PRACTICAL

ELECTRONICS

NOVEMBER 1974

25p

PE MINISONIC

miniature battery operated sound synthesiser

Inexpensive • Easy to build

... STARTS THIS MONTH

PRACTICAL
ELECTRONICS

VOLUME 10 No. 11 NOVEMBER 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

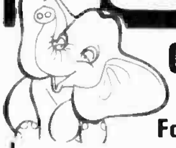
NEWS AND COMMENT

Our December issue will be published mid-November. This issue will be in large demand and readers are advised to place an order with their Newsagent NOW!

Henry's

TRANSISTORS, VALVES AND SEMI-CONDUCTOR DEVICES · ANY QUANTITIES
UK'S LARGEST STOCKISTS

FREE NEW '74/75 SEMI-CONDUCTOR AND VALVE LISTS Ref No. 36 on request



CASH & CARRY PRICES
For CALLERS or BY POST

(GB carr/Pack 15p per item)

Ref. No.		Price £ p
1	D1203 Telephone amplifier—suction	4·95
2	D1201 Telephone amplifier—cradle	7·50
3	T1206 2 station intercom	4·95
4	T1306 3 station intercom	9·95
5	T1406 4 station intercom	12·50
6	TAIA 2 station telephones intercom	13·50
7	W12 2 station wireless intercom	18·20
8	DP303 Door phone intercom	7·00
9	PK3 ETCH your own printed circuits	2·25
10	EA41 Reverberation amplifier	11·75
11	U550 Ultrasonic switch	12·75
12	XP4002 Photoelectric alarm system	13·50
13	Solid state tachometer	11·30
14	Power dash transistor assisted ignition	13·50
15	Car auto lock	2·75
16	4A 6–12V battery charger	4·85
17	FF21 Car radio/tape quad adaptor	4·68
18	Fully disappearing car aerial	2·00
19	Electric disappearing car aerial	7·80
20	ET (F1009) Morse code key/buzzer	1·70
21	VH105 Aircraft band converter	4·50
22	LM300 50K Disco mic.	12·95
23	DF50B 50K Communications mic.	5·75
24	Car lighter plug 1W voltage adaptors 300mA (each) (state 6/7½/9V)	1·95
25	STC Time delay module	1·50
26	Gravenire 931A photo-electric unit (with data)	3·50
27	3 cw. 3×500W sound to light	21·50
28	3 cw. 3 × 1,000W sound to light + override	41·25
29	150W light display projector with wheel	23·50
30	MM1 (BZ005) 4 channel 9V mixer	4·20
31	MX100 deluxe 4 channel mixer	8·78
32	H67(G1320) Stereo headphone amplifier	10·50
33	MP12 6–CH Slider control mixer	27·95
34	RE208 Stereo phone adaptor	2·25
35	MD802 Stereo phones	2·20
36	CIS200 Stereo phones	2·75
37	CIS250 Stereo phones	6·50
38	G1301 and G1305 Stereo phone controls	2·95
39	Car stereo speakers in pods. Special offer (pair)	2·95
40	Crystal lapel microphone	0·60
41	E1052 Car speakers front/rear fadar	1·00
42	Bib groove clean (Ref. No. 42)	1·76
43	Bib Record care kit (Ref. No. 43)	2·20
44	Bib cassette recorder care kit (Ref. No. 26A)	1·96
45	Bib cassette tape splicing kit (Ref. No. 24)	1·64
46	BASF reel-reel hobby box	2·40
47	2000 OHM Headphones	1·50
48	4000 OHM Headphones	1·55
49	Cassette recorder mic. (2½mm & 3½mm plugs)	1·85
50	420 ES Microscope	5·70
51	UP050 Low cost 9V eliminator	2·25
52	RE 527 Tape head	1·70
53	Cambridge pocket calculator	17·95
54	BC808 Percentage pocket calculator	21·95
55	BC817 Memory pocket calculator	28·95
56	BCM850 Percentage and memory calculator	33·25
57	Sinclair scientific calculator	27·20
58	Sinclair Cambridge Memory	23·95
60	Antex soldering iron kit (SKI)	3·30
61	Bib record care kit (Ref. No. 59)	1·17
62	5pc Chassis punch kits	5·50
63	Longs desoldering tool	5·50
64	1A in line mains suppressors	2·50
65	BSS2 (E1013) 7 way stereo speaker switch	2·20
66	Weller 8200D—PK expert gun kit	8·20
67	"S" Dec breadboard	1·98
68	"2" Dec breadboard	4·29
69	"4" Dec breadboard	7·50
70	"T" Dec breadboard	3·65
71	Instant head soldering gun	2·30
72	40W soldering iron	1·90

ELECTRONIC COMPONENTS AND EQUIPMENT

More selection—bigger stocks of electronic components and equipment for supply purposes. Let us quote for your requirements. (Please enclose large SAE with all enquiries)

BUILD IT YOURSELF

MW/LW portable radio £7·98 (P. & P. 32p). MW/LW radio tuner £5·25 (P. & P. 20p). 9V regulated power supply £2·15 (P. & P. 15p). 15W inverter £5·20 (P. & P. 30p). 40W inverter £6·60 (P. & P. 40p). Sinclair micromatic radio £2·25 (P. & P. 15p). Sinclair Cambridge Calculator £13·84 post paid.

MULTI-KITS

Ready to use and use again.

Educational and practical.

All transistor circuits with full handbacks.

10 in 1 10 projects £5·95 (post 20p).

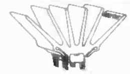
50 in 1 50 projects £13·95 (post 25p).

150 in 1 150 projects £21·50 (post 30p).

Radionic X 20 20 (Elec.) projects £4·95 (post 20p).

Radionic X 40 40 (Radio) projects £9·45 (post 20p).

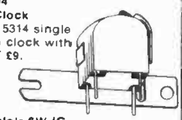
ELECTRONIC COMPONENTS



Ceramic Filters
Miniature 10·7 mHz filters 40p pair.

IC IF Unit
CA3089 10·7 MHz IC £2·94

IC Clock
MM 5314 single chip clock with CCT £9.



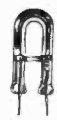
Sinclair 6W IC
IC12 with data and PC board £2·10.

Radio IC Chip
ZN414 Radio IC with circuit £1·20.

Stereo Cassette Tape Head
Replacement for most recorders £2·00

Ultrasonic transducers
With data/circuits £5·90 pair.

Strobe tubes
ZFT8A (similar to 4A) £4.
ZFT12A £5.



7 segment indicators
3015F with data £1·70 each.

(Post/Packing 15p per 1–6 items G.B. unless stated)

Spring delay units
HP42 9in twin spring £3·30 (P. & P.) 20p. HR1 6in twin spring £6·85 (P. & P.) 25p.

Fibre optics
0·01in dia. mono filament £5·50 per 100 metres. 0·13in dia. 64 fibres £1 per metre. 15mm dia. mares tails £10·50 each.

Radio Control XTALS
Matched pair for 465 kHz IF £2 pair for all superhet trans. RX's.

Handsets
Lightweight telephone handsets brand new complete with diagrams for intercoms. £3 pair.

MARRIOT TAPE HEADS
4 Track Mono or
2 Track Stereo

"17" High Impedance	£2·50
"18" Med Impedance	£3·50
"36" Med. Impedance	£5·00
Erase Heads for "17" "18" and "36"	£1·00
"63" 2 track mono. High imp.	£1·75
"43" Erase Head for "63"	75p

(Post, etc., 15p any quantity.)

QUALITY CASSETTE TAPES

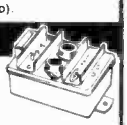
"Living Sound" made specially for Henry's by EMP Tapes Ltd. 5 screw type with library case. Post paid (G.B.).

	£ 3 for	£ 6 for	£ 10 for	£ 25 for
C60	1·10	2·00	3·15	7·50
C90	1·47	2·85	4·65	11·37
C120	1·83	3·54	5·60	14·00

SPECIAL OFFER CASSETTE STORAGE

Rotating unit up to 32 cassettes stackable £3·60 (P. & P. 15p). Car unit with bracket for 10 cassettes £2·80 (P. & P. 10p).

AMTRON KITS



Model No.		£ p
127	Noise reduction unit	£9·55
707	Windscreen wiper timer	£7·97
157	Private TV loop trans.	£4·95
525C	120–160 mHz VHF tuner	£11·31

		£ p
310	Radio control receiver	£3·29
300	4-channel R/C transmitter	6·61
345	Superhet R/C receiver	6·61
65	Simple transistor tester	1·66
115	8 watt amplifier	4·50
120	12 watt amplifier	4·73
125	Stereo control unit	6·61
130	Mono control unit	4·16
605	Power supply for 115	5·31
610	Power supply for 120	5·31
615	Power supply for 2 x 120	6·64
230	AM/FM aerial amplifier	3·29
240	Auto packing light	6·90
275	Mic. preamplifier	6·98
570S	LF generator 10Hz–1mHz	21·45
575S	Sq. wave generator 20Hz–20Khz	19·77
590	SWR meter	9·47

		£ p
630	STAB Power supply 6–12V 0·25–0·1A	9·24
690	DC motor speed Gov.	3·31
700	Electronic Chaffinch	7·92
760	Acoustic switch	12·57
780	Metal Detector (electronics only)	10·91
790	Capacitive Burglar alarm	7·92
835	Guitar preamp.	4·99
840	Delay car alarm	6·99
875	CAP Discharge ignition for car engine (-Ve Earth)	13·19
80	Scope Calibrator	2·65
255	Level indicator	6·98
525	120–160mHz VHF timer	11·31
715	Photo cell switch	8·97
795	Electronic continuity tester	4·97
860	Photo timer	15·51
235	Acoustic Alarm for driver	8·61
465	Quartz XTAL checker	9·90
220	Signal Injector	2·65
390	VOX	13·82
432	Testakit	21·83
670	Buffer Battery Charger	7·59
850	Electronic Keyer	16·37

TEST EQUIPMENT
MULTI-METERS

(Carr./packing 35p)	£
U4324 20k/V with case	9·25
U435 20k/V with steel case	8·75
U4313 20k/V with steel case	12·50
U4317 20k/V with case	16·50
U4341 33k/V plus transistor tester steel case	10·50
U4323 20k/V plus 1kHz 465kHz OSC with case	7·70
ITI–2 20k/V slim type	5·95
THL33D (L33DX) 2k/V Robust	7·50
TP5SN 20k/V (Case £2)	8·25
TP10S 2k/V	6·25
TW20S 20k/V	10·00
TW50K50k/V	11·25
EP10KN 10k/V	9·95
AF105 50k/V Deluxe (case £1 90)	12·50
S100TR 100k/V Plus transistor tester	22·50

GENERAL TEST EQUIPMENT

(† Carr./packing 50p. * Carr./packing 30p) unless stated.

NEW REVOLUTIONARY SUPERTESTER 680R £
680R Multi-tester 18·50

NEW REVOLUTIONARY SUPERTESTER 680R	£
680R Multi-tester	18·50
Accessories	
Transistor tester	11·00
Electronic voltmeter	18·00
Ampclamp	11·95
Temperature probe	11·95
Gauss meter	11·95
Signal injector	5·95
Phase sequence	5·95
EHT probe	5·95
Shunts 25/50/100A	4·50
†3100 IMA Strip chart recorder	44·00
†Tk40 AC Multivoltmeter	19·75
†Tk15 Grid dip meter 440kHz–28mHz	19·95
†Tk65 28 Range valve voltmeter	22·50
†Tk20D RF Generator 120kHz–500mHz	18·95
†Tk22D AF Generator 20Hz–200kHz	19·95
*HM350 In circuit transistor tester	19·50
*C3025 Deluxe meter 1–300mHz	6·95
*TT145 Compact transistor tester	14·75
†G3–36 R/C osc. 20Hz–200kHz	19·75
*C3042 SWR Meter	5·75
*SE350A Deluxe signal tracer	12·95
*SE400 Mini-lab. all in one tester	15·50
C1–5 Scope 500,000kHz (carr. £1)	43·00
*C3043 5 CH F/A meter 1–300mHz	5·75
Resistance sub box (post. etc.)	2·40
Capacitor (20p)	2·10
2A variable transformers (carr. £1)	6·55
Radio activity counter 0–10r (carr. £1)	9·97
Mains unit for above (carr. 50p)	3·75

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Without doubt U.K.'s best range of modular and complete equipment. Lighting, mixing, microphones, accessories, speakers, amplifiers, lenses, etc., etc.

FREE stock lists (Ref. No. 18) on request. CALL IN AND SEE FOR YOURSELF at Henrys Disco Centre, 309 Edgware Road. Tel. 01-723 6963.

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ALL PRICES INCLUDE VAT

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10E12 ¼W KIT: 10 of each E12 value, 22 ohms—1M, a total of 570 (CARBON FILM 5%). £3·65 net
10E12 ½W KIT: 10 of each E12 value, 22 ohms—1M, a total of 570 (CARBON FILM 5%). £3·85 net
25E12 ¼W KIT: 25 of each E12 value, 22 ohms—1M, a total of 1425 (CARBON FILM 5%). £8·35 net
25E12 ½W KIT: 25 of each E12 value, 22 ohms—1M, a total of 1425 (CARBON FILM 5%). £8·45 net
5E12 ¼W KIT: 5 of each E12 value, 10 ohms—1M, a total of 305 (METAL FILM 5%). £2·85 net
PLEASE NOTE: DUE TO CURRENT WORLD SHORTAGES THESE KITS MAY TEMPORARILY CONTAIN BOTH WATTAGE AND VALUE SUBSTITUTIONS.

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. Mounting: 0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, 3½p. 0·068µF, 0·1µF, 4½p. 0·15µF, 4½p. 0·22µF, 5½p. 0·33µF, 8p. 0·47µF, 9p. 0·68µF, 12p, 1µF, 15p. 1·5µF, 23p. 2·2µF, 26p.

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 2½p. 0·0047µF, 3p. 0·0068µF, 0·01µF, 0·015µF, 0·22µF, 0·033µF, 3½p. 0·047µF, 0·068µF, 0·1µF, 4½p. 0·15µF, 6½p. 0·22µF, 8½p. 0·33µF, 12p. 0·47µF, 14p.
160V: 0·01µF, 0·015µF, 0·02µF, 3p. 0·047µF, 0·068µF, 3½p. 0·1µF, 4½p. 0·15µF, 5p. 0·22µF, 5½p. 0·33µF, 6½p. 0·47µF, 8½p. 0·68µF, 12p. 1µF, 14p.

MINIATURE CERAMIC PLATE CAPACITORS
50V: (pF) 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1K, 1K5, 2K2, 3K3, 4K7, 6K8, (µF) 0·01, 0·015, 0·02, 0·033, 0·047, 2½p each. 0·1, 30V, 4½p.

POLYSTYRENE CAPACITORS 160V 5%.
(pF) 10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680, 1000, 1500, 2200, 3300, 4700, 10,000, 4½p.

RESISTORS
CF—High Stab Carbon Film 5%. MF—High Stab Metal Film, 5%.

W.	Type	Range	1-99	100-499	500-999	1000+	Size mm
⅛	CF	22-1M	1	0·75	0·60	0·55	2·4 × 7·5
¼	CF	22-2M2	1	0·75	0·60	0·55	3·9 × 10·5
½	CF	22-1M	1	0·75	0·60	0·55	5·5 × 16
¼	MF	10-2M7	2	1·54	1·32	1·1	3 × 7
½	MF	10-2M2	2	1·43	1·21	0·99	4·2 × 10·8
1	MF	10-10M	3	1·98	1·81	1·65	6·6 × 18
2	MF	10-10M	4·5	3·52	3·08	2·75	8 × 17·5

For value mixing prices, please refer to our catalogue (price in pence each).
VALUES AVAILABLE—E12 Series only. Net prices above 100.

