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The Specification sounds fine the System sounds great

Viscount 111 Audio Suite complete £49

14 + 14W per channel 40Hz to 40kHz ± 3dB Total distortion at 10 watts at 1kHz —0·1%.

This is real value for money! We have designed 3 systems and the heart of them all is the Viscount III amplifier. A unit of great eye appeal with teak finished cabinet. It is available in 2 versions—R100 for ceramic cartridges, and R101 for magnetic and ceramic. FET's (Field effect transistors) are incorporated on the input stages, just like top priced units. FET's give you more of the signal you want and almost none of the hiss you don't. Both units have output sockets for headphones and tape recorder. Filters and tone controls give a wide range of bass and treble adjustment.

For all systems we have chosen the famous Garrard SP25 Mk. III deck which comes complete with teak finished plinth and perspex cover.

The exclusive Duo loudspeaker systems are incomparable for quality within their price range. Large speakers in extremely substantial cabinets. There's a choice of the Duo II's for the smaller room or the big Duo III's for real bass response.

PRICES

SYSTEM 1

Viscount III R101 amplifier	£22·00+90p p&p
2 x Duo Type II speakers	£14·00+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
Total	£59·00

Available complete for only £52+£3·50 p&p

SYSTEM 2

Viscount R101 amplifier	£22·00+90p p&p
2 x Duo Type III speakers	£32·00+£3 p&p
Garrard SP25 Mk. III with MAG. cartridge, plinth and cover	£23·00+£1·50 p&p
Total	£77·00

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SYSTEM 3

Viscount III Amplifier R100	£17·00+90p p&p
2 x Duo Type II speakers, pair	£14·00+£2 p&p
Garrard SP25 Mk. III with CER. diamond cartridge, plinth and cover	£21·00+£1·50 p&p
Total	£52·00

Available complete for only £49+£3·50 p&p

SPEAKERS Duo Type II

Size approx. 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts, 3 ohms. Simulated Teak cabinet.
£14 pair+£2 p&p.

Duo Type III. Size approx. 23½" x 11½" x 9½". Drive unit 13½" x 8½" with H.F. speaker. Max. power 20 watts at 3 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32 pair+£3 p&p.

SPECIFICATION R101

14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2 −58dB. R100 same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx 13¾" x 9" x 3¾".

Goods not despatched outside U.K.

RTVC

Radio and TV Components (Acton) Ltd., 21c High Street, Acton, London W3 6NG, 323 Edgware Road, London, W2. Mail orders to Acton. Terms C.W.O. *All enquiries S.A.E.*

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AC188	27p	BFY51	21p
ACY19	23p	BFY52	22p
AD149	47p	MAT100	25p
AD161/162	72p	MAT101	29p
ADT140	62p	MAT120	25p
AF118	45p	MAT121	29p
AF124	22p	OC28	58p
AF125	19p	OC35	48p
AF126	20p	OC44	12p
AF127	19p	OC45	12p
AF178	67p	OC71	11p
AF179	66p	OC72	12p
AF180	45p	OC75	20p
AF239	32p	OC200	27p
BC107	11p	OC201	38p
BC108	11p	OCP71	60p
BC109	11p	ST140	15p
BC147	12p	ST141	23p
BC148	12p	UT46	35p
BC149	12p	2N696	15p
BC157	15p	2N706A	12p
BC158	14p	2N2926G	14p
BC159	14p	2N2926Y	13p
BD131	75p	2N2926O	12p
BD132	75p	2N3053	25p
BF115	25p	2N3054	60p
BF178	32p	2N3055	72p
BF179	56p	2N3702	15p
BF180	30p	2N3703	14p
BF181	32p	2N3704	15p
BF184	30p	2N3705	14p
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BF194	14p	2N3711	14p
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OA91	6p	BYZ12	22½p

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From 2 to 33 volts, 400mW, 15p; 1·5W, 22½p

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40 P.I.V., 1·5A
200 P.I.V., 2·0A

50p

FUSES AND HOLDERS

1¼in glass—2½p
60, 100, 150, 250, 500, 750mA; 1, 1·25, 1·5, 2, 2·5, 3, 5, 7·5, 10, 15 amp.
¾in glass—2½p
100, 250, 500mA; 1, 2·5 amp.
Anti-surge 1¼in—8p
250, 500, 750, 850mA; 1, 1·5, 2, 3 amp.
Anti-surge 20mm—5p
80, 125, 200, 315, 400, 500, 630, 800mA; 1, 2 amp.

PANEL FUSEHOLDERS

For 1¼in fuses	18p
For 20mm fuses	15p

CONTROLS, Log. or Lin.

Single, less switch, 15p
Single, D.P. switch, 24p
Tandem, less switch, 40p
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

RESISTORS

Carbon
All 5%, high-stability, E12 values. ½W, 1½p; 1W, 4p; 2W, 6p
Wire-wound
5W, 10p; 10W, 12p

ELECTROLYTICS

1µF	450V	19p	1,000µF	25V	27p
2µF	500V	20p	1,000µF	50V	39p
4µF	350V	14p	2,000µF	25V	36p
8µF	450V	16p	2,000µF	50V	53p
16µF	450V	17p	2,500µF	25V	45p
25µF	50V	8p	2,500µF	50V	60p
32µF	450V	24p	3,000µF	25V	48p
50µF	50V	10p	5,000µF	25V	55p
100µF	25V	10p	5,000µF	50V	98p
100µF	50V	10p	8–8µF	450V	18p
250µF	25V	12p	8–16µF	450V	20p
250µF	50V	17p	16–16µF	450V	27p
500µF	25V	18p	16–32µF	450V	63p
500µF	50V	25p	32–32µF	450V	49p
			50–50µF	350V	38p

MINIATURE ELECTROLYTICS

1µF	25V	10µF	64V
2·5µF	64V	16µF	40V
4µF	40V	25µF	25V
5µF	64V	30µF	15V
8µF	15V	50µF	15V
8µF	40V	100µF	15V
10µF	15V		

7p

ALUMINIUM BOXES with lids and screws

Type	Length	Width	Depth	Price
GB7*	2¾in	5¼in	1½in	38p
GB8*	4in	4in	1½in	38p
GB9*	4in	2¾in	1½in	38p
GB10*	4in	5¼in	1½in	44p
GB11	4in	2½in	2in	38p
GB12	3in	2in	1in	33p
GB13	6in	4in	2in	52p
GB14	7in	5in	2½in	63p
GB15	8in	6in	3in	81p
GB16	10in	7in	3in	92p

* These sizes fit standard Veroboards

VEROBOARD

Size	0·1 matrix	0·15 matrix
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3¾in × 3¾in	24p	25p
3¾in × 5in	27p	29p
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Valve and Transistor Data book, 9th edition, 75p
Transistor equivalent book, BP1, 40p

LOW-OHM RESISTORS

2½ watt wire-wound. 1Ω, 1·8Ω, 2·7Ω, 3·3Ω, 3·9Ω, 4·7Ω, 5·6Ω, 6·8Ω, 8·2Ω

11p

CAPACITORS

				0·0027µF	500V	S/M	15p
				0·003µF	500V	Cer.	5p
2·2pF	500V	S/M	7½p	0·0033µF	125V	P.S.	6p
3·3pF	500V	S/M	7½p	0·0033µF	500V	Poly.	6p
5pF	500V	S/M	7½p	0·0033µF	1,000V	MDC	6p
10pF	125V	P.S.	5p	0·0036µF	500V	S/M	15p
10pF	500V	S/M	7½p	0·0047µF	125V	P.S.	9p
15pF	125V	P.S.	5p	0·0047µF	500V	Poly.	6p
15pF	500V	Cer.	4p	0·0047µF	500V	S/M	20p
18pF	500V	S/M	7½p	0·0047µF	1,000V	MDC	6p
22pF	125V	P.S.	5p	0·005µF	100V	Mylar	3p
22pF	500V	S/M	7½p	0·005µF	500V	Cer.	5p
25pF	500V	S/M	7½p	0·0068µF	125V	P.S.	10½p
27pF	500V	Cer.	4p	0·0068µF	500V	S/M	30p
33pF	125V	P.S.	5p	0·0068µF	500V	Poly.	6p
33pF	500V	S/M	7½p	0·0082µF	125V	P.S.	10½p
39pF	500V	S/M	7½p	0·0082µF	500V	S/M	30p
47pF	125V	P.S.	5p	0·01µF	12V	Disc	4p
47pF	500V	Cer.	4p	0·01µF	125V	P.S.	10½p
50pF	500V	S/M	7½p	0·01µF	160V	Poly.	4p
56pF	500V	S/M	7½p	0·01µF	250V	M.F.	3p
68pF	125V	P.S.	5p	0·01µF	400V	Poly.	3p
68pF	500V	S/M	7½p	0·01µF	500V	Cer.	5p
75pF	500V	S/M	7½p	0·01µF	500V	S/M	30p
82pF	500V	S/M	7½p	0·01µF	600V	MDC	7p
100pF	125V	P.S.	5p	0·01µF	1,000V	MDC	9p
100pF	500V	S/M	7½p	0·015µF	160V	Poly.	3p
100pF	500V	Cer.	5p	0·015µF	400V	Poly.	3p
120pF	500V	S/M	7½p	0·02µF	100V	Mylar	3p
150pF	125V	P.S.	5p	0·022µF	18V	Disc	5p
150pF	500V	S/M	7½p	0·022µF	250V	M.F.	3p
150pF	500V	Cer.	5p	0·022µF	400V	Poly.	3p
180pF	500V	S/M	7½p	0·022µF	600V	MDC	7½p
200pF	500V	S/M	7½p	0·022µF	1,000V	MDC	9p
220pF	125V	P.S.	5p	0·033µF	250V	M.F.	4p
220pF	500V	Cer.	5p	0·033µF	400V	Poly.	4p
250pF	500V	S/M	8p	0·047µF	12V	Disc	6p
270pF	500V	Cer.	5p	0·047µF	160V	Poly.	3p
300pF	500V	S/M	8p	0·047µF	250V	M.F.	3p
330pF	125V	P.S.	5p	0·047µF	400V	Poly.	4p
330pF	500V	S/M	8p	0·047µF	600V	MDC	8p
390pF	500V	S/M	8p	0·047µF	1,000V	MDC	10p
470pF	125V	P.S.	5p	0·1µF	30V	Disc	6p
470pF	750V	Disc	5p	0·1µF	250V	M.F.	4p
500pF	500V	S/M	8p	0·1µF	400V	Poly.	5p
560pF	500V	S/M	8p	0·1µF	600V	MDC	10p
680pF	125V	P.S.	6p	0·1µF	1,000V	MDC	13p
680pF	500V	S/M	8p	0·15µF	250V	M.F.	5p
820pF	500V	S/M	8p	0·22µF	160V	Poly.	6p
0·001µF	100V	Mylar	3p	0·22µF	250V	M.F.	5p
0·001µF	125V	P.S.	6p	0·22µF	400V	Foil	10p
0·001µF	400V	Poly.	3p	0·22µF	1,000V	MDC	15p
0·001µF	500V	S/M	10p	0·33µF	250V	M.F.	8p
0·001µF	500V	Cer.	5p	0·47µF	250V	Foil	8p
0·001µF	1,000V	MDC	6p	0·47µF	400V	Foil	15p
0·0015µF	400V	Poly.	3p	0·47µF	1,000V	MDC	20p
0·0015µF	500V	S/M	10p	1·0µF	250V	M.F.	15p
0·0015µF	500V	Cer.	5p				
0·0018µF	500V	S/M	10p				
0·002µF	100V	Mylar	3p				
0·002µF	500V	Cer.	5p				
0·0022µF	125V	P.S.	6p				
0·0022µF	500V	S/M	10p				
0·0022µF	1,000V	MDC	6p				

Note:
S/M = silver mica 1% tol.
P.S. = polystyrene 2½% tol.
MDC—a.c. rating = 300V.
M.F. = Mullard min. foil.
Cer. = ceramic.

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Co-axial	8p
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D.I.N. 3 pin	13p
D.I.N. 4 pin	14p
D.I.N. 5 pin, 180	13p
D.I.N. 5 pin, 240°	15p
D.I.N. 6 pin	15p
Jack, 2½mm unscreened	9p
Jack, 2½mm screened	10p
Jack, 3½mm unscreened	8p
Jack, 3½mm screened	12p
Jack, ¼in unscreened	12p
Jack, ¼in screened	20p
Jack, stereo, unscreened	20p
Jack, stereo, screened	35p
Phono, plastic top	5p
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Phono, fitted 4 ft lead	8p
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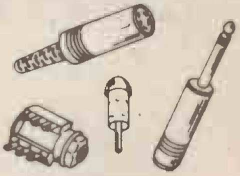

LINE SOCKETS

Car aerial	14p
Co-axial	17p
D.I.N. 2 pin (speaker)	15p
D.I.N. 3 pin	16p
D.I.N. 5 pin, 180°	16p
D.I.N. 5 pin, 240°	16p
Jack, 3½mm	15p
Jack, ¼in screened	43p
Jack, stereo, screened	30p
Phono, plated metal	14p

SOCKETS

Car aerial	8p
Co-axial, surface	8p
Co-axial, flush	8p
D.I.N. 2 pin (speaker)	10p
D.I.N. 3 pin	9p
D.I.N. 5 pin, 180°	9p
D.I.N. 5 pin, 240°	9p
Jack, 2½mm	10p
Jack, 3½mm	10p
Jack, ¼in unswitched	15p
Jack, ¼in switched	17p
Jack, stereo, switched	24p
Phono, single	5p
Phono, 2 on a strip	7p
Phono, 3 on a strip	9p
Phono, 4 on a strip	10p
Wander, single, red or black	5p
Wander, twin strip	7p
Banana 4mm red, or black	6p

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1N5399	21p	2N3325	53p	2N5459	49p	*AD161/162	60p	BC159	12p	BF195	15p	NKT271	18p
1N5402	28p	2N3405	60p	40250	71p	AF114	24p	BC167	11p	BF244	30p	NKT274	18p
1N5407	45p	2N3663	52p	40251	89p	AF115	24p	BC168	10p	BF254	14p	NKT275	23p
1S44	9p	2N3702	13p	40361	55p	AF116	22p	BC169	11p	BF255	15p	NKT403	65p
1S940	5p	2N3703	13p	40362	68p	AF117	22p	BC177	14p	BFX18	90p	NKT404	61p
2N696	17p	2N3704	13p	40406	75p	AF118	82p	BC178	13p	BFX29	31p	NKT405	79p
2N697	18p	2N3705	13p	40408	70p	AF124	24p	BC179	14p	BFX84	25p	NKT603F	30p
2N706	12p	2N3706	13p	40412	67p	AF125	24p	BC182L	11p	BFX85	32p	NKT613F	30p
2N930	21p	2N3707	13p	40430	140p	AF126	22p	BC1838	10p	BFX87	29p	NKT674F	24p
2N1131	29p	2N3708	10p	40432	185p	AF127	22p	BC184L	11p	BFX88	26p	NKT677F	22p
2N1132	29p	2N3709	11p	40512	195p	AF129	33p	BC185	42p	BFX50	23p	NKT713	30p
2N1302	19p	2N3710	13p	40602	52p	AF239	36p	BC212L	16p	BFY51	20p	NKT773	25p
2N1303	19p	2N3711	13p	40669	140p	AL102	77p	BC213L	16p	BFY52	23p	OA47	8p
2N1304	26p	2N3731	120p	AC107	46p	ASY26	27p	BC214L	16p	BFY90	104p	OA90	6p
2N1305	26p	2N3794	15p	AC126	20p	ASY27	36p	BC257	9p	BSX20	16p	OA91	5p
2N1306	33p	2N3819	23p	AC127	20p	ASY28	27p	BC258	8p	BY164	45p	OA95	6p
2N1307	33p	2N3820	53p	AC128	20p	ASY29	36p	BC259	9p	BY238	18p	OA200	9p
2N1308	36p	2N3904	35p	AC141H	34p	AU111	97p	BC267	17p	BYX38-300	38p	OA202	10p
2N1309	36p	2N3906	35p	AC141HK	37p	B30C250	24p	BC268	15p	BYX38-300R	38p	OC19	50p
2N1596	102p	2N4036	55p	AC142H	25p	B30C550/300	34p	BC269	17p	C407	17p	OC25	42p
2N1599	122p	2N4058	13p	AC142HK	29p	B1912	66p	BC300	49p	C762	19p	OC28	70p
2N1613	23p	2N4059	10p	AC153K	22p	B5041	72p	BC301	37p	C1412	102p	OC29	76p
2N1711	26p	2N4060	11p	AC176	16p	BA102	25p	BC303	60p	E2512	164p	OC35	60p
2N1893	54p	2N4061	11p	AC176K	17p	BA130	22p	BCY30	60p	EA403	10p	OC36	65p
2N2147	95p	2N4062	12p	AC187K	17p	BA145	27p	BCY31	75p	EB383	10p	OC41	42p
2N2218	34p	2N4124	18p	AC188K	23p	BA155	15p	BCY70	18p	EC401	18p	OC42	46p
2N2218A	44p	2N4126	27p	*AC187K/188K		BA156	13p	BCY71	33p	EC402	17p	OC44	42p
2N2219	38p	2N4284	24p		40p	BAX13	13p	BCY72	15p	ER900	54p	OC45	38p
2N2219A	53p	2N4286	15p	ACY17	31p	BB103/B	16p	BD121	105p	MC140	25p	OC70	21p
2N2270	62p	2N4289	15p	ACY18	19p	BB103/G	16p	BD123	105p	MJ481	120p	OC71	38p
2N2369A	19p	2N4291	15p	ACY19	23p	BC107	12p	BD124	100p	MJ491	135p	OC72	38p
2N2483	35p	2N4292	15p	ACY20	20p	BC108	11p	BD130	50p	MJ371	108p	OC75	40p
2N2484	42p	2N4410	24p	ACY21	21p	BC109	12p	BD131	79p	MJE521	92p	OC81	25p
2N2646	47p	2N4443	111p	ACY22	21p	BC122	21p	BD132	86p	MJE2955	165p	OC81D	25p
2N2904	38p	2N4906	305p	ACY39	63p	BC125	15p	BD135	38p	MJE3055	82p	OC83	25p
2N2904A	42p	2N4915	215p	ACY40	17p	BC126	22p	BD136	44p	MPF102	37p	OC84	25p
2N2905	44p	2N4991	62p	ACY41	18p	BC140	30p	BD141	227p	MPS6531	35p	P346A	26p
2N2905A	47p	2N5062	61p	ACY44	31p	BC147	10p	BDY20	92p	MPS6534	30p	82CN1	10p
2N2924	20p	2N5088	38p	AD140	63p	BC148	9p	BF115	23p	NKT211	25p	* Matched pair	

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Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
					(see note below)		
C	1/20W	5%	82 Ω–220K Ω	E12	9	8·0	7
C	1/8W	5%	4·7 Ω–470K Ω	E24	1	0·8	0·7
C	1/4W	10%	4·7 Ω–10M Ω	E12	1	0·8	0·7
C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·8
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3·5	3
WW	1W	10% ±1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	12 Ω–10K Ω	E12	7	7	6
WW	7W	5%	12 Ω–10K Ω	E12	9	9	8

Codes: C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions on total value of resistor order.)

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70 watt power amp. module kit. £12·60 nett. Power supply kit, £6·00 nett. Matching pre-amp kit, £3·30 nett. (Above prices for mono.) Stereo Kit. 2 power amps. pre-amp kit. power supply kit and matched controls for building into your own cabinet, £38·40 nett.

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A precision made pocket sized test meter, ideally suited for testing electronic circuits or electronic appliances. Supplied complete with test lead and batteries. RANGES—DC Voltages: 10, 50, 250, 1,000V (1,000 opV). AC Voltage: 10, 50, 250, 1,000V (1,000opV). DC Current: 1mA, 100mA. Resistance: 0-150K ohms. Decibel: −10 +22db (at AC 10V range) £2·47, P. & P. 25p.

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Features large easy-to-read meter, wide choice of ranges. With test leads, batteries and manual. Size 4½" × 3½" x 1". RANGES D.C. Voltages 0–5–25–50–250–500–2500v. A.C. Voltages 0–15–50–100–500–1000v. D.C. Current: 0–50μA 2·5mA–250mA. Resistance: 0–6000 ohms 0–6 megohms (300 ohms and 30 Kohms, at centre scale). Capacity: 10μμf to ·001μf, ·001μf to ·1μf. Decibels −20 to +22dB. £4·90. P. & P. 25p.

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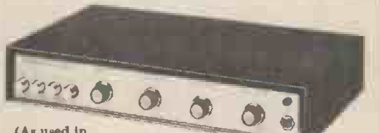
PREMIER 800 STEREO AMPLIFIER



(As used in SYSTEM 'ONE' above)

A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30-20,000 Hz = 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Controls: Bass, Treble, Volume, Balance, Selector. Mono/Stereo switch. Stereo headphone socket. Attractive slim line design black leatherette cabinet with aluminium front panel. Size 12½" x 6½" x 2⅞".

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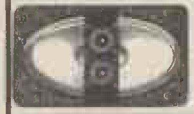
E.M.I. 13×8in. HI-FI SPEAKERS



Fitted two 2½in tweeters and crossover net work. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.
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Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone low impedance microphone, with transformer, radio, tape, etc. Max. input 1·5v. Max. output 2·5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

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SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED. TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

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TT3	3"	450'	POLYESTER	37p	DT6	5¾"	1800'	POLYESTER	£1·12
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SP5	5"	600'	P.V.C.	42p	SP7	7"	1200'	P.V.C.	62p
LP5	5"	900'	P.V.C.	50p	LP7	7"	1800'	P.V.C.	75p
DT5	5"	1200'	POLYESTER	75p	DT7	7"	2400'	POLYESTER	£1·25
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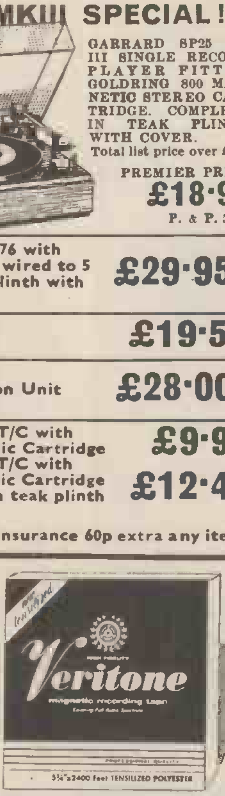
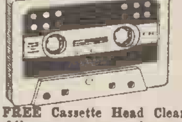


TAPE CASSETTES



C60	(60 min.)	37p	3 for £1·05
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100μA	£3·20	300V. D.C.	£3·10
100-0-100μA	£3·45	1 amp. D.C.	£3·10
500μA	£3·35	5 amp. D.C.	£3·10
1mA	£3·10	300V. A.C.	£3·10
		VU Meter	£3·75

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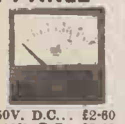
80 mm.
square fronts



50μA	£3·20	50V. D.C.	£2·60
50-0-50μA	£3·10	300V. D.C.	£2·60
100μA	£2·75	1 amp. D.C.	£2·60
100-0-100μA	£3·10	5 amp. D.C.	£2·60
500μA	£3·00	300V. A.C.	£2·60
1mA	£2·60	VU Meter	£3·37
20V. D.C.	£2·60		

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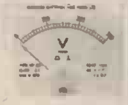
Type MR.85P. 4¼in. × 4¼in. fronts.

