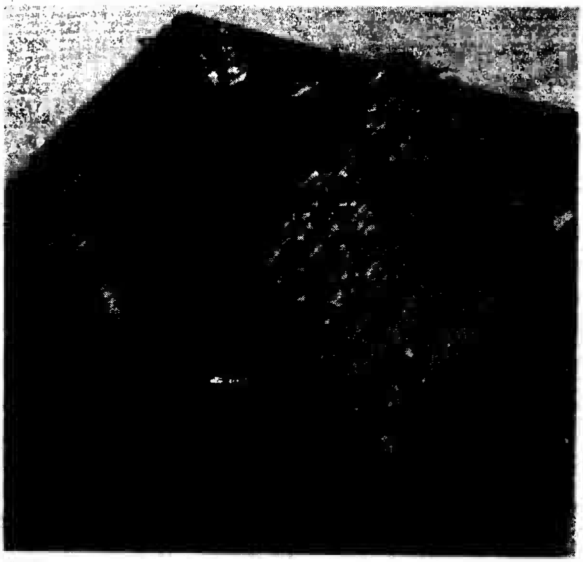
the panel, countersunk 6BA screws being used. All the other components are similarly mounted on the rear of the panel, as shown in Fig. 3. Interconnections between the Veroboard and other components are kept as short and direct as possible. Capacitors C6 to C10 are mounted between S1 and a small 1-way or 2-way tagstrip fixed to the rear of the front panel. Power supply components R20 and D4 to D6 are mounted on a 5-way tagstrip which is again mounted on the rear of the front panel, close to the supply switch S2 and the supply input sockets. The form of construction described is illustrated in the photographs. While the type of cabinet used by the writer is specified, the unit could be accommodated in a much smaller space and any suitable cabinet or case which is to hand may be utilised.

TESTING

After completion the unit can be quickly checked by connecting an oscilloscope to each of the outputs in turn. Alternatively, both outputs can be examined simultaneously if a double beam instrument is available. With a suitable signal applied to the input, ensure that the output square wave has a 1:1 mark-space ratio and negligible overshoot. Ensure also that the amplitude can be varied from zero to 10 volts peak by means of VR1. The pulse output should be checked in a similar manner, while the pulse width should be variable from a maximum 1:1 mark-space ratio to a minimum 1µS by means of S1 and VR2.

With the outputs checked satisfactorily ensure that varying the input signal amplitude between the limits specified does not affect the time duration or amplitude of the output signals. Similarly check that the unit functions satisfactorily for variations in the input signal frequency between the limits quoted. Failure to function within the frequency limits can be resolved by a small alteration to the value of R5, though this should not be necessary.

If the oscilloscope used has a sufficiently good response characteristic the rise times of the output signals can be checked. It must be remembered, however, that as the rise times are likely to be less than 100nS (1.0µS) the oscilloscope should have a Y amplifirer response time which is better than this figure. Also ensure that the correct compensated probe is used since even a short length of twisted pair or a coaxial test lead can provide misleading results due to self-capacitance in the test leads themselves. Such capacitance, unless compensated for, can indicate a much slower rise time than is actually the case, the leading edge of the signal being slowed up. Typical square wave and pulse output waveforms are shown in the oscillograms in Figs. 6 to 10. These records were taken on a double beam oscillo-



Another view of the front panel rear

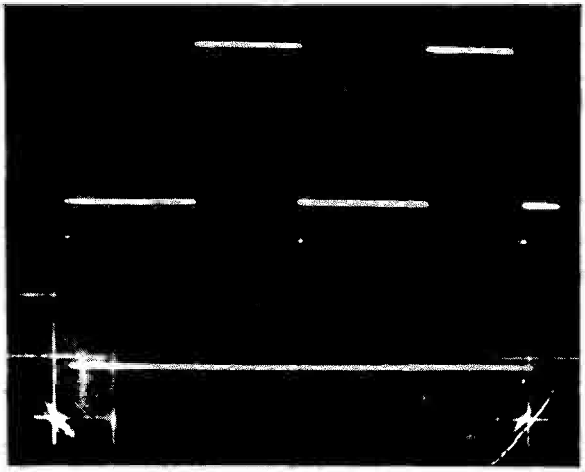


Fig. 6. Square wave output (above) with 500μS pulse output (below) at a repetition rate of 30Hz. The pulse is just discernable

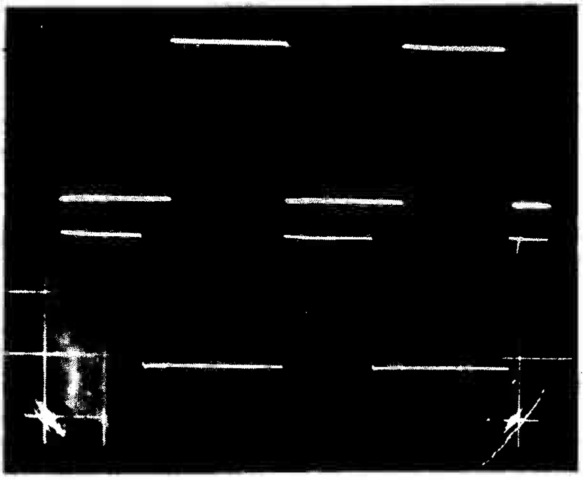


Fig. 9. Square wave output (above) with 75μS pulse output (below) at a repetition rate of 5kHz

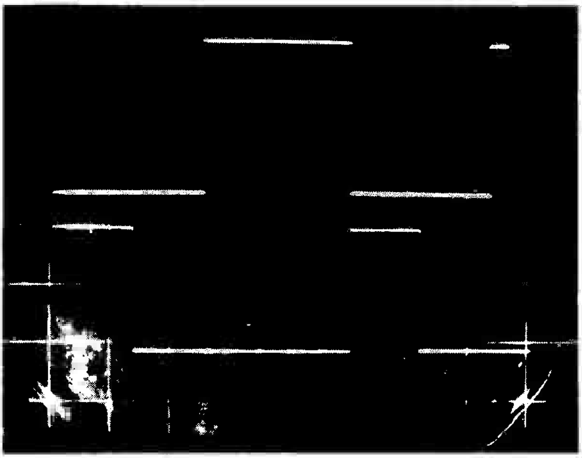


Fig. 7. Square wave output (above) with 2.5mS pulse output (below) at a repetition rate of 100Hz

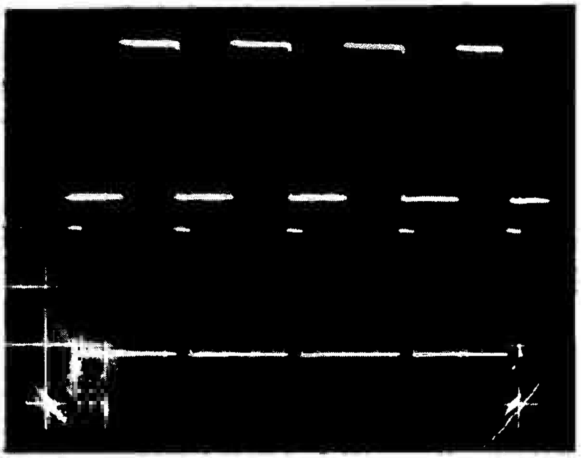


Fig. 10. Square wave output (above) with 10μS pulse output (below) at a repetition rate of 10kHz

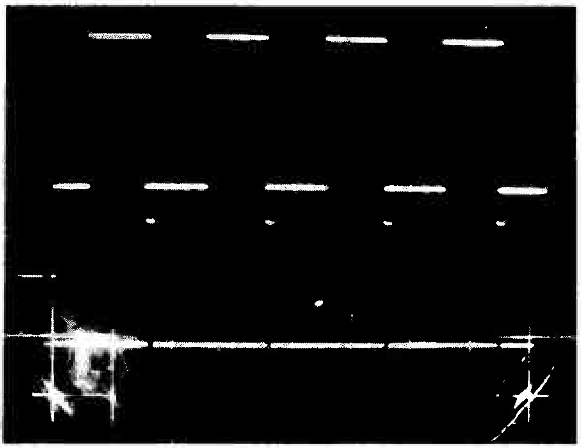


Fig. 8. Square wave output (above) with 150μS pulse output (below) at a repetition rate of 1kHz

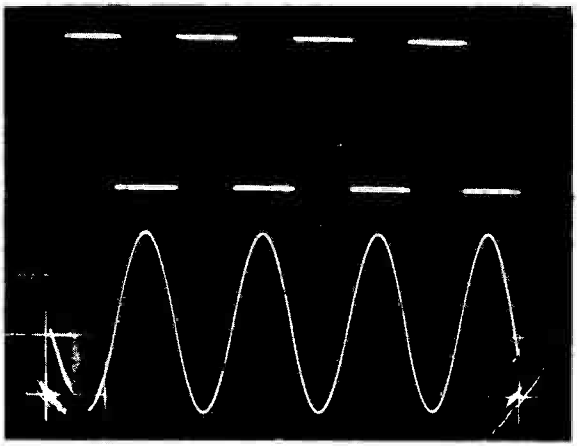


Fig. 11. Square wave output (above) and sine wave input drive (below) at 1kHz. Sine wave Y sensitivity is 1 volt/cm

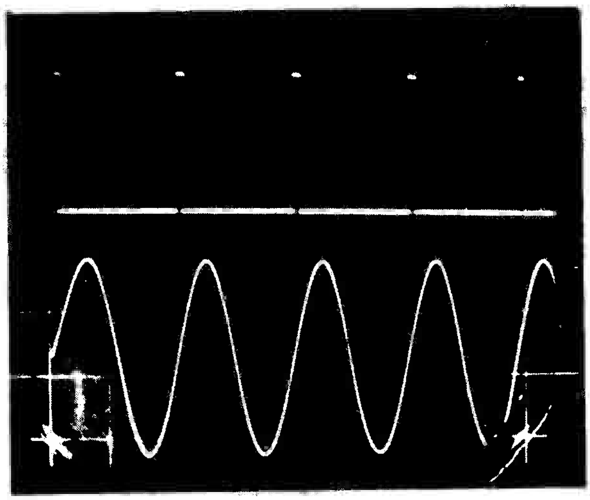


Fig. 12. 70μS pulse output (above) and sine wave input drive (below) at 1kHz. Sine wave Y sensitivity is 1 volt/cm

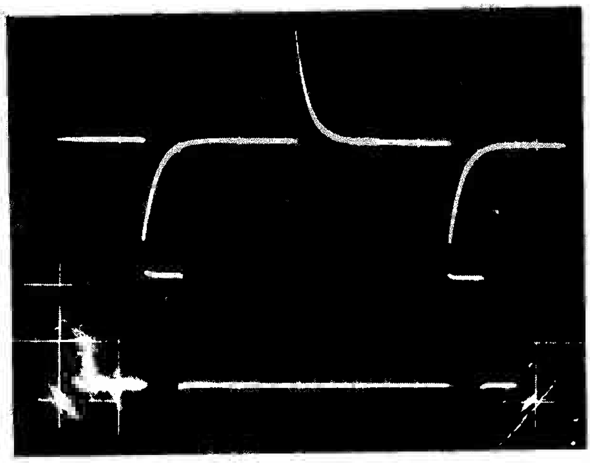


Fig. 13. Differentiated output (above) and 100μS pulse output (below) at 1kHz

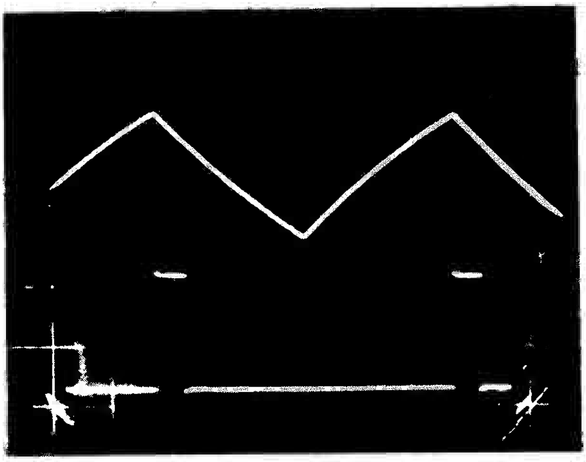


Fig. 14. Integrated output (above) and 100μS pulse output (below) at 1kHz

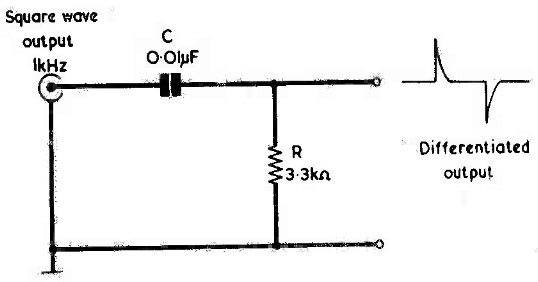


Fig. 4. An R–C circuit which enables a differentiated output to be obtained

scope so as to allow the separate output waveforms to be shown simultaneously for comparison. Figs. 11 and 12 also show the output waveforms in relation to the input sine wave.

In some applications, waveforms other than square and pulse are required and many commercial units also provide differentiated and integrated outputs. Simple forms of such waveforms can be easily obtained by the addition of a C-R static network of appropriate time constant across the output sockets.

The oscillogram in Fig. 13 shows a typical differentiated waveform together with simultaneous pulse output. Here a C-R network was connected across the square wave output as shown in Fig. 4. The time constant was kept small in relation to the frequency of the fundamental waveform, in this case 1kHz.

Alternatively, the oscillogram in Fig. 14 shows a typical integrated waveform together with the output pulse. In this case the C-R network across the output had a long time constant in relation to the fundamental frequency. This circuit is shown in Fig. 5. While the linearity of the integrated slope is adequate for most normal purposes, it could be improved by increasing the time constant, though this would of course further reduce the peak amplitude. More complex waveforms can be obtained by further additional circuitry, although those shown should cover the requirements of most everyday experimental and workshop purposes. ■

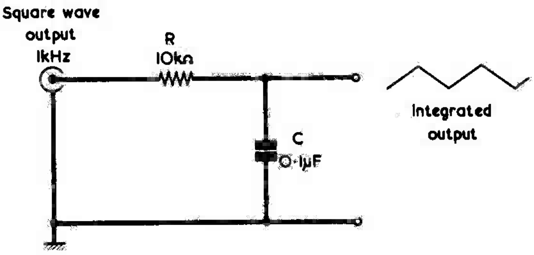


Fig. 5. Producing an integrated output

QSX

By
FRANK A. BALDWIN

(All Times GMT)

The season for reception of Latin American transmissions here in the U.K. will soon be upon us and we therefore go straight into a report of some of the stations that have been logged of late.

● LATIN AMERICA

4755	**0202**	HJKC Emisora Nuevo Mundo, Bogota, Colombia, with LA music, series of adverts, jingles and station identification. 1kW (63.09m).
4761	**2315**	YVPP Radio Frontera, San Antonio, Venezuela, talk in Spanish followed by identification, heard through facsimile interference. 2kW (63.03m) listed **4760**.
4775	**0230**	HJKW La Voz de Maria, Bogota, Colombia, LA songs and with clear identification. 1kW (72.83m).
4810	**2350**	HCRF4 Radio Canal Manabita, Portoviejo, Ecuador, with LA songs music and with clear full identification at midnight. 1kW. (62.31m).
4840	**0410**	OAX8F Radio Atlantida, Iquitos, Peru, long period of announcements in Spanish (noticarios) till 0426 when Andean music featured. 1kW (61.98m).
4845	**2233**	HJGF Radio Bucaramanga, Bucaramanga, Colombia, LA songs ending in Coca-Cola advert and station identification. 1kW (61.92m).
4860	**2330**	YVQE Radio Maracaibo, Venezuela, drama in Portuguese followed by identification. 10kW (61.73m).
4885	**2027**	ZYG26 Radio Pioneira de Teresina, Cartagena, Brazil, with 'futebol' commentary and identification. 1kW (61.45m).
6175	**2350**	ZYV74 Radio Guarani, Belo Horizonte, Brazil, sports commentary in Portuguese with identification at midnight. 10kW (48.58m).

None of the above mentioned LA stations were featured in the last QSX (January issue) and by adding the two lists, a fair selection of LA stations to listen out for will be presented.

● CHINA

Much confusion reigns among many SWL's with respect to transmissions from this country and, when heard, are usually listed as R. Peking.

Radio Peking broadcasts on a multiplicity of channels, we cannot list them here by reason of the space allocation, but there is a R. Peking External Service, a Home Service 1 and a Home Service 2. Additionally, apart from the Chinese regional transmitters, there is an External Service radiated from the Fukien Front station intended for Taiwan and other offshore islands.

The External Service is also relayed by Radio Tirana, Hailar, Huhehot, and Lhasa. Dx'ers will be more interested in the last three transmitters mentioned and here we present some information to aid in the logging of these.

Hailar 3900 From 1400 to 1500 in Mongolian. Channel then used by Fukien Front from 1215 to 2000 and from 2100 to 2330 in Standard and other Chinese dialects. Hailar is in Inner Mongolia.

