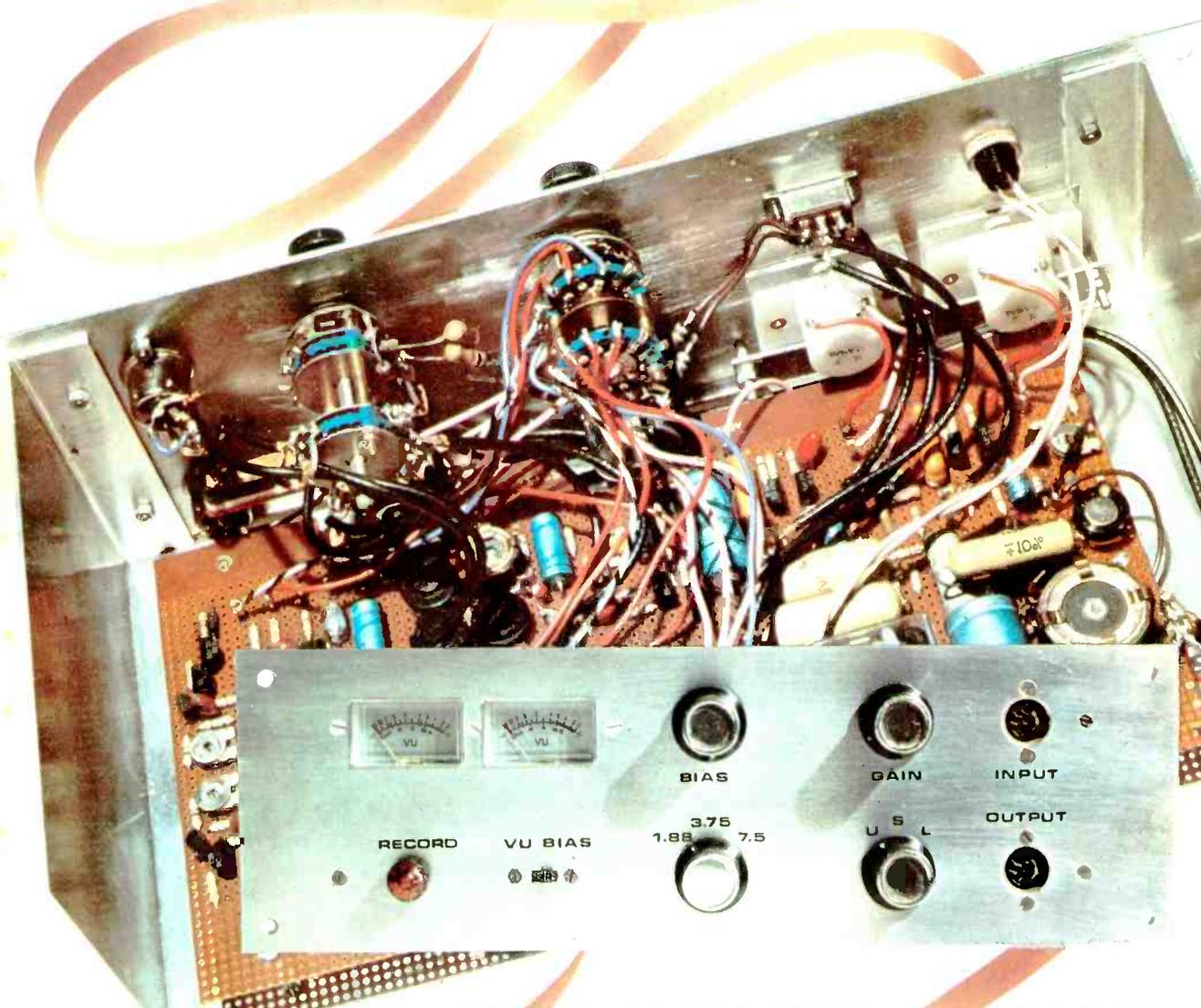


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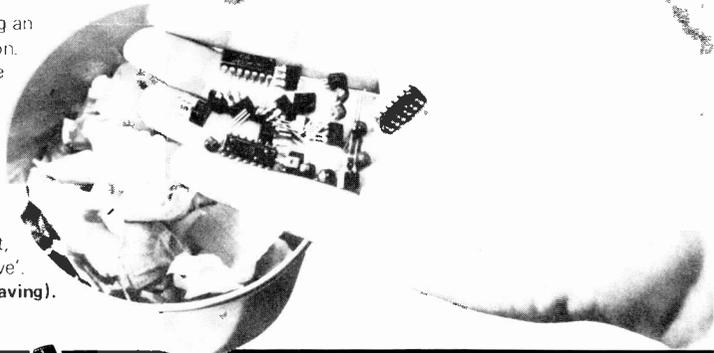
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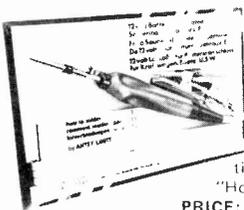
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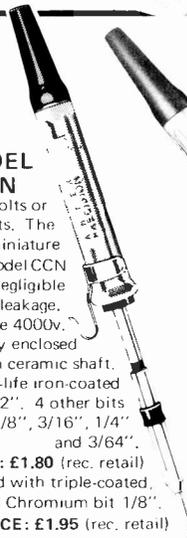
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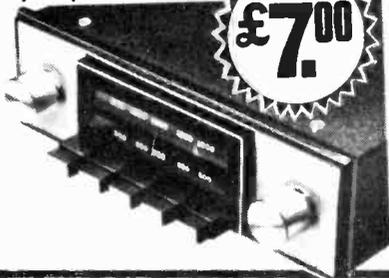
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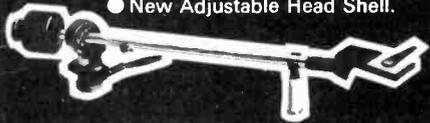
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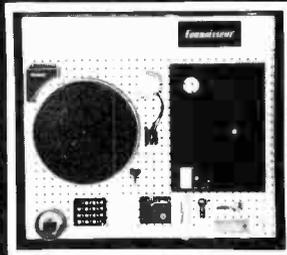
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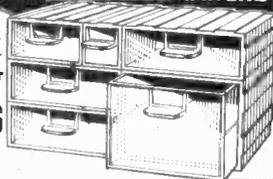
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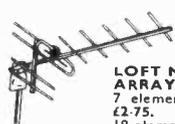
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8N7403	0-20	0-18	0-16	8N7454	0-20	0-18	0-16	8N74153	1-35	1-27	1-20
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8N7433	0-65	0-60	0-50	8N7497	0-85	0-80	0-75	8N74184	2-40	2-20	1-80
8N7437	0-65	0-60	0-50	8N7498	2-50	2-30	2-00	8N74185A	2-40	2-20	1-80
8N7438	0-65	0-60	0-50	8N74104	1-45	1-35	1-20	8N74190	1-95	1-85	1-75
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8N7442	0-75	0-72	0-70	8N74110	0-80	0-70	0-60	8N74193	2-00	1-90	1-80
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AA730 10p	BC147 12p	BU105 2.25	OC44 15p	T1843 35p	2N3085 55p
AA742 15p	BC159C 12p	BY100 15p	OC45 15p	V405A 25p	2N3440 75p
AAZ13 10p	BC182 10p	BY126 15p	OC57 50p	ZTX108 12p	2N3442 1.25
AC107 35p	BC214 15p	BY127 15p	OC71 15p	ZTX300 12p	2N3525 75p
AC126 25p	BCY32 75p	BYZ13 35p	OC72 25p	ZTX301 15p	2N3614 55p
AC127 25p	BCY34 35p	CI06D 65p	OC77 46p	ZTX302 18p	2N3615 75p
AC128 25p	BCY39 1.00	GET111 55p	OC81 1.5p	ZTX311 50p	2N3702 10p
AC176 25p	BCY42 30p	GET112 55p	OC83 25p	ZTX300 15p	2N3704 10p
AC187 25p	BCY43 25p	GET880 45p	OC140 55p	ZTX503 17p	2N3705 10p
AC188 25p	BCY55 2.50	LM309K	OC170 25p	ZG301 30p	2N3714 1.80
ACY17 30p	BCY70 15p	(T03) 1.87	OC171 30p	2N404 20p	2N3771 1.75
ACY20 20p	BCY71 20p	MAT121 25p	OC300 45p	2N527 35p	2N3773 2.00
ACY21 20p	BCY72 15p	MJE340 50p	OC901 75p	2N696 15p	2N3790 2.25
ACY39 55p	BCY87 2.90	MJE370 70p	OC920 85p	2N697 15p	2N3819 35p
AD140 50p	BCZ11 50p	MJE520 70p	OC923 50p	2N706 10p	2N3900 50p
AD149 50p	BD124 80p	MJE2955	OCPT1 1.25	2N930 20p	2N3866 15p
AD161 35p	BD131 75p	1-1.0	ORP12 50p	2N987 45p	2N3903 85p
AD162 35p	BD132 80p	MJE3055	ORP60 40p	2N1131 25p	2N3906 12p
AF117 20p	BF115 25p	75p	P346A 20p	2N1132 25p	2N4061 12p
AF118 50p	BF167 25p	MFP105 40p	RA8510 AP	2N1302 18p	2N4062 12p
AF124 25p	BF173 25p	NKT124 20p	RA8510 AP	2N1304 22p	2N4126 15p
AF139 30p	BF179 30p	NKT216 40p	RA8508 AP	2N1305 22p	2N4871 35p
AF186 40p	BF180 30p	NKT217 40p	55p	2N1307 25p	2N5457 30p
AF239 40p	BF194 15p	NKT403 70p	TAA263 75p	2N1308 25p	2N5777 50p
ASV27 20p	BF195 15p	NKT404 50p	TIL209 39p	2N1613 20p	28001 1-00
ASV28 25p	BF861 25p	OA5 50p	TIP29A 50p	2N1671 1.00	28012 1-00
BA102 30p	BF898 25p	OA10 35p	TIP30A 60p	2N2147 75p	28018 6.25
BA115 7p	BFX13 60p	OA81 10p	TIP31A 60p	2N2140 50p	28026 8.90
BA145 15p	BFX34 75p	OA91 7p	TIP32A 70p	2N2217 25p	28031 5.00
BAX13 5p	BFX37 30p	OA200 7p	TIP33A	2N2221 20p	28033 65p
BAX16 7p	BFX38 20p	OA202 10p	1.00	2N2222A	28324 95p
BC107 10p	BFY50 20p	OC16 75p	TIP34A	25p	40250 50p
BC108 10p	BFY51 20p	OC20 85p	TIP35A	1.50	40390 40p
BC109 10p	BFY52 20p	OC23 85p	2.50	2N2906 20p	40361 15p
BC109C 12p	BFY64 50p	OC25 40p	TIP36A	3.00	40362 50p
BC113 10p	BLX36 8.00	OC35 60p	3.00	cols) 10p	40486 75p
BC117 20p	BRY20 15p	OC36 65p	TIP41A 75p	2N3053 20p	40636 1-10
BC143 35p	BSY27 15p	OC42 40p	TIP42A 85p	2N3054 50p	40430 1-00

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 (8 Lead) D.I.L. 15p

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BY127 Mullard 15p 25 + 12p 100 + 10p 500 + 9p 1000 + 8p	AD161, AD162 35p each 25 + 32p 100 + 28p 500 + 25p 1000 + 22p	AD161, AD162 35p each 25 + 32p 100 + 28p 500 + 25p 1000 + 22p
OA202 10p 25 + 8p 100 + 7p 500 + 6p 1000 + 5p	2N3053 20p 25 + 18p 100 + 15p 500 + 12p 1000 + 10p	2N3055 55p 25 + 50p 100 + 45p 500 + 38p 1000 + 33p
OC35 Mullard 50p 25 + 45p 100 + 40p 500 + 35p 1000 + 30p		

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400 M/W 5%
 Miniature
BZY 88 Range
 All voltages
 3-3 - 33 Volt
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 Complete with 8-page booklet, circuits and data
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Type	Volts	Price
	P.I.V.	1-11
3 AMP RANGE		
8C35A	100	75p
8C35B	200	70p
8C35D	400	85p
6 AMP RANGE (T048)		
8C40A	100	85p
8C40B	200	90p
8C40D	400	£1.00
8C40E	500	£1.20
10 AMP RANGE (T048)		
8C45A	200	£1.00
8C45B	200	£1.00
8C45D	400	£1.25
8C45E	500	£1.45
15 AMP RANGE (T048)		
8C50A	100	£1.25
8C50B	200	£1.35
8C50C	200	£1.65
8C50E	500	£1.95
DIAC D32	25p	
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40430	(T066)	85p
40669	(Plastic)	£1.00
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Contents

- 1 Bass unit 204mm (8in) diameter.
- 1 Dome HF radiator 25.4mm (1in) diameter.
- 1 Port tube.
- 1 Crossover panel with colour coded leads.
- 1 Terminal board.
- 1 Foam gasket.
- 1 Input lead complete with DIN plug and spade terminals.
- Acoustic wadding foam pad.
- Fixing screws and hardware.
- Cabinet template (on bottom of box).

Specification

20 watts DIN, 4 ohms impedance, 8in bass unit, dome HF radiator, crossover frequency 4,000Hz.

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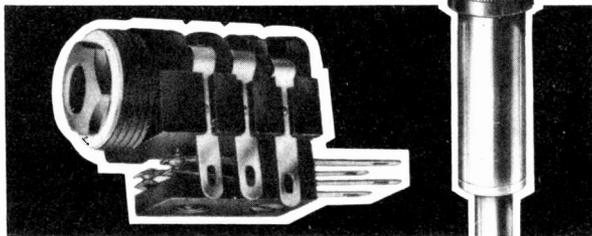
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PE3

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Improved Type panel or PCB mounting with free mounting clip—clear or black. Order LED1A. Please add postage. **Monsanto** miniature PCB mounting with radial leads. Order LED2. Please add postage. **NOW ONLY 35p each with connection data.**

7 SEGMENT LED DISPLAY

0.325in Characters 0-9 and nine letters. TTL, DTL compatible. **ONLY £2.46 each, p.p. 10p. BCD-7Seg Dec Driver, £1.30.**

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Full 4 Function—will perform Addition, Subtraction, Multiplication and Division including Chain or Mixed Multiplication or Division as well as true credit balance. **Constant Key:** Fixed or Floating decimal point. Batteries and leather case supplied.

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The I.C. Radio in a TO18 can. Supplied complete with data sheet No. 10 which contains specification, circuit and details and prices of components such as ferrite rods, compression trimmers etc.

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Dual-in-line or Zig-Zag (Durril), 14 and 16 pin
Our Price 1p per pin

VDR's & Thermistors

A15B	75p	GL23	£1.00	VA1005	15p
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CZ4	13p	R54	£1.46	VA1033	13p
CZ13A	13p			VA1040	10p
E298 ED/A258	10p			VA1053	10p
E298 ZZ/06	10p			VA1055	10p
GL16	£1			VA1034	10p

Potentiometers



5KΩ	50KΩ	500KΩ
10KΩ	100KΩ	1MΩ
25KΩ	250KΩ	2MΩ

log or lin less switch (& 1KΩ lin)
log or lin with switch
dual less switch
dual with switch 10K, 100K & 1M
log only
10K log 10K antilog less switch

12p
24p
40p
52p
40p

Capacitors

disc ceramic		low voltage	
0.1μF 18v	5p	0.1μF 30v	5p
0.22μF 18v	5p	0.22μF 6v	5p
0.47μF 12v	5p	0.47μF 3v	5p
ceramic plate		30V	
1000pf	10p	4700pf	10p
2200pf	10p	10,000pf	10p

Slider Pots

Single	Dual	log
10K	10 + 10K	or
25K	25 + 25K	lin
50K	50 + 50K	
100K	100 + 100K	Knobs
30p	50p	10p

Resistors

1/2 watt 5% Carbon Film - low noise
Hi-Stabs
All E24 values 1p each plus p. & p. 7p for up to 50 Resistors and a further 2p for each additional 50. Deduct 33% for 100 of one type or 25% for mixed orders over £1 in value.

1 W	10% Carbon Composition	3p each
2 W	10% Carbon Composition	6p each
2 1/2 W	5% Wire wound	9p each
5 W	Wire wound	9p each
10 W	Wire wound	10p each

plus p. & p. 7p for up to 25 resistors plus 1p for each additional 25.

Eliminators



9 volt @ 20mA (PP3)	£1.25
6 volt @ 50mA	£1.50
9 volt @ 50mA	£1.50
6 & 9 volt, 50mA	£2.50
9 & 9 volt, 50mA	£2.50
7 1/2 volt for cassette recorders	£2.00
6, 7 1/2 or 9 volt	£3.00
3, 4 1/2, 6, 7 1/2, 9, 12 @ 500mA (illus.)	£3.99

Car Battery Converter fully stabilised to provide 6, 7 1/2 or 9 volts
(p. & p. 15p on all types)

Ceramic - plate

1 8pf	8 2pf	33pf	120pf
0.1μF	0.08μF	3p	47μF
3 3pf	1 2pf	4p	68μF
3 9pf	1 5pf	56p	220pf
4 7pf	1 8pf	68p	270pf
5 6pf	2 2pf	82p	330pf
6 8pf	2 7pf	100p	

all 5p. each

mylar film

1000pf	2p	0.1μF	3p	0.68μF	4p
2000pf	2p	0.2μF	3p	1μF	4p
5000pf	2p	0.4μF	3p	2μF	5p
		0.5μF	3p		

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BA102	25p	OA79	9p	IN4001	6p
BA115	17p	OA90	7p	IN4002	7p
BA130	10p	OA91	7p	IN4003	8p
BA145	20p	OA200	10p	IN4004	8p
BA148	20p	BY100	15p	IN4005	10p
BA154	13p	BY126	15p	IN4006	12p
BA155	14p	BY127	15p	IN4007	15p

SGS EA1000



3 Watt Audio Amplifier
Our Price inc. handbook £2.45

10 - less 15%
25 - less 25%
100 - less 33%

5 Watt Audio Amplifier
Our Price £3.99
Less quantity discount.

Presets

Vertical or Horizontal
0.1 watt 5p 0.25 watt 7p

100	1K	10K	100K	1M
250	2.5K	25K	250K	2.5M
500	5K	50K	500K	5M

polystyrene 160V

10pf to 10,000pf in multiples of 10, 15, 22, 33, 47 & 68. 3p each

metallised polyester 250V (C280)

0.1μF	3p	0.08μF	3p	47μF	8p
0.15μF	3p	1μF	4p	68μF	11p
0.22μF	3p	1.5μF	4p	1μF	13p
0.33μF	3p	2.2μF	5p	1.5μF	20p
0.47μF	3p	3.3μF	6p	2.2μF	24p

metallised polyester 400V (C281)

0.1μF	4p	0.47μF	6p	22μF	10p
0.15μF	4p	0.68μF	6p	33μF	14p
0.22μF	4p	1μF	7p	47μF	15p
0.33μF	5p	1.5μF	8p		

silvered mica 1% (-50pf) 500V

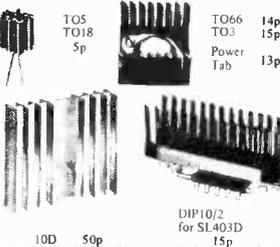
2.2pf-820pf	7p	4.7nF-5600pf	19p
1nF-2.2nF	9p	6800pf-0.1μF	29p
2.7nF-3.6nF	16p		

mixed dielectric 600V

0.1μF	7p	0.047μF	7p	22μF	16p
0.22μF	7p	0.08μF	8p	47μF	24p
0.33μF	7p	1μF	8p	1μF	33p

CHROMASONIC electronics

Heat Sinks



TO5 TO18 5p
TO66 TO3 15p
Power Tab 13p
DIP10/2 for SL403D 15p
10D 50p

Transistors & Integrated Circuits

AC107	25p	BC147	10p	BF196	15p	OC81	19p	2N1304	22p	2N5172	15p
AC126	17p	BC148	10p	BF197	15p	OC140	20p	2N1711	25p	2E788	10p
AC127	15p	BC149	10p	BF272	55p	OC170	23p	2N1893	30p	ZENERS SERIES	10p
AC128	15p	BC157	12p	BFY50	24p	OC171	30p	2N2926	all 10p		
AC176	15p	BC158	10p	BFY51	21p	ZTX107	15p	2N3053	23p	LO05T1	£1.50
AC187	25p	BC159	12p	BRV39	36p	ZTX108	12p	2N3054	50p	LO36T1	£1.50
AC187K	25p	BC159	15p	BSX21	26p	ZTX109	15p	2N3055	49p	LO37T1	£1.50
AC188	25p	BC268	15p	BSY95A	14p	ZTX300	12p	2N3702	12p	MC1303	£1.75
AC188K	25p	BD115	67p	BU105/02	£1.75	ZTX301	15p	2N3703	12p	MC1350	75p
ACY20	20p	BD131	70p	MJE430	67p	ZTX302	20p	2N3704	10p	MC1351	£1.00
AD140	40p	BD132	78p	MPF192	40p	ZTX303	20p	2N3705	10p	MC1359	£1.00
AD149	40p	BD132/M P		MPF103	37p	ZTX304	25p	2N3706	10p	MFC4000B	49p
AD161	60p		149p	MPF104	37p	ZTX341	20p	2N3707	15p	MFC4010A	55p
AD182	60p	BF150	21p	MPF105	40p	ZTX500	15p	2N3708	12p	LM380	£1.45
AF114	18p	BF167	20p	MPF106	45p	ZTX501	15p	2N3709	12p	SL403D	£1.50
AF115	18p	BF173	20p	OC28	40p	ZTX502	20p	2N3710	12p	TAD100	£1.50
AF116	18p	BF180	25p	OC35	40p	ZTX503	17p	2N3711	12p		
AF117	18p	BF181	30p	OC44	15p	ZTX504	50p	2N3819	35p	FILTER LP1175	£1.50
AF139	28p	BF184	25p	OC45	15p	ZTX531	25p	2N3903	15p	μA709C	45p
BC107	10p	BF185	25p	OC71	11p	2N697	18p	2N3904	17p	μA718	45p
BC108	10p	BF194	15p	OC72	17p	2N706	12p	2N3905	21p	μA723C	£1.85
BC109	10p	BF195	15p	OC76	15p	2N708	15p	2N3906	12p	μA741C	50p

mixed dielectric 1000V

1000pf	6p	6800pf	9p	1μF	12p
2200pf	6p	0.01μF	9p	22μF	22p
3300pf	6p	0.1μF	9p	2000pf	5p
4700pf	6p	0.07μF	12p	47μF	30p

Ceramic

12KV d.c.	8KV d.c.	HI-K 750V.			
10pf	9p	2000pf	9p	1000pf	5p
15pf	9p	220pf	9p	1500pf	5p
22pf	9p	250pf	9p	2000pf	5p
68pf	9p	270pf	9p	3000pf	5p
82pf	9p	300pf	9p	5000pf	5p
100pf	9p	750V DISC	10,000pf	5p	
120pf	9p	470pf	5p	feed-through	
140pf	9p	1000pf	5p		
150pf	9p	5000pf	5p		
180pf	9p	10,000pf	5p	1000pf	5p

Veroboard

Copperclad Plain

0.1"	0.15"	0.15"	
2 1/2" x 1"	6p		
2 1/2" x 3 1/2"	20p	16p (9)	10p
2 1/2" x 5"	24p	21p (7)	12p
3 1/2" x 3 1/2"	24p	21p (8)	
3 1/2" x 5"	27p	27p (10)	
1 7/8" x 2 1/2"	67p		37p
1 7/8" x 3 1/2"	90p		52p
1 7/8" x 5"			75p

Spot-face Cutter 36p
Pin Insertion Tool 47p
Terminal Pins 18p per pack of 36

ADCOLA INVADER



Coax Plug 5p
Phono Socket 4p
Coax (Flush) Socket L706 A* £1 70 p. & p. 10p
Coax (Surface) Socket 8p
Coax L706 A* £1.85 p. & p. 10p
Rotary MAIN 25p
SINGLE WAFER ROTARY 25p
SLIDE D.P.D.T 17p
TOGGLE 5 P. S. T. 250V. 1A 18p
TOGGLE D.P.D.T. 250V. 1A 20p

Available in Red, Black, Green, White, Yellow, Blue and Grey.

4mm PLUG. Stackable same colours (except Grey) as terminals.

Sovbit Solder Dispenser. Contains 12 ft. of coiled 18 g. w. g. Enin Multi-core Solder Alloy.

Mullard B Siemens Electrolytics

CAP μF	VOLTAGE						
	4	6.3	10	16	25	40	63
1	—	—	—	—	—	—	8p
1.5	—	—	—	—	—	—	8p
2.2	—	—	—	—	—	—	8p
3.3	—	—	—	—	—	—	8p
4.7	—	—	—	—	—	—	8p
6.8	—	—	—	—	—	—	8p
10	—	—	—	—	—	—	8p
15	—	—	—	—	—	—	8p
22	—	—	—	—	—	—	8p
33	—	—	—	—	—	—	8p
47	—	—	—	—	—	—	8p
68	—	—	—	—	—	—	8p
100	—	—	—	—	—	—	8p
150	—	—	—	—	—	—	8p
220	—	—	—	—	—	—	8p
330	—	—	—	—	—	—	8p
470	—	—	—	—	—	—	8p
680	—	—	—	—	—	—	8p
1000	—	—	—	—	—	—	8p
1500	—	—	—	—	—	—	8p
2200	—	—	—	—	—	—	8p
3300	—	—	—	—	—	—	8p
4700	—	—	—	—	—	—	8p

CAP μF	VOLTAGE			
	16	25	40	64
500	—	—	33p	40p
1250	—	—	50p	—
1600	—	—	—	75p
2000	—	—	40p	50p
2500	—	—	—	75p
3200	—	—	50p	—
4000	—	—	75p	83p
6400	—	—	75p	83p

Quantity Prices on application.

Aluminium Boxes

Including baseplate and screws

No.	L.	W.	D.	Price	p. & p.
(7)	2 1/2"	4 1/2"	1 1/2"	35p	8p
(8)	4"	4"	1 1/2"	35p	8p
(9)	4"	2 1/2"	1 1/2"	35p	8p
(10)	4"	4 1/2"	1 1/2"	40p	8p
(11)	4"	2 1/2"	2"	35p	8p
(12)	3"	2 1/2"	1 1/2"	32p	9p
(13)	6"	4 1/2"	2"	50p	10p
(14)	7"	5 1/2"	2 1/2"	58p	12p
(15)	8"	6"	3 1/2"	75p	18p
(16)	10"	7 1/2"	3 1/2"	85p	20p

Hi-Volt Electrolytics

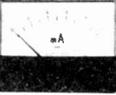
1.2	4	8μF	450V	14p	32μF	450V	20p
15μF	450V	15p	50μF	350V	20p		
8	8μF	450 V.W	18p	32	32μF	350 V.W	25p
8	18μF	450 V.W	20p	32	32μF	450 V.W	43p
16	18μF	450 V.W	25p	50	50μF	350 V.W	35p

SEW PANEL METERS

CLEAR PLASTIC PANEL METERS

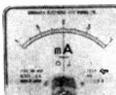
TYPE 8W.100 100mm x 80mm Fronts

30μA	£3-80
50-0-50μA	£3-80
100μA	£3-80
100-0-100μA	£3-70
300μA	£3-80
1mA	£3-40
20V d.c.	£3-40
50V d.c.	£3-40
300V d.c.	£3-40
1 amp. d.c.	£3-40
5 amp. d.c.	£3-40
300V a.c.	£3-40
VI Meter	£4-15



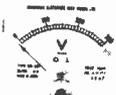
TYPE MR.85P. 4 1/4in. x 4 1/4in. Fronts

50mA	£3-10
100mA	£3-10
500μA	£3-10
1 amp.	£3-10
5 amp.	£3-10
15 amp.	£3-10
30 amp.	£3-20
20V d.c.	£3-10
50V d.c.	£3-10
150V d.c.	£3-10
300V d.c.	£3-10
100μA	£3-40
100-0-100μA	£3-30
200μA	£3-30
500μA	£3-20
500-0-500μA	£3-10
1mA	£3-10
1-0-1mA	£3-10
5mA	£3-10
10mA	£3-10



TYPE MR.88P. 1 21/32in. square Fronts.

200μA	£1-75
300μA	£1-75
500μA	£1-75
750μA	£1-75
1 amp.	£1-75
5 amp.	£1-75
10 amp.	£1-75
3V d.c.	£1-75
15V d.c.	£1-75
20V d.c.	£1-75
50V d.c.	£1-75
100V d.c.	£1-75
200μA	£1-85
500μA	£1-80
500-0-500μA	£1-75
1mA	£1-75
2mA	£1-75
5mA	£1-75
10mA	£1-75
20mA	£1-75
50mA	£1-75
100mA	£1-75
150mA	£1-75



"SEW" BAKELITE PANEL METERS

TYPE MR.85. 3 1/2in. square Fronts.

1 amp.	£2-15
5 amp.	£2-15
15 amp.	£2-15
30 amp.	£2-15
50 amp.	£2-15
5V d.c.	£2-15
10V d.c.	£2-15
20V d.c.	£2-15
50V d.c.	£2-15
150V d.c.	£2-15
300V d.c.	£2-15
50mV d.c.	£2-40
100mV d.c.	£2-40
30V a.c.	£2-80
50V a.c.	£2-80
150V a.c.	£2-80
300V a.c.	£2-80
500μA	£2-15
1mA	£2-15
1-0-1mA	£2-15
10 amp. a.c.	£2-15
5 amp. a.c.	£2-15
10 amp. a.c.	£2-15
10mA	£2-15
100mA	£2-15
300mA	£2-15
500mA	£2-15



TYPE SD.830 82-5mm x 110mm Fronts

10mA	£2-50
50mA	£2-50
100mA	£2-50
500μA	£2-50
1 amp.	£2-50
5 amp.	£2-50
10 amp.	£2-50
5V d.c.	£2-50
10V d.c.	£2-50
20V d.c.	£2-50
50V d.c.	£2-50
100μA	£2-70
100-0-100μA	£2-70
200μA	£2-70
500μA	£2-55
1 amp.	£2-50
5 amp.	£2-50



TYPE MR.52P. 2 1/2in. square Fronts.

50μA	£2-40
50-0-50μA	£2-85
100μA	£2-85
100-0-100μA	£2-75
200μA	£2-55
500μA	£2-20
1 amp.	£2-20
5mA	£2-20
10mA	£2-20
50mA	£2-20
100mA	£2-20
500μA	£2-20
1 amp.	£2-20
5 amp.	£2-20

TYPE MR.45P. 2in. square Fronts.

50μA	£2-50
50-0-50μA	£2-30
100μA	£2-30
100-0-100μA	£2-05
200μA	£2-05
500μA	£1-95
500-0-500μA	£1-85
1mA	£1-85
5mA	£1-85
10mA	£1-85
50mA	£1-85
100mA	£1-85
150mA	£1-85

TYPE SD.640 63-5mm x 85mm Fronts

50μA	£2-60
50-0-50μA	£2-55
100μA	£2-55
100-0-100μA	£2-55
200μA	£2-55
500μA	£2-55
1 amp.	£2-35
5 amp.	£2-35
10 amp.	£2-35
5V d.c.	£2-35
10V d.c.	£2-35
20V d.c.	£2-35
50V d.c.	£2-35
100μA	£2-35
100-0-100μA	£2-35
200μA	£2-35
500μA	£2-35
1 amp.	£2-35
5 amp.	£2-35
10 amp.	£2-35
50μA	£2-35
100μA	£2-35
500μA	£2-35
1 amp.	£2-35
5 amp.	£2-35
10 amp.	£2-35

TYPE MR.65P. 3 1/2in. x 3 1/2in. Fronts

50-0-50μA	£3-70
100μA	£3-00
100-0-100μA	£2-90
200μA	£2-90
500μA	£2-65
500-0-500μA	£2-40
1 amp.	£2-40
5mA	£2-40
10mA	£2-40
50mA	£2-40
100mA	£2-40
500μA	£2-40
1 amp.	£2-40
5 amp.	£2-40
10 amp.	£2-40
20 amp.	£2-40
30 amp.	£2-40
5V d.c.	£2-40

TYPE MR.45P. 2in. square Fronts.

50μA	£2-50
50-0-50μA	£2-30
100μA	£2-30
100-0-100μA	£2-05
200μA	£2-05
500μA	£1-95
500-0-500μA	£1-85
1mA	£1-85
5mA	£1-85
10mA	£1-85
50mA	£1-85
100mA	£1-85
150mA	£1-85

TYPE 8-80 80mm square Fronts

50μA	£3-50
50-0-50μA	£3-40
100μA	£3-40
100-0-100μA	£3-30
200μA	£3-05
500μA	£2-85
1 amp.	£2-85
5V d.c.	£2-85
10V d.c.	£2-85
20V d.c.	£2-85
50V d.c.	£2-85
300V d.c.	£2-85
1 amp. d.c.	£2-85
5 amp. d.c.	£2-85
300V a.c.	£2-85
VI Meter	£3-70

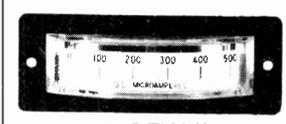


TYPE SD.460 46mm x 50-5mm Fronts

50μA	£2-40
50-0-50μA	£2-35
100μA	£2-35
100-0-100μA	£2-35
200μA	£2-35
500μA	£2-20
1mA	£2-15
5mA	£2-15
10mA	£2-15
50mA	£2-15
100mA	£2-15
500μA	£2-15

TYPE MR.65P. 3 1/2in. x 3 1/2in. Fronts

50-0-50μA	£3-70
100μA	£3-00
100-0-100μA	£2-90
200μA	£2-90
500μA	£2-65
500-0-500μA	£2-40
1 amp.	£2-40
5mA	£2-40
10mA	£2-40
50mA	£2-40
100mA	£2-40
500μA	£2-40
1 amp.	£2-40
5 amp.	£2-40
10 amp.	£2-40
20 amp.	£2-40
30 amp.	£2-40
5V d.c.	£2-40



"SEW" EDGEWISE METERS

TYPE PE.70. 3 1/2in. x 1 1/2in. x 2 1/2in. deep.

50μA	£3-40
50-0-50μA	£3-30
100μA	£3-30
100-0-100μA	£3-20
200μA	£3-20
500μA	£3-05
1 amp.	£3-05
5 amp.	£3-05
10 amp.	£3-05
20 amp.	£3-05
30 amp.	£3-05
5V d.c.	£3-05

"SEW" EDUCATIONAL METERS

TYPE ED.107. Size overall 100mm x 90mm x 105mm

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 2in. mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50μA	£5-50
100μA	£5-10
1mA	£4-85
50-0-50μA	£5-10
1-0-1mA	£4-85
1A d.c.	£4-85
5A d.c.	£4-85

10V d.c. £4-85
20V d.c. £4-85
50V d.c. £4-85
300V d.c. £4-85
Dual range 500mA/5A d.c. £5-10
5V/50V d.c. £5-10



POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range enam. Single pole fixing. 1/2in. dia. shafts. Bulk quantities available. **25 WATT.** 10V/50/100/250/500/1000/2500 ohms. 90p. P. & P. 71p. **50 WATT.** 10V/50/100/250/500/1000/2500 ohms. £1.15. P. & P. 14p. **100 WATT.** 15/10/25/50/100/250/500/1000/2500 ohms. £1.65. P. & P. 71p.



"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality. Low price. Immediate delivery

8-260 General Purpose Bench Mounting		8-260 Panel Mounting	
1 amp.	£7-00	1 amp.	£7-00
2 1/2 amp.	£8-05	2 1/2 amp.	£8-05
5 amp.	£11-75		
8 amp.	£15-90		
10 amp.	£22-50		
12 amp.	£23-60		
20 amp.	£49-00		
25 amp.	£58-00		
40 amp.	£82-50		

ALL MODELS INPUT 230V 50/60 CYCLES OUTPUT VARIABLE 0-260 VOLTS. Special discounts for quantity



AUTO TRANSFORMERS

0/115/230V. Step up or step down. Fully shrouded.

80W	£2-10	P. & P. 18p
150W	£2-70	P. & P. 18p
300W	£3-60	P. & P. 23p
500W	£5-25	P. & P. 33p
1000W	£7-50	P. & P. 38p
1500W	£10-20	P. & P. 43p
2250W	£17-25	P. & P. 50p
3000W	£35-00	P. & P. £1

AVOMETER MOVEMENTS

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multi-meter. Brand New and Boxed. **£3-50** Post 25p.

240° Wide Angle 1mA Meters

MW1-6 60mm square	£3-97
MW1-8 80mm square	£4-97

Post extra

RP214 REGULATED POWER SUPPLY

Solid state. Variable output 0-24V d.c. up to 1 amp. Dual scale meter to monitor voltage and current. Input 220/240V a.c. Size 185 x 85 x 105mm. £8-97 Post 25p.

PS.200 REGULATED P.S.U.

Solid state. Variable output 5-20V d.c. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240V a.c. Size 7 1/2in. x 5 1/2in. x 3 1/2in. £14-97. Post 25p.

PS.1000B REGULATED POWER SUPPLY

Solid state. Output 6, 9 or 12V d.c. up to 1.3 amp. Meter to monitor current. Input 220/240V a.c. Size 4in. x 3 1/2in. x 6 1/2in. £11-97. Post 25p.

LB4 TRANSISTOR TESTER

Tests PNP and NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with all instructions, etc. £4-50. Post 20p.

LB3 TRANSISTOR TESTER

Tests 1C0 and B. Pnp/npn. Operates from 9V battery. Complete with all instructions, etc. £3-95. Post 20p.

MCA.280 AUTOMATIC VOLTAGE STABILISER

Input 88-125V a.c. or 178-250V a.c. Output 120V d.c. or 240V a.c. 200VA rating. £11-97. Post 50p.

SEND S.A.E. FOR LIST OF SEMICONDUCTORS AND VALVES

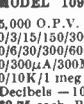
G. W. SMITH & CO. (RADIO) LTD. Also see next three pages

MULTIMETERS for EVERY purpose!

T860 POCKET MULTIMETER
High-precision at low cost.
Ranges: D.c. 15V, 150V, 1,000V (10,000 O.P.V.), a.c. 15V, 150V, 100V (1,000 O.P.V.).
D.c. Current 150mA. Resistance 100k ohms.
#1-85. Post 15p.



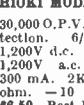
MODEL 1092 Testmeter.
5,000 O.P.V.
0/315/150/300/1,200V d.c.
0/6/30/300/600V a.c.
0/500μA/300mA
0/10K/1 meg Ω
Decibels -10 to +16 dB
#2-75 each. Post 15p.



HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1,000V d.c.
10/50/250/1,000V a.c.
500μA/250mA. 20K/2 meg. ohm. -5 to +62dB.
#4-97. Post 15p.



HIOKI MODEL 730X
30,000 O.P.V. Overload protection.
0/30/80/300/600/1,200V d.c. 12/60/120/600/1,200V a.c. 60μA/30mA/300 mA. 2K/200K/2 meg. ohm. -10 to +63 dB.
#6-50. Post 15p.



MODEL TE-12
20,000 O.P.V. 0/6/6/30/120/600/1,200/3,000/6,000V d.c. 0/6/30/120/600/1,200V a.c. 0/60μA/6/60/600mA. 0/6K/600K/6 Meg./60 Meg. Ω 0-2mF. #5-97. Post 17p.



MODEL TE-200 20,000 O.P.V.
Mirror scale, overload protection.
0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50μA/250mA. 0/60K/6 meg Ω. -20 to +62dB. #3-95. Post 13p.



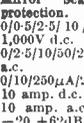
MODEL 500 30,000 O.P.V. with overload protection
mirror scale 0/0-5/2/5/10/25/100/250/500/1,000V d.c. 0/2-5/10/25/100/250/500/1,000V a.c. 0/50μA/5/50/500mA. 12 amp. d.c. 0/60K/6 Meg./60 Meg. Ω.
#8-57. Post paid.



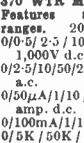
HIOKI MODEL 750X
50,000 O.P.V.
43 ranges 0-3 to 1,200V d.c. 0-3 to 1,200V a.c. 0-30μA/300mA. 0-3K/30 meg ohms. -10 to +17dB.
#3-97. Post 20p.



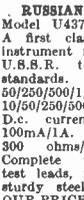
HT1008A MULTI-METER
Features a.c. current ranges. 100,000 O.P.V. Mirror Scale, Overload protection.
0/0-5/2-5/10/30/250/500/1,000V d.c. 0/2-5/10/50/250/500/1,000V a.c. 0/10/250mA/2-5/25/250mA/10 amp. d.c. 0/20K/200K/2MEG/20 MEG. -20 +62dB. #12-50. Post 25p.



370 WTR MULTIMETER
Features a.c. current ranges. 20,000 O.P.V. 0/0-5/2-5/10/50/250/500V d.c. 1,000V a.c. 0/2-5/10/50/250/500/1,000V a.c. 0/50μA/1/10/100mA/1/10 amp. d.c. 0/100mA/1/10 amp. a.c. 0/5K/50K/500K/5MEG/50MEG. -20 +62dB. #15. Post 25p.



RUSIAN 22 RANGE MULTIMETER
Model U437 10,000 O.P.V. A first class versatile instrument manufactured in U.S.B.R. to the highest standards. Ranges: 2-5/10/50/250/500/1,000V d.c. 2-5/10/50/250/500/1,000V a.c. D.c. current 100mA/1/10/100mA/1A. Resistance 30 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy metal carrying case. OUR PRICE #5-97. Post 25p.



ROUND SCALE TYPE PENCIL TESTER
MODEL TS-85
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0-20K ohms. ONLY #1-97. Post 13p.



LT 601 MULTI-METER
New style 20,000 O.P.V. pocket multimeter. 5/25/50/250/500/2,500V d.c. 10/50/100/300/1,000V a.c. 50μA/250A. 6K/6 meg ohms. -20 to +22 dB. #3-75. Post 20p.