50μA	£3·60	50mA	£2·80
50-0-50μA	£3·10	100mA	£2·80
100μA	£3·10	500mA	£2·80
100-0-100μA	£3·00	1 amp.	£2·80
200μA	£3·00	5 amp.	£2·80
500μA	£2·90	15 amp.	£2·80
500-0-500μA	£2·80	30 amp.	£2·90
1mA	£2·80	20V. D.C.	£2·80
1-0-1mA	£2·80	50V. D.C.	£2·80
5mA	£2·80	150V. D.C.	£2·80
10mA	£2·80	300V. D.C.	£2·80
		15V. A.C.	£2·80
		300V. A.C.	£2·80
		S Meter 1mA	£2·87
		VU Meter	£3·60
		1 amp. A.C.*	£2·80
		5 amp. A.C.*	£2·80
		10 amp. A.C.*	£2·80
		20 amp. A.C.*	£2·80
		30 amp. A.C.*	£2·80

Type MR.38P. 1 21/32in. square fronts.



		200mA	£1·60
		300mA	£1·60
		500mA	£1·60
		750mA	£1·60
		1 amp.	£1·60
		2 amp.	£1·60
		5 amp.	£1·60
		10 amp.	£1·60
50μA	£2·10	3V. D.C.	£1·60
50-0-50μA	£1·90	10V. D.C.	£1·60
100μA	£1·90	15V. D.C.	£1·60
100-0-100μA	£1·75	20V. D.C.	£1·60
200μA	£1·75	100V. D.C.	£1·60
500μA	£1·65	150V. D.C.	£1·60
500-0-500μA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1-0-1mA	£1·60	750V. D.C.	£1·60
2mA	£1·60	15V. A.C.	£1·70
5mA	£1·60	50V. A.C.	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1·60	S Meter 1mA	£1·70
150mA	£1·60	VU Meter	£2.10

Type MR.52P. 2½in. square fronts.

50μA	£3·10	10V. D.C.	£2·00
50-0-50μA	£2·60	20V. D.C.	£2·00
100μA	£2·60	50V. D.C.	£2·00
100-0-100μA	£2·50	300V. D.C.	£2·00
500μA	£2·30	15V. A.C.	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.45P. 2in. square fronts.

50μA	£2·25	5 amp.	£1·70
50-0-50μA	£2·10	10V. D.C.	£1·50
100μA	£2·10	20V. D.C.	£1·50
100-0-100μA	£1·87	50V. D.C.	£1·50
200μA	£1·87	300V. D.C.	£1·50
500μA	£1·75	15V. A.C.	£1·80
500-0-500μA	£1·70	300V. A.C.	£1·80
1mA	£1·70	S Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp	£1·70	30 amp. A.C.*	£1·70

Type MR.65P. 3½in. × 3¼in. fronts.

50μA	£3·87	10V. D.C.	£2·20
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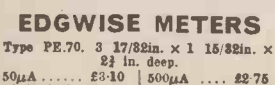

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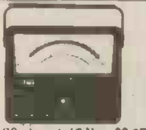

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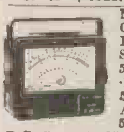

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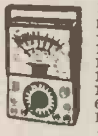

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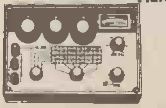

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2N1305	22p	2N3715	123p	40348	52p	BC182	10p	BSX28	32p	OC19	37p
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2N1889	32p	2N3858A	30p	40600	57p	BCY32	50p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	25p	BSY38	20p	OC46	15p
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2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	20p	OC83	25p
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2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	20p	BD112	50p	GET880	30p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	15p	BD116	112p	GET887	20p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	60p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	75p
2N2613	35p	2N4255	42p	AD149	47p	BD124	60p	GET896	22p	OC203	40p
2N2614	30p	2N4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	40p	2N4285	17p	AD161	35p	BD132	80p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	17p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	12p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
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2N2905	25p	2N4292	15p	AF118	60p	BF152	28p	MJ421	80p	P346A	22p
2N2905A	20p	2N4294	17p	AF121	30p	BF154	20p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	15p	MJ440	95p	ST141	20p
2N2906A	25p	2N4964	18p	AF125	19p	BF159	35p	MJ480	97p	TI834	62p
2N2907	23p	2N4965	18p	AF126	19p	BF163	35p	MJ481	125p	TI843	40p
2N2923	15p	2N5027	52p	AF127	16p	BF167	18p	MJ490	100p	TI844	10p
2N2924	15p	2N5028	57p	AF139	28p	BF170	33p	MJ491	137p	TI845	27p
2N2925	15p	2N5029	47p	AF178	42p	BF173	19p	MJE340	50p	TI846	11p
2N2926G	10p	2N5030	42p	AF179	45p	BF177	30p	MJE370	80p	TI847	11p
2N2926O	10p	2N5172	12p	AF180	50p	BF178	25p	MJE371	80p	TI848	12p
2N2926Y	10p	2N5174	52p	AF181	40p	BF179	30p	MJE520	60p	TI849	12p
2N3011	20p	2N5175	52p	AF186	39p	BF180	35p	MJE521	70p	TI850	12p
2N3014	32p	2N5176	45p	AF239	30p	BF181	32p	MPF102	42p	TI851	10p
2N3053	18p	2N5232A	30p	AF279	47p	BF182	30p	MPF103	35p	TI852	11p
2N3054	46p	2N5245	45p	AF280	47p	BF184	20p	MPF104	37p	TI853	22p
2N3055	60p	2N5246	42p	AFZ11	32p	BF185	20p	MPF105	37p	XB112	12p
2N3133	30p	2N5249	67p	ASY26	25p	BF194	15p	MPS3638	32p	XC141	35p
2N3134	15p	2N5265	325p	ASY27	30p	BF195	15p	NKT124	42p	ZTX107	15p
2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	12p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	15p
2N3390	25p	2N5307	37p	ASY50	25p	BF198	15p	NKT128	27p	ZTX300	12p
2N3391	20p	2N5308	37p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	15p
2N3391A	30p	2N5309	62p	ASY54	25p	BF224	14p	NKT137	32p	ZTX302	20p
2N3392	17p	2N5310	42p	ASY67	45p	BF225	19p	NKT210	30p	ZTX303	20p
2N3393	15p	2N5354	27p	ASY86	32p	BF237	22p	NKT211	30p	ZTX304	25p
2N3394	15p	2N5355	27p	ASZ21	51p	BF238	22p	NKT212	30p	ZTX500	15p
2N3402	22p	2N5356	32p	AUY10	150p	BF244	23p	NKT213	30p	ZTX501	15p
2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	20p	ZTX502	20p
2N3404	32p	2N5366	32p	BC108	10p	BFW87	25p	NKT215	22p	ZTX503	17p
2N3405	45p	2N5367	57p	BC109	10p	BFW88	23p	NKT216	35p	ZTX504	40p
2N3414	22p	2N5457	30p	BC113	10p	BFW89	20p	NKT217	40p	ZTX531	25p

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CA3000	180p	FJH141	25p		
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CA3012	88p	FJH181	25p	SN7448	125p
CA3013	105p	FJH221	25p	SN7450	20p
CA3014	124p	FJH231	25p	SN7451	20p
CA3018	84p	FJH241	25p	SN7453	20p
CA3018A	110p	FJH251	25p	SN7454	20p
		FJJ101	50p	SN7460	20p
CA3019	84p	FJJ111	50p	SN7472	30p
CA3020	126p	FJJ121	60p	SN7473	40p
CA3020A	160p	FJJ131	60p	SN7474	40p
		FJJ141	125p	SN7475	45p
CA3021	156p	FJJ181	75p	SN7476	45p
CA3022	130p	FJJ191	65p	SN7483	87p
CA3023	126p	FJJ211	125p	SN7486	33p
CA3026	100p	FJJ251	125p	SN7490	87p
CA3028A	74p	FJL101	125p	SN7492	87p
CA3028B	105p	FJY101	25p	SN7493	87p
		IC10	250p	SN7495	87p
CA3029	87p	IC12	250p	SN7496	87p
CA3029A	165p	L900	40p	SN74107	52p
		L914	40p	SN74153	135p
CA3030	137p	L923	40p		
CA3035	122p	LM380	122p	SN74154	200p
CA3036	72p	MC724P	60p		
CA3039	82p	MC780P	247p	SN74160	180p
CA3041	109p	MC788P	146p		
CA3042	109p	MC790P	124p	SN74161	260p
CA3043	137p	MC792P	66p		
CA3044	120p	MC799P	66p	SN74164	220p
CA3045	122p	MC1303L	200p		
CA3046	81p			SN74165	225p
CA3047	137p	MC1304P	225p		
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CA3055	240p	MC1552G	461p		
CA3059	165p			TAA243	150p
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FCH101	85p			TAA293	97p
FCH111	105p	MFC4000P	55p	TAA300	175p
FCH121	105p			TAA310	125p
FCH131	50p	PA222	260p	TAA320	72p
FCH141	105p	PA230	140p	TAA350	175p
FCH151	105p	PA234	92p	TAA435	147p
FCH171	105p	PA237	210p	TAA521	132p
FCH181	105p	PA246	150p	TAA522	360p
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FCH201	130p	PA264	190p	TAA811	445p
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FCJ141	525p	SN7406	80p	UA703C	137p
FCJ201	100p	SN7408	20p	UA709C	45p
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4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
4005 600PIV	10p	12p	26p
4006 800PIV	12p	15p	27p
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50 + less 15% 100 + less 20%

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200PIV	25p	50p	55p	£1·42
400PIV	30p	55p	62p	£1·77
600PIV	32p	60p	72p	£2·12
800PIV	35p	75p	87p	£2·47
1000PIV	40p	85p	£1·05	£2·77

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25 + less 15% 100 + less 20%

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6AG7	40p	35Z5	50p	PC88	60p
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6AK6	60p	50C5	50p	PC900	48p
6AL5	20p	80	55p	PCC84	40p
6AM6	30p	85A2	50p	PCC85	40p
6AQ5	38p	807	50p	PCC88	55p
6AS6	40p	1625	50p	PCC89	50p
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6AU6	25p	6146	160	PCF80	30p
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6BW7	80p	DL92	35p	PCL82	35p
6BZ6	40p	DL94	48p	PCL83	65p
6C4	33p	DL96	45p	PCL84	45p
6CD6	125p	DM70	40p	PCL85	40p
6CL6	50p	DY86	32p	PCL86	45p
6CW4	65p	DY87	33p	PFL200	65p
6F1	62p	E88CC	100p	PL36	55p
6F6G	35p	E180F	100p	PL81	50p
6F13	45p	EABC80	35p	PL82	45p
6F14	70p	EAF42	35p	PL83	45p
6F15	65p	EB91	20p	PL84	40p
6F18	50p	EBC41	55p	PL500	75p
6F23	85p	EBC81	30p	PL504	80p
6H6	17p	EBF80	40p	PY32	55p
6J4	50p	EBF83	40p	PY33	63p
6J5	25p	EBF89	32p	PY80	40p
6J5GT	30p	EBL21	60p	PY81	30p
6J6	20p	EC86	60p	PY82	35p
6J7	45p	EC88	60p	PY83	38p
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12AX7	30p	EF89	28p	UCL82	35p
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12BA6	40p	EF92	35p	UF41	60p
12BE6	40p	EF183	35p	UF80	35p
12BH7	45p	EF184	35p	UF85	40p
19AQ5	35p	EH90	40p	UF89	40p
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20F2	65p	EL33	£1·25	UL84	40p
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20P1	50p	EL42	65p	UY85	40p
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AA119	7p	BAY31	7p	OA10	22p
AA129	10p	BAY38	15p	OA9	10p
AAZ13	10p	BY100	15p	OA47	8p
AAZ15	10p	BY103	22p	OA70	7p
BA100	15p	BY122	37p	OA73	10p
BA102	30p	BY124	15p	OA79	7p
BA110	25p	BY126	12p	OA81	8p
BA111	27p	BY127	15p	OA85	7p
BA112	70p	BY164	52p	OA90	7p
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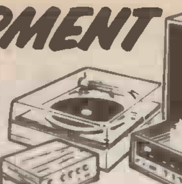

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BSR		ZERO 100A	£41·65
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SL75B	£26·00	TD150AB II	£37·80
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† Mono * Stereo Cartridge
All other models less Cartridge
Carriage 50p extra any model.

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Decks supplied with cartridge ready wired in teak veneered plinth with cover.

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Garrard SP25 III/9TAHCD	£15·95
Garrard SP25 III/G800	£18·50
Garrard SP25 III/M75-6	£19·50
Garrard SP25 III/M44-7	£20·35
Garrard SP25 III/M55-E	£22·30
Garrard SP25 III/G800 (Play on Plinth and Cover)	£19·75
Garrard AP76/G800	£29·50
Garrard AP76/M75-6	£30·25
Garrard AP76/M55E	£32·95
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Exceptional budget price amplifier. All silicon transistor. Handsome Walnut case. Switched input selector, separate balance, volume, treble, bass controls, Output 2 x 6W RMS. Inputs Mag. Tape. Xtal. Tuner, Tape Out. £14·75. Carr. 37p.

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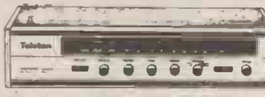

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F.2000, Garrard 2025T/C Changer fitted stereo cartridge, with plinth and cover and pair of G.W.S. Speakers. Total Rec. Price £97·73½. OUR PRICE £52·95. Carr. £1.

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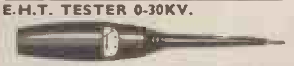

Completely self-contained with built-in voltmeter. Easy to read, very accurate, robust construction. An essential for colour television servicing, etc. Size 360mm. long. 50mm. dia. £6·95. P. & P. 25p.

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0/6/30/120/600 V. AC.
0/12/600uA/12/300MA/12 Amp. DC.
0/10K/1 MEG/100 MEG.
−20 to + 50 db. 0·01 — ·2 mfd.
Transistor tester measures Alpha, beta and Ico.
Complete with batteries, instructions and leads. £13·50. P/P 25p.

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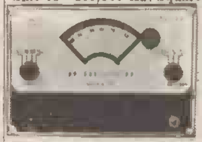
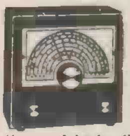
Sine 18—200,000 Hz: Square 18—50,000 Hz



Output max. + 10 dB. (10 K ohms). Operation internal batteries Attractive 2-tone case 7½" x 5" x 2". Price £17·50. Carr. 17½p.

TE-16A Transistorised Signal Generator



5 ranges 400kHz—30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5½ x 5½ x 3½in. Complete with instructions and leads. £7·97½. P. & P. 20p.

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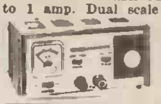
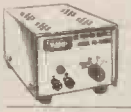
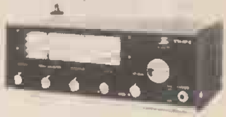


Input 220/240V AC. Size 185 x 85 x 105mm. £8·97 P. & P. 25p.

PS.1000B REGULATED POWER SUPPLY



Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240v AC. Size 4" x 3½" x 6½". £11·97. P. & P. 25p.



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everyday electronics

PROJECTS...
THEORY.....

FOR ALL SEASONS

Our cover this month has quite an outdoor touch. Of course, you don't have to be an apiarist to sense that things are beginning to buzz in the outside world. Spring is now well advanced and thoughts are likely to be turning towards all kinds of pastimes and occupations for the coming summer months.

It is an appropriate time to point out that do-it-yourself electronics has no closed season. Outdoor activities like gardening, touring, camping, sporting events, and so on, present many unique opportunities for putting electronics to effective use. So we advise, take stock *now*, anticipate your needs and start building to remedy any deficiencies in this respect.

GOOD COMPANION

The *Constructors Companion* given free with every copy of this month's EVERYDAY ELECTRONICS is small and compact. It has been designed for your pocket, so that wherever you go you can have essential facts constantly at hand. Compiled with the beginner particularly in mind, this booklet will prove a valuable *aide-memoire* for the more experienced constructor as well.

Those still feeling their feet will be glad of the technical back-up they can instantly call upon when confronted with a choice of allegedly alternative or equivalent parts when shopping personally for components.

READY ACCESS

Our regular readers will already appreciate the amount of important and useful information they are accumulating, as the months go by. True, not everyone will have an immediate need for every project described. But a word of advice: do not discard back numbers. You never know when circumstances may arise that create a definite need which some previously described project would satisfy exactly.

This leads us on to another common problem: how to store numerous copies of a magazine so that ready access may be made at any time to one particular article. The only really satisfactory solution is to keep copies of the magazine in the binder specially designed to hold 12 issues of EVERYDAY ELECTRONICS and which is now available.

Fred Bennett.

Our June issue will be published on Friday, May 19

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...EASY TO CONSTRUCT
...SIMPLY EXPLAINED

VOL. I NO. 7 MAY 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Audio Tone Generator

BY FRED JUDD

This simple tone generator covers the audio range from 50 to 2,000 Hz and has been specifically designed for use with a tape recorder to make electronic music.

THE multivibrator is one of the most commonly used electronic oscillator circuits and generates an almost square waveform. It can be made to cover a wide frequency range without the need for switching in different values of components and moreover will produce a high output signal level for a relatively small supply voltage. As a primary signal generator it has many uses as a test instrument in audio as well as electronic applications.

The generator described in this article is used as a tone source for the creation of electronic music and "science fiction" sound effects in conjunction with a tape recorder. The feature *Electronic Sounds and Music* on page 363 deals with the use of the tone generator in detail.

GENERATOR CIRCUIT

The circuit diagram is given in Fig. 1 and employs three *pnp* transistors, two of which form the multivibrator (TR1 and TR2), the remaining one, TR3, being used as a squaring amplifier.

The operating frequency and mark to space ratio (see Fig. 2) of the multivibrator are set by the time taken for C2 and C3 to charge up enough to switch transistors TR2 and TR1 respectively. This "charging time" is determined by the value of the capacitor and the value of the resistor through which it is charged.

Providing the time taken for each capacitor to charge is similar then the mark to space

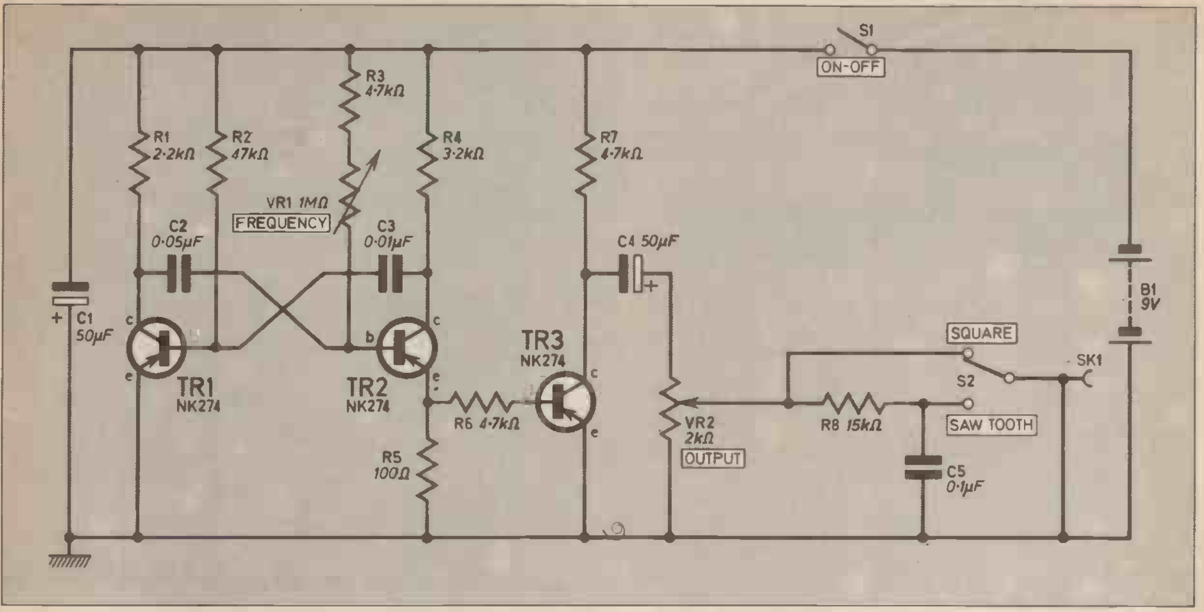


Fig. 1. Complete circuit diagram of the Audio Tone Generator.

ratio will be 1 to 1 or the mark and space will be of similar duration (Fig. 2). If we now change one of the controlling values—in this case VR1—both the frequency and mark to space ratio will be altered.

If we increase the value of VR1 the frequency will decrease as C2 will take longer to charge, and the mark to space ratio will alter for the same reason (see Fig. 3). Thus frequency control is achieved by VR2 and the total frequency range is approximately 50 to 2,000Hz.

The waveform has a mark to space ratio of 1 to 1 at approximately 1,500Hz at all lower frequencies the mark to space ratio increases becoming about 1 to 20 at the lowest frequency (Fig. 3).

The output from the multivibrator is taken from the emitter of TR2, through R6 to the base of TR3. Transistor TR3 is switched hard on and off by the output from TR2 and thus ensures a completely square output at its collector. The output level from TR3 is continuously variable from O to approximately 7 volts by VR2.

SAWTOOTH OUTPUT

The square wave output from TR3 can also be switched via S2 through an integrating network, C5 and R8, to provide an approximately sawtooth waveform (Fig. 4) of about 1 volt peak-to-peak maximum output, instead of the square-wave.

One of the major differences between a square wave and a sawtooth wave is the harmonic content and hence the tonal quality, when either are made audible via an amplifier and loudspeaker. The square wave contains only odd harmonics, in addition to its fundamental, whereas a sawtooth wave consists of both odd and even harmonics plus the fundamental.

Audibly the square wave has a sound rather like that produced by a clarinet particularly in the region of middle C (261Hz approx.). The sawtooth wave has a sound rather more like a

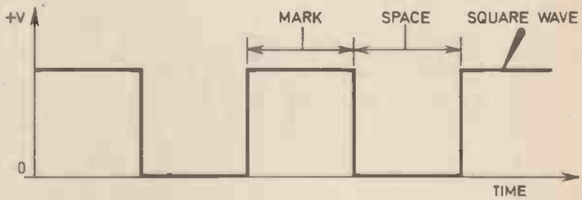


Fig. 2. A square wave with a 1 to 1 mark to space ratio.

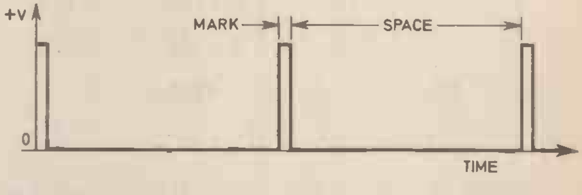


Fig. 3. A square wave with a 1 to 20 mark to space ratio.