PRESET SKELETON POTENTIOMETERS
MINIATURE 0·25W Vertical or horizontal 6p each 1K, 2K2, 4K7, 10K, etc. up to 1MΩ
SUB-MIN. 0·05W Vertical. 100Ω to 220KΩ 5p each

Wavechange Switches
1P, 4W; 1P, 12W; 2P, 2W; 2P, 4W; 2P, 6W; 3P, 3W; 4P, 2W; 3P, 4W; 4P, 3W, 30p

B. H. COMPONENT FACTORS LTD.

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Tel.: Cheddington 668446 (Std. Code 0296)
CATALOGUE No. 3 20p.

Miniature Mullard Electronics

1·0µF	63V	6½p	68µF	16V	6½p
1·5µF	63V	6½p	68µF	63V	12p
2·2µF	63V	6½p	100µF	10V	6½p
3·3µF	63V	6½p	100µF	25V	6½p
4·0µF	40V	6½p	100µF	63V	14p
4·7µF	63V	6½p	150µF	16V	6½p
6·8µF	63V	6½p	150µF	63V	15p
8·0µF	40V	6½p	220µF	6·4V	6½p
10µF	25V	6½p	220µF	10V	6½p
10µF	63V	6½p	220µF	16V	8p
15µF	16V	6½p	220µF	63V	21p
15µF	63V	6½p	330µF	16V	12p
16µF	40V	6½p	330µF	63V	25p
22µF	25V	6½p	470µF	6·4V	9p
22µF	63V	6½p	470µF	40V	20p
32µF	10V	6½p	680µF	16V	15p
33µF	16V	6½p	680µF	40V	25p
33µF	40V	6½p	1000µF	16V	20p
32µF	63V	6½p	1000µF	25V	25p
47µF	10V	6½p	1500µF	6·4	15p
47µF	25V	6½p	1500µF	16V	25p
47µF	63V	6½p	2200µF	10V	25p
			3300µF	6·4	26p

VEROBOARD	0·1	0·15
2½ × 5"	36p	36p
2½ × 3¾"	33p	25p
3¾ × 5"	42p	46p
3¾ × 3¾"	36p	36p
2½ × 1"	9p	9p
2½ × 5" (Plain)	—	19p
2½ × 3¾" (Plain)	—	16p
5 × 3¾" (Plain)	—	29p
Insertion tool	73p	73p
Track Cutter	56p	56p
Pins, Pkt. 50	22p	22p

TRANSISTORS

AC126	16½p	BC212L	12p
AC128	22p	BC213L	12p
BC107	11p	BC214L	17p
BC108	12p	OC44	18p
BC109	13p	OC71	13p
BC148	12p	OC81	16p
BC149	12p	OC170	23p
BC182L	12p	TIS43	33p
BC183L	12p	2N2926	11p
BC184L	13p	2N3702	11p

POTENTIOMETERS
Carbon Track 5KΩ to 2MΩ, log or lin. Single, 16½p. Dual Gang 46p. Log Single with Switch 26p. Slider Pots, 10K, 100K, 500K. 30mm, 34p. 45mm, 47p. 60mm, 55p.

DIODES	
1N4001	6½p
1N4002	7½p
1N4003	9p
1N4004	9½p
1N4005	12p
1N4006	14p
1N914	7p
1N916	7p
BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

PLUGS	
DIN 2 Pin	12p
3 Pin	13p
5 Pin 180°	16p
Std. Jack	20p
2·5mm Jack	13p
Phono	6p

SOCKETS	
DIN 2 Pin	10p
3 Pin	10p
5 Pin 180°	12p
Std. Jack	15p
2·5mm Jack	13p
Phono	6p

ELECTROLYTIC CAPACITORS. Tubular & Large Cans (µF/V): 1/25, 2/25, 4/25, 4·7/10, 5/25, 8/25, 10/10, 10/50, 16/25, 22/63, 25/25, 25/50, 32/25, 50/25, 100/10, 100/25, 6½p. 50/50, 8p. 100/50, 200/25, 11p. 250/50, 18p. 500/10, 11p. 500/25, 15p. 500/50, 18p. 1000/10, 15p. 1000/25, 22p. 1000/50, 40p. 2000/10, 20p. 1000/100, 90p. 2000/25, 30p. 2000/100, 95p. 2500/25, 38p. 2500/50, 62p. 3000/50, 80p. 5000/25, 66p. 5000/50, £1·10.
HI-VOLT: 8/350, 19p. 16/350, 22p. 32/350, 33p. 50/250, 20p. 100/100, 20p. 100/250, 30p. 4/450 14p. 16/450 23p.

METALLISED PAPER CAPACITORS
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500V: 0·025, 0·05, 6p. 0·1, 6p. 0·25, 7½p. 0·5, 9p.
1000V: 0·01, 11p. 0·022, 13p. 0·047, 0·1, 15p. 0·22, 23p. 0·47, 28p.

Integrated Circuits	
µA709C	50p
µA741C	55p
µA723C	£1
ZN414	£1·32

Screened Wire, Metre	6½p
Twin Screened Wire, Metre	12p
Stereo Screened Wire, Metre	12p
Connecting Wire, All colours, Metre	2½p
Neon Bulb, 90V Wire Ended	5 for 24p
Panel Neon, 240V, Red, Amber, Clear	16½p

NEW CAPACITOR KITS — Please send for List

NOTE: ALL STOCK ADVERTISED IS SUBJECT TO AVAILABILITY

SPARKRITE Mk II

Electronic Ignition...

Better on all points
Because you keep your points!

The SPARKRITE MK.2 is a full capacitive discharge electronic system. Specifically designed to retain the points assembly with all the advantages and none of the disadvantages. No misfire because contact breaker bounce is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high rpm. Contact breaker burn is eliminated by reducing the current to about 1/50th of norm, thus avoiding arcing. But you can still revert to normal ignition if need be. In seconds. If points go (very unlikely) you can get replacements anywhere. All these advantages.

●Fitted in 15 minutes. ●Up to 20% better fuel consumption. ●Instant all weather starting. ●Cleans plugs – they last 5 times longer without attention. ●Faster acceleration. ●Faster top speeds. ●Coil and battery last longer. ●Efficient fuel burning with less air pollution.

The kit comprises everything needed

Ready drilled scratch and rust resistant case, metalwork, cables, coil connectors, printed circuit board, top quality 5 year guaranteed transformer and components, full instructions to make positive or negative earth system, and 6 page installation instruction leaflet.
WE SAY IT IS THE BEST SYSTEM AT ANY PRICE!

PRICES

D.I.Y. Kit only £10·93 incl. VAT and P & P
Ready Built Unit £13·88 incl. VAT and P & P
(Both to fit all cars with coil/distributor ignition up to 8 cylinders)
We can supply units for any petrol-engined vehicle (boat, motorcycle etc) with coil/contact breaker ignition. Details on request. Call in and see us for a demonstration.

ELECTRONICS DESIGN ASSOCIATES
(Dept PE11), 82 Bath Street, Walsall WS1 3DE Phone 33652

P. F. RALFE

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MUFFIN INSTRUMENT FANS
Dimensions 4·5in × 4·5in × 1·5in. Very quiet running, precision fan specially designed for cooling electronic equipment, amplifiers etc. For 110V, a.c. operation (practise is to run from split primary of mains transformer or use suitable mains dropper). CC only 11 watts. List price over £10 each. Our price, in brand new condition, is £3·50.

ITT METRIX
Model 101B miniature oscilloscope. D.C. 10mHz. Sensitivity 100mV. Single-beam. Dimensions 20cm × 14cm × 13cm. Weight 5½lb. Sold brand new at nearly one half maker's list price. **Only £50.**

AVO VALVE TESTERS
Brief-case type 160. Full working condition throughout. £65.

500MHz FREQUENCY DIVIDER TCD 500.
Sensitivity 10mV (1–300MHz), 50mV (300–500MHz). The TCD500 is designed to extend the range of existing frequency counter by 10 or 100 times to a maximum of 500MHz. Completely self-contained, no external standards required. The TCD500 is suitable for any type frequency counter over 5MHz. Solid-state, small size. Brand new.

AERIAL CHANGE-OVER RELAYS
of current manufacture designed especially for mobile equipments, coil voltage 12V, frequency up to 250MHz at 50 watts. Small size only 2in × ⅞in. Offered brand new, boxed. Price £1·50, inc. P. & P.

DIGITAL FREQUENCY METER
Type 'FT300'
Reads as frequency meter up to 99·99 kHz in three ranges or as tachometer, 99,990 r.p.m. Solid-state instrument. Clear read-out. Size only 8in × 5in × 2½in. Weight 4½lb. BCD outputs. Operating voltage 110/240V a.c. Made by famous manufacturer. These units are brand new in original makers cartons. Our price: £55.

Large selection of
RF PLUGS AND SOCKETS
Available ex-stock: BNC plugs 50 30p; BNC sockets 50 25p; N. type plug 50 50p; Burndept plugs 40p; Burndept sockets 20p; All plugs and sockets are brand new. Please add appropriate amount for postage.

EDDYSTONE 770R RECEIVER
Range 19–165mHz. As new. £125.

DURATRAK VARIACS
Type 100L. 230V input, 0–230V a.c. output. 8 amps. Brand new minus control knobs. Price only £15, carriage £1.

PLEASE ADD 8% VAT TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH.

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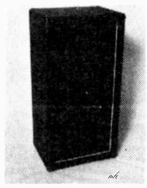
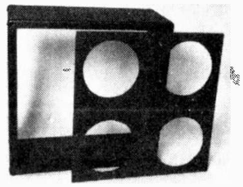
331 High Street, Rochester, Kent. Tel: Medway (0634) 404199

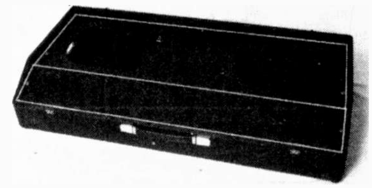
SPEAKER CABINETS IN KIT FORM REPRESENT HUGE SAVINGS



2′ x 12″ Cabinet



4′ x 12″ Cabinet



Disco Console (includes lid not shown)
Takes two slaves

For a long time now a large number of customers have asked us to produce cabinets in kit form, and above we show examples of cabinet styles and these are now available either fully built or in kit form ready for you to produce a professional finish in a very short time!

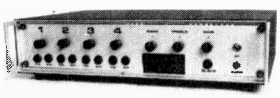
Kits are available in all specifications and all the kits contain everything you need as follows:-

1) 4 sides with handle cutouts, front edges rounded, 1 back with jack socket hole, and1 baffleboard with speaker cutout
2) P.V.C. cut to size for frame and back, plus false front and back timbers, white front piping and speaker cloth
3) Recessed handles with fixing screws, jack socket, all fixing screws, corner plates, glue, and full instructions!

PRICE & TYPE LIST

Type	*Size*	*Price manufactured*	*Kit price*
2 x 12″ (illustrated above)	36″ x 18″ x 13″ x $\frac{3}{4}$	£19.50	£12.50
4 x 12″ (illustrated above)	31″ x 31″ x 13″ x $\frac{3}{4}$	£24.50	£17.50
4 x 12″ P.A. Column	48″ x 27″ x 13″ x $\frac{3}{4}$	£30.00	£21.50
1 x 18″	31″ x 31″ x 13″ x $\frac{3}{4}$	£24.50	£17.50
1 x 15″ with two top horn cutouts	36″ x 20″ x 13″ x $\frac{3}{4}$	£21.00	£13.50
Mini Disco (state deck cutout BSR, GARRARD etc.)	33″ x 20″ x 8″ x $\frac{1}{2}$	£20.00	£13.00
Maxi Disco (illustrated) (state deck cutout BSR, GARRARD etc.)	42″ x 20″ x 10″ x $\frac{1}{2}$	£25.00	£18.50

Please ask for quotation on any other type or size of cabinet you may require.



ERC 100 watt power amplifier
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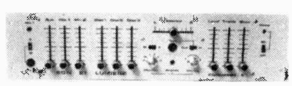
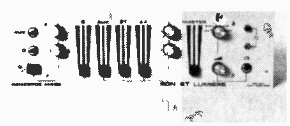
* Fully protected against short or open circuit
* Less than 0.1% distortion at all powers
* Rise time 4muS-stability – Unconditional Price £66.50



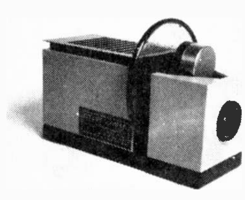
* Stereo studio disco mixer
* Full PFL and Monitor facilities
* As used by John Peel, Mark Wesley, Paul Burnett, DLT, Dave Christian, Tony Prince
* Price £120.00



* Concorde mono M400 mixer
* Full PFL and Monitor facilities
* Mike overide
* Magnetic inputs
* Broadcasting quality £85.00

ALL OUR PRICES INCLUDE VAT AND UK DELIVERY

VALUE!!



LOOK!!

Disco imp projector 150 watt tungsten
unbeatable price £19.75
Includes liquid wheel and postage
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Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1·50. 3 for ONLY 55p + P. & P. 30p.

SPECIAL one as above PLUS Power Transistors ONLY 55p each + P. & P. 15p.
PAXOLINE BOARDS 7¼ × 9" approx. 4 for 30p + P. & P. 20p.

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16½ × 4" approx. 2 for 55p

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Etch resistant printed circuit marker pen 99p each

VEROBOARDS
Packs containing approx., 50sq. in. various sizes, all 0·1 matric 55p

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CH1. 2·5mH 29p CH2. 5·0mH 30p
CH3. 7·5mH 31p CH4. 10mH 33p
CH5. 1·5mH 28p
COILS
DRX1 Crystal set 31p DRR2 Dual range 45p

COIL FORMERS & CORES
NORMAN ¼" Cores & Formers 8p
⅜" Cores & Formers 10p

SWITCHES
DP/DT Toggle 36p SP/ST Toggle 30p

FUSES
1¼" and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A
QUICK-BLOW 5p each.

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Crystal 3·5mm plug 42p
8 ohms 2·5mm plug 22p
8 ohms 3·5mm plug 22p

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2-WAY CROSSOVER NETWORK
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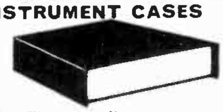
CATALOGUE AND LISTS
Send S.A.E. and 10p.