MODEL TH-12
20,000 O.P.V. Overload protection. Slide switch selector. 0/0-25/2-5/10/50/250/1,000V d.c. 0/10/30/250/1,000V a.c. 0/50μA/25/250mA d.c. 0/3K/30K/300K/3 meg. -20 to +50dB.
#4-97. Post 15p.



MODEL TE-300 30,000 O.P.V. Mirror scale, overload protection 0/0-6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm -20 to -63dB. #5-97. Post 15p.



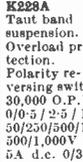
MODEL PL436
20k Ω/V d.c. 8k Ω/V a.c. Mirror scale. 0-6/3/12/30/120/600V d.c. 3/50/120/600V a.c. 600mA. 10/100K/1 Meg/10 Meg Ω. -20 to +46dB. #6-97, Post 12p.



TMK MODEL TW-50K 46 ranges, mirror scale, 50K/V d.c. 5K/V a.c. D.c. Current: 0-125, 0-25, 1-25, 2-5, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50μA, 2-5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: -20 to +81.5 dB. #8-50. Post 17p.



MODEL K228A
Tant band suspension. Overload protection. Polarity reversing switch. 30,000 O.P.V. 0/0-5/2-5/15/50/25/500/1,000/2,500V d.c. 0/15/50/150/500mA/5A d.c. 0/3K/300K/3meg. #28-95. Post 20p.



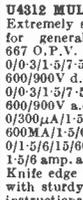
HIOKI MODEL 700X
100,000 O.P.V. Overload protection. Mirror scale. 0/3/0-4/1-2/1-3/6/12/30/60/120/300/600/1,200V d.c. 1-5/3/6/12/30/60/150/300/600/1,200V a.c. 15/30μA/3/6/30/60/150/300mA/6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm -20 to +63dB. #13-50. Post 20p.



MODEL C-7080 EN
Giant 6in mirror scale. 20,000 O.P.V. 0/0-25/1/2-5/10/50/250/500/1,000/5,000V d.c. 0/2-5/10/50/250/1,000/5,000V a.c. 0/50μA/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg. -20 to +50dB. #13-95. Post 30p.

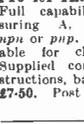


U4312 MULTIMETER
Extremely sturdy instrument for general electrical use. 667 O.P.V. 0/0-3/1-5/7-5/30/60/150/300/600/900V d.c. and 75mV. 0/0-3/1-5/7-5/30/60/150/300/600/900V a.c. 0/300μA/1-5/6/15/60/150/600mA/1-5/6 amp. d.c. 0/1-5/6/15/60/150/600mA/1-5/6 amp. a.c. 0/200 Ω/3K/30K Ω. Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. #9-50. Post 25p.

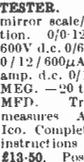


Selected TEST EQUIPMENT

FTC-401 TRANSISTOR TESTER
Full capabilities for measuring A, B and IC. npn or pnp. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. #7-50. Post 20p.



Models-100TR MULTIMETER/TRANSISTOR TESTER. 100,000 O.P.V. mirror scale/overload protection. 0/0-12/0-6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0/1/2/600μA/12/300mA/12 amp. d.c. 0/10 K/1 MEG/100 MEG. -20 to +50dB. 0-01-2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. #13-50. Post 25p.



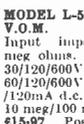
MODEL 449A IN-CIRCUIT TRANSISTOR TESTER
Checks true a.c. beta in/out. Checks Ico. Checks diodes in/out. Checks SCR, etc. Beta HI 10-500. LO 2-30. Ico 0-5000μA. 220/240V a.c. operation. #17-50. Post 25p.



TE-20D RF SIGNAL GENERATOR
Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated Variable R.F. attenuator, audio output, Xtal socket for calibration. 220/240V a.c. Brand new with instructions. #15. Carr. 37p. Size 140mm x 215mm x 170mm.



MODEL L-55 FET V.O.M.
Input impedance 10 meg ohms. 0/0-3/1-2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120μA/1/20mA d.c. 0/1K/100K/10 meg/100 meg ohms. #15-97. Post 25p.



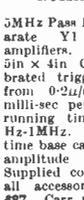
CI-5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100kHz V. RMS/mm. 0-1-25; HOR. AMP. Bandwidth 300kHz. Sensitivity at 100kHz V. RMS/mm. 0-3-25; Pre-set triggered sweep 1-3,000μsec. free running 20-200,000Hz in nine ranges. Calibrator pip. 220mm x 360mm x 430mm. 115-230V a.c. operation. #39. Carr paid.



TO-3 PORTABLE OSCILLOSCOPE
3in tube, V amp. Sensitivity 0.1V p-p/cm. Bandwidth 1-5cps-1.5MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0.9V. p-p/cm. Bandwidth 1-5cps-800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10cps-300kHz. Synchronization. Internal/external. Illuminated scale 140mm x 215mm x 330mm. Weight 15lb. 220/240V a.c. Supplied brand new with handbook. #40-00. Carr. 30p.



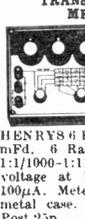
RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE
5MHz Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in x 4in C.R.T. Calibrated triggered sweep from 0-2μsec to 100 milli-sec per cm. Free running time base 50 Hz-1MHz. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. #87. Carr. paid.



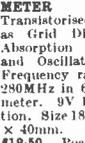
TE-18A Transistorized Signal Generator. 5 ranges 400KHz-30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. 3 1/2in x 5 1/2in x 3 1/2in. Complete with instructions and leads. #7-97. Post 25p.



TRANSISTORISED I.C.R. A.C. MEASURING BRIDGE
A new portable bridge offering excellent range and accuracy at low cost. 10-111 meg Ω. 6 Ranges ±1%. L: 1 μH - 111 nF. C: 10pF - 1110 nF. d. 6 Ranges +2%. TURNS RATIO 1:1/1000-1:1100. 6 Ranges ±1%. Bridge voltage at 1,000cps. Operates from 9V 100μA. Meter indication. Attractive 2-tone metal case. Size 7 1/2in x 5in x 2in. #20. Post 25p.



MODEL TE15 GRID DIP METER
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Hz-280MHz in 6 coils. 500μA meter. 9V battery operation. Size 180mm x 80mm x 40mm. #12-50. Post 20p.



BELO AF-5A SOLID STATE SINE SQUAWE WAVE GEN. OSCILLATOR.
Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. +10dB (10K ohms). Operation internal batteries. Attractive 2-tone case 7 1/2in x 5in x 2in. Price #17-50. Carr. 17p.



MODEL MG-100 SINE SQUAWE WAVE AUDIO GENERATOR
Range 19-220,000 Hz. Sine Wave 19 - 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm x 90mm x 90mm. Operation 220/240V a.c. #17-50. Post 37p.



MODEL AT201 DECADE ATTENUATOR
Frequency range 0-200kHz. Attenuator 0-111dB, 0.1dB step. Impedance 600 ohms. Max. input power 30dBm. Size 180mm x 90mm x 55mm. #12-50. Post 37p.



TE-65 VALVE VOLTMETER
28 ranges. D.c. volts 1-3-1,500V a.c. volts 1-3-1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. #17-50. Post 30p. Additional probes available: R.F. #2-12; H.V. #2-50.



MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER
Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0-3% d.c. 1% a.c. Scale length 160mm. 0/300/750A/1-5/3/7-5/15/30/75/150/300/750mA/1-5/3/7-5/15/30/75/150/300/750V d.c. 0/3/7-5/15/30/75/150/300/750V a.c. 0/1-5/3/7-5/15/30/75/150/300/750V a.c. Automatic cut out. Supplied complete with test leads, manual and test certificates. #49. Post 50p.



G. W. SMITH & CO. (RADIO) LTD.
Also see opposite page and next two pages

UNE-30 RECEIVER



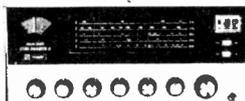
4 Bands covering 550kHz-30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. \$18-75. Carr. 37p.



UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 550kHz-30MHz. FET. 8 Meter. Variable BFO for 88B. Built-in Speaker. Bandspread, Sensitivity Control. 220/240V a.c. or 12V d.c. 12 1/2in x 4 1/2in x 7 1/2in. Brand new with instructions. \$25. Carr. 37p.

SKYWOOD CX203 COMMUNICATION RECEIVER



Solid state. Coverage on 5 bands 200-420 kHz and 0-55 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO, AVC, ANL, "S" meter. AM/CW/88B. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. size 3 1/2 x 2 1/2 x 1 1/2 in. Complete with instructions and circuit. \$28-50. Carr. 30p.

LAFAYETTE HA-600 SOLID STATE RECEIVER



General coverage 150-400kHz, 550 kHz-30MHz. FET front end. 2 mech. filters. product detector, variable BFO, noise limiter. 8 Meter. Bandspread. RF Gain. 15in x 9 1/2in x 8 1/2in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. \$50. Carr. 50p.



TRIO 9595DS COMMUNICATION RECEIVER
4 band covering 150-400kHz, 550 kHz-30MHz continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. 88B-CW. ANL. Variable BFO. 8 meter. Sep. bandspread dial. IF frequency 455kHz. Audio output 1.5W. Variable RF and AF gain controls 15V/250V a.c. Size 7in x 13in x 10in with instruction manual. \$40-50. Carr. paid.

EMI LOUDSPEAKERS

Model 350. 13in x 8in with single tweeter/crossover. 20-20,000Hz. 15W RMS. Available 8 or 15 ohms. \$7-25 each. Post 37p.
Model 450. 13in x 8in with twin tweeter/crossover. 55-13,000Hz. 8W RMS. Available 8 or 15 ohms. \$3-62 each. Post 25p.

HONEYWELL DIGITAL VOLTMETER VT.100



Can be panel or bench mounted. Basic meter measures 1V d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug-in cards. Specification: Accuracy: $\pm 0.2, \pm 1$ digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1.999). Input Impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110-230V a.c. 50/60 cycles. Overall size: 5 1/2in x 2 1/2in x 8 1/2in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. \$35-50. Carr. 50p.

SINCLAIR IC-12



Project 60 Package offers.
2 x Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. \$15-95. Carr. 37p. Or with PZ6 power supply. \$18-00. Carr. 37p.
2 x Z30 amplifier, stereo 60 pre-amp, PZ8 power supply. \$20-25. Carr. 37p.
Transformer for PZ8. \$2-97 extra.
Add to any of the above \$4-45 for active filter unit and \$13-00 for pair of Q16 speakers. All other Sinclair products in stock.
2000 amp. \$21-95. Carr. 37p.; 3000 amp. \$23-50. Carr. 37p.; Neoteric Amp. \$43-95. Carr. 37p. IC12. \$1-80. P. & P. 10p.
NEW PROJECT 60S—\$20-97. Carr. 37p.

WHARFEDALE MID-RANGE HI-FI UNITS
As used in world famous system. 5in dia. Impedance 4/8 ohms. High flux ceramic magnet. 20W RMS. Brand new \$1-50. Carr. 37p.

SPECIAL OFFER! GOODMAN'S AXIOM 301
Hi-Fi 12in 20W twin cone full range speaker. 30-16,000Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed. \$21-75. OUR PRICE \$12-50 each. Carr. 50p.

HA-10 STEREO HEADPHONE AMPLIFIER
All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. Inputs 5M Ω /100M Ω . Output 50mV. \$5-97. Post 15p.

SPECIAL PURCHASE! NEAT G30J STATIC BALANCE PICK-UP ARMS
Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick-up rest and plug in phono leads. BRAND NEW—FULLY GUARANTEED. ONLY \$8-95. Post 25p.

KAMODEN HM-350 TRANSISTOR TESTER
High quality instrument to test Reverse Leak current and D.C. current. Amplification factor of NPN, PNP, transistors, diodes, SCR's, etc. 4" x 4 1/2" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. \$12-50. Post 30p.

KAMODEN HMG-500 INSULATION RESISTANCE TESTER
Range 0-1,000 Megohms. 500 Volt. Battery operated. Wide range clear meter 4 1/2" x 4". Complete with deluxe carrying case, battery and instructions. \$19-95. Post 30p.

ARF-300 AF/RF SIGNAL GENERATOR
All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine/square. 10V. P-P. RF 100 KHz to 200 MHz. Output 1v maximum. Operation 220/240V. AC. Complete with instructions and leads. \$29-95. Post 50p.

CR81 8 track Rec. \$28-85
CR81D 8 track Rec. \$25-95
CR81T 8 track/Receiver \$19-95
CR808S 8 track system \$14-00
Carrage 50p extra (recorders and decks 75p).

AKAI BARGAINS

SUPER MONEY SAVING OFFERS—BUY NOW WHILE STOCKS LAST! ALL BRAND NEW AND FULLY GUARANTEED



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| 1791 Tape Rec. | \$73-95 | GXC40 Cassette Rec. | \$82-25 |
| X3000 Tape Rec. | \$99-95 | GXC40D Cassette/Receiver | \$82-95 |
| GX370 Tape Deck | \$250-95 | GXC40T Cassette/Receiver | \$123-95 |
| 4000DS Tape Deck | \$73-95 | GXC45D Cassette Deck | \$89-95 |
| 4000DS Dust Cover | \$4-75 | GXC46 Cassette Recorder | \$117-50 |
| X201D Tape Deck | \$123-95 | GXC60D Cassette Deck | \$111-25 |
| X221D Tape Deck | \$169-95 | GXC65D Cassette Deck | \$110-25 |
| GX220D Tape Deck | \$148-50 | X200SD Tape/Cass/8 Rec. | \$259-50 |
| GX280D Tape Deck | \$249-40 | CR80SD 8 track | \$182-50 |
| X1810D Tape/8 track Deck | \$169-95 | CR81 8 track Rec. | \$80-85 |
| GX1900D Tape/Cass. Deck | \$177-95 | CR81D 8 track Rec. | \$55-95 |
| X200SD Tape/Cass/8 Rec. | \$223-30 | CR81T 8 track/Receiver | \$119-95 |
| CR80SD 8 track | \$182-50 | CR808S 8 track system | \$14-00 |
| CR81 8 track Rec. | \$80-85 | | |
| CR81D 8 track Rec. | \$55-95 | | |
| CR81T 8 track/Receiver | \$119-95 | | |
| CR808S 8 track system | \$14-00 | | |

GENUINE BARGAIN! KOSS SP.3XC STEREO HEADPHONES
10-15,000Hz. Impedance 4-6 ohms. Brand new. Boxed and fully g'rated (List \$9-50). OTR PRICE \$6-50. Post 25p.

1021 STEREO LISTENING STATION
For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in x 4in x 2 1/2in. \$2-25. Post 15p.

MP7 MIXER PREAMPLIFIER
5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9 1/2in x 3in x 3in. Inputs Mic: 3 x 3mV 50K; 2 x 3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K. \$8-97. Post 20p.

TE-1035 STEREO HEADPHONES
Low cost high performance stereo headphones. Foam rubber ear cups. Adjustable head-band. 8 ohm impedance. 25-18,000Hz. With lead and stereo jack plug. ONLY \$1-97. Post 12p.

NEW GARRARD MODULES



Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.
SP23 H Module/M75-6 . . . \$23-50
AP76 Module/M75-6 . . . \$33-80
AP96 Module/M75-6 . . . \$38-75
Zero 1008 Module/M93E . . . \$52-60
Carr. 50p extra any item.

HOSIDEN DH-088 DE-LUXE STEREO HEADPHONES
Features unique mechanical 2 way units and fitted adjustable level controls. 8 ohm impedance 20-20,000cps. Complete with spring lead & stereo jack plug \$7-97. Post 12p.

DOLBY SYSTEM NOISE REDUCTION UNIT

Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 2 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 15kHz \pm 1dB 10kHz-35dB. Size 1 1/2in x 9 1/2in x 3 1/2in. A.c. 200/250V. OUR PRICE \$32-50 Carr. 50p.

HOSIDEN DHO-2S STEREO HEADPHONES
Wonderful value and excellent performance combined. Adjustable head-band. 8 ohm impedance. 20-12,000 cps. Complete with lead and plug. ONLY \$2-37. Post 12p.

TAPE CASSETTES
Top quality Hi-Fi Low Noise in Library cases.
C80 3 for 75p 10 for \$2-35
C90 3 for \$1-05 10 for \$3-30
C120 3 for \$1-35 10 for \$4-20
Tape Head Cleaner 30p each. Post 10p extra.

EA.41 REVERBERATION AMPLIFIER
Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverboration control. Beautiful walnut cabinet. 7 1/2in x 3in x 4 1/2in. \$5-97. Post 15p.

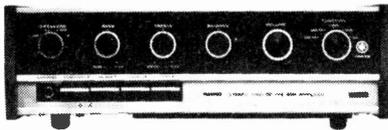
★ TRANSISTORISED FM TUNER ★
6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in x 4in x 2 1/2in. 3 I.F. Stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108MHz. Ready built ready for use. Fantastic value for money. \$5-37. Post 12p. Stereo multiplex adaptors \$4-97.

TE 1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET
Sensitive, soft earpads, adjustable head-band. Magnetic impedance 2,600 ohms. \$1-97. Post 15p.

G. W. SMITH & CO. (RADIO) LTD.
Also see previous pages and opposite page

FANTASTIC OFFER!

NIKKO TRM50 STEREO AMPLIFIER



17+17W r.m.s. stereo amplifier with inputs for Magnetic and Crystal phono, Tuner, Tape, Aux and Tape Monitor. Outputs for two pairs of stereo speakers and tape. Stereo headphone socket. Full range of controls including loudness control, scratch filter, etc. Size 13in x 9 1/2in x 3 1/2in.
Unrepeatable offer—limited stocks!

List price £59.50
OUR PRICE
£39.95
Carriage 50p

NIKKO TRM 50 SYSTEM



NIKKO TRM50 17+17W r.m.s. stereo amplifier, BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Linton 2 speakers and all leads.

OUR PRICE **£104.90** Carr. and Ins. £1.50

LEAK DELTA 30 SYSTEM



Leak Delta 30 stereo amplifier, Goldring GL75, plinth, cover and G800 cartridge. Pair of Linton 2 speakers and all leads.

OUR PRICE **£123.50** Carr. and Ins. £1.50

TELETON SAQ206B SYSTEM



Teleton SAQ206B amplifier, BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE **£54.40** Carr. and Ins. £1.50

SUPER BARGAIN! 8-TRACK CAR STEREO TAPE PLAYER



Tone, volume and balance controls. Track selector. Complete with matched pair of stereo speakers, connections and fittings.

ONLY **£15.95** Post 30p

HOMER INTERCOMS



Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.

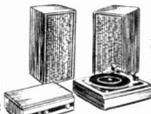
2 Station, £2.97, 3 Station £5.25, Post 15p.
4 Station £6.62, Post 17p.

BH.001 HEAD SET AND BOOM MICROPHONE

Moving coil. Ideal for language teaching, communications. Headphone imp. 16 ohms. Microphone imp. 200 ohms.
£4.62, Post 15p.



WHARFEDALE LINTON SYSTEM



Wharfedale Linton Amplifier, Linton Turntable, pair of Linton 2 speakers and all leads.

OUR PRICE **£104** Carr. and Ins. £1.25

LINTON RECEIVER SYSTEM £165. Carr. and Ins. £1.50.

AMSTRAD 8000 II SYSTEM



Amstrad 8000 II 7+7W stereo tuner amplifier, BSR MP60, plinth and cover, Goldring G800 cartridge, pair of Apollo speakers and all leads.

OUR PRICE **£45.50** Carr. and Ins. £1

Amplifier only, £14.50. Carr. 50p.

MONOTONE 6750 SYSTEM



Monotone AM/FM 4+4W stereo tuner amplifier. Garrard 2025 T/C, plinth and cover, stereo cartridge, pair of m a t c h i n g speakers and all leads.

OUR PRICE **£35.50** Carr. and Ins. £1

MW/LW CAR RADIO



Fully transistorised, dual waveband. Size 6 1/2in x 4 1/2in x 2 1/2in. 12V d.c. Neg. or pos. earth. Complete with fixing kit, speaker and leads.

ONLY **£7.50** Post 20p



B.S.R. TD8S 8-TRACK STEREO TAPE PLAYER DECK

Integrated preamps (output 125mV) to feed into any stereo amplifier. Automatic and manual programme selector. 4 pole synchronous motor. 210/240V a.c.
OUR PRICE **£16.25**
Carr. 37p.

CREDIT TERMS FOR CALLERS AND MAIL ORDER CUSTOMERS. 20% deposit. Balance over 12, 18, 24 or 36 months. ACCESS & BARCLAYCARD WELCOME.

HI-FI EQUIPMENT

SAVE UP TO 33 1/3% OR MORE



SEND S.A.E. FOR FULL DISCOUNT PRICE LISTS AND PACKAGE OFFERS!

SAVE £££'s PHILIPS GA308 TRANSCRIPTION TURNTABLE

2 speeds 33 1/3 and 45 r.p.m. Lightweight tubular counterbalanced arm. Belt driven low speed synchronous motor. Viscous damped pick-up lift/lower device. Complete with teak plinth and hinged cover. GA308 less cartridge (list £36.55)
OUR PRICE **£24.50**. Post 50p.
LIMITED NUMBER ONLY!

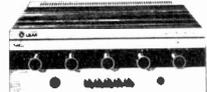


RECORD DECKS

(Post 50p)	BSR McDONALD	
C114 Mini	£4.97	
C129 Mono	£6.50	
C137	£8.35	
MP60	£9.50	
610	£12.95	
810	£31.25	
210/TPD3	£8.75	
MP60/G800	£12.95	
MP60/TPD1	£16.05	
MP60/TPD1/G800	£19.50	
MP60/TPD2	£14.35	
610/TPD1	£18.95	
510/TPD1	£17.95	
HT 70	£13.99	
HT70/G800	£17.25	
HT70/TPD1	£20.35	
HT70/TPD1/G800	£23.90	
810 Plinth/Cover	£9.25	
GOODMANS TD100 Teak	£51.95	
GOLDRING GL69/2	£18.50	
GL72/P	£20.95	
GL72/P	£27.50	
Plinth 69/72	£7.02	
LID 72	£3.25	
GL75	£26.95	
GL75/P	£35.25	
Plinth 75	£7.35	
LID 75	£3.60	
G99	£19.25	
GL85P/C	£58.95	
G101P/C	£20.50	



LEAK BARGAINS!



LIMITED OFFER! ALL STOCKS BRAND NEW AND GUARANTEED

Delta 30	£46.95
Delta 70	£57.95
Delta FM	£55.95
Delta AM/FM	£67.95
Delta 75	£125.00
Leak 150 pair	£37.50
Leak 250 pair	£47.95
Leak 600 each	£33.95

Post 50p extra each item.

ROTEL BARGAINS!

ALL BRAND NEW AND GUARANTEED



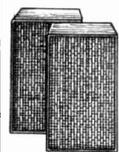
RA210 Amp.	£23.35
RA310 Amp.	£35.95
RA610 Amp.	£48.25
RX150 Receiver	£45.95
RX200 Receiver	£57.50
RX400 Receiver	£70.95

Post 50p extra any item.



SPECIAL OFFER! ROTEL RH700 STEREO HEADPHONES

20-20,000Hz. 8-16 ohm. (List £9.95). OUR PRICE **£6.75**. Post 25p.



SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 14 1/2in x 9in x 7 1/2in. 8 ohms. 8W RMS. 16W peak. Complete with DIN lead. **£12.95**. Carr. 50p.

PLINTHS AND COVERS

(Post 50p)	
Budget SP25, etc.	£3.80
Budget SP25 Play on	£4.80
Budget AP76/Zero 1008	£4.50
Budget B.S.R.	£3.25
SME 2000 System	£34.50

RECORD DECK PACKAGES (Post 50p)

Decks supplied with stereo cartridge ready wired in plinth with cover.

GARRARD 2025TC/9TAHCD	£12.75
SP25 III/G800	£18.60
SP25 III/M75-6	£18.50
SP25 III/M44-7	£19.75
SP25 III/M44-E	£20.95
SP25 III/M55-E	£22.40
AP76/G800	£27.95
AP76/M75-6	£30.25
AP76/M55-E	£30.50
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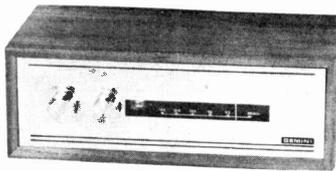
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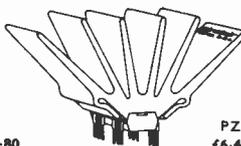
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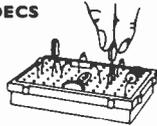
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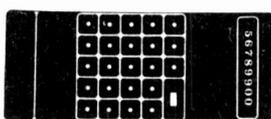
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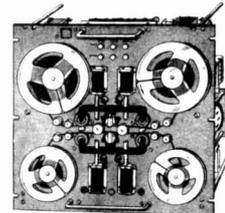
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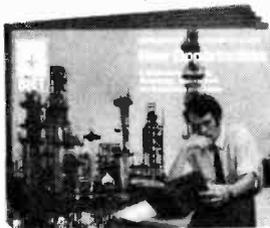
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- AUDIO MIXER (Jan. 72)** Rs, Cs, Pots (i.c. excl.), PCB (1½in × 2in), £1.55.
- BIOLOGICAL AMPLIFIER (Jan./Feb. 73)—Pre-amp Set** S/c's, Rs, Cs, Pots (i.c. excl.) £2.05. PCB (2in × 4in), 85p.
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MICROPHONE MIXER (Apr. 69)—S/c's, Rs, Cs, Pots, £2.90. Slider Pots extra, £1.15. PCB (3½in × 4½in)—also holds pots, £1.20.

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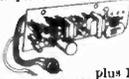
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ACI15	0-24	AD182 (MP)		BC150	0-18	BD139	0-55	BF195	0-12	OC22	0-38	2G373	0-17	2N2221	0-20	2N3091	0-16	2N4061	0-12
ACI17K	0-20	ADT140	0-55	BC151	0-18	BD140	0-60	BF196	0-14	OC23	0-42	2G374	0-17	2N2222	0-20	2N3391A	0-14	2N4062	0-12
ACI22	0-20	ADT140	0-50	BC152	0-17	BD155	0-65	BF197	0-14	OC24	0-56	2G377	0-20	2N2268	0-17	2N3392	0-14	2N4284	0-17
ACI25	0-17	AF114	0-24	BC153	0-28	BD175	0-60	BF200	0-45	OC25	0-55	2G377	0-20	2N2388	0-17	2N3393	0-14	2N4285	0-17
ACI26	0-17	AF115	0-24	BC154	0-30	BD176	0-60	BF222	0-95	OC26	0-25	2G381	0-18	2N2389	0-14	2N3394	0-14	2N4286	0-17
ACI27	0-17	AF116	0-24	BC157	0-18	BD177	0-65	BF257	0-45	OC28	0-50	2G382	0-16	2N2411	0-24	2N3385	0-17	2N4287	0-17
ACI28	0-17	AF117	0-24	BC158	0-12	BD178	0-65	BF268	0-60	OC29	0-50	2G401	0-30	2N2412	0-24	2N3402	0-21	2N4288	0-17
ACI32	0-14	AF118	0-35	BC159	0-12	BD179	0-70	BF269	0-65	OC36	0-42	2G414	0-30	2N2646	0-47	2N3403	0-21	2N4289	0-17
ACI34	0-14	AF124	0-35	BC161	0-12	BD180	0-70	BF269	0-65	OC36	0-42	2G414	0-30	2N2646	0-47	2N3403	0-21	2N4290	0-17
ACI37	0-14	AF125	0-25	BC161	0-12	BD185	0-65	BF269	0-65	OC36	0-42	2G414	0-30	2N2646	0-47	2N3403	0-21	2N4291	0-17
ACI41	0-14	AF126	0-28	BC167	0-12	BD186	0-65	BF270	0-85	OC41	0-20	2N388	0-35	2N2712	0-21	2N3405	0-42	2N4291	0-17
ACI41K	0-17	AF127	0-28	BC168	0-12	BD187	0-70	BF271	0-30	OC44	0-15	2N404	0-20	2N2414	0-21	2N3444	0-15	2N4292	0-17
ACI42	0-14	AF139	0-30	BC169	0-12	BD188	0-70	BF272	0-80	OC45	0-12	2N404A	0-28	2N2904A	0-21	2N3417	0-28	2N4293	0-17
ACI42K	0-17	AF178	0-50	BC170	0-12	BD189	0-75	BF273	0-35	OC70	0-10	2N624	0-42	2N2905A	0-21	2N3417	0-28	2N4294	0-17
ACI51	0-15	AF179	0-50	BC171	0-14	BD190	0-75	BF274	0-35	OC71	0-10	2N627	0-49	2N2905A	0-21	2N3525	0-75	2N4548	0-32
ACI54	0-20	AF180	0-50	BC172	0-14	BD195	0-85	BFW10	0-80	OC72	0-14	2N698	0-42	2N2906	0-15	2N3646	0-09	2N4549	0-30
ACI55	0-20	AF181	0-45	BC173	0-14	BD196	0-85	BFX29	0-27	OC74	0-14	2N599	0-45	2N2906A	0-18	2N3702	0-10	2N4550	0-30
ACI56	0-20	AF186	0-45	BC174	0-14	BD197	0-90	BFX29	0-27	OC74	0-14	2N599	0-45	2N2907	0-20	2N3703	0-10	2N302A	0-42
ACI57	0-24	AF239	0-37	BC175	0-22	BD198	0-90	BFX85	0-20	OC76	0-15	2N697	0-24	2N2924	0-14	2N3706	0-09	2N302A	0-42
ACI65	0-20	AL102	0-65	BC177	0-19	BD199	0-95	BFX86	0-22	OC77	0-15	2N698	0-24	2N2924	0-14	2N3706	0-09	2N302A	0-42
ACI66	0-20	AL103	0-65	BC178	0-19	BD200	0-95	BFX87	0-24	OC77	0-15	2N699	0-24	2N2924	0-14	2N3706	0-09	2N302A	0-42
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
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ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11	2N305	0-84
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ACI67	0-20	AL103	0-65	BC178	0-19	BD205	0-80	BFX88	0-22	OC81D	0-15	2N706A	0-08	2N2925	0-14	2N3707	0-11		

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T05	T066	T066	T064	T048	T048	T045	T048
50	0-23	0-25	0-35	0-47	0-50	0-53	1-15
100	0-25	0-33	0-47	0-47	0-50	0-58	0-63
200	0-35	0-37	0-49	0-49	0-57	0-61	0-75
400	0-43	0-47	0-56	0-56	0-67	0-75	0-93
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800	0-63	0-70	0-80	0-80	0-90	1-20	1-50

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PIV	300mA	750mA	1A	1.5A	3A	10A	30A
50	0-04	0-05	0-05	0-07	0-14	0-21	0-60
100	0-04	0-06	0-05	0-13	0-16	0-23	0-75
200	0-05	0-09	0-06	0-14	0-20	0-24	1-00
400	0-06	0-13	0-07	0-20	0-27	0-37	1-25
600	0-07	0-16	0-10	0-20	0-34	0-45	1-86
800	0-10	0-17	0-11	0-25	0-37	0-55	2-00
1000	0-11	0-25	0-14	0-30	0-46	0-63	2-50
1200	—	—	—	0-38	0-57	0-75	—

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VBO	2A	6A	10A
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T5	8 2G382T OC82
T6	8 2G344B OC44
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T9	8 2G399A 2N1302
T10	8 2G417 AF117
All 50p each pak	

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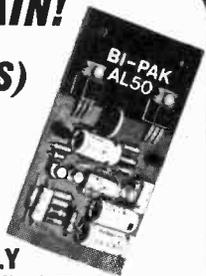
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SPECIFICATION

- Frequency Response 20Hz — 20KHz ± 1dB
- Harmonic Distortion better than 0.1%
- Inputs: 1. Tape Head 1.25 mV into 50K Ω
- 2. Radio, Tuner 35 mV into 50K Ω
- 3. Magnetic P.U. 1.5 mV into 50K Ω
- All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.
- Bass Control ± 15dB at 20Hz
- Treble Control ± 15dB at 20KHz
- Filters: Rumble (High Pass) 100Hz
- Scratch (Low Pass) 8KHz
- Signal/Noise Ratio better than — 65dB
- Input overload + 26dB
- Supply + 35 volts at 20mA
- Dimensions 292mm x 82mm x 35mm

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62	250	12 4	9.5 x 12.7 x 11.4	5.80 67
55	350	15 0	14.0 x 10.8 x 12.4	7.77 82
63	500	27 0	17.1 x 11.4 x 15.9	11.20 *
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128	2000	63 0	24.1 x 21.6 x 15.2	34.10 *

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4	150	3 0	8.9 x 6.4 x 7.6	0-115-200-220-240	2.00 36
66	300	6 0	10.2 x 10.2 x 9.5	"	3.89 52
67	500	12 8	14.0 x 10.2 x 11.4	"	5.78 67
84	1000	16 0	11.4 x 14.0 x 14.0	"	10.49 82
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70	6	3	3 12	10.2 x 7.6 x 8.6	0-12V at 3A x 2	2.24 42
108	8	4	5 4	10.0 x 8.3 x 8.2	0-12V at 4A x 2	2.48 52
72	10	5	6 3	7.9 x 10.8 x 10.2	0-12V at 5A x 2	2.94 52
17	16	8	7 8	12.1 x 9.5 x 10.2	0-12V at 8A x 2	4.54 52
115	20	10	11 13	12.1 x 11.4 x 10.2	0-12V at 10A x 2	5.78 67
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Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P
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79	1.0	2 0	7.0 x 6.4 x 6.0	"	1.35 36
3	2.0	3 2	8.9 x 7.0 x 7.6	"	2.01 36
20	3.0	4 6	10.2 x 8.9 x 8.6	"	2.48 42
21	4.0	6 0	10.2 x 10.0 x 8.6	"	2.94 52
51	5.0	6 8	12.1 x 10.0 x 8.6	"	3.66 52
117	6.0	7 8	12.1 x 10.0 x 10.2	"	4.36 52
88	8.0	10 0	14.0 x 11.7 x 10.0	"	5.64 67
89	10.0	12 2	14.0 x 10.2 x 11.4	"	7.14 67

Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P
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103	1.0	2 10	8.3 x 7.3 x 7.0	"	1.94 36
104	2.0	5 0	10.2 x 8.9 x 8.6	"	2.69 42
105	3.0	6 0	10.2 x 10.2 x 8.3	"	3.65 52
106	4.0	6 4	12.1 x 11.4 x 10.2	"	4.83 52
107	6.0	12 4	12.1 x 11.1 x 13.3	"	7.14 67
118	8.0	18 9	13.3 x 13.3 x 12.1	"	9.32 97
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Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P
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126	1.0	3 0	8.9 x 7.6 x 7.6	"	1.88 36
127	2.0	5 6	10.2 x 8.9 x 8.6	"	2.94 42
125	3.0	8 8	11.9 x 9.5 x 10.0	"	4.48 52
123	4.0	10 6	11.4 x 9.5 x 11.4	"	5.78 67
120	6.0	16 12	13.3 x 12.1 x 12.1	"	8.37 82
122	10.0	23 2	16.5 x 12.7 x 16.5	"	13.85 *

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50	12.5	11 14	13.3 x 10.8 x 12.1	5.20 67

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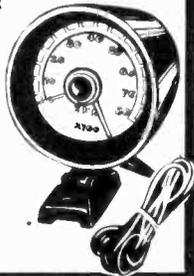
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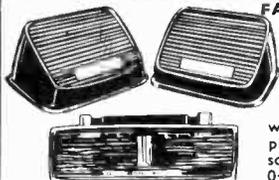
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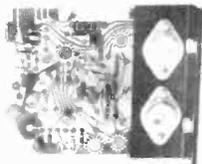
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OUR TRANSISTOR

THIS seems a good time to reveal our own secret suspicions concerning the origin of the transistor. We admit that for long we have had an irresistible feeling that this device was in fact conceived with the private constructor expressly in mind. Yes indeed, and plenty of evidence points this way—other important users and impressive applications notwithstanding.

Forget, for a moment or two, those epic moon journeys monitored on colour television. Forget (if you can) those ubiquitous transistor radios. Forget those prodigious computers—and those in-vogue status setting personal appurtenances like pocket calculators and solid state wristwatches. Instead, reflect upon what the transistor has meant to us as private constructors and experimenters. For we as much as any other body of individuals have cause to be jubilant and grateful in respect of that revolutionary technological breakthrough a quarter century ago.

We suggest that if the trio of research physicists at Bell Labs had been working to a specification drawn up with the private constructor's interests foremost in mind, they could hardly have done better. Those readers able to cast their minds back to the pre-transistor days when the valve ruled the roost will certainly be appreciative of the transformation set in train by the solid state amplifying device. It ushered in an era of expansive amateur activities, by bringing within the private individual's reach, literally to his table top, previously undreamed of electronic techniques.

By comparison with the thermionic devices it was going to replace, the transistor when it made its debut seemed so ridiculously simple to handle, so small and undistinguished in appearance, so undemanding in power, as not to be true. Not that there were no headaches for the average constructor and experimenter initially, when trying to get to grips with strange new concepts involving solid state physics, with a little chemistry and metallography thrown in. It was rather a traumatic experience trying to adjust to the transistor's idiosyncrasies. (An h.t. line of minus 6 volts—what nonsense was this? Though we got our potentials right once again when the *npn* version arrived.) First attempts to make practical use of the strange component were accompanied with trepidation, for burnt-out transistors weren't uncommon in those pioneering days.

Seen now in retrospect, these were but little teething troubles. The advantages and rewards arising from the solid state device were soon made apparent. Without the transistor and its descendants amateur activity would never have reached the advanced technical stage, nor have been able to embrace such wide and diverse applications as it does today. Undoubtedly the basic simplicity of construction is the great single factor which has stirred up popular interest in solid state electronics. It is now an ideal sparetime hobby which can be pursued without difficulty in the home.

Yes, constructors and enthusiasts all, there is cause to be exuberant. And don't forget, without the transistor there could hardly be PRACTICAL ELECTRONICS. So we all owe a vote of thanks to Messrs. Bardeen, Brattain, and Shockley. And surely no true enthusiast will dare deny that our suspicions are well founded.—F.E.B.

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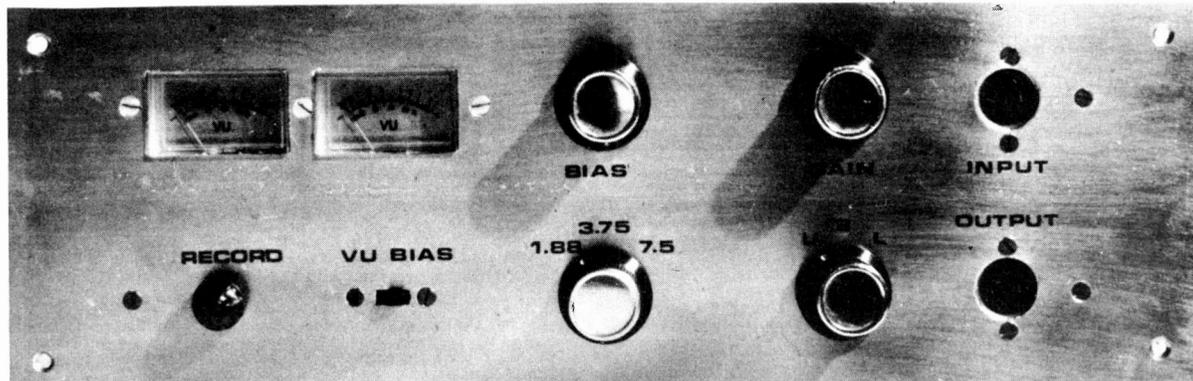
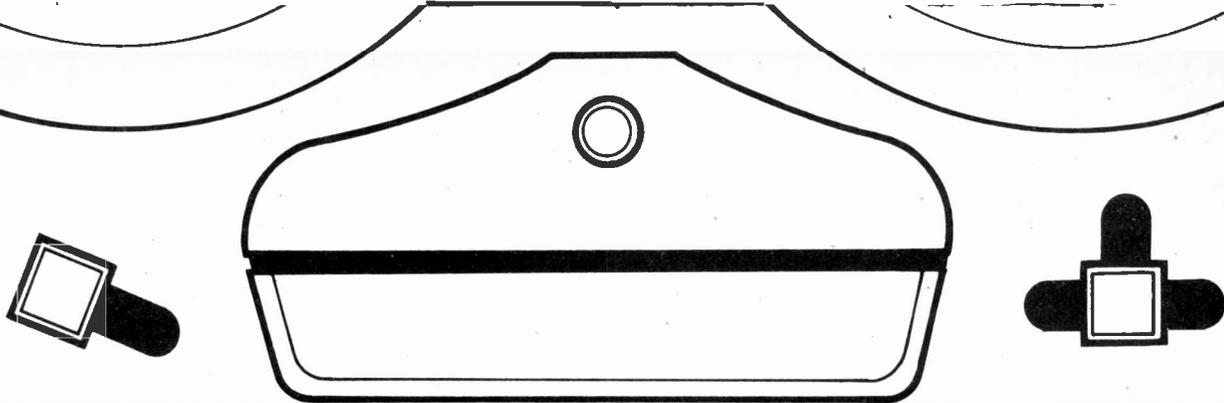
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Hi-Fi Tape Link

By P. S. EWER

THERE must be many readers who possess a tape recorder whose quality does not match that of the rest of their hi-fi system and who would like to improve it to save the expense of buying a completely new deck.

This article describes how to convert a reasonable quality deck to hi-fi by renewing the electronics and the heads whilst retaining the original tape transport system. All that is required is a tape deck of reasonable quality, the author using a Collaro Studio. Full constructional details relating to the deck will be given.

Since it is assumed that the constructor will already possess a high quality amplifier, this will not be described. Microphone facilities are not included because in the author's opinion these are best provided by a comprehensive mixer.

OVERALL SYSTEM

A block diagram of the overall system is shown in Fig. 1. A six-pole three-way switch is used to select either upper track, lower track, or stereo operation (S3). A relay (RLA) is used to control record and playback modes. The relay itself is controlled by an external switch normally fitted to the tape deck. This switch is also used to control the supply to the bias and erase oscillator, which is on in the record position and off in the playback.