Huhehot 4068, 6974 From 1400 to 1500 in Mongolian. Huhehot–Inner Mongolia.

Lhasa 4035, 5935, 9490 From 1600 to 1700 in Hindi to South East Asia and from 1700 to 1800 with repeat of programme in Hindi to South Asia.

Fukien Front The People's Liberation Army transmitter has a schedule from 1000 to 2000 and from 2010 to 0425 on a number of channels. For U.K. listeners, try at 2300 on **2600**, **3200**, **3400**, **4380**, **4840**, **5170**, **5240**, **5900**, **6400** and on **7025**. The station relays the Peking Taiwan Service in Standard Chinese.

● CHINESE REGIONALS

The Chinese regional stations can often be logged here in the U.K. A channel which can often provide useful results is that of **4500**, where we logged Urumchi, Sinkiang Uigher region at 1536. The schedule of this one is from 2200 through to 1635 but it has also been heard on other channels at times differing from that quoted. Try **4110**, **5057**, **5440**, **5800** and **6280** where it has been reported from time to time.

Wuhan, Hupeh, has often been logged here on **3940** with a programme of Chinese music around 2150.

Shenyang, Liaoning, Provincial Service can be heard on **4832** where it is from 2100 to 2400 among other time periods. Try around 2230, although it was slightly off-channel when we heard it – on **4832.5** in fact.

● CAPE VERDE ISLANDS

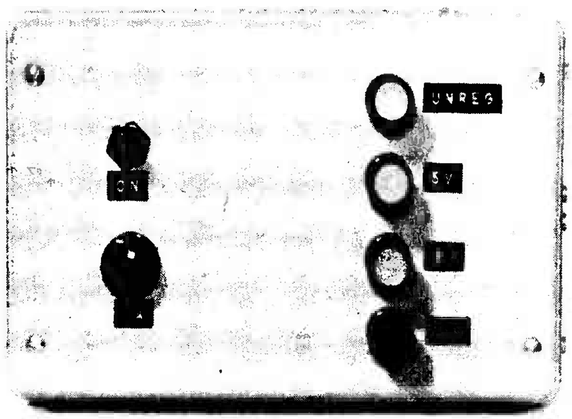
Radio Barlavento is listed on **3930** but recently logged here on a measured **3931** at 2349 with announcements in Portuguese followed by a programme of light music. CR4AC has a power of 1kW and the late-night schedule is from 2200 to 0100.

● GAMBIA

Radio Gambia, Bathurst, can sometimes be heard, free of interference, on **4820**. We recently logged them at 2240, announcements in English and a rendering of "Two Lovely Black Eyes", what a surprise!

● LIBERIA

Monrovia (ELWA) on **4770** can often be heard around 2200 or so. Logged here at 2220 with a song programme and announcements in English.



LOGI

A supply unit for digital integrated circuits which offers two separate 5 volt outputs at currents up to 600mA each.

THE MOST COMMONLY USED LOGIC ELEMENTS (THE SN7400 series) run from a 5V supply rail. Since the standard series is designed to switch at speeds up to several megahertz, current consumption tends to be high if a number of integrated circuits are used in a system. The power supply described employs readily available componenets to produce a suitable rail voltage at currents up to 1.2 amps.

CIRCUIT

The circuit is shown in Fig. 1. In principle it consists of a transformer to provide a 9V r.m.s. output, a bridge rectifier, a reservoir capacitor and two MVR-5V regulators. The MVR-5V regulator is an integrated circuit regulator housed in a T0-3 case which is specifically intended to provide 5V output at currents up to 600mA for logic circuits. It has built-in current limiting and is short-circuit proof. Only three connections need to be made to it: the unregulated positive supply is applied to pin A, the 5V regulated supply appears at pin B and the case (terminal C) connects to the negative line. This last connection makes it possible to bolt the regulator direct to a heat sink which is at chassis potential.

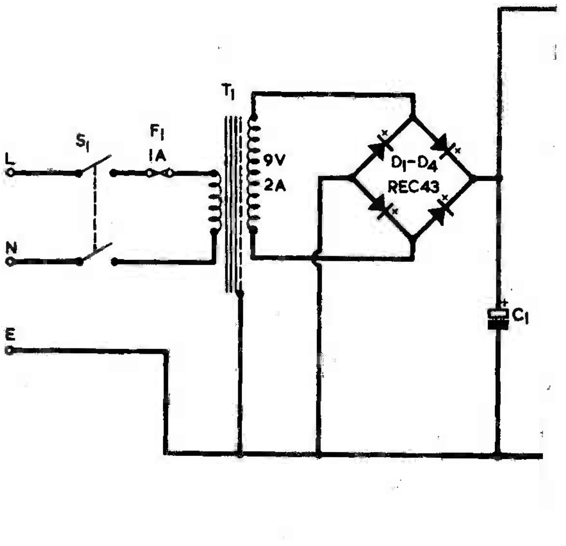
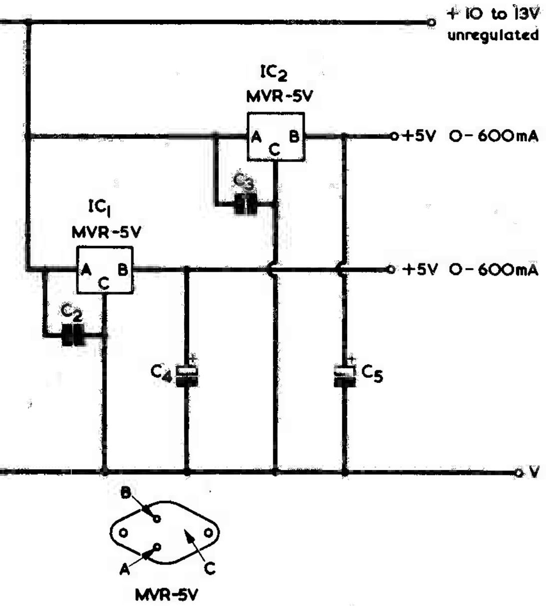


Fig. 1. The circuit of the 5V logic supply unit. There ar

Cover Feature

C SUPPLY UNIT

by A. Foord



two regulated 5V outputs and an unregulated output

COMPONENTS

Capacitors

C1	150,00µF, high-ripple electrolytic, 16V Wkg. (R.S. Components)
C2	0.1µF disc ceramic
C3	0.1µF disc ceramic
C4	10µF electrolytic, 16V.Wkg
C5	10µF eleetrolytic, 16V.Wkg

Transformer

T1	Mains transformer, 9V 2A secondary, type 633 (R.S. Components)

Integrated Circuits

IC1, IC2	Regulator type MVR-5V (R.S. Components)

Rectifier

D1–D4	Bridge rectifier type REC43 (R.S. Components)

Switch

S1	D.P.S.T. toggle

Fuse

F1	1A fuse and holder

Miscellaneous

3 Red terminals, insulated
1 Black terminal, insulated
2 Heat sinks, Redpoint type 2P
Case (see text)

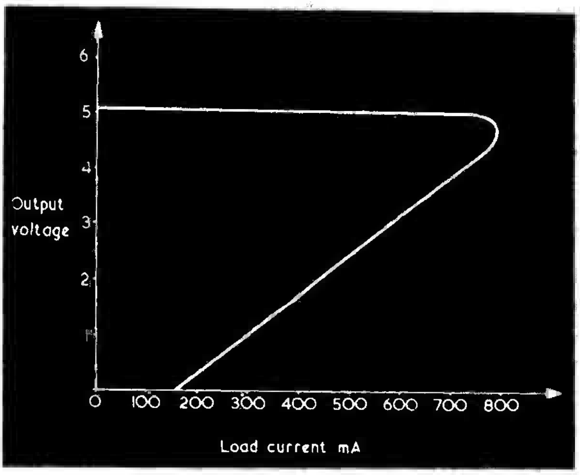


Fig. 2. The foldback overload characteristic

The short-circuit protection is of the foldback type, where the short-circuit current is less than 200mA. This reduces the power dissipation under short-circuit conditions to a safe value. A typical overload characteristic is shown in Fig. 2.

The MVR-5V is in the R.S. Components range, as also are the mains transformer T1, the bridge rectifier D1-D4, and the reservoir capacitor C1. All these parts may be obtained from Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN.

Two regulators are used so that total currents of up to 1.2A can be supplied. This means that in practice a large system would have to be divided into sections, each consuming up to 600mA. This is not a disadvantage because it helps to reduce noise spikes on the supply lines. Such noise spikes can become a problem if several amps are supplied from a single 5V line.

Capacitors C2 and C3 were found to be essential to prevent the regulators from oscillating at a high frequency under load conditions, and they should be placed as close as possible to the regulator terminals.

The bridge rectifier is run within its rating in free air, and can be bolted to any convenient metalwork.

PERFORMANCE

With both 5V lines loaded to 600mA the output ripple on either line is 3mV peak-to-peak, the unregulated output voltage is 10V and the unregulated output ripple is 0.5V peak-to-peak.

The regulated output voltage is 5V plus or minus 0.25V at 600mA maximum for each output. The total load on the unit must not exceed 1.2A.

CONSTRUCTION

Any reasonable layout may be employed and that used by the author can be seen in Figs. 3 and 4 and the photographs. The components were mounted in an Imhof case type 1480A, which has the outside dimensions shown in Fig. 4. This case is available by mail

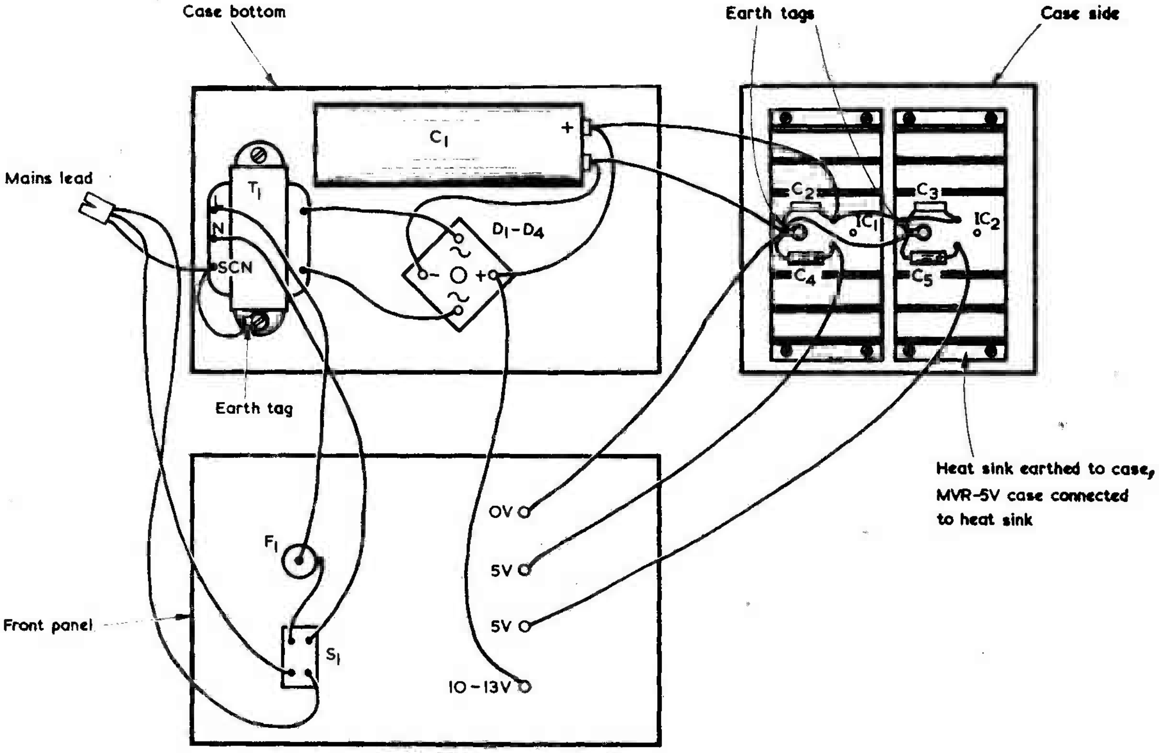
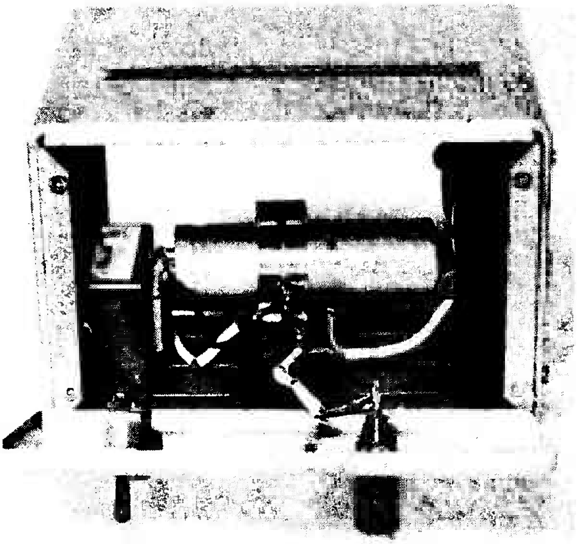


Fig. 3. How the components are wired up. The integrated circuit regulators are behind the heat sinks



The unit with its front panel open and its rear panel removed. The mains transformer, bridge rectifier and reservoir capacitor are mounted on the bottom of the case. On the right-hand side are mounted the two matt black heat sinks. Part of the lower 0.1µF ceramic capacitor may also be seen

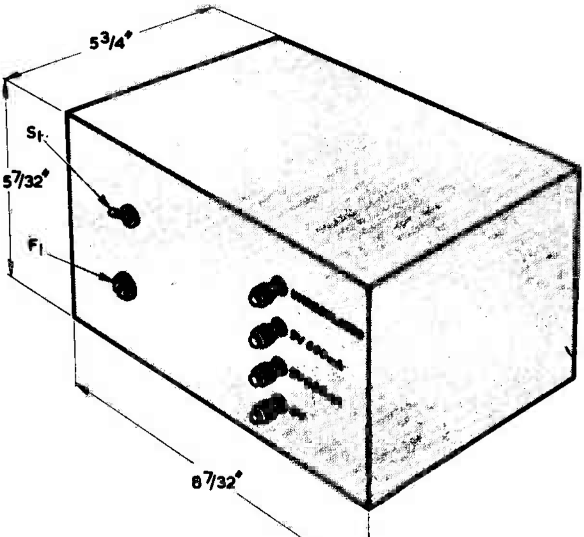
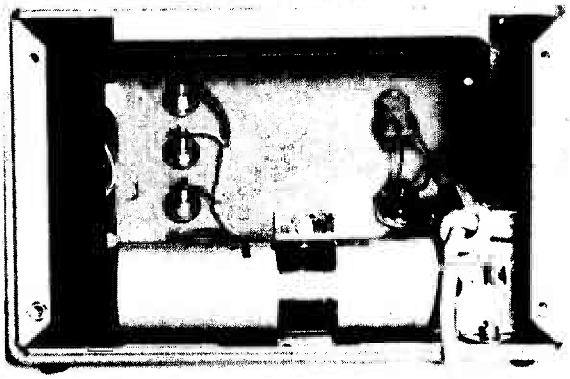


Fig. 4. A suitable front panel layout. The dimensions apply to the case employed by the author

order from Imhof-Bedco Limited, Ashley Works, Cowley Mills Road, Uxbridge, Middlesex, but it is, unfortunately, uneconomic to purchase it in 1-off quantities. At the time of writing the price of the case is £3.44 plus post and packing, but Imhof-Bedco Limited operate a Minimum Order Value of £7.50. Alternative cases of around the same size can, of course, be used, provided they can accept the heat sinks.

The transformer, reservoir capacitor, and bridge rectifier were mounted on the floor of the case. The heat sinks were mounted on the inside at one side. C2 and C3 were mounted directly across the regulator terminals. C4 and C5 were also mounted across the terminals, although this is not too good a place for electrolytic capacitors because of the temperature here. Alternatively, C4 and C5 could be connected across the terminals at the front panel, in which case it might be wise to have 0.1µF capacitors connected directly across the regulator output terminals.



A view from the rear with the front panel open. The heat sinks now appear on the left

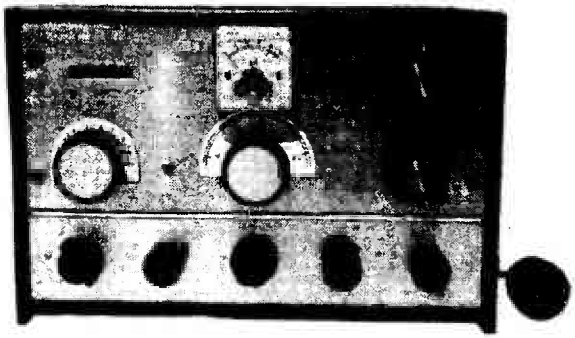
Each regulator has to be mounted on a heat sink of thermal resistance 4.75°C/W or better. The types used (Redpoint 2P) are approximately 4¾ by 2 by 1½in. and have a thermal resistance of 3.4°C/W each. If the heat sinks are in close proximity and in a restricted air flow then they should be better than 4.75°C/W to allow for this factor. If both regulators are bolted to a single heat sink then it should have a thermal resistance of 2.3°C/W or better. The Imhof case employed for the prototype had ventilation slots in the bottom and louvres in the back panel.