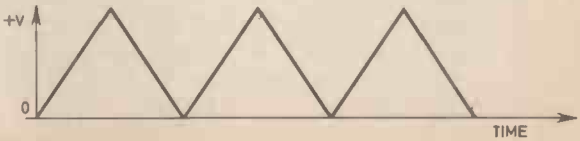
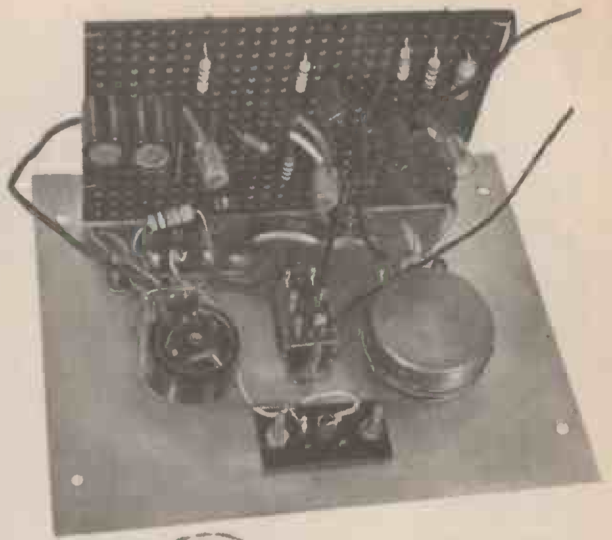


Fig. 4. A sawtooth waveform.

Audio Tone Generator



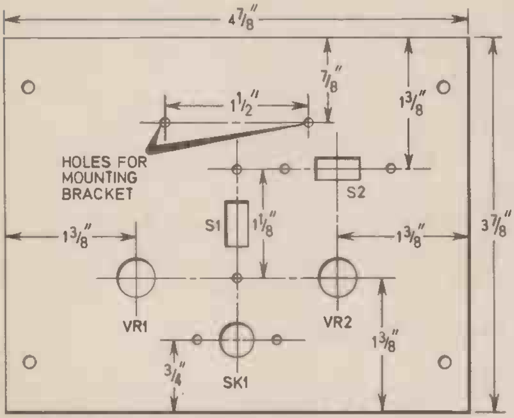
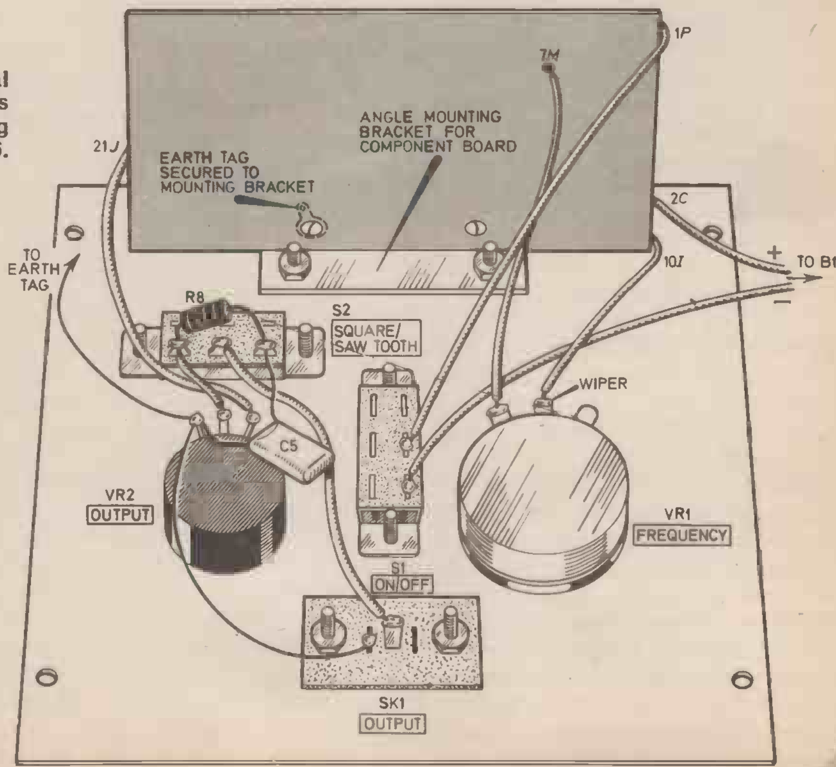


Fig. 5. Front panel drilling details.

Approximate cost of components...
£ 2·60 plus case

Fig. 7. Wiring of the final unit. The tinted area is the component mounting board as shown in Fig. 6.



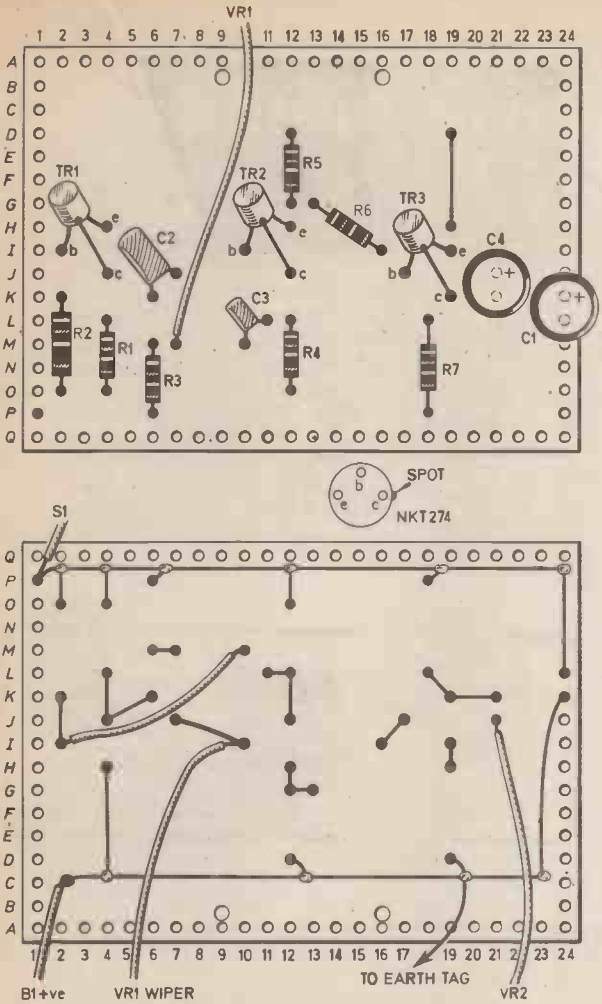


Fig. 6. Top and underside views of the component board. The transistor connections between the two diagrams are viewed from the underside.

Components....

Resistors

R1 2·2kΩ
R2 47kΩ
R3 4·7kΩ
R4 3·2kΩ
R5 100Ω
R6 4·7kΩ
R7 4·7kΩ
R8 15kΩ
All $\frac{1}{4}$W ±10% carbon

SEE SHOP TALK

Capacitors

C1 50μF elect. 12V
C2 0·05μF
C3 0·01μF
C4 50μF elect. 12V
C5 0·1μF

Transistors

TR1 NKT 274 germanium *pnp*
TR2 NKT 274 germanium *pnp*
TR3 NKT 274 germanium *pnp*

Potentiometers

VR1 1MΩ log carbon
VR2 2kΩ lin carbon

Switches

S1 S.P.S.T. slide
S2 S.P.D.T. slide

Miscellaneous

SK1 Phono socket
B1 PP9 9V battery
Control knobs (2 off) Eagle type F10, case 5 x 4 x 3in made from universal chassis panels or a similar size case, battery connector, aluminium angle 2 x $\frac{3}{8}$ x $\frac{3}{8}$in. Veroboard 5 x 4 x 0·15in matrix plain perforated, earth tag, connecting wire, 4BA fixings.

flute. Both waveforms are used extensively in electronic organ voicing and for electronic music.

CONSTRUCTION

The prototype unit was housed in a box made from universal chassis parts. The pieces used assemble into a box measuring 5 by 4 by 3 inches. The sides and top and bottom can be assembled leaving one plate for the front panel and one for the rear. The plate used for the front panel is drilled as shown in Fig. 5 and is used to mount all the components.

If the layout and assembly of the generator is as shown there is just room in the case for a PP9 9 volt battery. Even if you spread the layout a little there should still be room for a slightly smaller 9 volt battery. The circuit board is 0·15 inch matrix plain perforated veroboard and is mounted on a 2 inch length of $\frac{3}{8}$ by $\frac{3}{8}$ inch aluminium angle.

Commence wiring of the component board by inserting all components except the transistors, and the wire link on the top of the board as shown in Fig. 6. Turn the board over and connect up the two supply lines along the two sides of the board using 18 or 22 s.w.g. tinned copper wire. Next connect up the remaining components using the component leads where possible and connect the flying leads.

Finally insert the transistors checking carefully the lead connections with the underside view shown in Fig. 6, and solder them to the other components using a heat shunt on each lead as it is soldered. After checking the circuit board mount the board on the aluminium angle bracket and mount this on the front panel together with the remaining components.

Wire up all the components to the circuit board as shown in Fig. 7 and check the completed unit carefully before connecting the battery and switching on.

Continued on page 386

SHOP TALK

By Mike Kenward

THIS month we have one item which many readers will probably wish to construct but which is not given in the form of a constructional project. It is the simple passive mixer that is described and drawn up in the *Making Electronic Sounds and Music* feature.

Since this is really a bonus that will be useful to those following the article we have not given full constructional details or a components list. All the component values are given on the circuit diagram and the wiring diagram shows how they are put together. The three sockets can be any type suitable for use with your particular tape recorder—the types we have shown are phono sockets.

The complete unit can be mounted in any small case. No battery or power supply is necessary. We would like to emphasise that this is a simple passive mixer and will not be able to cope with all inputs.

A more advanced type of mixer may form the subject of a future article. However this simple mixer should be suitable for use with the *Audio Tone Generator* that is also described in this issue.

Audio Tone Generator

There should be very few buying problems for the *Audio Tone Generator*. As described above the sockets could be changed to any suitable type if your equipment does not use phono sockets or if you already have other types. Once again the case for this project can be any type that is available in a suitable size.

Bee Counter

We find it difficult to comment on the availability of cedar wood —not after-shave—but apparently this wood must be used or the bees will not accept it!

As far as the remaining components for the *Bee Counter* go make sure that the resistors you buy are of adequate wattage. The lamp and holder should be of the miniature type so that they can be accommodated in the wooden base panel. Since the current drawn by this circuit is fairly large the section in the article concerning the battery should be noted.

There are a number of Post Office type counters available so make sure you get the right one —4·2 ohms coil resistance is the important thing.

Metal Locator

The *Metal Locator* is a project which we are sure will create great interest but please remember that this is a simple one-transistor design and cannot be expected to out-perform a £30 unit. The use of Perspex or Paxolin is recommended for the locator head as these materials are not affected by damp or water.

All remaining components for the locator should be readily available. The use of a subminiature switch is recommended since only a small hole then needs to be cut in the plastic beaker. Any 50μA moving coil meter could be used in the locator provided it will fit the beaker lid. The one specified is probably the cheapest.

Finally do not forget the operating licence and don't say we did not tell you!

New Products

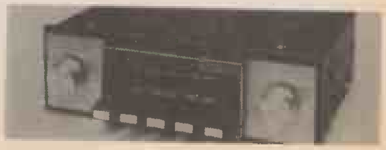
Two products from one go-ahead firm have been introduced this month. Both in the audio field, possibly the most outstanding is the Unisound 505 as Radio and T.V. Components call their do-it-yourself £25 stereo system. This competitively priced unit comes as a complete kit and only needs two screwdrivers to put together. All the electronics are in module form and are supplied with wiring looms that only need connecting up using a screwdriver supplied with the kit.

The large EMI speakers are housed in attractive cabinets again put together with only a screwdriver. It is said that anyone who can wire up a mains plug can put the system together in one evening. The system utilises modified Mullard Unilex modules, has an output of 3·7 watts continuous sine wave r.m.s. per channel; and frequency response of 40Hz to 20kHz at the 3dB down points. It would be very difficult to buy the individual components —including Garrard 2025TC deck, cartridge, plinth and cover and build a unit to match this one for £25, excluding the two speakers and cabinets.

The second unit from RT-VC is a £7 push button car radio kit, slightly more difficult to construct but any reader who has some experience of soldering should be able to build a working unit.

The kit is of good quality and uses the same push button tuning unit as radios costing three or four times the price. These features ensures good sensitivity and the pre-aligned i.f. (intermediate frequency) module and tuner avoid complicated alignment.

The kit is suitable for 12V positive or negative earth operation and readers may like to note that an after sales service—to repair any item not functioning correctly—is operated by RT-VC for all their kits; cost about £2 depending on the fault.



Making Electronic Sounds and Music

BY FRED JUDD

Simple experiments with a tape recorder

THE term "electronic music" almost defies explanation because it is not the music that is electronic but the equipment and methods of creating it.

Its origin goes back many years, in fact to the invention of the thermionic valve and even as early as 1921 a "concert" of electronic music was performed in Paris by an Italian, Luigi Russolo, who used what was then called electrical sound generating and reproducing equipment.

Electronic music was difficult to perform directly from sound generators, etc., because composition required arranging the sounds in a given order and even changing the order, and sometimes the sounds, at a later time.

MODERN METHODS

Magnetic tape recording finally provided the ideal medium for composition. The sounds required could be recorded and rearranged afterwards by simply cutting out the pieces of tape containing them and splicing these together again in the order required. This technique paved the way for composers who, with both electronics and magnetic tape at their disposal, could produce new kinds of music with tonal qualities never before possible.

More recently of course the music synthesizer has taken over the task of tone generation, etc., and electronic music composers can now programme a synthesizer, couple it to a tape recorder and produce "instant" electronic music.

Nevertheless there is much that can be accomplished by the amateur with an ordinary domestic tape recorder, an audio tone generator (like the one described on page 358) and some splicing tape. The techniques are simple and you can get a good deal of fun out of experimental electronic music and "science fiction" sounds.

Your efforts need not be wasted either because you can enter them for the experimental music and sounds section of the annual British Tape Recording Contest (details later).

EQUIPMENT

An ordinary spool to spool tape recorder is the main requirement and if you have a stereo recorder with provision for recording independently on either track or you can get together with a friend and use two tape recorders, so much the better. A tape recorder with track-to-track or duoplay facility is also advantageous especially if it permits echo effects.

It is not possible to lay down procedures for specific makes and types of tape recorder but you will find that most of the techniques described can be applied.

Note that cassette or cartridge tape recorders are of limited use for creative recording of this nature which requires fairly extensive tape cutting and splicing.

Most modern spool to spool tape recorders are designed for stereo operation employing half or quarter track on standard quarter inch wide tape. If the tape recorder has a track-to-track recording facility it will have separate recording and replay heads, thus allowing a recording on one track to be copied on to another together with other signals.

Some stereo recorders may only have a common record/replay head which will not normally allow track-to-track copying but may have a facility for making separate recordings on each of two tracks. Information concerning such facilities should be given in the tape recorder instruction book. If in doubt, you should contact your dealer or the manufacturer for such information.

AUDIO TONE GENERATOR

An audio tone generator is not absolutely essential but is most advantageous. The simple *Audio Tone Generator* described on page 358 is quite suitable as it covers a wide enough frequency range and will deliver a square-wave or a nearly sawtooth-wave output signal, thus providing two basic sounds.

Sounds picked up by a microphone can also be used because these can be reshaped by tape cutting and splicing and by certain recording techniques. Magnetic tape will be required of course and for initial experimental work low priced brands will suffice.

Some splicing tape and blank leader tape will also be required. Do not use ordinary plastic sticky tape, such as Sellotape, for splicing as this may damage the tape and will not give a long lasting joint. Small kits of coloured leader and proper splicing tape are readily available. A small tape splicer is also a very useful, though not essential, tool.

FIRST EXERCISES

It is important to know the extent to which your tape recorder can be used. If it has two or three speeds, as most of them do, record some musical sounds, whistling will do, at all three speeds and then play them back at one speed only, say the highest.

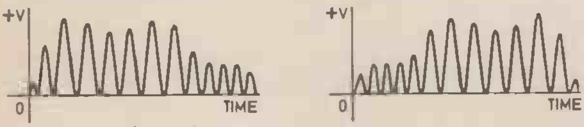
The sounds recorded at the lower speed(s) will be raised in pitch, by one or two octaves, depending on the speed. If the replay speed is double that of the recording speed the pitch is raised one octave and the sounds will occur faster but if the replay speed is half the recording speed, the pitch will be reduced by one octave and the sounds will occur slower. This is one of the most simple but most used techniques.

REVERSE REPLAY

Now, if your recorder is a stereo machine try turning the tape over (reverse the spools) and see if you can obtain replay on another track in reverse, i.e., the sounds will be going backwards. This technique is also commonly used for electronic music because it alters the nature of the sound completely by placing what was the beginning of the sound, i.e., its attack, at the end as illustrated in Fig. 1 in which (a) is the sound as recorded and (b) as played in reverse.

If you cannot play sounds in reverse try this exercise; connect a tone generator, or if this is not available record whistles through a micro-

Fig. 1. (a) Original waveform of the recorded sound (b) The sound recorded and shown in (a) played in reverse.



(a) (b)

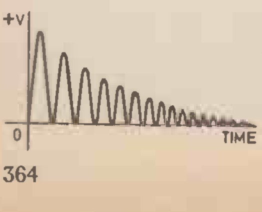
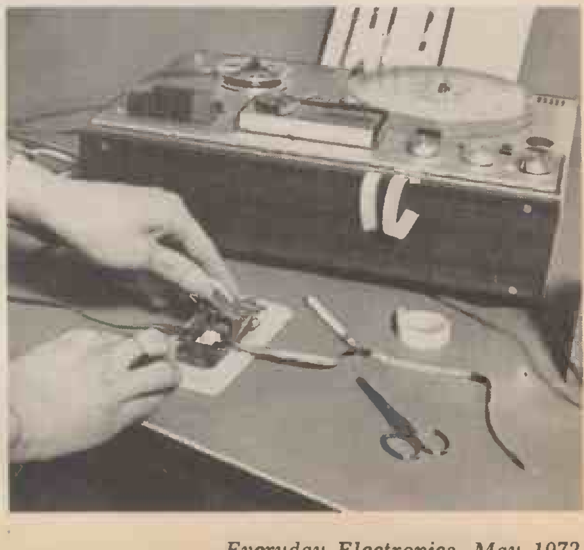


Fig. 2. Waveform of a sound which starts instantly and slowly dies away.

Photograph showing the use of a tape splicer to join up a number of sounds.



Recording various sounds, using the microphone, to form a composition.

phone. Start with the recording level control at the maximum, set the tape running to record the sound but then almost simultaneously slowly turn the record level control to zero.

On replay you will have a sound that starts instantly and then slowly dies away as in Fig. 2. With a little practice you will be able to get various dying away or decay times depending on the speed at which the recording level control is turned off. Now try the reverse procedure; gradually increase the sound whilst recording and then quickly stop it.

TAPE CUTTING EXERCISES

Now try some tape cutting; first use the highest tape speed and record a few sounds of different pitch, i.e., from a tone generator, or whistles via the microphone, each one lasting two or three seconds.

Locate the beginning of each sound on the tape by carefully feeding the tape across the head and then cut the tape about two inches in front of the sound. Run off the remainder until you reach the beginning of the next sound; cut the tape here and splice to the end of the piece containing the first sound. Cut and join pieces of the remainder of the sounds.

On replay you will have a series of short sounds each rapidly following the other. Now try a similar exercise but this time insert pieces of blank leader tape between each sound.

MUSIQUE CONCRÊTE

Finally a variation of the two previous exercises. Record a few sounds each at a different tape speed. These should preferably be musical sounds, such as whistles or tones, or sounds produced by tapping a wine glass for example. Cut one or two pieces of each from the tape and assemble them at random with pieces of blank leader between groups. The pieces may be long or short.

Try replaying the assembled tape at different speeds and note the effect. You are well on the way to a form of composition known as "musique concrête" which is the creation of abstract forms of music out of real sounds. The same technique can, however, be used for abstract forms of electronic music in which the main sound source is an audio tone generator.

USING A TONE GENERATOR

The exercises outlined above demonstrate how almost any recorded sound can be altered by tape cutting and by recording and replay at different tape speeds. Electronic music does not normally include natural sounds recorded via a microphone and therefore the sound sources are electronic, i.e., from tone generators of one kind or another. The recording and tape cutting techniques, however, remain the same.

If you have a full range audio signal generator then tones can be recorded at the pitch required. The simple generator described on page 358 has a frequency range of approximately 50 to 2000Hz.

If frequencies outside the range of the generator are required it is simply a case of recording and replaying at different tape speeds for example; if a frequency of around 4000Hz is required, record the highest pitch of the generator (approximately 2000Hz) at a tape speed of $3\frac{3}{4}$in/sec (inches per second) and replay at $7\frac{1}{2}$in/sec.

If a very low pulsing sound is required at say 20 to 25Hz record a square-wave signal from the generator at its lowest pitch and then replay the recording at half the speed. Some experiment in this direction will soon reveal the tonal and pitch ranges that can be obtained simply by recording and replaying at various tape speeds.

Once this has been done, further experiment with the audio tone generator can be carried out in order to discover the type of sounds that can be produced. Start by recording a continuous note and while recording this vary the frequency and output controls on the generator, try this for both the square and sawtooth outputs (note that the output in the sawtooth position is much lower than in the square wave position).

Try cutting and reversing the sounds recorded to obtain various effects. You can also try making recordings at a distorted level by turning up the record level control, this will distort the original sound and produce yet another effect. Try switching from one output waveform to the other whilst recording—you can vary frequency and output at the same time—and also try switching the generator on and off while recording, again you can vary the output and frequency whilst turning on and off.

Edit the sounds produced by cutting and splicing and experiment fully with all possible

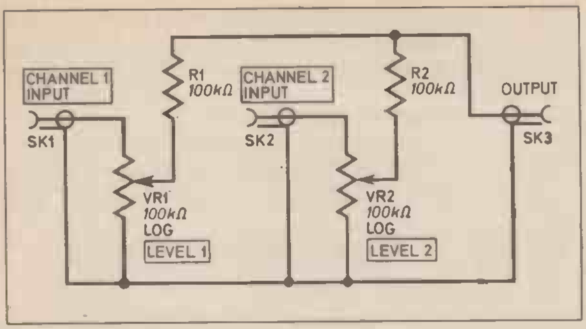


Fig. 3. Circuit diagram of a passive mixer that can be used for making electronic music.

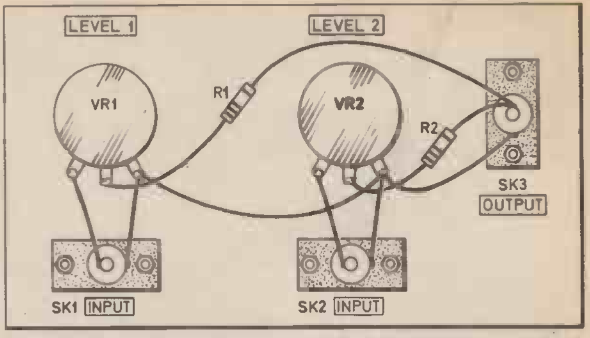


Fig. 4. Constructional details of the circuit shown in Fig. 3. Shop Talk refers to this figure.

effects. Once you have done this and feel fully conversant with the various effects that the generator is able to produce you can start to add one effect to another.

SIGNAL MIXING

Recording from track-to-track or using two separate tape recorders may necessitate mixing signals that are to be recorded and re-recorded i.e., signals from a recording already made to be mixed with signals from another source such as the tone generator.