A ganged potentiometer (VR6, VR106) controls the gain of the record amplifier which is fed from the input signal via a DIN socket. The output of

the record amplifier is fed via a resistor and the relay contacts to the record/replay heads. It is also fed to the meter circuit which can also be used to read the bias voltage.

The resistor between the record amplifier and the head is used to achieve constant current drive.

In the record mode the relay contacts connect the heads to the record amplifier. The bias oscillator is on and feeds the erase heads. Two 50 kilohm potentiometers (VR7 and VR107) are used to control the bias. When only single track operation is selected then the unused output of the bias oscillator is grounded via a 10 kilohm resistor (R42).

In the playback mode the output of the heads is fed directly to the playback amplifier and then out via another DIN socket.

HEAD REQUIREMENTS

A tape recorder is only as good as its heads and to achieve the required performance heads of very high calibre are essential.

The characteristics required for the record/replay head are

1. Low eddy current loss at high frequency so that a high bias frequency can be used both to avoid interference (this being particularly important when recording stereo radio transmissions with its attendant sub-carrier output problems), and to enable the minimum pre-emphasis to be employed.

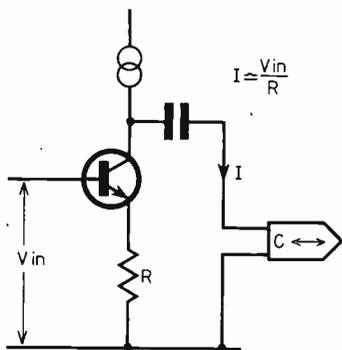


Fig. 2a. Constant current drive using the high output impedance of a transistor collector

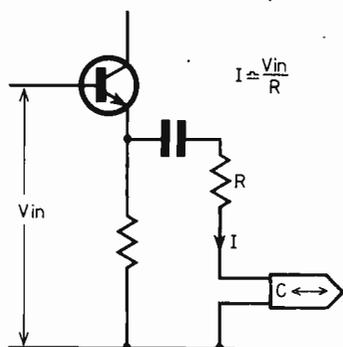


Fig. 2b. Constant current drive using the head in the feedback loop

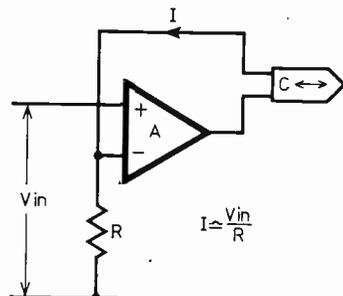


Fig. 2c. Actual method used which uses a series resistor to provide the constant current

Furthermore, even allowing for the full pre-emphasis required, there should be no overload, and the general distortion figure should be low.

CONSTANT CURRENT DRIVE

Because the record/replay head is an inductor its impedance rises with frequency. Therefore to induce a constant magnetic flux in the tape head the head should be driven from a constant current source. (This is the opposite of the constant voltage drive which requires a low output impedance from the amplifier.)

A high impedance in comparison with that of the head is thus required and there are many ways of achieving this in practice.

Use can be made of the intrinsically high collector impedance of a transistor, or the head may be included in the feedback loop of an amplifier as shown in Figs. 2a and 2b. Both these approaches give an excellent approximation to the ideal current drive requirements.

However, both systems have the disadvantage of bias rejection problems and the consequent need for tuned circuits in series with the head. As this is considered to be a major drawback, the author has adopted a different method of obtaining this constant current.

METHOD USED

The basic recording amplifier has a very low output impedance and the record signal is fed to the head via a resistor of a value which is large in comparison with that of the head over the frequency range under consideration.

The bias signal is now attenuated by the resistor and the output impedance of the amplifier (see Fig. 2c).

The penalties to be paid for this solution are: firstly, the departure from accurate current drive (the source impedance is now no longer negligible in comparison with the head impedance); and secondly, the need for a high rail voltage if a reasonable value of series resistor is to be used.

The impedance of the specified Bogen head varies from 170 ohms to a maximum of 10 kilohms. At even the highest tape speed under consideration, the output from the head begins to drop at three kilohertz. Departure from constant current above this frequency can thus be compensated for in the recording pre-emphasis.

A value of 33 kilohms was chosen for the series resistor. Between 20Hz and 3kHz the variation in

the record current is truly negligible, and even up to 18kHz the drop in current is only 3.7 per cent.

RECORD AMPLIFIER CIRCUIT

The output required from the amplifier is 10.8 volts peak-to-peak for full modulation of the tape. Allowing for the full pre-emphasis to be utilised and for the saturation losses in the amplifier transistors, a rail voltage of at least 48 volts is required. In fact 55 volts are available thus allowing for a small overload.

Referring to the circuit diagram (Fig. 3), it will be seen that the circuit is similar in conception to that commonly employed in audio power amplifier design.

Transistor TR1 forms a low noise input stage and has a gain of 4.5 times. TR2 is the workhorse of the amplifier. It has a boot-strapped collector load for high gain with low distortion due to the limited modulation index of the collector current, and forms the driver for the output stage.

Transistors TR3 and TR4 comprise the output stage which operates in class A, a requirement for low distortion when a large output is required.

The amplifier has good linearity even before feedback, and this, coupled with the high gain and hence large amount of allowable feedback, serves to reduce distortion to a very low level.

The overall loop gain at d.c. is unity giving exceptional stability of the mid-rail voltage. Components R5, R6, and C9 provide a.c. feedback, and the frequency response for the different speeds is shaped by L1 in conjunction with C5, C6, or C7, the frequency of maximum treble boost being switched according to the speed in use, and the amount being preset by the series resistors VR1 to VR3.

The nominal gain is approximately 70 and this gives an input sensitivity in the region of 55mV. C11 is a phase shifting capacitor required to give stability by preventing high frequency oscillation.

METERING CIRCUIT

It is the author's opinion that average reading meters of the volume unit (VU) variety allow short duration overloads to occur without any indication. The recording meters in this recorder are therefore of the peak reading kind having a fast attack, and a slow decay time of about 2.5 seconds.

This reduces the effect of meter movement inertia, for the pointer generally has less far to travel to

COMPONENTS...

Resistors

R1, R101	390k Ω	R26, R126	1k Ω
R2, R102	180k Ω	R27	5.6k Ω
R3, R103	100k Ω	R28	1.2k Ω
R4, R104	6.8k Ω	R29, R129	1M Ω
R5, R105	100k Ω	R30, R130	15k Ω
R6, R106	10k Ω	R31, R131	10k Ω
R7, R107	150 Ω	R32, R132	2.2k Ω
R8, R108	10k Ω	R33, R133	56 Ω
R9, R109	39k Ω	R34, R134	8.2k Ω
R10, R110	6.8k Ω	R35, R135	10M Ω
R11, R111	220 Ω	R36	270 Ω
R12, R112	220k Ω	R37, R137	39k Ω
R13, R113	220 Ω	R38, R138	82k Ω
R14, R114	33k Ω	R39, R139	150k Ω
R15, R115	180k Ω	R40, R140	10M Ω
R16, R116	100k Ω	R41, R141	10k Ω
R17, R117	33k Ω	R42	10k Ω
R18, R118	39k Ω	R43, R143	15k Ω $\frac{1}{2}$ W 5%
R19, R119	3.3k Ω	R44	10 Ω $\frac{1}{2}$ W 2%
R20, R120	3.3k Ω	R45	3.3k Ω
R21	220 Ω	R46	3.3k Ω
R22, R122	560k Ω	R47	10 Ω $\frac{1}{2}$ W 2%
R23, R123	22k Ω	R48	22 Ω 5W 5% wirewound
R24, R124	18k Ω	R49	47 Ω $\frac{1}{2}$ W 10%
R25, R125	4.7k Ω		

All $\frac{1}{2}$ W 5% carbon film histab unless otherwise stated, 2 off of each except R21, R27, R28, R42 and R44-R49

Capacitors

C1, C101	560pF polystyrene
C2, C102	2.2 μ F 25V Tantalum
C3, C103	10 μ F 25V Tantalum
C4, C104	100 μ F 64V elect.
C5, C105	0.15 μ F 5% polyester
C6, C106	0.068 μ F 5% polyester
C7, C107	0.027 μ F 5% polyester (use 0.022 μ F and 0.005 μ F in parallel)
C8, C108	50 μ F 25V elect.
C9, C109	2.2 μ F 25V Tantalum
C10, C110	16 μ F 40V elect.
C11, C111	47pF 10% polystyrene
C12, C112	0.47 μ F polyester
C13, C113	0.33 μ F polyester
C14, C114	10 μ F 10V Tantalum
C15, C115	5 μ F 10V Tantalum
C16, C116	50 μ F 16V Tantalum
C17, C117	2.2 μ F 16V Tantalum
C18, C118	0.1 μ F polyester
C19, C119	1,800pF 2% polystyrene
C20, C120	50 μ F 25V elect.
C21	50 μ F 40V elect.
C22, C122	1 μ F polyester
C23, C24	2,500 μ F 40V elect.
C25, C125	330pF ceramic
C26	0.022 μ F 10% polyester
C27	0.22 μ F 10% polyester
C28	0.022 μ F 10% polyester
C29	640 μ F 25V elect.

2 off each except C21 and C26-C29

Potentiometers

VR1, VR101	} 100 Ω preset (R.S. Mouldtrim) (6 off)
VR2, VR102	
VR3, VR103	
VR4, VR104	1k Ω submin skeleton preset (2 off)
VR5, VR105	4.7k Ω submin skeleton preset (2 off)
VR6, VR106	10k Ω + 10k Ω log ganged pot
VR7, VR107	50k Ω + 50k Ω lin ganged pot

Inductors

T1	20V-0-20V $\frac{1}{2}$ A (R.S. 20V Rectifier)
T2	Bias transformer } (see next month for details)
L1, L101	4mH (2 off)

Heads

EH1	Bogen erase head type UL296
RPH1	Bogen universal head type UK207E

(These are available from Cole Electronics Ltd., 7-15 Lansdowne Road, Croydon CR9 2HB and Brenell Engineering Co. Ltd., 231/5 Liverpool Road, London, N.1 who also market a tape deck incorporating these heads).

Transistors

TR1, TR101	BC159
TR2, TR102	BC147
TR3, TR103	BC157
TR4, TR104	BC147
TR5, TR105	BC148
TR6, TR106	BC157
TR7, TR107	BC149
TR8	BC158
TR9, TR109	2N3823
TR10, TR110	BC159
TR11, TR12	BFY50

All 2 off except TR8

Diodes

D1, D101	OA47 (2 off)
D2	BZY88C 27V 400mW Zener
D3	BZY88C 20V 400mW Zener
D4, D5	BA145 (2 off)
D6	12V 1.5W Zener
D7-D10	BA148 or 1N4002 (4 off)

Integrated Circuit

IC1, IC101	SN72741P or 741OPA (2 off)
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Relay

RLA	12V 185 Ω 4 changeover contacts (ITT)
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Meters

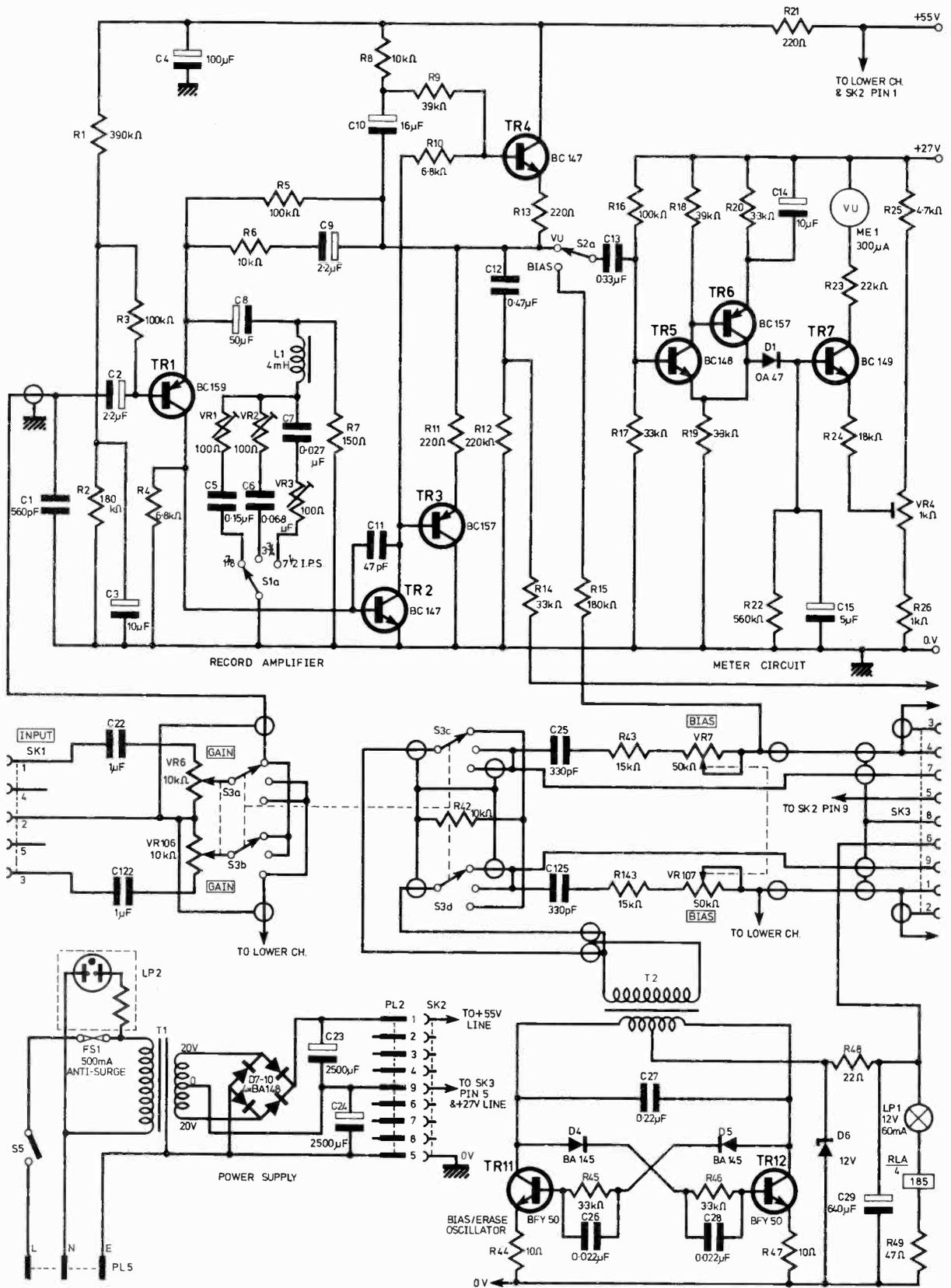
ME1, ME101	VU meters. Sensitivity 1.228V a.c. for 0dB (300 μ A) (2 off)
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Switches

S1	4 pole 3 way (R.S. miniature Maka-switch)
S2	2 pole changeover miniature slide
S3	6 pole 3 way (R.S. miniature Maka-switch)
S4	see text

Miscellaneous

SK1	5 pin 180 $^\circ$ DIN socket
SK2, SK3	B9A valveholder (2 off)
SK4	5 pin 180 $^\circ$ DIN socket
PL2, PL3	B9A plug (2 off)
PL4	Mains plug Bulgin type P429
LP1	12V 0.75W lamp and holder
LP2	Mains neon with integral resistor
$9\frac{1}{2}$ in \times 5in 0.1in matrix plain Veroboard	
16 s.w.g. aluminium for chassis (see Pt. 2 for dimensions), TO5 clip-on heatsinks (2 off), plastic cable clips (2 off), capacitor clips (2 off), 21, 30 and 34 s.w.g. enamelled copper wire	



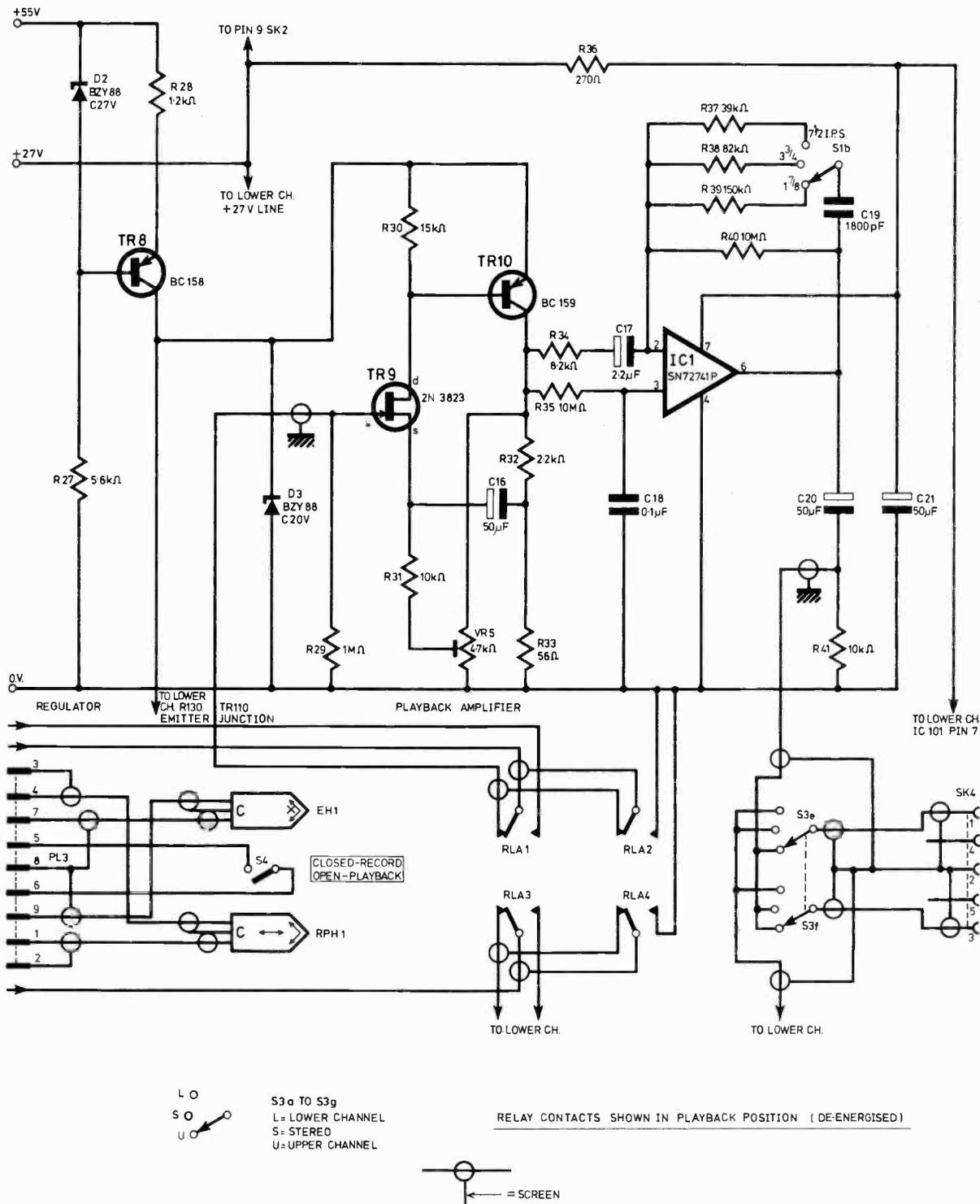


Fig. 3. Full circuit diagram of the stereo tape link. Only the upper channel has been shown; the lower channel electronics being identical to the upper channel. Components numbers of the lower channel are upper channel numbers plus 100

indicate a transient, and is easier for the eye to follow.

Referring now to the circuit diagram, transistors TR5 and TR6 comprise a unity gain voltage follower having a very low output impedance.

The metering signal is rectified by diode D1 and stored in C15. Because of the low impedance of the voltage follower the major limitation on the charging time of C15 is the forward resistance of the diode which is a gold-bonded germanium type.

The discharge time is governed by the combination of the reverse resistance of the diode, R22 and the input impedance of TR7.

In the absence of an input signal the base of TR7 is at 6.7 volts. Preset VR4 is set so that TR7 is just cut off and hence no current flows through the meter. As the signal input increases the charge on C15 increases positively hence forward biasing TR7. Resistor R23 provides the meter with overload protection.

BIAS AND ERASE OSCILLATOR

A very pure bias waveform is needed if the full dynamic range of the tape is to be realised. Also, due to the dependence of frequency response, output level, distortion and modulation noise on the bias amplitude, the oscillator amplitude should be drift free.

Push-pull operation is used to minimise even harmonic distortion and the rail voltage is regulated to ensure amplitude stability of the waveform.

So that adequate filtering of the oscillator harmonic output is assured, the tuned circuit must have a high working Q . This is achieved by the employment of a low impedance tuned circuit wound with thick wire on a low loss high permeability pot core. The tuning capacitor should have low dielectric losses as well.

The transistors are protected against reverse breakdown of their base emitter junctions by diodes D4 and D5. Although this breakdown does not interfere with the operation of the oscillator, it can, after a period of time, cause reduction in the current gain of the transistors.

Zener diode D6 regulates the voltage supplied to 12 volts. The bias is arranged to decay slowly by discharging C29 when switching off from record. This is essential if magnetisation of the heads is to be avoided.

In practice, the oscillator works well. The output rises by 0.25dB over the first minute of operation and is thereafter stable. The waveform is good, as indicated by the inaudible change in the tape noise after virgin tape has been passed by the erase head. It is important when performing this test to pull the tape away from the record head as this will record modulation noise. Modulation noise is inherent in all biased recorders and can be reduced only by the use of low noise tapes and careful design of the heads.

REPLAY AMPLIFIER

The output of the record/replay head when playing a tape rises at the rate of 6dB per octave (i.e. it doubles for every doubling of frequency) up to the point at which high frequency fall-off occurs.

The replay amplifier compensates for this characteristic, and provides a high level output signal suitable for feeding long screened cables.

When considering the connection of the head to the amplifier it is important that no appreciable direct current flows through it, as this would result in magnetisation of the head, and a consequent increase in the background hiss of the tape. It is thus inadvisable to couple the head via a capacitor as the charging current for it will pass through the head.

F.E.T. INPUT STAGE

The use of a field effect transistor as an input device allows direct connection of the head. Because of the very high input impedance of the f.e.t. it requires only a miniscule bias current (about 2nA) which is insufficient to affect the head. Compared to a bipolar transistor the f.e.t. also possesses a generally lower noise and distortion level.

The f.e.t. and TR10 comprise a complementary feedback pair operating at a gain of 50 from an input signal of 2.7mV at 1kHz and at $7\frac{1}{2}$ inches per second. This stage has a flat frequency response. The f.e.t. has a considerable spread in the gate to source bias voltage for a given drain current, being anywhere from 0.5 to 7.5 volts. It is not easy to design away this variation, and a preset resistor (VR5) has therefore been provided for setting-up.

SUPPLY RIPPLE REDUCTION

An interesting feature of the input stage is the method of supply ripple reduction. Transistor TR8 is biased as a current source. Zener diode D2 maintains the base-emitter potential constant in the presence of ripple on the 55 volt line, reducing modulation of the collector current.

The high source impedance of the current combined with the low slope resistance of the Zener diode D3 attenuates the ripple to a negligible level.

EQUALISATION

The function of equalisation is left to the last stage, thus resulting in lower noise levels, and greater accuracy of equalisation which, if carried out earlier could cause variations in the input impedance.

The general purpose operational amplifier type 741 is the equaliser and output stage and is eminently suitable for this application. Because of its high gain and low output impedance it is capable of producing very accurate equalisation. It has its own internal frequency compensation for stability and its output is short circuit protected.

The d.c. source impedances of the inverting and non-inverting inputs are similar and the d.c. gain of the stage is set to unity to minimise drift of the quiescent output voltage with temperature.

The equalisation components R37-39 and C19 are selected according to the speed in use and set to the CCIR standards of 70, 140 and 280 microseconds.

POWER SUPPLY

The power supply is quite simple, providing two outputs of 55 volts and 27 volts. Full wave rectification and large value reservoir capacitors are employed to produce good supply regulation and low output ripple.

In the second part of this article, next month, construction of the Hi-Fi Tape Link will be described

ARE WE ALONE?

From time to time the question of other living entities, whether they be elementary forms or whether equivalent to homo sapiens or better, is revived. Over the past year or so the climate of acceptability has improved in these matters and there are less sceptics each year.

While all science fiction has been treated as having license in this direction, examination tends to show that in our galaxy, at least, the chances of bug-eyed monsters or intelligent vegetations being our companions is losing ground. In general all the findings so far point to a cycle of emergence to the present level of homo sapiens as the most likely, though minor variations could occur.

At the present state of knowledge the evidence is in favour of similar forms of life to that which exists now. This being the case the field is narrowed quite considerably and statistically it is known that there is a high possibility of life existing elsewhere, but the possibility of communication presents a major problem.

From several sources recently there have come new suggestions for contacting other intelligences. Some are based on the concept that if there are fundamental laws governing the matter, they would be the same for all. The use of mathematical constants and the geometric forms regarded as fundamental, is a natural step.

ECHOES FROM SPACE?

There have been two recent suggestions, one which relates to a cyclic condition of the movements of heavenly bodies and one which is based on the problem of long time echoes of known broadcasts.

The first of these suggestions involves the possibility of near approaches to the solar system by stars which might have a planetary system. Statistics show that there is a quite frequent approach to within 50 light years of the solar system.

A second line put forward is based on the phenomenon of echoes, first noted by Störmer and Van der Pol in 1928. While they appeared to be curious and puzzling at that time this is not really the case now.

However, renewed interest has been aroused by D. Lunan, who has studied available data over a long period and has offered certain suggestions as to the reason for the echoes.

One of the suggestions is that the echoes behave as though they were reflected from a point at or near the orbit of the moon. He has constructed maps which are very similar to the star maps of the northern hemisphere and suggests that the star Epsilon Boötis might



BY FRANK W. HYDE

be the source from which a probe has been dispatched.

The probe may be in orbit and attempting to make earth beings aware of its existence by re-transmitting broadcasts. It is also suggested that the probe may have arrived in the solar system about 11,000 years ago.

Perhaps all the evidence has not been released but the matter was given considerable discussion at a meeting of the Interplanetary Society.

The echoes are both long-time, that is years, and short-time, that is 3 to 15 seconds and it is the latter that Lunan has investigated.

It is easier to offer an alternative for this suggestion because the periods are short enough to avoid the complication of dissipation of power. A short time of three seconds could be a direct reflection from the earth's other moon that has so frequently been postulated or even from the moon itself over a long path.

However, for both of the extremes of timing there is a simple answer which involves the model of the ionosphere that was considered satisfactory for a long time. This was a layer type model like the successive skins of an onion.

The ionosphere in fact is not a bit like that and not only are there now many doubts about propagation theories that have been held for so long, but the layer theory disappeared with the advent of *Sputnik 1*. In this connection there is much evidence that indicates that there is no homogeneity about these layers at all.

Moreover, there is considerable variation in the density of the northern and southern hemispheres. This variation of density in the layers has a considerable effect on

the length of reflection paths. It is, therefore, possible for a signal to go round the earth several times before emerging at a particular angle that could be recorded as an echo.

It would be possible to expand on the Lunan theory, but suffice to say that the answer to the appearance of regular patterns can only come from a specific attempt to make a practical test of Lunan's work. It is in fact an experiment that could be undertaken by amateurs and perhaps here is an opportunity for UFO supporters to produce some practical answers to their claims.

USSR RESEARCH

As a result of finding amino acids in the Murchison meteorite the Russians have been carrying out further experiments on meteorites that have fallen in the past. They concluded — so state academicians Vinogradov and Vdovykin — that there is evidence for the chemical evolution of life.

They also state that it is not necessary for there to be special fortuitous circumstances for this to come about; in short, life could evolve anywhere where there is a dust accretion in the galaxy. This has been deduced from an examination of the Mighei meteorite which fell in the Ukraine in 1889.

The Murchison meteorite revealed amino acids and the Mighei meteorite shows an acid which is similar to *DNA* but has a spiral which is symmetrical. From this fact they conclude that it is not of biological derivation.

CRAB NEBULA AGAIN

The crab nebula has been much in the news of late. The original noting of this supanova by the Chinese astronomer Yang Wei-Tek was on July 4, 1054. Little other record of this occurrence is found in literature though it must have been an event of considerable note.

However, in 1955 W. C. Miller discovered evidence that the North American Indians had recorded the event. Pictures were found showing the crescent moon with the nova nearby. This was thought to be a unique record and the date was confirmed as July 5, 1054.

Recently another discovery was made at Fern Cave in California. This cave was occupied at the time of the event in 1054 and so could be depicting an event during the formation of the settlement. The timing has been checked by four investigators and though no absolute claim for identification is made it seems unlikely that it records any other event.

The fact that the nova was more brilliant than Venus must have made it an outstanding sight.

Gerry Brown . . .

ON THE FRINGE



SENSE OF SMELL

Apropos of our discussion some months back, relating to "sniffing", it seems that someone else has latched on to the idea of recruiting bugs to serve as extensions to our probosci. This time it's some form (goodness knows what) of marine bacteria which come as a package-deal for detecting the smells associated with just about anything from bombs to pineapples.

These wonderful little "critters" can, I gather, be trained (presumably in the good old Pavlovian way) to glow whenever they sense or come in contact with a material of one's choosing. It is then simply a matter of detecting this light with a photocell (photomultiplier?) to identify the type of smell. Unlike previous attempts to make bugs useful in the role of an olfactory sense, this way would appear to be far more flexible.

The particular application to which this artificial nose might show some real worth ultimately is tele-olfaction.

Using this new way to sense smell at a distance ought not to be too difficult, but may be complicated by the fact that odours do not seem to be represented to us in the same way that, say, colour is; to wit, it is not simply a question of discovering primary odours then combining them to produce "hues" (or phews!).

No doubt, the limitation would be on the number of trained bacteria packages one could incorporate in a transducer, since each package would only respond to a particular smell. Assuming a compromise could be accepted at around one hundred or so packages, that is one package for each of the more common smells, then by fanning air over the device, sequential interrogation of the bacterias' photocells would classify both type and amplitude of odour.

This, though, is only part way to the ultimate in communication. There still needs to be a method for reproducing the "pong" from the transducer output waveform. This should be a simpler job because, following receipt of this signal, it might then be decoded within the receiver and the resultant employed to address a corresponding set of control valves, so releasing the correct aromatic. As an alternative, heaters could be arranged to vapourise the material.

Whether there should be a delay between different signals is a moot point; naturally, it would not be the best of schemes to follow one smell by another when the chance existed that they might clash or produce some offensive "mixture".

Honestly, imagine one of these things going wrong. There is little doubt that TV servicemen would suddenly find new uses for the humble pair of bull-nosed pliers!

SHOCK THE VILLAINS

Mugging, and the crop of pensioner-bashing cases we have witnessed lately must be distasteful to anyone with a sense of respect for their fellows. For a while now I have considered a number of possibilities for beating this, very real, public menace, but it is not something to be easily reckoned with.

Anyhow, having contacted the Chief Constable for my area and



discovered that, "no, you were not permitted to use portable high-voltage equipment with a view to shocking the villains into submission", the only effective alternative seemed to be a notion based on the word "shock". The best deterrent thus appeared to be one that could attract a lot of attention to one's predicament by others in the vicinity of the incident.

An electronic device to meet our requirements generally needs to have quite bulky proportions, so probably the best "noise-maker" would be a small klaxon employing a miniature electric motor, this driving a coarse-pitch gear pinion bearing directly against a piece of bent metal (certainly noisier than any loud-speaker of twice the size). The metal "noise-maker" could be carved out of the lower part of a hand-held lamp case the upper portion being utilised for photo-flash attention lamps.

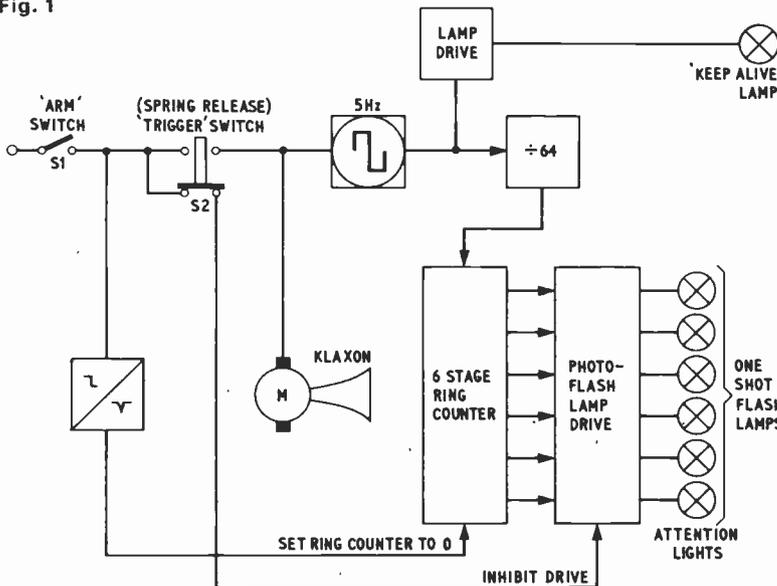
This kind of alternative, at least, should come within the limits of the law and Fig. 1 gives the general picture of how such a set-up would function.

Two switches control the device. The "arm" switch (preferably concealed) connects a supply battery preparatory to possible operation. Simultaneously, photo-flash lamp drive is inhibited while a "set" pulse is fed to a six-stage ring counter whose outputs all go to logical "0".

Release of the spring-return "trigger" switch starts the klaxon and also causes the clock generator to run. In turn, a (deliberately over-run) "keep-alive" lamp rapidly flashes while the divider counts down the signal from the clock. Thus, every 13 or so seconds, the ring counter will be advanced one step and so fire (one at a time) the photo-flash lamps.

Naturally, the device ought not to be too inelegant physically, but should be of sufficient size to prevent any feeble-minded body-vandal shoving it in a convenient Gladstone bag!

Fig. 1



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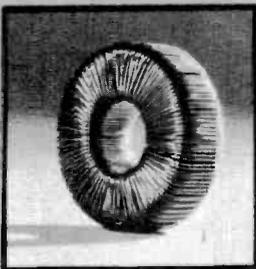
NEW PRODUCT

The unique test instrument illustrated gives an instantly visible display of the Logic State of DIL Integrated circuits. The device automatically selects its power supply from the terminals of the IC's being inspected. Each Logic Checker is supplied complete with a set of clip-on Logic plates. For fuller details see the new Arrow catalogue.



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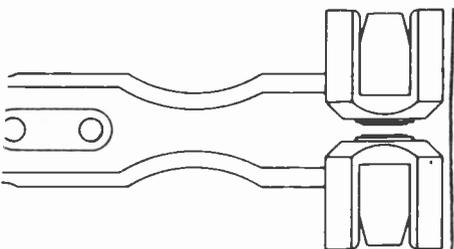
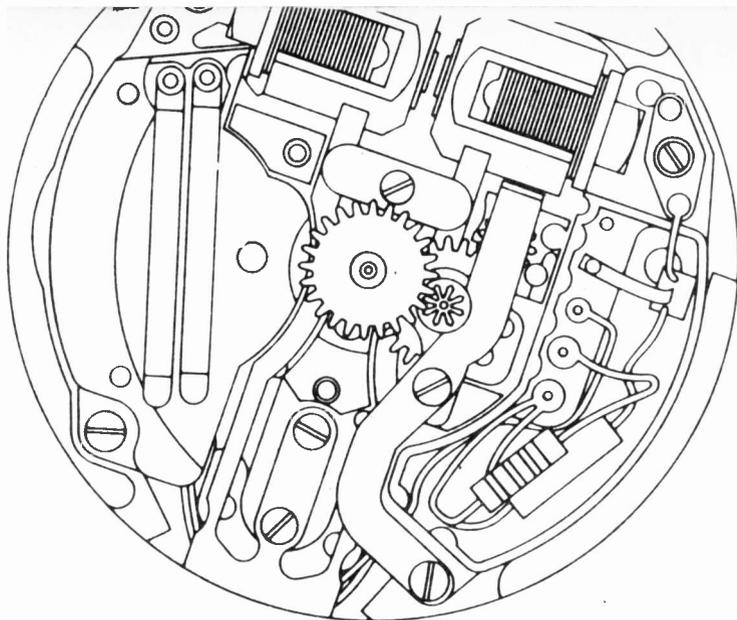
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2N5190	0.92	AF125	0.20	BC308	0.08	BF273
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ELECTRONIC TIMEPIECES

By **JB DANCE M.Sc.**

MOST watches and small clocks being manufactured at the present time still employ a main-spring as the source of power and a balance wheel plus hair spring as the timing mechanism. The basic design of such timepieces has remained essentially unaltered since Huygens developed the balance wheel mechanism in the 17th Century.

RECENT PROGRESS

The first battery powered wrist watch was marketed in 1952, but recent developments in micro-miniature integrated circuits have enabled high quality electronic watches to be produced which are much more accurate than the more common types of watch. Most of the quartz crystal controlled watches show an accuracy of about one minute per year.

Electronic watches do not have a spring which requires winding periodically, but their miniature battery must be replaced about once per year. Smaller movements suitable for ladies' watches are becoming available, but considerable problems arise in designing watches which can be powered by miniature mercury cells which must have the minimum acceptable life of one year.

TYPES

Some of the main types of electronic watches can be classified in the following way. Many variations of these main types are available.

First generation watches employ a conventional balance wheel and hair spring as the timing mechanism, but they are powered by a battery instead of

a main spring. They have the advantage that they do not have to be wound, but their accuracy is not generally so much greater than that of a conventional watch.

Second generation watches employ a tuning fork mechanism operating at about 300-500Hz as the timing device; a transistor circuit drives the tuning fork. Such watches have an accuracy of about one minute per month, this being considerably better than that of an ordinary watch. Tuning fork watches do not tick, but emit a slight hum.

Third generation watches employ a quartz crystal oscillator which normally operates at a frequency of between about 8kHz and 33kHz; most types have an accuracy of about one minute per year. The pulses from the quartz crystal are used to control the speed of a motor which drives the hands of the watch. Various techniques are employed to accomplish this.

Fourth generation watches do not employ hands to indicate the time, but incorporate a digital display which shows the time in actual figures. These watches have no moving parts and are completely electronic. They employ a quartz crystal oscillator and have an accuracy of about one minute per year. They are only just becoming available.

PRICES

Unfortunately the price of electronic watches is still quite high. The price of many watches is increased because a gold case is employed.

In the case of stainless steel cased watches, one finds tuning fork models ranging from just under

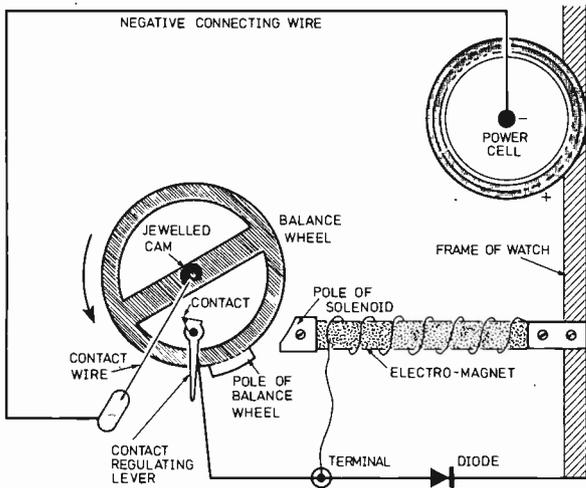


Fig. 1. The circuit diagram of the first electric watch

£40 upwards, with the smaller ladies' watches rather more expensive. The quartz crystal controlled watches are generally priced from about £100 upwards, but some of the watches providing a digital display are not so much more expensive than other quartz crystal controlled watches.

It seems fairly certain that the prices of electronic watches will fall during the next few years. The components of all electronic digital watches can be mass produced and assembled by relatively unskilled personnel. This will effect a great saving in labour costs at a time when the general trend is for labour costs to rise rapidly and integrated circuit production costs to fall—especially if large numbers are produced. Thus it seems we are experiencing a revolution in watch design.

Although one has the annual cost of the power cell replacement (typically £1), most electronic watches do not require servicing so frequently as ordinary watches. The forces in the transmission gearing are usually less than in conventional watches and therefore satisfactory functioning is almost independent of the increase of viscosity of the oil with time. In general the regular cleaning and preventative maintenance recommended for balance wheel watches are unnecessary with most electronic types; one only has the watch attended to if it stops or does not keep time with its normal accuracy.

CLOCKS

Electronic clocks are also available with either a digital display or with the analogue display provided by ordinary hands. Many electronic clocks are quartz crystal controlled and provide an accuracy of about one minute per year. Both battery powered and mains types are available.

Some of the main types of electronic timepieces will now be considered in reasonable detail. The development of electronic clocks has followed a rather similar pattern to that of watches (although the problems of size are not nearly so acute) and therefore clocks and watches will be discussed together

THE FIRST ELECTRIC WRIST WATCH

The first battery driven wrist watch was developed by the French Company LIP in collaboration with the Elgin Company of the U.S.A. This watch was introduced into the LIP range on 15th March 1952, but the same type of movement is still being produced by this Company. The Hamilton Company introduced a similar type of movement very shortly after the LIP watch became available.

Although this type of watch is electric rather than electronic, it will nevertheless be discussed, since it led to the development of some electronic types and has been described as the greatest advance in watch design for some centuries. The same basic principle has also been used in clocks manufactured by the Hamilton, Vedette, Bayard and Odo Companies.

PRINCIPLE OF OPERATION

The principle of operation of the LIP type R.148 movement is shown in Fig. 1. The R.184 is similar, but it also indicates the date.

As the balance wheel rotates in an anticlockwise direction, the jewelled cam on the balance wheel pivot pushes the contact wire onto the contact. A current then flows from the power cell through the electro-magnet and the contacts and back to the cell. The energising of the electro-magnet at the instant the pole of the balance wheel is approaching the pole of the magnet causes the two poles to be attracted together so that the balance wheel is given an impulse.