INSTRUMENT CASES



(Black Vinyl covered)

No.	Length		Width		Height	Price
BV1	8"	×	5¼"	×	2"	£1·10
BV2	11"	×	6"	×	3"	£1·45

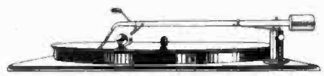
ALUMINIUM BOXES

BA1	5¼"	×	2¼"	×	1½"	42p
BA2	4"	×	4"	×	1½"	42p
BA3	4"	×	2¼"	×	1½"	42p
BA4	5¼"	×	4"	×	1½"	50p
BA5	4"	×	2½"	×	2"	42p
BA6	3"	×	2"	×	1"	34p
BA7	7"	×	5"	×	2½"	70p
BA8	8"	×	6"	×	3"	90p
BA9	6"	×	4"	×	2"	58p

P. & P. 10p on each box

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1·95
Chrome Finish
Model 60 £1·50



Ref. 36A. Record/Stylus Cleaning Kit 33p
Ref. 43. Record Care Kit £2·42
Ref. 31. Cassette Head Cleaner 58p
Ref. 32. Tape editing Kit £1·68
Model 9. Wire Stripper/Cutter 83p
Ref. 46. Spirit Level 62p
Ref. B. Stylus and Turntable Cleaning Kit 34p
Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1·37
Ref. J. Tape Head Cleaning Kit 62p
Ref. 56. Hi-Fi Stereo Hints and Tips 42p
Ref. 45. Auto Changer Groove Cleaner £1·08

ANTEX SOLDERING IRONS
X25. 25 watt £2·05
CCN 240. 15 watt £2·48
Model G. 18 watt £2·26
SK2. Soldering Kit £3·25
STANDS: ST3, suitable for all models £1
SOLDER: 18SWG Multicore 7oz £1·61
22SWG 7oz £1·61. 18SWG 22ft 51p
22SWG Tube 33p

ANTEX BITS and ELEMENTS

Bits No.		
102	For model CN240 3/32"	42p
104	For model CN240 1/8"	42p
1100	For model CCN240 3/32"	42p
1101	For model CCN240 1/8"	42p
1102	For model CCN240 1/4"	42p
1020	For model G240 3/32"	42p
1021	For model G240 1/8"	42p
1022	For model G240 3/16"	42p
50	For model X25 3/32"	48p
51	For model X25 1/8"	48p
52	For model X25 3/16"	48p

ELEMENTS
ECN 240 £1·30 ECCN 240 £1·32
EG 240 £1·07 EX 25 £1·16

ANTEX HEAT SINKS 10p

VAT included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

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Pack No.	Qty.	Description	Price
C1	200	Resistors mixed values approx. count by weight	0·55
C2	150	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 0·1%, 0·01% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C8	10	Reed Switches	0·55
C9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	30	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets, etc.	0·55
C15	5	Mains Slide Switches	0·55
C16	20	Assorted Tag Strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	2	Relays 6—24V Operating	0·55
C20	1	Pack Sheets of Copper Laminate approx. 20 sq. ins.	0·55

PLUGS AND SOCKETS

PLUGS		
PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·16
PS 5	D.I.N. 5 Pin 240°	0·16
PS 6	D.I.N. 6 Pin	0·17
PS 7	D.I.N. 7 Pin	0·18
PS 8	Jack 2·5mm Screened	0·18
PS 9	Jack 3·5mm Plastic	0·12
PS 10	Jack 3·5mm Screened	0·18
PS 11	Jack ¼" Plastic	0·15
PS 12	Jack ¼" Screened	0·22
PS 13	Jack Stereo Screened	0·36
PS 14	Phono	0·10
PS 15	Car Aerial	0·22
PS 16	Co-Axial	0·15

INLINE SOCKETS		
PS 21	D.I.N. 2 Pin (Speaker)	0·14
PS 22	D.I.N. 3 Pin	0·20
PS 23	D.I.N. 5 Pin 180°	0·20
PS 24	D.I.N. 5 Pin 240°	0·20
PS 25	Jack 2·5mm Plastic	0·16
PS 26	Jack 3·5mm Plastic	0·16
PS 27	Jack ¼" Plastic	0·30
PS 28	Jack ¼" Screened	0·35
PS 29	Jack Stereo Plastic	0·30
PS 30	Jack Stereo Screened	0·38
PS 31	Phono Screened	0·18
PS 32	Car Aerial	0·22
PS 33	Co-Axial	0·22

SOCKETS		
PS 35	D.I.N. 2 Pin (Speaker)	0·08
PS 36	D.I.N. 3 Pin	0·11
PS 37	D.I.N. 5 Pin 180°	0·11
PS 38	D.I.N. 5 Pin 240°	0·11
PS 39	Jack 2·5mm Switched	0·12
PS 40	Jack 3·5mm Switched	0·12
PS 41	Jack ¼" Switched	0·20
PS 42	Jack Stereo Switched	0·30
PS 43	Phono Single	0·08
PS 44	Phono Double	0·10
PS 46	Co-Axial Surface	0·10
PS 47	Co-Axial Flush	0·20

LEADS

LS 1	Speaker Lead 2 pin D.I.N. plug to open ends approx 3 metres long (coded)	0·20

CABLES

CP 1	Single Lapped Screen	0·07
CP 2	Twin Common Screen	0·11
CP 3	Stereo Screened	0·12
CP 4	Four Core Common Screen	0·23
PC 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·09
CP 8	Twin Oval Mains Cable	0·07
CP 9	Speaker Cable	0·05
CP 10	Low Loss Co-Axial	0·18

CARBON POTENTIOMETERS
Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

VC 1	Single Less Switch	0·15
VC 2	Single D.P. Switch	0·28
VC 3	Tandem Less Switch	0·46
VC 4	1K Lin Less Switch	0·15
VC 5	100 K anti-Log	0·46

HORIZONTAL CARBON PRESETS
0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4·7M

IT'S NEW IT'S POWERFUL
(15 + 15w R.M.S.) **AND—**
IT LOOKS GOOD!

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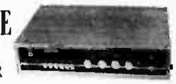

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7in EP. 18¾in × 7in × 8in (50 records) £2·10
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REPANCO TRANSFORMERS
240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 14V, 15V, 17V, 19V, 21V, 25V, 31V, 33V, 40, 50 and 25V–0–25V.

Type	Amps	Price	P. & P.
MT50/½	½	£1·93	30p
MT50/1	1	£2·42	35p
MT50/2	2	£3·30	40p

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GP91-18C 200mV at 1·2cm/sec	£1·35
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GP96-1 100mV at 1cm/sec	£2·80
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J-2010C Crystal/Hi Output Compatible	£1·20
J-20068 Stereo/Hi Output	£1·75
J-2105 Ceramic/Med Output	£1·95
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R1	50 Mixed 100 ohms–820 ohms	50p
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R3	50 Mixed 10kΩ–82kΩ	50p
R4	50 Mixed 100kΩ–1MΩ	50p

THESE ARE UNBEATABLE PRICES—JUST 1p EACH INCL. V.A.T.

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C60, 36p; C90, 48p; C120, 60p.

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35 intelligent, young minded people who

1. Want to earn really good salaries.
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They must be prepared to earn their selection by training hard for 6 months and repaying the cost of their training out of their subsequent salary.

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1N914	0·06
1N4007	0·12
1S113	0·25
1S131	0·13
1S202	0·23
2G371	0·40
2G381	0·22
2G414	0·30
2G417	0·25
2N404	0·22
2N697	0·15
2N698	0·30
2N706	0·10
2N706A	0·12
2N708	0·15
2N709	0·40
2N1091	0·55
2N1131	0·25
2N1132	0·25
2N1302	0·18
2N1303	0·18
2N1304	0·22
2N1305	0·22
2N1306	0·28
2N1307	0·28
2N1308	0·28
2N2147	0·75
2N2148	0·60
2N2160	1·00
2N2218	0·23
2N2219	0·25
2N2369A	0·16
2N2444	1·99
2N2613	0·28
2N2646	0·50
2N2904	0·20
2N2904A	0·25
2N2906	0·20
2N2907	0·23
2N2924	0·13
2N2925	0·15
2N2926	0·10
2N3054	0·50
2N3055	0·60
2N3702	0·11
2N3705	0·15
2N3706	0·11
2N3707	0·13
2N3709	0·10
2N3710	0·11
2N3711	0·11
2N3819	0·35
2N4289	0·20
2N5027	0·53
2N5088	0·33
2S301	0·59
2S304	1·15
2S501	0·75
2S703	1·00
AA129	0·20
AAZ12	0·75
AAZ13	0·10
AC107	0·35
AC126	0·25
AC127	0·25
AC128	0·20
AC187	0·20
AC188	0·20
ACY17	0·35
ACY18	0·27
ACY19	0·27
ACY20	0·22
ACY21	0·22
ACY22	0·16
ACY27	0·25
ACY28	0·25
ACY39	0·65
ACY40	0·22
ACY41	0·22
ACY44	0·32
AD140	0·50
AD149	0·50
AD161	0·39
AD162	0·39
AF106	0·30
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·20
AF118	0·50
AF119	0·30
AF124	0·30
AF125	0·30
AF126	0·30
AF127	0·30
AF139	0·33
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AF179	0·65
AF180	0·55
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ASY26	0·25
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ASY28	0·25
ASY29	0·30
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ASY50	0·20
ASY51	0·40
ASY53	0·20
ASY55	0·20
ASY62	0·25
ASY66	0·33
ASZ21	1·00
ASZ23	0·75
AU101	1·50
AUY10	1·00
BC107	0·12
BC108	0·12
BC109	0·12
BC113	0·16
BC115	0·20
BC116	0·20
BC116A	0·23
BC118	0·20
BC121	0·20
BC122	0·20
BC125	0·68
BC126	0·65
BC140	0·55
BC147	0·12
BC148	0·10
BC149	0·12
BC157	0·14
BC158	0·12
BC160	0·63
BC169	0·14
BCY31	0·45
BCY32	1·20
BCY33	0·38
BCY34	0·45
BCY38	0·55
BCY39	1·00
BCY40	0·80
BCY42	0·30
BCY70	0·15
BCY71	0·20
BCZ10	0·60
BCZ11	0·65
BD121	1·00
BD123	1·00
BD124	0·80
BDY11	1·45
BF115	0·22
BF117	0·50
BF167	0·25
BF173	0·28
BF181	0·35
BF184	0·22
BF185	0·22
BF194	0·13
BF195	0·13
BF196	0·15
BF197	0·15
BF861	0·25
BF898	0·25
BFX12	0·20
BFX13	0·25
BFX29	0·28
BFX30	0·28
BFX35	0·98
BFX63	0·50
BFX84	0·25
BFX85	0·28
BFX86	0·25
BFX87	0·25
BFX88	0·22
BFY10	1·00
BFY11	0·50
BFY17	0·40
BFY18	0·45
BFY19	0·55
BFY24	0·45
BFY44	1·00
BFY50	0·20
BFY51	0·20
BFY52	0·20
BFY53	0·17
BFY64	0·45
BFY90	0·75
BSX27	0·50
BSX60	0·93
BSX76	0·18
BSY26	0·17
BSY27	0·20
BSY51	0·50
BSY95A	0·12
BSY95	0·12
BT102/500R	0·75
BTY42	0·92
BTY79/100R	0·75
BTY79/400R	1·10
BY100	0·15
BY126	0·14
BY127	0·15
BY182	0·85

	£p
BY213	0·25
BYZ10	0·45
BYZ11	0·40
BYZ12	0·40
BYZ13	0·35
BYZ15	1·25
BYZ16	0·60
BZY88	0·10
C111	0·55
CRS1/05	0·30
CRS1/40	0·45
CS4B	1·90
CS10B	3·50
DD000	0·15
DD003	0·15
DD006	0·25
DD007	0·40
DD008	0·38
GD3	0·33
GD4	0·10
GD5	0·33
GD8	0·25
GD12	0·10
GET102	0·50
GET103	0·40
GET113	0·35
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GET120	0·50
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GET875	0·40
GET880	0·55
GET881	0·25
GET882	0·35
GET885	0·40
GEX44	0·08
GEX45/1	0·45
GEX941	0·45
GJ3M	0·50
GJ4M	0·50
GJ5M	0·25
GJ7M	0·50
HG1005	0·50
HS100A	0·20
MAT100	0·20
MAT101	0·25
MAT120	0·20
MAT121	0·25
MJE520	0·65
MJE2955	1·10
MJE3055	0·75
MJE340	0·50
MPF102	0·40
MPF103	0·36
MPF104	0·35
MPF105	0·46
NKT128	0·45
NKT129	0·30
NKT211	0·25
NKT213	0·25
NKT214	0·24
NKT216	0·40
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NKT219	0·33
NKT222	0·30
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NKT251	0·24
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NKT777	0·38
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OA79	0·10
OA81	0·10
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OA86	0·15
OA90	0·07
OA91	0·07
OA95	0·07
OA200	0·08
OA202	0·10
OA210	0·20
OA211	0·25
OAZ200	0·50
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OAZ202	0·45
OAZ203	0·45
OAZ204	0·45

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OAZ205	0·45
OAZ206	0·45
OAZ207	0·45
OAZ208	0·40
OAZ209	0·40
OAZ210	0·40
OAZ211	0·40
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OAZ224	0·45
OAZ241	0·25
OAZ242	0·15
OAZ244	0·25
OAZ246	0·15
OAZ290	0·38
OC16	1·00
OC16T	1·00
OC19	0·50
OC20	2·00
OC22	1·00
OC23	1·25
OC24	1·10
OC25	0·40
OC26	0·40
OC28	0·70
OC29	0·65
OC30	0·40
OC35	0·55
OC36	0·65
OC41	0·35
OC42	0·40
OC43	0·70
OC44	0·18
OC44M	0·17
OC45	0·18
OC45M	0·18
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OC66	0·50
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OC76	0·30
OC77	0·55
OC78	0·25
OC79	0·30
OC81	0·28
OC81D	0·28
OC81M	0·20
OC81DM	0·18
OC81Z	0·45
OC82	0·28
OC82D	0·25
OC83	0·25
OC84	0·30
OC114	0·38
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OC139	0·40
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OC141	0·80
OC169	0·20
OC170	0·25
OC171	0·30
OC200	0·55
OC201	0·80
OC202	0·90
OC203	0·55
OC204	0·65
OC205	1·00
OC206	1·10
OC207	1·00
OC460	0·20
OC470	0·30
OCP71	1·00
ORP12	0·55
ORP60	0·45
ORP61	0·48
SX68	0·20
SX631	0·45
SX635	0·55
SX640	0·75
SX641	0·75
SX642	0·60
SX644	0·85
SX645	0·85
TIC44	0·29
V15/30P	0·75
V30/201P	0·75
V60/201	0·50
V60/201P	0·75
XA101	0·10
XA102	0·18
XA151	0·15
XA152	0·15
XA161	0·25
XA162	0·25
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XB102	0·30
XB103	0·35
XB113	0·30
XB121	0·43

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ZS170	0·10
ZS271	0·18
ZT21	0·25
ZT43	0·25
ZTX107	0·12
ZTX108	0·10
ZTX300	0·14
ZTX304	0·24
ZTX500	0·15
ZTX503	0·16
ZTX531	0·25
INTEGRATED CIRCUITS	
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7401	0·20
7402	0·20
7403	0·20
7404	0·20
7405	0·20
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7437	0·43
7438	0·43
7440	0·20
7441AN	0·85
7442	0·85
7450	0·20
7451	0·20
7453	0·20
7454	0·20
7460	0·20
7470	0·33
7472	0·38
7473	0·44
7474	0·48
7475	0·59
7476	0·45
7480	0·60
7482	0·87
7483	1·20
7484	1·00
7486	0·50
7490	0·75
7491A	1·10
7492	0·75
7493	0·75
7494	0·85
7495	0·85
7496	1·00
7497	4·82
74100	2·16
74107	0·51
74110	0·57
74111	0·86
74118	1·00
74119	1·92
74121	0·57
74122	0·80
74123	1·44
74141	1·00
74145	1·44
74150	2·30
74151	1·15
74154	2·30
74155	1·15
74156	1·15
74157	1·09
74170	2·88
74174	1·80
74175	1·29
74176	1·44
74190	2·30
74191	2·30
74192	2·30
74193	2·30
74194	1·72
74195	1·44
74196	1·58
74197	1·58
74198	3·16
74199	2·88

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Keyboards: High quality adjustable type.
Sloping front 49-note C to C. **£14·35.**
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Palladium earth bar per octave length. **15p.**
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Leaflet MES 51 shows a complete circuit for a basic fully polyphonic organ. Send only **15p** for leaflet and start building now! **REMEMBER**—when you have built this organ you will later be able to use the same top quality component parts as the basis of a large sophisticated instrument with all the facilities you want. Watch our ads for details.

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DMO2 (without tremulant) **£12·25.**

★ S.a.e. please for full technical details.

Trade enquiries welcome.