Some recorders have built-in mixing facilities whilst others may permit a form of mixing by using the track-to-track recording facility or by superimposing one sound on another previously recorded. Again the tape recorder instruction book will provide information of this nature.

However, it is possible to build a very simple mixing circuit as shown in Fig. 3; Fig. 4 shows the construction. This is known as a passive mixing network, but will alow two signal sources to be mixed at different levels and coupled to a common input on a tape recorder (Fig. 5).

TAPE LOOPS

Another interesting technique widely used for electronic music is the tape loop. This is the use of a small endless loop of tape containing recordings which are played continuously to produce repeating rhythm patterns.

Record a few natural sounds, or low pitched tones from an audio generator, of quite short duration, one immediately after the other. Cut a piece of the tape containing the sounds, about 18 inches long, and splice the ends together so as to form a complete loop. Place the loop in the recorder so that it runs past the tape heads when the machine is set to replay. You can hold the loop under tension by one of the methods shown in the photographs. Try running the loop at different speeds and, if possible, reverse the direction.

Record some percussion sounds, e.g., sounds produced by knocking together empty boxes, etc. Cut out pieces and make up a loop consisting of the various sounds and blank leader tape. For the first attempt use only two or three sounds and two or three pieces of leader.

You can make up an almost endless variety of fascinating rhythm patterns by this method and if you use two tape recorders the rhythm loop can be copied from one to the other whilst other sounds are added.

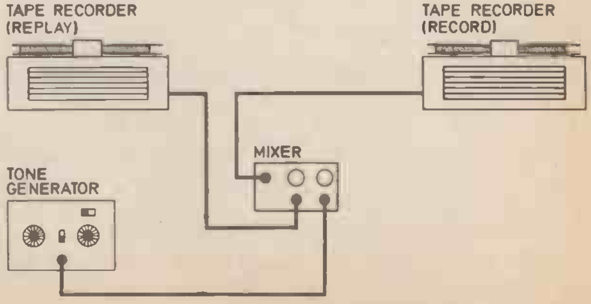
MULTIPLE RECORDING

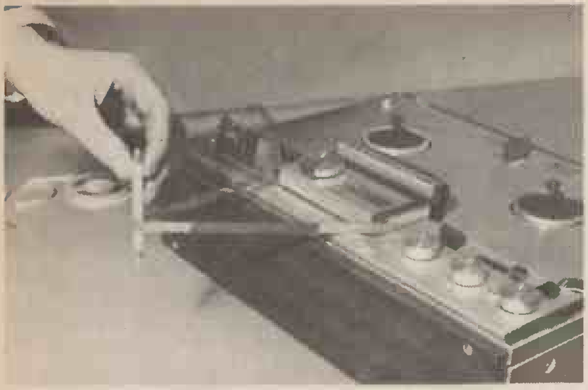
If you have a tape recorder with a track-to-track recording facility the scope is much wider as sounds may be recorded on one track and then re-recorded on to another track whilst adding more sounds. If your tape recorder can produce the echo effect this too can be used in various ways to produce those echoing science fiction sounds. Try allowing the echo to build up into a crashing roar and see if you can play it in reverse.

Now that you have discovered the variety of sounds and rhythms available using the facilities you have it is up to you to put these together to form an interesting "musical" passage. It may take some time before you achieve the required effect.

By combining even a few of the techniques outlined the number of permutations possible are fantastic. Instructions on composition cannot be given because no rules exist. Your ideas must come solely from imagination and experiment.

Fig. 5. Using the passive mixer to combine two signals for recording purposes.





The three photographs on the left illustrate various methods of using a tape loop. The top photograph shows a reversed loop held under tension by passing it around a pencil; this is only suitable for short periods.

The centre photograph shows a reversed loop held under tension by a small spool hanging over a table edge; this is only suitable for fairly large loops.

The lower photograph shows a system that can be used for any size loops by routing the tape around suitable objects—batteries are shown. This photograph also shows a cardboard tape holder used to keep recorded sections of tape in the order required.

COMPETITION

Finally, why not try an entry for the "technical experiment class" of the annual British Tape Recording Contest. It is open to anyone and the closing date for the 1972 contest is not until June 30. The Technical Experiment class allows for tapes of up to 4 minutes duration and includes; sound composition, electronic music, musique concrête, multi-track music and experimental sound recordings. The prizes are worthwhile and you can get an entry form free by writing to The Secretary, British Amateur Tape Recording Contest, 33 Fairlawnes, Maldon Road, Wallington, Surrey, and enclosing a stamped addressed envelope. You may also be interested to know that the special "Tape of the Year" award for 1971 was for an experimental class entry.

Every tape entered is carefully assessed by the expert judges and their comments are passed to the contestant concerned when the tape is returned. Thus you will know how to make an even better tape next time. ▣

PLEASE TAKE NOTE

The approximate cost of components given in the Simple Calculator article last month was incorrectly shown as £1·20. This should have been £2·20.

The probe flying lead in the Signal Injector article (March issue) should be soldered to Y3 not Y2 as stated in the text.

The Normatest 2,000 multi-range test meter mentioned in Shop Talk last month is available from: Croydon Precision Instrument Company, Hampton Road, Croydon, CR9 2RU.

THEY MADE THEIR MARK

No1 Introduction

By J. E. Gregory

ELECTRONICS is an internationally uniform world of symbols. Look at any advertisement or study the simplest circuit diagram in EVERYDAY ELECTRONICS and you will be confronted with strange symbols of every shape. Magical signs used to signify basic units of physical quantity; Table 1 lists some of them.

Although electronics is regarded as a modern science and hobby many of these units are named after pioneers, scattered throughout the world, whose accumulated research spans hundreds of years.

This series sets out to explain the symbol, and perhaps more important something of the man who gave his name to it. But let's begin our potted history of electronics at the beginning.

THE GREEKS HAD A WORD FOR IT

Take the word electronics itself, for that we must go back in time to ancient Greece. To the ladies of Greece passing time by decorating their spinning wheels with amber, found on shores in the far north. They observed that the amber when contacting the threads would draw the threads to itself as they separated from the wool, and then push them away in a frictional force. The Greek word for amber was elecktron, from the verb elkein to attract. Although this phenomenon was observed and noted by several of the great Greek philosophers we have to jump two thousand years to the early 1600's and to the reign of Good Queen Bess, who was persuaded by her physician William Gilbert, to attend a demonstration of a frictional electric machine based upon the power of amber to attract. This power he called electricity.

It was soon realised that the crackling and sparking of Gilbert's electric machine were the same phenomena on a minute scale, as thunder and lightning, but how to prove it?

THE KITE FLYER

One of the first to try was the fifteenth child of an English immigrant; born in Boston Massachusetts in the year 1706, this was the well known American statesman and philosopher Benjamin Franklin (see illustration above).

His historic but dangerous experiment trying to capture electricity from the sky occurred during a thunderstorm in the summer of 1752, when accompanied by his small son, he flew a kite with an iron door key. During the storm, he saw that sparks sprang from the key to his wrist, what he didn't realise of course was that if the lightning had actually struck the kite he would have been killed.

The study of natural phenomena had to take second place to his other activities, but he came to the conclusion that thunderstorms were simply the levelling of opposed electrical potentials, between one cloud and another or between a cloud and earth.

It was Franklin who introduced the positive and negative signs for electric charges, realising there are two kinds which neutralise each other.

Next month we move from America to 18th Century Italy and a scientist, Alessandro Volta, after whom the Volt, the measurement of electrical potential is named.

Photograph: Science Museum, London.

Table I FUNDAMENTAL UNITS

unit symbol	name of unit	physical quantity
A	Ampere	Electric Current
V	Volt	Electric Potential
F	Farad	Electric Capacitance
Ω	Ohm	Electric Resistance
W	Watt	Power
Hz	Hertz	Frequency
H	Henry	Inductance

These basic units are often inconveniently large or small and the units are prefixed with the following symbols:

p	pico	÷ 1,000,000 million
n	nano	÷ 1,000 million
μ	micro	÷ 1 million
m	milli	÷ 1,000
k	kilo	× 1,000
M	mega	× 1 million
G	giga	× 1,000 million

Hence 5kV = 5,000 Volts ; or 5mV = 0·005 Volt

ELECTRONIC CIRCUITS–
.....IN THEORY and PRACTICE

TEACH-IN

...FOR BEGINNERS

By Mike Hughes M.A.

7 SEMICONDUCTORS: Transistors

This year sees the twentieth birthday of the component most responsible for bringing electronics within the scope of do-it-yourself enthusiasts; it has greatly simplified design and construction and has also brought about terrific reductions in costs. It is the "transistor".

As a replacement for the valve, it allows us to use low voltages and removes the arduous task of having to assemble valve bases and massive transformers on tank like chassis. Connections to a transistor are few and the basic way it operates in a circuit is quite easy to understand.

PNP—NPN

The transistor is a member of the semiconductor family and is basically a sandwich of different types of either silicon or germanium. The "filling" of the sandwich can either be *p*- or *n*-type material; we can clad a *p*- type filling with *n*-type material giving what we call an *npn* transistor. Alternatively a *pnp* device is made by filling a *p*- type material with an *n*- type.

One encounters both types in practice but nowadays *npn* devices made from silicon predominate, the reason being that they are easier to make and hence cheaper!

Fig. 1(a) shows a diagramatic cross-section of both types of transistor, *pnp* and *npn*. One end is heavily doped and is called the "emitter"; the other end is lightly doped and called the "collector".

The filling material is very thin in practice (usually one or two microns; 1 micron is a millionth of a metre) and is called the "base". In its simplest form you can think of an *npn* device as two diodes connected together by their anodes (back-to-back), and facing each other in a *pnp* device, Fig. 1(b).

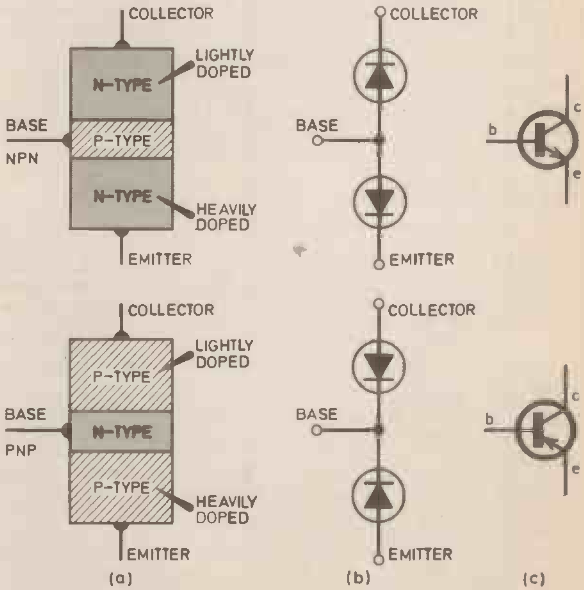


Fig. 1. (a) Schematic diagram of the internal make-up (b) equivalent representation and (c) circuit symbol for (top) *npn* transistor and (bottom) *pnp* transistor.

BASE CONNECTIONS

All the transistors you will come across have connections brought out from the emitter, base and collector. A very common silicon *npn* device is the BC108 and we shall be referring to this frequently in this series.

Fig. 2 shows what it looks like. If you have one handy see if you can identify which lead is which.

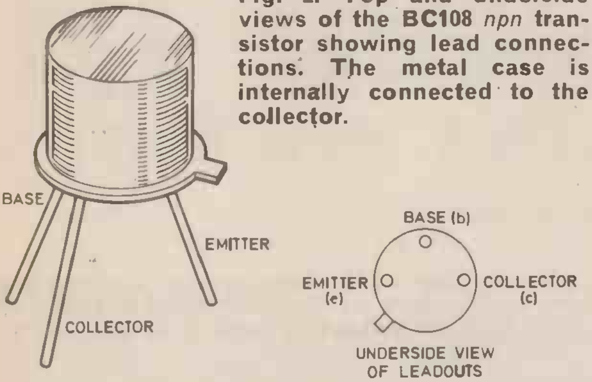


Fig. 2. Top and underside views of the BC108 *npn* transistor showing lead connections. The metal case is internally connected to the collector.

The emitter is the one closest to the spigot on the side of the can, the collector is diametrically opposite, and the base is between the two but set off to one side. This is a metal can transistor and the can is electrically "live"—in actual fact it is connected to the collector as well as the lead out wire.

Different types of transistor may have different shaped cans and some are in plastic encapsulations. Always make sure you know which lead is which before you start using a transistor.

Most constructional projects in EVERYDAY ELECTRONICS give you lead designations for the transistors specified, but if you want to experiment with alternative types make sure you know the correct base lead connections.

SIMPLE TEST

Use the BC108 *npn* transistor to identify the effect of the two diodes connected back-to-back. First of all make an ohmmeter on the Demo Deck. Use a 4·5V battery (**not** 9V) in series with a 2·2 kilohm resistor and VR2 (5 kilohm). Complete the circuit and set VR2 to give zero ohms at full scale deflection and then connect the leads of your ohmmeter between the base and emitter connections of the transistor—to do this it is best to solder the transistor on to three adjacent pins of the Demo Deck and use crocodile clips on the leads from the meter.

If you connect the meter so that the lead coming directly from the negative terminal of the battery goes to the emitter, the meter needle will move to almost full scale showing there is little resistance in the transistor. Now reverse the leads so that the base is more negative than the emitter—you should see that no current flows (indicated by meter needle not moving). Thus the base-emitter junction is a diode and follows the same rule that we saw last month.

Now leave the lead on the base and transfer the one from the emitter to the collector—again no current flows but reverse the leads and current flows between the base and collector.

If you connect the leads between the collector and the emitter no current should flow whichever way you have them because in both connections, the current would have to pass through a reverse biased diode.

This simple experiment can be used as a rough and ready test to check if a transistor is likely to be in working order, and provided you remember the rule "make p stand for positive for current to flow" you can use it to identify *npn* and *pnp* transistors.

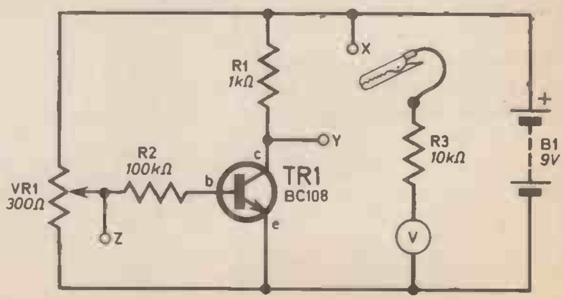
REVERSE VOLTAGE LIMITS

Like all diodes, the junctions of a transistor have reverse voltage limits. These are usually specified with abbreviations. For the BC108 the reverse emitter-base voltage (V_{ebo}) is 5V—i.e. you must never make the base more than 5 volts negative with respect to the emitter (this is why we had to use 4·5V for our ohmmeter instead of the 9V we have been used to). Likewise the reverse base/collector voltage (V_{cbo}) is 30V. You might expect the reverse voltage between the emitter and the collector to be equal to the highest of the other two but this is not the case—it is lower—for the BC108 V_{ceo} is 20V.

The "O" in the suffixes of the reverse voltage characteristics indicates that the third terminal is "open circuit" i.e. not connected.

HOW THE TRANSISTOR WORKS

Let's see what a transistor actually does by using the circuit of Fig. 3(a). Now that we are using the transistor in a real circuit it is important to note the polarity of the supply voltage—for an *npn* transistor the collector must always be kept more positive than the emitter (the converse applies to *pnp* devices). We are going to make the transistor work like a tap and control the amount of current flowing through R1. You can see this happening if you follow the details through on the Demo Deck.



VR1 is a 300 ohm potentiometer working as a potential divider giving us a variable supply at its wiper.

Wire up the circuit of Fig. 3(a) on the Demo Deck as shown in Fig. 3(b), but do not connect R2 to the base of the transistor just yet.

Resistor R3 and the 1mA meter makes a 10V range voltmeter in the usual way. Connect the negative lead to the emitter of the transistor. All voltages we measure will be relative to that of the emitter.

First measure the power rail at point X—it should, of course, be +9V; now measure the potential at the collector of the transistor (point Y) it should be +8·2V. This is what is expected because no current can flow through the back-to-back diodes of the transistor, but the meter will draw some! If you had a high sensitivity meter (say 20 kilohm per volt) this current would be negligible and you would see +9V at both points, X and Y.

Now set VR1 so that the potential on its wiper is zero (with respect to the emitter) and connect R2 to the base of the transistor. VR1 potential is measured by attaching the crocodile clip from the meter to point Z. Again measure the potential at the collector—it should not have changed.

We shall now see what happens if we increase the potential at the wiper of VR1. Do this in 0·5V increments (use crocodile clip at point Z) and for each setting measure the collector potential. You should see that once the potential of the wiper exceeds 600mV, the potential at the collector falls, and continues to fall towards zero as the controlling voltage is increased. Once the collector potential reaches almost zero no more control can be effected. We say that the transistor is now fully conducting between collector and emitter. This state is called "saturation."

Record your results and plot a graph of collector voltage versus voltage at the wiper. A graph should be obtained similar to that of Fig. 4.

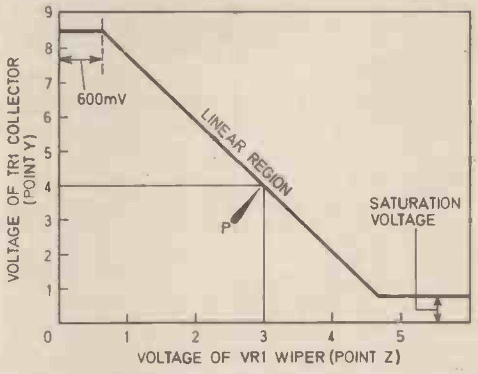


Fig. 4. The graph obtained by plotting the recorded results of experiment using circuit of Fig. 3(a), i.e. voltage at point Y versus voltage at point Z.

Control of the collector/emitter current is brought about by passing a current through the forward biased base/emitter junction. The more current we pass into the base in this way, the more current we can control between the collector and the emitter. The controlling current is called "base current," (I_b) and the controlled current "collector current," (I_c).

Base current is set by the potential difference between the wiper of VR1 and the emitter of the transistor, acting through the resistance R2

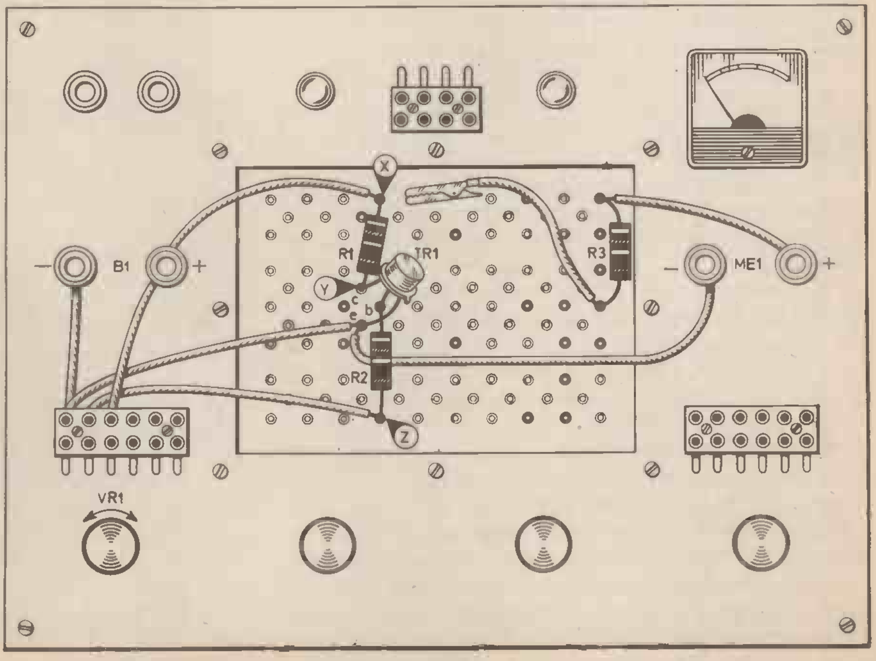


Fig. 3(a) (left). The circuit diagram used for investigating some of the properties of a BC108 transistor.

Fig. 3(b) right. The circuit of Fig. 3(a) wired up on the Demo Deck.

and any internal resistance between base and emitter. The latter is small and can be neglected at this stage. We must, remember, however, that the base must be made at least 600mV positive with respect to the emitter before any current can flow (this is the usual forward voltage drop for any silicon junction).

We can thus calculate the current flowing into the base by measuring the potential at the wiper of VR1, subtracting the base emitter forward voltage drop (600mV) and dividing by the value of R2.

GAIN

If you do this for your experiment you will find that the base current ranges from 0 to 0·084mA. The range of collector current we are controlling was from 0 to 9mA. It can be seen that the transistor enables us to use a very small current to control a larger one. We call this effect "current amplification." The factor that governs the ratio between I_b and I_c is called "gain" and although it increases with I_c it is pretty well constant for any given transistor. It can, however, vary widely between different types of transistor and even between devices having the same type number! Provided you take a combination of base and collector currents within the controllable region (this is called "linear region") you can calculate the gain of the transistor you are using.

It would be best to increase the potential at VR1 until the collector potential is approximately 4V. This reduces the shunting effect of our voltmeter.

Use the precise values of voltage measured to calculate the current through R2 and R1 then use the ratio of these values to calculate the gain.

gain = collector current ÷ base current

$= I_c \div I_b$

For the BC108 transistor it should be approximately 200, but as we have said, will vary from device to device.

Example To calculate the gain from your plotted curve (similar to the one of Fig. 4) select a convenient point on the linear region such as point *P* of Fig. 4.

The base current, I_b is given by the voltage difference between the base and emitter divided by the base resistor.

$$\text{i.e.} \frac{3 - 0{\cdot}6}{100{,}000} = 0{\cdot}024\text{mA}$$

Now the voltage drop across the collector resistor R1 is $(9-4)\text{V} = 5\text{V}$. Therefore, collector current I_c is $(5 \div 1000) = 5\text{mA}$.

Substituting these values for I_c and I_b in equation (1) gives the gain $= (5 \div 0{\cdot}024) = 208$.

There are various ways of describing current gain for a transistor so we shall define that measured above a little more precisely—it was the d.c. current gain. This is sometimes abbreviated to the designations β (beta) or h_{FE}. The latter is rather a strange type of designation but is one of a range of what are called "h" parameters—we need not worry ourselves about these in this series except for the term h_{FE} which is usually used in manufacturer's data sheets. Do not confuse h_{FE} with h_{fe}, the latter is called the small signal current gain and we shall not be dealing with this until later.

The gain equation above can be rewritten: $I_c = h_{FE} \times I_b$

Remember that the experiment we have just done has been using a silicon *npn* device. We could have used one made from germanium having *npn* structure and obtained a similar effect—except that the base/emitter forward voltage drop would have been only about 200mV and h_{FE}, in general, would have been lower.

We could also have used a silicon or germanium *pnp* device but would have had to reverse the battery connections so that the collector was negative with respect to the emitter. The same rules would have applied and we could have still calculated a value for h_{FE}.