The balance wheel continues to rotate after the contact has been made and the wire returns to its normal position. When the balance wheel swings in the opposite direction, the cam merely pushes the contact wire away from the contact and the magnet is not energised. The electro-magnet passes a current which increases to about 1mA over a period of 3 milliseconds and then the current falls rapidly to zero. The current pulses occur every 0.4s. For simplicity a magnetic shunt employed in this type of watch is not shown in Fig. 1.

SPARK SUPPRESSION DIODE

A diode is connected in parallel with the electro-magnet. When the contacts are joined little current flows through this diode, since the potential across the electro-magnet reverse biases the diode. When the contacts break, however, the current ceases to flow through the electro-magnet and a back e.m.f. is developed across the latter, owing to its inductance. The diode shorts out this back e.m.f. and thus prevents damage to the delicate contacts by sparking.

The cam illustrated in Fig. 1 consists of a jewel. The amplitude of the balance wheel oscillations can be controlled by adjusting the contact regulating lever; the latter rotates the contact arm on its axis.

The amplitude of the oscillations of the balance wheel remains fairly constant and this results in the watch keeping more accurate time than many watches which are powered by a main spring. There is some negative feedback, since if the amplitude of oscillation decreases, the contact time is increased and this provides more power which helps to stabilise the amplitude of oscillation.

The mean current taken from the 1.55V cell is normally 5µA, but does not exceed 7µA. A 100mA-hour battery therefore has a life of some 15 to 18 months.

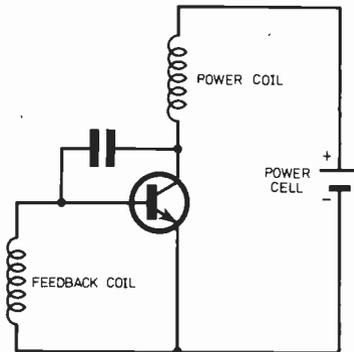


Fig. 2 (left). A circuit which can be used to drive the balance wheel of a watch

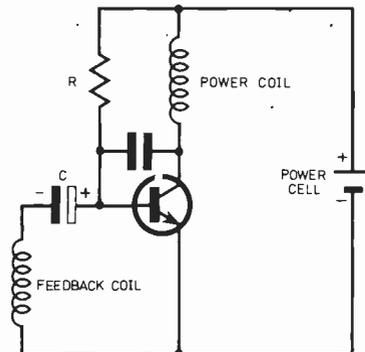


Fig. 3 (right). A circuit used in some self-starting watches and clocks for driving the balance wheel

ELECTRONIC WATCHES WITH A BALANCE WHEEL

The main problem with the type of electric watch just described is that the contacts must be very carefully designed and positioned if they are to have a reasonable life. In any case, the contact life tends to be limited.

The work of Marius Lovet of France has led to the development of electronic watches with balance wheels in which the switching is carried out by a transistor.

The balance wheel of such electronic timepieces carries small permanent magnets which move near to two coils—a feedback coil and a power coil. The currents induced in the feedback coil by the movement of the balance wheel magnets drive the transistor into conduction so that the power coil receives a pulse. The magnetic field developed by this coil acts on the magnets to give the balance wheel a driving pulse.

CIRCUIT

The type of circuit shown in Fig. 2 may be used in timepieces which employ an electronically driven balance wheel. If the latter is stationary, the base and emitter are at the same potential and therefore the collector current is extremely small.

When a magnet of the balance wheel moves past the feedback coil, however, the voltage induced in this coil causes the transistor to conduct. A current therefore flows in the power coil and an impulse is

produced which powers the balance wheel. The pulse duration is typically 10 milliseconds. Spurious oscillations of the circuit can be suppressed by connecting a capacitor between the base and collector of the transistor. The resistance of the coils may be a few hundred to a few thousand ohms.

One of the disadvantages of this type of circuit is that the balance wheel does not commence to oscillate automatically. The watch must be rotated to start it. This difficulty can be avoided by connecting a resistor of about 100 to 200 kilohms in the base circuit (as shown in Fig. 3) so that a very small current flows in the base and collector circuit even when the balance wheel is stationary.

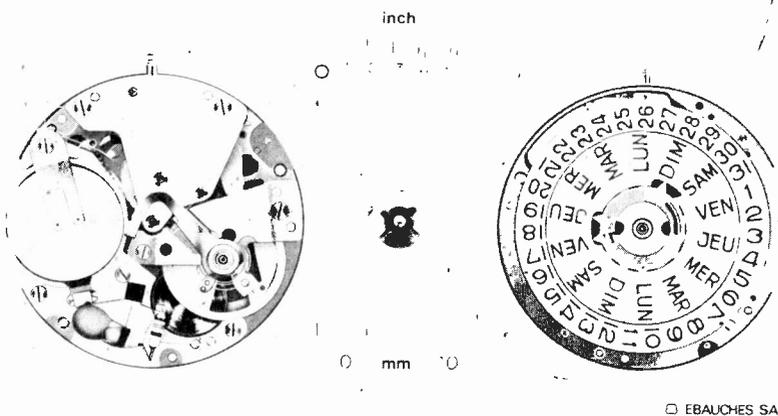
The current flowing through the power coil interacts with the magnets of the balance wheel and causes the latter to move. The minute oscillations are built up by transistor action until the normal amplitude of vibration is reached.

Although a current flows through the circuit continuously, this current can be eliminated by connecting an electrolytic capacitor in series with the feedback coil (as shown in Fig. 3).

Contactless circuits of this general type are widely employed in some of the more economical types of electronic watch. For example, the LIP movement type RE.50 (introduced in 1970) was the first electronic watch for ladies available anywhere in the world. Much of the internal volume is occupied by the 1.55V, 60mA-hour cell which is 7.9mm in diameter. One finds similar circuits in the 9154 "Dynotron" movement produced by Ebauches S.A.

The Swissonic 10 electronically driven balance wheel movement. The magnets can be seen fixed to the balance wheel and the power coil under the balance wheel. The first three letters of the days of the week are shown in French

The Nepro Elevox watch which incorporates an electronic alarm



□ EBAUCHES SA



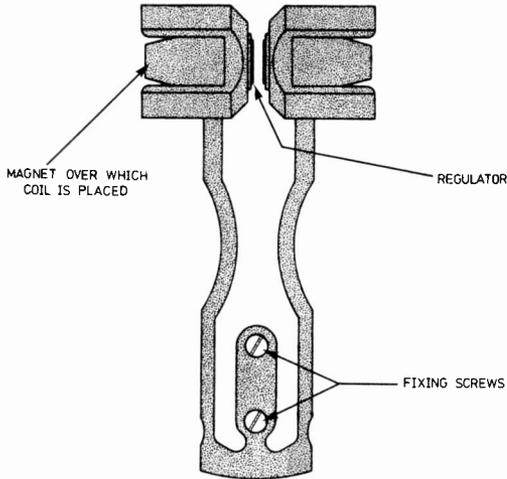


Fig. 4. The miniature tuning fork used in the Bulova 214 series of "Accutron" models

(a large group of Swiss watch manufacturers), in the Junghans 600.12 self starting wrist watch produced in Germany, etc.

Electronic clocks employing this type of movement are produced by Junghans (type ATO-MAT-WERK 726); the mean current consumption is less than $160\mu\text{A}$ at 1.4V or a total of less than 1.5A-hour per year. Similar types of clock are produced by the Jaz Company.

ELECTRONIC ALARMS

The first wrist watches with electronic alarm systems were introduced by the Nepro Company of Switzerland in 1972 after five years of development work. Although watches which have an alarm powered by a spring are available, the stored energy is rather small and this results in the intensity of sound being low and the duration limited. In addition, the alarm spring must be wound each time the alarm is used.

The Nepro watches employ a 1.5V battery of 40mA-hour capacity to power their wrist watch alarms. The current is about 8 to 12mA and the battery has a life of about a year with normal use. The alarms of these watches sound for five minutes unless cancelled by a push button.

ALARM MODELS

One type of wrist watch with an alarm produced by Nepro is the "Memotron". A vibrating membrane generates the sound in the MB 500 alarm system contained in this watch. This is the smallest electronic alarm in production, having a volume of only 0.8 cubic centimetres.

Watches using this type of alarm can be used to remind a person of appointments throughout the day and can therefore be used for many purposes for which normal alarm clocks are unsuitable. The Nepro Company also produce a range of very small alarm clocks with battery powered alarms.

TUNING FORK WATCHES

The first tuning fork movement was announced by the Bulova Company on 25th October 1960. This watch, which was the result of six years of research by Dr Hezel of Bulova, represented a real revolution

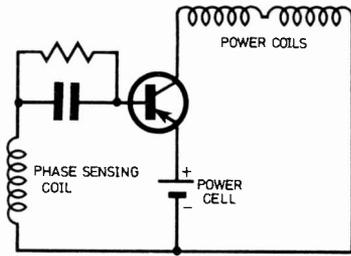


Fig. 5. The circuit of the Bulova 214 series of "Accutron" watches

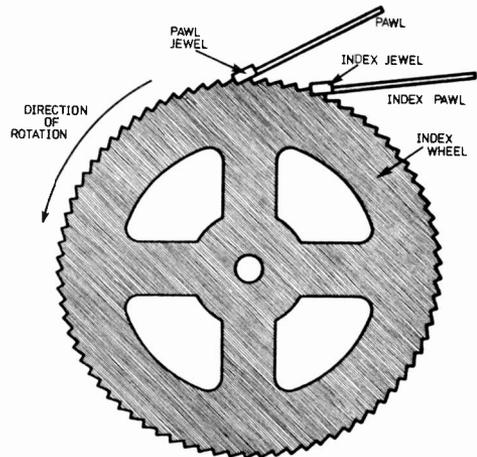


Fig. 6. The pawl mechanism used in the Bulova "Accutron" watches for converting the tuning fork vibrations into a rotary motion

in watch design. It was the first watch to employ an electronic mechanism and the first to use a timing mechanism not based on the balance wheel. In addition, it was the first watch to be delivered to the purchaser with a written guarantee of its time keeping accuracy; this is ± 1 minute per month.

The frequency of operation of the tuning fork watches made by Bulova for men is 360Hz. The mechanical loss of energy has been reduced to a very low level and this enables the low power consumption of about $8\mu\text{W}$ to be obtained. The tuning fork mechanism is relatively insensitive to shock.

The tuning fork employed in the Bulova 214 series is shown in Fig. 4. It is made of a special alloy which is little affected by changes of temperature. A strong conical magnet and a magnetic cup are fitted to each prong of the tuning fork.

A coil is fitted over each magnet. The coils must be fixed in position so that they are very close to the vibrating magnets but never touch them. The coils have a total of about 16,000 turns, comprising about 200 metres of insulated copper wire of diameter 0.015mm. About one quarter of the number of turns on the one coil is used for feedback purposes.

CIRCUIT

The circuit of the 214 series of Bulova watches is shown in Fig. 5. It consists of a simple transistor oscillator with a feedback coil (or "phase sensing

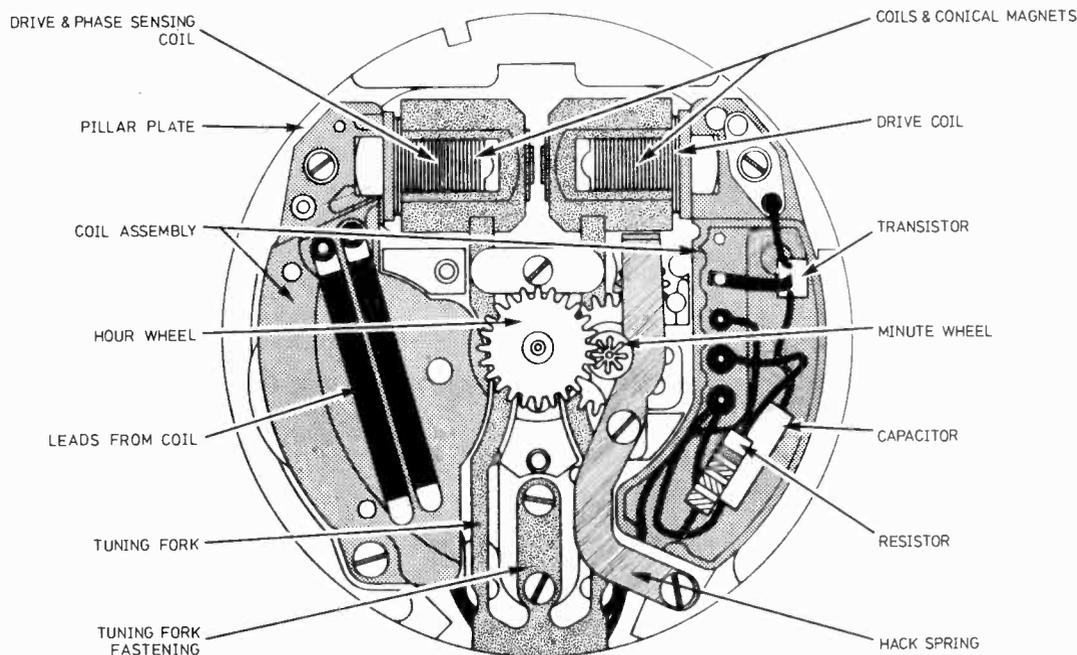


Fig. 7. The inside of a Bulova 214 series "Accutron" watch

coil") and two power coils. Indeed, it is basically very similar to the circuits of Figs. 2 and 3 which drive balance wheel watches.

The alternating voltages induced in the phase sensing coil are applied (via the battery and capacitor) to the base-emitter junction of the transistor. This diode junction rectifies these voltages and the capacitor is charged with such a polarity that the voltage across it opposes the power cell voltage.

The resistor in parallel with the capacitor allows the charge of the latter to leak away slowly so that a small pulse of current flows each time the voltage across the phase sensing coil is near to its maximum value and at a time when the polarity of the voltage induced in the power coils opposes that of the power cell.

If the total voltage induced in the power coils at the instant the transistor conducts were exactly equal to the cell voltage, no current would flow through them. At the correct amplitude of vibration, the voltage induced across the power coils at a time when the transistor conducts is about 10 per cent less than the cell voltage. A 10 per cent increase in the amplitude of vibration would therefore result in the current pulses to the power coils becoming zero and the amplitude would then quickly fall to its correct value. Similarly, a 10 per cent decrease in the amplitude would raise the current through the power coils to double its normal value and return the amplitude quickly to normal.

TRANSLATING THE VIBRATIONS

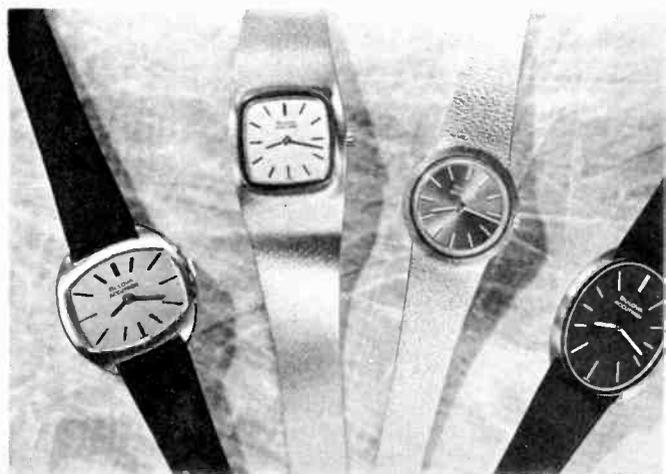
The vibrations of the tuning fork are converted into rotary motion by means of the ratchet and pawl mechanism shown in Fig. 6. Attached to one arm of the tuning fork is a straight spring (the "index") tipped with a tiny jewel which engages ratchet teeth on an index wheel. The wheel advances one tooth for each complete vibration of the tuning fork. A

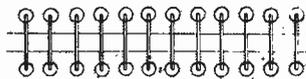
pawl holds the index wheel in position during the return stroke of the index jewel. Although the index wheel is only 2.4mm in diameter and 0.04mm in thickness, it has 300 teeth spaced at 0.025mm intervals. The index wheel drives a gear train which turns the hands of the watch.

The rate of rotation of the index wheel is unaffected by any normal changes in the amplitude of vibration of the tuning fork. The index wheel will move one tooth per vibration of the tuning fork when the index jewel moves any distance between just over one and just under three times the distance between adjacent teeth. If the index wheel moves a distance just over the distance between successive teeth, the pawl jewel will push it back during the time the index jewel returns; the net movement is then one tooth.

continued on page 231

Four small Accutron watches for ladies, using a tuning fork movement





INDUSTRY NOTEBOOK

By Neku's

YEAR OF THE HYBRID

This could be the year of the hybrid microcircuit. Thick film technology has made enormous strides through development of special inks for printing resistive networks, plenty of chip capacitors and active devices are available and potting techniques have also had their share of improvement. The result is a neat module of high reliability which has become extremely attractive to equipment manufacturers.

The manager of the very active hybrid microcircuit division of Welwyn Electric, Brian Attwood, tells me that although Welwyn started research on thin films some seven years ago and reached a high degree of perfection, the less expensive thick film technology has now reached the stage where it can do all the jobs of thin film. Welwyn are now fully concentrated in the thick film area with a plant capacity capable of handling £1 million worth of circuits a year, although he admits that actual production has not yet reached this figure.

Welwyn is engaged in the high technology end of the business with as many as a couple of dozen components in a single package. At any one time some 60 different circuits are going through the plant and some 500 types of circuits, all custom built by Welwyn, are in field service.

Also bidding for a big share of the hybrid market but in the higher volume area is Newmarket Transistors Ltd., a member of the Pyc Group.

Two recently announced products are a low level audio amplifier, the performance of which can be adjusted as required by external components or links, and a self-contained hearing aid amplifier.

The company states that thick film hybrids have now reached a

stage where costs are becoming appreciably lower than discrete assemblies. So confident is Newmarket that they are inviting users of circuits using discrete components to send details to the Newmarket design team who will then evaluate it in hybrid terms free of charge and submit a quotation for supplies.

Yet another firm spreading its wings with hybrids is Coutant Electronics, best known as a supplier of power supply units. Coutant started a thick film facility for in-house use manufacturing mainly encapsulated voltage regulators and over voltage protection units. Now the company is offering a full design and manufacturing service to allcomers.

POLLUTION MEASUREMENT

The big investment in design of pollution measurement equipment by Plessey looks as if it may be starting to pay off. The company's water quality monitoring equipment came through a four-month evaluation at the Water Pollution Research Laboratory, Stevenage, with flying colours and installations are now operating with the Sussex, Lancashire and Trent River Authorities. Orders have been taken from similar authorities in Sweden, Italy and France, the forerunners of a profitable export trade.

Another notable order, although valued only at £20,000 is for an environmental monitoring system at Lovisa, Finland, where that country's first nuclear power station is scheduled to come into operation in 1975. The Plessey installation measures meteorological, hydrographic and water quality data at the outfall of the station's water cooling system. A total of 38 separate parameters are automatically monitored and the resulting data should prove extremely valuable even before the station comes into operation.

PROFESSIONAL COMPONENTS FOR THE AMATEUR

SDS Components at Portsmouth have opened a retail shop for the home constructor at their premises at Gunstore Road, Hulsea Trading Estate. This is not the first time a wholly professional supplier has turned to the amateur market for extra revenue and it will be interesting to see if the project fares better than some earlier attempts elsewhere which, in the end, proved uneconomic.

Many famous names are listed in the product list which can be obtained by sending 20p to SDS Components Ltd. Tim Curtis,

managing director of SDS, says that he intends to break down the barriers between the amateur fraternity and industrial manufacturers.

NEW OUTLET FOR EVR

Electronic Video Recording — EVR — has been slow in market development but good business could result from its use at sea. Most ships now have TV for the use of the crew when in port and in coastal waters. In fact Marconi Marine has supplied more than 4,000 multi-standard receivers to vessels of all types.

Ships' crews are just like their shore-based counterparts and like to have TV on tap all the time. Hence the interest in EVR which will allow the TV to keep entertaining from video telecartridges when out of normal reception range.

Marconi Marine has entered an agreement with Telmar Programme Service for the supply of recorded programmes on the EVR film cartridge system which is manufactured at Basildon, Essex. The cartridges each give two 30-minute monochrome programmes or one 30-minute colour programme.

Many thousands of recorded programmes are available and ships will be able to exchange programmes at ports throughout the world. The playing units are manufactured by a number of companies under licence from the EVR partnership of ICI and CIBA-GEIGY.

RACAL AND THE YOUNGER MAN

Chairman and managing director of Racal Electronics, Ernest Harrison, believes in youth. He likes to spot likely managers early in life and then give them the opportunity to show what they can do.

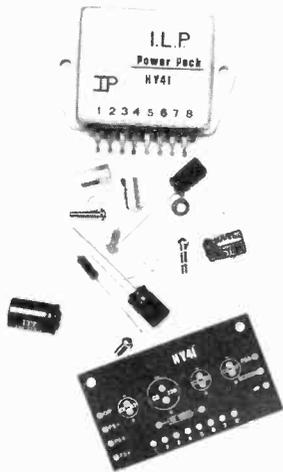
Some recent promotions prove the point. Keith Thrower who heads up a newly-formed Advanced Development Team has made big progress on the engineering side. He now has a top job at the age of 38. David Elsbury, 36, has climbed the ladder to become managing director of Racal Mobilcal Ltd., one of the most profitable of all Racal companies and the one that recently booked the largest ever contract for the company valued at £1.8 million.

Two other youngsters who now have top jobs are Gerry Smith, heading up Racal's Singapore office, and Jim Diggins, who joined Racal at the age of 25 and is now managing director of Racal Communications Ltd.

Harrison told me that in general successful people need to be "well seen" before they are 30 years old. Very few good people, he says, ever leave the company because promotion prospects are good.



I.L.P. (Electronics) Ltd



THE HY41

The HY41 supersedes the popular HY40 introduced by I.L.P. last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

OUTPUT POWER: British Rating 40 WATTS PEAK, 20 watts R.M.S. continuous.

LOAD IMPEDANCE: 4–16 ohms.

INPUT IMPEDANCE: 30K ohms at 1KHz.

VOLTAGE GAIN: 30db at 1KHz

TOTAL HARMONIC DISTORTION: less than 0.15% (typical 0.05%) at 1KHz.

FREQUENCY RESPONSE: 5Hz–50KHz ± 1db.

SUPPLY VOLTAGE: + 22.5volts D.C.

SUPPLY CURRENT: 0.8 amps maximum.

PRICE: inc. comprehensive manual, P.C. board, five extra components and P. & P.:—
MONO: £4.90 **STEREO:** £9.80

UNIQUE HYBRID PRE-AMPLIFIER

The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16–25 Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely integrated system.

INPUTS

Magnetic Pick-up (within ±1db RIAA curve) 2mV. 47K Ω

Tape Replay (external components to suit head). 4mV. 47K Ω

Microphone (flat) 10mV. 47K Ω

Ceramic Pick-up (equalized and compensatable) 20–2000mV. variable.

Tuner (flat) 250mV. 100K Ω

Auxiliary 1 250mV. 47K Ω

Auxiliary 2 2–20mV. 100K Ω

OUTPUTS

Main Pre-amp output 500mV.

Direct tape output 120mV.

ACTIVE TONE CONTROLS (Bexendall)
 Treble + 12db.
 Bass + 12db.

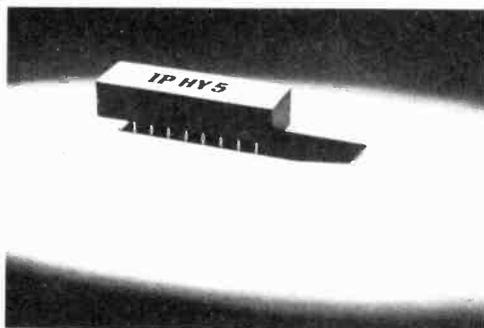
INTERNAL STABILIZATION

Enables the HY5 to share an unregulated supply with the Power Amplifier.

SUPPLY VOLTAGE

16–25 volts

PRICE: MONO: £3.60 **STEREO:** £7.20



SUPPLY CURRENT

6mA approx.

OVERLOAD CAPABILITY

better than 26db on most sensitive input infinite on tuner and auxl.

OUTPUT NOISE VOLTAGE: 0.5mV.



POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

Specification

Input: 200–240 Volts.

Output: ± 22.5 Volts at 2 amps.

Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: £4.50 inc. P. & P.

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CANTERBURY 63218

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Power Watts	Tolerance	Range	Values available	Price 1-99	100+
1/4	5%	2.2-2.2MΩ	E12	1p	0.8p
1/2	5%	2.2-10MΩ	E12	1p	0.8p
1	5%	2.2-10MΩ	E12	2p	1.5p
4	10%	1-10MΩ	E12	6p	—

Quantity prices available for any selection. Ignore fractions on total order.

CAPACITORS

Electrolytics, general purpose, miniature, axial lead. Mullard O15, O16, O17 series.

Value	Price	Value	Price
1mf 63V	6p	22mf 63V	6p
1.5mf 63V	6p	47mf 63V	6p
2.2mf 63V	6p	100mf 40V	6p
3.3mf 63V	6p	150mf 25V	6p
4.7mf 63V	6p	220mf 25V	11p
6.8mf 63V	6p	470mf 25V	13p
10mf 63V	6p	680mf 25V	20p
15mf 63V	6p	100mf 25V	25p

POLYESTER FILM CAPACITORS

Mullard C296 series. 400V d.c.

mf: 0.001, 0.0015, 0.0022, 0.0033, 0.0047, 0.0068, 0.01, 0.015, 0.022, price 2½p.

mf: 0.033, 0.047, 0.068, 0.1, price 4p.

mf: 0.15, price 6p.

mf: 0.22, price 7p.

mf: 0.33, price 10p.

mf: 0.47, price 13p.

160V d.c.

mf: 0.1, 0.15, price 4p; 0.22, price 5p; 0.33, price 6p; 0.47, price 7p; 0.68, price 10p; 1.0, price 13p.

Mullard 280 series P.C. mountings. 400V d.c.

mf: 0.01, 0.015, 0.022, price 3p; 0.033, 0.047, price 4p.

250V d.c.

mf: 0.068, 0.1, 0.15, price 4p.

mf: 0.22, 0.33, price 5p.

mf: 0.47, price 7p; 0.68, price 10p; 1.0, price 11p.

CERAMIC DISC CAPACITORS

Working voltage 50V d.c., Plaquette body with 25in leads.

Range: 22pf-10,000pf, price 2p.

POTENTIOMETERS

Carbon track, 1K-2m, log or linear, single gang, price 12p; 5K-2m, log or linear, dual gang, price 37p; 5K, 2m, log or linear, single gang with switch, 24p.

Knobs for above 10p.

SLIDER POTENTIOMETERS

Single 10K, 25K, 50K, 100K, log or linear, 31p.

Dual gang, 10K plus 10K, etc., above values log or linear, 50p.

Knobs for above @ 10p.

PRE-SET POTENTIOMETERS SKELETON

Horizontal or vertical mountings, 0.25V, miniature, price 5½p.

VEROBOARDS

Dimensions	0.1 metrics	0.15 metrics	Dimensions	0.1 metrics	0.15 metrics
2½in × 3½in	22p	16p	17in × 2½in	75p	57½p
2½in × 5in	24p	24p	17in × 5in (plain)	—	82p
3½in × 3½in	34p	24p	17in × 3½in (plain)	—	60p
3½in × 5in	27p	27p	17in × 2½in (plain)	—	42p

Pins insertion tool, 52p. Spot face cutter, 42p. Pkts. of 50 pins, both sizes, 20p.

JACK PLUGS AND SOCKETS

Standard screened*	12p	2.5mm screened	8p
Stereo screened	30p	3.5mm screened	10p
Standard sockets	12p	2.5mm sockets	7p
Stereo sockets	15p	3.5mm sockets	7p

DIN PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin (180° or 240°). Plugs, price 12p. Sockets, price 8p.

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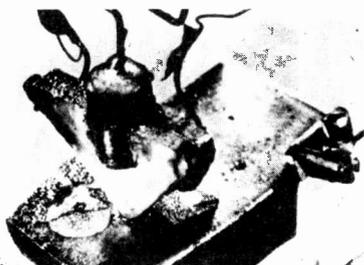
SILVER JUBILEE

...THE FIRST TRANSISTOR

THE TEAM

THE original transistor device was demonstrated in public for the first time on June 30, 1948, at Bell Telephone Laboratories' New York premises. This was the point-contact transistor, invented by two physicists, John Bardeen and Walter Brattain, who had been researching into solid state materials. They formed part of a Bell Laboratories team led by William Shockley.

A few months following the successful experiment that resulted in the first practical solid state amplifying device, Shockley set out to formulate a theory to explain transistor action. He proposed, in fact, the junction transistor structure. This theory was later developed in practice and the junction transistor became the very successful successor to the point-contact transistor and the latter was obsolete by about 1956.

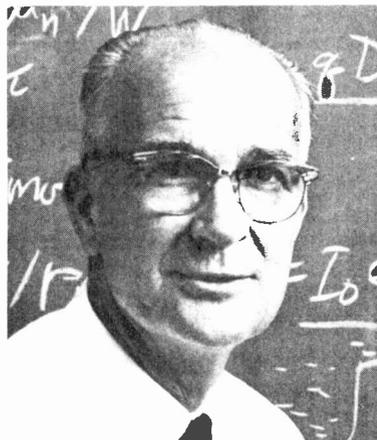


One of the first experimental point-contact transistors.

A whole new field of semiconductor technology sprang from the exploitation of the pn junction, as originally proposed by Shockley. An amazing range of devices have been developed through the application of the pn junction principle, where conduction is performed through minority as well as majority current carriers—holes and electrons.

William Shockley was also responsible for proposing the four layer $pnpn$ device, which led to the silicon controlled rectifier (thyristor); and also for a different class of unipolar devices, based upon the field effect. These inventions followed within a few years of the junction transistor.

For their outstanding contributions to transistor physics, John Bardeen, Walter Brattain, and William Shockley were awarded the 1956 Nobel Prize in Physics.

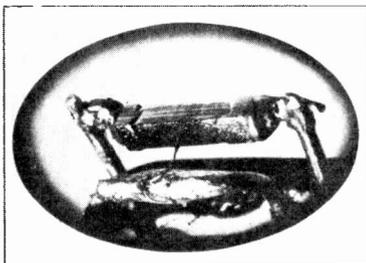


DR WILLIAM SHOCKLEY

Dr W. Shockley was born in London of American parents on February 13, 1910. Reared in California, he received his B.Sc. degree at the California Institute of Technology in 1932 and his Ph.D at the Massachusetts Institute of Technology in 1936. He joined Bell Telephone Laboratories in 1936. During the war he served as Director of Research for the U.S. Navy. Afterwards he returned to Bell and became director of the solid state physics research programme which saw the development of early junction transistors.

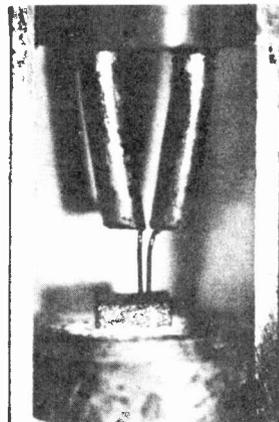
In 1963 Dr Shockley was named the first Alexander M. Poniatoff Professor of Engineering Science at Stamford University. He has received numerous awards for scientific achievement and public service, and serves on many top level Advisory Committees in the United States. Dr Shockley has contributed over one hundred articles to scientific journals, and more than 70 U.S. Patents have been granted for his inventions.

★ Dr William Shockley is to lecture at the I.E.E. in London on February 14.



An early version of a junction transistor.

An early production version of the point-contact transistor.



IERE and IEE

The IERE is marking the 25th anniversary of the invention of the transistor by devoting a specially enlarged issue of its Journal—*The Radio and Electronic Engineer*—to a unique collection of nearly 20 papers on semiconducting subjects contributed by leading British scientists and engineers who have worked in this field during the past quarter of a century.

This Transistor Issue of the *Radio and Electronic Engineer* which is dated January-February 1973, may be obtained from the IERE Publications Sales Department, 9 Bedford Square, London WC1B 3RG, price £2.00 per copy, post free.

To celebrate this silver Jubilee, the Institute of Electrical Engineers, in conjunction with the Institution of Electronic and Radio Engineers, has arranged a number of events which will take place between the 12 and 16 February 1973.

12th-16th February 1973

An exhibition at the Institution of Electrical Engineers demonstrating the evolution from the point-contact transistor to complex integrated circuits.

13th February 1973 10.00 a.m.

A colloquium "The 25th anniversary of the Transistor" at the Royal Society.

14th February 1973 5.30 p.m.

A lecture by Dr William Shockley "The invention of the transistor: an example of creative-failure methodology" at the IEE.

15th February 1973 10.30 a.m.

A half-day discussion meeting "What next in semiconductors" at the IEE.

3.00 p.m.

A lecture by Dr W. E. J. Farvis "The influence of the transistor in our society and economy" at the IEE.



Transistor Trail

FROM RECTIFYING CONTACTS TO PN JUNCTIONS

A STARTLINGLY new and revolutionary technical device rarely appears simply out of the blue. The invention or discovery is generally a culminant achievement by a research worker who has followed in the train of a number of earlier researchers and experimenters.

Experience suggests that requisite conditions for a momentous breakthrough are (1) a sufficiently advanced state of theoretical knowledge, (2) a large demand or potential need for a particular kind of device and (3) a sufficiently sophisticated technology capable of undertaking development and then quantity production of some innovation.

Amplification of electric currents is an essential part of electronics. The idea of a solid state amplifier had been a vision in the minds of many scientists and experimenters for many years before the triumph of 25 years ago.

As beneficiaries of the electronic wonder of the century, it is appropriate for us to look back and try to pick out some of those stepping stones that formed a path, no matter how faint and discontinuous, which led to the ultimate success of Messrs. Bardeen, Bratain, and Shockley.

EARLY INVESTIGATIONS

With some justification we can identify the commencement of the trail to the transistor with Michael Faraday, who in 1833 recorded the non-linear characteristics of certain conductors of electricity. He found that silver sulphide had a negative temperature coefficient.

In 1873 Willoughby Smith discovered that light affected the resistance of crystalline selenium.

In 1876 Adams and Day observed non-linear conduction phenomena on light-sensitive selenium cells.

(A fascinating light beam wireless communication system was created by the American experimenter and inventor Alexander Graham Bell (1847-1922). Speech was transmitted some distance in space by modulating a light beam and then received upon a selenium element, which produced an electrical output corresponding to the speech input.)

The earliest detailed investigation of the rectifying effect of dis-similar materials in contact, was carried out by the Austrian physicist Braun around 1874. Braun explored a variety of crystals, but mainly lead and ferrous sulphide, and used a base electrode and wire as a point-contact. He observed that the resistance was dependent upon the polarity of the applied voltage, as well as on the nature and condition of the contact surfaces. Braun likened this phenomena to the conduction between closely spaced electrodes in a gas.

Braun also appears to have been the first to observe the rectification effect produced by selenium.

Like many pioneers, Braun had his critics and his discoveries did not gain immediate recognition.

POINT-CONTACT RECTIFIERS

Point-contact rectifiers were first put to practical use as signal detectors in the early days of wireless, around 1904. Natural lead sulphide was commonly used. During the mid-1920's the crystal detector was finally ousted from radio receivers by the thermionic valve.

PLATE RECTIFIERS

Plate or "metal" rectifiers consist of thin semi-conducting layers with metallic electrodes on either side. Cuprous oxide and selenium are the two most important materials that have been widely used.

The rectification effect of contacts between metals and cuprous oxide was already known to Braun. The first useful device appears to have been made by Grondahl in 1920.

The cuprous oxide rectifier was used on a large scale for power rectification and for use in measuring instruments, from the mid-1920's to the late 1930's. Then it began to be replaced by the selenium rectifier which offered many advantages.

The selenium photocell was widely used during the period 1930-40.

NEW CONCEPTS

Investigation into the properties of semiconducting materials appears to have received a great impetus in the 1930's. One important new concept was the "hole", introduced by A. H. Wilson in 1931 when formulating the transport theory of semiconductors based on the band theory of solids.

But the mechanism by which the widely used metal-semiconductor rectifiers ("metal" rectifiers) operated was not clearly understood. One theory that received general acceptance was based on the Schottky effect (1938), a concept similar to the ideas put forward to explain thermionic emission. According to Schottky, cold emission or field emission is produced by the application of a few volts across a thin film of semiconducting material (the copper-oxide coating); and this is due to stable space charges in the semiconductor alone, without the presence of a chemical layer.

Also during the same period N. F. Mott offered a theory for swept-out metal semiconductor contacts which is known as the Mott Barrier.

In 1938 Hensch and Pohl published an account of a solid-state amplifier. This consisted of a single crystal of potassium bromide with a single wire of platinum providing control of current through the crystal. No practical developments resulted.

WAR-TIME ADVANCES

The invention of radar just before the second World War stimulated a new interest in the solid state rectifier as a detector of microwaves. And so the silicon point-contact detector was developed.

During the 1940's the technique of crystal "doping" was introduced. Boron added to highly purified silicon was found to result in highly sensitive crystals. This arose from experiment and the theory behind this effect could not then be explained.

This was a very significant period for the future of solid state. For one thing, the requirement for improved detectors for operation at centimetric wavelengths led to an intensive search for new materials. The discovery of germanium was one direct result of this activity.

POINT-CONTACT TRANSISTOR

Shortly after the war, Bardeen, Brattain, and Shockley were involved in research on copper oxide rectifiers. Bardeen showed that a Schottky barrier layer could exist at the free surface of a semiconductor. This layer makes the contact properties independent of thermionic work functions. Following upon this, Bardeen and Brattain initiated the series of experiments that led to the invention of the point-contact transistor.

They placed two point-contacts close together on the surface of a crystal. It was found that a current flowing through one could influence the current flowing through the second circuit. The first practical solid state amplifying device had arrived. This was December 1947.

In working out the basic mechanism involved in point-contact transistors, Bardeen discovered the carrier-injection phenomena. This injection of extra current carriers into the semiconductor in the region of contact when forward bias voltage is applied produces the "transistor" action.

Later, Shockley carried out a research experiment to diagnose the surface phenomena of the original transistor. In the process, he found he had devised a new type of transistor. This was patented as the junction transistor. An account of this important discovery was published in 1949. Within a few years the *pn* junction device was to prove vastly superior to the point-contact device, both from manufacturing and application view points.

It is of interest to note that around the mid 1930's Shockley had instigated some research into copper oxide rectifiers in an attempt to invent a solid state amplifying device. The results were negative.

DIFFERENT MECHANISMS

The rectifying properties of metal-semiconductor contacts are due to a different mechanism to that now understood to be responsible in the case of *pn* junctions.

During the last decade, the metal-semiconductor type of contact has returned to favour, albeit with new materials, and it has assumed a new prominence in special devices such as field effect or metal oxide semiconductor transistors (m.o.s.t.), and Schottky barrier diodes used for microwave purposes. The m.o.s. technique is extensively used in integrated circuit manufacture.

Thus it seems the circle has been completed. Development of the *pn* junction has stimulated further widespread research into solid state physics over these last 25 years, and a new interest has arisen in the rectifying phenomena which was the starting point of this "trail to the transistor". And so more devices seem likely to be developed in the future which make use of both mechanisms of current transport.

ELECTRONIC TIMEPIECES

continued from page 225



The Omega f300 watch. A balanced tuning fork movement is used

Regulation of the watch is effected by moving either of the small regulator plates which are attached to the ends of each side of the tuning fork. This makes an extremely minute change in the effective length of the fork. An adjustment of half a second per day can be made.

An interior view of the mechanism of the Bulova 214 series watches is shown in Fig. 7.

MODELS

The Bulova tuning fork watches are known by the name "Accutron", a word derived from "accuracy" and "electronics". In 1970 this Company introduced the first Accutron watches for ladies (series 230). These employ a power cell of the same size as that used in Accutron watches for men, but the frequency of the electronically driven tuning fork is 480Hz so that the movement can be made far smaller. The shape and construction of the tuning fork is different from that in the models for men, but the current consumption remains at 8-10 μ A.

A few other companies now offer tuning fork watches. Longines offer the Ebauches caliber 6312 "Mosaba" movement in their "Ultron" watches. (Mosaba is a word derived from "Movement sans balance"). Baume and Mercier have given the name "Tronosonic" to their tuning fork watches, whilst Omega refers to such watches as "f300". Bulova also produce clocks with tuning fork mechanisms.

GRAVITATIONAL EFFECTS

The frequency of some types of tuning fork watches is dependent on their position owing to the pull of gravity on the prongs of the fork. When the prongs (or "tines") point downwards, the watch may run a few seconds per day faster than when the prongs are horizontal.

This disadvantage has been almost eliminated in the balanced Mosaba movement designed by Ebauches S.A. It operates at 300Hz and is marketed as the Swissonic 100 range by Longines in their "Ultron". The Omega "f300" range also employs a balanced tuning fork movement.

Next month the final article will look at, among other things, quartz, cybernetic and digital watches.

PE Sound Synthesiser

2

STABILISED POWER SUPPLY

By G. D. SHAW

If the modular concept outlined last month, is to be followed in its entirety, this implies that not only must each circuit be entirely self contained but also that each circuit, complete with its various controls, should be capable of operating as a separate entity either within, or external to, the framework of the synthesiser as a whole.

These factors, coupled with the experience gained in building the prototype, contributed towards a decision to redesign the instrument into a fully modular form based on one of the many commercially available racking systems.

This month modifications to a standard racking system will be described together with constructional details of the twin stabilised power unit that will supply the various synthesiser card modules.

CHOICE OF RACKING SYSTEM

It was believed that, in the interests of economy, the Card Frame System 1 by Vero offered the greatest value. Utilisation of this particular system, however, means that the constructor will be obliged to manufacture his own modular inserts which may perhaps be a deterrent to those not having the facilities or experience to tackle sheet metal fabrication. In this case the modular racking system type 3E also by Vero has the advantage that it covers a range of components which may be easily assembled into modular inserts.