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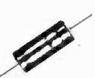
CAPACITORS

Sub-miniature
Axial lead electrolytic



Mfd	V	Price	Mfd	V	Price	Mfd	V	Price
1	63	6p	68	6·3	6p			
1·5	63	6p	68	16	6p			
2·2	63	6p	68	63	14p			
3·3	63	6p	100	4	6p			
4·7	63	6p	100	10	6p	470	6·3	6p
6·8	40	6p	100	25	6p	470	10	14p
6·8	63	6p	100	40	6p	470	25	16p
10	25	6p	100	63	16p	470	40	25p
10	63	6p	150	6·3	6p	680	6·3	14p
15	16	6p	150	16	6p	680	16	16p
15	40	6p	150	25	6p	680	25	25p
15	63	6p	150	40	14p	680	40	28p
22	10	6p	150	63	16p	1000	4	14p
22	25	6p	220	4	6p	1000	10	16p
22	63	6p	220	10	6p	1000	16	25p
33	6·3	6p	220	16	6p	1000	25	28p
33	16	6p	220	25	14p	1500	6·3	16p
33	40	6p	220	40	16p	1500	10	25p
47	4	6p	220	63	25p	1500	16	28p
47	10	6p	330	4	6p	2200	6·3	25p
47	25	6p	330	10	6p	2200	10	28p
47	40	6p	330	16	14p	3300	6·3	28p
47	63	6p	330	63	28p	4700	4	28p

PLUGS AND SOCKETS

DIN PLUGS
2 pin (1 flat) 8p
3 pin 9p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p

DIN Sockets
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3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 7p, 6 pin 9p

MAINS
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SA 2190 3 pin 5A chassis plug 20p
SA 1862 Line socket for above 23p

McMURDO
RP8 8 way chassis plug 52p

RS8 way chassis socket 68p

PHONO
Plug plastic 5p
Plug screened 12p
Chassis socket 4p

JACK
Std. ¼" mono plug
Plastic 13p
Screened 21p

Std ¼" stereo plug
Plastic 18p
Screened 30p
Open mono socket ¼" 10p; Moulded mono socket ¼" with 2 break contacts 14p; Moulded stereo socket ¼" with 3 break contacts 18p; 3·5mm. plug plastic 9p; screened 15p; open socket 9p.

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SG3402N Amplifier/Multiplier	£1·69
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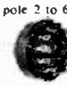
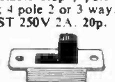
SWITCHES

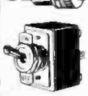
Rotary with adjustable stop 1 pole 2 to 12 way; 2 pole 2 to 6 way; 3 pole 2 to 4 way; 4 pole 2 or 3 way, each **36p.**
Mains rotary DPST 250V 2A. **20p.**





Slide
Sub-miniature
DPDT **9p**

Push to make non-locking **12p**



Toggle 250V 1·5A with ON/OFF plate **25p.**

High quality "sub-miniature" toggle switches
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Four Pole DT 3A 240V a.c. **£1·37**

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PP3, 6, etc., battery clip dual min. **9p.**
PP1, 9, etc., battery clip separate per pair **6p.**
Pair crocodile clips, 1 red, 1 black insulated sleeve **10p.**
Solder Multicore 22 s.w.g. 10 metres **25p.**
Silicone grease in special dispenser 20ml **54p.**
Terminal Block 12-way 5A **14p.**
Probe clips spring loaded per pair **30p.**
Panel fuse holders 20mm **20p;** 1¼in **35p.**

Transformers
LT700 min. output transformer Pri. 1·2kΩ Sec. 5Ω 200mW **50p.**

Sub-min. Mains Transformer
6–0–6V 100mA **95p,** 12–0–12V 50mA **95p.**
Size: Both approx. 30 × 27 × 25mm

Min. Mains Transformer
Size: 46 × 31 × 38mm.
0–12V 250mA. 0–12V 250mA **£1·36.**

Mains Transformer MT3AT
Pri. 200–220–240V. Sec. 12–15–20–24–30V 1A **£3·31.**

Mains Transformer MT206AT
Pri. 200–220–240V. Sec. 0–15–20V 1A. 0–15–20V 1A **£3·98.**

Hook-up wire, 7 strand 0·2mm. PVC covered tinned copper wire for light general connexions up to 1·4A. 11 colours: black, blue, brown, green, grey, orange, pink, red, violet, white, yellow. 10 metres of any one colour **20p.** Pack of 11 (1 of each colour) 10m. coils **£2·05.**

Single core screened **8p** per metre.
Twin individually screened **10½p** per metre.
High quality single screened 50Ω 100pF per metre, ideal for high grade audio connexions **15½p** per metre.

Mains 3-core sub-miniature 1A black PVC covered 19 strand 0·1mm per conductor. **7½p** per metre.

POTENTIOMETERS

Rotary miniature carbon track ¼" spindle

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above **33p.**

Dual gang (Stereo) without switch Log or Lin 5k to 2M as above **49p.**

Single gang Lin or Log 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) **16p**

PRESETS
Sub-miniature 0·1W Vert or Horiz
100, 250, 500, 1k, 2·5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M **6p**

RESISTORS

Carbon Film	½W	5%	1Ω to 1M; 10% 1·2M to 10M	E12	1p
Carbon Film	¼W	5%	1Ω to 10Ω; 10% 1·2M to 10M	E12	1p
Carbon Film	⅛W	5%	11Ω to 910k	E12 & E24	1p
Carbon Film	1W	5%	10Ω to 10M	E12	3½p
Metal Oxide	½W	2%	10Ω to 1M	E12 & E24	4p
Wirewound	2½W	10%	0·22ohms to 0·47ohms	E12	14p
Wirewound	2½W	5%	1ohm to 270ohms	E12	12p

E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades
E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades

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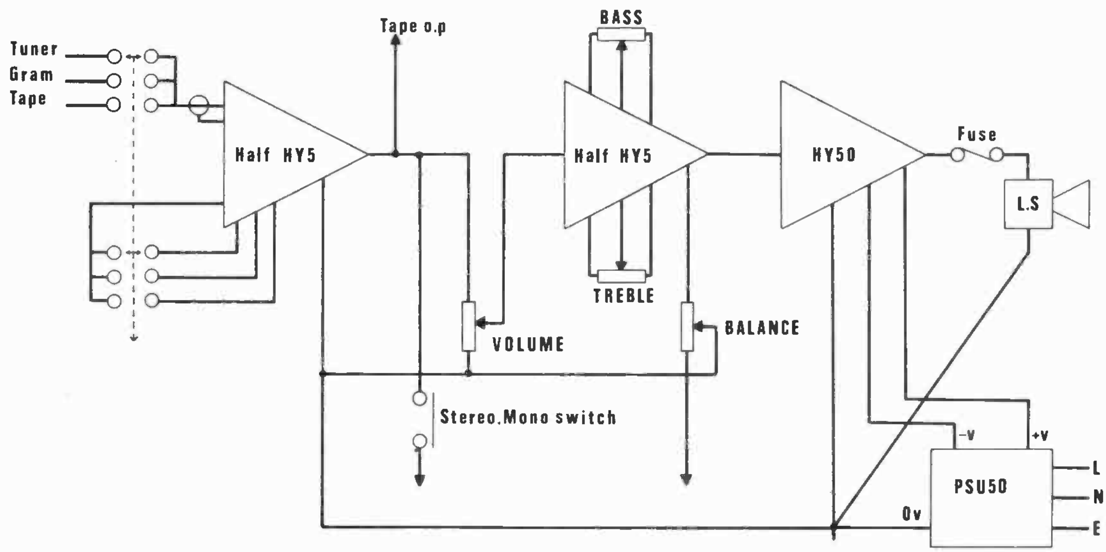
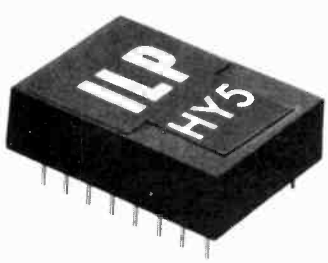
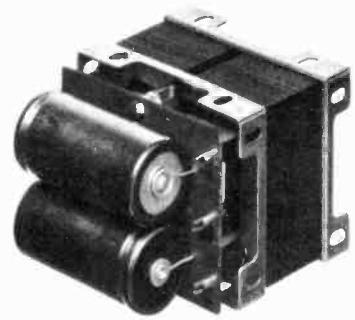


MONO ELECTRICAL CIRCUIT DIAGRAM WITH INTERCONNECTIONS FOR STEREO SHOWN





The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

TECHNICAL SPECIFICATION
Inputs: Magnetic Pick-up 3mV RIAA; Ceramic Pick-up 30mV; Microphone 10mV; Tuner 100mV; Auxiliary 3–100mV; Input/Impedance 47kΩ at 1kHz. **Outputs**: Tape 100mV; Main output 0db (0·775V RMS). **Active Tone Controls**: Treble ±12db at 10kHz; Bass ±12db at 100Hz. **Distortion**: 0·5% at 1kHz. **Signal/Noise Ratio**: 68db. **Overload Capability**: 40db on most sensitive input. **Supply Voltage**: ±16–25V.

PRICE £4·50 + 36p VAT P. & P. free

The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided, input, output, power lines and earth.

TECHNICAL SPECIFICATION
Output Power: 25W RMS into 8kΩ. **Load Impedance**: 4–16kΩ. **Input Sensitivity** 0db (0·775V RMS). **Input Impedance**: 47kΩ. **Distortion**: Less than 0·1% at 25W typically 0·05%. **Signal/Noise Ratio**: Better than 75db. **Frequency Response**: 10Hz–50kHz ± 3db. **Supply Voltage**: ±25V **Size**: 105 × 50 × 25mm

PRICE £5·98 + 48p VAT P. & P. free

The PSU50 can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS
Output voltage: ±25V. **Input voltage**: 210–240V. **Size**: L.70. D.90. H.60mm.

PRICE £5 + 40p VAT P. & P. free

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COMPLETE* STEREO SYSTEM

System 1. £51·00

40 Watt Amplifier. Viscount III – R102 now 20 watts per channel.
System I includes:
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) – 58dB. Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. 13¾"×9"×3¾".
Garrard SP 25 Mk III deck with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. 17½"×10¾"×6" in simulated teak. Drive unit 13"×8" with parasitic tweeter. 10 watts handling.

Complete System £51·00

System 2. £69·00

Viscount III amplifier (As System I)
Garrard SP 25 Mk III deck (As System I)
Two Duo Type III matched speakers – Enclosure size approx. 27" x 13" x 11½"
Finished in teak veneer. Drive units 13" x 8" bass driver, and two 3" (approx.) tweeters.
20 watts R.M.S., 8 ohms frequency range — 20 Hz to 18,000 Hz.

Complete System £69·00

PRICES: SYSTEM 1	
Viscount III R102 amplifier	£24.20 + £1 p & p
2 Duo Type II speakers	£14.00 + £2.20 p & p
Garrard SP 25 with Mag. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p
total: £59.20	

Available complete for only: **£51·00** + £3.50 p & p

PRICES: SYSTEM 2	
Viscount III R102 amplifier	£24.20 + £1 p & p
2 Duo Type III speakers	£39.00 + £4.00 p & p
Garrard SP 25 with Mag. cartridge de luxe plinth and hinged cover	£21.00 + £1.75 p & p
total: £84.20	

Available complete for only: **£69·00** + £4.00 p & p

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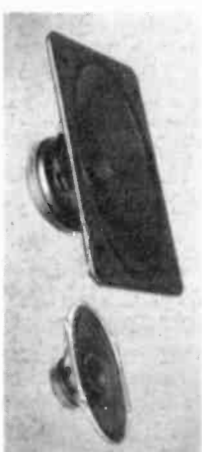


20 WATT SPEAKER SYSTEM

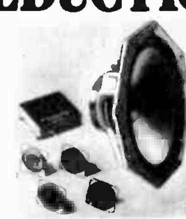
System consists of a 13"×8" (approx) eliptical woofer unit with a 8"×5" (approx.) mid range unit incorporating parasitic tweeter and crossover components.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–1½
Cone, Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, speech coil-1" with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.

OUR PRICE £6.60. Complete + 90p p & p.

15" 14A/780 BASS UNIT

Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.

Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p&p



950 KIT

Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
Huge 19" × 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each 3¼" dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0·5". Recommended list price £44·00.

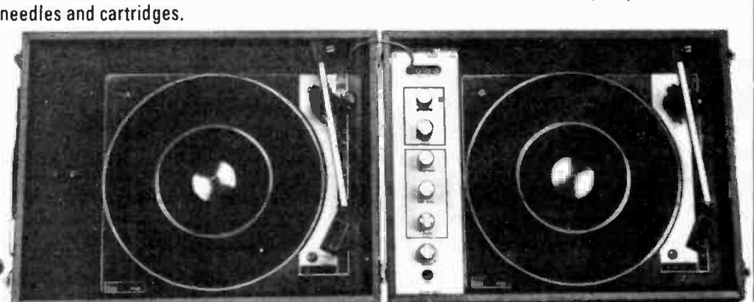
Special Offer
OUR PRICE £19.50 + £1·50 p&p

FOR DISCO PAGE AND DETAILS OF HOW TO ORDER – TURN OVER...

PORTABLE DISCO CONSOLE

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.
Two B.S.R. single play professional series decks, fitted with crystal cartridges.

The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls. The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.
The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.



TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7″, 10″ or 12″ records.
Rumble, wow and flutter – Rumble – Better than –35dB. Wow – Better than 0.2%. Flutter – Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size – Unit Closed – $17\frac{3}{4}'' \times 13\frac{3}{4}'' \times 8\frac{3}{4}''$ (approx.)
Unit Open – $35\frac{3}{4}'' \times 13\frac{3}{4}'' \times 4\frac{3}{8}''$ (approx.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

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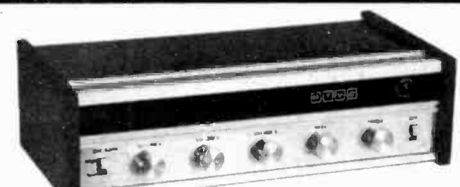
DISCO 50

45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER
Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470 K
Size: $19\frac{1}{4}'' \times 10\frac{1}{2}'' \times 8''$ (approx.) | **Amplifier £27.50 + £1.50 p. & p.**



DISCO AMPLIFIER

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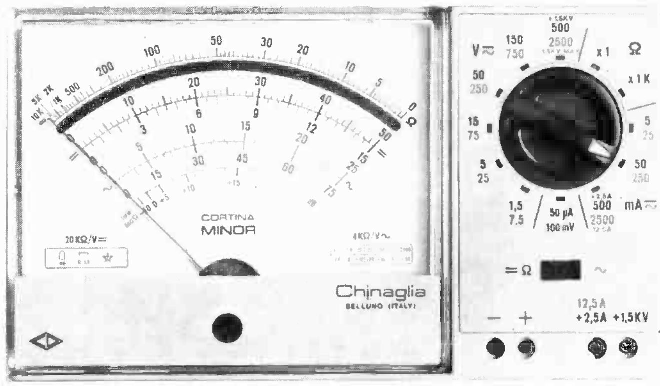

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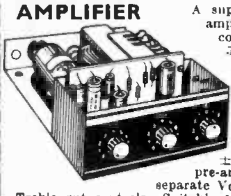

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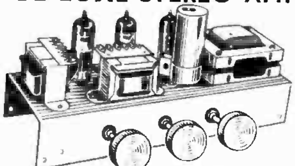

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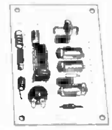

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Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £7·60. Carr. 75p.

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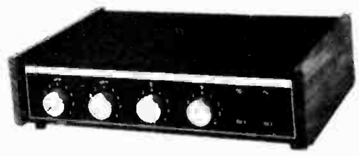
5in. 3 ohm £1·25, P. & P. 15p. 7 × 4in. 3 ohm £1·40, P. & P. 20p. 10 × 6in. 3 or 15 ohm £2·10, P. & P. 30p. E.M.I. 8 × 5in. 3 ohm with high flux magnet £1·70, P. & P. 20p. E.M.I. 13½ × 8in. with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm £3·50, P. & P. 30p. E.M.I. 13 × 8in 3, 8 or 15 ohm with two inbuilt tweeters and crossover network £4·65, P. & P. 30p.
E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £1·25 + 20p, P. & P.
BRAND NEW. 12in. 15w. H/D Speakers, 3, 8 or 15 ohms. State which. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £9·72. Guitar models: 25w. £9·72. 35w. £10·80. P. & P. 45p.

12in. **"RA" TWIN CONE LOUDSPEAKER,** 10 watts peak handling. 3 or 8 or 15 ohm (state which) £2·70. P. & P. 36p.
"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14¾" × 1⅛" 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 £6·43 each. P. & P. 34p.