If you are a little confused by the difference between *npn* and *pnp* devices do not worry too much as this stage—most of the early experiments in Teach-In will use *npn* devices and when you have got used to these you will find it quite straightforward to switch over to *pnp* devices when necessary. The most important thing to remember is the polarity of battery voltage when using one type or the other. An aid to remembering what the polarity ought to be is to bear in mind the direction of conventional current flow;

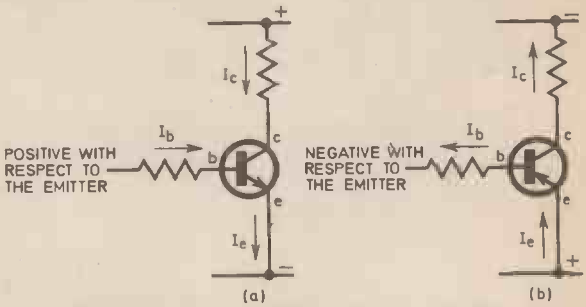


Fig. 5. Circuits showing major current flow directions for (a) *npn* and (b) *pnp* transistor. I_b—base current, I_c—collector current, I_e—emitter current.

the arrow on the emitter of the symbol points in the direction of current flow, i.e. it points away from positive and towards negative. See Fig. 5.

Whether using *npn* or *pnp* devices an aid to remembering how to turn collector/emitter current "on", is to make the potential at the end of the resistor connected to the base tend towards the same polarity voltage as applied to the collector; the more you move towards this voltage, the more I_b increases, and I_c will increase in direct proportion.

When the potential feeding the base rises towards the supply voltage the voltage at the collector falls towards the emitter voltage. This is called "inversion."

In Fig. 3 R1 is called the "collector load." The limit of I_c control is set by the value of this resistor; if it has a high value then it does not matter how much base current you apply, you cannot control more collector current than that given by the collector supply voltage divided by the value of collector load. On the other hand, if the load is too low you might find yourself trying to force more collector current than the construction of the transistor can handle. Thus one of the specifications of a transistor is the maximum collector current it can handle without "blowing". This is called I_{cmax} and for the BC108 is 100mA.

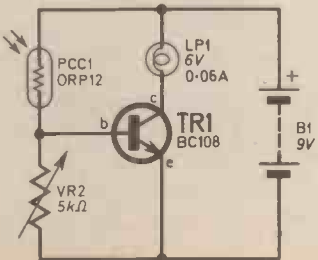
A final parameter we must deal with is the power rating of a transistor. As current is passing through it a certain amount of heat is dissipated. We already know that too much heat can spoil the properties of a semiconductor so it must be limited. The limit is set by the maximum power dissipation parameter, P_{cmax}. It is easy to calculate what the power dissipation is likely to be; it is the dissipation you would get if you replaced the transistor in the circuit with a resistor having the same ohmic value as the collector load.

Table 1 gives you some typical values of parameters for some common transistors of varying types, powers and polarities.

Table 1: THE MORE IMPORTANT CHARACTERISTICS OF SOME COMMON TRANSISTORS

Type	Polarity	$P_{c\,max}$	V_{cbo}	V_{ceo}	V_{ebo}	$I_{c\,max}$	h_{FE}
BC108	*npn*	300mW	30V	20V	5V	100mA	240
2N2926	*npn*	200mW	18V	18V	5V	100mA	150
BFY51	*npn*	800mW	60V	60V	6V	1A	70
BFX13	*pnp*	300mW	−20V	−15V	−5V	100mA	120
2N3702	*pnp*	360mW	−40V	−25V	−5V	200mA	60
AC126	*pnp*	500mW	−32V	−32V	−10V	100mA	100
OC72	*pnp*	125mW	−16V	−16V	−3V	125mA	50
OC26	*pnp*	12W	−16V	−16V	−10V	3·5A	50
OC36	*pnp*	30W	−80V	−32V	−40V	10A	70

Fig. 6(a) (below). The circuit diagram of the "Electronic Candle" which illustrates positive feedback.
Fig. 6(b) (right). The circuit of Fig. 6(a) wired up on the Demo Deck. Ensure that PCC1 is close to LP1.



ELECTRONIC CANDLE EXPERIMENT

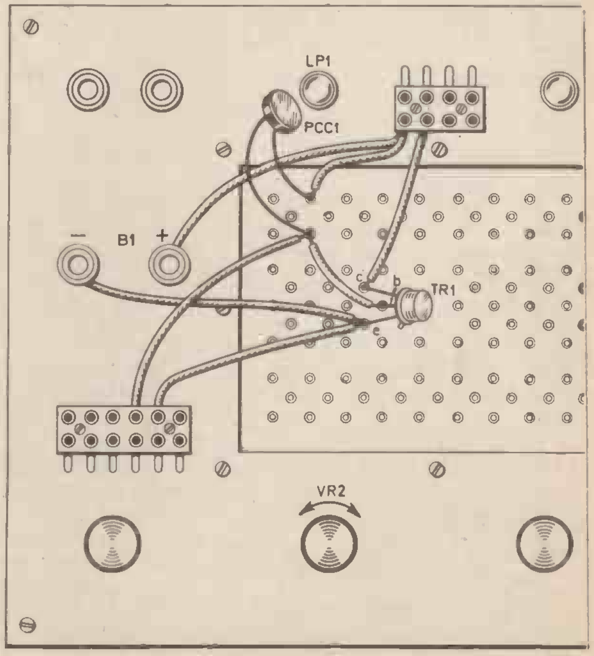
We shall now make a simple working circuit using the circuit diagram of Fig. 6(a). This is wired up on the Demo Deck as shown in Fig. 6(b). Connect the ORP12 (light dependent resistor) very close to the LP1 on the Demo Deck as shown below. Set VR2 to zero ohms. The potential at the base of TR1 will be zero, therefore no current will flow between collector and emitter. Now, in a reasonably lit room, increase the value of VR2. At a certain point the potential at the base will reach 0·6V (set by the potential dividing effect of PCC1 and VR2) and the transistor will start to conduct (the bulb will glow dimly).

Continue to increase the resistance of VR2; the current flowing through PCC1 will now pass into the base/emitter circuit of the transistor in preference to the higher resistance path through VR2. This base current will cause TR1 to pass more collector current until the bulb is fully illuminated.

When you reach this point (the minimum value of VR2 that will give full illumination) try casting a shadow over PCC1, the lamp will go dim and ultimately go out altogether as I_b reduces due to the resistance of PCC1. We did a similar sort of thing in Teach-In Part 4.

The difference is that we now have a circuit that is much more sensitive to small changes in light level which is brought about by the transistor amplifying the current from the photo resistive cell.

If you place the cell very close to the bulb in a dimly lit room you can set the value of VR2 so that the ambient lighting does not turn the transistor on, but the light from the bulb will.



Break the light path between the bulb and the cell and the bulb goes out and stays out. Now use a match or lighter to provide a stimulus of light. Bring it close to the bulb/cell assembly and the bulb lights up; you can now remove the match and the bulb will stay on because its own light output is holding the transistor on. This is called "positive feedback" and in this circuit will provide an amusing party trick—especially if assembled to look like a candle.

A bit of practice at "snuffing" the candle with the fingers (actually you are breaking the light path between the bulb and the cell) will make the effect even more astounding.

Photograph of the Demo Deck set up for the Electronic Candle Experiment showing the lamp being "lit" by the light emitted from the lighter.

TEACH-IN PART 6—ERRATA

Fig. 4(b) last month shows a lead connected wrongly. The lead from the junction of R3 and the negative meter terminal should go to the negative end of VR1 (not the wiper as shown) i.e. the one connected to the battery negative.

Next month: Multivibrators. The components needed for next month in addition to those already acquired are: resistors 22 kilohm (2 off), 100 ohm (1 off); capacitors 0·1μF polyester (2 off), 500μF elect. 12V (1 off); transistors BC108 (1 off); diodes OA91 (1 off).

Ruminations
By Sensor

Not so Clever

The coal miners' strike has shown how dependent we are, in this age of high technology, on the efforts of men who work in damp, dirty and often dangerous conditions.

I find it difficult to comprehend that on one hand the semiconductor industry owes its existence to the ability to obtain and to process materials with an impurity content of less than ten parts in a thousand million, and to operate with tolerances down to one millionth of a metre, while on the other hand men have still to dig fossil trees out of the earth (albeit with mechanical assistance) so that these fossilised remains can be burnt to boil water in order to raise steam and to generate electricity! Without coal and electricity there would be no semiconductor industry; truly our idol has feet of clay!

Let There be Light

Have you heard about the old lady who telephoned the C.E.G.B. to complain that, during the power cut, the buses were passing her house with all their lights on? She also said that she could manage to get along quite well without the electricity, except for the little light in the hall, and could they please leave that one switched on.

Many people must have been irritated, in the early days of the strike, to see street lights blazing all day and switched off at night, due to their electric clock switch mechanisms getting umpteen hours behind. To the electronics man the answer to this problem is so simple—a light operated switch, either using discrete components or in integrated form.

A recently introduced integrated circuit provides the necessary photo cell, level sensor and time delay all on one tiny chip of silicon and complete with lens. It could operate a relay or, better still, work into a switching transistor controlling the street lamp directly.

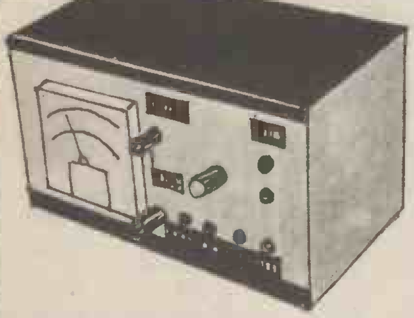
Some years ago, I was shown around a large generating station, where, tucked away in a dusty corner there was a cast iron box about the size of a domestic cooker. This apparatus was installed at the station about twenty five years ago and its purpose was to switch on all the electric street lamps in the town.

When switched on it produced a ripple which was superimposed on the mains. Sections of street lighting were grouped together under the control of master switches, spread throughout the town, which were operated by switching on the ripple equipment. The system had been in use but for some reason, unknown to my guide, had been discontinued. It would have been a blessing during February 1972.

Watch for these features in the JUNE

Wash 'n Wipe

We have produced one very popular car wiper accessory now we are going to describe another. This unit starts the wipers automatically when the washers are used, keeps the wipers going for a pre-determined time, and then turns them off. For all 6 and 12V cars fitted with washers and self parking wipers. Extremely useful with the Windscreen Wiper Control or just on its own.



Multimeter

Probably the most useful of all test equipment is a multimeter and next month we show you how to build a fairly simple one that will meet the needs of most constructors.

Light to Sound Converter

A project for those who like to experiment. This unit produces an audio tone, the frequency of which is dependent on the light level sensed by a photocell.

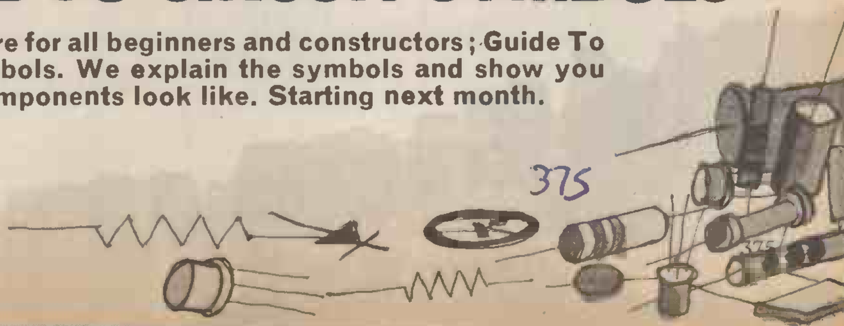
Also...

A new feature for all beginners and constructors...

GUIDE TO CIRCUIT SYMBOLS

A new feature for all beginners and constructors; Guide To Circuit Symbols. We explain the symbols and show you what the components look like. Starting next month.

On sale Friday, May 19



Use this 'electronic eye' to monitor the busyness of your bee-hives

By G.A.Cozens

BEE COUNTER

MODERN research calls for accurate measurement and comparisons, and with this in mind this device was designed to help the bee-keeper assess the performance of his beehives more definitely, and to compare the different strains of bees under the same working conditions and so help to breed a strain which will produce the most honey under all the difficulties encountered in our changing climate without the rather nasty habit of the English bee, of attacking the bee-keeper as soon as he appears anywhere near the hive.

Approximate cost of components... £ 2·20 plus case

The Bee Counter is an instrument which records the number of bees entering the hive, and used in conjunction with other devices such as a wind speed indicator, a wind direction indicator, an air temperature thermometer, a maximum/minimum thermometer, a rain gauge and a sunshine recorder, then some degree of assessment can be made, and some basis established for the bee-breeder to work upon his main goal—lots of honey from a reasonably good tempered, busier bee.

The Bee Counter makes use of the fact that bees are highly organised in their habits, and utilises the bees sense of sight and smell. These bee "characteristics" are used in the design of the cabinet housing all the circuitry which is described later in full detail.

THE CIRCUIT

The complete circuit diagram of the counter is shown in Fig. 1 and is basically an amplifier which works as follows.

The lamp LPI, which is always "alight" when

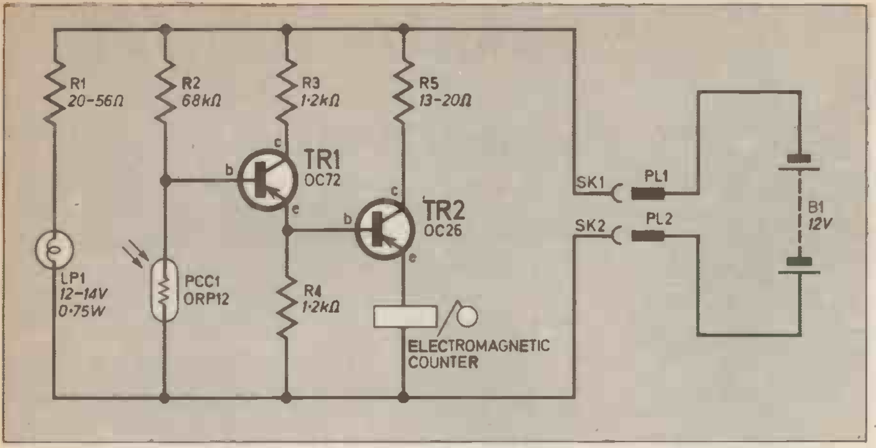


Fig. 1. The complete circuit circuit diagram of the Bee Counter.

the unit is switched on, illuminates the light dependent resistor, PCC1, and causes its resistance to be at a low value, about 100 ohms.

The l.d.r. and R2 form a potential divider circuit and under "illuminated conditions" of the l.d.r., a positive voltage with respect to the emitter, is applied to the base of TR1 causing it to be in a conducting state.

With TR1 conducting, a negative voltage is applied to TR2 base with respect to the emitter and consequently TR2 is "off" (not conducting).

When the light path between LP1 and PCC1 is broken, the resistance of PCC1 increases considerably (to about 100 kilohm for complete "blackout"). This causes the potential at TR1 base to go negative and turns it "off". This state of TR1 causes the voltage applied to the base of TR2 to go more positive and causes it to switch "on" i.e. conduct—current flows through TR2.

When current flows through the emitter leg of TR2 containing the relay coil in the counter, the relay is energised.

When the light to PCC1 is restored, TR2 switches "off" and the counter is de-energised and springs back to its off position and in doing so mechanically adds "one" to the counter readout.

The arrangement of LP1 and PCC1 in the case is so devised that the bee, on entering the hive, breaks the light path between these devices and its entry is thus recorded.

The 13-20 ohm 3 watt resistor, R5, in the collector circuit of the power transistor, TR2, is to prevent damage to the counter or the transistor if the entrance passage to the hive should become blocked, as once happened in the prototype when a drone got stuck in the narrow part.

A heavy duty battery is required to operate the Bee Counter since current drain is substantial—250 mA when TR2 is "off" and 400 mA when TR2 is "on" at 12V. A car battery is therefore recommended to supply the power. The cost of this battery is not included in approximate cost.

The voltage is fairly critical as it must be sufficient to operate the counter, but not high enough to cause overheating of TR2 or the counter coil in the event of the passage being blocked for long.

If the apparatus is disconnected every night the battery will last at least a week on one charge.

Components....

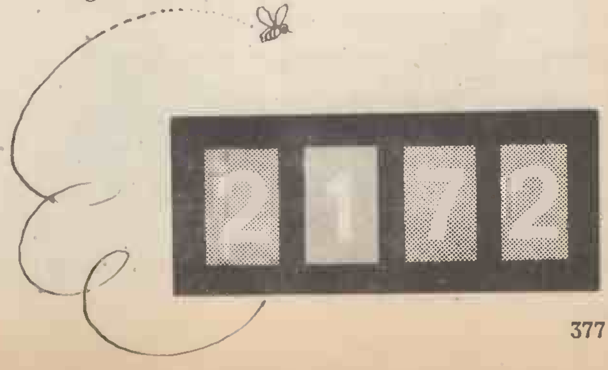
SEE SHOP TALK

Resistors
- R1 20–56Ω 3 watt
- R2 68kΩ
- R3 1·2kΩ
- R4 1·2kΩ
- R5 13–20Ω 3 watt
- All ½ watt carbon ± 10% unless otherwise stated

Transistors
- TR1 OC72 (or similar) germanium *pnp*
- TR2 OC26 germanium *pnp*

Light Dependent Resistor
- PCCI ORP12

Micellaneous
- LP1 12-14V 0·75W bulb and holder
- PL1, PL2 Wander plugs, 1 red 1 black (2 off)
- SK1, SK2 Sockets to suit plugs PL1, PL2
- B1 12V battery—heavy duty rechargeable type (Not accounted for in cost box.)
- Counter: Post Office type 14C 4·2Ω 4 figure readout. Cedar wood, Perspex and adhesive, Paxolin, wood screws, 4 B.A. nut and bolt, wood glue.



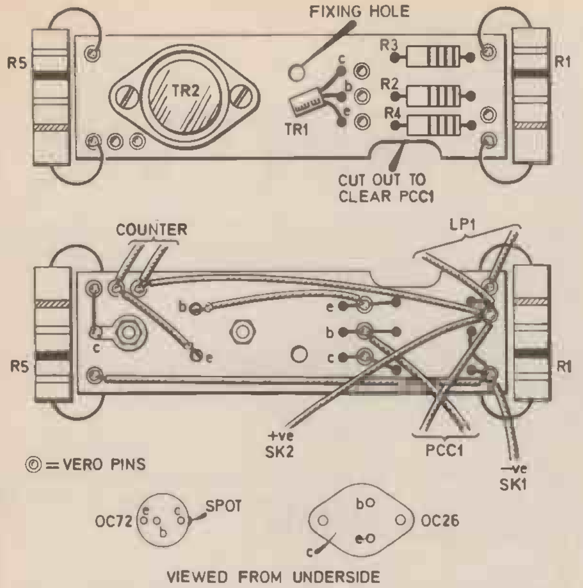


Fig. 2. The layout of the components on both sides of the Paxolin board. Veropins are used for attachment.

Variations in performance can be dealt with in several ways. The lamp should be bright enough to turn off the amplifier, but not any brighter than necessary. This is best adjusted by altering the series resistor R1, which may be increased to as high as 56 ohms.

Also, the size of the light hole can be varied, or a part of the l.d.r. painted over so that it has less area exposed, until the instrument is sufficiently sensitive, but positive in its action.

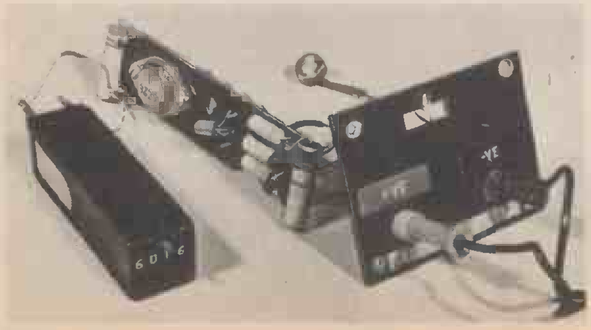
THE COUNTER

The electromagnetic counter used is a Post Office type. It has a four digit readout and can thus count up to 9,999. The maximum count rate is ten per second.

COMPONENT WIRING

Most of the components of Fig. 1 are mounted on a piece of Paxolin size $4\frac{1}{2}$ x $1\frac{1}{4}$ inches with a cut-out as shown along one side to accommodate the light dependent resistor, PCC1.

Both sides of the board containing the components are shown in Fig. 2.



Veropins are used for mounting the components in position and small holes should be drilled where indicated to accommodate these pins.

Three more small holes of the same size should be drilled to take the leads of TR1 as shown.

Drill the component board fixing hole and the four holes for transistor TR2; (see reverse side of component board Fig. 2); $\frac{1}{8}$in. diameter holes will do for all five holes.

Begin assembly by pushing in all the Veropins and then attach TR2 to the board using two small nuts and bolts.

The connection to the collector of TR2 is via its casing, so a solder tag should be attached to one of the securing bolts to enable this connection.

Attach and solder all the components, link wires and flying leads as detailed in Fig. 2 making sure a heat shunt is used when soldering in TR1, which incidently should be the last component connected.

The l.d.r. should be attached to the board via 6in. long flexible leads.

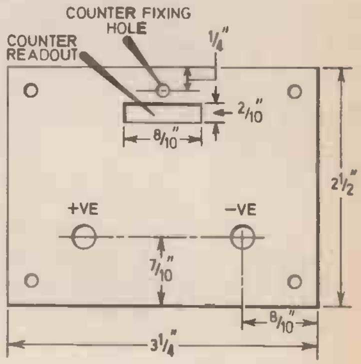
The flying leads to the counter should be about 4in. long.

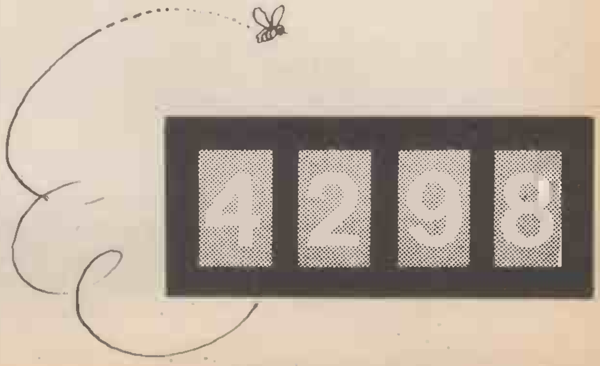
The two wander sockets used for battery connection to the counter, are attached to the end of the case which is made from a piece of Paxolin, dimensions are given in Fig. 3.

The connection wires from the wander sockets to the component board should be about 4in. long.

Connection to the battery is made via two wander plugs and a length of twin flex.

Fig. 3. Dimensions of the end made from Paxolin to accommodate the wander sockets for battery connection, and counter readout.