This latter system is extremely well designed and the component parts of the assemblies are precision made, these factors, naturally enough, being reflected in the price of the 3E System which is several times greater than that of System 1.

Fig. 2.1 shows a general view of the assembly of the card frame to be used as the mainframe of the synthesiser chassis. The aluminium end plates are already pre-drilled to suit the standard Vero components normally used in the assembly of a System 1 Card Frame. It will be necessary, however, to provide additional holes to allow for modifications to the standard assembly and to provide mounting facilities for a number of components. Drilling details are shown.

MAINTAINING A TIGHT ASSEMBLY

The slotted card support sections are made of plastic and are secured to the end plates by means of

self tapping screws. Repeated removal and replacement of these screws will result in wearing of the threads which will, in turn, make the assembly sloppy. It is suggested therefore that assembly of the mainframe is only attempted when all necessary drillings, etc. have been completed, and that, once assembled, it is left so. If the constructor wishes, for any reason, to have the facility of stripping the assembly down repeatedly he would be well advised to redrill the securing screw holes and tap them to take a suitably sized metallic thread insert.

COMPONENTS . . .

RACKING SYSTEM

Card Frame

Kit of parts for a System 1 Card Frame with a pair of guide mouldings to suit (Part No. CFMN/1)

SK7-SK13 8 pin McMurdo sockets (Part No. RS8)
(7 off)

PL1-PL7 8 pin McMurdo plugs (Part No. RP8)
(7 off)

Frame parts above available from Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hants., SO5 3ZR

MODULE FRONT PANELS

Fig. 2.2 shows the composite front panel layout with dimensions. It will be seen that the panel is divided vertically into eight separate sections. These sections represent the front panels of individual modular units and, with the exception of the strip on the extreme right of the panel, can be removed from the mainframe complete with their respective card supports and circuitry.

The right hand strip is permanently fixed to the mainframe by two small aluminium brackets.

The left-hand panel is slightly wider than the remainder mainly to act as "fill-in" on the full width of the front panel.

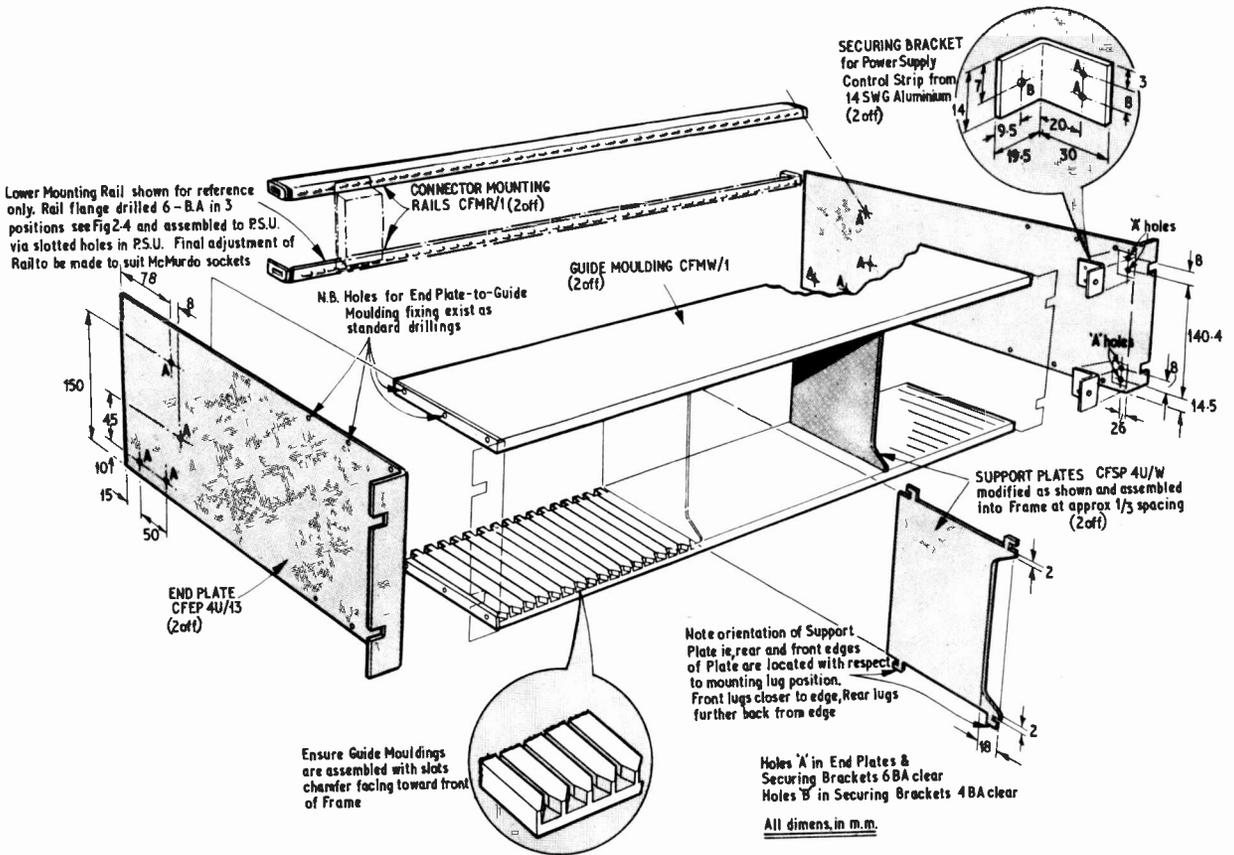
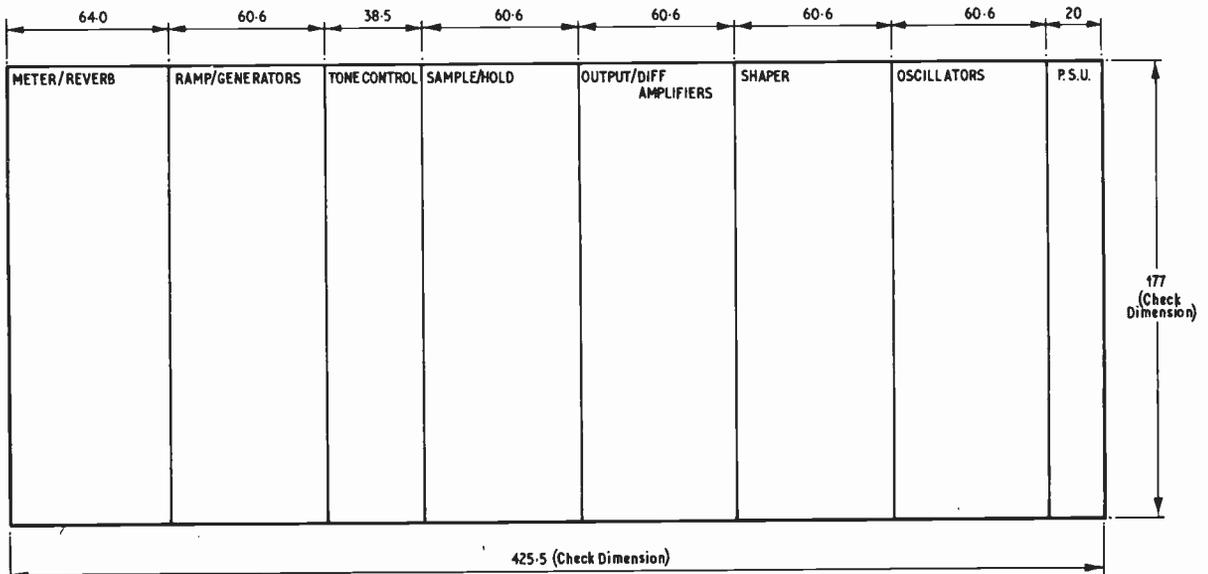


Fig. 2.1. Perspective view of the Card Frame System 1. The end slots on the upper mounting rail require to be elongated for future adjustment of McMurdo sockets



All dimensions in mm.

NOTE
Finished size dimensions are for REFERENCE only.
Final assembly of Panels into Case are to correspond to overall Check Dimensions shown

Fig. 2.2. Composite front panel. These sections represent the front panels of individual modular units as indicated

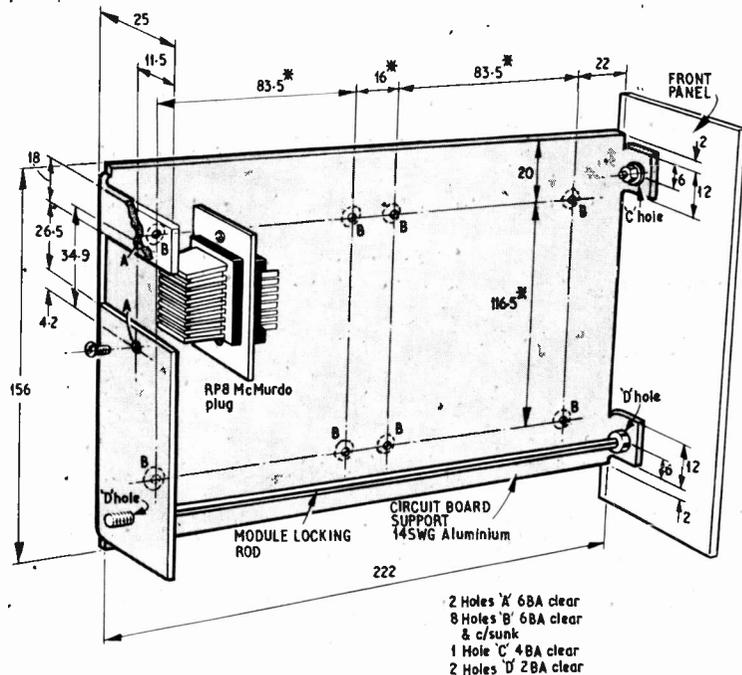
Fig. 2.3a. Drilling and bending details for circuit board support plate and McMurdo plug (b) details of retaining rod

Dimensions shown thus * are for reference only and are to be marked from Components Board.
All dims in mm.

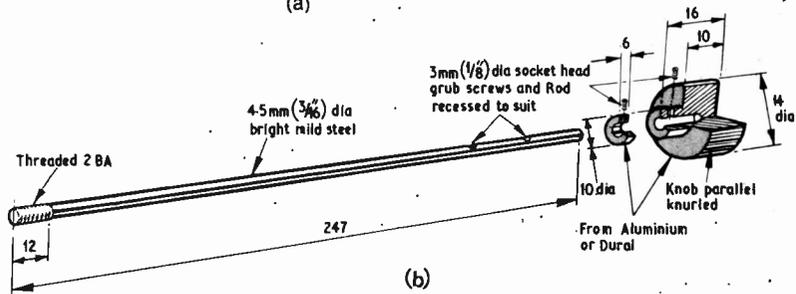
MODULE SUPPORT PLATE

Circuit boards are supported on a plate to one end of which is attached the module front panel and to the other end a plug which mates with a socket at the rear of the mainframe assembly. Fig. 2.3a shows details of this support plate. Care should be taken in bending this item and the bends should be made as tightly as possible. Lack of attention to this point will mean that the overall depth of the plate is greater than specified with the result that the front panel, when attached, will not be flush with the card support moulding in the main frame.

Modules are retained in the main frame by means of a $\frac{1}{16}$ in (4.5mm) rod, Fig. 2.3b, screwed 2B.A. at one end, which passes through the front panel and engages with a Rosan bush, or similar, in the power supply sub-frame. This arrangement also provides a means whereby the module may be withdrawn from the main frame and, for this purpose, a locking collar is provided, about the lower lug on the circuit board support plate.



(a)



(b)

P.S.U. SUB-FRAME ASSEMBLY

Fig. 2.4 shows the bending and drilling details of the power supply sub-frame. As with the circuit board support plate care should be taken that the clamping and bending is carried out as shown and that the bends are made as tightly as possible. Details have not been provided about the positioning of holes for Rosan bushes or components within the sub-frame.

POWER SUPPLY UNIT

In a project of this kind the predictability of circuit performance depends largely on the ability of the power supply to maintain its voltage rails within relatively close limits. This is particularly true where the oscillators and hold circuits are concerned since quite small variations in supply rail voltage can cause significant changes in the low frequency and "droop" characteristics respectively.

The power supply unit is based on one of the latest regulator i.c.s to appear from Fairchild, the μ A7815. This particular device is capable of passing up to 1.5 amps without the necessity of external series regulating transistors, thus it is operating well within its maximum capability. Output ripple and noise is around 500 microvolts or less while load

regulation from zero to 400mA is better than 1 per cent. (Total current requirement for the basic synthesiser is 400mA per rail.)

The output voltage of the i.c. is specified as being plus or minus 5 per cent of its nominal rated voltage thus the constructor may find up to 1.5 volts variation across the two power supply rails. This is not necessarily a disadvantage since all the voltage dividers in the synthesiser which require an accurately set voltage are fitted with presets.

CIRCUIT

The circuit diagram of the power supply unit is shown in Fig. 2.5.

Construction is perfectly straightforward (see Fig. 2.6) the only recommendation being that the leads from the transformer to the bridge rectifiers be routed to avoid passing directly over the regulators and that they be twisted together in the interests of hum reduction.

Wires carrying a.c. to the power supply control strip on the front panel should pass through holes drilled in the rear of the sub-frame and fitted with rubber grommets. These leads should be 10in (254mm) in length measured from the rear face of the sub-frame.

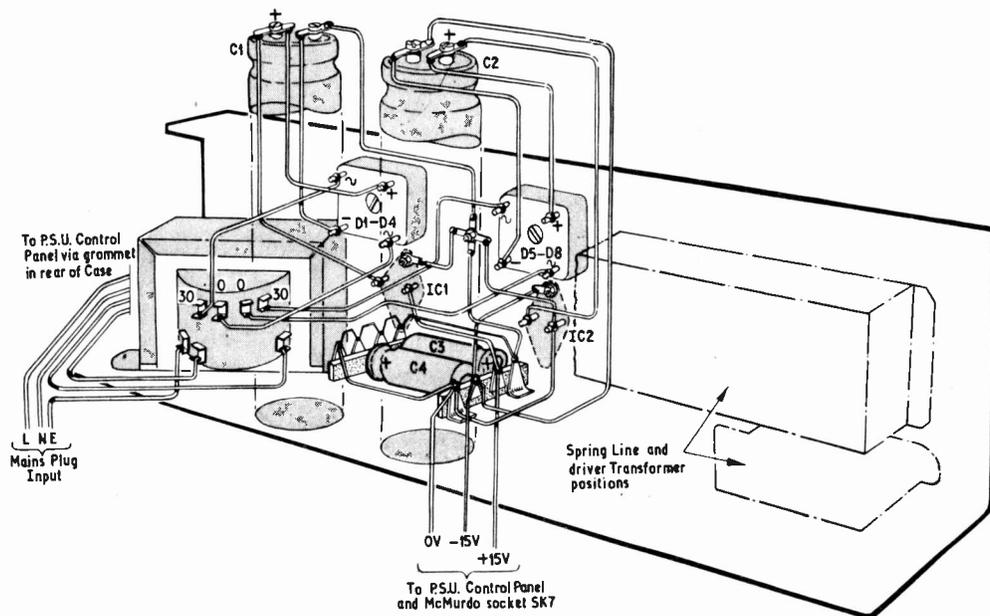


Fig. 2.6. Mounting and wiring details of p.s.u. components

Smoothed d.c. supplying the indicator lamps and calibrating voltage points is taken from the d.c. bus-bars coupling the McMurdo Red-Range sockets and thus may pass over the top of the sub-frame.

When the power supply unit has been wired up, with the exception of the d.c. to the indicators and calibrating voltage sockets, the mainframe assembly may be commenced.

ARRANGEMENT OF PANEL UNITS

Referring for a moment to Fig. 2.2, the constructor should decide at this stage the actual arrangement or order in which he wishes the panel units to be placed relative to one another. The arrangement shown need not be adhered to with the exception of the meter and reverberation unit and the power supply control strip, which have to be sited as shown at the extreme left- and right-hand sides of the front panel respectively.

This decision is necessary at this time in order that the support plates may be correctly placed between the slotted mouldings. Viewed from the front of

the assembly, the correct position of these plates is in the slot immediately to the right of the one occupied by a circuit-board support plate.

Since component placement on all front panels offers very little clearance at the left-hand side of the panel it is necessary to cut out the front face of the support plates as shown in Fig. 2.1. The 18mm depth of the cut-out is adequate to clear potentiometers and sockets on all front panels except that of the output amplifiers which will be fitted with ganged "pan-pots".

The optimum position for the support plates is approximately one third of the distance in from the end plates, the exact point, of course, depending upon the module arrangement chosen by the constructor.

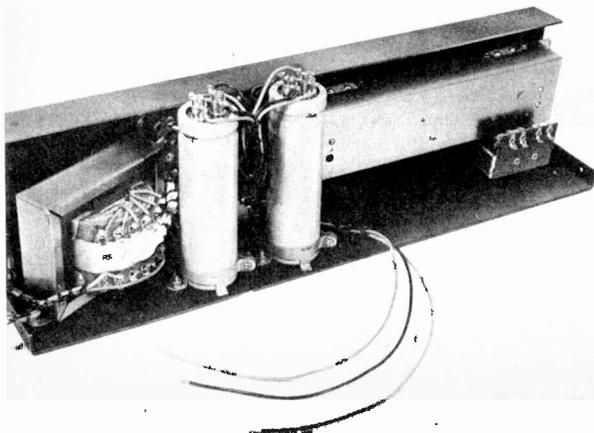
MAIN FRAME ASSEMBLY

Assembly of the main frame should be started by loosely securing the bottom slotted moulding between the end plates. The support plates may then be dropped into their respective slots and the upper slotted moulding placed over the lugs on the top edge of the panels and loosely secured between the end plates. Ensure that the chamfered edge of the slots in the mouldings are towards the front face of the assembly and that the vertical panels are in the same respective slot in both mouldings.

This being so, the securing screws may be fully tightened and lugs on the vertical panels twisted through 45 degrees where they protrude through the upper and lower faces of the mouldings.

SECURING THE P.S.U.

The power supply sub-frame may now be secured to the rear of the end plates. The lower socket support should be drilled to mate with the slotted holes in the power supply sub-frame (Fig. 2.4) and loosely secured in position. Similarly the upper socket support should be placed loosely in position.



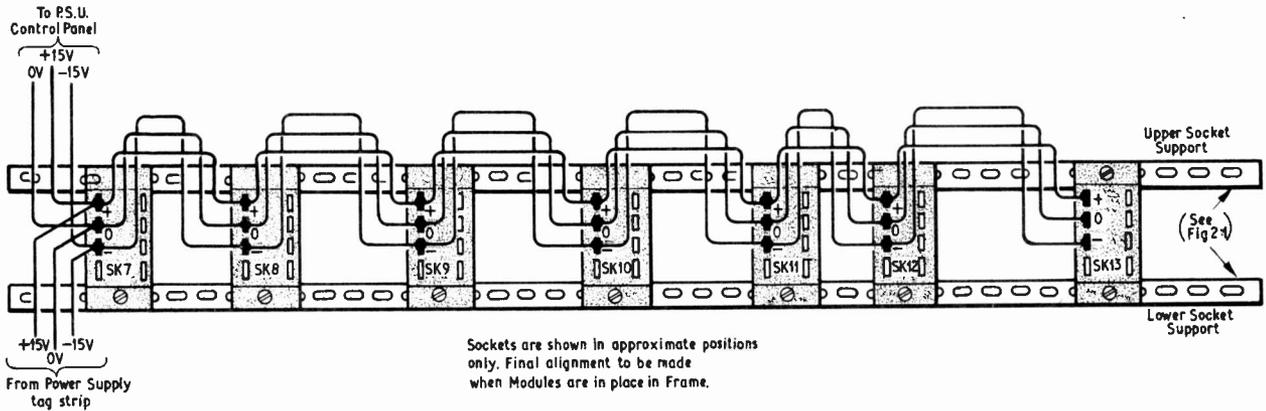


Fig. 2.7. Socket arrangement and wiring on connector mounting rails

POSITIONING THE SOCKET SUPPORTS

The final position of these latter supports is determined by inserting an assembled circuit support plate, complete with plug, into the slotted mouldings until the front panel is flush with the face of the mouldings.

A socket is now placed over the plug so that its securing lugs abut the supports at the rear face and the supports adjusted so that they align with the

socket lugs and are parallel with the front face of the mouldings. The socket supports can now be secured firmly at this point and the socket placed in position for the first of the modules to be incorporated into the assembly.

Ideally all the sockets should be placed in position at this time; but if this is not possible the first socket to be positioned should be immediately adjacent to the power supply control module so that its terminals can provide a convenient jumping off point for the leads supplying d.c. to this latter assembly.

The arrangement for supplying power to the individual sockets is illustrated in Fig. 2.7, while Fig. 2.8 illustrates the arrangement for wiring up the rear of the power supply control strip.

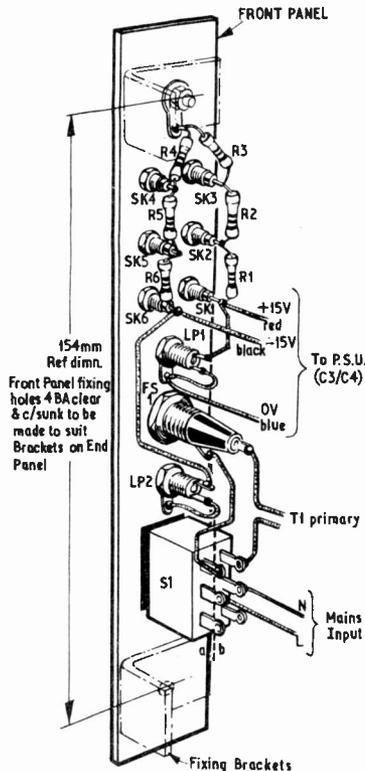


Fig. 2.8. Wiring details for rear of p.s.u. control strip

TESTING THE P.S.U.

The power supply may be tested on completion of assembly and wiring up the main frame. The main purpose of testing is to establish whether the ripple and noise and output voltage levels of each regulator are within their rated specification. Load regulation may also be checked by coupling a 30 ohm 10 watt wirewound resistor across each power rail and observing the change in output voltage on the oscilloscope. If the offset on the scope is not sufficient to enable the trace to be observed at a sufficient degree of sensitivity, a high resistance voltmeter should be used.

The level of change of output voltage at the moment of connecting the resistor across the power rails is likely to be of the order of 150 millivolts or less. Note that the resistor will be dissipating about 7.5 watts and is likely to get uncomfortably hot after a few moments across the power rails. It is best therefore to incorporate a switch in series with the resistor.

The main frame assembly is designed to be accommodated in a standard 19in case in the Vero range. A later article will include details of the types of cases which may be used and modifications necessary in order to fit a.c., d.c., and keyboard sockets to the rear of the case.

Next month: The operation and construction of the voltage controlled oscillators and voltage inverter will be given.

SIGNAL INJECTOR & TRACER

By R. A. PENFOLD

THIS project uses a single, inexpensive, TTL integrated circuit, type SN7402, and a few discrete components.

The SN7402 i.c. is a quad, two-input, positive, NOR gate, intended for switching rather than linear applications. However, this device is available for less than the price of many single transistors.

Although when used as a gate its usefulness to the home constructor is rather limited, with a little ingenuity it can be adapted to perform other functions.

THE SN7402 INTEGRATED CIRCUIT

Internal connections to the pins of the SN7402 are shown in Fig. 1.

It is housed in a dual-in-line 14 pin package. As will be seen from looking at Fig. 1, each gate has two inputs, and a single output. The output voltage of the gate will be high only if all the input voltages are low. The output potential will be low, if any of the inputs are at a high potential. Therefore, if one of the inputs is connected to earth, the input will be controlled by the remaining input alone.

The gate may now be biased into a linear operating condition, by connecting this input to earth through a suitable resistor. The value of this resistor must be such that the voltage at the output is approximately half the supply voltage.

INJECTOR CIRCUIT

The function of the gate under the conditions described above is that of a Class A amplifier. The input and the output are 180 degrees out of phase, and the stage thus has very similar characteristics to a single stage transistor amplifier.

By capacitively coupling two gates together, with each output connected to the input of the other gate.

Fig. 1. The internal circuit of the SN7402N quad two input positive NOR gate

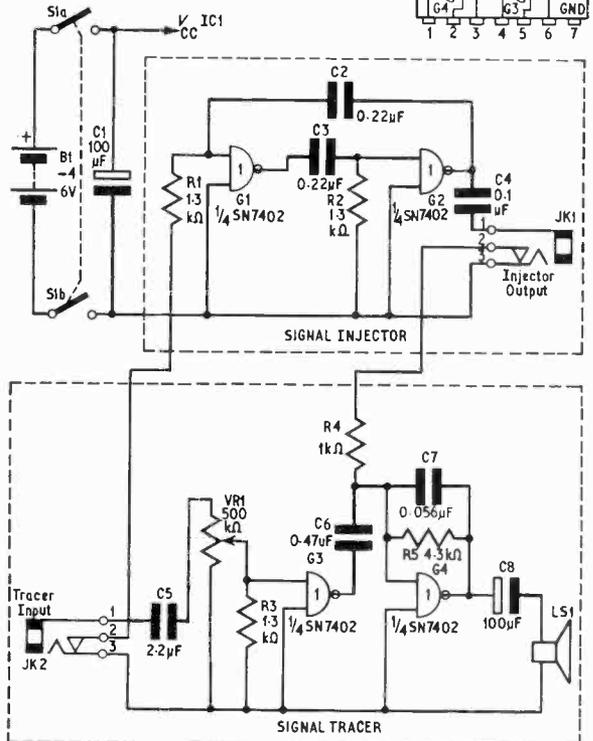
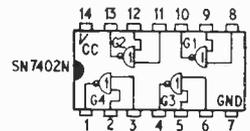


Fig. 2. Circuit diagram of the complete signal injector and tracer unit

a circuit similar to that of a free-running, or astable multivibrator, is obtained. A circuit diagram showing two gates connected in this fashion is shown in the upper half of Fig. 2.

The circuit operates as follows. When the supply is connected, the voltages at the outputs will begin to rise, and due to slight variations in component tolerances in the circuit, one will start to rise more quickly than the other.

For example, assume that the output voltage of gate 1 rises most quickly. This rise in voltage will be coupled by C3 to the input of gate 2. This will cause the output voltage of gate 2 to fall, this fall in voltage being coupled by C2 to the input of gate 1.

A further rise in the voltage at gate 1 output will occur, and this regenerative process will continue until this voltage is at its highest level, and gate 2 output is at its lowest level.

Capacitor C2 will now begin to charge through gate 1, and the voltage at gate 1 input will begin to rise, causing the output voltage to fall. This fall in voltage is coupled to gate 2, causing its output voltage to swing to a slightly higher level.

A regenerative action will again take place, until gate 1 output is very low, and gate 2 output is very high. C3 will now begin to charge through gate 2,

and the opposite will occur. The circuit will thus begin to oscillate continuously, the actual frequency of oscillation being determined by the value given to C3 and C2.

The output is taken through the isolating capacitor, C4, to the output socket. The output wave shape will be almost square, and harmonics of the fundamental frequency will thus be available up to frequencies of many megahertz.

TRACER CIRCUIT

The signal tracer circuit consists of the remaining two gates suitably biased, and coupled by a capacitor, C6. The circuit of the tracer is shown in the lower half of Fig. 2.

There is enough output available to drive a 25 ohm impedance loudspeaker. This should preferably have a fairly high efficiency, as the output is not very large, although perfectly adequate for this function.

Capacitor C7 is used to limit the high frequency response of the amplifier, which is otherwise so good, that instability arises.

Resistors R4, and R5 bias the output stage, and as R5 is connected to the output, it also introduces a certain amount of negative feedback to the amplifier.

The input to the amplifier is taken through C5, and the potentiometer which is the sensitivity control.

COMPONENTS . . .

INJECTOR AND TRACER

Resistors

R1, R2, R3 1.3kΩ (3 off)

R4 1kΩ

R5 4.3kΩ

All ±5%, 1/8W carbon

Potentiometer

VR1 500kΩ logarithmic

Capacitors

C1 100μF 6.4V elect.

C2, C3 0.22μF (2 off)

C4 0.1μF disc ceramic

C5 2.2μF non elect.

C6 0.47μF

C7 0.056μF

C8 100μF 6.4V elect.

Integrated Circuit

IC1 SN7402N positive NOR gate

Miscellaneous

S1 Double pole single throw slider

JK1, JK2 3.5mm jack sockets with break contact

PL1, PL2 3.5mm jack plugs

LS1 15 to 30Ω, 2½ to 3½in speaker

1.6in × 2in 0.1in matrix Veroboard

Universal Chassis members: 4in × 2in side panels (2 off); 5in × 2in side panels (2 off);

5in × 4in plates (2 off) (Home Radio type CU51A, CU52A and CU156 respectively) 1½V batteries type U7 (4 off) and battery holder

RADIO FREQUENCY DETECTOR

If the tracer is to be used with r.f. signals, a detector must be added at the input of the amplifier. This could be made an integral part of the unit, but in the prototype a separate r.f. probe was used. The circuit of this probe is shown in Fig. 3.

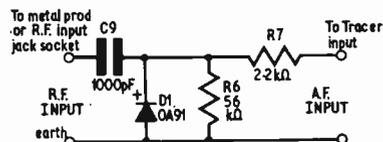


Fig. 3. The circuit of a simple detector which can be built into a small metal tube to enable the tracer to be used with radio frequencies

COMPONENTS . . .

R.F. DETECTOR

Resistors

R6 56kΩ R7 2.2kΩ

Capacitors

C9 1,000pF

Diode

D1 OA91

Miscellaneous

Metal tube for case plus metal for prod



Photograph of the completed signal injector and tracer unit showing the layout of the front panel. The box is built using universal chassis members

The casing, and metal prod for the probe will both have to be home made. They can be constructed from whatever suitable materials are at hand. Pen cases, pen light torch cases, and 35mm film containers are popular for housing this type of probe.

The metal prod can be a long bolt, or something similar. The hardware used for the prototype probe consists of a disused penlight torch case, some rubber grommets, and a steel knitting needle for the metal prod. The output should be taken through a screened lead to a 3.5mm jack plug. The components can be mounted on a small piece of 0.1in matrix Veroboard.

If the detector is to be an integral part of the unit, an extra jack socket will have to be mounted on the front panel. The break contact of this should be wired in parallel with that of the other input socket. The detector is wired between these two sockets.

CIRCUIT ISOLATION

Due to breakthrough between the trace and injector circuits, these cannot both be run at the

same time. The internal wiring of the i.c. is such, that the power supply must be connected to all, or none of the gates.

The circuit has, therefore, to be arranged so that when the plug is inserted into the tracer input socket, the break contact of the jack disconnects one of the biasing resistors of the injector, thus disabling it. When the injector lead is plugged in, the result is the same, except that it is the tracer, output stage biasing which is removed.

The unit requires 6V at about 20 to 25mA, and this is supplied by four batteries wired in series. A supply of no more than 7V may be used, or the i.c. will be destroyed.

CONSTRUCTION

The circuit is built on a piece of 0.1in matrix Veroboard, measuring 2in x 1.6in. A diagram giving the layout of this board is given in Fig. 4.

When completed this board is bolted to the rear right-hand side of the case and must be insulated from the case. This may be achieved by placing a piece of expanded polystyrene between the board and the case. C1 is not mounted on the board, but is mounted on switch S1.

ALUMINIUM CASE

An aluminium case is constructed using Home Radio Universal Chassis Members, and measures 5in x 4in x 2in.

The front, back, and side panels are bolted together using eight 2BA bolts, the holes for which are already drilled in the panels.

The base plate is fixed in place by four 6BA bolts.

Break copper strips at 9D, 10F, 10G, 10I, 10J and 10K

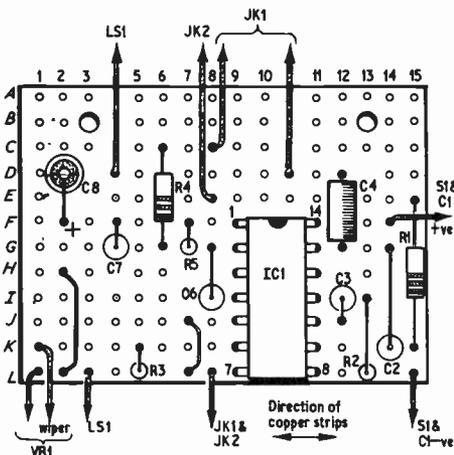
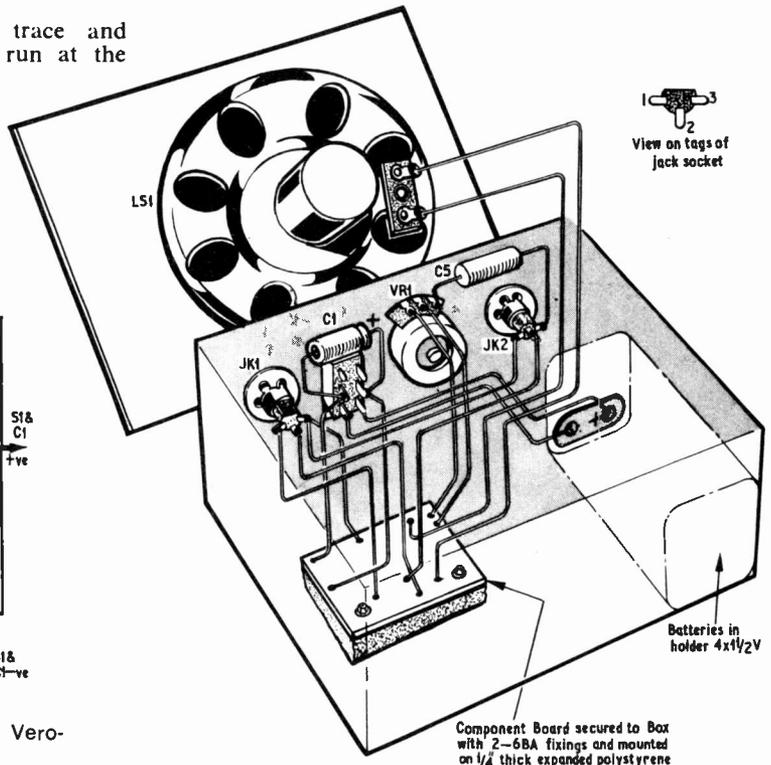
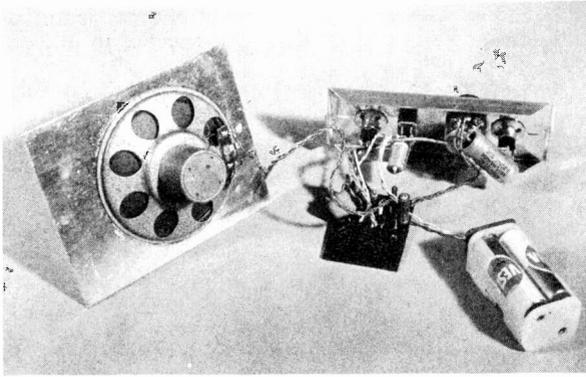


Fig. 4. Layout of the components on the Veroboard panel and interwiring details





Two 4BA self-tapping screws are required to hold the lid in place. The holes for these should be drilled centrally on the flanges of the side panels, using a No. 31 twist drill.

A drill of the same size may be used to drill the holes for the 6BA bolts. A No. 24 twist drill is used to make the mounting holes in the lid. The speaker should be mounted on the lid at any convenient place.

Details of the front panel can be seen in the photograph. The exact size of the mounting holes will vary according to the type of switch, or jack socket used, but the positioning of the holes will of course remain the same.

The batteries are positioned to the rear, and at the left-hand side of the case, opposite the main component board. They should be mounted in a battery holder of the type specified in the components list. Battery clips of the type used with PP3, or PP6 batteries are used to make the connection to the holder.

USING THE UNIT

Switch S1 is the main supply on-off switch.

As described earlier, the function of inject, or trace is obtained by merely inserting the appropriate test lead.

When using the injector, the first test would be to the speaker of the radio, or amplifier under test. Tests should then be made at the inputs of the earlier stages, working forwards towards the r.f. stages, or the amplifier input.

When a test is made, and no output comes from the speaker, the faulty stage has been located. It is the stage which lies between the last, and the penultimate one to be tested. Because the output of the injector is so rich in harmonics, it may be used to test the a.f., r.f., and i.f. stages.

USING THE TRACER

To use the tracer, the same procedure is used, except in reverse, with the first test being made at the input of the amplifier, and then working towards the speaker.

A signal of some kind must be connected at the input and when this signal is not received by the tracer the faulty stage has been located. It is again the one that lies between where this last test, and the previous one were made.

When testing i.f., or r.f. stages of a receiver, the r.f. probe must be substituted for the ordinary test leads. ★

NEWS BRIEFS

Tidal Monitoring System

THE TASK of monitoring tidal conditions and wave height along the coast of Spain presents enormous difficulties using conventional monitoring techniques. To overcome this problem Plessey Environmental Systems have supplied pressure sensors and a digital logging system to the Spanish maritime authorities to provide precise information at 25 of the harbours around Spain's coastline, which is one of the longest in Europe.

The pressure sensors are accurate to ± 0.3 per cent of full scale and this measured pressure is encoded into a frequency modulated analogue signal which is transmitted to a central data collection unit in Madrid where it is stored on magnetic tape for subsequent analysis by computer.

New Radar Testing Equipment for Europe's MRCA

EUROPE'S new multi-role combat aircraft (MRCA) uses a highly sophisticated radar system and efficient testing is vital for such a system. EMI Electronics' Systems & Weapons Division have just announced that they are supplying radar testing equipment to assist in-flight testing.

Unlike conventional airborne radar testing methods which limit thorough evaluation of the radar to the period that the aircraft is in flight, the EMI systems will enable the radar's performance to be examined in detail on the ground.

When fitted to the aircraft, the equipment will continuously record the video signal from the radars onto magnetic video tape which can later be replayed on ground equipment.

The new technique is expected to yield far more information from each test than was previously possible.

UK Tops Europe in Data Transmission

THE NUMBER of terminals sending and receiving computer data in the Post Office's Datel services has grown by more than a quarter over the last year.

Datel terminals in service reached a new peak of 22,214, a growth of 27 per cent. Although the UK has only a quarter of Europe's computers, there are more data-transmission terminals in Britain than in the rest of Europe combined.

POINTS ARISING

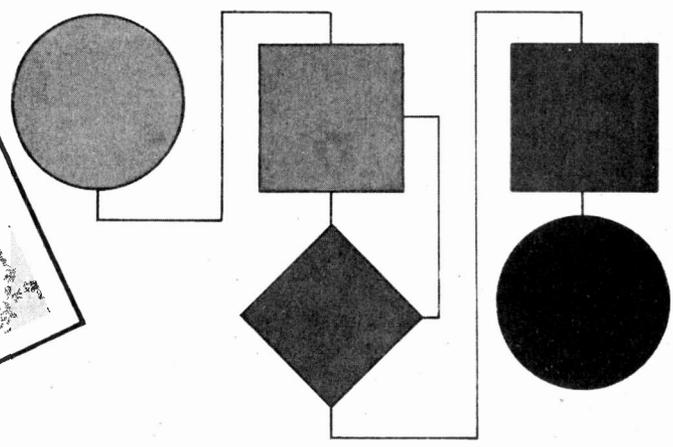
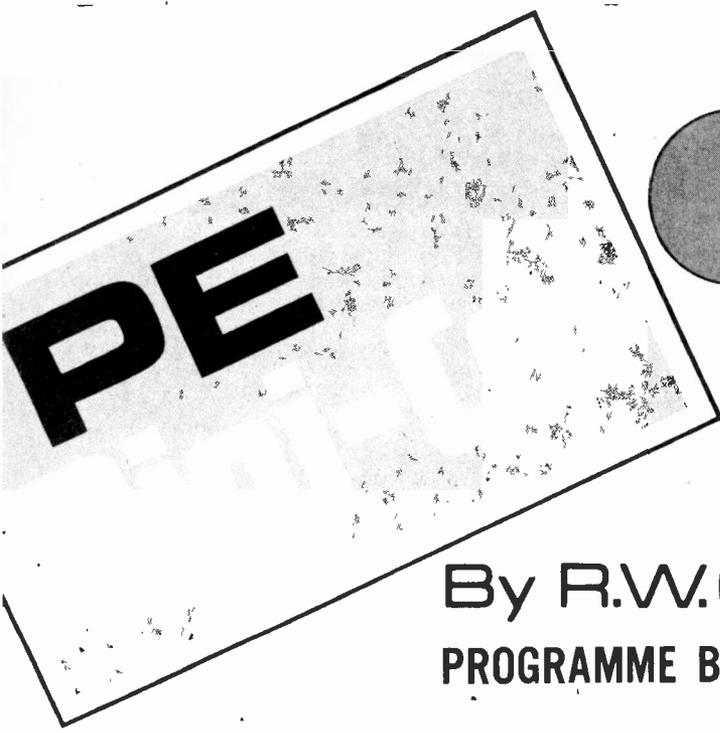
I.C. LINEAR OHMMETER (January 1973)

This article was the work of Charles Griffiths B.Sc (Eng). We apologise for the fact that an incorrect initial was attached to our author's name.

BIOLOGICAL AMPLIFIER (January 1973)

In Fig. 3, page 34, the value of resistor R5 should be 5.6k Ω . In the last paragraph under the side heading Alphaphone on page 38 reference to C10 should read C11.

Fig. 5, page 39, the pin numbers 9 and 10 should be transposed in both the circuit diagram and case interwiring. In the case interwiring pin 12 should be 11. These corrections bring Fig. 5 into agreement with the circuit diagram Fig. 3.



By R.W. COLES PART 9 PROGRAMME BOARD

THE BULK of the Digi-Cal logic has now been described. Throughout the articles covering the logic boards from DISPLAY to ADDER, readers will constantly have encountered a variety of signals, attributed to a mysterious PROGRAMME BOARD.

The far-reaching influences of this board thus having been established, the time has arrived to delve into the method of deriving the plethora of programme output signals, a most important aspect of the calculator.