SPECIAL BARGAIN OFFER!
Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge. **Brand new. ONLY £7·86 + p. & p. 60p.**

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

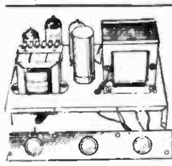


A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. Bass, boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2½"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

AMPLIFIER KIT	£11·34	P. & P. 30p
(Magnetic input components 33p extra)		
POWER PACK KIT	£3·46	P. & P. 40p
CABINET	£3·46	P. & P. 40p

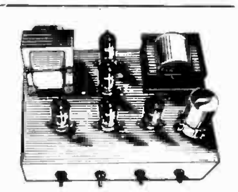
(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £24·60. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities 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 plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £5·90. P. & P. 45p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £4·92. P. & P. 45p.

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 Ω 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 EZ80 rectifier. Simple instruction booklet 15p × SAE (Free with parts). All parts sold separately. ONLY £9·60. P. & P. 60p. Also available ready built and tested £12·75. P. & P. 70p.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam earmuffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for Mono. PRICE £3·24. P. & P. 25p.

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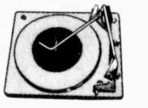
BSR HI-FI AUTOCHANGER
STEREO & MONO



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 13¼ × 11¼in. Above motor board 3¼in. Below motor board 2¼in.
with STEREO and MONO XTAL **£6·75** Post 45p.

PORTABLE PLAYER CABINET
Modern design. Black rexine covered. Silver front grille. Padded Lid. Chrome fittings. Size 17in × 15in × 7in. Few only in red rexine. Motor board cut for BSR deck **£4·50** Post 50p

BSR JUNIOR SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono compatible cartridge. **£4.95** Post 25p

R.C.S. DISCO DECK SINGLE RECORD PLAYER
Fitted with auto stop. Stereo/mono cartridge. Baseplate. Size 11in × 8¼in. Turntable. Size 7in diameter. A/C mains. 200/250V motor has a separate winding 14 volt to power a small amplifier. Three speeds. Plays all records.

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SOLID MAHOGANY PLINTH
With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Size 12¼ × 14¼ × 7¼in. **£5·95**
Post 45p

COMPACT PORTABLE STEREO HI-FI
Two full size loudspeakers 13¼ × 10 × 3¼in. Player unit clips to loudspeakers making it extremely compact, overall size only 13¼ × 10 × 8¼in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. 240V AC Mains.

Attractive Teak finish Weight 13 lb.
Bargain Price **£25** 85p Carriage

SPECIAL OFFER!
SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0 TO 60 MINUTES

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. Fully insulated. Makers' last list price £4·50. Brand new and fully guaranteed.
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BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1.
ALUMINIUM BOXES 3 × 3 × 3in 60p; 4 × 4 × 4in 70p; 6 × 4 × 4in 80p; 9 × 4 × 4in £1; 12 × 4 × 4in £1·30.
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PAXOLIN PANEL 10 × 8in 20p.
1¼ inch DIAMETER WAVECHANGE SWITCHES, 45p ea.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way.
1 p.1. 2-way, or 2 p. 2-way, or 4 p. 3-way.
TOGGLE SWITCHES, sp. 20p; dp. 25p; dp. dt. 30p.
Sub-miniature, sp. 33p; dp. dt. 50p.

BRITISH FM/VHF TUNING HEART
88 to 108 Mc/s British made. 2 Transistors ready aligned requires 10·7 Mc/s I.F. Complete with tuning gang. Connections supplied but some technical experience essential. **Our price £3·95** Post 20p
SUITABLE I.F. STRIP £4·95

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. **£2·20** Post 20p
Details S.A.E. Size 3¼ × 1¼ × 1¼in.

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: 1¾ × 1¼ × ¾ in. Response 25 c/s to 25 kc/s, 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 10p

R.C.S. POWER PACK KIT
12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£2·95** Post 25p
12 VOLT 300mA KIT, £2·75. 9 VOLT 1 AMP KIT, £2·95.

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	50 + 50/300V	50p
4/350V	14p	500/25V	20p	32 + 32/350V	35p
8/350V	22p	1000/25V	35p	32 + 32/450V	60p
16/450V	30p	1000/50V	47p	350 + 50/325V	55p
32/500V	50p	8 + 8/450V	22p	16 + 16 + 16/275V	45p
25/25V	10p	8 + 16/450V	25p	32 + 32 + 32/350V	65p
50/50V	10p	16 + 16/450V	40p	900/350V	95p
100/25V	10p	32 + 32/350V	40p	4700/63V	95p

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1000mF 12V 20p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.
CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 4p; 0·5 13p; 1mF 15p; 2mF 150V 15p.
500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
TWIN GANG. "0-0" 208pF + 176pF, £1.10p.
Slow motion drive 365pF + 365pF with 25pF + 25pF, 50p;
Twin 500pF 65p. Twin 410pF 50p. Twin 120pF 50p.
SHORT WAVE SINGLE: 10pF, 30p; 25pF, 55p; 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. 100pF. **50p** each

NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ¼W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
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GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £3·00
1 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £3·00
2 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
5 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
12, 36, 48V 2 amp. £2.20; 20V 3 amp £2. 3, 5, 8, 10, 13 or 5-0-5V 5 amp. £1·50; 6-0-6V 500mA 90p; 9V 1 amp 95p; 12V 300mA 75p; 12V 500mA 85p; 12V 750mA 95p.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £2·80; 500W £6·25; 750W £10; 1000W £15
CHARGER TRANSFORMERS. Input 200/250V. for 6 or 12V, 1½ amp £1·50; 2 amp £1·80; 4 amp £2·50
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FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs. 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER
Primary 0-110-240V. Secondary 0-240V 3 amps 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make (Value £19) OUR PRICE **£12** Carr. 95p
Can be used as 800 watt auto transformers 240-110V.

SET OF 3 MOTORS FOR COLLARO STUDIO 115 VOLT TAPE DECK
£1·50 Post 50p

VOLUME CONTROLS
Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p.

80 ohm Coax 5p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd £1·75; 60 yd £2·60. FRINGE LOW LOSS Ideal 625 and colour. 10p per yd

Wire Wound controls 1¼in diam. 3 Watts. 10 ohms to 100K British Made with long spindles ¼in dia. 45p each.
DUAL CONCENTRIC POT 500K LOG AND 500K LIN D.P. switch. Inner spindle 3¼in; outer spindle 2¼in 75p.

E.M.I. 13½ × 8in. SPEAKER SALE!

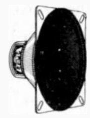
With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. **£2·75** State 3 or 8 or 15 ohm. Post 25p
13 × 8in Bass unit 20 watt rubber cone surround £5·50

LOUDSPEAKER FRONT GRILLES
Teakwood strips mounted on cloth backing, easily glued on to baffle to modernise cabinets. Size 18¼ in × 10¼in. **75p**
Or size 10¼in × 7¼in. **45p**

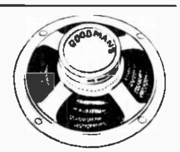
E.M.I. 6½in. HI-FI WOOFER

8 ohm. 10W. Large ceramic magnet. Special Rubber cone surround. Frequency response 30-12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**
Suitable Cabinet 12 × 8 × 6 £4 Suitable Tweeter £2



ELAC CONE TWEETER
The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3¾ × 3¾ × 2in deep. Rating 10W, 3 ohm.
Crossover £1·25 **£1·90** Post 20p.

GOODMANS 8 in. WOOFER



8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi system. **£3·75**

SPECIAL OFFER LOUDSPEAKERS
ALL BRAND NEW

3 ohm, 2½in; 2¾in; 3½in; 5in.
8 ohm, 2½in; 2¾in; 5in × 3in; 3in; 4in; 5in.
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25 ohm, 2½in; 3in; 5 × 3in; 5in.
35 ohm, 3in; 5in.
80 ohm, 2½in; 2¾in. 120 ohm 3in. **£1** EACH

LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in £1·25; 6½in £1·50; 8 × 5in £1·60; 8in £1·75; 10 × 6in £1·90; 10in £2·50
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in diameter 4W £2·50, 10 in diameter 5W £2·50; Post 25p. 12in diameter, 6W, £2·95; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16Kc/s. 8W 8 ohm or 15 ohm £2·20. De Luxe Horn Tweeters 2-18Kc/s, 15W, 15 ohm £3·50.
TWO-WAY 3,000 c.p.s. CROSSOVERS 3, 8 or 15 ohm £1·25.

R.C.S. 3 WAY CROSSOVER
Complete with 12 ft. twin lead fitted with din speaker plug. Ready assembled with leads for speakers, bass, mid and tweeter. Crossover frequencies—950 cps and 3,000 cps. **£1·95**

VALVE OUTPUT TRANSFORMER 40p.
MIKE TRANSFORMER MU metal 100-1 £1·25.
PUSH-PULL VALVE OUTPUT TRANSFORMERS.
50 watt ... £12·50 100 watt ... £15·00

ELECTRO MAGNETIC PENDULUM MECHANISM
1·5V d.c. operation over 200 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 20p

R.C.S. RECORD PLAYER AMPLIFIER
2 stage triode pentode valve. 3 watts output. Volume on/off and tone controls. Printed circuit A.C. mains complete and tested. **£4·50** Post 25p
Complete with speaker.

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18 OUTLET BOXES, SURFACE MOUNTING 25p.
BALANCED TWIN RIBBON FEEDER 300 ohms, 7p yd.
JACK SOCKET Std. open-circuit 14p. closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 7p. Phono Socket 7p
JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 15p DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p DIN SOCKETS Lead 3-pin 18p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p.
VALVE HOLDERS 5p; CERAMIC 10p; CANS 5p.

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SONIC SPIN-OFF

A GREAT and thriving audio industry has been built up based upon the almost universal enjoyment derived from listening to well reproduced music, whatever the brow level. However, just "listening" does not offer the ultimate in pleasure or satisfaction for those of a musically creative mind. To such "actively" inclined persons electronics offers a number of paths for exploration. Experimenting with the composition of electronic music, for example. This particular activity received a tremendous boost with the arrival of the synthesiser. Coupled with multi-track recording, the synthesiser offers musically inspired adventurers the chance to create original sound and musical patterns with comparative ease—something that would have been beyond their wildest dreams a mere five years ago.

Also worth noting is the fact that active music making is very much part of life for the younger generation. Not surprisingly among today's younger people is to be found a real awareness of the exciting possibilities of synthesised sound. So the future of this new form of musical art seems well assured.

But synthesisers are generally complex and costly instruments. Thus they have not reached all those hands that are eager to experiment. We certainly know that many of our readers have been intrigued by the P.E. Sound Synthesiser series, although being unable for various reasons to take on the commitment of building this grand assemblage of electronics. What they learnt from these articles must have made them envious of those able to participate in this rapidly developing form of musical art.

The likely occurrence of such thoughts and aspirations did not escape us. So during the latter stages of development of the P.E. Sound Synthesiser consideration was given to the feasibility of a much simpler synthesiser to meet an obvious popular demand. The aim was to produce an instrument that would be relatively inexpensive and not unduly complicated circuit-wise, but that would embody certain essential features to make it sufficiently versatile for serious experimental work in the fields of music composition and sound effects production, and also to serve as a useful teaching aid.

The outcome of this endeavour has been a great success and it is now revealed for all to see and, of course, to build for themselves. The P.E. Minisonic is unique and unprecedented, the first miniature battery operated instrument fully warranting inclusion in the ranks of synthesisers and in all truth a first class constructor's item. Incidentally, critics of the larger kind of project might like to ponder the fact that the Minisonic is a practical example of spin-off from a much larger and more complex design. This exciting compact instrument is a direct beneficiary of the development work expended on the P.E. Sound Synthesiser and of operational experience gained in its subsequent use in an artistic role.

F.E.B.

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THE P.E. Minisonic is a synthesiser in miniature and contains the necessary circuitry to produce all the basic forms of modulation which have come to be associated with its larger brethren. Thus a ring modulator is incorporated together with the means for producing frequency, amplitude and harmonic modulation.

Being battery operated the P.E. Minisonic is safe for the younger enthusiast to build and operate and can expect to give up to 50 hours of entertainment from one pair of PP9 batteries.

Although an entirely self-contained instrument which includes two 250mW monitoring channels and loudspeakers, the P.E. Minisonic may be connected to a range of external apparatus including power amplifiers, tape recorders, signal generators, etc.

The overall cost to build the P.E. Minisonic is under £50.

SPECIFICATION

Two Voltage Controlled Oscillators (VCOs)
Sawtooth waveform. Ten octave range, logarithmic law control

Two Envelope Shapers with Voltage Controlled Amplifiers (VCAs)
Envelope shapers have variable attack and decay. VCA has up to 54dB attenuation

Keyboard Controller
Incorporates "hold" or analogue memory

White Noise Generator

Ring Modulator

Voltage Controlled Filter (VCF)
Passband variable over 5Hz to 15kHz with a 54dB dynamic range

Two 250mW output amplifiers with input mixer stages

The VCOs and Envelope Shapers are controlled from the keyboard by means of a stylus, but provision is made for plugging in an external keyboard for the benefit of those constructors more musically inclined

(Patent applied for in respect of certain aspects of this design)

PE MINISONIC

A MINIATURE BATTERY OPERATED SOUND SYNTHESISER

By G. D. SHAW

PART ONE

THE popularity of the synthesiser is not in any doubt—the phenomenal growth rate of some of the synthesiser manufacturers, particularly during the 1972-73 period and the great interest shown in various "do-it-yourself" designs which have appeared in the meantime, only go to underline the wide, general appeal of the instrument.

Although the synthesiser may be employed in an enormously diverse range of applications under the general heading of sound manipulation, specifically within the field of music it may be rightly said that the instrument has provided the greatest dynamic to have occurred for centuries. In fact, we, as the listening public, have scarcely begun to feel the impact in terms of new compositions and effects which may be achieved.

As far as the individual is concerned, probably the greatest bar to synthesiser ownership has been the relatively high cost of the commercially available instruments and even the "do-it-yourself" designs which have so far appeared, although significantly lower in cost than their commercial brothers, are by no means cheap to construct. There can be few electronics enthusiasts who would willingly set aside a hundred pounds or so to finance a complex project on which there was no firm guarantee of performance.

Since the *P.E. Sound Synthesiser* first appeared the author has received many requests to design a simpler, low-cost instrument which could possibly be considered suitable for a schools project and which would serve to introduce to the younger members of our society the fascination inherent in the electronic manipulation of sound.

The P.E. Minisonic is therefore presented with the view of complying with the requests received although it is by no means suggested that it is the complete answer.

DESIGN CRITERIA

Most synthesisers rely on a duplication of circuits in order that the most exotic effects may be achieved but such duplication can only be accommodated in terms of additional expense. Consequently there were two principal criteria which governed the design of the P.E. Minisonic.