The Redpoint heat sinks may be obtained in 2-off quantities from Electrovalue, 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.

No detailed dimensions are given and the constructor may plan the front panel layout to suit the particular terminals and switch employed. If the heat sinks are mounted outside the case then it becomes difficult to fit the capacitors at the regulators.

The unit was tested with the full load current of 1.2A (600mA each output) and the heat sinking was found to be conservative even though the sinks were inside the case. ■

TRANSMITTER-RECEIVER



FOR 160 METRES

– Part 2

by F. G. Rayer, Assoc. I.E.R.E., G30GR

In this concluding article our contributor gives final details on the 160 metre transmitter-receiver. Also described is a suitable power supply unit.

TOP OF CHASSIS

Capacitors VC2-VC3 and VC4 are mounted to the flat plate, as shown in Fig. 3 (published last month). A spindle coupler and a short length of ¼in. rod allows VC2-VC3 to be set back, as illustrated.

The v.f.o. box is made from a 9 by 2in. 'Universal Chassis' side. Two V-cuts are made in each flange 2⅝ins. from the ends. The chassis side is then bent to the shape shown in Fig. 3, forming a 'box' about 2⅝ by 3¾ by 2ins. deep. The sharp bends required are best made by clamping the chassis side between two blocks of wood, one narrow enough to go between the flanges and set level with the bending line. A flat metal plate measuring about 2½ by 3½ins., which functions as a cover, is cut out and drilled for self-tapping screws which are later driven into matching holes in the flanges.

VC4, L4, TC4 and C16 are inside the box. TC4 is supported with stout wires and can be adjusted through a hole in the box top. The wires are 14 or 16 s.w.g. and are very short. In the prototype the v.f.o. proved to be perfectly stable and reliable. The connections to the Denco coil used for L4 should be soldered quickly and a heat shunt is advisable, as the plastic in which the coil pins are held may otherwise melt and become deformed. The same remarks apply to all the other Denco coils employed in the transmitter-receiver.

A bracket for the tuning indicator is cut from scrap or a spare 'Universal Chassis' side and is screwed to the front panel by two of the chrome 6BA bolts referred to a little earlier. The bracket is as illustrated in Fig. 3 and its flange has two holes at 2½in. centres for the mounting bolts. The valveholder should take up a position such that the tuning indicator display is centred behind the rectangular aperture in the front panel. The valveholder should be orientated such that the display is forward. Wiring to the indicator is as shown in Fig. 3. Three leads pass through a chassis grommet, one to the 6.3 volt line at pin 4 of V1, one to the a.g.c. circuit and one to h.t. positive.

VC6-VC7 is fixed to the front panel by short bolts passing into its threaded holes. Before mounting, its two sets of fixed vanes should be connected together and two insulated leads connected to the rear fixed vanes. These leads will later connect to L6 and to S1(a).

VC5 is bolted to the panel above VC6-VC7, and is set back a little with extra nuts, washers or spacers. A lead (not shown in Fig. 3) runs from the frame of VC5 to the frame of VC6-VC7, and then to the chassis at the adjacent tagstrip.

Capacitors C25, C26 and choke RFC2 are supported by this tagstrip, as shown in Fig. 3. A lead from pin 1 of V8 runs through an adjacent chassis hole and connects to the junction of C26 and RFC2.

L6 is wound on a former 3½ins. long and 1in. in diameter, and consists of 70 turns of 22 s.w.g. enamelled wire, wound side by side. The coil is fixed by a bracket to the chassis, and the lower end of the coil should be about 1in. clear of the chassis surface. The top end of the coil connects to VC5, and the bottom end is connected to the wire previously fitted to VC6-VC7 fixed vanes.

The two leads from the speaker, when this is fitted, pass through a hole in the chassis to the secondary of T1.

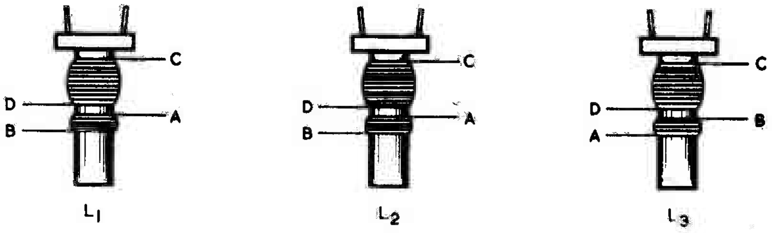


Fig. 5. Details of the home-wound versions of L1, L2 and L3

BELOW THE CHASSIS

The wiring and components below the chassis are illustrated in Fig. 4 (published last month). A tagstrip near the back anchors power leads and other connections. The power input is carried by a four-core lead providing 300 volts nominal l.t., a common chassis connection and two 6.3 volt supplies. The tags 'X' of V1 to V5 are wired together and to the tagstrip, and these valves require 6.3 volts at 1.41 amps. Tags 'Y' of the remaining valves are similarly wired together and to the tagstrip, and these require 6.3 volts at 2.26 amps.

The non-earthy leads to VR2 run close to the chassis underside. The speaker transformer, T1, is bolted to the rear flanged member over V9 valveholder and is not shown in Fig. 4. Its primary connects to tag 1 of IFT1 and to pin 1 of V4.

All the points marked 'MC' are tags bolted tightly to the chassis. Several of the coils have trimmers soldered across two of their tags. If Denco coils are used here, stout wire may be soldered to the appropriate pins and the trimmers soldered to these wires.

COILS

Details of the coils are given in the Table and Fig. 5. It will be seen that L1, L2 and L3 may be either home-wound, as in Fig. 5, or modified Denco coils. If the home-wound coils are employed, chassis holes are required at the lower ends of their formers to allow access to their cores. The outer ends of the formers are covered by trimmers. The Table also includes the modulation choke L7. The 'Hygrade' choke referred to is an R.S. Components part. It may be obtained from Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN, or from Home Radio (Components) Ltd., who list it under Cat. No. CLF25.

TABLE
Details of Inductors

Coils L1, L2 and L3 may either be modified Denco components or home-wound. All Denco coils are valve types.

Denco Versions

L1.	Aerial Coil. Denco Blue Range 2 with 32 turns removed from tuned winding. A pin 8, B pin 9, C pin 6, D pin 1.
L2.	Mixer R.F. Coil. Denco Yellow Range 2 with 32 turns removed from tuned winding. A pin 9, B pin 8, C pin 6, D pin 1.
L3.	Oscillator Coil. Denco Red Range 2 with 20 turns removed from tuned winding. A pin 8, B pin 9, C pin 1, D pin 2.

Home-Wound Versions

All home-wound versions are wound with 34 s.w.g. enamelled wire on 7mm. by 27mm. formers with dust cores and 4-way tagboards. Details are given in Fig. 5.

L1.	C–D 130 turns wound over $\frac{7}{16}$in. A–B 60 turns wound over $\frac{1}{8}$in. Spacing between windings, $\frac{1}{16}$in.
L2.	Same as L1 except A–B 50 turns wound over $\frac{1}{8}$in.
L3.	C–D 115 turns wound over $\frac{7}{16}$in. A–B 50 turns wound over $\frac{1}{8}$in. Spacing between windings $\frac{1}{16}$in.
L4.	Denco White Range 2 with small winding removed.
L5.	Denco Yellow Range 2 with small winding removed.
L6.	70 turns 22 s.w.g. enamelled wire on 1in. diameter former. See text.
L7.	'Hygrade' 10H 90mA choke, or 80–100mA pentode output speaker transformer primary, secondary unused.

V.F.O. STAGE

In the transmitter v.f.o. circuit, C17 and C18 swamp out stray circuit capacitances and, providing the connecting leads in this stage are thick and are kept short, the frequency stability should be found more than sufficient. A check of v.f.o. frequency coverage can be made by applying h.t. to this stage and listening to the carrier on a receiver.

When construction is completed and the v.f.o. box lid has been screwed on, coverage is adjusted by means of TC4 and the core of L4. These adjustments should result in the range of 1.8 to 2.0MHz being provided without using the extreme open and closed settings of VC4. The threaded section of L4 core is then locked by passing a nut over it and tightening this against the plastic of the coil former.

A pointer or cursor is fitted to the flange of the slow motion drive and markings are made on a thin card scale fixed to the panel. Accurate calibration is easy if a 100kHz crystal marker is available for use with the receiver. Tune the latter to 1.8MHz by means of the crystal, and tune the v.f.o. to zero beat, marking its scale 1.8MHz. Repeat for 1.9 and 2.0MHz. Then tune the station receiver to the marker harmonic on 3.7MHz, tune the v.f.o. until its second harmonic is at zero beat, and mark the scale for 1.85MHz. Repeat for 1.95MHz, with the receiver set at 3.9MHz. The 10kHz points can be filled in by estimate.

BUFFER AMPLIFIER

The buffer amplifier may be checked with both V7 and V8 plugged in. S2(a)(b) is set to 'Net', thereby allowing no h.t. supply to V8. Clip a current reading meter across R24, with negative to point 'G' and positive to chassis. Set the v.f.o. to 1.9MHz and adjust the core of L5 for maximum grid current in V8. This will be about 2 to 3mA. R.F. output tests show that there is no loss of efficiency provided grid current is not less than about 2mA or more than 4mA, and the current should be within these figures across the band. If grid current is excessive, increase R21 to 47kΩ, 68kΩ or 100kΩ as necessary. The grid current tends to depend somewhat on the actual valves employed and the h.t. voltage.

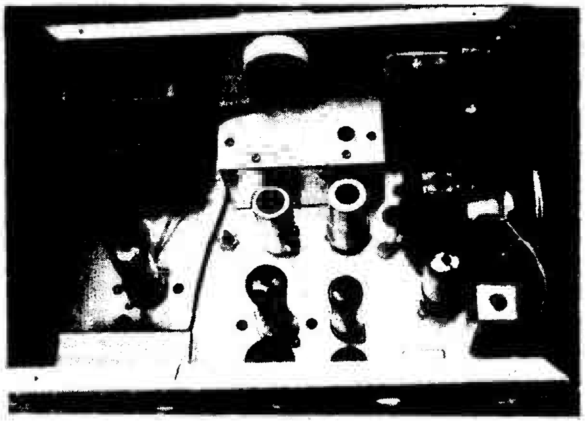
POWER AMPLIFIER

The power amplifier stage is most easily tested by coupling the output to a 250 volt 15 watt household lamp. This may be temporarily connected across VC6-VC7. Alternatively, the lampholder can be connected to a coaxial plug, which is then inserted into the aerial socket.

Set both VC5 and VC6-VC7 to maximum capacitance. Switch to 'Transmit' and rotate VC5 for resonance as shown by a dip in anode current. Gradually reduce the capacitance of VC6-VC7 whilst at the same time readjusting VC5 for minimum anode current. The minimum anode current at resonance, as indicated by meter M1, will increase, and the lamp will light more brightly. Load in this way for about 33mA at 300 volts h.t., or 40mA at 250 volts h.t., to obtain the 10 watt input.

Commencing this operation with VC5 at maximum capacitance ensures that L6 is not accidentally resonated at 80 metres. This is possible in some circumstances, with V8 acting as a doubler, but the transmitter is not intended to be operated in this manner.

In use, the power amplifier is brought into circuit by means of S1(a)(b). Initially, set S2(a)(b) to 'Net' to enable the v.f.o. to be tuned to receiver frequency, then return this switch to its original setting. S1(a)(b) then provides complete change-over from reception to transmission.



A further view above the chassis. The tuning indicator can be seen at the right

COMPONENTS – POWER SUPPLY

Resistors
(All 10%)

R1	220kΩ 1 watt
R2	270Ω 2 watts
R3	270Ω 2 watts

Capacitors

C1	32μF electrolytic, 450 V.Wkg.
C2	8μF electrolytic, 450 V.Wkg.

Inductors

L1	Smoothing choke, 10H at 120mA, 200Ω, Parmeko P3142 or similar
T1	Mains transformer, secondaries 300–0–300V 120mA, 6.3V 2A, 6.3V 2A, 6.3V 2.5A. Electrovoice type 195A (Home Radio Cat. No. TM9)

Rectifiers

D1	Silicon rectifier, 1A, 1,000 p.i.v.
D2	Silicon rectifier, 1A, 1,000 p.i.v.

Fuse

F1	250mA cartridge fuse and holder

Switch

S1	s.p.s.t. toggle

MODULATOR

The modulator incorporating V9 and V10 can be checked with the transmitter output feeding in to a lamp, as just described. The signal may be picked up on the station receiver. The r.f. gain control of the latter will probably need to be set at minimum to avoid overloading, and it may also be necessary to disconnect the receiver aerial, substituting a short wire.

Speech in the microphone should sound clear and strong on the receiver, and the lamp brilliance should increase during speech. Avoid acoustic feedback, evident as a howl, from the receiver back to the microphone, by turning down the receiver a.f. gain and keeping the speaker and microphone well separated.

RECEIVER R.F. STAGE

L1 is above the chassis, and VC1 is simply peaked for best reception, thus allowing compensation for changes to the aerial. The core of L1 and trimmer TC1 should be set up such that VC1 covers the 1.8 to 2.0 MHz range comfortably.

As the tuning range is only 1.8 to 2.0MHz, no tracking difficulties arise between L2 and L3. If the full swing of VC2-VC3 gives a larger coverage than is required, slightly reduce the inductance of L2 and L3 by means of their cores and increase the capacitance of TC2 and TC3. When coverage is suitable, tune in a signal near 1.8MHz and adjust L2 core for the best indication in the tuning indicator. Then tune to a signal near 2.0MHz and adjust TC2 for best results. These adjustments are repeated several times.

The v.f.o. can assist in initially finding the receiver range. If S2(a)(b) is set to 'Net', the receiver may be tuned to v.f.o. frequency with the aid of the tuning indicator.

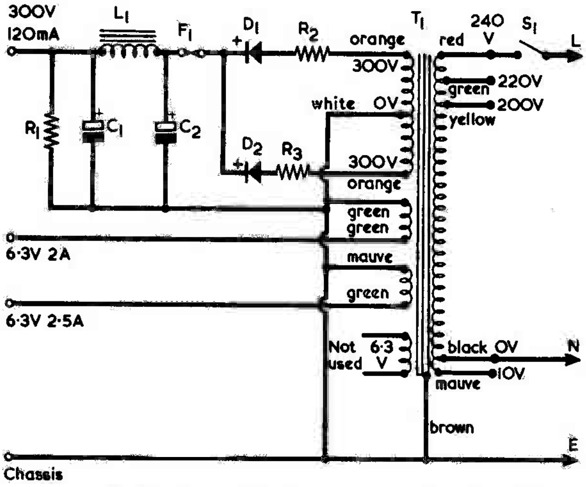


Fig. 6. The circuit of the power supply unit employed by the author. As is explained in the text, other power supply units offering similar outputs may be used instead

Finally, a pointer or cursor is fitted to the flange on the slow-motion drive for VC2-VC3. This is then fitted with a scale similar to that for VC4.

I.F. AMPLIFIER

The specified i.f. transformers are supplied prealigned and will require only a slight adjustment after they have been wired in. A correct type of core adjusting tool should be employed. A stable signal should be tuned in correctly, and the i.f. transformer cores are then adjusted for best indication in V5.

WORKING NOTES

Any usual type of Top Band aerial can be used. This will generally be end-fed and may operate directly from the transmitter or be used with a tuner or matching device. If the end fed wire is reasonably long and will load the transmitter without a matching unit, the latter is unnecessary. Such a unit is, however, necessary with a whip or short wire.

A coaxial lead from the transmitter-receiver may run to a standing wave ratio indicator, matching unit or r.f. meter, when one or more of these are employed. Transmitter loading with an aerial follows the same procedure as that described for testing with a lamp load.

POWER SUPPLY

The power supply unit actually used by the author is shown in Fig. 6. Other supply units with adequate h.t. and heater outputs would be just as suitable. The mains transformer specified has a 6.3 volt 2.5 amp heater winding and this supplies the transmitter heaters, which require 2.26 amps. Another 6.3 volt winding is rated at 2 amps and is used for the receiver heaters, where the total current is 1.41 amps. A third 6.3 volt winding on the transformer is ignored.

The h.t. output from the supply unit in Fig. 6 allows the transmitter to be operated with the full permitted input of 10 watts.