DIGI-CAL PROGRAMME

The requirements of Digi-Cal are humble, re-programming not being required in the normal run of things and the tasks for which a programme is necessary, namely the four arithmetic functions of addition, subtraction, multiplication and division can be carried out with only a few programme steps and without recourse to any high level language facilities other than the press of an appropriate key.

Programming then is carried out at the basic level of logic gates and flip-flops, and the Digi-Cal philosophy is retained by making the programmes variable by wiring in diodes where required in a matrix arrangement.

The separate jobs to be controlled by the programme include shifts, transfers, register and counter clearing, routing and clock pulse initiation, all of which must be carried out in a strict sequence.

PRINCIPLES OF PROGRAMME GENERATION

The programmes for Digi-Cal are formed in a diode matrix in the form of a Read Only Memory or R.O.M. "Memory" because a number of separate addressable locations are provided, and "Read Only" because the instruction data in each address location is fixed at the wiring-up level and is not altered by the operator.

In the present system the R.O.M. array is addressed sequentially by means of a counter. In this

way each location in the memory is addressed in turn starting each time at address "1" and continuing to the final address of each R.O.M. in an incremental fashion.

It is not possible to jump back or forward in the sequence and random addressing of a particular location is likewise impossible.

Pausing during a sequence for an indefinite length of time is possible, as is aborting the sequence by clearing the address counter and stopping the clock.

BASIC CIRCUIT

The incremental ADDRESS COUNTER/R.O.M. programme system is best understood initially by means of a simplified circuit without any trimmings (Fig. 9.1).

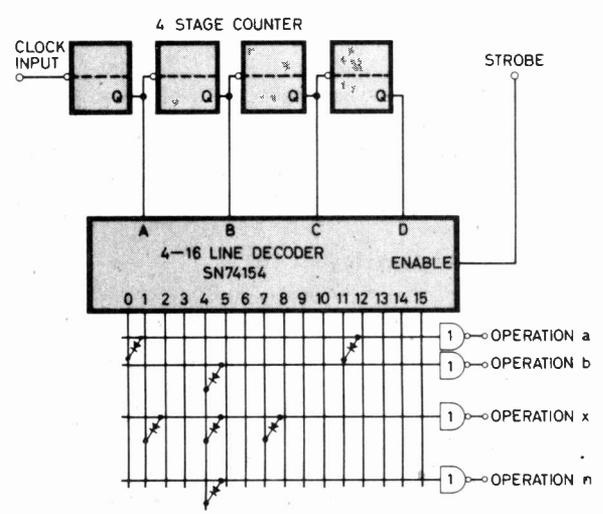


Fig. 9.1. Principles of Read Only Memory Programme generation

Here, a four stage binary counter with 16 possible states is driven continuously by a clock pulse train. The system states of the counter are individually decoded by gates which produce an active low output when inputs are in the appropriate states.

These gates are in the form of an SN74154 TTL M.S.I. decoder which has extra facilities to generate the complement versions of the four inputs required by the decoder gates and a common overriding enable, or strobe input which can be used to inhibit all outputs.

The pin connections of the SN74154 is shown in Fig. 9.2. Referring again to Fig. 9.1 with Fig. 9.2 in mind, it can be seen that, as the counter steps through the sequence, each output from the decoder is enabled in turn for one clock period, thus establishing the programme steps.

The number of operations to be controlled by the programme depends on the requirements of the machine controlled, and can be few or many as required only four being shown in the basic circuit.

All that remains to perform a particular operation in a particular programme step, is to connect a diode across the appropriate intersection where the step line crosses the operation line.

DIODE MATRIX

Inverters are used at the output end of the operation lines to act as what could be described as "sense amplifiers" in traditional memory terms. Another way of looking at the operation lines and inverters is as multi-input NOR gates with the number of inputs to each gate being determined by the number of times that an operation is used.

Note that each operation can be used any number of times and also that any number of different operations can be activated simultaneously.

The basic circuit has no facilities for stopping or starting the sequence which therefore runs continuously. Also only one programme is catered for and, because of the ripple-through counter circuit propagation delays combine to give spurious pulses of a few nanoseconds width on some of the step lines.

All of these disadvantages have to be overcome in the Digi-Cal circuit, which is shown in Fig. 9.3.

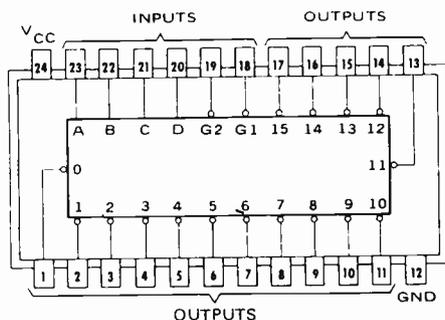


Fig. 9.2. The pin connections of the SN74154 four line to 16 line decoder

FULL CIRCUIT

The full circuit looks very much more complicated at first sight but the R.O.M. arrays can be easily identified, and the rest of the tangle breaks up into sections with specific jobs.

First out of the way are IC108, 109 and 110 which are simply there to divide the master (ungated) clock signal from board CB by a factor of a thousand, to allow the programme circuits to operate at slow speed.

This eases reflection and decoding problems while keeping the operation of the calculator logic tied to a master synchronising clock signal. The only special thing about these dividers is the fact that the three SN7490 are connected in the $\div 10$ mode which gives a 1:1 mark space output from the final stage.

This is arranged by connecting the A stage of the circuit after the B, C, D stage.

STOPPING AND STARTING

An SN7493 (IC112) is used as the programme counter, and it is made to stop or start counting by means of a gate in its clock line. Gate G1 itself is controlled by a latch flip-flop which is SET by a pulse from the EQUALS key monostable in the keyboard logic and RESET by the programmes themselves.

Setting the latch is accomplished by using the clock input with a permanent "1" on the D input and clearing is achieved by using the programme STOP PROGRAMME operation to energise the CLEAR input of the first flip-flop via a monostable formed from the other flip-flop and a couple of inverters.

This method of forming a monostable was described in the article covering the CLOCK BOARD, Fig. 7.5, a monostable being necessary in this case to prevent "race" conditions removing the RESET input before the latch was properly cleared.

PROGRAMME SELECTION

Three separate programmes are required in Digi-Cal; three rather than four because the sequences for ADDITION and SUBTRACTION are identical, the distinction being drawn by the fact that the ADDER BOARD operates either as a subtractor or an adder depending on the FUNCTION CODE which is produced directly by keyboard depressions.

The ADD/SUBTRACT programme is quite simple as might be expected and requires only a few steps. Seven steps are, however, provided to allow reprogramming if any "frills" such as round-off or true negative answer are considered possible later.

The MULTIPLY and DIVIDE programmes are separate and have a possible 15 steps each, to allow for the increased complexity of these operations. Some spare steps are also left in these operations, and can be employed as required.

The selection of the required programme is accomplished by utilising the G1/G2 ENABLE inputs on the SN74154 decoders providing the MULTIPLY and DIVIDE sequences, and by using the D input for the same purpose on the SN7442 of the shorter ADD/SUBTRACT sequence.

Using the D input as an enable is possible with the SN7442 because if the D input is high, the output selected must be greater than seven and since only outputs one to seven are used, a high D input means all programme steps are disabled even though they may be addressed by the A, B and C counter outputs.

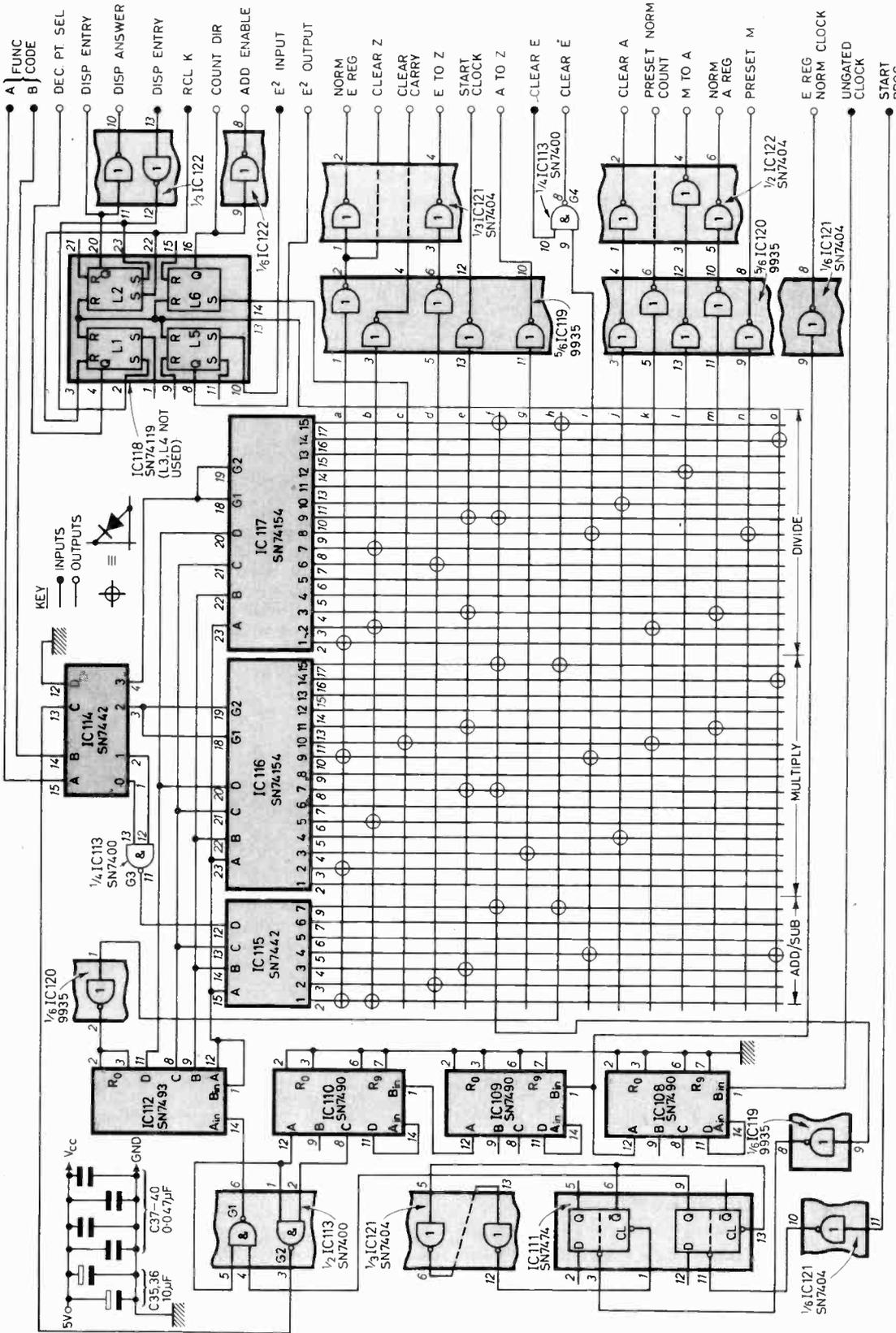


Fig. 9.3. The full circuit diagram of the PROGRAMME BOARD. Power supply connections to the SN74154 and SN74119 are shown in Figs. 9.2 and 9.6. All others have V_{cc} to pin 14 and GND to pin 7 except the SN7490 and SN7493 which has V_{cc} to pin 5 and GND to pin 10, and SN7442 which has V_{cc} to pin 16 and GND to pin 8

COMPONENTS . . .

Capacitors

C35, C36 10 μ F 15V elect. (2 off)
C37-C40 0.047 μ F (4 off)

Diodes

D104-D142 West Hyde type "red" (or any small silicon diode) (39 off)

Integrated Circuits

IC108-IC110 SN7490 (3 off)
IC111 SN7474
IC112 SN7493
IC113 SN7400
IC114, IC115 SN7442 (2 off)
IC116, IC117 SN74154 (2 off)
IC118 SN74119
IC119, IC120 DTL9935 (2 off)
IC121, IC122 SN7404 (2 off)

Printed Circuit Board

0.1in Veroboard (8.2in x 3.4in)

Edge Connector

32 way 0.1in pitch edge connector (optional)

STROBE SYSTEM

Enabling the appropriate programme decoder is not done in a d.c. manner, with a constant input throughout a particular sequence but in an a.c. manner by routing enabling or "strobe" pulses to the selected decoder which occur in the centre of each addressing period.

This scheme is used to kill two birds with one stone, since by enabling decoder outputs only in the middle of each address period the problem of spurious outputs or "glitches" is overcome.

By the time the enable pulse arrives the address counter is resting in a particular state and propagation delay problems are overcome.

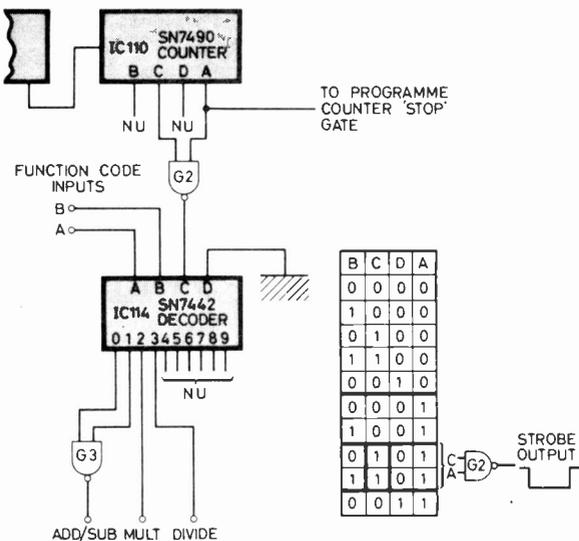


Fig. 9.4. Gate G2 is used to generate a strobe pulse by detecting simultaneous C and A outputs during the clock period as shown in the truth table. The decoder is used to select the appropriate part of the programme according to the FUNCTION CODE inputs

This selection system involves IC114, G2 and G3 and to make the principle clearer it is redrawn in an integrated way as Fig. 9.4. Two states of the final divider (IC110), count sequence are detected by gate G2 which gives a negative strobe pulse near the end of the run (see Truth Table).

The strobe pulse is applied to the c input of IC114 which is being under-used in this application as a two to four line decoder with strobe input.

One of the outputs zero to three is addressed by the two line FUNCTION CODE generated by the KEYBOARD in response to the arithmetic selection made by the operator.

The selected output will remain high however, until the strobe pulse takes the c input low. The result of all this is that a continuous stream of strobe pulses is delivered, via the logic described, to the STROBE or ENABLE input of the selected programme decoder. Gate G3 is used as a negative logic NOR gate to ENABLE the single ADD/SUBTRACT programme whether addition or subtraction is called.

PROGRAMME OUTPUTS

Fifteen programme operations are possible on this board, and although more of these would be useful, board space is a limiting factor for the layout of the R.O.M. matrix.

Because of this limited number of available lines, some outputs do two or more jobs which seem to be unconnected. For example, line A is responsible for normalising the entry register, clearing the Z REGISTER, and clearing the EQUALS LATCH on the M COUNTER boards.

PROGRAMME OPERATION CODE ASSIGNATIONS

- a Normalise Entry Register
Clear Z Register
Clear M Counter Equals Latch
- b Clear Carry Store
Clear M Counter (to 000000)
- c Set latch, changing clock count to DOWN and disabling A inputs to ADDER
- d Transfer the contents of the E register to the Z register
- e Start Arithmetic Clock
- f Stop programme sequence
- g Transfer the contents of the A register to the Z register
- h Clear the Programme Counter
- i Clear E register
- j Clear A register
- k Preset NORM code from the thumbwheel into the clock counter
- l Transfer contents of M counter to A register
- m A register NORM in progress
- n Preset M counter to 999999
- o Clear latch array/select A register for display with point position determined by thumbwheel

B	C	D	A
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
0	0	0	1
1	0	0	1
0	1	0	1
1	1	0	1
0	0	1	1

These operations are not related and are grouped together because they do not interfere with each other if performed at the same time.

It must be remembered, however, that if a CLEAR Z signal is required by a programme, the other signals are also produced which may or may not be important if a "home-made" programme sequence is employed.

Programme outputs are arranged to be either "active high" or "active low" depending on the requirements of the logic they drive, and for this reason either one or two inverters are placed at the end of the operation lines.

The inverters connected directly to the R.O.M. lines are from the DTL family and are type 935 which do not have input diodes (Fig. 9.5). This enables the R.O.M. diodes to be used as an integral part of the circuit without reducing noise immunity.

LATCH ARRAY

The latch array performs a variety of jobs which are related to the programme, one of the most obvious of which is to stretch programme operations over a number of steps.

"Stretching" is achieved by using the programme to SET a latch in a particular step, and to RESET it in another. The latch output is then used to control a particular operation which must be continued for longer than one step.

Latch L6 is used in this way to control the CLOCK COUNTER direction and ADDER ENABLE during a REGISTER NORMALISATION in the MULTIPLY sequence. Latch L5 is used to control routing logic during an E^2 operation, being SET by pressing the E^2 key and RESET by the CLEAR LATCH ARRAY programme operation at the end of each sequence.

Latches L3 and L4 are not used, but are available if required, and L1 and L2 operate together to control the display selection.

Latch L1 controls the decimal point selection (fixed or floating) and L2 controls the register selection (A or E).

The i.c. used in this position is the very versatile SN74119, which like the SN74154 decoders is housed in a 24 pin dual-in-line package. The logic of this device is simply that of six cross-coupled gate latches with a common clear line, and is shown in Fig. 9.6.

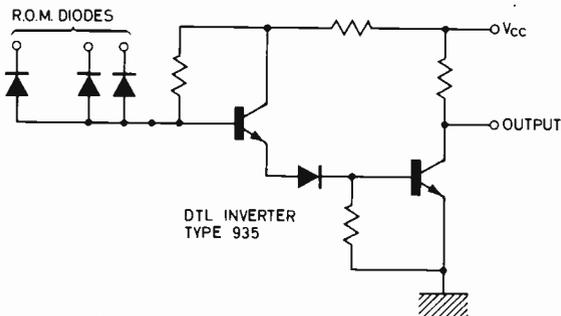


Fig. 9.5. This diagram shows how the R.O.M. diodes and the DTL inverters are used to form NOR gates

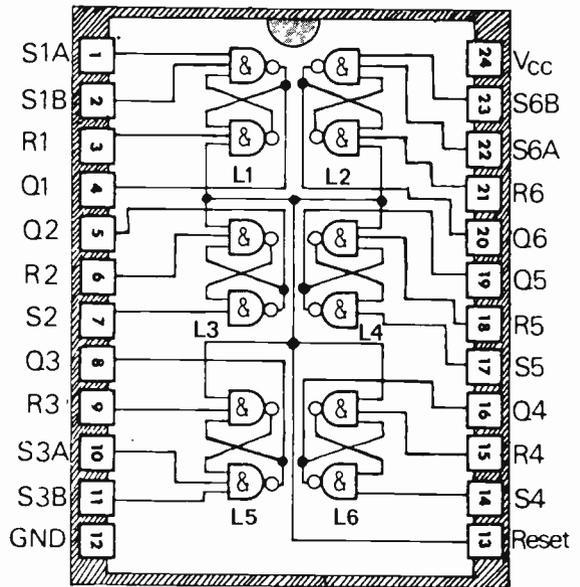


Fig. 9.6. Internal logic of the SN74119 hex SET/RESET LATCH

CLOCK AND CLEAR

There are only a couple of items left on the full circuit to be mentioned, the first of these being G4 which is used to NOR the CLEAR E output from the programme and the CLEAR E input from the CE key to give a combined signal.

Next, the E REGISTER normalising clock output is taken as a tapping from the divider-chain so that although much faster than the final programme clock, the normalising clock is slower than the arithmetic clock to prevent difficulties with the long line lengths used.

PROGRAMMING

The programmes used in the prototype are shown in Fig. 9.7, which presents the sequences as flow diagrams.

The operations inside the shaded boxes in the MULTIPLICATION and DIVISION programmes show the conditional branching operation carried out by the CLOCK GENERATING BOARD, and are included in the flow diagram for completeness.

Each of the square boxes corresponds to the programme step with which it is numbered, several operations being possible at each step. The spare steps do not give rise to any outputs from the board, but may be used to advantage if the basic programme is expanded or re-arranged.

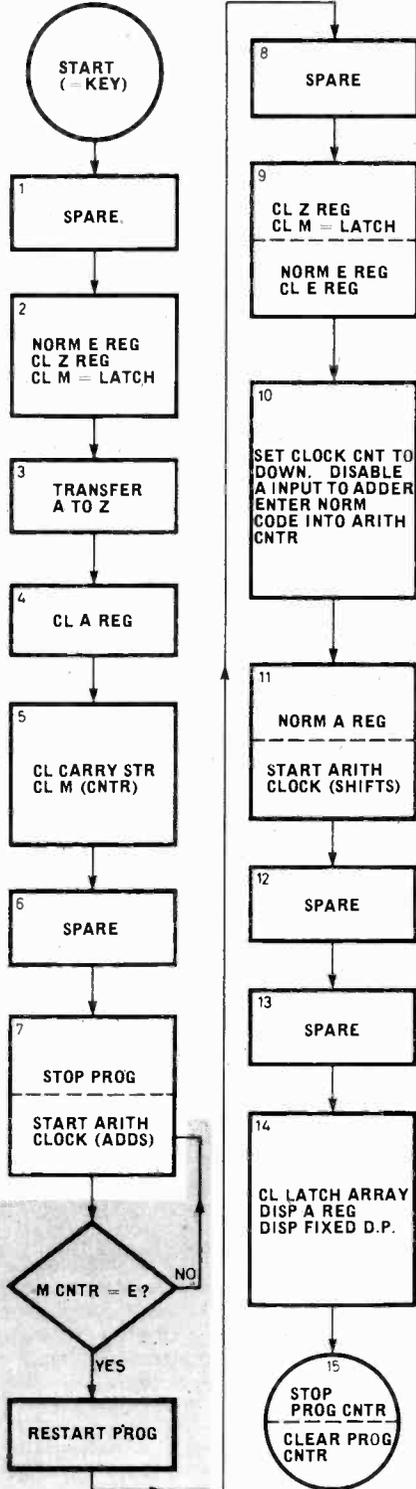
Re-programming does not require any particular skill other than commonsense and a knowledge of the way the circuits operate.

The writer has had very little time to consider just what improvements could be programmed into the calculator, but with a little ingenuity and perhaps modification, true negative answers (as opposed to complement versions as the machine stands) should be possible.

ADDITION SUBTRACTION



MULTIPLICATION



DIVISION

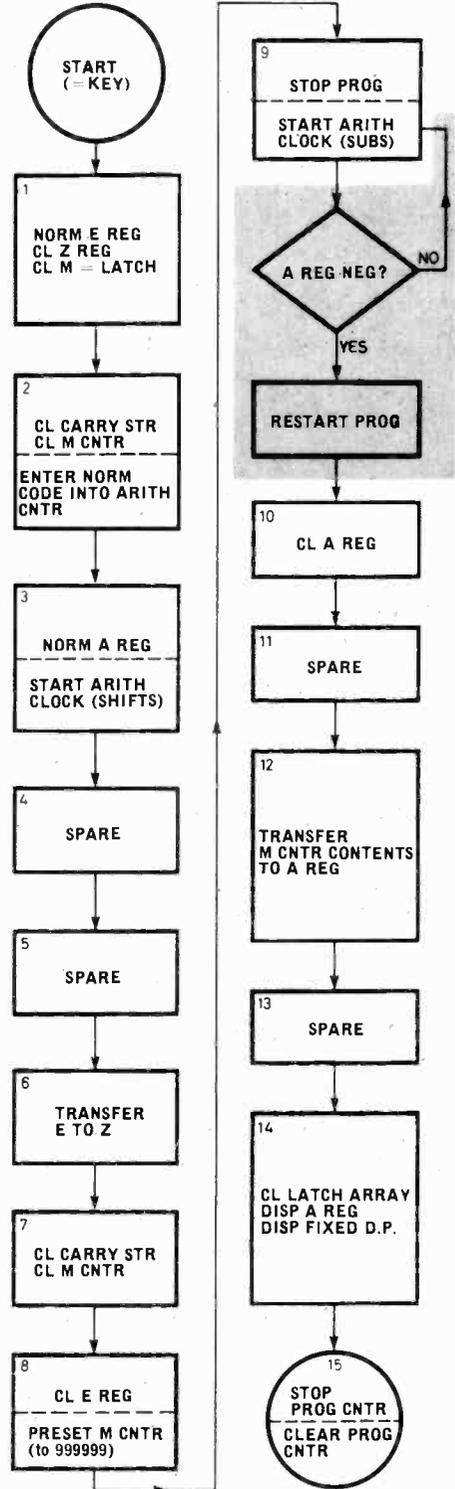


Fig. 9.7. This flow diagram shows the three programmes used on the PROGRAMME BOARD. The same programme is used for addition and subtraction as mentioned in the text

PROGRAMME BOARD

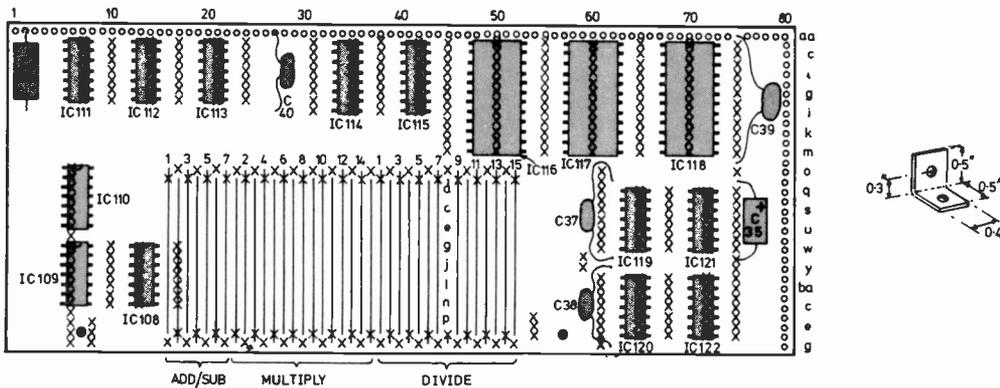
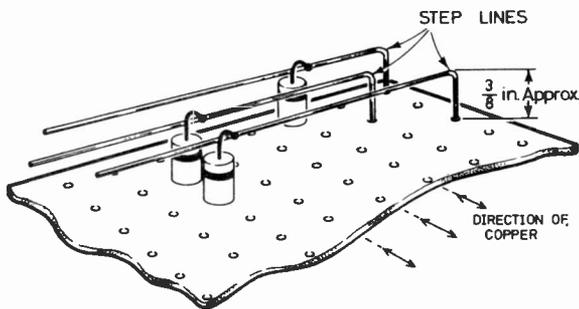


Fig. 9.8. The layout of the components on the Veroboard panel. Crosses show breaks in copper strips



Diode matrix construction

PROGRAMME BOARD WIRING DESTINATIONS

aa	not used
ab	START PROG (fr kbd)
ac	RECALL K (fr kbd)
ad	UNGATED CLK IN (fr CB/43)
ae	FUNC CODE A (fr kbd)
af	DISP E (to disp)
ag	E ² (fr kbd)
ah	DISP E (fr kbd)
ai	FUNC CODE B (fr kbd)
aj	CNT DIR'N (to CB/28)
ak	CLEAR E (to ED/2)
al	CLEAR E (fr kbd)
am	not used
an	GND
ao	E ² (to E ² logic)
ap	+5V
aq	CLEAR Z REG etc (to Z2/43, kbd (NORM) and M1/19)
ar	CLEAR CARRY etc (to AD/23, M1/20, M2/20)
as	DISP A (to DISP)
at	START CLK (to CB/44)
au	not used
av	DEC PT SEL'N (to kbd)
aw	TRANSFER E TO Z (to Z1/24)
ax	E REG NORM CLK (to kbd)
ay	ADD ENABLE (to AD/37)
az	NORM A REG (to CB/37)
ba	PRESET NORM CNT (to CB/27)
bb	TRANSFER M TO A (to CB/39)
bc	not used
bd	PRESET M (to M1/21, M2/21)
be	CLEAR A REG (to A1/44, A2/44)
bf	TRANSFER A TO Z (to Z2/24)

CONSTRUCTION

This circuit is built on a Veroboard panel (Fig. 9.8) and carries a good deal of wiring on both sides. The R.O.M. operation lines are formed by the printed tracks on the board, but the step lines are formed from bare tinned copper wire running at right-angles to the tracks.

These are spaced from the board by about $\frac{3}{8}$ in so that diodes may be soldered-in where required. Note that the diodes are inserted with their red ends uppermost, connected to the step lines.

Wiring is congested but not critical, thanks to the low programme speed, and both sides of the board carry wire interconnections.

An edge connector of 32 or more ways is recommended for use with this board, but it is not essential; connections can be soldered directly to the printed tracks if desired. If an edge connector is used it is necessary to clean the track ends thoroughly with fine emery paper and then coat them with a tarnish preventer and cleaner such as Electrolube.

TESTING

Programme selection and step sequences can be easily checked after construction by using a large value capacitor on the CLOCK BOARD to give a very slow programme sequence. Steps can then be followed with a multimeter set to a low voltage range.

Operational testing can be carried out only with the ADD/SUBTRACT programme until the M COUNTER boards and E² logic are constructed, but when this is working, little trouble should be experienced with the other programmes.

Note: In Fig. 6.10 (Dec. 72) Z1/22, Z1/43, Z2/22, and Z2/43 go to Z2/44 not CB/13. Z1/21, Z2/21 go to CB/23. A1/42, A2/42 go to CB/40. A1/43, A2/43 go to CB/38. In Fig. 7.7 (Jan. 73) CB/40 should go to A1/42, A2/42.

Next month: M Counter Boards

Designing with

Integrated circuits

BY A. FOORD

6

Simple Memory Circuits

THIS month we will show how simple memory circuits may be constructed from gates and how the master-slave bistable is developed. In the way that a transistor bistable can be made from two cross-coupled inverting stages, a bistable can also be made from two inverting gates. This is shown in Fig. 6.1 for NAND gates, although a similar NOR circuit is also possible.

If the clear and set inputs are at 1, and so have no effect, then for either gate a 1 at its input would produce a 0 at its output, and vice versa. Since the output of one gate is the input of the other, the two outputs must be in opposite states. If Q is 1 then \bar{Q} must be 0, and vice versa.

If the clear input is 0 and the set input is 1, then \bar{Q} becomes 1 and Q becomes 0. If the set input is 0 and the clear input is 1 then the opposite state is set up with Q equal to 1 and \bar{Q} equal to 0.

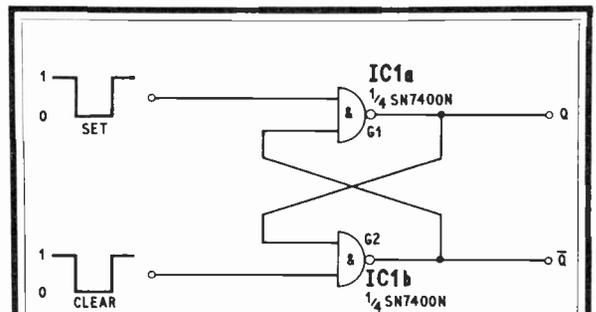
If a momentary 0 input is applied to either the set or clear input the corresponding output will become a 1 and will remain in this state until a 0 is applied to the other input. The circuit can therefore act as a memory and can be used to eliminate the effects that are obtained from contact bounce on a mechanical switch. This could be checked as an experiment (Fig. 6.2).

From the truth table it can be seen that, if 0 levels are applied to both inputs, then both the Q and \bar{Q} outputs will be 1. For a true bistable circuit this condition would be avoided.

GATED MEMORY

When input gates are added to the basic memory in Fig. 6.1, it can be made to respond to input levels only during a specific clock time interval, as shown in Fig. 6.3. While the clock input is at 0, gates 1 and 2 have a 1 at their outputs and the set and clear inputs are locked out of the memory. New information can only reach the memory when the clock input is at 1.

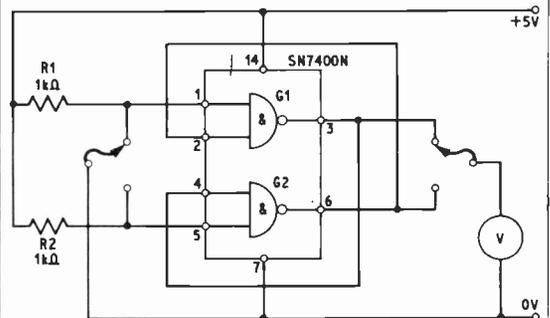
A 1 at the set input with a 0 at the clear input will give a 0 input to gate 3 and a 1 input to gate 4, then Q will be a 1. The other possible states are shown in the truth table.



TRUTH TABLE

INPUT		OUTPUTS	
CLEAR	SET	Q	\bar{Q}
0	1	0	1
1	0	1	0
0	0	1	1
1 (last 0)	1	0	1
1	1 (last 0)	1	0

Fig. 6.1. The basic bistable circuit



momentary 0 on an INPUT sets corresponding OUTPUT to 1
Fig. 6.2. The basic bistable circuit used to eliminate the effects of switch contact bounce

GLOSSARY

BISTABLE CIRCUIT A circuit in which the output has two stable states.

NAND GATE A logic circuit where all inputs must have 1 level signals to produce a 0 level output.

NOR GATE Any one input or more than one input having a 1 level signal will produce a 0 level output.

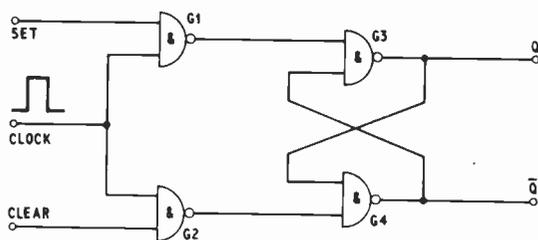
TRUTH TABLE A chart which tabulates all the combinations of possible states of the inputs and outputs of a circuit.

If both set and clear inputs are at 0 when the clock goes high the inputs to the memory remain at 1 and the output does not change from its previous state. In the truth table T_n represents the time during the clock pulse while T_{n+1} represents the time after the clock pulse. Similarly Q_n represent the state of the memory at the time of the clock pulse. (These are common terms used in manufacturers' data on digital i.c.s.)

When the sampling interval is over and the clock returns to 0, further changes in set and reset can have no effect until the next clock pulse. The memory is said to have "clocked", because the sampling point can be timed to occur when the required data is at the set and clear inputs, and data outside this time will be ignored. For this circuit the set and clear levels need not be pulses because input pulsing is provided by the clock.

DATA LATCH

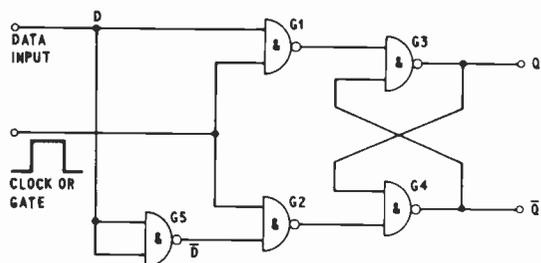
The previous circuit had three useful conditions, Q_n , 0, and 1. In some applications the data latch



TRUTH TABLE

INPUTS T_n		OUTPUT T_{n+1}
CLEAR	SET	Q
0	0	Q_n (Q at T_n)
0	1	1
1	0	0
1	1	INDETERMINATE

Fig. 6.3. The gated memory with SET and CLEAR inputs



INPUT	OUTPUT
D	Q
0	0
1	1

Fig. 6.4. The gated memory with a single data input

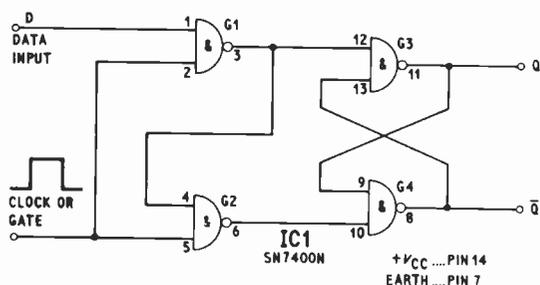
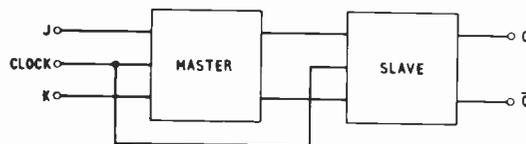


Fig. 6.5. The gated memory with a single data input and the minimum number of gates. It can be realised with an SN7400N



TRUTH TABLE

INPUTS		OUTPUT T_{n+1}
J	K	Q
0	0	Q at T_n
0	1	0
1	0	1
1	1	\bar{Q} at T_n



- 1 Isolate slave from master
 - 2 Enter information to master
 - 3 Disenable inputs
 - 4 Transfer information from master to slave
- Fig. 6.6. The basic action of a master-slave bistable circuit

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2N3702	0-10	BC109	
2N3703	0-10	BC148	
2N3704	0-10	BC177	
2N3819	0-25	BC184L	
2N4286	0-15	BC212L	
2N4289	0-15	BD130	
2N4443	0-88	BT	
2N5082	0-42		
2N5083	0-42		
2N5192	0-46		
2N5195	0-46		
2N5457			
40361			
40362			
40432			
40512			
40669			
AC128			
AD142			
AD149			
AD161			
AD162			

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AC188	0.25	BFX86	0.25	NKT403	0.75	OC470	0.30		
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ACY21	0.20	BFY17	0.25	NKT777	0.25	S18T	0.80		
ACY22	0.10	BFY18	0.25	078B	0.38	8AC40	0.25		
ACY27	0.25	BFY19	0.25	0A5	0.80	8FT308	0.88		
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is used for storing the output information in counters or computers until the readout has been achieved. This enables counting to recommence while the readout from a previous phase is still taking place.

If only the two middle entries in the truth table are required (as is usual) then a single data input can be used while the complement is obtained from an inverter, Fig. 6.4. The input data is up-dated during the clock pulse and retained when the clock goes low.

MINIMISED DATA LATCH

The circuit in Fig. 6.4 required five gates to realise it because the D was obtained by the direct inversion of D. However, D can be obtained from the output of gate 1, because D is only needed at the input to gate 2 when the clock is high; therefore, gate 1 will provide the required information.

The minimised circuit shown in Fig. 6.5 may be realised as an experiment using a single SN7400N. Data D will be entered into the memory while the clock is high and retained when the clock is low.

LOGIC GATE BISTABLES

In the previous circuits the inputs are coupled to the bistable circuit all the time the clock pulse is high, so that these circuits can only be made to toggle (divide by two) if the inputs are a.c. coupled. However, it is essential in logic circuits to overcome this problem without giving up the advantages of d.c. coupling, so circuits were developed which prevent the output transitions from altering the input information which was present when the leading edge of the clock occurred.

These circuits are usually designed in the form of two gated memories, one holds the output state and one holds the input information read in at the beginning of the clock pulse. Since this information is later transferred to the output memory, such a circuit is called a "master-slave" bistable.

Several different versions are available but they all have the master-slave action shown in Fig. 6.6. Here the operation shown is the J-K function where information is transferred from master to slave on the falling edge of the clock pulse. From the truth table it can be seen that this J-K master-slave bistable will divide by two if J and K are taken to 1, and an input applied to the clock.

CONCLUSION

We have shown how the simple memory circuit develops into the master-slave bistable, with its many advantages.

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THE Yachtsman's winter break, this year in the setting of a sunny Spanish harbour, the annual International Boat Show provides us with a shop window of marine electronics for small craft.

As in previous years there has been a steady development of the electronic gadgetry available, this year has seen the introduction of the l.e.d. (light emitting diode) to boat electronics, a new type of knotmeter and some advancement in the receiver, transmitter field.

One firm whose name must be to the forefront when we consider this year's innovations is EMI; in fact one could call it their year of innovation, with no less than four completely new instruments available. The most interesting new product is a magnetic log.

The new log operates by the transducer generating an a.c. magnetic field in the water surrounding it. As the boat moves through the water a small e.m.f., dependent on the boat speed, is produced and sensed by the transducer head. This induced signal, fed back through the system, is amplified to give a display of speed and distance. Housed in the normal EMI Electra range case the biggest advantage of this instrument is that there are no moving parts below the water and virtually no projection (only 3mm) below the hull surface.

The other innovations from EMI are an automatic direction finder, an f.m. radio telephone, and a gas detector and alarm. The direction finder is a three band receiver covering the range 175kHz to 3,000kHz. To use it, it is tuned to the required radio beacon and automatically gives an immediate and continuous bearing of the transmitter. The unit has its own internal supply or can be powered from a 12V or 24V ship's supply.

The Electra Gas Alarm uses a solid state imported detection unit and provides both visual and audible alarms of dangerous concentrations of gases.

It is interesting to note that the Electrascan MKII radar has been ordered by the RNLi for use in lifeboats. Whilst on the subject of radar both Decca and Electronic Laboratories have introduced MKII radars and the Decca Super 101 MKII is now sold with a magnifier that increases picture size to 9 inches.

TECHNICAL INNOVATION

As far as real technical innovation goes, this is the first time that we have found a l.e.d. used in a depth sounder. Produced by Marine Electronics and available for about £39, the sounder works on the same principle as a neon type and probably has a similar accuracy.

Instead of providing a point of light at the depth reading, the l.e.d. is turned on when the pulse is transmitted and off when the pulse is received, thus providing an arc of light showing the depth.

Brookes and Gatehouse—manufacturers of perhaps the most reliable and widely used instruments for the racing yachtsmen—have, we feel, done the sensible thing in offering most of their instruments for use on ship's supply. At last no more fiddling with batteries in a heavy seaway.

Baron Instruments, another contender for the "crack" racers' instrument panel, have redesigned their meter faces and introduced a new range—the Baron Sailboat Console—the meters are lit by l.e.d.'s and are 4½ inches in diameter. Provided the instruments can prove themselves at sea, with the new meters (which were in fact suggested by us last year) we feel that this range is the most likely to rival B. and G. this year.