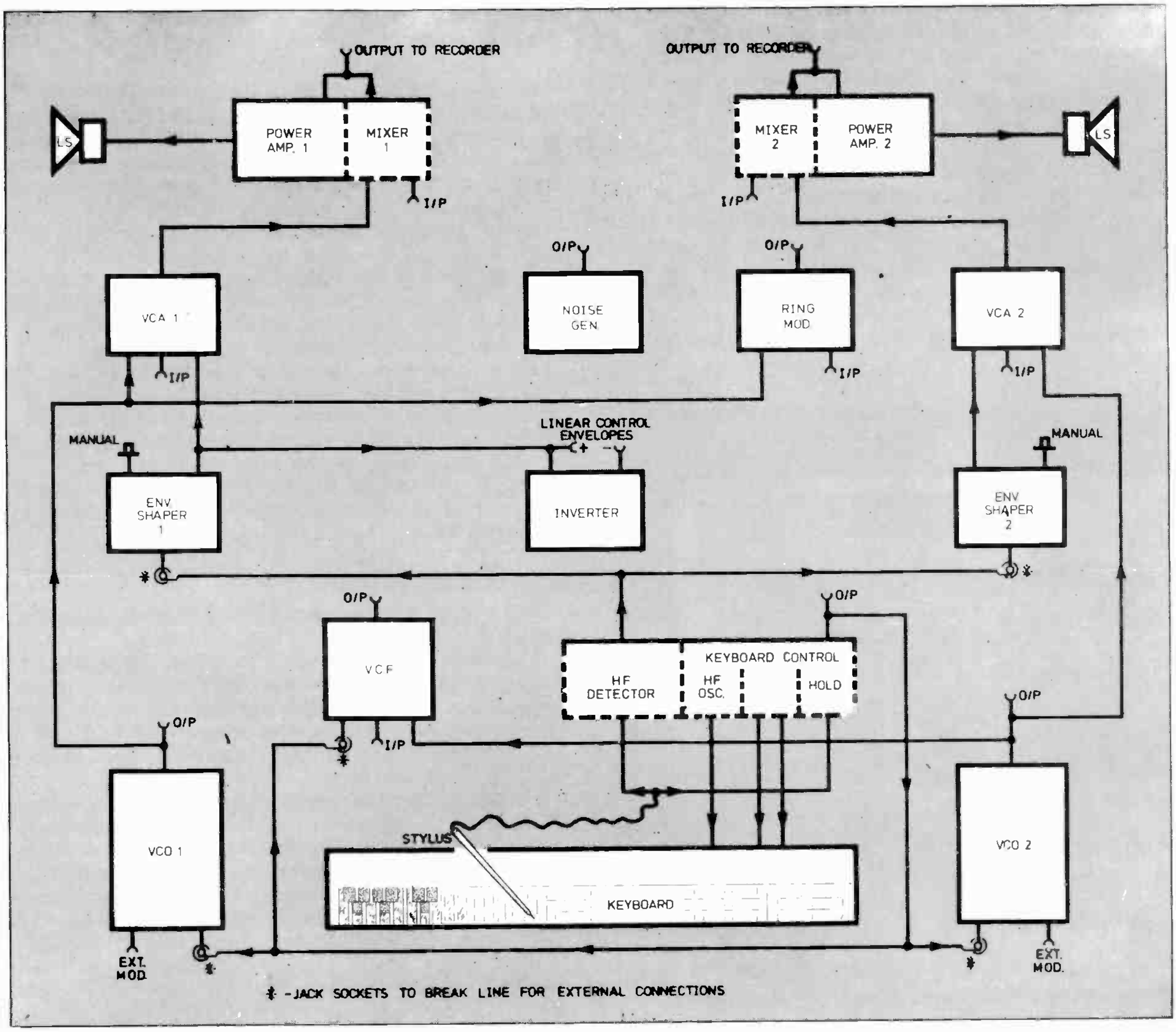


Fig. 1.1. Block diagram of the P.E. Minisonic showing the internal connections between modules

Firstly, the instrument should be able to produce the four forms of modulation, under controlled conditions, which are generally associated with the synthesiser. Thus there are facilities for amplitude, frequency and harmonic modulation, and a ring modulator is included in the scheme. Secondly, to comply with the possible requirement for duplication of circuits, each circuit within the basic instrument to be described can operate quite independently of the remainder.

The second criterion means that the constructor is offered the option of either tackling the project in accordance with the details to be published or of selecting individual circuits and building these separately for experimental purposes.

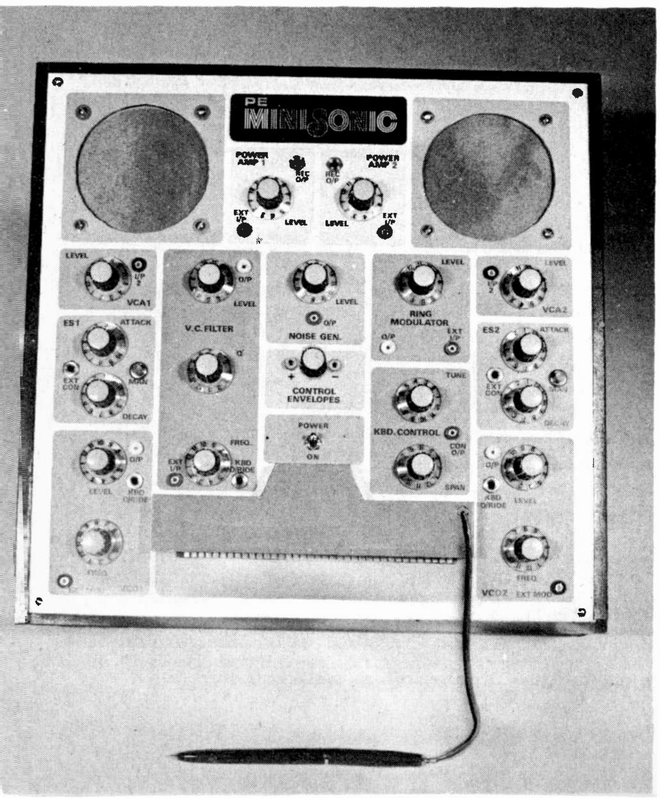
As with most synthesiser designs the possible permutations of circuits are legion and there are no hard and fast rules governing the numbers of circuits of a particular type which are to be included within a particular scheme.

THE SYNTHESISER EXPLAINED

For the benefit of those readers who may, as yet, be unsure of what a synthesiser actually does, the following brief explanations are included.

In general, all sounds may be defined in terms of three parameters: the first being pitch or frequency; the second the amplitude or volume of the sound in relation to the period over which it is audible; and the third the timbre or harmonic content of the sound.

Most naturally occurring sounds and many of those produced by acoustic instruments tend to have fairly complex structures. In the case of acoustic instruments the harmonic content, for any defined pitch, generally varies over the audible duration of the produced sound and can be made to change deliberately depending on whether the instrument is played loudly or softly.



These characteristics are not usually built in to electronic musical instruments and consequently the unchanging pitch and harmonic relationship of any particular sound produces a rather bland effect.

In the synthesiser all parameters governing the produced sound are continuously variable and, indeed, may be varied throughout the duration of a sound. This means that the instrument may be used to imitate conventional acoustic instruments with great exactitude or, on the other hand, it may be used to create totally unique sounds which can range from the amusing to the horrendous.

VOLTAGE CONTROL

The circuits in the synthesiser are operated by means of voltage control, a system which has been utilised by electronics designers for quite a number of years.

Robert A. Moog is generally credited with being one of the first designers to bring voltage control into the realms of electronic music and since the inception of his first voltage-controlled oscillators (VCO) and voltage-controlled amplifiers (VCA) the overall principle has been adopted for an ever widening circle of applications.

The great advantage of the system is that, although the controlling voltage may be derived from within the controlled circuit, it may also be derived from an external source. This, in turn, offers the advantages that differing types of circuit can control one another in various ways and also that, since control and signal paths are quite separate from one another, remote control operation becomes a practical possibility.

In the case of the P.E. Minisonic, control voltages are used in the oscillators to vary the pitch, in the VCA's to vary the sound volume and in the filter to vary the harmonic content.

These examples, of course, relate to the use of voltages of varying levels but there is another form of application in which pulses of fixed polarity voltage can be employed to command the initiation of an event. Again in the P.E. Minisonic this application is utilised in the envelope shaper to signal the start of the envelope which is, in turn, used to drive the VCA.

MINISONIC DESIGN

The overall scheme of the P.E. Minisonic is shown in Fig. 1.1.

Two independent channels are provided each comprising a VCO, an Envelope Shaper/VCA, a mixer stage and a 250mW power amplifier. A white noise generator gives an alternative sound source, whilst a ring modulator and voltage controlled filter (VCF) may be incorporated for additional effects.

To satisfy musical requirements a stylus operated "keyboard" is provided together with a keyboard controller which incorporates an analogue memory. The purpose of this latter circuit is to provide a series of voltages which define the VCO frequencies in terms of musically related tones.

As with the *P.E. Sound Synthesiser* a variable "Tune" and "Span" facility is available and this means, in practical terms, that the upper and lower frequency limits of the three octave, printed-circuit keyboard can be varied at will either in tune or with a range of semitonal frequency increments.

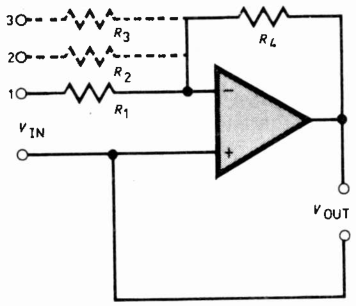


Fig. 1.2. An operational amplifier used in the inverting mode

It is appreciated that a stylus operated "keyboard" is far from ideal in the sense that it requires a great deal of skill to play it satisfactorily and also from the point of view that problems of contact oxidisation can present themselves after a period of use.

Provision is thus made for the connection of a keyboard of conventional design and it is worth pointing out that, with a little ingenuity, a discarded doll's piano can have contacts fitted and be made to perform quite creditably.

There is also an output point for connection to external amplifier or tape recorder. A tape recorder having "sound-with-sound" facilities is particularly useful in that it facilitates the whole potential of the synthesiser being realised.

Within limits imposed by the specific recorder a number of successive recordings can be made and overlaid in such a way as to result in the production of quite complex sound structures.

OPERATIONAL AMPLIFIERS

With the exception of three different types of special purpose integrated circuit which will be described in detail in the appropriate articles, the overall functions of the synthesiser are based on a combination of discrete semiconductors with the ubiquitous 741 operational amplifier.

Where these latter devices are used as part of an input stage for either control or audio signal applications, they are employed in the inverting mode as shown in Fig. 1.2.

In this type of circuit the junction of R_1 and R_4 is known as the virtual earth point. This is because current into the inverting input via R_1 is balanced by an equal and opposite current through the feedback resistor R_4.

The implication is that, when R_1 and R_4 are equal, the gain is unity and, in fact, the gain of such a stage may be expressed as R_4/R_1. The impedance seen by the input signal is effectively the resistance of R_1 and this will not change if additional inputs are provided as shown dotted in Fig. 1.2.

Where more than one input is required the gain of the individual stages is determined in terms of the ratios of the input resistors with the feedback resistor as shown above and the output signal of the operational amplifier, at any instant, is equal to the sum of the signals times the gain.

This point is made in some detail because, in the P.E. Minisonic, the minimum numbers of inputs are provided in order to comply with the requirements of simplicity.

PROGRAMMING

In the case of the VCO, four separate inputs are routed to the control stage. One of these provides a fixed voltage bias which sets the minimum operating frequency of the oscillator; another gives a manually variable voltage which will set the oscillator frequency at any point within its working range; a third routes in a voltage derived from the "keyboard" memory circuit; whilst the fourth is used for external modulation.

All four inputs may be driven at the same time and, in combination, "programme" the oscillator to give a specific frequency or effect. When all the inputs are d.c. the output frequency of the oscillator is unvarying but if, say, a sine wave signal is applied to the external modulation input then the output frequency of the VCO will rise and fall in time with the frequency of the modulating signal and in proportion to its amplitude. This particular scheme is illustrated in Fig. 1.3.

The term used to describe the programming of one oscillator by another is "frequency modulation" and in the specific case where the frequency of the programming oscillator lies between 6 and 8Hz, the overall effect is known as "vibrato".

Where additional modulating inputs are included in the scheme and each is coupled to external oscillators having differing frequencies and output waveforms, then it is possible to create some very complex effects. Careful manipulation of the programming frequencies such that each are multiples of the other, or fractionally related, will give rise to repetitive rhythm patterns covering a wide frequency range.

Whereas programming the VCO results in the production of a fixed frequency or frequency pattern, somewhat similar effects may be achieved by programming the VCF, although, in this case, the effect is based on changing harmonic relationships rather than the creation of discrete frequencies.

As with the VCO, the filter is provided with three control inputs, two of them for bias and manual

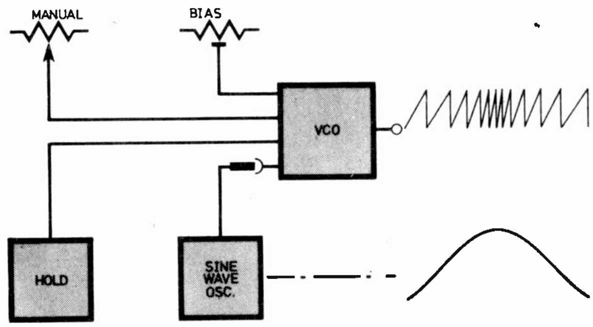


Fig. 1.3. By connecting a sine wave oscillator to the VCO, frequency modulation is obtained. The other inputs are permanently wired. The manual control sets the centre frequency and the preset bias control sets the minimum operating frequency; the remaining connection is from the "hold" circuit via the stylus

HOUSING — CUTTING DETAILS

Hardwood Strip

A 4ft 3in $\frac{3}{16}$in

B 5ft $1\frac{1}{2}$in $\frac{1}{4}$in

C 1ft $\frac{5}{8}$in $\frac{5}{8}$in

Cut A into two pieces 1ft in length and two pieces $11\frac{5}{8}$in length.

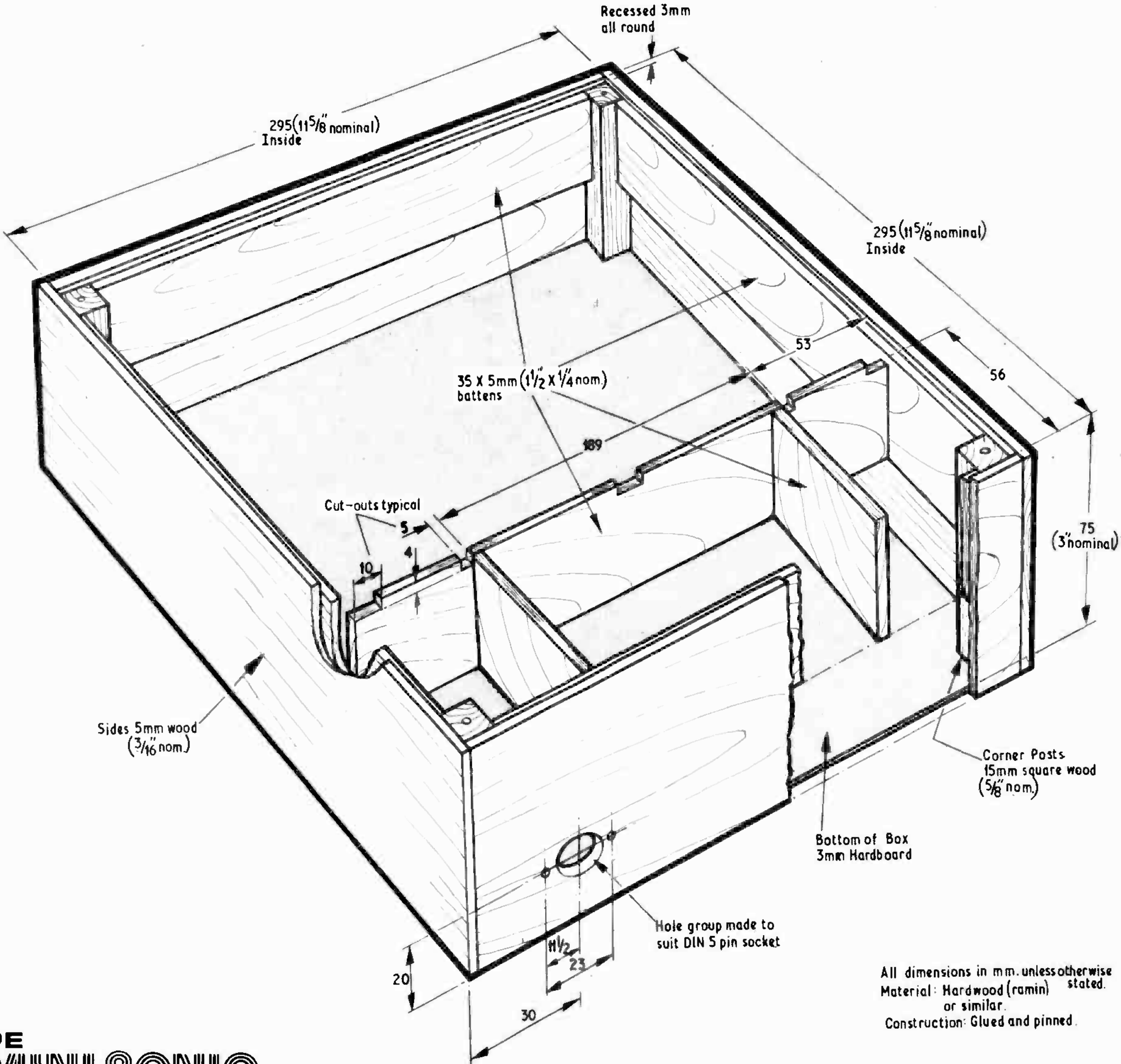
Cut B into four pieces $10\frac{3}{8}$in, one piece $11\frac{1}{8}$in and two pieces 2in length.