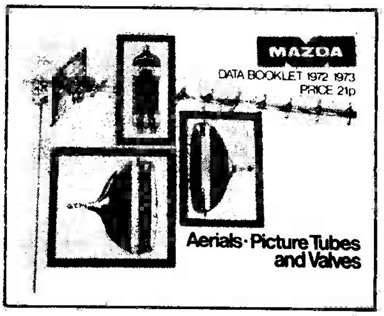
The transmitter-receiver has also been used successfully with smaller power supplies. A 300 volt 100mA supply is about adequate, while a 275 volt 100mA supply gives good results. A 250 volt 100mA supply is somewhat on the small side, whilst a 250 volt 80mA supply is the minimum recommended. These lower output supplies have no effect on reception, but with less than about 275 volts at 100mA available the p.a. has to be run at substantially less than 10 watts input. This input is achieved with a p.a. supply of 33mA at 300 volts, or 40mA at 250 volts. An input of 50mA at 200 volts would also represent 10 watts, but it will be found that efficiency and r.f. output fall off at such a low voltage. ■

MAZDA BOOKLET

Did you know that the world's first valve for amateur constructors, produced in 1922, was the type AR bright emitter triode? And that the SP61, used in quantity by the R.A.F. in the R1132 receiver, helped to win the Battle of Britain? And that the T31, Britain's first thyratron designed specifically for 405 line timebases, appeared in 1936? And that the world's first ever commercial valve manufactured for sale was the type A, which was made in 1906 at Ponders End?

These facts appear in the Obsolete Valves section of the 168-page Mazda Pocket Data Booklet for 1972–1973, whose cover you can see in the accompanying photograph. However, they take up only a minute fraction of a comprehensive booklet which gives essential data on Mazda valves and picture tubes. Included are current types as well as obsolescent and obsolete types, and there is data on four new types of colour tube, three new types of monochrome tube and three new valve types. A further feature of the booklet is an eight-page section covering Mazda u.h.f. aerials and their lashing kits.

The booklet has been specifically compiled for use in maintenance work by the radio trade and will be particularly helpful for the service engineer and the enthusiast who repairs present-day as well as vintage receivers. There is a cover charge of 21p, and discounts apply to the Radio and TV trade when purchasing from a Mazda wholesaler. Further details are available from the Publicity Department, Thorn Radio Valves and Tubes Limited, Mollison Avenue, Brimsdown, Enfield, Middlesex, EN3 7NS.



Currently available is the 1972–1973 Mazda Pocket Data Booklet. Priced at 21p, this gives concise details of valves, picture tubes and Mazda u.h.f. aerials

MAINS FAILURE WARNING DEVICE

by R. E. Stewart

SOME TIME AGO THIS JOURNAL PUBLISHED A CIRCUIT for an audible mains failure indicator.* This circuit enabled a neon relaxation oscillator to commence running when the mains supply failed, the oscillator being powered by a 100μF capacitor which had previously been charged to the mains voltage. The neon oscillator was coupled to a loudspeaker, which gave an audible tone at the frequency of oscillation of the neon circuit. A 100μF capacitor takes a surprisingly long time to discharge under these conditions and the audible warning tone available from the oscillator can be heard at a relatively high level for more than five minutes, after which the level falls slowly. The tone will still be given, at a reduced level, more than fifteen minutes after the mains supply has ceased.

SIMPLER CIRCUIT

The earlier circuit used four rectifier diodes and it recently occurred to the present author that the same facility can be given in a simpler circuit having two rectifier diodes only.

This circuit appears in the accompanying diagram. When the a.c. mains voltage is present across the two outside rails, both D1 and D2 conduct on the half-cycles which cause the upper rail to be positive. In consequence both C1 and C2 become charged, with their upper plates positive. C1 charges to a potential which is the peak value of the alternating voltage, whilst C2 charges to a slightly lower voltage because of the presence of R4 across it. In practice, the difference between the two potentials is of the order of 10 to 15 volts. Resistors R1 and R3 are merely limiting resistors.

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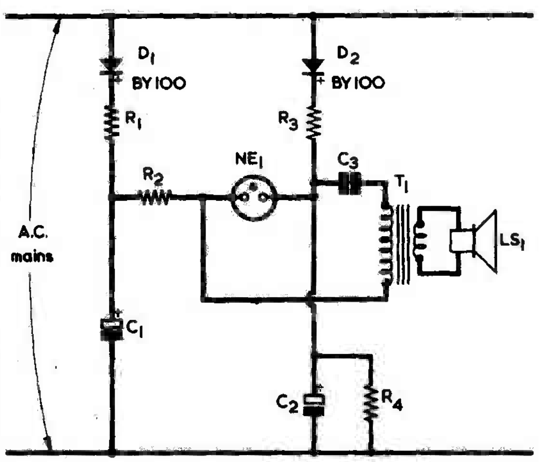
* G. A. French, 'Mains Failure Indicator', *The Radio Constructor*, September 1971.



The circuit of the mains failure warning device. This produces an audible tone when the mains supply ceases

COMPONENTS

Resistors (All 10%)	
R1	56Ω 1 watt
R2	3.9MΩ ½ watt
R3	20Ω 1 watt
R4	22kΩ 6 watts
Capacitors	
C1	100μF electrolytic, 350V Wkg.
C2	16μF electrolytic, 350V Wkg.
C3	0.005μF plastic foil, 250V Wkg.
Transformer	
T1	Valve output transformer, 33:1 (see text)
Diodes	
D1	BY100
D2	BY100
Neon	
NE1	Miniature wire-ended neon bulb
Speaker	
LS1	3Ω loudspeaker

The potential difference on the upper plates of C1 and C2 is applied to R2 and NE1 in series and, when the mains supply is present, is too low to allow the neon to strike.

In the event of a failure of mains voltage, the two rectifiers cease to conduct. C2 discharges rapidly by way of R4, whereupon the voltage applied to R2 and NE1 exceeds the striking voltage of the neon bulb and the latter starts to operate as a relaxation oscillator. The sawtooth voltage appearing across its electrodes is passed to the loudspeaker via C1 and T1. Very soon after the cessation of the mains supply, the upper plate of C2 is at the same potential as the lower supply rail, and the full voltage across C1 is applied to the neon oscillator circuit. This continues to run until C1 is discharged below the burning voltage of the neon, or until the mains supply is reapplied. In the latter instance both C1 and C2 become fully charged again, and the low voltage difference on their positive plates is once more applied to the neon circuit.

AVAILABILITY

All the components are readily available, although some are a little critical. C1 should be a good quality modern capacitor, since it is required to hold its charge for a long period. R4 dissipates about 4.5 watts. If it is difficult to obtain this resistor with the 6 watt dissipation figure specified in the Components List it may be made up from a series combination of two 10kΩ resistors of 3 watts or more, or three 6.8kΩ resistors of 2 watts or more.

The neon bulb, NE1, is a small wire-ended component, obtainable from Home Radio under Cat. No. PL32A. Similar bulbs are available from other suppliers. Both wires protrude from one end of the glass body of the neon bulb.

The transformer, T1, is rather a critical component and the writer employed an Elstone valve output transformer type MO/T. This has three primary to secondary ratios, and the primary tap employed is that which gives a step-down ratio of 33:1. The transformer can be obtained from Home Radio under Cat. No. T012.

The audible output of the warning device is sufficiently loud for a room or small workshop but is not, of course, in the high wattage category. The speaker used should be a reasonably sensitive model.

Either the live or the neutral side of the mains supply can connect to the upper supply rail. All the components, including the speaker, have to be enclosed in an insulated case to ensure prevention of accidental shock. The speaker frame should be looked upon as a potential live circuit point, and its mounting bolt heads should not appear outside the insulated case, where they might be touched.

If NE1 is in complete darkness it may not strike reliably. Small ventilation holes should enable sufficent external light to enter, and will also permit the cool running of R4.

The neon circuit oscillates quite readily, although there may be some small variances in performance between neon bulbs of the same nominal type. Failure to oscillate may be cleared by a slight change to the value of R2. The frequency can be varied by changing the value of C3, but it is best to start off here with the value of 0.005μF specified. ■

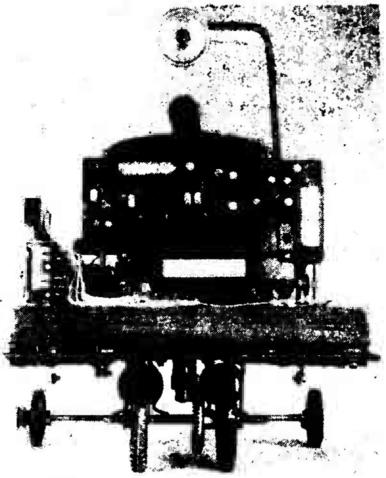
RADIO & ELECTRONICS CONSTRUCTOR

OUR NEXT ISSUE FEATURES

CRYSTAL MICROPHONE PRE-AMPLIFIER
by R. A. Penfold

A simple integrated circuit pre-amplifier which enables the high impedance of a crystal microphone to be matched to the low input resistance of a transistor a.f. amplifier.

MODIFICATION TO CYCLOPS
Part 1 by L. C. Galitz



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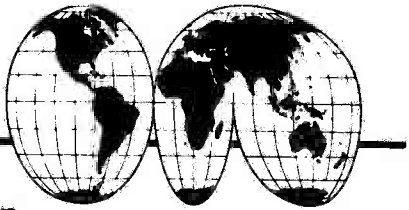
SHORT WAVE NEWS



FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Since last writing about conditions on the short wave bands, we note that a general improvement has taken place and in the weeks that lie ahead, signals from Latin America on the LF bands should slowly build up in strength whilst those from Asia and the Far East will become progressively weaker. All this of course is in conformity with the annual pattern of events but, as so often happens on the short waves, things can go awry and there are always surprises just when least expected, which is part of the fascination associated with the 'SWL game'.

This month we commence with –

AROUND THE DIAL

Australasia and South East Asia are areas of the world from which signals are not easy to receive here in the UK, apart that is from some of the powerful transmitters of Radio Australia (even these are not always that easy). One of the transmissions we would like to draw to your attention is that of –

●NEW ZEALAND

A watch for several mornings on **9520** (31.51m) at 0850 could result in the logging of ZL18 Wellington. We have heard this station on a number of occasions recently from 0850 when the interval signal, the call of the N. Zealand Bellbird, is repeated every five seconds until 0857, at which time there is the identification in English, a short hymn, a military march and then the news, after 6 pips at 0900. A further newscast, after 6 pips, is radiated at 1000. The whole transmission lasts until 1145 and is beamed to Australia. The identification is "This is Radio New Zealand, the short wave division of the New Zealand Broadcasting Corporation" The power is just 7.5kW and there is a parallel transmission (not heard by us) on **11705** (25.63m). The address for reports is – New Zealand Broadcasting Corporation, P.O. Box 98, Wellington.

Still keeping to the same area of the world, you may still have time to log –

●INDONESIA

On a measured **4763** (62.98m) at around 2320 is RRI (Radio Republik Indonesia) Medan, at which time we heard Arabic-type chants both in solo form and with male chorus. Medan is the capital of East Sumatra and is noted for large rubber and tobacco plantations.

Or try **4840** (61.98m) around 1530 when you may hear RRI Ambon. This one had been logged several times with Arabic-type chants and announcements in Indonesian. Northeast across the South China Sea lies –

●TAIWAN

Once known as Formosa, Taiwan can be logged on **7150** (41.95m) around 1430 onwards. We heard it from that time through to 1500, when three short and one long pip, followed by announcements in Chinese by both male and female announcers, were made. Taiwan lies 100 miles East of the Chinese mainland, the capital being Taipei. The address for reports is – Broadcasting Corporation of China, 53 Jen Ali Road, Sec. 3, Taipei City, Republic of China.

Back again across the South China Sea, Southwestwards, lies –

●SOUTH VIETNAM

The capital of this war-torn republic is Saigon and transmissions from here may be heard on **7245** (41.40m) from around 1500 onwards. Our log entry is for 1517, when we heard a programme of Asian-type music and songs, the latter rendered by a young lady with a most charming voice.

Northward, across Laos, lies the great landmass of China (more fully dealt with in QSX this issue). For a very difficult DX exercise, you may care to try and log one of the Chinese regional stations such as –

●CHINA

Changchun operates on **3310** (90.63m) and is reported to have a schedule from 2000 to 1400. We logged it at 2200 when a talk in dialect by a male speaker was being radiated. Needless to say, the surrounding QRM had to be contended with, always a problem around 90 metre band frequencies. Changchun is in the Kirin province of China and is a great railway centre.

South from China, across Thailand and the Gulf of Siam, we come to –

●MALAYSIA

At Kuala Lumpur the capital city, and also that of Selangor State, a transmitter operates on **7110** (42.19m) and this can often be heard around 1415. We logged it at 1435 when a programme of Asian-type music with announcements in Chinese was being radiated. The address for reports is – Radio Malaysia, P.O. Box 1074, Kuala Lumpur.

At Johore Bahru is located the BBC Far Eastern station that relays the BBC World Service, in the appropriate languages, to this part of the world. This Service can be heard on a number of channels but you may care to try **3915** (76.62m) where it can be heard from around 2200 onwards, our last logging being at 2239. The address is – P.O. Box 416, Johore Bahru, Malaysia.

Northwest, across the Bay of Bengal and Bangladesh, lies –

●NEPAL

At Katmandu the capital, on the Vishnumati river some seventy-five miles from the Indian frontier, the transmitter of Radio Nepal operates on **5000** (60.000m) and at times, through interference from MSF or one of the other standard frequency transmitters on this frequency, signals from Nepal can be heard around 1500 or so. Our last 'sighting' of this one was at 1515.

Southwards from Nepal we have –

●INDIA

One of the more difficult Indian stations to receive here in the UK is that at Kurseong but it can be heard at times on **3355** (89.41m), during the afternoon. We logged it recently at 1525 when a programme of typical Indian music was being radiated.

Southwestwards across the Indian Ocean lies –

●SEYCHELLES

On the largest of this ninety-two island group, Mahe, the Far Eastern Broadcasting Association has a transmitter which radiates on several channels and one such is **11955** (25.09m). On this frequency we logged a programme in English at 1730 onwards. The address is F.E.B.A., Box 234, Mahe, Seychelles.

Northeast across the Arabian Sea we come to –

●PAKISTAN

Karachi may be logged on **21590** (13.89m) at 0800 when the local news in English is broadcast after station identification.

For a difficult channel – and it is really difficult – try that reported in QSX January issue, 3871.5 (77.48m) from 2015 onwards to 2130 sign-off. We wish you luck with the QRM!

Northwards from Pakistan we come to –

●AFGHANISTAN

Radio Afghanistan from Kabul the capital, just south of the Hindu Kush; 6,900 ft above sea level, has a transmitter which radiates on **4775** (62.82m). We heard it at 1534 with a programme of local music and announcements, presumably a newscast, in Pushto/Dari. The address is P.O. Box 544, Kabul.

TIME-CHECK

The stations mentioned in the foregoing paragraphs are listed on a time basis for those who prefer to plan their listening periods.

GMT	*Freq.*	*Stn.*	*Rcvd*
0800	21590	Karachi	
0850	9520	Wellington	
1430	7150	Taiwan	
1435	7110	Kuala Lumpur	
1515	5000	R. Nepal	
1517	7245	Saigon	
1525	3355	Kurseong	
1530	4840	Ambon	
1534	4775	Kabul	
1730	11955	Mahe	
1930	3400	Fukien	
2015	3871.5	Karachi	
2200	3310	Changchun	
2239	3915	Johore Bahru	
2239	3940	Wuhan	
2320	4763	Medan	
2400	6225	Peking	

CURRENT SCHEDULES

●CUBA

Radio Havana broadcasts to Europe in English on **15140** (19.81m) from 2010 to 2140; to the USA in English on **11930** (25.14m) from 0100 to 0450 and from 0100 to 0600 on **11910** (25.18m); from 0330 to 0600 on **11760** (25.51m); from 0630 to 0800 on **9525** (31.49m) and to Latin America in English from 2050 to 2150 on **15285** (19.62m) and on **17715** (16.93m).

●CHINA

Radio Peking broadcasts in English to Europe from 2030 to 2130 on **5030** (59.64m), **6270** (47.84m), **6610** (45.38m), **6825** (43.95m) and on **7590** (39.52m).

Also in English for Europe from 2130 to 2230 on the above channels.

●HUNGARY

Radio Budapest broadcasts to Europe in English from 1745 to 1800 on **6170** (48.62m), **7220** (41.55m), **9833** (30.50m), **11910** (25.18m), **15415** (19.46m), **17795** (16.85m) and on **21505** (13.95m). Also from 1945 to 2000 on all the channels listed here except **6170** which is changed to **6110** (49.09m), and again from 2130 to 2200 when the **6110** channel is changed to **5980** (50.16m).

On Tuesdays and Fridays, there is a DX programme in English for Europe from 1615 to 1630 which is repeated from 2245 to 2300.

HERE AND THERE

●POLAND

Warsaw can be heard with a newscast in English at 2030 on **6035** (49.71m).

●CANADA

Radio Canada International radiates a newscast in English at 2130 on **9610** (31.21m).

●SOUTH AFRICA

RSA Johannesburg may be logged with a programme in English, directed to New Zealand, at 0800 on **21545** (13.92m).

●PORTUGAL

Radio Portugal radiates a programme in English at 2100 on **6025** (49.79m) after station identification. Sign-off is at 2130 with the National Anthem.