BEE COUNTER

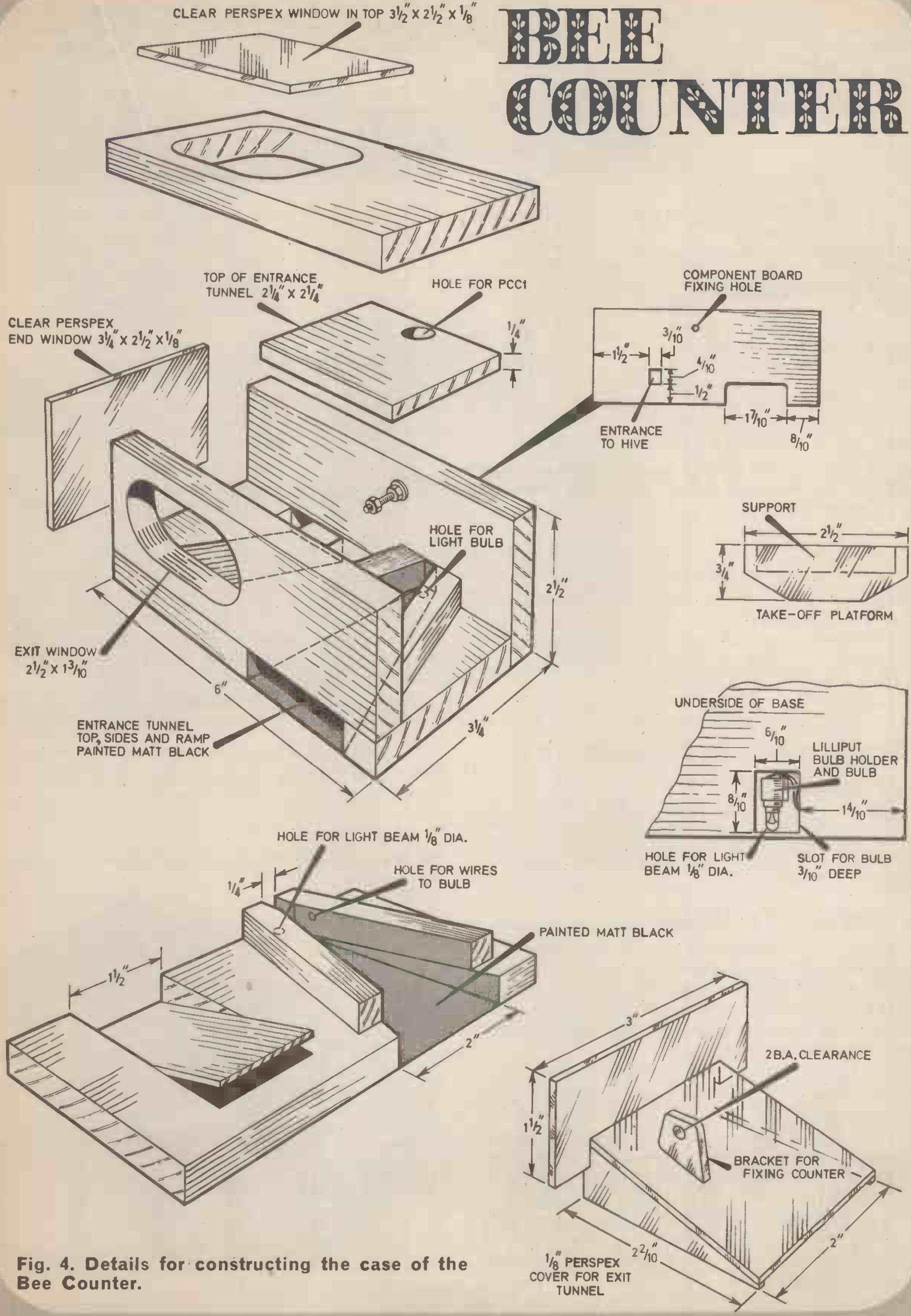
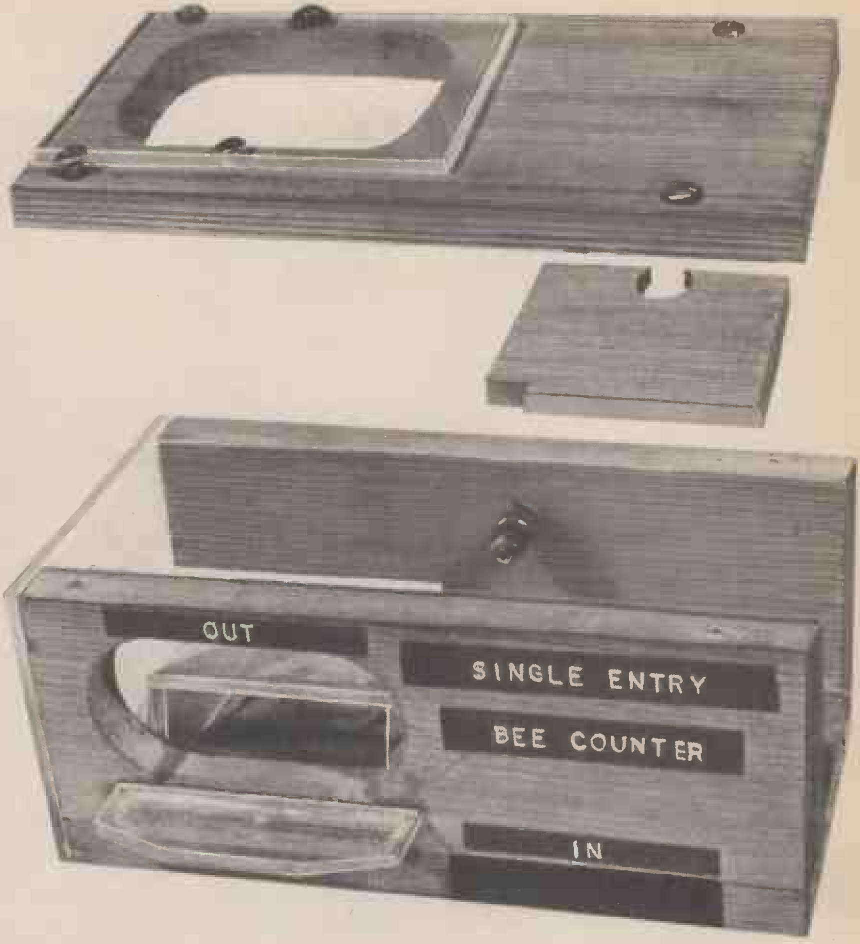


Fig. 4. Details for constructing the case of the Bee Counter.



A photograph of the prototype with top and tunnel lid (which holds PCC1 in position) removed. The photograph clearly shows the entrance and exit tunnels (labelled IN and OUT respectively). The take-off platform, made from Perspex, is located just beneath the exit cut-out, and is glued in position with Perspex adhesive.

EXIT AND ENTRANCE GEOMETRY

As said before, this device and its design utilises the bees' senses of smell and sight. From inside the hive, the exit from the hive appears as a bright opening to the outside world and so the exit path through the instrument must be a tunnel with transparent sides and top to allow this condition to be fulfilled.

In the instrument this tunnel slopes upwards so that when the bee emerges, it finds itself on a platform of Perspex, about ¾in. wide, situated above the hive base, and flies away.

When it returns, it will land on the hive base (landing/alighting board) and walk towards the hive.

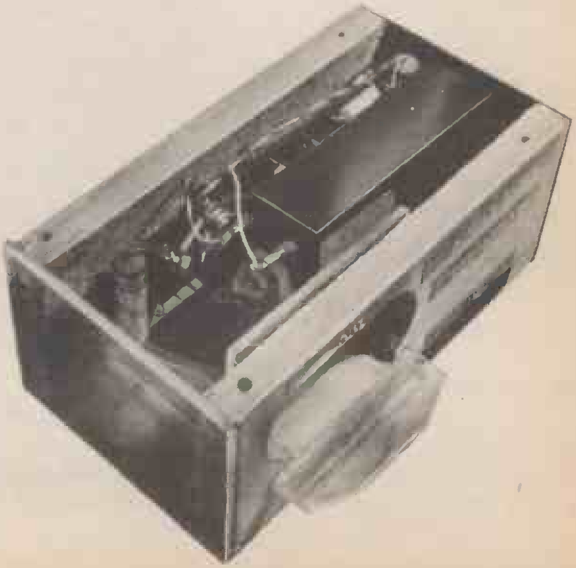
The entrance to the hive is now through the Bee Counter which is a tunnel painted matt black; when the bee walks along the front of the instrument and reaches this tunnel it will enter.

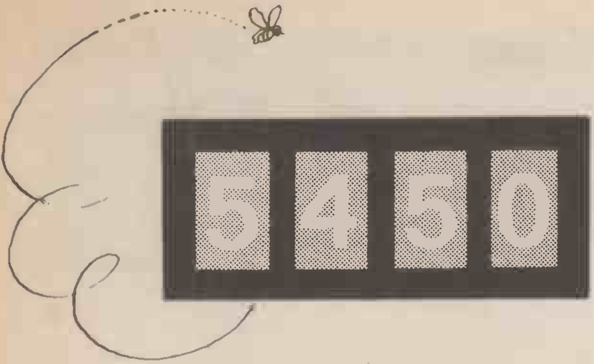
On entering, the tunnel becomes narrower and at the same time slopes upwards until it is just wide enough for a single bee to pass.

There is a lamp under the narrow part, with a hole in the floor of the tunnel, made up to the level of the floor with Perspex cement so that light can shine up through it.

The light dependent resistor is situated in the roof of the tunnel and as the bee walks between this and the lamp, the light beam is cut and the circuit activated.

Positions of the "electronics" within the case.





CONSTRUCTION OF CASE

Cedar wood should be used to construct the case as this material will be readily acceptable to the bees.

Cedar wood will also withstand the weather without the need for painting but it is well to remember that if the counter is to be used in exposed outdoor conditions, weather protection becomes an important consideration, whereas in laboratory conditions it is not so.

The best compromise for an outdoor installation is a shelter which will keep off the rain.

First of all make all the wooden parts of the case as detailed in Fig. 4.

Now solder the two thin flexible covered wires to the bulb holder tags and screw in the bulb. These wires are led out through the top of the base and the bulb assembly is glued in position.

It is not likely that the bulb will need replacement because it is "under run" and there is a 20 ohm resistor (R1) in series with the bulb which reduces the light and heat dissipated in the bulb.

When the glue has set, fill up the light hole with Perspex cement so that it comes flush with the passage floor.

Glue down the two sides of the tunnel so that the width of the narrowest region is $\frac{1}{4}$in. Paint the tunnel top, bottom and sides a matt black.

The light dependent resistor should be a push fit into a hole in the tunnel roof.

Glue and screw the front and back to the base and glue the exit ramp in position. Drop the tunnel roof into position indicated. The other parts of the case are made from Perspex and their dimensions are given in Fig. 4.

With these made we can proceed with the assembly.

ASSEMBLY

Begin by screwing the Perspex side and top windows in position as indicated. Glue the Perspex platform to the front and place the Perspex exit guide in position.

Now solder the two wires from the bulb holder to the component board as detailed in Fig. 2, push the l.d.r. in position and then attach the board to the back of the case by means of a 4 B.A. nut and bolt. This bolt should be countersunk into the back so the back is flush with the front of the hive. If there is a gap here, the bees will try to go in or out through the smallest crevice.

Attach the wander sockets to the Paxolin side and solder to the appropriate flying leads from the component board. Next screw the Paxolin side to the case.

When the flying leads to the counter have been connected, fit the counter into its locating holes, (one end in the Paxolin and the other in the bracket on top of the Perspex exit guide) and secure with nuts. The counter digits should be visible through the slot in the Paxolin side.

Screw the top on and the unit is complete.

CAPACITY AND POSITION OF CASE

The single entry counter (as this is) is only suitable for a three or four frame hive, since with a full scale hive the returning bees would sometimes overload the tunnel capacity.

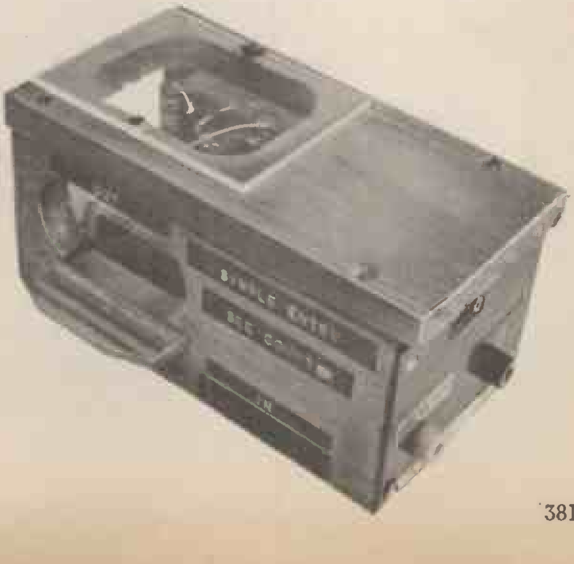
The maximum a single entry counter can handle is about 60 per minute.

For a full scale hive a three entry counter is necessary. This means the entry tunnel is divided into three passages, each with its own light beam arrangement, amplifier and counter.

Whereas the single entry model is only $6\frac{1}{4}$in. wide, which is about right for most observation hives, it is better to make the three entry model $16\frac{1}{2}$in. wide so that it takes up the whole width of a Standard National hive.

When the counter is put in front of the hive the hive should be moved back by a distance equal to the depth of the Bee Counter, in this case $3\frac{1}{4}$in. so that the point of entry is exactly as it was without the counter.

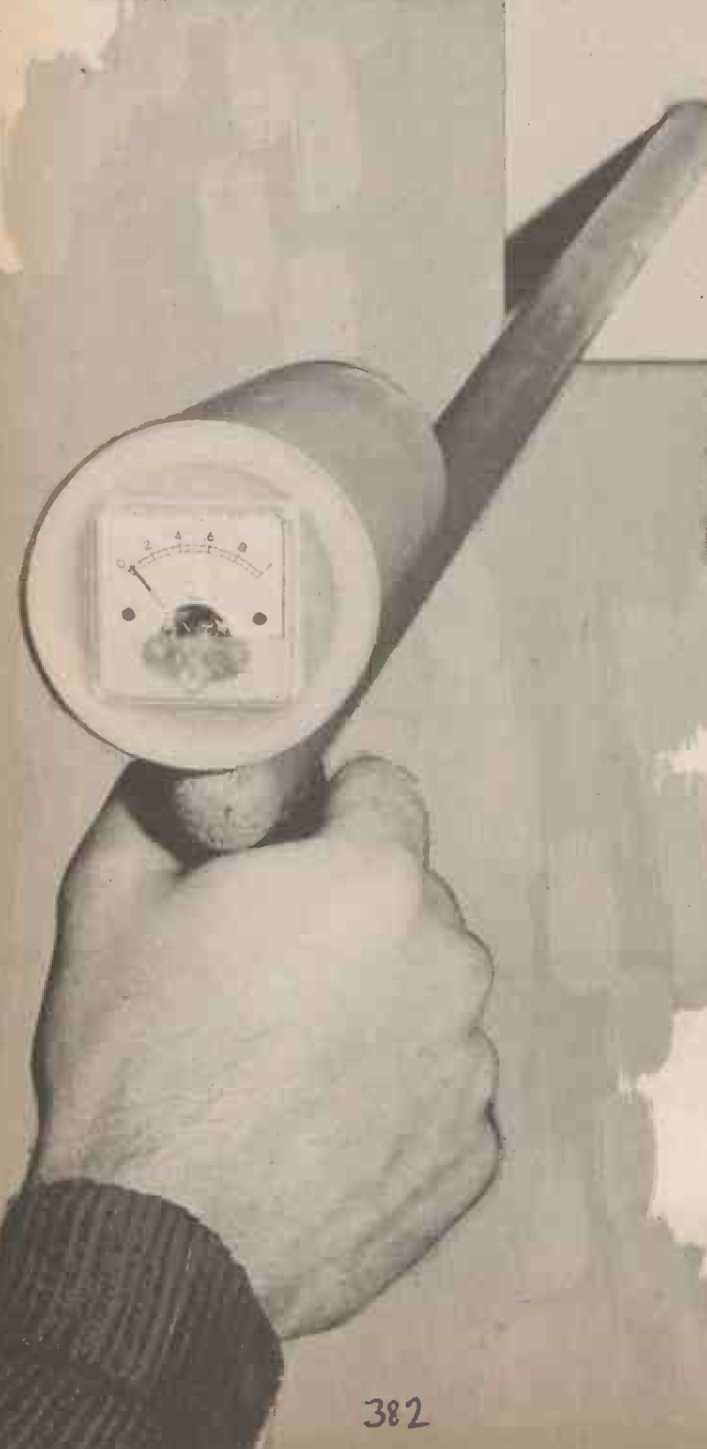
When this is done the bees will soon get used to the new conditions and will be using the exit and entry passages without any confusion. ▣



METAL

A simple, easy to construct self—contained locator giving a meter indication of buried metal.

By D. Bollen



Approximate cost of components... £4·00 plus case

THE metal locator described in this article was designed for simplicity and ease of operation. A single transistor circuit is used to give a clear meter indication of the presence of buried metal without the need for headphones or a nearby portable radio as used by some locators. Under typical operating conditions the instrument will detect a 2p coin at a depth of about 1 inch.

CIRCUIT OPERATION

The complete circuit of the metal locator is shown in Fig. 1. Transistor TR1 acts as a common base oscillator with positive feedback between collector and emitter controlled by trimmer C4. Search coil inductor L1 is tuned by C2 to give an oscillation frequency of 100kHz.

When the circuit is functioning, L1 will induce eddy currents in nearby metal and this transfer of energy causes an increase of TR1 emitter current. Although small, the accompanying change of d.c. voltage across R3 can be detected by a sensitive null (or zero registering) voltmeter.

In Fig. 1 the d.c. null voltmeter consists of R3, R4, R5, R6 and ME1. Capacitor C5 is included

LOCATOR

to remove unwanted a.c. from the voltmeter input, and diodes D1 and D2 protect the meter movement against overload.

At a certain setting of C4, the d.c. voltage at TR1 emitter will equal the voltage at the junction of R5 and R6 so that no current flows through ME1; this can be taken as the normal operating point for the circuit. If metal is brought close to L1, the emitter voltage of TR1 will rise by several millivolts in relation to the voltage at the junction of R5 and R6, and the meter will read.

Full scale sensitivity of the null voltmeter is around 150 millivolts. Metal Locator response is shown in Fig. 2, where meter reading is plotted against depth for three weights of metal.

CONSTRUCTION

Commence construction by cutting a piece of 0·1 inch matrix plain perforated circuit board to a size of 3·1 by 1·4 inches, and drill holes to take C4, VR1, and S1 (see Fig. 3).

Cut two brackets from a length of $\frac{1}{2}$ inch aluminium angle and drill to accept the meter terminal screws and 6B.A. circuit board mounting screws.

Bolt the brackets to the circuit board, complete with solder tags, and insert all terminal pins in the positions shown in Fig. 3.

With C4, VR1, and S1 in place on the circuit board, proceed to mount and solder the remaining components in the following order; resistors, capacitors, wire links and leads, diodes and the transistor, using a heat shunt to protect the diodes and transistors while soldering them.

Obtain a plastic beaker with lid (of minimum dimensions 5 inches high by $2\frac{1}{2}$ inches diameter) and cut away the centre of the lid to accept the meter MEI. Next, drill holes in the beaker for L1 leads, woodscrews, and to allow access to the circuit board controls, see Fig. 4.

When following the step-by-step instructions in Fig. 5, for making up the search coil L1, ensure that the pile windings can slide easily off the 5 inch diameter former. Short strips of insulating tape, placed sticky side out around the former, will hold the turns together and facilitate removal of the coil. Do not use Sellotape for this purpose as it is likely to damage the wire.

The metal locator frame (Fig. 4 and 6) consists of a chipboard or plywood handle, a $\frac{5}{8}$ inch diameter dowel pole, and two s.r.b.p. or Perspex sheets for the search head. Screw and glue the handle to the pole and then glue the other end of the pole to the search head top board, this assembly can then be painted.

To complete the construction, screw the

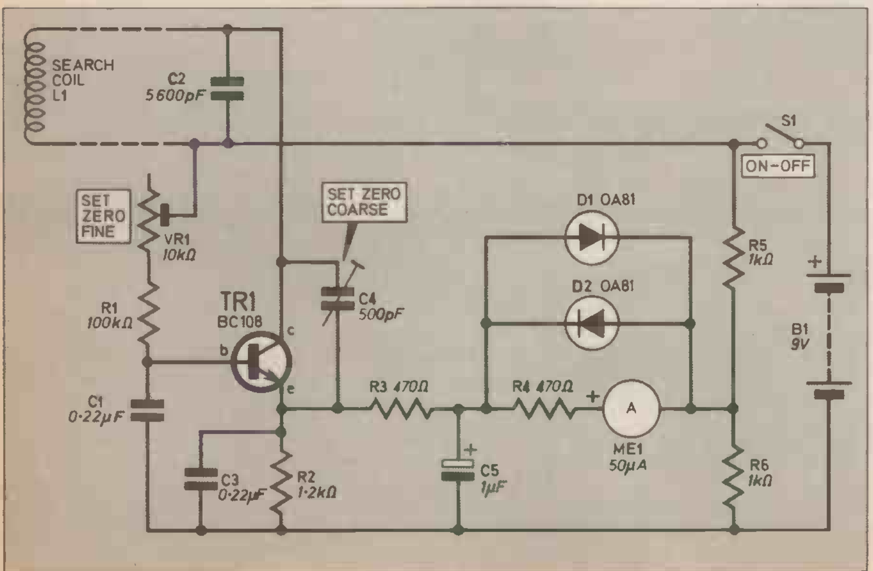


Fig. 1. Circuit diagram of the Metal Locator. The search coil L1 is mounted in the locator head and the dotted lines are the connecting wires to the circuitry.

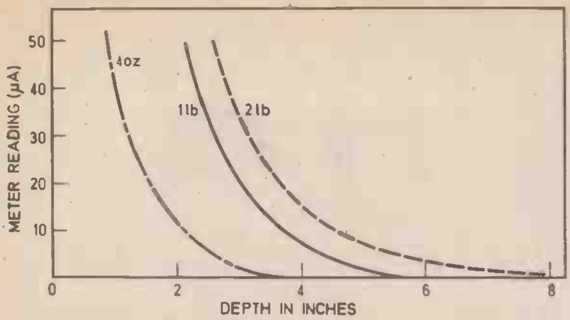


Fig. 2. Response curves of the Metal Locator.

plastic beaker to the pole opposite the handle, securely clamp the search coil between the boards, run twin leads from L1 to the beaker, and position the battery.

In the prototype, the battery was held in place behind the meter with a rubber band, as shown in the photograph, but it could equally well be fixed inside the beaker with a small clip or elastic band.

SETTING UP

Adjust VR1 to mid track, C4 to minimum capacitance (unscrewed), and switch on. The meter pointer should go beyond full scale. With the search coil well away from metal objects, screw in C4 until the meter reads somewhere between zero and full scale. Trim for a zero reading with VR1.

OPERATING LICENCE

The *Metal Locator* described in this article is designed to operate in the frequency band specified by the Ministry of Post and Telecommunications (16 to 150kHz). The circuit design of the locator should not be altered in any way that may affect the operating frequency.

A licence must be obtained before using the locator; this costs 75p for 5 years. An application form for a licence is obtainable from the Ministry of Post and Telecommunications, Waterloo Bridge House, Waterloo Road, London, S.E.1.

If the meter fails to read, or no response is obtained from adjustment of C4, check for wiring errors.

A certain amount of drift will be evident immediately after the locator has been switched on, therefore allow the circuit to settle down and then readjust C4 and VR1. Locator response can then be checked with metal weights and compared with Fig. 2.