Cut C into four pieces $2\frac{3}{4}$in length.

Hardboard

Two pieces measuring $11\frac{5}{8}$in $11\frac{5}{8}$in will be required. The hardboard should be $\frac{1}{8}$in (3mm) thickness and should ideally be faced with white plastic on one or both sides.

The type which is faced on both sides is slightly more expensive but shows less tendency to warp.



PE MINISONIC

Fig. 1.4. Details of the case assembly. Major dimensions are shown in inches (1in = 25·4mm)

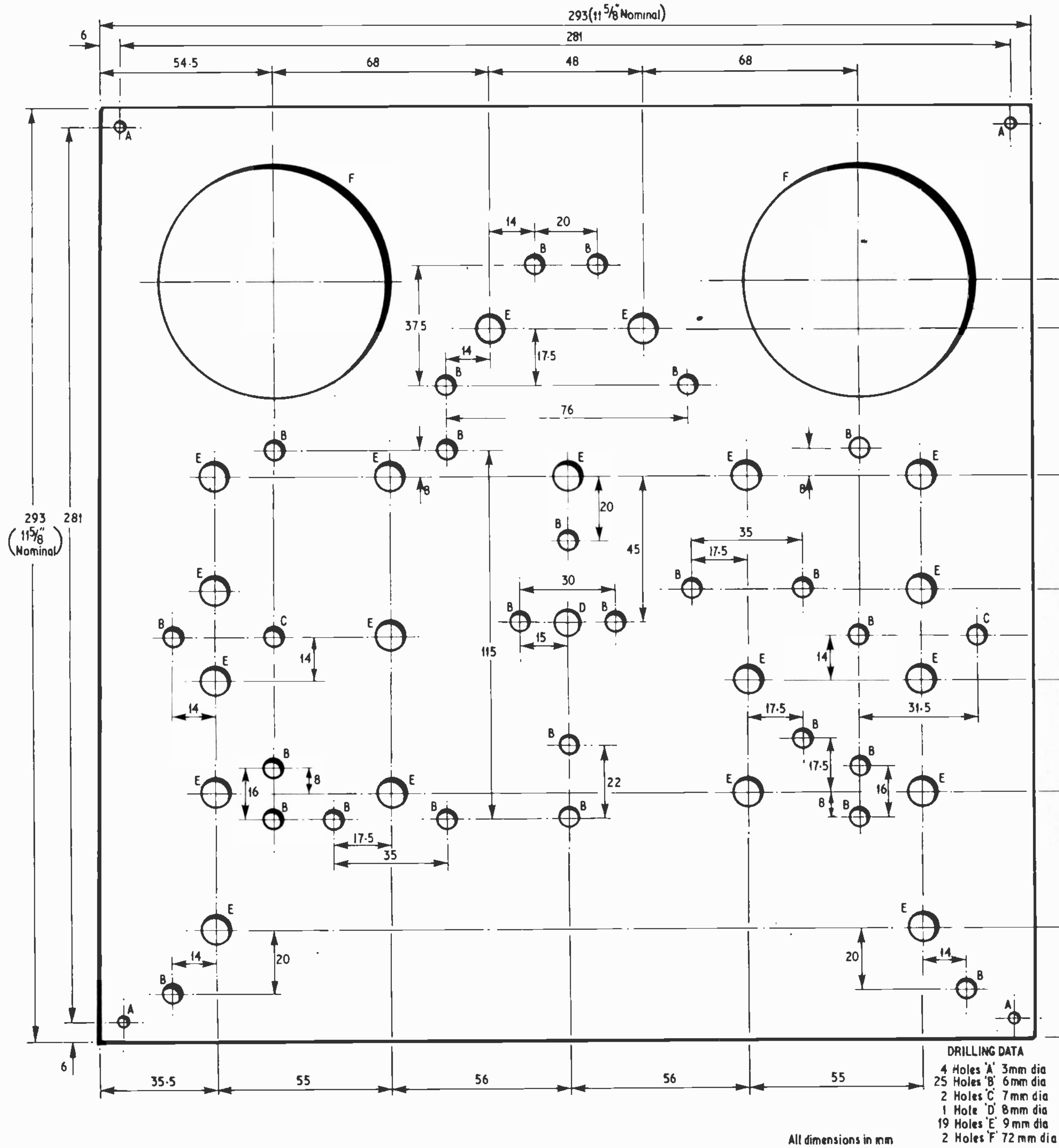


Fig. 1.5. Details of the front panel drilling required for use with scheme shown in block form in Fig. 1.1

control, whilst the third is from the "keyboard" memory circuit so that the filter pass-band range may be "played".

The VCF is a ladder network filter based on the design originally devised by Moog but very much simpler in circuitry and operation. Even so it is extremely efficient and it is quite an easy matter to "lose" the audio signal within the filter unless some care is taken with its operation.

ENVELOPE SHAPER

The envelope shaper is a circuit which produces a voltage which varies with time in a manner prescribed by two controls.

The "attack" control adjusts the period over which the output voltage of the envelope shaper rises to its peak whilst the "decay" control adjusts the period taken by the output to return to zero again.

This so-called "envelope" when applied to the input of a VCA ensures that the audio signal follows, in terms of volume, the prescribed pattern, i.e. with the envelope at its peak; so too is the volume of the audio signal.

Programming of the envelope shaper is not quite as simple as with the VCO and VCF since its operation is dependent upon the application of a pulse of at least −1V which has a duration at least as long as that set by the attack control.

In the P.E. Minisonic two control inputs are provided on the envelope shaper, one coming direct from the keyboard stylus and the other from a manual push button. However, the same basic principles governing the use of additional inputs may be followed although the result is never quite so predictable.

Further details on the programming of the various P.E. Minisonic circuits will be given in the appropriate articles together with instructions for obtaining specific effects.

CONSTRUCTING THE MINISONIC HOUSING

In the interests of simplicity the case of the P.E. Minisonic is constructed from a framework made up of standard hardwood strips which are normally available from most "do-it-yourself" stores or timber yards. Fig. 1.4 gives details of the case assembly.

The top and bottom panels of the case are made from white faced hardboard or similar material and are secured into the case by four corner screws as shown. Fig. 1.5 gives details of the front panel drillings which are required for use with the scheme shown in block form in Fig. 1.1.

The case should be assembled with panel pins and adhesive (Araldite is probably the best type to use) and can be sprayed a suitable colour on completion. During assembly care should be taken to ensure that the case is assembled with absolutely square corners and it is a good idea to use the top and bottom panels as a guide in this respect.

Both front and rear panels are secured to the housing by means of four corner screws.

The front panel, once assembled with components, is normally a permanent fixture whilst the rear panel has to be removable to allow for changing the batteries.

Next month: The VCO, Envelope Shaper/VCA, and Voltage Controlled Filter

NEWS BRIEFS

ON CALL

With the opening last month of a further Carphone centre for the Midlands, motorists whose cars are equipped with car radiophones are now able to make calls over a much extended area.

Now they can call from a new 3,000 square mile area which includes Wolverhampton, Coventry, Birmingham, Rugby, Northampton and Banbury. This is the first of five new centres to be completed and the station, located in Birmingham, is able to handle 300 users.

The other four areas will be opened up over the next two years but what is perhaps more important to users is the fact that now any user from one area can also operate in another area. Up to the present this has not been possible but the Post Office have now modified the system suitably.

LICENCE FOR SAFETY

The car licence plate could well perform a somewhat more complex role in the future if scientists at RCA Corporation have their way.

Using a complex antenna capable of receiving at one frequency and retransmitting at another, twice the first, they propose that an electronic "number plate" can be created which will be capable of interrogation at will on instruction transmitted to it.

Apart from this "big brother" aspect, the system can, of course, also be used for much more apparently useful purposes such as simple radio communication to and from a vehicle or perhaps operation as a transponder in collision-avoidance radar.

With suitable devices buried in the road at intervals, traffic could be examined not only as to quantity but also as to quality, with identification of such items as ambulances and fire engines being used to control traffic lights.

This basic idea is not new but the means for doing it cheaply is, and here RCA scientists reckon the cost could be in the "few dollars" region when manufactured in quantity.

HIGH FLYER

Air traffic control systems were well in the news last month with the announcement of two large orders, one to Plessey and the other to Marconi.

The first is an export order from Mexico and involves an automated radar air traffic control system at Monterrey Airport and instrument landing systems for Puerto Vallarta and Tijuana airports. The equipments form part of the first stage in a multi-million pound programme for the complete modernisation of air traffic operations in Mexico.

The second contract is for the supply of a radar data processing system for Scotland. This is a major contract, worth something in the region of £1·25 million, and involves equipment capable of monitoring both civil and military aircraft in the 2 million cubic miles of airspace above Scotland, Northern England and the North Sea.

Based on the new Marconi Radar Systems Locus 16 processor, one of the first systems in the world to use synthetic "clutter free" radar presentation exclusively, the system will provide an automated radar presentation, simplifying the control of aircraft in the Scottish terminal area which includes the areas round the rapidly expanding Glasgow and Edinburgh airports.

ANTI-THEFT ALARM

By B.A. ANDERSON

DESPITE steering locks, "Krookloks", and the like, car stealing is still a thriving business. A possible reason for the apparent failure of many commercial anti-theft devices is the need for a mechanical key to deactivate them. Thieves have been accustomed to mechanical keys for centuries, and it is thus not unduly surprising to hear of vehicles being stolen despite locks of various kinds.

The anti-theft system described here uses an electronic key in the form of a specific value of resistance for deactivation. The system measures the resistance electronically and deactivates only if the value is correct. With careful installation the security offered by this design is exceptionally high, and with a cost of around £3·00 it is good insurance for a possession which may be worth over £1,000.

THE CIRCUIT

As may be seen from Fig. 1, resistors R1, R2, R3 and R4 comprise a Wheatstone bridge with a removable element R1, which connects to the bridge via a plug and socket. With R1 connected, opening a car door operates a courtesy light switch and connects the battery to the circuit. Since the values of R1 to R4 are all equal, the bridge is balanced, TR1 and TR2 remain off, and relay RLA is off. The car can thus be used normally.

If R1 is disconnected however, or is replaced with an incorrect value of resistance, the bridge is unbalanced and an out-of-balance voltage appears between the junctions of R3/4 and R2/incorrect R1. Depending on whether the incorrect value of R1 is too high or too low, this out-of-balance voltage may be positive or negative. Diodes D1 to 4 are thus connected as a bridge rectifier to render the out-of-balance voltage a constant polarity and this is applied to TR1 with positive to base and negative to emitter.

Hence, unbalancing the bridge will always turn on TR1, which in turn switches on TR2 and RLA. The end result is immediate operation of RLA on opening a car door when R1 is incorrect.

The contacts on RLA are arranged to disconnect the starter switch and earth the starter solenoid (RLA4), to sound the horn (RLA3), and to short out the contact breaker points in the distributor (RLA2). In addition contacts RLA1 bypass the triggering door switch so that reclosing the door after setting off the alarm has no effect.

Once triggered, the alarm can be immediately deactivated with the correct R1 by the owner, or by disconnection of the battery by the thief. However, battery disconnection precludes stealing the car, and any attempt at reconnection will result in retriggering of the alarm when the door is reopened.

With R1 inserted, and the doors closed, the alarm is disconnected from the battery, and hence draws no current when the car is parked. Removal of R1 will then activate the alarm, although still no current will be drawn until a door is opened by a thief. Thus the car can be left parked and protected for long periods with no drain whatsoever on the battery.

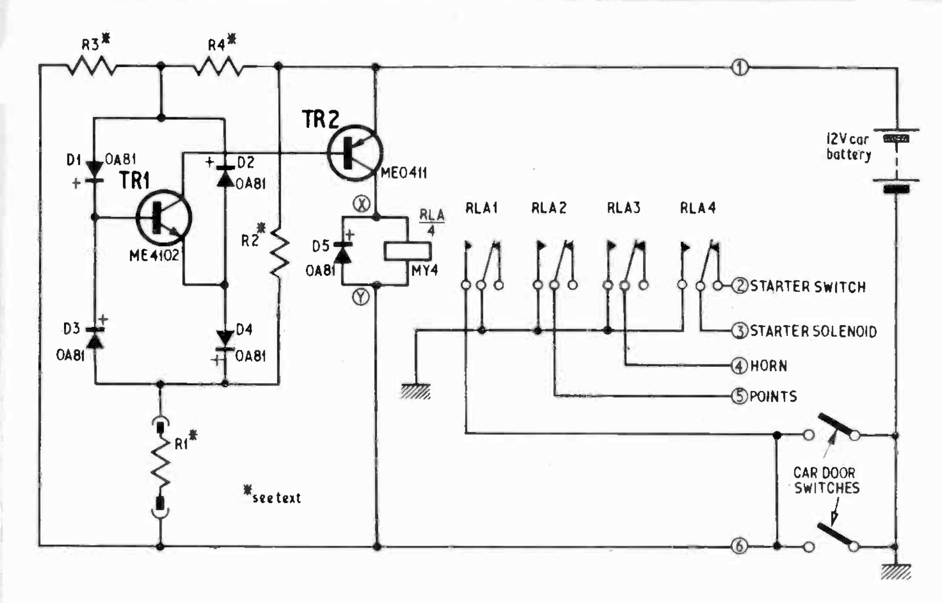
CONSTRUCTION

The components of the alarm may be assembled on a small piece of Veroboard using the layout of Fig. 1, the relay being mounted separately. A small plastic lunch box may be used as a container for the alarm, and the Veroboard may be glued to a piece of foam rubber and then to the box, and the relay may be glued directly to the box. Connections from the relay and the circuit board may be brought out to a terminal block on the outside of the box for connecting to the car.

Alternative components to those specified may of course be used, however it should be noted that TR1 and TR2 have been chosen for their high V_{cbo} and complimentary gains. Alternatives may be more prone to failure due to voltage spikes from an inductive or capacitive discharge ignition system, and the sensitivity and selectivity of the bridge may be adversely affected.

Diodes D1 to 4 must be of the specified types, since alternatives may have a higher turn-on voltage which would severely restrict the sensitivity of the bridge. If using a different relay, ensure that the coil

ANTI-THEFT ALARM



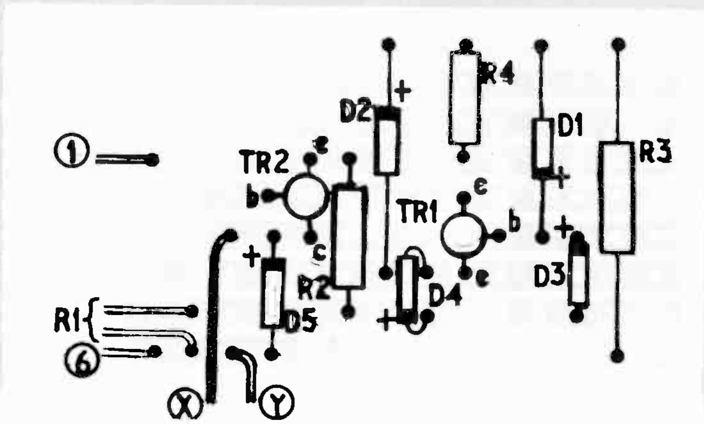


Fig. 1. Circuit diagram of the Anti-theft alarm (above) and the Veroboard and component layout (below)

COMPONENTS . . .