●ISRAEL

Kol Yisrael, Jerusalem can be heard at 2100 on **9625** (31.16m) with station identification, a newscast and following programme in English.

●GHANA

Tema can be logged at 2115 on **9545** (31.43m) when station identification and the news in English can be heard.

AR88 MODIFICATIONS

The modifications described in this article involve quite extensive changes to the existing receiver circuitry. They should only be carried out by the more experienced constructor who fully understands the principles involved. Access to the AR88 circuit diagram and service information is necessary.

by

James Kerrick

Some notes on improving the performance of this famous communications receiver

ALTHOUGH THE AR88 IS BY MODERN STANDARDS AN old receiver it can nevertheless be used quite successfully as a general coverage set provided certain modifications are carried out. The two most pressing modifications described here are firstly a new cascode r.f. stage and secondly a product detector. A few other alterations are described and these, together with a complete re-alignment, will produce a reasonable receiver for general use. It is important, however, to bring the set into full working order before it is altered, and access to a Manual is essential.

The author is indebted to J. Hollingworth for his article in the May 1965 issue of *The Radio Constructor.*[1] Material in the 'RSGB Handbook'[2] has also been helpful in the production of ideas.

THE R.F. STAGE

The 6SG7 used in the first r.f. stage is an old noisy valve, and the noise factor of the whole receiver may be improved by the substitution of a modern all-glass type. The gain may also be increased if suitable precautions are taken to maintain stability.

The cascode is a frequently used input circuit and Fig. 1 shows the first r.f. stage modified to take this type of valve. The ECC84 is employed. The lower triode works in the grounded cathode mode and the upper triode in the grounded grid mode. A.G.C. is shunt fed to this stage and manual r.f. gain is achieved by applying a variable positive voltage to the cathode of the lower triode.

The a.g.c. to the r.f. stage is voltage delayed by the zener diode. The a.g.c. voltage is applied to the Darlington pair given by the two 2N4060's and the zener diode remains unconductive for voltage at the second emitter up to the zener value, which may conveniently be around 5 to 6 volts. Under these conditions the voltage applied to the ECC84 grid remains at zero. When the a.g.c. voltage increases further, the zener diode drops its fixed voltage and a progressively increasing negative voltage biases back the ECC84.

The author purchased his receiver without a tuning meter and the cathode of the first i.f. valve, in whose circuit the meter would otherwise connect, is returned to chassis via a 100Ω resistor. The circuit of Fig. 1 enables an S-meter to be operated direct from the a.g.c. line, and the meter is connected, as shown, with a series pre-set variable resistor which sets the meter sensitivity according to personal preference. A disadvantage here is that the meter does not register until the a.g.c. voltage is about 1.2 volts negative; however, the author did not feel that this factor warranted further circuit complexity.

The old valve and its holder are removed and a new B9A holder, with pins 1 and 9 towards the ganged tuning capacitor, is fitted on an adaptor plate. A sheet of copper foil is sweated to the inter-stage screen to extend it to the valveholder base. The old decoupling capacitors were discarded and new 0.01μF disc ceramic capacitors used exclusively throughout the r.f. and oscillator stages. If the side panel of the r.f. box is removed, wiring-up may proceed easily with Fig. 2 as a guide. All cascode earths are returned to the copper screen above the valveholder, and wiring should be short and rigid. Note that the heaters of both r.f. valves are decoupled to earth by ceramic capacitors.

The existing 'Tone Control' potentiometer, which is of little use, is removed, and the r.f. gain control of

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[1] J. Hollingworth, 'Improving the Performance of the AR88', *The Radio Constructor,* May 1965. (This issue is now out of print.)

[2] *The Radio Communication Handbook,* Fourth Edition, published by Radio Society of Great Britain, 35 Doughty Street, London W.C.1.

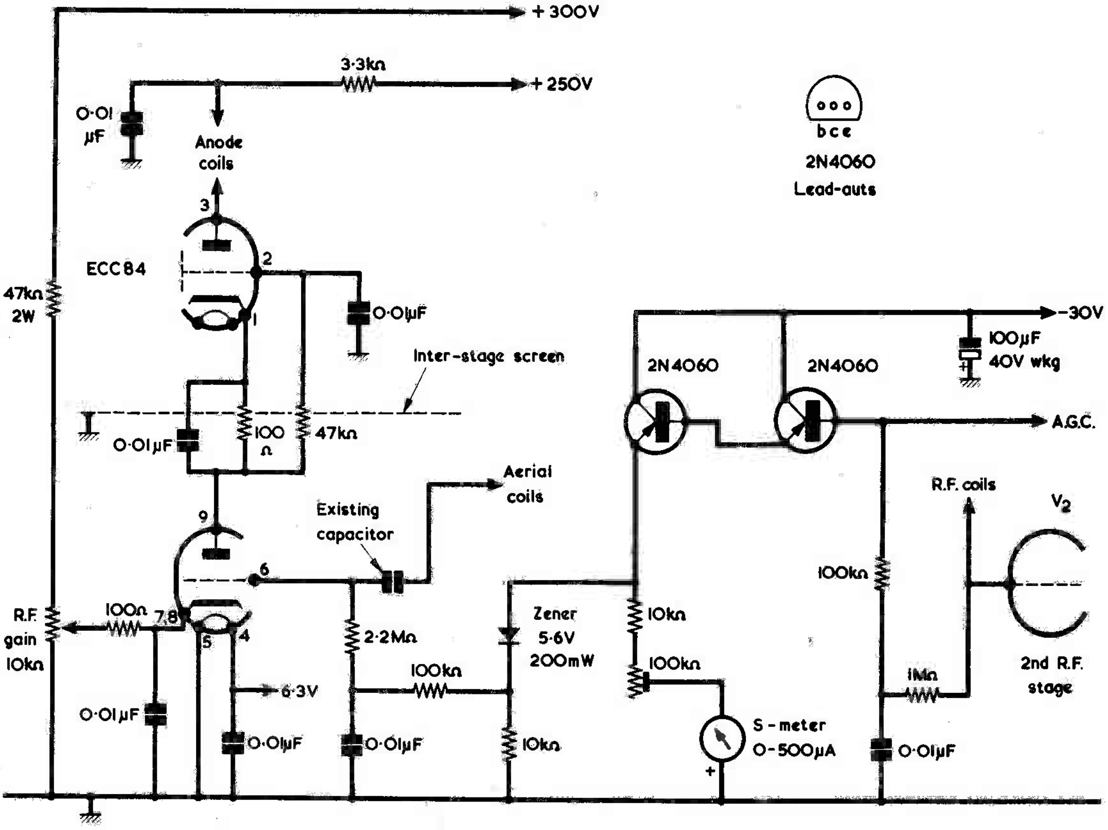

Fig. 1. The modified aerial input stage incorporating an ECC84 cascode valve. Note the use of 0.01µF decoupling capacitors

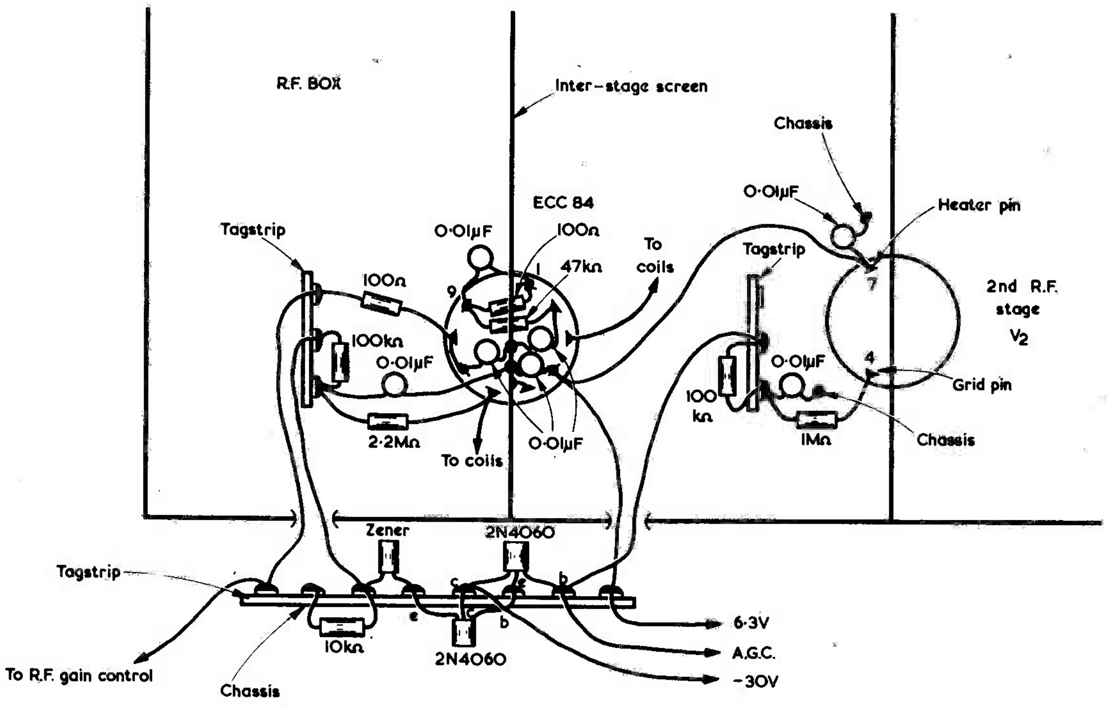

Fig. 2. Layout of the principal components in the modified r.f. stage

Fig. 1 is fitted in its place.

A rather curious fault was found on completion of this modification: on bands 5 and 6, adjustment of the aerial trimmer caused the stage to oscillate. It was eventually found that coupling was taking place via the tuning capacitor frame. The coupling was only eliminated completely by earthing the frame with copper braid soldered in strips down each side between the frame and chassis, and by removing the rubber grommet, etc., from the end nearest the bank of smoothing capacitors and replacing this with a stout $\frac{3}{16}$in. nut and bolt, thus firmly fixing the tuning capacitor to the chassis.

The negative 30 volt supply is derived from the receiver bias network, at the junction of C97 and R43.

DETECTORS

Two detectors are provided in the modified receiver for both a.m. and s.s.b./c.w., and the new circuit is illustrated in Fig. 3. The i.f. signal is switched between a voltage doubling a.m. diode detector incorporating two OA79's and a conventional double-triode product detector, the switching being carried out by a small relay. This relay is energised when the receiver function switch is set to 'Rec C.W.', the energising circuit being completed by the contacts of S23 which previously controlled the h.t. supply to the b.f.o. The h.t. wiring to these two contacts is now removed and transferred to two contacts of the relay. The modification has the effect that a.m. reception is provided on the 'Rec. Mod' setting of the function switch and s.s.b./c.w. on the 'Rec. C.W.' setting. Thus the new facilities are accomplished by the same panel control as in the unmodified receiver.

Power for the relay is drawn from the heater line, the heater voltage being rectified by the 1N4002, which charges up the 100µF capacitor to a peak value of around 8 to 9 volts. When the relay is switched on, the discharge of the capacitor helps to bring the armature over. The relay may be any small type capable of energising under these voltage conditions and having four changeover contact sets. Three of these appear in Fig. 3 and another in Fig. 4, which will be discussed later. In Fig. 3 the existing b.f.o. V12, now the c.i.o., is switched by one of the contact sets, as shown. The remaining two contact sets switch the input and output either to the a.m. detector or the product detector. The latter, employing an ECC81, operates in conventional fashion, with mixing taking place in the right-hand triode and the audio signal being filtered in the anode circuit.

Modification starts with the complete removal of the two 6H6 valves, V8 and V9, together with their holders and all associated components. The relay occupies, on a mounting plate, the hole vacated by V8, and the product detector valve occupies a mounting plate in the V9 position. All the small components are mounted on tagboards fixed to the receiver side opposite to the coil box, and the 'bathtub' capacitors there are discarded. The 100pF capacitor connected to the anode of V12 is mounted between pins 3 and 4 of V12 valve-

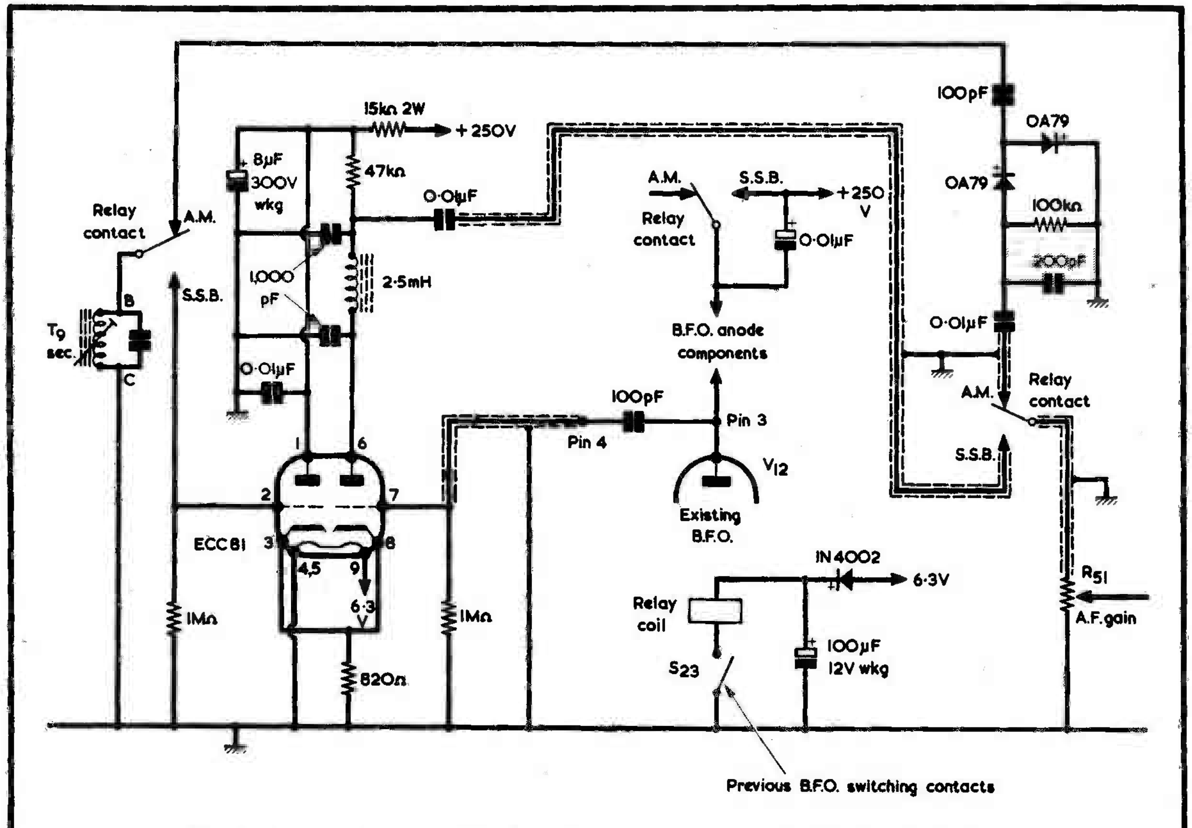

Fig. 3. The new detector circuit. This may be switched either to a.m. or to s.s.b./c.w.

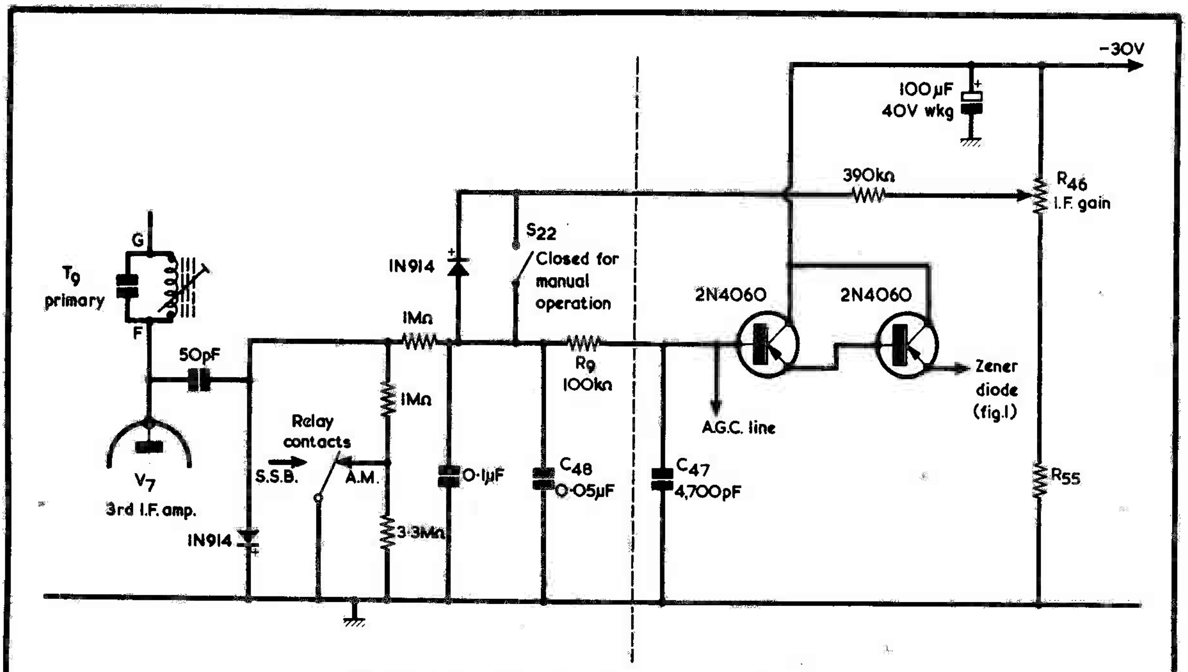

Fig. 4. The a.g.c. detector circuit after modification

holder, and the c.i.o. signal is taken via coaxial cable to the product detector. The audio signal is likewise carried by coaxial cable.