Increased sensitivity can be achieved by reducing the value of C3 to 0·15μF, but this will enhance circuit drift to the point where frequent adjustment of VR1 is necessary. Conversely, drift and sensitivity will be reduced if C3 is increased in value.

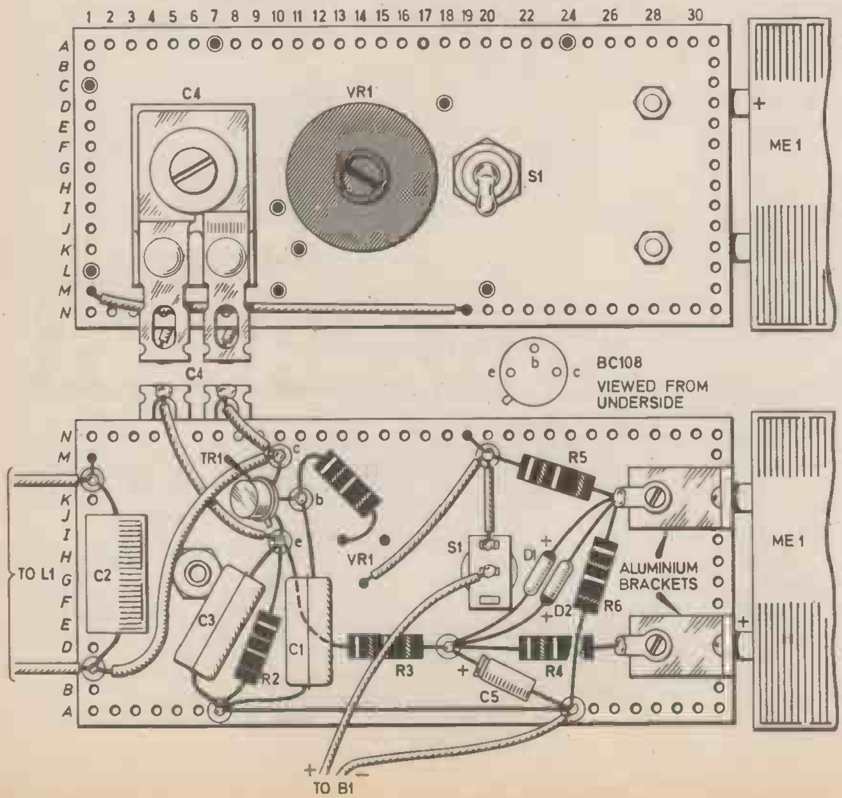


Fig. 3. Top and underside views of the circuit board and meter assembly. The circled connections represent the terminal pins used in the construction of this item. These pins are clearly indicated in the top diagram.

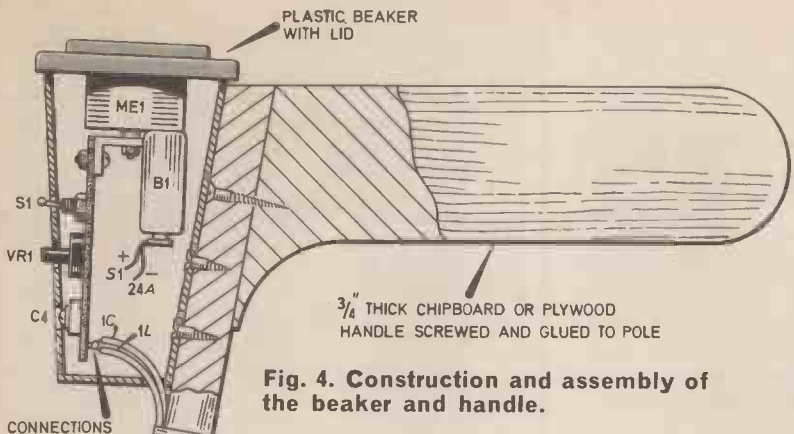


Fig. 4. Construction and assembly of the beaker and handle.

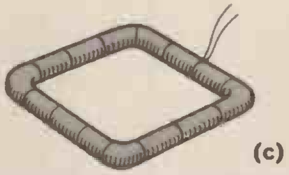
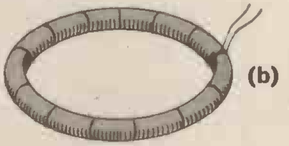
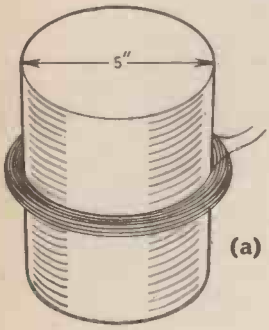
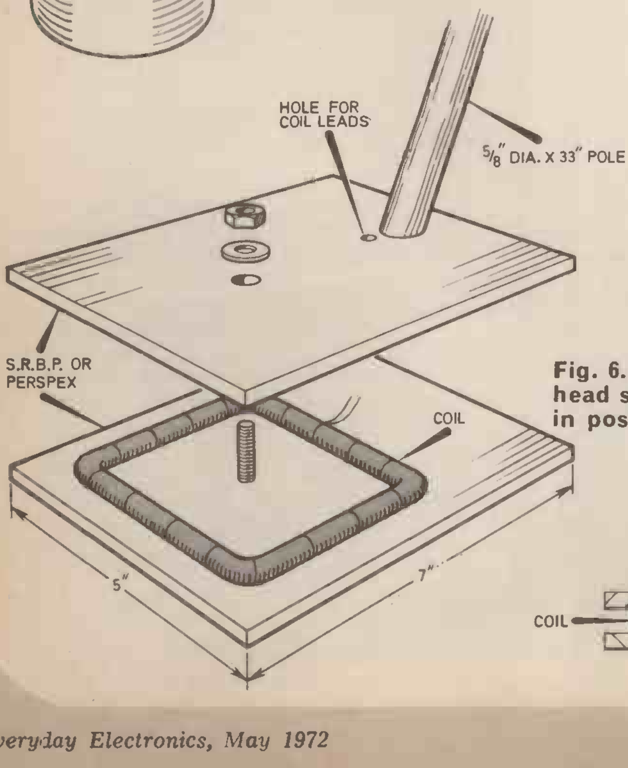


Fig. 5 (a). Coil wound on former (b) Coil removed from former and bound with tape (c) Shaped coil.





METAL LOCATOR



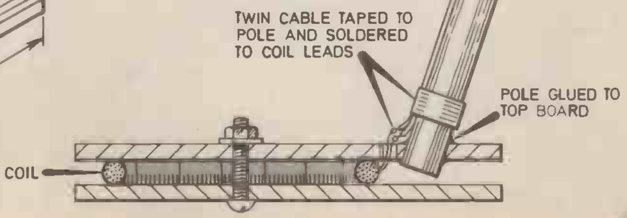


Fig. 6. Construction of the locator head showing how the coil is held in position.

Components....

Resistors
R1 100kΩ
R2 1·2kΩ
R3 470Ω
R4 470Ω
R5 1kΩ
R6 1kΩ
All ± 10% ½ watt carbon.

SEE SHOP TALK

Capacitors
C1 0·22μF polyester 250V
C2 5,600pF polystyrene
C3 0·22μF polyester 250V
C4 500pF mica compression trimmer
C5 1μF elect. 12V

Semiconductors
TR1 BC108 silicon *npn*
D1 OA81
D2 OA81

Meter
ME1 50μA f.s.d. moving coil. SEW type MR 38P

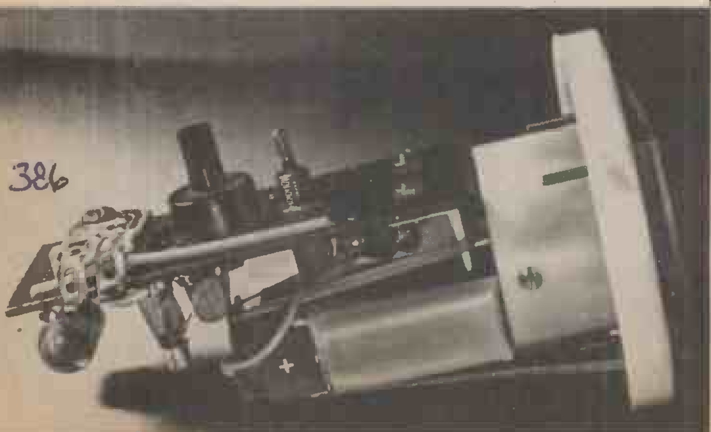
Switch
S1 S.P.S.T. sub-miniature toggle

Miscellaneous
VR1 10kΩ miniature carbon T.V. type preset B1 PP3 battery. Circuit board 3·1 inch by 1·4 inch plain, perforated 0·1 inch matrix Veroboard and Veropins. 26 s.w.g. cotton covered or enamelled copper wire, plastic beaker (see text), connecting wire, wood and screws for assembly, ½in aluminium angle for brackets.

USE

The locator is now ready for use and can be used for beachcombing or searching the back garden or waste ground. The locator may be subjected to damp and the pole, in particular, should be painted for protection if nothing else.

Photograph showing the construction of the circuit board and meter mounted on the beaker lid.



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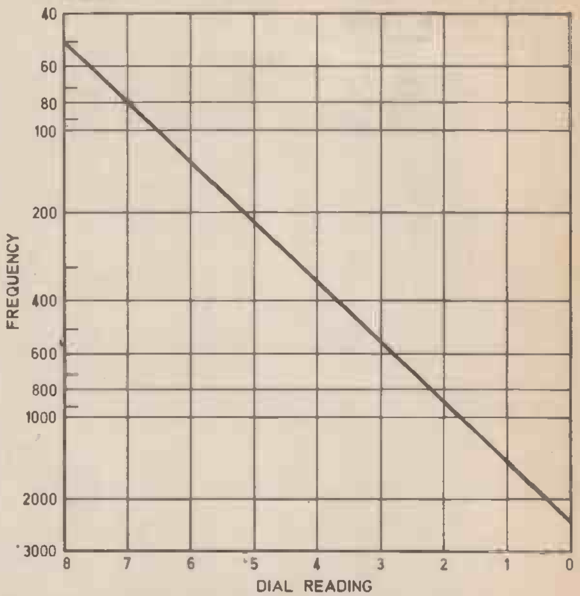


Fig. 8. Approximate output frequency for various control settings.

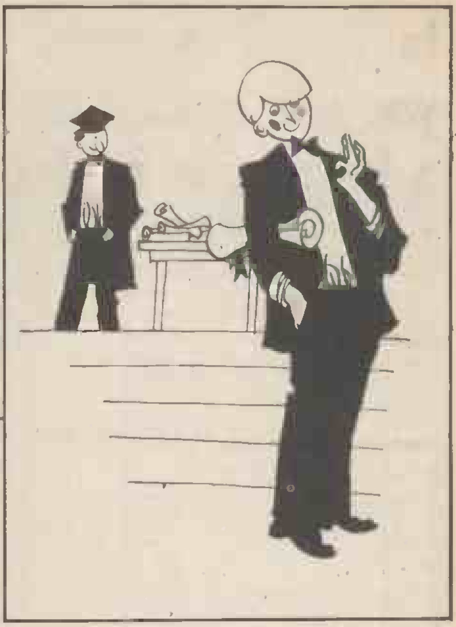
FINAL ASSEMBLY

Final assembly amounts to attaching the front panel to the box frame with self tapping screws, fitting the battery inside and fitting rear panel.

The generator can be connected to the input of any amplifier but the signal output level should be adjusted in accordance with that required by the amplifier input. To comply with the calibration chart given in Fig. 8 turn VR1 fully anti-clockwise and fix the frequency control knob to read zero. The output control knob is fixed in the same way i.e., to read zero with VR2 fully anti-clockwise.

The Audio Tone Generator is now ready for use and can be tried out in conjunction with a tape recorder.

TEACH-IN
Half term test
ANSWERS



Last month we posed some problems under the heading *Teach in Half-Term Test*. We will now answer those problems and try to show how we arrived at the answers. If you have got some of them wrong do not worry, just try and follow our explanation and see where you went wrong.

(1) They flow from negative to positive in reality. Although we assume that conventional current flows from positive to negative the actual electrons flow from negative to positive.

(2) (b) μA (microamps), (e) A (amps)

(3) 22 volts. $V = IR$ hence $V = 0{\cdot}01 \times 2{\cdot}2 \times 1{,}000 = 22V$

(4) It does not matter. All the resistor does is to limit the current; this can be done at any point around the circuit.

(5) 2·8mA. Total resistance is $2{\cdot}2k\Omega + 1k\Omega = 3{\cdot}2k\Omega$.

Current flow $I = \frac{V}{R} = \frac{9}{3{\cdot}2 \times 1{,}000} = 2{\cdot}8 \div 1{,}000A = 2{\cdot}8mA$

(6) R1 and R3 ½W, R2 1W. Total circuit resistance

$$R_T = R1 + \frac{R2 \times R3}{R2 + R3} = 10 + 33{\cdot}3 = 43{\cdot}3\Omega.$$

$$\text{Total current } I = \frac{V}{R} = \frac{9}{43{\cdot}3} = 0{\cdot}21A$$

Dissipation of $R1 = I^2R = 0{\cdot}21 \times 0{\cdot}21 \times 10 = 0{\cdot}44W$. The nearest commercial rating is ½W. Next calculate the voltage drop across R2 and R3 together $V = IR = 0{\cdot}21 \times 33{\cdot}3 = 7V$.

We know that $W = I^2R$, but $I = \frac{V}{R}$ therefore

$W = \frac{V}{R} \times \frac{V}{R} \times R$ and, cancelling $W = \frac{V^2}{R}$

$$\text{Dissipation in R2} = \frac{V^2}{R} = \frac{7 \times 7}{50} = \frac{49}{50} = 0{\cdot}98W$$

$$\text{Dissipation in R3} = \frac{V^2}{R} = \frac{49}{100} = 0{\cdot}49W$$

(7) 0·4W or 400mW. Maximum dissipation occurs when the value of VR1 equals that of R1 i.e. 50Ω. When both resistors are of equal value the voltage drop across each is half the voltage drop across both, therefore, maximum dissipation in VR1

$$= \frac{V^2}{R} = \frac{4{\cdot}5 \times 4{\cdot}5}{50} = \frac{20{\cdot}25}{50} = 0{\cdot}405W$$

(8) (a) 4·7kΩ ± 10%
(b) 22kΩ ± 5%
(c) 100kΩ ± 10%

(9) (b) 20μF 40V. In most applications using electrolytic capacitors the capacitance must be greater than a certain value; the tolerance of a normal 16μF would encompass 20μF. The important thing is that the working voltage is the same or greater.

(10) Reject it politely. He has given you a 120,000pF or 0·12μF capacitor. Check to see if he has the precise value and, if he does not, you may as well take this one, since it should be near enough to use as a substitute.

(11) C1 will charge up the fastest as it has the lowest value and is being charged through the lowest value resistor.

(12) C2 will take the longest time to charge, as it has the highest value and is being charged through the highest value resistor.

(13) Forward biassed. The conventional current flows from positive to negative and can thus flow through the diode in the direction of the arrow.

(14) 100V and 100mA. Peak reverse breakdown voltage will be the battery voltage. Since in the reversed biassed condition there is negligible current flowing R1 will not drop any voltage and the full supply voltage will appear across D1. In the forward biassed condition the diode can be assumed to be a short circuit thus only R1 can limit the current flowing hence

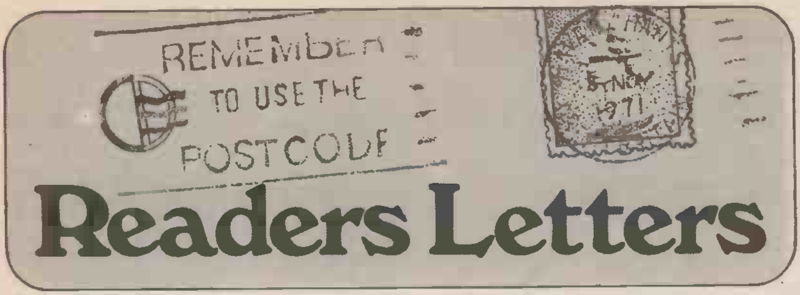
$$I = \frac{V}{R} = \frac{100}{1 \times 1{,}000} = 0{\cdot}1A \text{ or } 100mA$$

(15) (d) 100V, 150mA. Both ratings given are minimum ratings, 0·1A = 100mA.

(16) (b) 0·6V. As the diode is forward biassed the voltage would be 0·6V. There is always a voltage drop of approximately 600mV across silicon diodes due to the "knee" in the characteristic.

Well, how did you fare? If you got them all right that is excellent, if you did not the important thing is that you understand where you had difficulties. We suggest that you re-read the relevant sections of the *Teach-In* series.

We hope that you found the questions a challenge and at the same time they have opened your eyes to some calculation methods—particularly the calculation of dissipation. If you used $W = I^2R$ instead of deriving $W = \frac{V^2}{R}$ this does not matter but it may pay to look for an easier way next time.



Readers Letters

Bias Value

Having been a subscriber to *P.E.* and *P.W.* "off and on" for about 10 years I came across the January issue of EVERYDAY ELECTRONICS, which had my instant approval and now joins the rank of my other magazine's culminating in an endless and very informative pile on top the piano.

I find it is a magazine not only of theoretical enthusiasm but of great practical interest to the "everyday handyman" and certain to be a book for beginners, especially the very helpful facts "projected" by Mike Hughes, M.A.

I would hope in the future that perhaps Mr. Hughes could give reference to finding values of bias resistors, etc., needed for the satisfactory operation of different transistor parameters, and also relevant circuit operation of thyristors, unijunction and field effect transistors and other very useful flexible types of semiconductors.

Noticing other readers' troubles referring to the *Electro Laugh*, I also constructed this article and it worked first time owing to the way I adopt when working on, or constructing any project, I always check the finished article with the actual circuit diagram thus finding our little friend Q7 and P7.

Unfortunately the only earphone I had was a high impedance crystal type, but by connecting a resistor in the region of 250 ohms in parallel with it, it brought the overall impedance down to a satisfactory level with a slight reduction in volume.

J. Mason
S. Wales

We doubt if Teach-In *will be able to meet all your needs as it will finish after 12 months. However we will be publishing further series that should help.*

Another Bug

Naturally, I was quite flattered to discover that you had found my letter sufficiently interesting for inclusion in *Readers Letters* (March issue), however, I must admit that my pleasure was mixed with large helpings of disappointment and frustration due to your editing of the letter.

I am not complaining at all about the amount of space allocated to my comments—I realise you have the right to include only that which in your wisdom you decide is worthy of publication.

My complaint is that you have entirely neglected to make even a brief reference to what was after all the main point of my letter—the difficulty of obtaining items advertised in your magazine. By omitting any reference to this frustrating situation, my letter as printed is sailing under false colours—the few minor constructional queries were in fact, sorted out by trial and error once I got going. The real reason for being unable to get cracking was not so much mounting components, as actually getting hold of them!

The fact that you completely ignored my comments regarding suppliers leads me to two conclusions:

(One) That you accepted my comments to be an exaggeration of a somewhat hysterical nature, and were not a true picture of the real situation, or

(Two) That you accepted my statements as correct, but did not wish to offend your advertisers whose business you must obviously wish to retain.

With regard to the former, I feel I must now justify my remarks by quoting a few of the more deplorable examples of SERVICE, and leave you to form your own conclusions. These examples are on a separate sheet herewith enclosed.

Regarding (Two), whilst I realise that you are not to be held responsible for goods or services advertised in your columns, you do, however, have a moral responsibility to your readers. After all, it is you that place these offers before us, the readers, and if for example, I had not seen a certain item offered in your magazine, then I would have been saved the trouble and frustration that followed when the item failed to arrive, and all attempts to obtain satisfaction are largely ignored.

However, I have now found a couple of very good suppliers whose friendly, courteous, and extremely efficient service have allowed me to obtain some of the pleasure that I had hoped would be derived from my new hobby (Galleon Trading Co. and Radio Exchange Co.).

To date I have completed several very efficient radios, some from kits; also the *Astron*, a general purpose amplifier, and one or two other gadgets, and success rate so far is quite satisfactory, so the situation is not too black after all.

J. G. Richards
Sale, Cheshire

The above correspondent supplied us with details of orders placed with four different advertisers, none of which had been expediently dealt with, at the time of writing.

We have investigated all of these cases on behalf of our reader. The delays, regrettable as they are, seem to be unavoidable and can be largely attributed to the phenomenal success of this magazine's declared intention to popularise the hobby of electronics!

As a consequence, our advertisers are sometimes overwhelmed by a flood of orders, and delays do therefore sometimes arise. But we know all our advertisers make determined efforts to clear their back-log of orders as quickly as possible.

We, on our part, will always investigate any serious and reasonable complaints, on behalf of our readers.

Cell Life

I have just read the March issue of EVERYDAY ELECTRONICS and thoroughly appreciated the *Ruminations* by Sensor where he mentioned the tin saw and how much damage could result to a

MULTI-SPEED MOTOR

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000; 12,000 & 15,500 r.p.m. shaft is ¼ in. diameter 230/240v. Its speed may be further controlled with the use of our Thyrister controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 88p plus 23p postage and insurance.

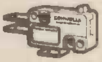
RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1 each or £11 per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

MAINS TRANSISTOR POWER PACK

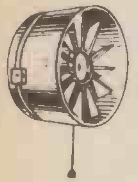
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 83p, plus 20p postage.

MICRO SWITCH



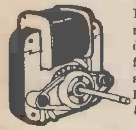
5 amp. changeover contacts, 9p each, £1 doz. 15 amp. Model 10p each or £1·05 doz.

EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets, £2 plus 36p post and ins.

MAINS MOTOR



Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 50p. Postage 15p for first one then 5p for each one ordered.

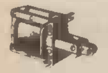
THERMOSTAT

Continuously variable 30°-90° C. Has sensor bulb connected by 33in. of flexible tubing. On operation a 15 amp 250 volt switch is opened and in addition a plunger moves through approx ⅛in. This could be used to open valve on ventilator etc. £1·50 plus 23p p. & ins.

5A 3-PIN SWITCHED SOCKETS

An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only 50p plus 18p post and insurance. (20 boxes post free).

MAINS OPERATED SOLENOIDS

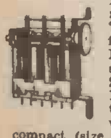


Model 772—small but powerful 1" pull—approx. size 1½" × 1¼" × 1½". 60p. Model 400/1 ⅜" pull. Size 2¼" × 2" × 1¾". 75p. Model TT10 1¼" pull. Size 3" × 2½" × 2½". £1·80 plus 20p post and insurance.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 38p. KNUCKLED MODEL FOR F.M. 50p.

3 STAGE PERMEABILITY TUNER

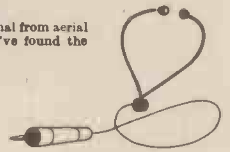


This Tuner is a precision instrument made by the famous 'Cyldon' Company for the equally famous Radiomobile Car Radio. It is a medium wave tuner (but set of longwave coils available 25p) with a frequency coverage 1620 Kc/s-525 Kc/s and intended to operate with an I.F. value of 470 Kc/s. Extremely compact (size only 2½ × 2 × ⅞ins. thick) with reduction gear for fine tuning. Snip price this month 50p, with circuit of front end suitable for car radio or as a general purpose tuner for use with Amplifier. Post free.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as PW circuit £5·95 plus 20p p. & p. De-luxe model with prepared circuit board £6·95. When ordering please state whether for positive or negative systems.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra post and ins. 20p.