Finally we think it is a pity to see Smiths Industries cashing in on the boat market with standard Radio-mobile car radios and tape units. Without the necessary marinisation we feel that these units will not stand up to marine use—particularly in salt water—and for Smiths to push the standard product for this purpose is surely not good policy.

PATENTS REVIEW...

WIRING HARNESSES FOR CARS

The Ford Motor Company patent No. 1 287 074 is concerned mainly with wiring harnesses for cars but most electronic enthusiasts will see far wider applications.

In a vehicle all the various electrics, such as sidelights, headlights, stoplights and wipers are usually connected to a power source by separate power carrying cables. The electrics are controlled by switches (usually located inside the vehicle remote from the devices) in the power cables from one of the supply terminals. The vehicle chassis acts as a common return to complete the circuit to the other supply terminal.

Providing heavy duty power lines for each separate remote electrical function is uneconomical. The Ford system is based on the house "ring main" idea and uses a flat strip power conductor capable of handling the total current load for all the vehicle electrics, see Fig. 1.

The strip conductor is flexible and is coated with flexible insulating material. On the surface of the insulating material a thin conducting layer is deposited and etched away to form a parallel series of thin low current control conductors. Each of these has connecting pads spaced out along its length and Ford suggest that in a practical system 20 to 30 control conductors can be used along with one main power conductor.

The vehicle power source is permanently connected to the power

conductor by a pin connector which bites through the insulating material and into the conductor. Similar power connectors can be used to connect the power conductor to any electrical device which requires a permanent supply of power.

Each remote electrical function that requires only a switchable power supply (such as headlights, etc) is connected to the power conductor by a gated plug. The gated plugs each house a transistor of which the emitter is permanently connected to the power conductor.

A resistor of around 1,000 ohms is connected between the base and emitter of the transistor and the base of the transistor is also connected to the required control conductor of the wiring harness. The transistor collector is connected externally to whatever electrical function is to be powered, Fig. 2.

The gate is controlled by a trigger signal from the control conductor and will only pass current to its load when a control signal is present.

In Fig. 2, the electrical functions or loads are lamps LP1 and LP2. When manual switches S1 and S2 are "off" the base of transistors TR1 and TR2 are at the same potential as the emitters and neither transistor conducts; thus lamps LP1 and LP2 do not light. If switch S1 is turned "on" the potential of control conductor CC1 falls, transistor TR1 is switched on and current flows through lamp LP1. Similarly if switch S2 is turned on, current flows through lamp LP2. The circuit takes into

account the high cold current surges involved in lighting most vehicle lamps.

Although SCR's may be used it is easier and cheaper to use switch resistors R1 and R2 (around 100 ohms each) which, together with the resistances connected between the emitters and bases of the transistors, form potential dividers which hold the base potentials constant at a level to which they fall on closing the switch. Current through the transistor can only increase until the voltage across the low emitter resistance (cable resistance, etc) raises the emitter potential to a similar value to the base potential.

BIO-NOTES

Readers of Gerry Brown's fascinating column will have noticed his comments in the January 1973 issue concerning "Electrophone Hearing" and his suggestion that the effect of feeding electric currents direct to the brain should be re-examined as a possible aid to the deaf.

Anyone wishing to follow this line of research will be interested by the content of two British patents Nos. 1 284 158 and 1 286 316 respectively from the ZCM Corporation of USA and Hermann Mengeler of Germany. Both patents were published some while ago but each contains useful technical information on the subject.

The ZCM patent details a method of using an audio signal to pulse a microwave radio signal, the resultant pulses being then fed to electrodes which are capacitively coupled to the subject's skin. This is claimed to produce a brain sensation in some respects equivalent to hearing.

The Mengeler patent claims a comparable system for introducing video information to the brain. In brief, a miniature TV camera produces a scanning voltage which is capacitively coupled to the subject's temples. This supposedly stimulates the optic nerve and produces sensations which the subject may train himself to equate with sight sensations.

Reference to these two patents before experimentation could well save readers wasted time and work—it could also save their subjects unnecessary electric shocks.

BP1 287 074

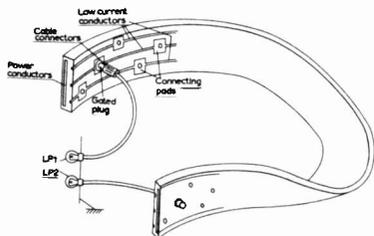


Fig. 1

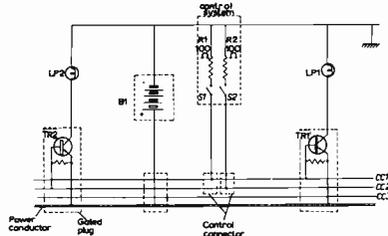


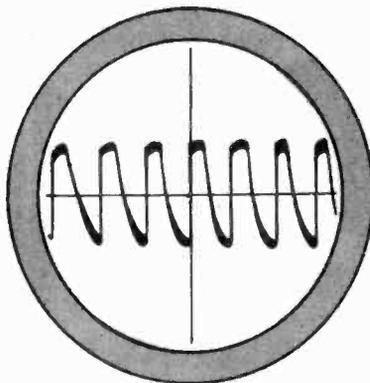
Fig. 2

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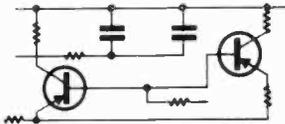
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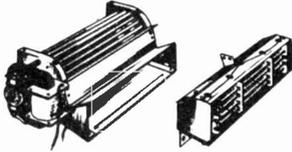
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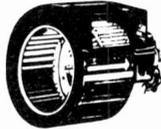


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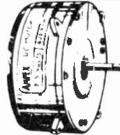
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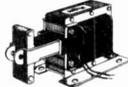
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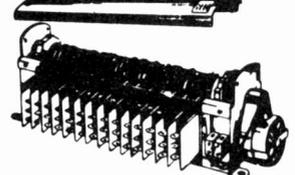
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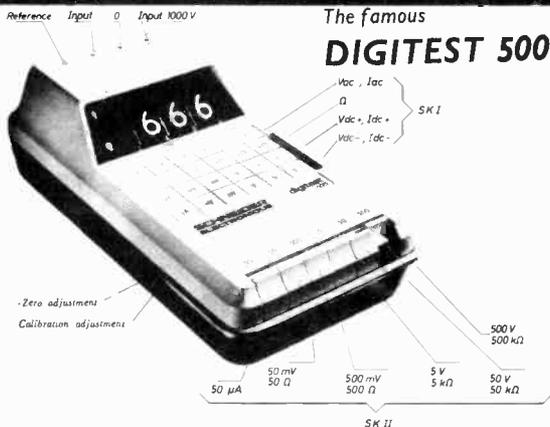
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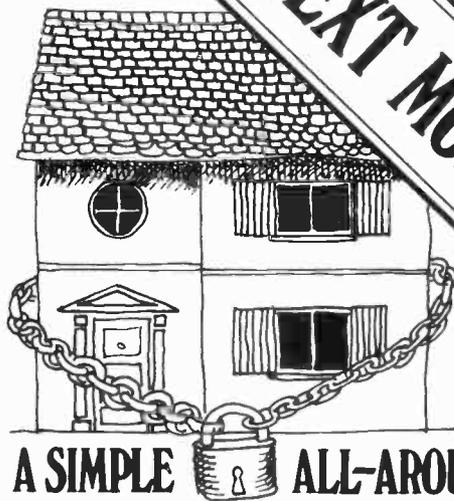
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MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

LOW COST DIGITAL MULTIMETER

A new £49 digital multimeter from **Sinclair Radionics** promises to be a strong contender in the professional quality meter market having as it does a claimed high accuracy, high input impedance, portability, and relative low cost. It is aimed at the replacement market as an economical substitute for analogue multimeters.

Measuring $190 \times 130 \times 58\text{mm}$ and weighing $1\frac{1}{2}\text{lb}$ (0.6kg), the multimeter can easily be held in the hand when making measurements. The leads are fixed to the instrument and wrap around a recess in the lightweight polypropylene case. Simple yet effective finger plate selector switches form an integral part of the case.

The instrument has ranges extending from $1\mu\text{A}$ up to 1A d.c. , 1mV to $1,000\text{V d.c.}$ and a.c. , and resistance ranges from $1,000\ \Omega$ to $1\text{M}\Omega$ full scale. Display is by three Nixies with a carry of one in a single neon. This gives an effective $3\frac{1}{2}$ digits without using a fourth tube.

The measuring technique is such as to reduce current consumption to a minimum, in fact, the manufacturer's specification promises 80 hours of switched-on operation with a current drain of 12mA .

Input impedance is very high at $1,000\text{M}\Omega$ compared to analogue meters, as are the accuracy parameters of 0.4 per cent on volts d.c., and 1 per cent on a.c. with an f.s.d. error of ± 2 digits.

An interesting aspect of the circuit is that it is all discrete, with a component count of around 300 (including 100 transistors) all mounted on three p.c.b.s.

In operation all inputs are brought within a 1V range and the incoming signals are analogue-to-digital converted to produce a pulse train the length of which is proportional to the input level. The

pulse train is passed to a chain of three cascaded pump circuits. Component values have been so chosen that the incoming pulse is summed in units, tens, and hundreds.

A "ring-of-ten" counter strobes each Nixie numeral terminal in sequence and for each strobe "tops up" the pump circuits. This action is used to time the point in the strobe sequence when the supply is switched onto the relevant Nixie to illuminate the correct numeral.

This instrument is available, by mail order, direct from the makers, **Sinclair Radionics Ltd.**, London Road, St. Ives, Huntingdonshire.

CASES

Encouraged by the success of their Contil Mod-2 range of instrument cases, **West Hyde Developments** recently launched a new complementary range of cases designated Mod-3 types.

The Mod-3 cases have fixed sides, in scuff resistant p.v.c. coated steel, made of two parts rigidly locked together. A chassis is supplied with the case, this and the panels being made up first and then assembled afterwards in the case.

Interior drilled side flanges allow the chassis plate to be positioned in any convenient position. The side flanges also take the rear and front panel fixing screws.

Case dimensions vary from $3\text{in} \times 7\text{in}$ to $6\text{in} \times 11\text{in}$ and further details and price list can be obtained from **West Hyde Developments Ltd.**, Ryefield Crescent, Northwood Hills, Northwood, Middlesex.

WAFER SWITCHES

The wafer switch is still one of the widest used components in electronics, and **Ultra Electronics (Components) Ltd** are now marketing a range of wafer switch kits.

One of the advantages of the switch kit is its versatility and ease with which the designer can make up prototype switching assemblies and change them on the spot.

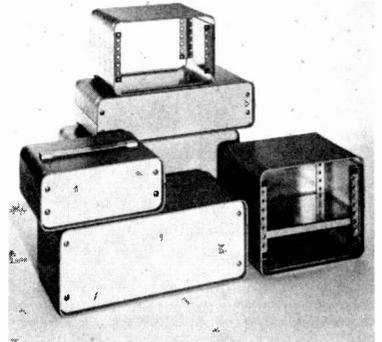
The Centralab Switchkits are packaged as separate components: the Series PA 1000 and PA 2000 kit contains, for example, 1,000 clips, 800 eyelets, 925 contacts, stators, rotors, nuts and packing washers, plus 25 index assemblies, 25 adjustable stops, eyeletting pliers and assembly tools and instructions. Further information and details of the switch kits can be obtained from **Ultra Electronics (Components) Ltd.**, Fassetts Road, Loudwater, Bucks.

Also available from **Ultra Electronics** is a free switch wallchart giving typical ratings and configurations.

SPECIAL OFFERS

Here is a chance to stock up with solid state devices at bargain prices. We have been advised by **A. Marshall & Son Ltd.**, that their advertisement next month will list a series of special offers, available only to readers of this magazine.

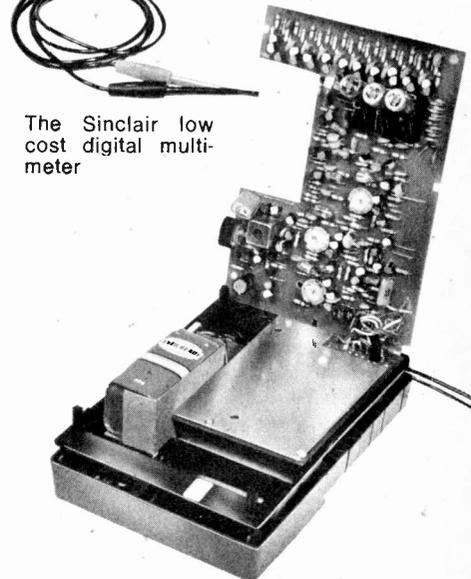
This well-known component supplier will be disposing of a large amount of stock at reduced prices, prior to moving into new premises.



Contil Mod-3 cases from West Hyde Developments



The Sinclair low cost digital multimeter



BELLING LEE INSULATED TERMINALS. Red or Black, 5 amp max. 10p pair, p.p. 31p

BERCOSTAT WIREWOUND RHEOSTAT. 50 volt, 800 Ω , 25 watts, 2in dia. 25p, p.p. 74p.

FINNED ALUMINIUM HEATSINK. 9in x 1 1/2in. Ready drilled. 20p, p.p. 64p.

SUB-MIN. CROC. CLIPS. Red or Black, insulated 4p. Min. quantity, 6, p.p. 31p.

GARRARD MAG. TAPE DECKS: 1 1/2 i.p.s., 50V, solenoid operated brakes, etc. Mains voltage motors 27-50 each, p.p. 12-23.

4jin PLANNAIR FANS. Complete, capacitor, ex equip. 2,800 r.p.m. 23-50, p.p. 40p.

ELECTRIC MOTORS, HOOVER OR CROMPTON PARKINSON. 250V. Single phase a.c.
1 h.p., 1,440 r.p.m., 23-75, p.p. 41.
1 h.p., 1,425 r.p.m. or 2,800 r.p.m., 26-75, p.p. 41-25.
1 h.p., 1,440 r.p.m., 22-25, p.p. 75p.

AUDIO CONNECTORS
3 pin Din Plug 13p each.
5 pin Din Plug A type, B type 13p ..
2 pin Din Speaker Plug/Socket 10p ..
3 pin Din Line Socket 13p ..
3-5mm Jack Plug Screened 10p ..
Standard Jack Plug 10p ..
Screened Standard Jack Plug 15p ..
Stereo Jack Plug 18p ..
Screened Stereo Jack Plug 18p ..

Phono Plugs: Red or Black 3p each. P.p. on above items 31p.

MAINS NEONS
Red or Green. Size: 1/2in x 1 1/2in. 15p, p.p. 31p.

LEVER ACTION P.O.1000 TYPE SWITCHES
Lock 4-pole changeover, 15p, p.p. 31p. Ex equip. Lock 2-pole changeover, 10p, p.p. 31. Ex equip.

AUDIO LEADS
Screened Phono Leads 46in long. 15p.
3-5mm JACK/3-5mm JACK 7ft 6in long. 40p.
5-Pin Din A Type, 5-PIN A TYPE. Approx. 5ft long. 70p.
P.p. on above items 54p.

MULLARD & MALLORY SCREW TERMINAL CAPACITORS 4,500 μ F 64V, 7,100 μ F 40V, 50p each
20,000 30V, 25,000 25V, 35,000 15V, 30p each
p.p. 10p.

MULLARD FULLWAVE RECTIFIERS
6-48V, 15 amp. 75p, p.p. 81p.

BELLING LEE 1.5 amp in-line rubber covered interference suppressor, 25p, p.p. 8p.

RUBBER 3 PIN 5 AMP NON-REVERSIBLE CABLE CONNECTORS, 20p, p.p. 54p.

SOLENOIDS 12 VOLT PULL ACTION
2in x 1in x 1 1/2in, 40p, p.p. 8p.

SIEMENS MINIATURE RELAY. Double pole changeover dust cover/base 48V, 2500, 50p, p.p. 5p new.

OMRON MK2 MIDGET POWER RELAY. 12V d.c. Double pole changeover. New, 70p, p.p. 5p.

STC MINIATURE RELAY 280 Ω . perspex cover, 6-15V new, 35p, p.p. 5p.

GARDNER'S POTTED TRANSFORMER. 0-250V. Input: 18V 500m/f, 50V 150m/a, 6V 250m/a output. Size: 3in x 2 1/2in x 2 1/2in. 21, p.p. 20p. Ex equip. tested.

TELESCOPIC AERIALS
Chromed 7in closed, 28in extended, 6 section ball jointed base, 23p, p.p. 8p new.

MULLARD 4 DM 180 INDICATORS in plastic holder/cover, ex equip., size approx 1 1/2in x 1 1/2in x 1 1/2in. 30p, p.p. 8p.

PRINTED CIRCUIT BOARD/19 ACY 19's 10 OA200
Diodes: 1 red relay; 1 AZ 229 zener ass. capacitor/resistors. Power supply 22V, 48V m/A d.c. Output 240V a.c. 21, p.p. 20p. Ex equip.

WIRING CABLE
Size: 1-020. Various colours. 350yd, 60p, p.p. 20p.

TOGGLE SWITCHES. Double throw. Ex equip. new condition, 75p doz., p.p. 13p.

TOGGLE SWITCHES. Single pole, double throw. Ex equip., new condition, 50p doz., p.p. 13p.

PAINTON PLUG SOCKETS. Type 159 series. Working voltage 350V a.c./d.c. current, max. 3 amp a.c./d.c. 7 pin plug and socket, 50p, p.p. 6p. 15 pin plug and socket, 21, p.p. 6p. 31 WAY PLUG AND SOCKET, 21-50, p.p. 6p.

CASH WITH ORDER PLEASE

FIELD ELECTRIC LIMITED

3 Shenley Road
Borehamwood, Herts.

Adjacent Elstree Mainline Station
Tel.: 01-953 6009

ELECTRONIC BARGAINS

SOLDERING IRONS

	Recommended Retail Price	Our Price
Antex CCN240	£1-80	£1-44
Antex CN240	£1-70	£1-36
Antex X25	£1-75	£1-40

STEREO HEADPHONES

MD802. Frequency 20-18,000 c.p.s. 8 ohm	£3-50	£2-25
MD806. Frequency 20-20,000 c.p.s. 8 ohm	£8-00	£4-95
Coiled Headphone		
Extension Lead		£1-35

AMPLIFIER MODULE

Amplifier module AE1000 3 watt, £2-37. 5 watt, £3.

FERRANTI RADIO CHIP, ZN414, £1-12

D.I.L. HOLDERS—14 pin 15p
16 pin, 16p.

COMPACT CASSETTE

	1	3	10
C60	30p	87p	£2-50
C90	40p	£1-17	£3-50
Cassette Head Cleaners			32p
8-track Head Cleaners			75p

Fully Guaranteed. Mail Order only
Cheque or P/O to: P. & P. 13p

T. F. J. ELECTRONICS
25 EASTBURY COURT
LEMSFORD ROAD
ST. ALBANS, HERTS.

4-STATION INTERCOM



Solve your communication problems with this 4-Station Transistor Intercom system (1 master and 3 Subs), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from Master to Subs and Subs to Master. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 40p.

MAINS INTERCOM (new model)
No batteries—no wires. Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control with lock system. Price 214-40. P. & P. 55p extra.

INTERCOM/BABY ALARM



Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 14p. P. & P. 25p.

Transistor TELEPHONE AMPLIFIER

Why not boost business efficiency with this incredible De-Luxe Telephone Amplifier. Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery 14p extra. P. & P. 22p. Full price refunded if not satisfied in 7 days.

WEST LONDON DIRECT SUPPLIES (FE/3)
169 KENSINGTON HIGH STREET, LONDON, W.8

Would you spend an hour a day to earn more money in Electronics-Television-Radio?

If you're willing to give up one hour or more a day we can help you get into the lucrative growth industries of electronics, television, radio.

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With our know-how and wide experience in teaching, plus your determination to study, we can turn your interest into the technical knowledge you need for success. Once you've got the qualifications you need, you'll be in a good position to take full advantage of the opportunities which exist today in all fields of electronics—in television (colour and black/white) and in radio. (We teach you the theory and practice of valve and transistor portable circuits while you build your own 5 valve receiver, transistor portable and high grade test instruments.)

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Self-build radio courses

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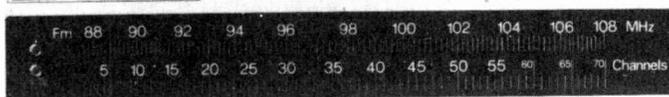
Sinclair Project 60

Project 60 Stereo FM Tuner

sinclair

STEREO
FM TUNER

tune



• Built and tested.
Post free.
£25

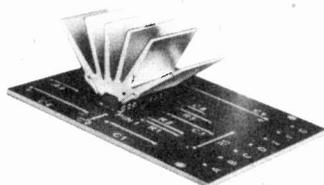
with phase lock-loop principle

Amongst the many advanced electronic features to be found in this remarkable stereo tuner, use of the phase lock loop principle ensures standards of audio quality better than from any other method of detection yet used. Varicap diode tuning, accurately formed printed circuit coils, an I.C. in the special stereo decoder section and switchable squelch circuit for silent tuning between stations contribute to the unsurpassed performance of this tuner, irrespective of price consideration. But the Project 60 FM Stereo Tuner is far from expensive – indeed, it offers fantastic value for money and will bring the thrill of stereo radio to many who previously may not have been able to afford it. The tuner may be used with any good system as well as Project 60, but if you use it with other Project 60 modules, you will find the matching front panels particularly impressive in appearance as well as function.

SPECIFICATIONS

Number of transistors: 16 plus 20 in I.C.
Tuning range: 87.5 to 108MHz.
Sensitivity: 7µV for lock-in over full deviation.
Squelch level: typically 20µV.
Signal to noise ratio: ±65dB.
Audio frequency response: 10Hz–15KHz (±1dB).
Total harmonic distortion: 0-15% for 30% modulation.
Stereo decoder operating level: 2µV.
Cross talk: 40dB.
Output voltage: 2 × 150mV R.M.S. max. (typically 2 × 50mV, stereo).
Operating voltage: 25–30V DC at 100mA.
Indicators: Stereo on-tuning.
Size: 93 × 40 × 207mm.

Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with pick-up, F.M. radio or small P.A. set up, etc. The free 40 page manual supplied, details many other applications which this remarkable IC, make possible. It is the equivalent of a 22 tran-

sistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak). 6–8Ω. **Frequency Response:** 5Hz to 100KHz ± 1dB **Total Harmonic Distortion:** Less than 1%. (Typical 0-1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 × 45 × 28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.

£2.98 Post free

Project 605



The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

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Sinclair Radionics Ltd, London Road, St. Ives, Huntingdonshire PE17 4HJ. Tel: St. Ives 64311

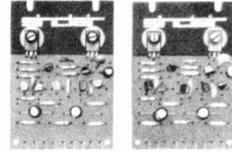
the world's most advanced high fidelity modules

Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. **Z.30 £4.48** **Z.50 £5.48**

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications).— Power Outputs: **Z.30** 15 watts R.M.S. into 8 ohms using 35 volts; 20 watts R.M.S. into 3 ohms using 30 volts. **Z.50** 40 watts R.M.S. into 3 ohms using 40 volts; 30 watts R.M.S. into 8 ohms using 50 volts. **Frequency response:** 30 to 300,000Hz ± 1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.

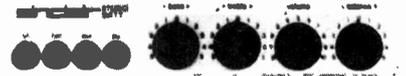


Stereo 60 Pre-amp/control unit

Built, tested and guaranteed. **£9.98**

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

SPECIFICATIONS—Input sensitivities: Radio — up to 3mV. Mag. p.u. 3mV; correct to R.I.A.A. curve ± 1dB. 20 to 25,000 Hz. Ceramic p.u. — up to 3mV. Aux — up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE +12 to —12dB at 10KHz; BASS +12 to —12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.



A.F.U. High & Low Pass Filter Unit

Built, tested and guaranteed. **£5.98**

For use between Stereo 60 unit and two Z.30s or Z.50s. The unit is very easily mounted and is unique in that the cut-off frequencies are continuously variable. As attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. There are two filter sections — rumble (high pass) and scratch (low pass). H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. Operating voltage from 15 to 35V. Current 3mA. **Size:** 66 x 40 x 90mm.



Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

PZ.5 30 volts un stabilised £4.98
PZ.6 35 volts stabilised £7.98
PZ.8 45 volts stabilised (less mains transformer) £7.98
PZ.8 mains transformer £5.98



Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control, etc.	£4.48
Mains powered record player	Z.30, PZ.5	Crystal or ceramic P.U. volume control, etc.	£9.45
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£23.90
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.30s, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£26.90
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50s, Stereo 60; PZ.8, mains transformer	As above	£34.88
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	£19.43

F.M. Stereo Tuner (£25) & A.F.U. (£5.98) may be added as required.

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Each Project 60 module is tested before leaving our factory and is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

SINCLAIR RADIONICS, ST IVES, HUNTINGDONSHIRE PE17 4HJ

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VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0-260V

All Types from 1 to 50 amp from stock.
SHROUDED TYPE
 1 amp, £7.00
 2.5 amp, £8.05
 5 amp, £11.75
 10 amp, £22.50
 15 amp, £25.00



(Panel Mounting) 1/2 amp, £4.75.
 1 amp, £7.00, 2 1/2 amp, £8.05. All carriage paid.

DOUBLE ENDED MOTOR UNIT

Powerful, continuously rated, 2-speed. Either 6 or 10 volt D.C. operation. PRICE £2 incl. P. & P.



12 VOLT D.C. MOTOR

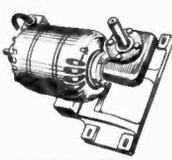
Powerful 1 amp. REVERSIBLE motor. Speed 3,750 r.p.m. complete with external gear train (removable) giving approx. final speed of either 125 r.p.m. or 240 r.p.m. Size: 4 1/2 in. x 2 1/2 in. dia. Either type price 95p inc. post.



REVERSIBLE SPLIT PHASE MOTOR
 250 r.p.m., 100-115/210-240V A.C., 2 in. x 1 in. Ideal for rim-drive models, display, etc. Extremely powerful for size, including small capacitor. 75p post paid.

PARVALUX TYPE SD19 230/250 VOLT A.C. REVERSIBLE GEARED MOTORS

30 r.p.m., 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. £6.80, Post Paid.



PARVALUX Type: SD1.S/86896/OJ
 230/250V A.C. 50 r.p.m. 7 lb/ins. Continuously rated. Less base. £6.30, Post Paid.



TYPE: SD1.S/89400/OM
 230/250V A.C. 50 r.p.m. 22 lb/ins. Continuously rated. Incl. base. £7.30, Post Paid.

The above motors are new and unused.

PARVALUX TYPE SD2. 200/250 VOLT A.C./D.C. HIGH SPEED MOTOR

Speed 9,000 r.p.m. approx. or 3,200 r.p.m. if used with built-in governor, or variable speed over a wide range if used in conjunction with our Dimmer Switch, illustrated below. PRICE £2. Post Paid.



600 WATT DIMMER SWITCH.
 Easily fitted. Fully guaranteed by makers. Will control up to 600W of all lights except fluorescent at mains voltage. Complete with simple instructions. £3 incl. P. & P.

VENNER ELECTRIC TIME SWITCH 200/250V Ex. G.P.O.

Tested. Manually set 2 on, 2 off every 24h. Override switch 15A, £3.45, 20A, £3.95. Post Paid. Also available with solar dial ON dusk, OFF dawn. Price as above.



24-HOUR TIMER

Can be adjusted to give a switching delay of between 1 hr. to 24 hrs. Driven by 200/250V A.C. synchronous motor. 15 amp c/o contacts. Mfg. Crater Controls Ltd. Supplied with scale calibrated 0-10 (2 hrs. per division). Brand New. £2. Post Paid.



HONEYWELL PROGRAMME TIMERS

240V. A.C. 5 r.p.m. motor. Each cam operating a c/o micro switch. Cams are individually variable, allowing innumerable combinations. Ideally suited for machinery control, automation, etc. Also in the field of entertainment, for chaser lights, animated displays, etc.
 15 cam model £6. Post Paid.
 10 cam model £5. Post Paid.
 2 cam model with 15 r.p.m. motor £2. Post Paid.



SIMPLE 12 CAM PROGRAMMER with 4 adjustable cams and 8 that may be profiled to individual requirements, available with 15 or 13 r.p.m. motor, £3.75. Post Paid.

36V 30 AMP. A.C. or D.C.

VARIABLE L.T. SUPPLY UNIT

INPUT 220/240V a.c.
 OUTPUT CONTINUOUSLY VARIABLE 0-36V



Fully isolated. Fitted in robust metal case with Voltmeter. Ammeter Panel Indicator and handles. Input and output fully fused. Ideally suited for Lab. or Industrial use. £70. Post Paid.

MOTOROLA MAC 11/6 PLASTIC TRIAC 400 PIV. 10 AMP

Now available EX STOCK. Supplied with full data and applications sheet. Price £1.12. Post Paid. Suitable DIAC (RCA 40583) 30p each.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube, solid state timing and triggering circuit. 230/250V a.c. operation.

EXPERIMENTERS' ECONOMY KIT
 Speed adjustable 1 to 30 flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £6.55. Post Paid

NEW INDUSTRIAL KIT
 Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1-80 f.p.s. approx. 1/2 output of Hy-Lyght. Price £11. Post Paid.

HY-LYGHST STROBE MK III
 Designed and produced for use in large rooms, halls and the photographic field and utilises a silica tube, printed circuit, also a special trigger coil. Speed adjustable 0-20 f.p.s. Light output approx. greater than many (so called 4 joule) strobes. £12.50. Post Paid.

THE 'SUPER' HY-LYGHST KIT

Approx. four times the light output of our well proven Hy-Lyght strobe. Incorporating:

- Heavy duty power supply.
- Variable speed from 1-13 flash per sec.
- Reactor control circuit producing an intense white light.

Never before a Strobe Kit with so HIGH an output at so LOW a price. ONLY £20.75. Post Paid.

ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE, Super Hy-Lyght Kit including reflector. £7.45. Post Paid.

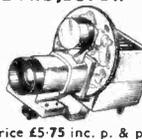
For Hy-Lyght Kit including reflector. £4.45.
7-inch POLISHED REFLECTOR
 Ideally suited for above Strobe kits. Price 66p. Post Paid.

RAINBOW STROBE FOUR LIGHT CONTROL MODULE

Will operate four of our Hy-Lyght or Suoer Hy-Lyght Strobes in either 1, 2, 3, 4 sequence; 2 + 2; or all together. Thoroughly tested and reliable. Complete with full connection instructions. Price: £18.75. Post Paid. Send S.A.E. for details.

COLOUR WHEEL PROJECTOR

Complete with oil-filled colour wheel. 100 watt lamp. 200/240V A.C. Features extremely efficient optical system. £18.50 + 35p. P. & P. 6 INCH COLOUR WHEEL. As used for Disco lighting effects, etc. Price £5.75 inc. p. & p.



BIG BLACK LIGHT

400Watt Mercury vapour ultra violet lamp. Outer bulb designed to absorb visible light and transmit u.v. rays. Extremely compact and powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos, etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb £16.50. Post Paid. Spare bulb £7.30. Post Paid.



BLACK LIGHT FLUORESCENT U.V. TUBES

4ft. 40 watt. Price £5.80 incl. P. & P. (For use in standard bi-pin fluorescent fittings). MINI 9 in. 6 watt black light U.V. tube. £1.45. Post Paid.

50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price £8.05. Post Paid.

Superior Quality Precision Made NEW POWER RHEOSTATS



100 WATT. 1 ohm, 10A; 5 ohm, 4.7A; 10 ohm, 3A; 25 ohm, 2A; 50 ohm, 1.4A; 100 ohm, 1A; 250 ohm, 0.7A; 500 ohm, 0.45A; 1 kΩ, 280 mA; 1.5 kΩ, 230mA; 2.5 kΩ, 2A; 3.5kΩ, 5 kΩ, 140mA. Diameter 3 1/2 in Shaft length 3/4 in, dia. 1/8 in. All at £1.73. 3p Paid.
 50 WATT. 1/5/10/25/50/100/250/500/1/1 1/2/5/5kΩ. All at £1.23. Post Paid.
 25 WATT. 10/25/50/100/250/300/500/1/1 1/2/5/3/5/5kΩ. All at 98p. Post Paid.
 Black Silver Skirted knob calibrated in Nos. 1-9. 1 1/2 in. dia brass bush. Ideal for above Rheostats, 18p ea.

RELAYS SIEMENS, PLESSEY, Etc.

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Col. (2)	52	3-6	2 c/o	61p*
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Col. 3	700	16-24	4 c/o	78p*
Contracts	700	15-35	2 c/o HD	73p*
	700	16-24	6M	65p*
Col. (4)	700	6-12	1 c/o HD	50p*
Price	700	20-30	6 c/o	75p
	1,250	24-36	4 c/o	63p*
	2,500	36-45	6M	61p*
HD =	2,400	30-48	4 c/o	50p*
Heavy duty	9,000	40-70	2 c/o	50p*
Post paid.	15k	85-110	6M	50p*

12 VOLT D.C. RELAY 140 ohm coil
 Type 1: Three sets c/o contacts rated at 5 amps. 78p incl. P. & P. (Similar to illustration below.)
 Type 2: One set of c/o contacts. 60p incl. P. & P.
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SPECIAL OFFER
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Three sets c/o contacts rated at 5 amps. PRICE: 60p. Post Paid. (100 lots £40 including P. & P.)



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 One set c/o contacts rated at 7.5 amps. Boxed. PRICE: 45p. Post Paid. (100 lots £32 inc. P. & P.)

MINIATURE LATCHING RELAY
 Manufactured by Clare-Elliott Ltd. Type F. 2 c/o permanent latching in either direction. Coil 1150 ohm, 15-30 Volt D.C. Size 3/4" high, 3/4" wide, 1/2" thick. Complete with 3" leads. New 73p, incl. P. & P.

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Each bank comprises a c/o contact at 10 amps 240V. A.C. Black knob 1 in. Fixing hole 1/2 in. ONE bank 30p; TWO bank 40p; THREE bank 55p; incl. P. & P. Quot. for quantity.



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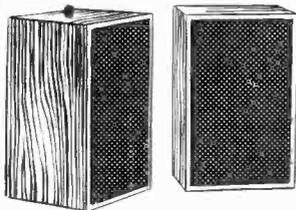
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R.088 MATCHED STEREO LOUD SPEAKERS Here's real value in stereo speakers! Each unit comes complete with 10-foot lead and phono plug, and look really smart. Power handling per speaker: 4 watts rms, 8 watts peak. Frequency range: 40-16,000 Hz. Flux density: 8,500 gauss. Impedance: 8 ohms. Dimensions: 9" high, 5 1/2" wide, 4 1/2" deep. Finish: oiled walnut.
ROC PRICE £9 50 pair.
Normal Price £10 75



A-3000 38-WATT SOLID STATE STEREO AMPLIFIER The A-3000 looks as good as it sounds! Giving you a big performance this superb audio amplifier has a full range of facilities on the front and rear panels. On the front - all the controls you're ever likely to need plus a headphone socket. On the rear - signal inputs, speaker outputs and a line fuse for circuit protection.
Specifications: 18 watts rms per channel into 8 ohms. Frequency response: 20-35,000 Hz ($\pm 2db$) Inputs: Magnetic, Ceramic, Tuner, Tape, Aux, Tape Play. Size: 345mm x 300mm x 130mm.

REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500

A superb hi-fi amplifier with all the features you've ever wanted - for under £46.00. Saving over £10.00 on the normal retail value. Up-to-the-minute slider controls for bass and treble, separate volume and balance controls. Headphone socket on front panel. Push-button input controls - magnetic phono (high/low) tuner, aux, mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz $\pm 1db$ at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2.5mV and 5mV RIAA, tuner/aux 250mV. Hum and noise: phono - 50db; tuner/aux - 65db. How's that for a specification! Size 14 1/2" wide, 3 1/2" high, 10 1/2" deep.



As reviewed in "POPULAR HI-FI" February 1972

ROC PRICE £35.20
Normal Price £55.50



OLSON RA-310 AM/FM/MPX STEREO TUNER

This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as its good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10.00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz, AM: 525-1605 kHz. FM Sensitivity: FM 3µV, AM 250µV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11 1/2" wide, 4" high, 7 1/2" deep.

ROC PRICE £31.20
Normal Price £50.00



REALISTIC SA-100B 6-WATT STEREO AMPLIFIER

Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide x 3" high x 5 1/2" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/headphone. The ends are oiled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 70,000 Hz $\pm 3db$. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.

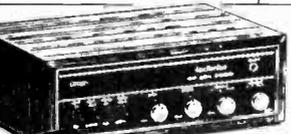
ROC PRICE £12.45
Normal Price £21.00

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TEC HR-007 HEADPHONE RADIO
When you want to listen to the radio all by yourself then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs. Frequency range is 535 to 1805 kHz medium wave band. Maximum output is 300 mW.
Normal Price £7 65 ROC PRICE £5 00

EAGLE LC 07 STEREO MOVING-MAGNET CARTRIDGE

Here's your opportunity to own a transcription cartridge for the price of a ceramic! It is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0.7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: $\pm 1dB$. Channel separation: 28dB. Compliance: 12-10 g/cm/dyn.
ROC PRICE £8 37



OLSON AM-395 40-WATT STEREO AMPLIFIER

An ideal unit for your new stereo separate system. It is more than £10.00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for tapping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz $\pm 3db$. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3.0mV RIAA, crystal phono 100mV, tape 160mV, tuner 180mV. Size 11 1/2" wide, 4" high, 7 1/2" deep. The specification reads well - sounds even better!

ROC PRICE £24.10
Normal Price £39 50



R.446 3-WAY MATCHED SPEAKERS

These will do justice to your amplifier - and to your pocket. At only £20.00 a pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a 6 1/2" base unit plus tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6 1/2" deep.

ROC PRICE £20.00
Normal Price £27 00 per pair.



OLSON AM-408 4-WATT STEREO AMPLIFIER

Here's a marvellous value for someone just starting to set themselves up in audio! At only £10.50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for tuntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz $\pm 3db$. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV, tuner/aux 80mV. Size 8" wide, 2 1/2" high, 4 1/2" wide.

ROC PRICE £10.50
Normal Price £15 70

25-WATT 3-WAY CRYSLER 'LIVING AUDIO' SPEAKER CE-56



This high quality speaker or has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10 1/2" x 7 1/2" x 8 1/2". Exactly right for matching the most modern decor.

ROC PRICE £27.25
Normal Price £39 95 each.



PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-18

This is one of the lowest priced stereo tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received - that's the time to switch to 'Stereo'! The SSA-18 has all the facilities you'd expect to find on tuners costing twice as much - separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz, AM 535-1805 kHz. Frequency response: 50-10,000 Hz $\pm 3db$. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4 1/2" high, 8" deep.

ROC PRICE £27.55
Normal Price £42 00

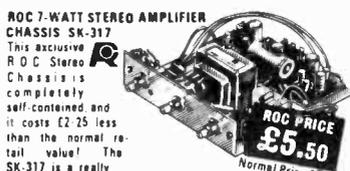
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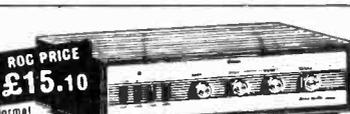
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ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317

This exclusive ROC Stereo Chassis is completely self-contained and its costs £2.25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5 1/2" wide, 1 1/2" high and 8 1/2" deep. It contains its own mains power supply, and has a ganged volume control and separate treble controls for each channel. Specification: frequency response 40-17,000 Hz $\pm 3db$, output 3.5 watts music power per channel into 8 ohms. Input, phono, 600mV; signal-to-noise ratio better than 45dB.

ROC PRICE £5.50
Normal Price £7 75



OLSON AM-372 16-WATT STEREO AMPLIFIER

Here's a really good amplifier at a really down-to-earth price - nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you - reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz $\pm 3db$. Output 3 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12 1/2" wide, 3 1/2" high, 7 1/2" deep.

ROC PRICE £15.10
Normal Price £25 20

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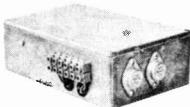
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This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.

Helps to promote easier starting (even under sub-zero conditions), improved acceleration, better high-speed performance, quicker engine warm-up and improved fuel economy. Eliminates excessive contact-breaker point burning and the need to adjust point and spark-plug gaps with precision.

Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour. A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7 1/2in x 4 1/2in x 2in, approx.

Complete assembly and wiring manual 25p, refundable on purchase of kit. Price: £10.50 plus 50p P. & P.

**PSYCHEDELIC LIGHTING
UNIT Mk. 3**



This unit represents a natural progression from our phenomenally successful Mk. 1 and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.

The unit is constructed on professional fibre-glass printed-circuit board material and uses latest full-wave triac circuitry. There is a master-level control, together with independent sensitivity controls for each channel. The original minimum ambient light level controls have been redesigned permitting their use as faders; allowing dimming from max. to zero at the turn of a knob. R.F.I. suppression is now incorporated as standard as well as provision for D.J. "Pulse-Flash" controls. The choice of two inputs enables operation from both high and low power amplifiers. Max. power 1.5kW per channel at 240V a.c. Complete assembly built and tested. Size 9in x 7in x 3in. Price £25 carr. paid.

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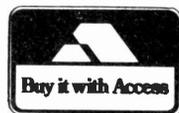
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AC132 12p	AF180 40p	BF178 32p	OC70 12p	2N3707 12p
AC176 12p	AF181 40p	BF179 32p	OC71 12p	2N3708 10p
AC187 22p	BC107 9p	BF180 32p	OC72 12p	2N3709 11p
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AD161 33p	BC148 13p	BF197 15p	2N2926R 9p	40361 35p
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250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p. 0.033μF, 0.047μF, 0.068μF, 31p. 0.1μF, 4p. 0.15μF, 5p. 0.22μF, 6p. 0.33μF, 61p. 0.47μF, 81p. 0.68μF, 111p. 1.0μF, 131p. 1.5μF, 20p. 2.2μF, 24p.