A.G.C. MODIFICATION

The modified a.g.c. stage is shown in Fig. 4. Part of the circuitry of Fig. 1 is included here.

The i.f. signals at the anode of V7, the third i.f. amplifier valve, are rectified and applied to the main a.g.c. line and the transistorised delay circuit incorporating the 2N4060's. The time constant is lengthened in the s.s.b. mode by switching in an extra resistor. This is carried out by the fourth contact set of the relay of Fig. 3.

The silicon diodes are type 1N914 or similar, and that shown across S22 contacts is wired directly to these contacts. The contacts close when manual operation is selected. C48, C47, R9, R55 and R46 are already fitted. R46 is the old 'R.F. Gain' control. Apart from components just mentioned, all the new parts to the left of the dashed line in Fig. 4 may be wired up on a tagboard near V7.

OSCILLATOR MODIFICATION

The oscillator stage was modified so that h.t. is applied to the oscillator in all modes given by the function switch. This minimises drift in frequency as the valve cools and heats when h.t. is removed and re-applied. Also, the heater of the valve is decoupled by a 0.01µF ceramic disc capacitor, and the existing decoupling capacitors are replaced by 0.01µF ceramic disc types. The modified supply circuit is shown in Fig. 5. It should be mentioned in passing that the resistor between the h.t. line and the stabilizer valve, V13, is shown as 2.7kΩ. This is the value given in the AR88 manual. The corresponding resistor in the author's receiver had a value of 3.3kΩ and it is probable that there are similar discrepancies in other receivers.

The circuit of Fig. 5 functions in the following manner. When the h.t. switch is closed power is supplied to the oscillator anode circuit via the left-hand diode, the right-hand diode being reverse biased because under these conditions, the h.t. rail before the switch drops to 250 volts. When the switch is opened the h.t. rail rises to around 500 volts and the oscillator is supplied via the right-hand diode. No h.t. current flows to the rest of the set because the left-hand diode is now reverse biased.

The new components may be easily wired up on a small tagstrip mounted on the outside of the oscillator box.

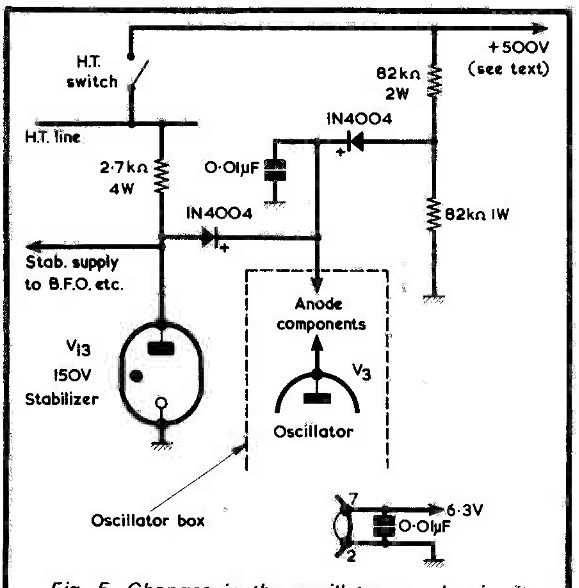

Fig. 5. Changes in the oscillator supply circuit which reduce frequency drift

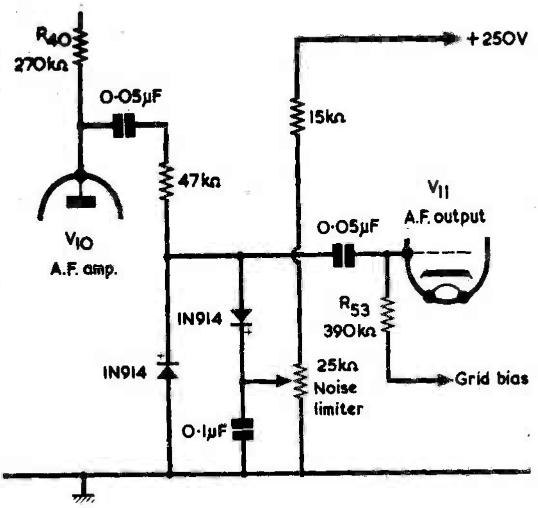

Fig. 6. The new audio noise limiter circuit

FINAL STAGES

A permanently operating audio noise limiter was fitted, this having the circuit shown in Fig. 6. The new control occupies the panel space vacated by the previous noise limiter potentiometer. The limiter uses silicon diodes and replaces that employing a 6H6 which was removed to make way for the product detector and relay.

The existing loudspeaker terminals were found to be inconvenient and a jack socket added to the rear apron was connected in parallel with them. The existing terminals are employed occasionally when it is desired to couple up auxiliary equipment, such as a tape recorder, to the receiver. Provision for headphones is always useful and a further jack socket was mounted on the front panel for low impedance phones, the socket being wired such that the loudspeaker output socket is muted when the phones are inserted.

A Bulgin miniature 3-pin mains socket was mounted on the rear apron since the author uses this type of connection on all mains equipment. On the AR88LF the mains input voltage switching is a rather rudimentary 110/230 volts arrangement, and the switch aperture was covered with a clear plastic plate to prevent operation.

Again on the AR88LF there is an input socket for a vibrator power pack. This was removed and replaced by an octal socket offering various outputs which could be used for powering ancillary equipment such as converters or crystal oscillators. The outputs provided on the author's receiver include Earth, 6.3 volts a.c., 30 volts negative, 250 volts positive, 500 volts positive (i.e. the h.t. voltage before the h.t. switch, as in Fig. 5) and a.g.c.

The final operation was a general 'tidy up' consisting of the removal of all unwanted components and wires, and the tying up of all new wiring into the cableform. Also, all switches and potentiometers were treated with Electrolube. This was followed by a complete re-alignment. ■

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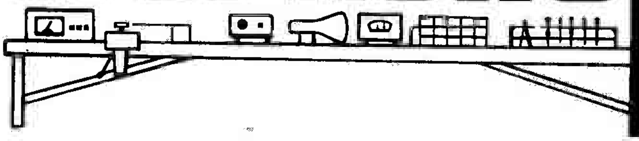


"TEN, NINE, EIGHT, SEVEN, SIX, FIVE, four, three, two, one, zero!"

There was silence for a moment.

"We have blast-off."

Again a short silence.

"All systems go!"

Dick stopped the motor of the small battery cassette tape recorder on his bench and put its microphone down. He quickly rewound the short section of tape on which he had just recorded his voice, selected playback and turned the volume control to its full setting.

"Ten, nine, eight, seven, six," brayed a distorted stentorian voice, "five, four, three, two, one, zero!"

There was a crash of metal on metal as the long-suffering Serviceman banged his soldering iron down on its rest.

"What," he snorted, "on earth . . . ."

"We have blast-off."

"For goodness' sake," spluttered Smithy, walking over to Dick's bench, "turn that . . . . . ."

"All systems go!"

TAPE RECORDER

With a preoccupied frown, Dick switched off the tape recorder. Turning slightly, he jumped as he suddenly found himself confronted with the irate visage of the Serviceman.

"Hell's teeth," he exclaimed. "I wish you wouldn't do things like that."

"Like what?"

"Like creeping up on me," said Dick indignantly. "It scares the living daylights out of me when you suddenly materialise out of nowhere."

Smithy gazed wrathfully at his assistant.

"Creeping up on you?" he repeated unbelieving. "Blimey, with all the noise you've just been making a whole regiment in hob-nailed boots could march up to you on corrugated iron without you realising it. In any case, what in blazes are you playing at with this recorder?"

"The service label on it says it's got a distorted output," explained Dick. "So I was just putting a signal on the tape to see how it sounded when I played it back."

"Do you have to record a signal that sounds like half a dozen space missions all rolled into one?"

"I've got to put *something* on the tape," retorted Dick. "Anyway, and as you could hear yourself, my voice was reproduced with quite noticeable distortion."

"Seeing that you had the recorder going full blast," remarked Smithy accusingly, "that distortion could quite simply have been the output stage overloading. Play back the bit you recorded once more, but at a lower volume level this time."

Dick carried out Smithy's bidding and the sound of his youthful voice was reproduced at a more comfortable level. The distortion was still present.

"There you are," said Dick triumphantly. "This recorder is quite definitely giving distortion. There must be something wrong in the playback amplifier stages."

"Don't jump to conclusions," grunted Smithy. "You forget that the chain of events which resulted in your voice being reproduced consisted of the initial signal from the microphone passing through the recorder amplifier and on to the tape, and then coming off the tape and passing through the recorder amplifier all over again. The distortion could have been introduced in the recording process, in the playback process or, even, in both processes."

"In both processes?" queried Dick. "How do you make that out?"

"In all domestic recorders," stated Smithy, "there are stages in the amplifier which are common to both the recording and the playback functions. It would be quite possible for a fault in these common stages to introduce distortion into the recording signal and then into the same signal when it's played back."

"Blimey," said Dick, impressed at this aspect of tape recorder operation, "that would be virtually distortion squared."

"It would, indeed," commented Smithy. "I've got a hunch, though, that there's quite a simple cause for the particular type of distortion you've got here. I've heard that rough-sounding edge on tape recorder outputs before. Rewind that bit of tape you used, set the machine to record, then run the tape back through without saying anything into the microphone."

Dick rewound the tape and the pair waited silently as the tape passed through.

"Right," said Smithy briskly. "Now, rewind that bit of tape once more, switch the recorder to playback, and run it through all over again."

Dick operated the controls and then finally set the tape running through with the recorder at playback.

There was silence for a short while then, suddenly, a click was audible from the recorder speaker.

"Ten, nine, eight, seven, six, five, four, three, two, one, zero!"

ERASE OSCILLATOR

Hastily, Smithy leaned forward and switched the machine off.

"This seems a pretty easy snag," he announced. "That signal you recorded should have been erased when you passed the tape through with the machine switched to record. It looks as though the erase oscillator has gone faulty."

"But how could that cause distortion?"

"Because," said Smith irritably, "if you haven't got an erase voltage you won't have a bias voltage either, will you?"

"Won't you?"

Smithy turned an exasperated glance at his assistant. The latter had assumed an expression of utter incomprehension.

This month Dick and Smithy embark on the repair of a faulty cassette tape recorder. Dick also takes advantage of this situation to put some questions to Smithy on the functioning of tape recorder erase oscillators.

"Look," said the Serviceman, "let's have a quick gander at the basic recording process as carried out in a small domestic machine. When we play back a recorded tape the tape passes first the erase head and then the record-playback head. This second head now functions as a playback head and the signals induced in its winding from the tape are passed to the recorder amplifier and subsequently reproduced over its speaker. Now, what happens at the erase head during playback?" (Fig. 1(a).)

"Nothing," said Dick promptly. "No erase voltage is fed to it."

"Why not?"

"Because if an erase voltage was passed to the erase head it would wipe off the recording before the tape reached the record-playback head."

"Fair enough," grunted Smithy. "At least you've got that bit right. Let's next see what happens when the recorder is set to record. Once again the tape passes the two heads, the erase head first and the record-playback head second." (Fig. 1(b).)

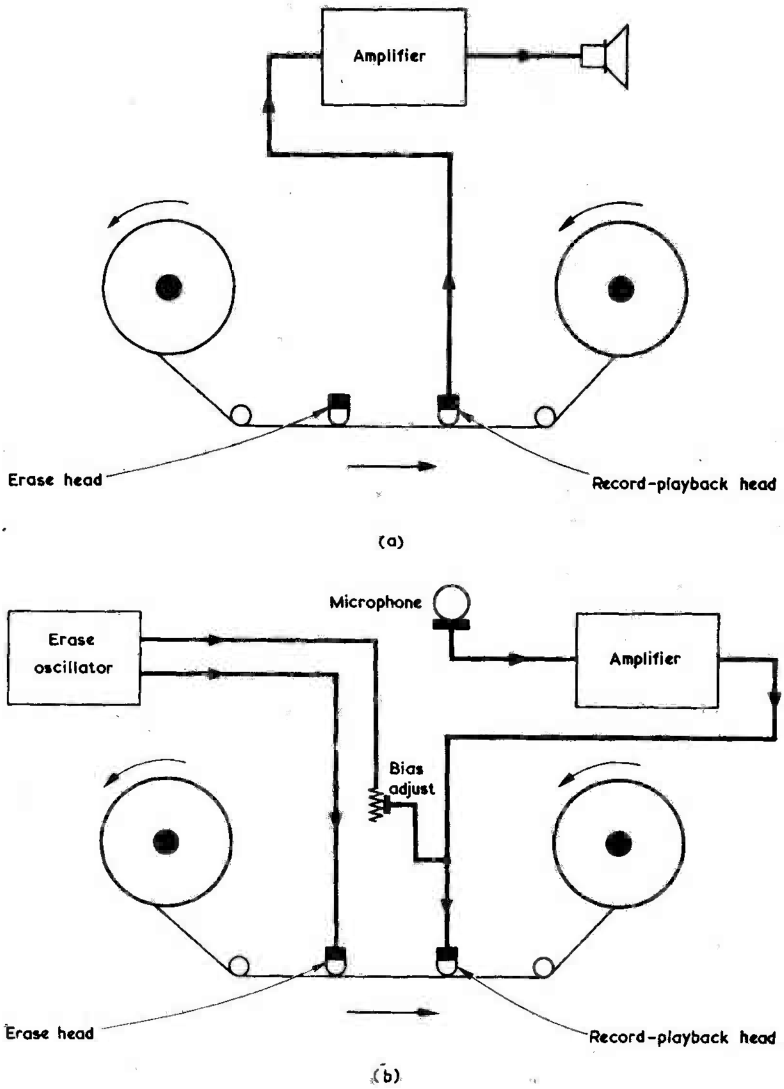


Fig. 1. (a) When a tape recorder is switched to playback, the signal from the record-playback head is fed to the amplifier for subsequent reproduction from the loudspeaker
(b) During recording the input signal (from a microphone here) is amplified and fed to the record-playback head. One output of the erase oscillator couples to the erase head, whilst a second output provides bias for the record-playback head

"Ah yes," cut in Dick. "Well, this time an input signal, which could be obtained from a microphone, is passed through the recorder amplifier and fed to the record-playback head. This head is now working as a record head, and it causes the signal to be recorded on the tape."

"Correct. And what about the erase head?"

"An alternating voltage of around 40kHz or more is taken from the erase oscillator and fed to the erase head," said Dick, "and this wipes off any signal that was previously recorded on the tape. The result is that the tape passing the record head has been wiped clean and is ready to take the signal that is now being recorded on it."

"And what about bias?"

"Bias?" I don't know anything about bias."

"Then I'll tell you about it. Whilst the recording process is being carried out a small proportion of the erase alternating voltage is also passed to the record head. This is the bias voltage, and it causes the signal to be recorded on the tape with a minimum of distortion. If no bias is passed to the record head the signal is applied to a non-linear section of the magnetic transfer characteristic of the tape and is subsequently reproduced in distorted form. As is occurring with the tape recorder on your bench."

"Blow me," said Dick excitedly. "I can see now why you carried out that erase test. You guessed that the signal on this machine had been recorded without bias and so you next checked whether the erase circuits were working properly."

"That's about it," confirmed Smithy. "I had a suspicion that no bias was getting to the record head. There could, of course, be quite a few faults which would cause this even when a correct erase voltage was being fed to the erase head. However, it's such a simple process to check whether erasure is taking place that I thought I'd do that straightaway. I was lucky too, since we can now go straight to a definite fault, which must lie somewhere in the erase oscillator circuit. It shouldn't be too hard for us to find out what's happened here."

Smithy's use of the plurals 'we' and 'us' caused Dick to brighten visibly. It was patent that the Serviceman had temporarily forgotten the work he had been carrying out on his own bench and was now completely engrossed in the cassette tape recorder. Dick liked doing jobs in company with the Serviceman.

"I'll start getting the back off," he offered.

"Yes, okay," returned Smithy. "Whilst you're doing that I'll go and get the service manual for this recorder."