STANDARD WAFER SWITCHES

Standard size 1¼" wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10way	12way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

THYRISTOR LIGHT DIMMER

For any lamp up to 200 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £1·99 plus 20p post and insurance.

THIS MONTHS SNIP

1 HOUR MINUTE TIMER. Made by Smiths complete with control knob and calibrated dial. This month's special bargain at 50p. Useful in the Kitchen, Office and Dark-room etc.

MULLARD AUDIO AMPLIFIER MODULE

Uses 4 transistors, and has an output of 750mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up .9 volt battery operated. Size 2" long × 1½" wide × 1" high.

SPECIAL SNIP PRICE 60p each. 10 for £5.

POCKET CIRCUIT TESTER

Test continuity for any low resistance circuit, house wiring, car electrics. Test polarity of diodes and rectifiers. Also ideal size for conversion to signal injector (circuit supplied), 30p or 2 for 50p. Post paid.

METAL LOCATOR
AUDIO TONE GENERATOR
BEE COUNTER

To receive details on these kits send s.a.e. for parts list.

MULLARD I.F. MODULE

This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. 75p each. 10 for £6·75. 100 for £62·50. With connection dia.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·25 plus 23p P. & I

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3½" x 6½" x 2" with leads and prods. Price £1·75 plus 20p postage.

Thermostat with Probe. Made by the famous Ranco Thermostat Co. Covers the range from approx. 0°–20°C. variable by a control spindle, handles currents up to 16 amps. Length of capillary and sensor tube approx. 3' 6". These are ideal for ovens and as a general purpose thermostat. Price 50p each or 10 for £4·50.

Small Tuning Condenser as fitted to many imported Japanese and Hong Kong radios. 2 gang about 200PF per gang. Size approx. 1" × 1" with a ¼" diameter spindle with dust cover. 25p each or 10 for £2·25.

Heat Sink. Small type as used with OC81 etc. Price 5p each or 10 for 45p.

Spectacle Frames. (No lenses) with built-in hearing aids. The amplifier and battery being housed in the arms. Although these are complete hearing aids we are selling them purely for the sub miniature components they contain. We give no guarantee that they are in working order also these may be secondhand. Price £2·50 each.

Foot Switch. Twin levers each of which operates a 10 amp QMB changeover switch. Price 90p each.

Programmers. 5 Revs per minute. Made by Magnetic Devices Ltd. The contacts may be set to trigger anywhere around the shaft, ideal for motivated lighting displays, sequential switching etc. Drive motors are 200–240v 50Hz. Model A has 5 change over contacts. Price £1·50. Model B has 11 change over contacts. Price £3.

Radiant Cooker Rings. As fitted to Tricity and many other popular cookers. We have two types. These are copper clad ¼" tubular construction. Both models having an external diameter of 6½" and the elements have been slightly flattened to increase radiation.

Backer Model 7D1 MkII again 2000 watts rated but 230–240v, has no cover over element ends. Price 65p each or 10 for £5·85.

Slide Switch. 2 pole change over panel mounting by two 6 BA screws. Size approx. 1" × ½" rated 250v lamp, 6p each. 10 for 54p. 100 for £5·10. 500 for £24.

As above but for printed circuit 5p each, 10 for 45p, 100 for £4·25.

Sub Miniature Slide Switch. DPDT 19mm (¾" approx.) between fixing centres. 12p each or 10 for £1·08.

KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

HOME SENTINEL INTRUDER ALARM
Electronic Components with suitable case .... £3·75
SNAP INDICATOR 75p
WINDSCREEN WIPER CONTROL
Components including metal for chassis £2
RECORD PLAYER. All components, but not case, loudspeaker, record deck or pick-up .... £5·50
DEMO DECK .... £6·75 POST PAID
FUZZ BOX .... £1·85
PHOTOGRAPHIC COLOUR TEMPERATURE METER .... £2·65
ASTRON RADIO £3
REMOTE TEMPERATURE COMPARATOR .... £4·25
ELECTRO LAUGH £2
TRANSISTOR MICROPHONE .... £1·70
AUTO ALERT
All electronic parts and metal bracket £2·50
RAIN WARNING ALARM
All electronic parts and chassis .... £1·80
WA-WA PEDAL .... £2·90
DARKROOM TIMER .... £4·50
SIGNAL INJECTOR 80p
SOIL MOISTURE METER .... £3·00
SIMPLE CALCULATOR .... £2·20
D.C. POWER SUPPLY .... £5·00
BABY ALARM .... £4·00

Mains Transformer. Primary 240v. tapped 220v. Secondary 20v. ½ amp. Price 60p each or 10 for £5·40.

Dial Thermometer—reading from 200–525F used on Tricity and other cookers. This has a flange and can be mounted through a 1½" hole or alternatively it can just be rested on the object whose temperature it is required to measure. Size 2 × ⅞" overall diameter. Depth ⅜" below and ½" above mounting panel. Price 80p each or 10 for £7·20p.

24-HOUR TIME SWITCH

Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. £2·50 post and ins. 23p. Additional time contacts 50p pair.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semiconductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.) 7 Park Street, Croydon CRO IYD

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AC127Z	50p
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AC176	20p
AC187	25p
AC188	25p
ACY17	30p
ACY18	25p
ACY19	25p
ACY20	20p
ACY21	20p
ACY22	10p
ACY39	55p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	50p
AD149	50p
AD161	35p
AD162	35p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF124	25p
AF125	20p
AF126	20p
AF127	20p
AF139	30p
AF180	50p
AF181	45p
AF185	50p
AF186	40p
AF239	40p
ASY26	25p
ASY27	30p
ASY28	25p
ASY29	30p
ASZ21	55p
BA100	15p
BA102	30p
BA110	25p
BA115	7p
BAX13	5p
BAX16	7p
BAY31	7p
BAY38	15p
BC107	10p
BC108	10p
BC109	10p
BC109C	12p
BC113	10p
BC114	20p
BC115	20p
BC116	20p
BC116A	25p
BC117	20p
BC118	20p
BC119	30p
BC134	20p
BC135	15p
BC136	20p
BC137	20p
BC138	20p
BC147	12p
BC148	10p
BC149	12p
BC153	20p
BC154	20p
BC167	15p
BC169	12p
BC169C	15p
BC177	20p
BC178	20p
BC179	20p
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BF197	15p
BFX13	25p
BFX29	25p
BFX30	25p
BFX84	25p
BFX85	30p
BFX86	25p
BFX87	25p
BFX88	20p
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OC24	60p
OC25	40p
OC26	25p
OC28	60p
OC29	60p
OC35	50p
OC36	60p
OC42	40p
OC43	50p
OC44	15p
OC45	12p
OC70	12p
OC71	12p
OC72	20p
OC75	25p
OC76	25p
OC77	40p
OC81	20p
OC81D	20p
OC81Z	40p
OC83	25p
OC84	25p
OC139	25p
OC140	40p
OC141	60p
OC170	25p
OC171	30p
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ZTX501	15p
ZTX502	20p
ZTX503	17p
ZTX504	40p
ZTX531	26p
IN914	7p
IN916	10p
IN4148	7p
IS44	7p
IS921	7p
IS922	8p
2G301	25p
2G302	30p
2G303	35p
2N404	20p
2N696	15p
2N697	15p
2N698	30p
2N706	10p
2N706A	12p
2N708	15p
2N930	20p
2N987	40p
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2N1303	18p
2N1304	22p
2N1305	22p
2N1306	25p
2N1307	25p
2N1308	25p
2N1309	25p
2N1613	20p
2N2147	75p
2N2160	60p
2N2217	25p
2N2218	20p
2N2218A	25p
2N2219	20p
2N2219A	25p
2N2220	25p
2N2221	20p
2N2221A	25p
2N2222	20p
2N2222A	25p
2N2369	15p
2N2369A	15p
2N2646	40p
2N2904	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906	20p
2N2906A	25p
2N2907	23p
2N2907A	25p
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7400	Quadruple 2-input NAND gates	20p	18p	14p	14p	12p
7401	Quad 2-input open collector NAND gates	20p	18p	16p	14p	12p
7402	Quad 2-input NOR gates	20p	18p	16p	14p	12p
7403	Quad 2-input open collector NAND gates	20p	18p	16p	14p	12p
7404	Hextuple inverters	20p	18p	16p	14p	12p
7405	Hex inverters with open collector outputs	20p	18p	16p	14p	12p
7410	Triple 3-input NAND gates	20p	18p	16p	14p	12p
7413	Dual 4-input Schmitt triggers	30p	27p	25p	22p	20p
7420	Dual 4-input NAND gates	20p	18p	16p	14p	12p
7430	Single 8-input NAND gates	20p	18p	16p	14p	12p
7440	Dual 4-input NAND buffer gates	20p	18p	16p	14p	12p
7441	BCD-Decimal decoder/Nixie driver	75p	72p	70p	60p	55p
7442	BCD-Decimal decoder (4-10-line) TTL O/P	75p	72p	70p	60p	55p
7443	Excess 3-Decimal decoder TTL outputs	£1·00	95p	90p	80p	70p
7447	BCD-Decimal 7 seg. decoder/indicator driver	£1·75	£1·60	£1·45	£1·30	£1·15
7448	BCD-Decimal 7 seg. decoder/driver TTL O/P	£1·75	£1·60	£1·45	£1·30	£1·15
7450	Expand dual 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
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7453	Quad 2-input expand AND-OR-INVERT gates	20p	18p	16p	14p	12p
7454	4-wide 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
7460	Dual 4-input expanders	20p	18p	16p	14p	12p
7470	Single J-K flip-flop (gated inputs)	30p	27p	25p	22p	20p
7472	Single J-K flip flop (gated inputs)	30p	27p	25p	22p	20p
7473	Dual J-K flip flop	40p	37p	35p	33p	30p
7474	Dual D flip flop	40p	37p	35p	33p	30p
7475	Quadruple bistable latch	45p	42p	40p	38p	35p
7476	Dual J-K flip-flops with Preset and Clear	40p	37p	34p	31p	28p
7480	Gated Full Adder	80p	72p	67p	59p	55p
7481	16-bit read/write memory	£1·25	£1·15	£1·10	£1·00	90p
7482	2-bit binary Full Adder	87p	80p	70p	65p	60p
7483	4-bit binary Full Adder	£1·00	90p	85p	80p	73p
7484	16-bit RAN with gated write inputs	90p	85p	80p	75p	71p
7486	Quadruple 2-input Exclusive OR gates	45p	41p	38p	35p	33p
7490	BCD decade counter	75p	70p	65p	60p	55p
7491	8-bit shift register	£1·00	95p	90p	80p	70p
7492	Divide twelve counter	75p	70p	65p	60p	55p
7493	4-bit binary counter	75p	70p	65p	60p	55p
7494	Dual entry 4-bit shift register	80p	75p	70p	65p	60p
7495	4-bit up-down shift register	80p	75p	70p	65p	60p
7496	5-bit parallel/serial in/out shift register	£1·00	97p	95p	90p	83p
74100	8-bit bistable latch	£2·50	£2·30	£2·00	£1·75	£1·50
74118	Hextuple Set-Reset latches	£1·00	95p	90p	80p	70p
74121	Monostable multivibrators	60p	55p	50p	46p	41p
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74150	16-bit data selector/multiplexer	£3·35	£3·20	£2·95	£2·15	£2·05
75151	8-bit data selector/multiplexer	£1·10	95p	90p	80p	70p
74153	Dual 4-line to 1-line data selector multiplexer	£1·35	£1·27	£1·20	£1·15	£1·10
74154	16-bit decoder/demultiplexer	£2·00	£1·75	£1·55	£1·30	£1·05
74155	Dual 2-line to 4-line decoder/demultiplexer	£1·55	£1·47	£1·35	£1·10	£1·05
74156	Dual 2-line to 4-line decoder/demultiplexer	£1·55	£1·47	£1·35	£1·10	£1·05
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74191	Sync 4-bit up-down counter, 1-line mode	£1·95	£1·85	£1·75	£1·60	£1·50
74192	Sync decade up-down counter, 2-line mode	£2·00	£1·90	£1·80	£1·65	£1·55
74193	Sync 4-bit up-down counter, 2-line mode	£2·00	£1·90	£1·80	£1·60	£1·40
74196	Asynchronous presettable decade counter	£1·50	£1·40	£1·30	£1·10	£1·00
74197	Asynchronous presettable 4-bit binary counter	£1·50	£1·40	£1·30	£1·10	£1·00

Complete data on the above in booklet 20 pages, Ref. 29, issue 2 at 15p post paid.

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TRIACS

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SC35D	400	3 amps	90p
SC40A	100	6 amps	90p
SC40B	200	6 amps	£1·05
SC40D	400	6 amps	£1·00
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SC45B	200	10 amps	£1·15
SC45D	400	10 amps	£1·25
SC50 A	100	15 amps	£1·35
SC50B	200	15 amps	£1·45
SC50D	400	15 amps	£1·75
SC40E	500	6 amps	£1·25
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SC50E	500	15 amps	£1·95
DIAC SD2			25p

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1 AMP MINIATURE PLASTIC WIRE ENDED

Type	P.I.V.	1-49	50+	100+	500+	1000+
1N4001	50	6p	5p	4½p	4p	3½p
1N4002	100	7p	6p	5p	4½p	4p
1N4003	200	8p	7p	6p	5p	4½p
1N4004	400	8p	7p	6p	5p	4½p
1N4005	600	10p	9p	8p	7p	6p
1N4006	800	12p	10p	9p	8p	7p
1N4007	1000	15p	12p	10p	9p	8p

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1002	100	2a	55p	4004	400	4a	75p
2002	200	2a	65p	6004	600	4a	80p
4002	400	2a	75p	1006	100	6a	70p
6002	600	2a	80p	2006	200	6a	75p
1004	100	4a	65p	4006	400	6a	£1·00
2004	200	4a	70p	6006	600	6a	£1·10

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1000 + 5p

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beginner's enthusiasm.

When I read about the *Signal Injector* by Alan Jardine I was reminded of the poor beginner.

Following the instruction to solder the leads direct on to the cell will result in heating up the electrolyte and a very short life for the cell.

Perhaps this is not important as the choice of a push-on/push-off switch allows no easy means of knowing if the thing is on or off. Very few beginners will remember to test each time, and cell life will be short it is expected. A push button perhaps?

The blind cannot be expected to lead the blind, and beginners are usually short of experience.

R. Quorn
Sussex

Of your two points concerning the Signal Injector, *the first is a bit exaggerated. It is true that the cell life will be reduced by applying heat (from soldering iron) to the battery terminals but this is only negligible for the time required to execute the connection.*

To install a holder to suit this type of battery would increase the cost by about 40 per cent.

We agree that it will be difficult to tell if the unit is on or off when not in use, but it can be determined; when the unit is "on" the push button will feel "loose" but in the "off" position this looseness disappears.

If this proves unsatisfactory a push-to-make release off type can be substituted.

More Accurate Timer

May I thank you for publishing another article combining the hobbies of electronics and photography (ref. *Darkroom Timer*, March issue).

Although of excellent design, I feel it must be stated that a timer with only a 5 second timing intervals is not nearly accurate enough for the demands of the high quality black and white or well balanced colour prints that are required. However, with a small modification, I have found that the timer may be converted to an accurate piece of equipment having a timing range of 5 to 45 seconds in one second steps.

The modification requires four extra components, which are a 5 position two-pole switch (S4), VR5, VR6 and VR7 which are skeleton presets of the values, 5 kilohm, 10 kilohm and 20 kilohm respectively.

These components form an additional timing circuit which is connected in series with the original (R_t).

Position 1 of the switch has no further resistance and acts as a short circuit; position 2 connects VR5 into circuit, whilst position 3 connects VR6; position 4 connects VR5 and VR6 and position 5 connects VR7 into circuit.

Each position of the new switch is to represent a further one second delay.

Position 1 of course, has no further delay, position 2 however, will give a one second delay, position 3 two seconds etc. when the presets are set as they were in the original timing circuit.

Now, any time, in one second steps may be selected from 5 to 45 seconds by selecting the required 5 second range, plus the required extra time (if any) on the new switch.

D. G. Smith
Emsworth, Hants.

Components

Let me say first of all how much I enjoy your magazine and as a newcomer to electronics I find your *Teach-In* articles very interesting and also *Shop Talk*, etc. However, I wonder if I may make a suggestion?

I constructed your *Demo-Deck* and find that in following this series for a month or so there is a list of the more minor components used in the experiments and I wondered if it would be at all possible, either, preferably, if you could publish the list of all the components that would be required for the rest of this series in one complete list or if possible broken up into the individual months during which they will be required.

The reason I say this is, that I, like many of your other readers no doubt, have no local supplier of components in my immediate vicinity and it usually means a trip to Edinburgh or Glasgow to purchase these components.

However, if I could have a full list this would make things much easier for me. It would also make it much easier to send off a full list by post to a mail order firm rather than asking for two or three small components every month or so. I wonder if this could be done.

I am very grateful to you and wish you every success for your future publications.

R. L. Grant
Scotland

It was our intention to publish an advanced list and in future we shall be publishing, at the end of each Teach-In *every month, a list of components additional to those you have already acquired.*

Calling Gloucester

Now that I'm receiving your magazine on regular order and greatly enjoying it, I feel that I ought to go a stage further in order to get any lasting benefit from your guidance.

Can I please find out through your pages how many people in the Gloucester area are willing to ask for, and attend, an evening class on useful, basic "everyday electronics"?

Should anyone be interested, could they please write to me at the address given, then provided enough wish it, our local Education Authority can be approached with evidence that the need for such a class does exist.

Many thanks for giving me a chance to ask for these people through your very sensible magazine.

E. L. Payn
82 Innsworth Lane,
Longlevens,
Gloucester
GL2 0DE

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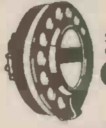

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BSY25	0·13	OC25	0·25
BSY26	0·13	OC26	0·25
BSY27	0·13	OC28	0·30
BSY28	0·13	OC35	0·25
BSY29	0·13	OC36	0·37
BSY95A	0·10	AD149	0·30
OC41	0·15	AUY10	1·25
OC44	0·13	2S034	0·25
OC45	0·10	2N3055	0·50
OC71	0·10		
OC72	0·10	**Diodes**	
OC81	0·13	AAY42	0·10
OC81D	0·13	OA95	0·09
OC83	0·18	OA79	0·09
OC139	0·13	OA81	0·09
OC140	0·15	IN9114	0·07

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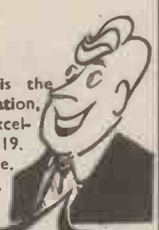

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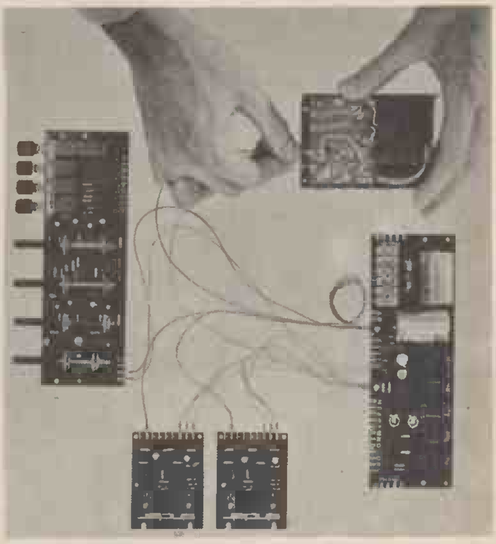
Project 605 the new simple way to assemble Sinclair high fidelity modules



For several years now you have been able to assemble your own high fidelity system to world beating standards using Sinclair modules. We have progressively improved these technically but hitherto the method of assembly at your end has remained the same – there has been no alternative to a soldering iron. Now for those who prefer not to solder, there is an alternative – Project 605.

In one neat package you can now obtain the four basic Project 60 modules plus a fifth completely new one – Masterlink – which contains all the input sockets and output components you previously bought separately. Also in the Project 605 pack are all the inter-connecting leads, cut to length and fitted at each end with plugs which clip straight onto the modules, eliminating soldering completely. The pack contains everything you need to build a complete 30 watt stereo amplifier together with a clear well illustrated Instruction Book. All you have to do is to arrange your modules in the plinth or case of your choice and then clip them together – the work of a few minutes.

Your hi-fi system will, as we said, match the finest in the world and you can add to it at any time to increase power or extend the facilities. For example a superb stereo FM Tuner unit is obtainable for only £25.

Guarantee If within 3 months of purchasing Project 605 directly from us, you are dissatisfied with it, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

sinclair

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St. Ives, Huntingdonshire PE17 4HJ.
Telephone: St. Ives (04806) 4311

Specifications

Output – 30 watts music power (10 watts per channel R.M.S. into 3 Ω).
Inputs – Mag. P.U. – 3mV correct to R.I.A.A. curve 20–25,000 Hz ± 1dB. Ceramic pick-up – 50mV. Radio – 50 to 150mV. Aux. adjustable between 3mV. and 3V.
Signal to noise ratio – Better than 70dB.
Distortion – better than 0.2% under all conditions.
Controls – Press buttons for on-off, P.U., radio and aux. Treble +15 to –15 dB at 10 kHz. Bass +15 to –15 dB at 100 Hz. Volume. Stereo Balance.
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Front panel – brushed aluminium with black knobs.

Project 605 comprises Stereo 60 pre-amp/control unit, two Z-30 power amplifiers, PZ-5 power supply unit, the unique new Masterlink, leads and instructions manual complete in one pack. Post free

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32/450V	20p	8+8/450V	18p	350+50/325V	50p
25/25V	10p	8+16/450V	20p	32+32+32/350V	48p
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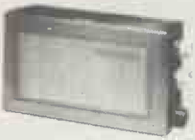

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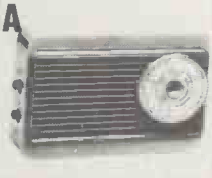

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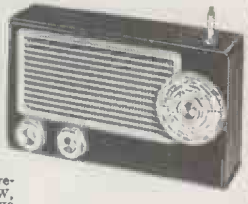

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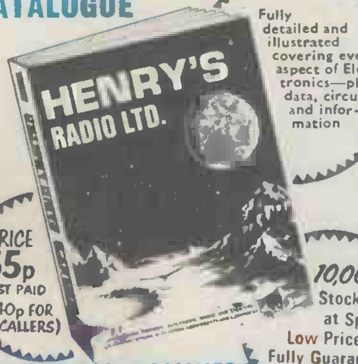

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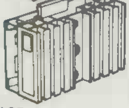

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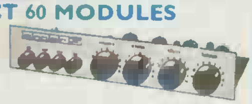

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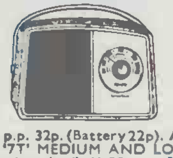

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Tel: 01-402 5854

P.A., Disco & Lighting Centre
309 EDGWARE ROAD, LONDON, W.2.
Tel: 01-723 6963

Mail Orders, Special Bargain Shop, Industrial Sales
303 EDGWARE ROAD, LONDON, W.2.
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