MYLAR FILM CAPACITORS 100V

0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF, 21p. 0.04μF, 0.05μF, 0.068μF, 0.1μF, 31p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7 RANGE REPLACES C426, C457 RANGES

(μF/V): 1/0/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/40, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6.3, 33/40, 47/4, 47/10, 47/25, 47/40, 47/63, 68/6.3, 68/16, 100/4, 100/10, 100/25, 100/40, 150/6.3, 150/16, 150/25, 220/4, 220/10, 220/16, 330/4, 330/10, 470/6.3, 5p each. 68/63, 150/40, 220/25, 330/16, 470/10, 680/6.3, 1,000/4, 9p. 100/63, 150/63, 220/40, 470/25, 680/16, 1,000/10, 1,500/6.3, 12p. 220/63, 470/40, 680/25, 1,000/16, 1,500/10, 2,200/6.3, 15p. 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/6.3, 4,700/4, 18p.

SOLID TANTALUM BEAD CAPACITORS

0.1μF 35V	2.2μF 35V	22μF 16V	12p
0.22μF 35V	4.7μF 35V	33μF 10V	
0.47μF 35V	6.8μF 25V	47μF 6.3V	
1.0μF 35V	10μF 25V	100μF 3V	

ELECTROLYTIC CAPACITORS Miniature P.C. mounting 5p each.

(μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

VEROBOARD

2 1/2 x 3 1/2	0.1	0.15
2 1/2 x 5	22p	16p
3 1/2 x 3 1/2	24p	24p
3 1/2 x 5	24p	24p
17 x 2 1/2	27p	27p
17 x 3 1/2	75p	57p
17 x 5	100p	78p
17 x 5 (plain)	—	85p
17 x 3 1/2 (plain)	—	60p
17 x 2 1/2 (plain)	—	42p
2 1/2 x 5 (plain)	—	42p
2 1/2 x 3 1/2 (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2.5mm insulated	8p
Standard insulated	12p	3.5mm insulated	8p
Stereo screened	35p	3.5mm screened	13p
Standard socket	15p	2.5mm socket	8p
Stereo socket	18p	3.5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable 22p/metre.

BATTERY ELIMINATOR £1.50

9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF 64V 74p	2500μF 64V 80p	4500μF 16V 50p
2500μF 40V 74p	2800μF 100V £2.60	4500μF 25V £1.68
2500μF 50V 58p	3200μF 16V 50p	5000μF 50V £1.10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0.01μF 10p	0.047μF 13p	0.22μF 20p
0.022μF 12p	0.1μF 13p	0.47μF 22p

POLYSTYRENE CAPACITORS 160V 2 1/2%

10pF to 1,000pF E12 Series Values 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI £2

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.

PRINTED BOARD MARKER 97p

Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

LARGE RANGE ITT/TEXAS ICs NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

	1-11	12-24	25-99	100+	7447	175	170	165	160	74118	100	85	75	65
7400	P	P	P	P	7448	175	170	165	160	74121	43	38	35	30
7401	20	18	16	14	7450	20	18	16	14	74124	210	180	160	130
7402	20	18	16	14	7451	20	18	16	14	74141	100	95	90	85
7403	20	18	16	14	7452	20	18	16	14	74145	150	145	140	135
7404	20	18	16	14	7453	20	18	16	14	74150	330	285	260	210
7405	20	18	16	14	7454	20	18	16	14	74151	110	95	90	85
7406	56	48	37	30	7460	20	18	16	14	74153	120	115	110	100
7407	56	48	37	30	7470	38	32	27	23	74154	200	190	180	170
7408	36	28	20	20	7472	34	30	27	21	74155	150	125	100	85
7409	36	28	20	20	7473	40	37	30	27	74156	130	120	100	80
7410	20	18	16	14	7474	60	56	52	50	74159	130	120	110	90
7411	23	21	20	20	7475	60	56	52	50	74180	155	135	120	100
7412	36	32	28	24	7476	40	36	32	30	74190	195	185	180	175
7413	34	32	28	22	7480	80	75	70	65	74191	195	185	180	175
7416	45	38	32	32	7481	125	120	115	110	74192	200	180	165	150
7420	20	18	16	14	7482	87	75	70	65	74193	200	180	165	150
7421	36	32	28	24	7483	100	90	85	80	74196	200	180	165	150
7422	48	44	38	35	7484	110	106	104	100	74197	160	150	145	140
7426	32	29	25	20	7485	250	245	240	235					
7427	42	38	36	34	7486	45	40	35	30					
7428	50	45	40	32	7490	75	70	65	55					
7430	20	18	16	14	7491A	100	90	80	75					
7432	40	36	32	30	7492	75	70	65	60					
7440	20	18	16	14	7493	80	70	65	55					
7441A	80	76	70	66	7494	85	80	75	70					
7442	80	76	70	66	7495	85	80	75	70					
7443	100	96	94	90	7496	100	95	90	85					
					74100	250	245	240	235					

LINEAR ICs

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SUPERSOUND 13 HI-FI MONO AMPLIFIER

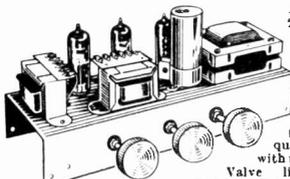


A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz-30kHz ± 3 db. Fully integrated pre-amplifier stage with

separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, cutcheon panel, input and output plugs. Overall size 3in high \times 6in wide \times 7in deep. A.C. 200/250V.

PRICE £10.50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum.

Valve line up—2 ECL86 Triodes, Pentodes. 1 \times E280 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approx. 1mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. \times 4in. \times 5in. Overall height including valves 3in. Ready built and tested to a high standard. **Price £8.92.** P. & P. 45p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7.5V, 9V and 12V at 1 amp continuous (14 amp intermittent). Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 8" \times 3 1/2" \times 2 1/2". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc. etc. Ready built and tested.

PRICE £4.50 P. & P. 35p.

BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2 1/2in \times 3in approx. 25p pair. P. & P. 5p.

LIMITED NUMBER! COILED SPRING BACK TELEPHONE CABLE. Closed approx. 10', extends to 36". 4 core or 6 core. 25p each. P. & P. 5p. 5 or more post free.

SPECIAL OFFER! MAINS TRANSFORMER. 200/240V A.C. input. 35V at 1 1/2 amp A.C. output. Overall size 2 1/2" \times 2 1/2" \times 3" approx. Suitable for drop through or vertical mounting. 90p. P. & P. 30p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-10-20, 20-20-30, 30-30-30V, at 2 amps full wave. Size 3inL \times 3 1/2inW \times 3inD. Price £1.85. P. & P. 30p.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. 85p. P. & P. 13p. Pri. 200/240V. Sec. 12-0-12 at 1 amp. 95p. P. & P. 13p. Pri. 200/240V. Sec. 10-0-10 at 2 amp. £1.45. P. & P. 30p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1 1/2" \times 1 1/2" \times 1 1/2". Brand new—complete with instructions. Price 88p. P. & P. 13p.

HANDBOOK OF TRANSISTOR EQUIVALENTS and SUBSTITUTES

A must for servicemen and home constructors. Including many 1000's of British, U.S.A., European and Japanese transistors. **ONLY 40p.** Post 5p.

Open 9-5.30 Monday to Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing. **LATEST B.S.E. C109/C189 4-SPEED AUTOCHANGER.** With latest mono compatible cartridge £8-97. Carr. 50p. With stereo cartridge £7-97. Carr. 50p.
Garrard SP25 MK II with heavy precision machined die cast turntable. £10-95. Carr. 50p.

SPECIAL BARGAIN OFFER!
PRECISION ENGINEERED PLINTHS
Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2020TC, 2500, 3000, 3500, 5100, SP25 II and III, EL65B, AT60, etc., or B.S.E. C109, C129, A21, etc. Black leatherette finish. Size 12 1/2in \times 14 1/2in \times 3 1/2in high (approx. 7 1/2in high, including rigid smoked acrylic cover). **NOW ONLY £4.50** P. & P. 30p.

LATEST ACOS GP91/18C Mono Compatible Cartridge with T/O stylus for LP/EP/78. Universal mounting bracket. £1.50. P. & P. 8p.

SONOTONE STANC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. **ONLY £2.50.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £3. P. & P. 10p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/78. £1.63. P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. £1.50. P. & P. 10p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top quality record player amplifier employing heavy duty double wound mains transformer. ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. \times 3d. \times 6h. Ready built and tested. **PRICE £3.95.** P. & P. 40p. **ALSO AVAILABLE** mounted on board with output transformer and speaker ready to fit cabinet below. **PRICE £5.25.** P. & P. 50p.
DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14 1/2" \times 12in., clearance 2in. below, 5 1/2in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 \times 15 \times 8in. **PRICE £4.75.** P. & P. 60p.

SPECIAL OFFER!! HI-FI LOUSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16 1/2in high \times 10 1/2in wide \times 5 1/2" deep. Fitted with E.M.I. Ceramic Magnet 13in \times 8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8.40 Carr. 65p.

CABINET AVAILABLE SEPARATELY £4.50. Carr. 60p.
Also available in 8 ohm with EMI 13in \times 8in. bass speaker with parasitic tweeter. £9.50. Carr. 65p.

LOUDSPEAKER BARGAINS
5in 3 ohm £1.05. P. & P. 15p. 7 \times 4in 3 ohm £1.15. P. & P. 20p. 10 \times 6in 3 or 15 ohm £1.90. P. & P. 30p. E.M.I. 8 \times 5in 3 ohm with high flux magnet £1.62. P. & P. 20p. E.M.I. 13 1/2" \times 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm £2.20. P. & P. 30p. E.M.I. 13 \times 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network £4.20. P. & P. 30p.
BRAND NEW. 12in 15W H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with HiLux ceramic ferrobar magnet assembly £6.75. Guitar models: 25w £6.75, 35w £5.20. P. & P. 35p each.



SPECIAL OFFER!

LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUSPEAKERS. With large ceramic magnet and plasticised cone surround. 8ohm impedance. £2.75. P. & P. 25p.

12in "RA" TWIN CONE LOUSPEAKER
10 watts peak handling, 3, 8 or 15 ohm. £2.20. P. & P. 30p. 35 ohm SPEAKERS 3". **ONLY 85p.** P. & P. 13p.
"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 1 1/2in \times 14 1/2in \times 1 1/2in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £5-95 each. P. & P. 25p.

VYNAIR & REKINE SPEAKERS & CABINET FABRICS
app. 6 1/2in. wide. Usually £1.75 yd., our price 75p yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexfoam earmuffs. Wired and fitted with standard stereo 1/4in jack plug. Frequency response 30-16,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. **PRICE £2-95.** P. & P. 15p.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR **PRICE £1-05.** P. & P. 8p.

CENTRE ZERO MINIATURE MOVING COIL METER. 100uA for balance or tuning. Approx. size 1in \times 1in \times 1/2in. Limited number 75p. P. & P. 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

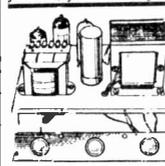
A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibre mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT £10.50 P. & P. 15p.
(Magnetic input components 30p extra)
POWER PACK KIT £3 P. & P. 30p.
CABINET £3 P. & P. 30p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested. £20.50. Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on chassis, plate 7 1/2in \times 4in. \times 4in. \times 4in. D. Incorporates ECC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and more with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £4.95. P. & P. 35p.

HSI "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £4.10. P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide \times 3in. deep \times 6in. high overall. A.C. mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE £2.95 P. & P. 35p.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 ohm speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and E280 rectifier. Simple instruction booklet 13p (Free with parts). All parts sold separately. **ONLY £7.97.** P. & P. 55p. Also available ready built and tested £10.97. P. & P. 60p.



(Please write clearly)
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

HARVERSON SURPLUS CO. LTD.

Dept. PE, 170 High St., Merton, London, S.W.19 Tel. 01-540 3985

SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

BSR LATEST SUPERSLIM STEREO & MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250V Size 18½ x 11½in.

Above motor board 3½in. below motor board 2½in. with STEREO and MONO XTAL £8.75 Post 25p.



BSR JUNIOR

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono cartridge £4.50 Post 25p



E.M.I. WOOFER AND TWEETER KIT £5.75

Available separately Post 25p.

Woolfer £4.25 Tweeter £1.90

Comprising a fine example of a Woolfer 10½ x 6½in. with a massive Ceramic Magnet, 440z. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 8½in. with special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard 8 ohms
Maximum Power 12 watts
Usual Response 35 to 18,000 c/s
Bass Resonance 45 c/s

SUITABLE ENCLOSURE 20 x 13 x 8in. MODERN DESIGN. TEAK WOOD FINISH £9 Post 25p



SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Two types available 0 to 60 minutes or 0 to 6 hours. Makers last list price £4.50. Brand new and fully guaranteed. Fully insulated.

OUR PRICE £1.50. P. & P. 15p or 23 pair. Post Free. (Please state type when ordering.)



WEYRAD P50 — TRANSISTOR COILS

BA2W Ferrite Aerial 75p	Spare Cores 3p
Osc. P50/1AC 33p	Driver Trans. LFDT4 58p
1.F. P50/2CC 470 kc/s 36p	Printed Circuit, PCA1 65p
3rd I.F. P50/3CC 38p	J.B. Tuning Gang 65p
P51/1 or P51/2 36p	Weyrad Booklet 10p
P50/8V 36p	OPTI 58p

Mollard Ferrite Rod 8 x ½in. 20p. 6 x ½in. 20p.

VOLUME CONTROLS

Long splines. Midset Size 5 K. ohms to 2 meg. LOG or LIN. L/R 15p. D.P. 25p. STEREO L/S 55p. D.P. 25p. Edge BK.S.P. Transistor 25p.

80 ohm Coax 4p yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1.40; 60 yd. £2. FRINGE LOW LOSS 10p. Ideal 625 and colour

8in. or 10in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50-60,000 c/s. Bass resonance 55 c/s 8 ohm impedance. 8in 10 watts, 10in 12 watts music power. £3.75



E.M.I. 13½ x 8in. SPEAKER SALE!

With twin tweeters. £3.95
Auto crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 25p. £2.25



TEAK CABINET

BRITISH MADE STEREO MULTIPLEX DECODER

Brand New. 7 transistors plus integrated circuit. Fibre-Glass printed circuit board. Size 21 x 6½ x 1. Pre-Aligned. Complete with stereo beacon indicator. 12V d.c. operation. 400mV Output for 100mV Input. Full instructions for any FM Tuner. Some technical experience essential. £6.50

ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 x 4in 45p; 8 x 1in 55p; 10 x 7in 65p; 12 x 8in 85p; 14 x 9in 95p; 16 x 9in 95p; 18 x 3in 50p; 16 x 10in 21. ALUMINIUM PANELS 18 s.w.g. 6 x 4in 9p; 8 x 6in 15p; 14 x 8in 16p; 10 x 7in 16p; 12 x 5in 20p; 12 x 8in 28p; 16 x 6in 28p; 14 x 9in 34p; 12 x 12in 40p; 16 x 10in 50p

HI-FI STOCKISTS RETURN OF POST DESPATCH

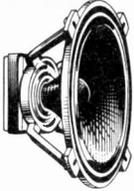
RADIO COMPONENT SPECIALISTS

Illustrated Colour Brochure, Radio Books and Component Lists 10p. (Export: Remit cash and extra postage.) Buses 50, 68, 159. Rail Selhurst. Tel. 01-684-1665

WHARFEDALE SUPER 10" HI-FI SPEAKER

15 watt. 4 to 8 ohms. Response 20 c/s to 12 kc/s. Bass resonance 42 c/s. Massive Ceramic Magnet. Deep fabric cone surround. Cast 'alloy' frame. Weight 5 lb. (Value £10-50.)

OUR PRICE £5.50



THE FAMOUS WHARFEDALE SOUND R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less.

PLEASE STATE VOLTAGE REQUIRED. £2 Post Free

Details S.A.E. Size 3½ x 1½ in.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12V or H.T. line 200-300V d.c. operation. Size: 1½ x 1½ x 2½in. Response 25 c/s to 25 kc/s, 26 dB gain. For use with valve or transistor equipment. £90p Post Full instructions supplied. Details S.A.E. 10p

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300-0-300V 120VA, 6-3V 4A O.T.: 6.3V 2A		£3.25
MINIATURE 200MA, 6-3V 1A, 2½ x 2½ x 2in		75p
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HEATER TRANS. 8-3V 3A		60p

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2A, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V. £2.25

1A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V £2.25

2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V £3.25

5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V £8.75

3A, 5, 8, 13V £1.90

3A, 5, 8, 10, 13V, 5-0-5V £1.20

3A, 5, 8, 10, 13V, 5-0-5V £1.30

3A, 5, 8, 10, 13V, 5-0-5V £1.50

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Input 200/250V for 6 or 12V. 1½A, £1.50; 2A, £1.50; 4A, £2.50.

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2/350V 14p	250/25V 14p	50+50/350V 35p
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16/450V 15p	1000/50V 47p	32+32/450V 33p
32/450V 20p	8+8/450V 18p	350+50/325V 50p
25/25V 10p	8+16/450V 20p	32+32+32/350V 43p
50/50V 10p	16+16/450V 25p	100+50+50/350V 48p
100/25V 10p	32+32/350V 25p	

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5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 85p.

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4 inputs speech and music, 4 way mixing. Response 10-30,000 c/s. Matches loudspeakers, 8-15 ohm. A.C. 200/250V. Separate Treble and Bass controls. £49 Post Free

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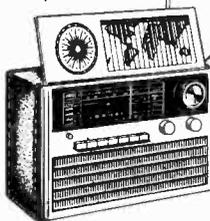
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WEATHERBAND. Frequency ranges: MW 240-1600kHz, FM 88-108MHz, Airband 108-145 MHz, VHF 145-175 MHz, 23 semiconductor, 12 transistors, 11 diodes and thermistors. Automatic frequency control. 31m telescopic aerial. Runs off mains a.c. 230/250V or off 4 U11 batteries, or use re-chargeable nickel alkali cell. Finished in strong leather grained case with carrying handle. Approx. size 10 1/2 in x 6 1/2 in x 3 1/2 in. Written guarantee. Special magnetic ear-piece for personal listening, dry batteries free. HURRY! Limited quantity only from Sonic Sound.

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Speaker Matching 3-8-16Ω
Example: 16Ω speaker to 8Ω
amplifier. 90p plus 20p p. & p.

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Bridge rectifier—200 P.I.V., 2.0A,
50p

Transistor sockets—7p
D.I.L. I.C. sockets—14 pin, 20p;
16 pin, 20p
IN4001—50 P.I.V., 1.0A, 6p
IN4002—100 P.I.V., 1.0A, 7p
IN4003—200 P.I.V., 1.0A, 8p
IN4004—400 P.I.V., 1.0A, 9p
IN4005—600 P.I.V., 1.0A, 12p

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with lids and screws
Type L, W, D, Price p. & p.
GB7 * 5 1/2in 2 1/2in 1 3/8in 38p 15p
GB8 * 4in 4in 1 3/8in 38p 15p
GB9 * 4in 2 1/2in 1 1/8in 38p 13p
GB10 * 5 1/2in 4in 1 3/8in 44p 18p
GB11 4in 2 1/2in 2in 38p 13p
GB12 3in 2in 1in 33p 13p
GB13 6in 4in 2in 52p 18p
GB14 7in 4in 2 1/2in 62p 19p
GB15 8in 6in 3in 81p 26p
GB16 10in 7in 3in 92p 26p
* These sizes fit standard veroboards



EQUIPMENT CASES

in plain aluminium with sloping front panel.
Type H, W, D, Price p. & p.
SF1 2in 5 1/2in 2in 45p 12p
SF2 2in 7 1/2in 3 1/2in 60p 16p
SF3 2in 9 1/2in 4 1/2in 75p 19p
Stove - enamelled silver-grey hammer finished, 25p extra.



CONSOLE CASES

in plain aluminium, ideal for mixers, instruments, etc.
Type W, A, B, C, D Price p. & p.
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GB20 8 9 3 1/2 2 3 £1.42 30p
GB21 10 9 3 1/2 2 3 £1.58 30p
GB22 12 9 3 1/2 2 3 £1.72 30p



VEROBOARD

Size matrix matrix
2 1/2in x 3 1/2in 22p 16p
2 1/2in x 5in 24p 25p
3 1/2in x 3 1/2in 24p 25p
3 1/2in x 5in 27p 25p
1 7/8in x 2 1/2in 75p 57p
1 7/8in x 3 1/2in £1 75p
Pins—either size, packet of 36, 18p

ELECTROLYTICS

1μF 450V	18p	1,000μF 25V	27p
2μF 450V	20p	1,000μF 50V	42p
4μF 350V	14p	2,000μF 25V	39p
8μF 450V	17p	2,000μF 50V	53p
16μF 450V	18p	2,500μF 25V	45p
25μF 25V	7p	2,500μF 50V	60p
25μF 50V	10p	3,000μF 25V	48p
32μF 450V	27p	5,000μF 25V	60p
50μF 50V	10p	5,000μF 50V	£1.10
100μF 25V	10p	8-8μF 450V	18p
100μF 50V	11p	8-16μF 450V	20p
250μF 25V	14p	16-16μF 450V	27p
250μF 50V	17p	16-32μF 450V	63p
500μF 25V	18p	32-32μF 450V	49p
500μF 50V	25p	50-50μF 350V	38p

MINIATURE ELECTROLYTICS

1μF 63V	6p	47μF 16V	7p
2.2μF 63V	6p	47μF 25V	6p
3.3μF 63V	6p	68μF 16V	6p
4.7μF 63V	6p	100μF 10V	6p
8μF 40V	7p	220μF 16V	7p
10μF 25V	6p	330μF 16V	11p
10μF 64V	7p	470μF 10V	11p
16μF 40V	7p	1,000μF 16V	19p
33μF 16V	6p	1,500μF 16V	23p

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PU12 Power unit for connection to 12V + or - E car electrical systems, giving 7 1/2V, stabilised output. **£3.25**

PU14 As above but switched for 6V, 7 1/2V or 9V output. **£5.10**

PP75 Mains power supply, output 7 1/2V d.c. **£1.95**

All units are complete with cable and plug.

CASSETTES

Top quality British made, low noise, complete with transparent library cases—C60—40p; C90—55p; C120—70p

BATTERY ELIMINATORS

suitable for transistor radios and similar light current equipment
PP6 Input 240V a.c. Output 6V d.c.
PP9 Input 240V a.c. Output 9V d.c.
Price £1.50 plus 12p p. & p.

ILLUSTRATED CATALOGUE

Post Free 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

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

SWITCHES

Toggle switches, standard size.
SW20—S.P.S.T. 18p; SW21—D.P.D.T. 23p.
Push Button, miniature, SW1—13p.
Wafer switches (rotary)—24p each.
SW4—1 pole, 12 way. SW5—2 pole, 6 way.
SW6—3 pole, 4 way. SW7—4 pole, 2 way.
SW8—4 pole, 3 way.

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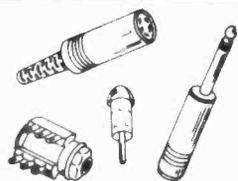
PLUGS

Car aerial 14p
Co-axial 9p
D.I.N. 2 pin (speaker) 10p
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 9p

Jack, 2 1/2mm unscreened 10p
Jack, 2 1/2mm screened 10p
Jack, 3 1/2mm unscreened 8p
Jack, 3 1/2mm screened 12p
Jack, 4 pin unscreened 12p
Jack, 4 pin screened 20p
Jack, stereo, unscreened 20p
Jack, stereo, screened 20p
Phono, plastic top 13p
Phono, plated metal 12p
Wander, red or black 3p
Banana 4mm, red or black 6p

LINE SOCKETS

Car aerial 14p
Co-axial 9p
D.I.N. 2 pin (speaker) 17p
D.I.N. 3 pin 16p
D.I.N. 5 pin, 180° 16p
D.I.N. 5 pin, 240° 15p
Jack, 3 1/2mm 15p
Jack, 4 pin screened 49p
Jack, stereo, screened 34p
Phono, plated metal 14p



SOCKETS

Car aerial 8p
Co-axial, surface 8p
Co-axial, flush 9p
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, 2 1/2mm 9p
Jack, 3 1/2mm 10p
Jack, 4 pin unscreened 15p
Jack, 4 pin 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

CAPACITORS

2.2pF	500V	S/M	7p	0.0027μF	500V	S/M	15p
3.3pF	500V	S/M	7p	0.003μF	500V	Cer.	5p
5pF	500V	S/M	7p	0.0033μF	1,25V	P.S.	6p
10pF	125V	P.S.	5p	0.0033μF	500V	Poly.	6p
10pF	500V	S/M	7p	0.0033μF	1,000V	MDC	6p
15pF	125V	P.S.	5p	0.0036μF	500V	S/M	15p
15pF	500V	S/M	7p	0.0047μF	125V	P.S.	9p
18pF	500V	S/M	7p	0.0047μF	500V	Poly.	6p
22pF	125V	P.S.	5p	0.0047μF	500V	S/M	20p
22pF	500V	S/M	7p	0.0047μF	1,000V	MDC	6p
22pF	500V	S/M	7p	0.005μF	100V	Mylar	3p
25pF	500V	S/M	7p	0.005μF	500V	Cer.	5p
27pF	500V	Cer.	4p	0.0068μF	125V	P.S.	10p
33pF	125V	P.S.	5p	0.0068μF	500V	S/M	10p
33pF	500V	S/M	7p	0.0068μF	500V	Poly.	6p
39pF	500V	S/M	7p	0.0082μF	125V	P.S.	10p
47pF	125V	P.S.	5p	0.0082μF	500V	S/M	30p
47pF	500V	Cer.	4p	0.01μF	18V	Disc	4p
50pF	500V	S/M	7p	0.01μF	125V	P.S.	10p
56pF	500V	S/M	7p	0.01μF	160V	Poly.	4p
68pF	125V	P.S.	5p	0.01μF	250V	M.F.	3p
68pF	500V	S/M	7p	0.01μF	400V	Poly.	3p
75pF	500V	S/M	7p	0.01μF	500V	Cer.	5p
82pF	500V	S/M	7p	0.01μF	500V	S/M	30p
100pF	125V	P.S.	5p	0.01μF	600V	MDC	7p
100pF	500V	S/M	7p	0.015μF	1,000V	MDC	9p
100pF	500V	Cer.	5p	0.015μF	400V	Poly.	3p
120pF	500V	S/M	7p	0.02μF	100V	Mylar	3p
150pF	125V	P.S.	5p	0.022μF	18V	Disc	5p
150pF	500V	S/M	7p	0.022μF	250V	M.F.	3p
150pF	500V	Cer.	5p	0.022μF	400V	Poly.	3p
180pF	500V	S/M	7p	0.022μF	600V	MDC	7p
200pF	500V	S/M	7p	0.022μF	1,000V	MDC	10p
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
56pF	500V	S/M	8p	0.1μF	600V	MDC	10p
680pF	125V	P.S.	6p	0.1μF	1,000V	MDC	14p
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	M.F.	8p
0.001μF	1,000V	MDC	6p	0.47μF	400V	Foil	15p
0.0015μF	400V	Poly.	3p	0.47μF	1,000V	MDC	25p
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				
0.002μF	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 2 1/2% tol.
MDC—a.c. rating = 300V.
M.F.=Mullard min. foil.
Cer.=ceramic.

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UNMARKED UNTESTED PAKS			
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Hex. Inverter,	BMC936	12p	11p	10p
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Hex. Inverter,	BMC940	12p	11p	10p
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Dual J/K Flip Flop,	BMC952	20p	18p	16p
Dual J/K Flip Flop,	BMC953	20p	18p	16p
Dual J/K Flip Flop,	BMC954	20p	18p	16p
Quad. 2-input Power,	BMC955	20p	18p	16p
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3/3-input NAND Gate,	BMC961	12p	11p	10p
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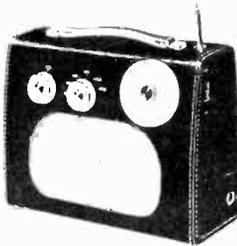


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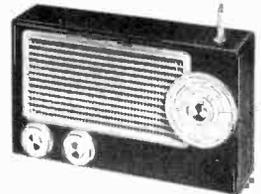


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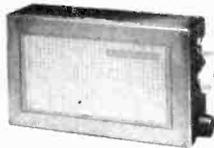
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POCKET FIVE



8 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5 1/2in X 1 1/2in X 3 1/2in. Easy build plans and parts price list 10p (FREE with parts).

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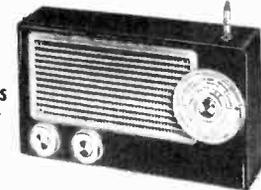


5 TRANSISTORS AND 2 DIODES

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Make this fascinating three channel unit from a kit which contains all the components needed to produce a reliable and entertaining display. Takes its drive from the speaker terminals of a record player, tape recorder or portable transistor radio. Will produce a brilliant 2kW of light using normal 240V lamps. All components with full step-by-step instructions £9-45

RESISTORS		VOLUME CONTROLS	
10% Carbon, E12 values,		Small size, LOG or LIN	
10-10M, 1/2W	1 1/2p	5, 10, 25, 50, 100, 250, 500k Ω	
1W	3p	1M Ω	
5% Hystab, E24 values,		Only 16p each	
10-1M, 1/2W	2 1/2p		
1W	3 1/2p		
2% M.O. E24 values,			
10-1M, 1/2W	4p		

CAPACITORS	
Tantalum—μF/V:	0 1/35, 0 22/35, 0 47/35, 1/35, 2-2/35, 4-7/35, 10/63, 10/25, 10/16, 22/16, 47/16 3, 100/3.
All at one price	17p
Moulded Polyester 250V:	0 01, 0 022, 0 033, 5p; 0 047, 0 068, 0 1, 7p; 0 22, 10p; 0 33, 12p; 0 47, 15p; 0 68, 18p; 1 0, 22p; 2 2, 35p
Printed Circuit Electrolytic—μF/V:	0 47/63, 1 0/63, 2 2/63, 4 7/40, 10/63, 22/40, 7p; 47/40, 10p; 100/63, 13p; 100/10, 7p; 220/40, 470/16, 13p; 1,000/16, 15p.

FIXED VOLTAGE REGULATORS	
TO3 case, Gives stabilised supply, MVR 5V, MVR 12V, MVR 15V.	
All at £1-50.	

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AC107	28p	AD149	47p	BC169	22p	OC72	19p
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AC128	20p	BC109	12p	BFY51	23p	2N2926	13p
AC132	19p	BC147	20p	OC28	52p	AD161	75p pr
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Approximate size: 12in x 8in. Bargain at only 25p per board.	

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2 1/2in x 3 1/2in	0 1	Freezer	60p
3 1/2in x 5in	0 15	Contact Fluid	75p
	20p	Insulating Lacquer	80p
	16p		
	24p		

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Patents Pending. 12 volt only—state pos. or neg. earth. Capacitive discharge ignition is recognised as being the most efficient system and will give you:
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★ Increased Battery Life
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Kit includes absolutely everything for assembly: Case, Cables, Coil Connectors, Silicon Grease, etc. 8 page illustrated instructions cover fitting of all types of tachometers. Call for a workshop demonstration. S.A.E. all enquiries please, or Phone 33652. (Many letters from satisfied customers.)
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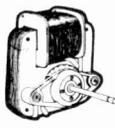
Complete with baseplate and screws

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Type No.	L	W	D	Price	P. & P.
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8*	4	4	1 1/2	25p	15p
9*	4	2 1/2	1 1/2	25p	13p
10*	5 1/2	4	1 1/2	29p	18p
11	4	2 1/2	2	25p	13p
12	3	2	1	22p	13p
13	6	4	2	35p	18p
14	7	5	2 1/2	42p	19p
15	8	6	3	54p	26p
16	10	7	3	61p	26p

* These sizes accept standard veroboard range. Nos. 12 to 16 available 15th January onwards.

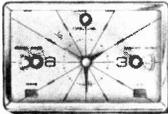
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MAINS MOTOR
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MINIATURE WAFER SWITCHES
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Learn in your sleep! Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£1-95 + 20p** p & p with glass front chrome bezel 75p extra.



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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 5A, 10A or 15A—*simply fit in place of switch.*

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Each kit comprises seven items—Choke, 2 tube ends, starter, holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20W, **£1**. Kit B—30-40W, **£1**. Kit C—80W, **£1-20**. Kit E—65W, **£1-20**. Kit F for 8ft 125W tube **£1-75**. Kit MF1 is for 6in, 9in and 12in miniature tubes, **£1**. Kit MF2 for 21in 13W miniature tube, **£1**. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.



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26 yards length 70W. Self-regulating temperature control. 50p post free.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP5, PP7, PP9 and others. Kit comprises: mains transistor, transformer, smoothing and load resistors, condensers and instructions. Real snip at only **£1-00**, plus 20p postage.

THERMOSTATS

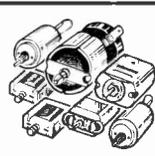
Type "A" 15A for controlling room heaters, greenhouses, airing cupboards. Has spindle for pointer knobs. Quickly adjustable from 30-38 deg. F. 48p. Type "B" 10A. This is a 17in long rod type made by the famous Sunvic Co. Spindle adjusts this from 30-50 deg. F. Internal screw alters the setting so this could be adjustable over 30 deg. to 1,000 deg. F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-at or fire alarm. 50p plus 12p post and insurance. Type "C". Simply clamp to tank, pipe, heatsink, casing. Break temperature adjustable by calibrated knob 70p. Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 23A. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16yd) 50p is wound round the pipes. 28p. P. & P. 5p. Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 50p plus 5p post.

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Long and medium wave, 7 transistor, size 6in x 4in x 1 1/2in with larger than usual speaker giving very good tone. Built-in ferrite aerial and telescopic aerial for distant stations. A real bargain complete with leather case, carrying sling, earplug and case. **£3-75** plus 25p post and ins.

THE REMITONE TRANSISTOR

Medium wave pocket loudspeaker radio. Loud and with good tone will make wonderful present. Buy while stocks last. Full money back guarantee. **£1-99** Only.



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A bargain parcel of 7 motors for **£1**. Some not as large as a postage stamp and only 7in thick, largest is 1 1/2in x 1 1/2in dia. Some work off 1 1/2V some as high as 18V. These motors are used in racing cars, power toys, etc. The largest is so powerful that it will drive a Mini-drill, model lathe, or similar. This is a 4 pole motor, optimum working 16.5V but very powerful even as low as 4 1/2V. Don't miss this wonderful snip.

COMPUTER TAPE

2,400ft of the Best-Magnetic Tape money can buy—users claim good results with Video and sound. 1in wide **£1-00** plus 30p post and insurance, with cassette, 1in wide **£1-00** plus 30p post and insurance with cassette. 1in wide **80p** plus 30p post and insurance with cassette. Spare spools and cassettes—1in 75p, 1in 75p each plus 20p post and insurance.

TANGENTIAL HEATER UNITS

This heater unit is the very latest type, most efficient and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Compact motor, impeller, 2kW element and 1kW element allowing switching 1 and 2 kW and with thermal safety cut-out. Can be fitted into any metal tin, case or cabinet. Only need control switch, **£3-50**. 2kW. Model as above except 2 kilowatts **£2-50**. Don't miss this. Control switch 35p. P. & P. 40p.

THIS MONTH'S SNIP

5 AMP VARIAC for £3

This heading is not quite accurate because it is not a variable transformer that we are offering but a solid state device which serves the same purpose in almost all applications and, of course, much smaller. Made by Ultra Electronics, can be fitted into ordinary switch box. Engrave a circle on the front plate, mark this off in divisions, fit a pointer knob, calibrate with your voltmeter (you will find the scale most accurate) you now have a power controller equal to a 5 amp variac costing £12 or more.

THYRISTOR LIGHT DIMMER

For any lamp up to 1kW. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2-95**, plus 20p post and insurance.

MULLARD UNILEX

This D.I.Y. Stereo Amplifier is still available complete at **£7** for the four Mullard Modules, or Modules can be bought separately as follows: 4W amp module (2 required) Mullard Ref. No. E.P.9000—**£1-65** each. Pre-amp module Mullard Ref. No. E.P.9001—**£1-60** each. Power module—Mullard Ref. No. E.P.9002—**£2-10** each. In addition and made to Mullard Specification we offer: Standard Control Unit with escutcheon—**£2-50** Knobs—Set of 4—50p.

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 external oscillator coil. 85p each. 10 for **£7-85**. 100 for **£22-50p**. With connection dia.

ATLAS TWENTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 2ft model, ideal kitchen, bedroom, hallway, porch, loft, etc. With tube assembled ready to instal, **£1-89**, plus P. & P. 30p and insurance.

STANDARD WAFER SWITCHES

Standard size 1 1/2in wafer—silver-plated 5-amp contact. standard 1/2in spindle 2in long—with locking washer and nut

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p							
2 poles	40p	40p							
3 poles	40p	40p							
4 poles	40p	40p	40p	70p	70p	70p	70p	85p	85p
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	£2-20	£2-20

POCKET BLEEPERS

These work on quite a low frequency, are carried in the pocket, and are mainly used in large buildings or areas so that key personnel can be contacted quickly. These contain two encapsulated circuits to energise the relay and cause the beep as well as rechargeable nickel cadmium cells. Quite costly things to buy. The ones we have are not new, but believed to be in good working order and sold on the understanding that if they are not, they will be replaced free. The size of the case, which is intended for carrying in top pocket, is approx. 4 1/2in long, 3in wide and 1 1/2in thick. Limited quantity at **£2** each.

9 VOLT BATTERY ELIMINATOR £1-00

PRESSURE SWITCH

We recently received a delivery of a very fine pressure switch made by Bailey & Mackey. Their type no. 108R. This is an elaborate switch and is adjustable to 16 p.s.i. but is set at 8 p.s.i. It has a reset button and is of very superior construction with a heavy brass body. We understand that the regular price of this is £12 and we have limited stocks offered at **£4-50** each.

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

POCKET CIRCUIT TESTER

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

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Marketed by British Relay under the name Luxitor. This is a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9 1/2in x 6 1/2in x 3 1/2in deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9V battery or an external 110V source. Speaker is an R-A elliptical 6in x 3 1/2in 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price **£3-50** each, 10 for **£21-50**. Post and insurance 20p.

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Size approx. 6 1/2in x 3 1/2in x 2in deep with brass inserts in four corners. This is a very strong case suitable for house instruments and special rigs, etc. Price 45p each, post 10p extra.

TELEPHONES

Complete as illustrated. Save your legs, time and temper, simply by putting in some telephones. Ex. G.P.O. not new—but guaranteed in good condition and serviceable. Supplied with diagram and instructions showing how to connect. Price 75p each + 50p post or 2 for £2 post paid.

Also available separately, dials and handsets 50p each + 20p post.

ROCKER SWITCH

13A self-fixing into an oblong hole. size approximately 1 1/2in x 1 1/2in 6p each. 10 for 72p.

SLIDE SWITCHES

Slide Switch. 2-pole changeover pane mounting by two 6BA screws. Size approx. 1 1/2in x 1 1/2in rated 250V 10A. 10 for 54p, 100 for £5-10, 500 for £24. Ditto as above but printed circuit 5p each. 10 for 45p, 100 for £4-25. Sub Miniature Slide Switch. DFDT 19mm (1in approx.) between fixing centres. 18p each or 10 for £1-08. SP Change over spring return 250V 1A. 10p.

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Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits 40p each, plus paid. Special price for all 8 kits £3 with free balance kit.

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- KA7 Electro-Magnet Kit.** Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.
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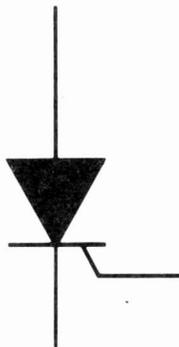
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Please quote reference 2373/PE on both envelope and letter.



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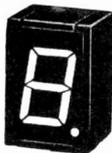
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28 pin DIL 12/24 hr. 4 1/2 digit, £11.50, data 8p. Kit £21. Indicators £1.29 ea. PCB £1.69. Case 38p. **PW ELECTRONIC CAR IGNITION KIT.** £6.67.

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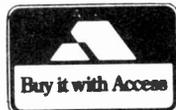
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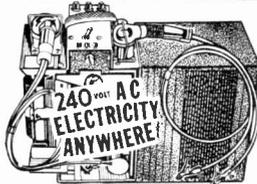
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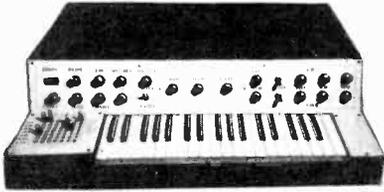
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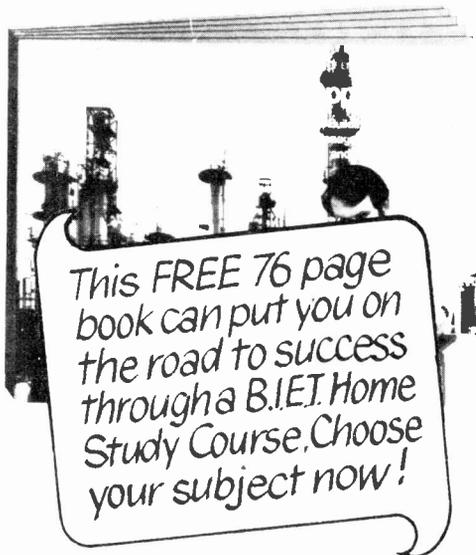
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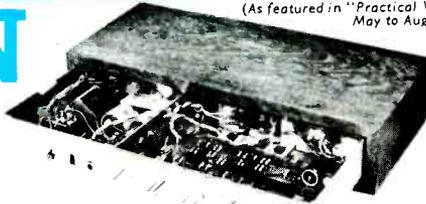


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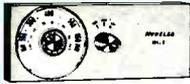
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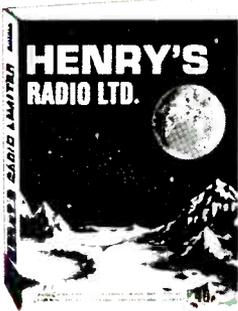
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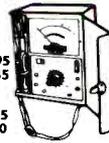
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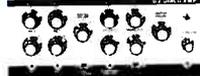
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