The Serviceman walked over to the filing cabinet. After some moments he returned and placed the recorder

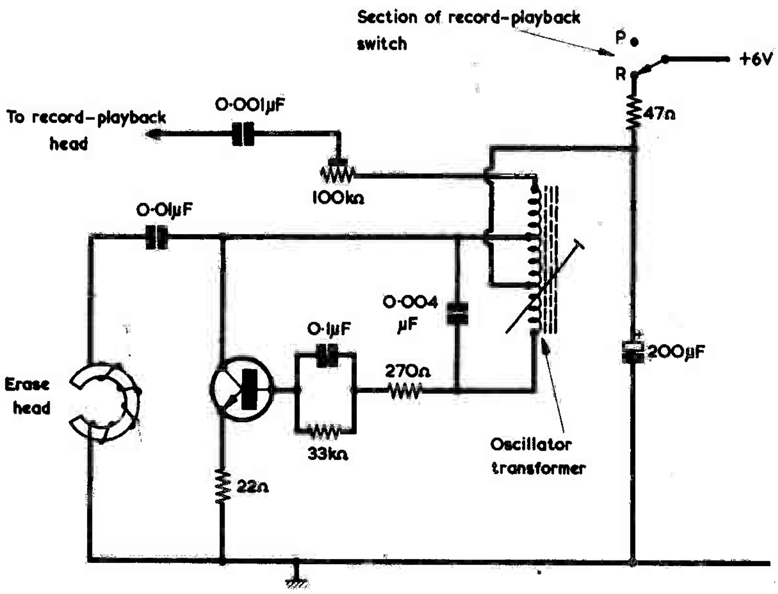


Fig. 2. A typical erase oscillator circuit, with representative component values

service manual, open at the circuit diagram, flat on Dick's bench. He proceeded to examine the circuit around the erase oscillator. (Fig. 2.) Dick had by now removed the back of the recorder, revealing the component side of its printed circuit board.

"There's nothing much to go wrong in this oscillator circuit," Smithy announced. "Provided we haven't got any faults in the oscillator transformer winding, it should be a pretty straightforward job."

HARTLEY OSCILLATOR

Dick looked over at the circuit diagram.

"That circuit seems fairly simple," he remarked cautiously. "The transistor collector goes to a tap in the transformer winding, the positive supply connects to the next tap down, and the bottom of the winding feeds the base of the transistor. I'm not too clear, though, about the section of the winding which is above the collector tap."

"It provides, due to transformer step-up action, a high voltage at erase frequency for application as bias to the record head circuit," said Smithy. "If you forget about it for a moment you'll see that the winding below the collector tap fórms the inductive section for a Hartley oscillator tuned circuit. The capacitive bit is provided by the 0.004µF capacitor connected across this inductive section. You'll remember that, in a Hartley oscillator, a central point in the tuned winding is earthy. The two outside ends of the tuned winding go to the collector and base of the oscillator transistor."

"Well, that's easy enough," remarked Dick. "I don't quite understand why there's a 270Ω resistor *and* a 33kΩ resistor in the base circuit, though. What are they for, Smithy?"

"The 33kΩ resistor," said Smithy, "is a base bias resistor. It's bypassed by a 0.1µF capacitor, which ensures that there is hardly any loss in current at the oscillator frequency which is fed to the base. The 270Ω resistor, on the other hand, is intended to definitely limit base current at the erase frequency. It is important for the erase oscillator in a tape recorder to give as true a sine wave as possible. By limiting the base current that 270Ω resistor ensures that the transistor is running just strongly enough to produce a nice clean sine wave across the tuned circuit without clipping or any other form of distortion taking place. The erase signal is fed to the erase head via the 0.01µF capacitor. In practice, the erase head inductance adds to the tuned winding inductance and modifies the frequency at which the circuit operates. Because of this, erase oscillator circuits have to be designed around a specific erase head inductance."

"I see," said Dick. "Now, what about that section of the transformer winding which is above the collector tap?"

"As I said just now," replied Smithy, "that section of the winding provides a high voltage at the erase frequency, and it is applied, as bias, to the record head. At first sight this may seem rather a peculiar way of setting about things, because the bias power level in the record head is much lower than the erase power level in the erase head. However, if the voltage available for bias appears at a high level, the small amount required by the record head can be fed to it by way of a relatively low value of capacitor. In our circuit this capacitor is the 0.001µF component in series with the 100kΩ preset pot. A low bias coupling capacitance eases frequency response problems at the record head. Another point is that the record head may have a significantly higher impedance than the erase head, whereupon it requires a high voltage source of bias. Returning to our own circuit, the function of the 100kΩ pre-set pot is to enable the bias level at the record head to be set up to an optimum level."

"Fair enough," remarked Dick. "I see that the supply to the erase oscillator is taken via a 47Ω resistor and a 200µF bypass capacitor. Is this to decouple the oscillator from the rest of the recorder circuits?"

"It will do that," confirmed Smithy, "but the main function of that 200µF electrolytic is to ensure that erase oscillations die down gradually when the oscillator supply is switched off. When the record-playback switch section is put to the playback position, the supply to the 200µF capacitor is broken. This then discharges into the erase oscillator itself, which produces an oscillation of continually decreasing amplitude as the voltage across the electrolytic falls." (Fig. 3).

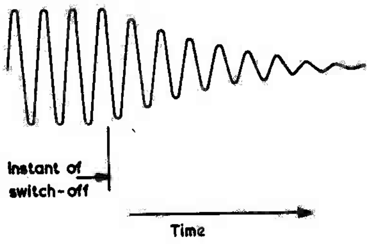


Fig. 3. The presence of the 200µF capacitor causes the output of the erase oscillator to fall gradually to zero after switch-off

"What's the point of that?"

"If the electrolytic weren't fitted," said Smithy in reply, "it would be possible for oscillation to cease abruptly on a half-cycle peak at the instant of switching off. This could cause partial magnetisation of the erase head core. With the electrolytic in circuit, though, the erase head is automatically degaussed each time the erase oscillator is switched off. Funnily enough, the idea of having an electrolytic capacitor across the supply to the erase oscillator used to be standard practice in the early tape recorders which employed valves, but it was used less frequently in the later models that appeared. It's now cropping up all over again in present-day transistor tape recorders."

"If," queried Dick, "the electrolytic capacitor is not mainly intended to provide decoupling, why bother to include the 47Ω series resistor?"

"That resistor," explained Smithy, "reduces current surges at the switch contacts whenever the erase oscillator is switched on. A discharged high value electrolytic capacitor can behave like a resistor of an ohm or so at the instant when a supply potential is connected to it. Because of this, needlessly high switch currents would flow if the 47Ω series resistor were omitted, and the switch life would be consequently shortened. Well now, that's enough nattering about the theoretical aspects of erase oscillators. Let's get down to some practical trouble-shooting on the actual oscillator we've got here!"

"Okey-doke," said Dick amicably, as he pulled his testmeter towards him. "Where do we start?"

"Voltage measurements," commented Smithy, "would seem to be the order of the day. I've got a niggling worry that there may be a fault in the oscillator transformer. If there is we'll have to order a new one, which means that this job will be hanging around until the replacement comes in."

Smithy turned to the layout diagram in the service manual, then pointed to a transistor and a skeleton pre-set potentiometer on the printed circuit board of the recorder.

"That's the oscillator transistor," he remarked, "and that's the 100kΩ potentiometer in series with the bias feed to the record-playback head. So you can take a few voltage readings at these points."

VOLTAGE MEASUREMENTS

"Righty-ho," said Dick obligingly, as he clipped the negative lead of his testmeter to the chassis of the recorder and switched the latter to the record function. "Let's have a go at the pot first. I don't know which end of its track connects to the transformer so I'll have to take pot luck here."

Dick fell silent for a moment.

"Get it?" he urged brightly. "Pot luck?"

"I heard you," sighed Smithy wearily. "Now do get on and check that voltage."

Dick applied his testmeter prod to one end of the potentiometer. (Fig. 4(a).)

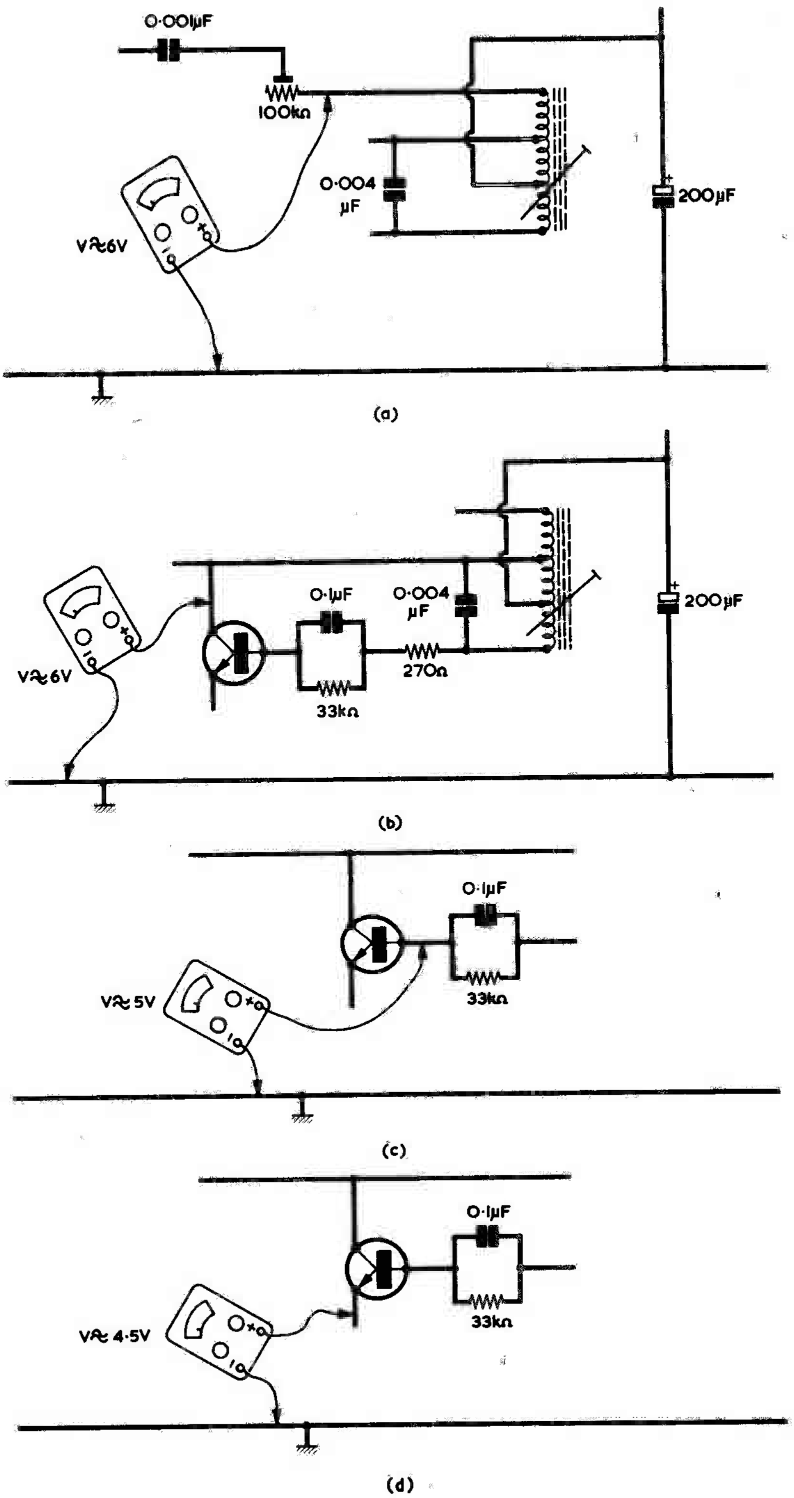
"I'm getting a reading of about 6 volts here," he announced. "It looks as though I've picked the track end which connects to the transformer first go."

"Good," said Smithy. "Now check for voltage at the transistor. The type used here is in the standard TO-18 can, with emitter, base and collector lead-outs running around in that order from the locating lug."

"Fair enough," said Dick. "Well, I'll try the collector first."

He place his positive test prod on the collector lead-out. (Fig. 4(b).)

"You've got about 6 volts there, too," remarked Smithy, who was



Figl 4. (a) When Dick checked the voltage at one end of the bias adjust potentiometer of Fig. 2, he obtained a reading of about 6 volts
(b) Measuring the voltage at the transistor collector
(c) A surprisingly high voltage was given at the base
(d) The fault was finally located when the emitter voltage was checked

watching the meter needle.

"I'll try the base next."

Dick placed the test prod on the base lead-out of the transistor. (Fig. 4(c).)

"Hallo," said Smithy. "We've found something already! There's a reading of about 5 volts on that base. Apart from the fact that I can now forget my worries about the oscillator transformer, this also means that we've bumped into something really queer in this transistor circuit. Try the emitter, Dick."

Dick put his test prod on the third lead-out of the transistor. (Fig. 4(d).)

"Ah-ha!" pronounced Smithy. "There's a reading of around 4.5 volts there. The transistor emitter circuit must be open. The reading you were getting on the base would be the 6 volts supply potential minus a volt or so dropped in the 33kΩ resistor due to the current drawn by the testmeter. And the reading on the emitter is about half a volt lower again because of the base-emitter volts drop in a silicon transistor, which this one happens to be."

Dick turned off the recorder, switched his testmeter to a low ohms range and checked the resistance between the transistor emitter and chassis.

"That 22Ω resistor in the emitter circuit is open-circuit," he called out, glancing at the meter. "There's barely any deflection in the meter at all."

"Check across the resistor itself," counselled Smithy.

Dick located the 22Ω resistor and applied his test prods across the two short lengths of its lead-outs that were visible above the board.

"Darn it," he said. "The resistor's all right."

"Is it?" remarked Smithy, in an interested tone. "I wonder if we've come across one of those hair-line fractures in the printed circuit foil which all the servicing books warn us about! Have a butcher's under the board, Dick."

Dick removed the screws holding the board in position and carefully turned it to reveal the copper foil. He then examined the copper side around the 22Ω resistor.

"I can't *see* anything," he said doubtfully. "The copper foil looks quite all right."

"Well " said Smithy, "there must be an open-circuit there somewhere. Keep your testmeter on the ohms range, put one prod on one end of each area of foil connecting to the resistor and run the other prod over the remainder of that area." (Fig. 5.)

Dick applied his testmeter prods to the copper foil as advised by Smithy.

"Well, I'm dashed," he said suddenly. "There *is* a fracture."

He peered closely at the copper print.

"I can just about see the break, too," he said. "Now that I know where to look!"

"Good," said Smithy approvingly.

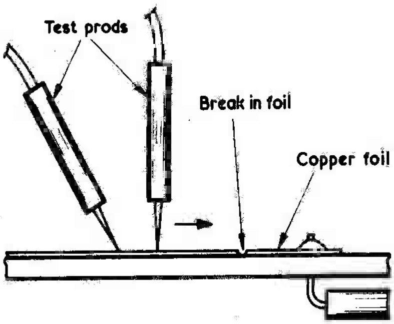


Fig. 5. In some cases, fractures in the copper foil of a printed circuit board may be located by holding two test prods against it, sliding one away from the other. The test prods connect to a testmeter switched to read resistance

"You'd better bridge it with a bit of wire. It looks as though we've got another job done."

Dick settled himself down in front of the recorder and proceeded to repair the break in the foil.

"There's one little thing that's been puzzling me," he remarked, as he worked on the printed circuit board. "Why *does* the erase oscillator have to give a pure sine wave?"

"It needs to give a pure sine wave," said Smithy, "because a waveform which isn't a sine wave can leave partial magnetisation of the tape and this would result in a noisy background on the subsequent recording. The gap in the erase head is usually much wider than that in the record-playback head and, because of this and the high amplitude of the erase signal, the erase magnetic field extends for a short distance on either side of the erase head gap. So the tape, on passing across the head, first enters a very small field which gradually increases to full strength at the gap itself and then tapers off to zero again after the tape leaves the gap. You could describe this as another form of degaussing effect."

"I can visualise that bit," said Dick. "But that still doesn't explain why the erase signal has to be a pure sine wave."

"If," said Smithy, "the erase signal waveform is not completely symmetrical about its zero line, it will give more magnetisation on the tape with one polarity than with the other. The result will be that the tape, after passing the erase head, will be magnetised in one direction instead of being completely demagnetised. This magnetisation will cause the tape to be noisy. Distortion of the sine wave will normally be caused by the presence of harmonics of the sine wave and it is the even harmonics which do the

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damage here. The odd harmonics are far less troublesome in this respect."

"Why's that?"

"You really need an oscilloscope for this point to be demonstrated," replied Smithy. "But I'll show you a few waveforms to give you an idea of what's involved."

The Serviceman took out his pen and sketched out five waveforms in the margin of the recorder service manual. (Figs. 6(a) – (e).)

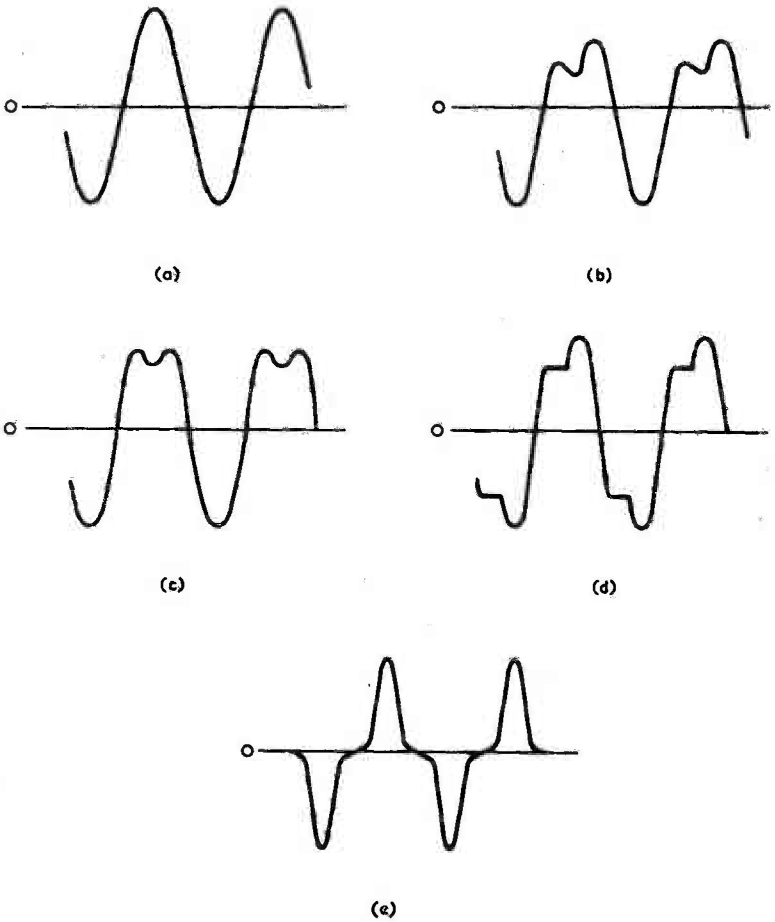
"Now," he went on, "the first of these waveforms is for a pure sine wave. As you can see, it's nice and symmetrical about the zero line. If, next, I add a bit of second harmonic you get a waveform like my second sketch. As you can see, this is definitely asymmetric. My third sketch is another example of second harmonic distortion, this time with a different phase relationship between the harmonic and the fundamental. That one's markedly asymmetric, too."

"What about the other two waveforms?"

"They're examples of the original sine wave plus added third harmonic," explained Smithy. "The phase relationship is different in the two waveforms. Neither of these two waveforms is a pure sine wave but they're still both symmetrical about the zero line. Because of this, third harmonic distortion in an erase oscillation is far less likely to result in partial magnetisation of the tape than is second harmonic distortion. You get the same effect with the higher harmonics; the even harmonics produce asymmetry and the odd harmonics do not."

There was silence for a moment as Dick absorbed these remarks.

"Blimey, Smithy," he exclaimed suddenly. "I've just thought of something! If it's the even harmonics which cause the trouble, why not use a Class A push-pull oscillator for generating the erase signal. One of the advantages



(a) (b) (c) (d) (e)

Fig. 6. (a) A pure sine wave
(b) A sine wave with second harmonic added
(c) Another example of second harmonic distortion
(d) Adding third harmonic to a sine wave
(e) Third harmonic with a different phase relationship

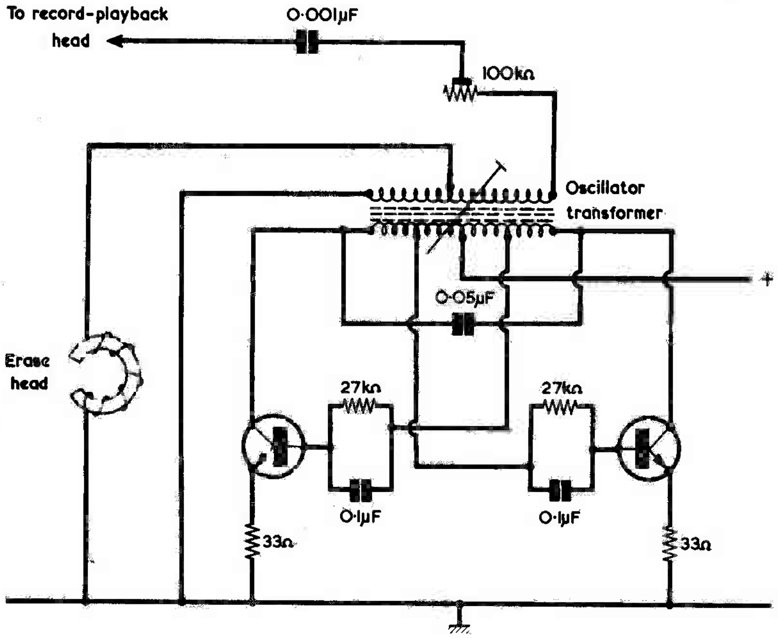


Fig. 7. A typical push-pull erase oscillator, with representative values. Note that a higher erase voltage is again provided for the bias circuit, as compared with that for the erase head

of a Class A push-pull audio output stage is that the even harmonics automatically cancel out, and the same should apply to a push-pull oscillator."

Smithy grinned, then walked over to the filing cabinet and returned with another service manual.

"That's an excellent scheme," he chuckled. "But I'm afraid you won't be able to claim it as your own original idea. Push-pull erase oscillators have been in use for ages now. There's a typical example in this second service manual, which is for a more pricey type of recorder than the one we've been fixing."

Smithy opened the second service manual and indicated the erase oscillator circuit (Fig. 7.)

FINAL CHECK

"Oh well," commented Dick philosophically, "my trouble is that I was brought into the world too late. Anyway, now that you've explained the erase oscillator action, tell me in a bit more detail why we also have to apply a bias signal to the record head."

Smithy drew breath to reply, then happened to glance at the Workshop clock.

"Ye gods," he exclaimed "is *that* the time? There's no more technical nattering for today, Dick. We must get on with some work."

"Well, will you tell me about the record bias business when we have our next gen-session?"

"Oh, all right. But you'd better next check out that recorder. And, *please,* no more space flight natter."

"As you like," said Dick cheerfully, as he switched on the recorder and picked up its microphone. "I'll start right away. Testing, testing, testing, one, two, three, four, five!"

"That," said Smithy, "is a bit more like it."

"Calling all cars, calling all cars."

"Now don't get carried away again."

"This is your captain speaking. Come in Snowey. Mayday, Mayday!"

"That's enough!"

"Reading you loud and clear. Roger, wilco and out!"

Smithy turned a helpless glance towards the ceiling, as Dick rewound the tape. However, his annoyance cleared when, as the tape was played back, his assistant's voice was now reproduced with complete clarity and lack of distortion.

As Smithy returned to his own bench he decided that there *must* be some advantages to having an assistant like Dick. He found it more profitable, though, to focus his thoughts on his work rather than attempt to actually categorise those advantages. ■

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Trade News . . .

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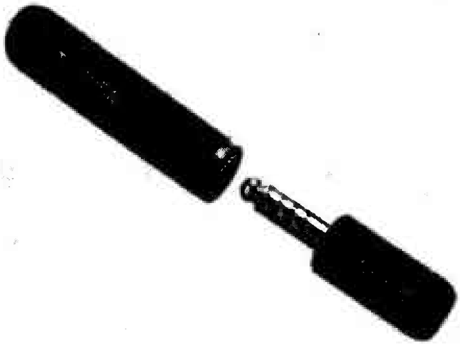

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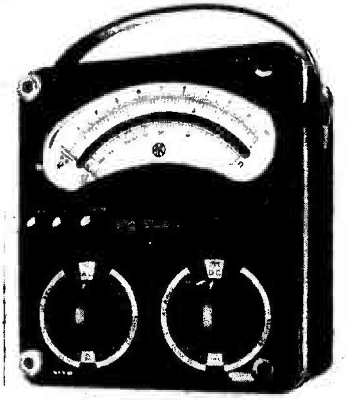

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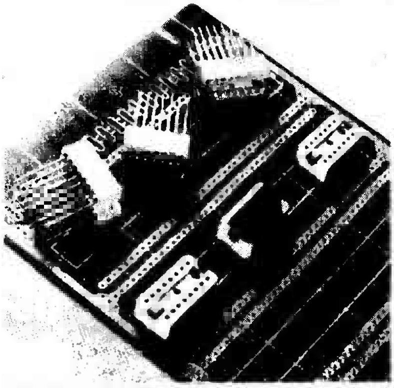
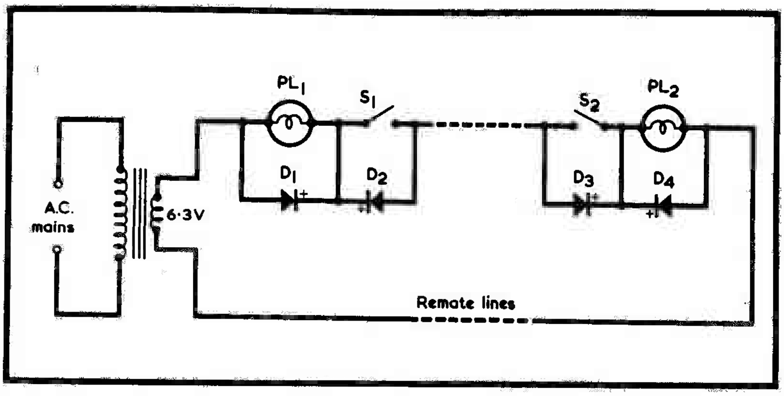


Radio Topics

By Recorder

SIGNALLING SYSTEM

The accompanying circuit shows an interesting system for two-way lamp communication via two wires, and I am indebted for it to an American reader, John T. Hunt of Pittsburg, Pa., who says he believes that the application is original and not previously published.



An interesting signalling circuit. Despite the fact that there are only two wires between the two halves of the circuit, each switch has independent control of the bulb remote from it

The two bulbs may be at separate locations, and they can be used for signalling or calling purposes. When both switches are open, neither bulb is illuminated because no current can pass through the back-to-back pairs of rectifiers. If S1 is closed current flows, on the half-cycles when the upper end of the mains transformer secondary is positive, through D1, switch S1, D3 and PL2, whereupon PL2 becomes illuminated. Pilot lamp PL1 cannot become illuminated because D1, across it, is in the conductive state.

If, on the other hand, S2 is closed, current flows during the half-cycles when the lower end of the 6.3 volt secondary is positive, the current path being via D4, S2, D2 and PL1. In consequence PL1 lights up. This current cannot cause PL2 to light up because of the conducting rectifier, D4, which appears across it.

Since one of the lighting circuits function on one set of half-cycles and the other on the alternate half-cycles, both lighting circuits are quite independent of each other. Closing S1 will cause PL2 to light up regardless of whether S2 is open or closed. Similarly, closing S2 will cause PL1 to light up irrespective of the state of S1.

I've checked out the circuit on the bench using silicon rectifiers type 1N4002 for the diodes and 3.5 volt flash lamp bulbs for PL1 and PL2, and it goes, of course, like a bomb. A minor point is that when S1 is closed, thus turning on PL2, this lamp glows slightly brighter if S2 is then closed. This is because S2 short-circuits the conducting D3, across which a forward voltage of 0.6 volt is otherwise dropped. The same effect occurs in the reverse direction, and PL1 becomes slightly brighter, with S2 closed, when S1 is subsequently closed. If this effect is considered to be of any consequence it could be obviated by using germanium rectifiers in the D2 and D3 positions.

REPAIR JOB

Using some old valves reminded me of a radio repair job that came my way a few weeks ago. When an aunt produced this radio for my attention my heart sank a little. I recognised the set because I had bought it for her way back in 1954 from one of the Nissen-hut factories which had sprouted up like mushrooms at that time. For the benefit of younger readers I should mention that there were great masses of ex-Government electronic surplus knocking around then, and that small factories, some employing fewer than 20 people and now completely extinct, had blossomed forth and were using it in simple low-cost 'no-name' superhets which they were producing like mad. This set was one of those superhets and I'd picked it up for a song from its small-time manufacturer.

At any event the set was dead, and so with difficulty I lugged out the works. I say 'with some difficulty' because the mounting bolts had rusted into the tapped holes in the chassis and needed quite a bit of brute force for their removal. Those sets were made for a quick sale and the manufacturer hadn't bothered about such niceties as plated bolts. When I did eventually get to look at the chassis I saw the usual nondescript collection of resistors and capacitors of various types and vintages which is germane to receivers of this class. Still, nothing appeared to have burned out and so I switched the chassis on and got the testmeter out.

The fault was dead simple. As soon as I put the positive testmeter prod on the triode anode of the octal-based double-diode-triode which preceded the output valve I heard a good loud crackle from the speaker. Also, the anode voltage, as indicated by the meter, was only a little lower than the voltage on the h.t. positive rail. That triode didn't seem to be passing much current, as was confirmed when I found that there was zero voltage across its cathode bias resistor.

Since the triode grid circuit was perfectly in order and the heater was burning away merrily, there was a good chance that either the cathode or anode lead-out from the glass envelope had become disconnected inside its pin. Accordingly, I applied the iron to the two valve pins in turn, running a little solder down the inside of each.

It worked. Immediately the valve had warmed up, the set went like a bomb. What surprised me was that its sensitivity and output quality were at least as good, if not significantly better, than are given by many of the quite expensive solid-state jobs we see around us today.

My 'repair' was not one which offered long-term reliability, and so I ordered a new valve from one of the postal firms which specialise in old types. As I did so I recalled that despite the fact that that old set, almost literally thrown together with any junky parts that would work, had been running daily since 1954, this was the first time it had broken down. And, even then, the fault was only a simple valve snag. There must be a moral here somewhere, but I'm dashed if I can quite find my way to it!

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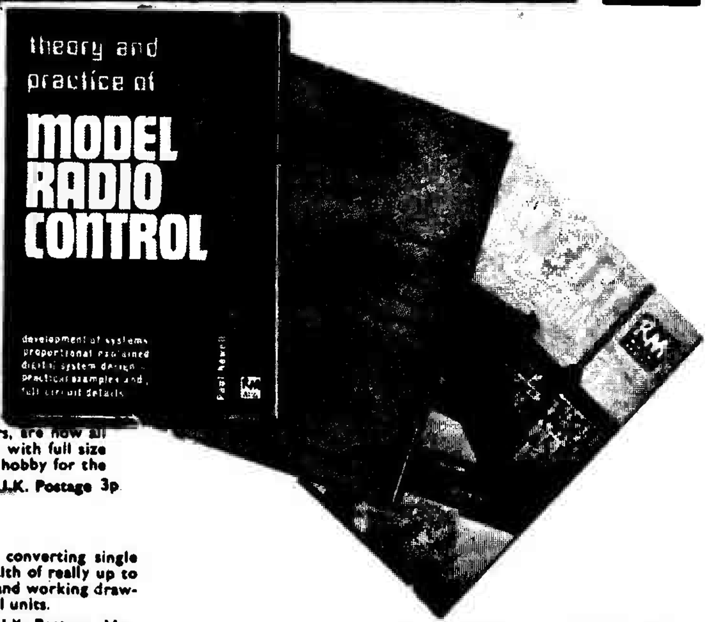

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5	0.84	0.73	0.65	0.53	1.0	0.94	0.86	0.74
10	3.4	2.9	2.6	2.1	4.2	3.8	3.4	2.9
15	7.6	6.6	5.8	4.7	9.2	8.5	7.8	6.6
20	13.0	12.0	11.0	8.4	17.0	15.0	14.0	11.0
25	21.0	18.0	16.0	13.0	26.0	24.0	22.0	18.0
30	30.0	26.0	23.0	19.0	38.0	34.0	31.0	26.0
35	41.0	36.0	32.0	26.0	51.0	46.0	42.0	36.0
40	51.0	47.0	41.0	34.0	67.0	60.0	55.0	47.0
50	84.0	73.0	65.0	53.0	100.0	94.0	86.0	74.0
60	120.0	110.0	93.0	76.0	150.0	140.0	120.0	110.0
70	160.0	140.0	130.0	100.0	210.0	180.0	170.0	140.0
80	210.0	190.0	170.0	130.0	270.0	240.0	220.0	190.0
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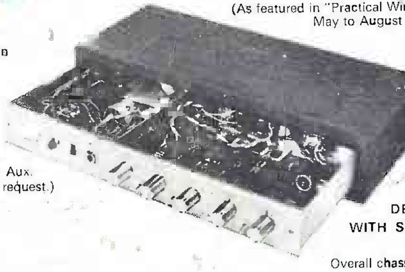

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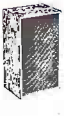

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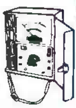

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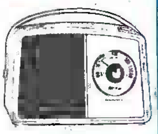

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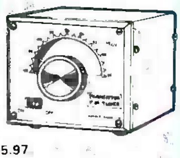

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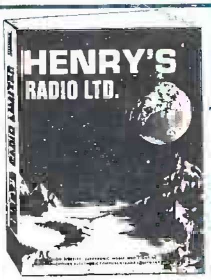

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