Resistors
R1 to 4 See Text, 5%, $\frac{1}{4}$W

Semiconductors
TR1 ME4102
TR2 ME0411
D1 to D5 OA81

Miscellaneous
RLA Omron type MY4, 12V d.c.
Veroboard, wire, terminals, terminal strip if required, box, etc.

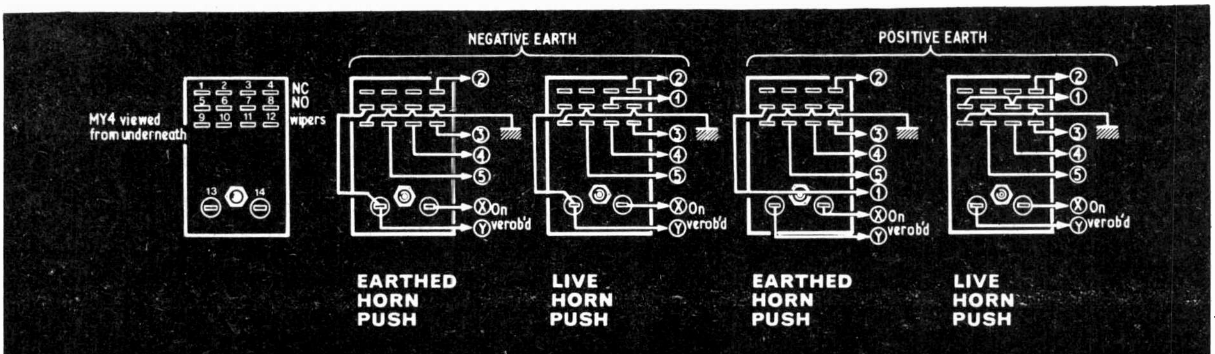


Fig. 2. Four sets of wiring for the Omron relay used in the prototype. From the left, the rear view of the relay showing the pin numbering and layout, connections for earthed horn push (– ve earth), live horn push (– ve earth), earthed horn push (+ ve earth) and live horn push (+ ve earth)

chosen will not exceed the dissipation of TR2, and that the contacts are of adequate rating for the circuits to be controlled.

INSTALLATION

By reference to your car's wiring diagram, determine whether it is negative or positive earth. Additionally determine whether the horn push operates the horn by earthing or by connecting to the "live" side of the battery. Connections to the contacts of RLA vary for negative and positive earth, and for earthing and live horn pushes, and the four possible connections are given in Fig. 2 for an Omron relay. Other relay types can be determined from the interconnecting point routes.

Whatever the polarity of your car's system, if the horn push is of the earthing type, check that it can be sounded with the ignition switched off. If it cannot, it will be necessary to disconnect the live supply horn lead from its ignition switched terminal at the fuse box, and reconnect it to a terminal that is unswitched by the ignition switch, i.e. a terminal that connects directly with the battery. Make certain the fuse ratings are suitable.

TESTING

Having wired RLA correctly, and having connected the Veroboard, the alarm should be tested by connecting 12V, positive to terminal 1 and negative to terminal 6. The relay should operate immediately, and drop out as soon as the correct value of R1 is connected.

With this test satisfactorily completed, seal the container (lunch box) against moisture, and mount it in the car. It should ideally be in the passenger compartment somewhere, well hidden, and in most cars a suitable place can be found up behind the dash panel, the box being secured with adhesive.

Connections to the car wiring harness are shown for positve and negative earth systems in Fig. 3, and both possible types of horn push circuit are shown.

WIRING-IN

All connections should preferably be soldered, well insulated and waterproofed with good quality PVC tape. Wires can be run back to the alarm along the existing harness, and should be bound over with PVC tape to match the rest of the harness for concealment when installation is complete. Connections particularly prone to tampering by the thief are the horn connection, the contact breaker connection, and the live battery connection, and these wires should be carefully concealed.

If utmost security is needed, the wires may be run in metal conduit and all terminations sheathed in metal terminal boxes. The fitment of air horns in place of the standard horn is an excellent measure, and suitable types including relay are available from Ivoryet Limited, 124 Cricklewood Broadway, London, N.W.2, at prices varying from £4 to £12, according to the number of trumpets with which you wish to disquiet the thief.

If you really want to induce cardiogenic shock in the criminal you can fit an air siren in place of the horn. A suitable type, the Mono 12V siren, is available from Klaxon Limited, Warwick Road, Tyseley, Birmingham, price about £10. Persons of a delicate constitution are warned not to set this device off accidentally.

If your car has a mechanically operated starter switch, and hence no starter solenoid—the early British Leyland Minis have such an arrangement, then terminal three of the alarm may be taken to the petrol pump, and terminal two should receive the wire formerly connected to the pump. The alarm will then immobilise the petrol pump in place of the starter motor.

OUT OF SIGHT

If you regularly leave your car out of earshot of yourself and passers-by, then there is little point in having the horn operated by the alarm, since it will only flatten the battery in time. The thief will not be able to steal your car with a flat battery, but clearly it will cause you inconvenience, and thus an on/off switch may be wired between terminal four and the horn, and hidden somewhere in the car. Switching it off will prevent the horn being sounded by the alarm, but the immobilising features will be retained.

The connection between R1 and the alarm is by a plug and socket of the constructor's choosing. R1 is mounted inside the plug, and the socket is mounted somewhere on the exterior of the car. If you do not wish to drill the bodywork directly to

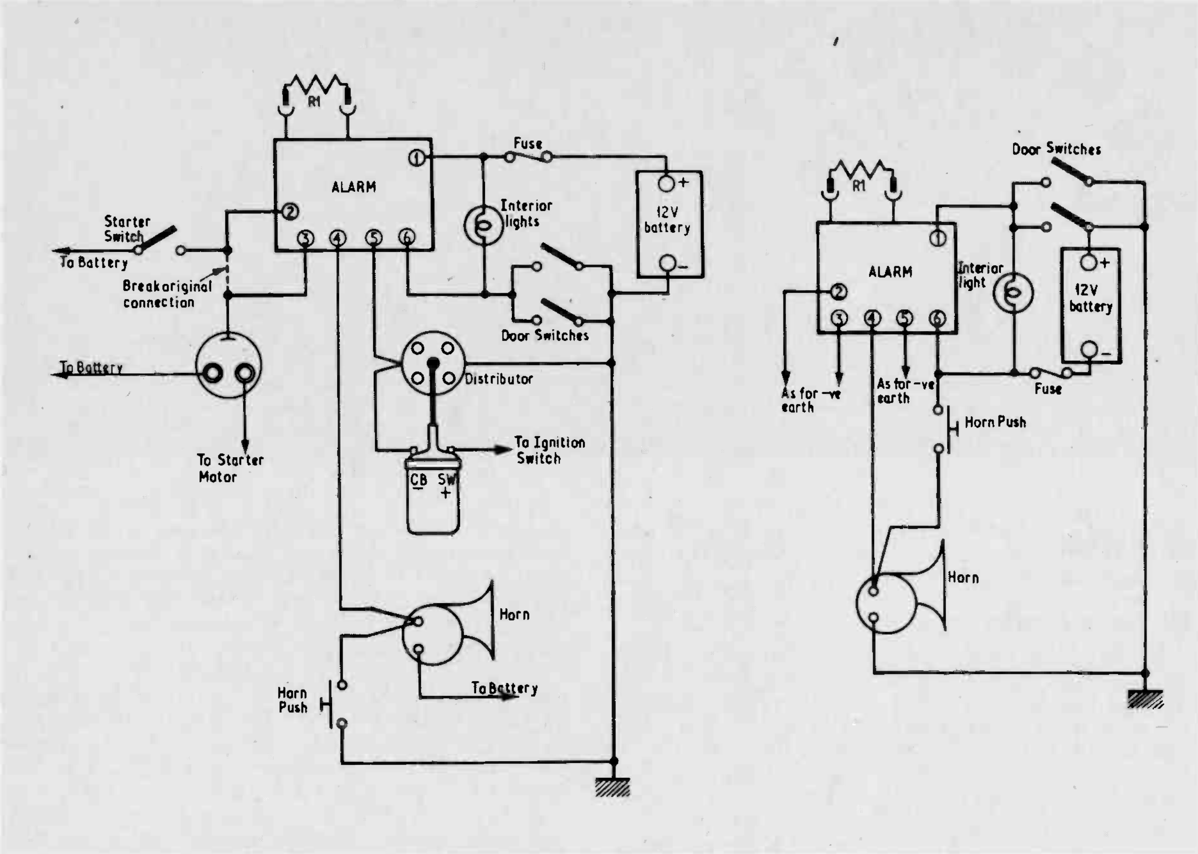


Fig. 3. Interconnections to the car wiring harness for negative (left) and positive (right) earth systems, showing the two variations of horn wiring as well

mount the socket, on the majority of vehicles it can be mounted in an air-grille or mounted in the centre of a badge. Removal of the socket at a later date can be concealed by a new badge. If mounting has to be done directly through the body, if the hole is in an unobtrusive position it may be sealed with a grommet on removal, and nine times out of ten will not be noticed.

The type of plug and socket chosen and the value of R1 are individual choices which ensure the security of the design.

The author has used connectors varying from Post Office jacks to multi-way edge connectors with success. If a multi-way connector is used additional security results since any two contacts may be used.

Values of R1 have varied from 47Ω to 4·7kΩ with equal success, but 5% tolerance or better should be used. Temperature drift offers no problems, but if the car is kept outside, values much above 2kΩ should be avoided since condensation can give problems with higher values.

When mounting the socket, remember it must be accessible to the driver who removes and replaces R1 each time the car is used, and the socket must also be mounted away from direct road spray. In the choice of type of connector, use only high quality professional types that will withstand the constant use and the elements.

HOW MANY

Three plugs and three R1's are required. One to use and carry in the pocket; one spare on the car key-ring; and another spare in the wallet or purse.

If your car does not have courtesy light switches, or if it lacks them on the rear doors, extras are easily fitted and cost about 13p from garages. They mount via spring clips in a ½in hole in the door pillars, and should be fitted to the boot and bonnet too if it can be opened from outside the car. Wire all switches in parallel and to the appropriate terminal on the alarm.

USE

Park the car, close all doors, and remove R1 in its plug. The alarm is now set. If it is triggered by a thief or accidentally the horn will sound, the ignition will be immobilised and the starter motor will not operate. Reclosing the triggering door will have no effect. Triggering by accident may be quickly silenced with the insertion of R1, and if you forget to insert the plug, unlock the door, and set off the alarm, the spare plug on the key-ring is readily available to stop the false alarm. Removal and replacement of R1 soon becomes automatic, and since it is removed on parking, no-one can tamper with the resistor. The car is of course driven with the resistor in place. ★

INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

555 CHIP IMPULSES PENDULUM

READERS interested in horology may find this circuit, using a 555 i.c. to impulse a pendulum, handy. The reed switch S1 of Fig. 1 is closed when the magnet swings near the reed, proximate the end of the pendulum swing.

The timer is triggered and stays high for 1·1 × C1 × VR1 seconds and there can be no re-triggering until the output has again gone low. Period adjustment is by VR1.

The period should be adjusted until the l.e.d. just goes on when the pendulum is vertically over the solenoid so that the pendulum is pulled towards the centre and when it reaches the centre the force is removed.

If required, a TTL output for counters or the like can be taken from pin 3 of the chip via a potentiometer. Changes in supply voltage make little or no difference to the time period of the chip but will change the force exerted by the solenoid. The circuit may be operated from between 5 and 18V depending on the type of solenoid and amplitude needed.

Component values are not critical and were selected more because they were to hand. For example C1 was selected at 1000μF but can be something smaller with suitable alteration of VR1. The solenoid used came from Henry's Radio and the reed switch from Electrovalue Ltd.

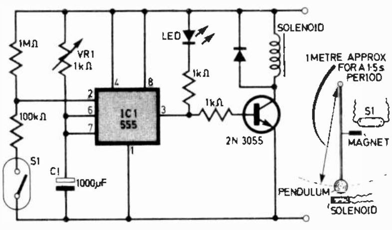


Fig. 1

R. J. Wylde
Eton College
Windsor

BASS BOOSTER

MOST of the popular slanted front-facing speakers used in car stereo systems have a very poor bass response. One way around this problem, without sacrificing the stereo image, is by mounting a third speaker in-between, flush mounted from the inside of the car boot. An Elac 8in × 5in was used.

This third speaker can be fed by crossover components, but this method was found unsatisfactory and expensive. Instead, the circuit of Fig. 1 was used, which proved to be cheaper, and offered much more flexibility.

The first stage can be fed directly from the speaker lines of the tape unit as shown in Fig. 1. This stage serves as both mixer and Miller integrator. The capacitor of the integrator was chosen to be 10nF so as to pass only real Bass and very little of the middle range, preventing shrinking of the stereo stage; this value is not too critical.

The next stage recovers the big loss of the first stage, and feeds the signal into a power amplifier through the Bass control. The amplifier used was Sinclair's super IC12, but any other cheap package will do. The decoupling capacitor (400μF) should be mounted as close as possible to the first transistor stage, which is prone to the pick up of low frequency engine noise. The IC12 module has its own decoupling capacitor, which should also be of a similar value.

M. Greenfeld,
Leeds.

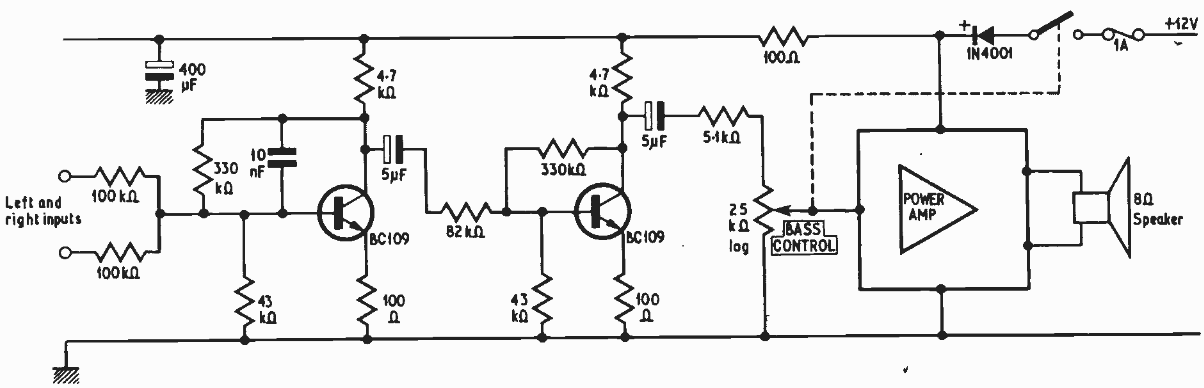


Fig. 1

VOLTAGE CONTROLLED OSCILLATOR

With the current interest in voltage controlled oscillators, it seemed to me that they were all rather complicated. Perhaps the readers will be interested in this circuit.

It is a linear device giving about 1kHz per volt. It can be built for less than £2.

Integrated circuit IC1 acts as an integrator and IC2 as a threshold circuit. The input signal is applied to both inputs of IC1. The f.e.t. acts as a switch controlled by the output of IC2. When the output of IC2 is near the positive rail TR1 acts as a near short circuit so the input is applied to the non-inverting input of IC1 giving a positive going output.

The non-inverting input of IC2 is at appproximately 6·3V and as soon as its inverting input rises above this level IC2 rapidly switches to −6·3V causing TR1 to act as a near open circuit. The ouput of IC1 then begins ramping in the opposite direction.

Thus the frequency of oscillation depends on the input voltage.

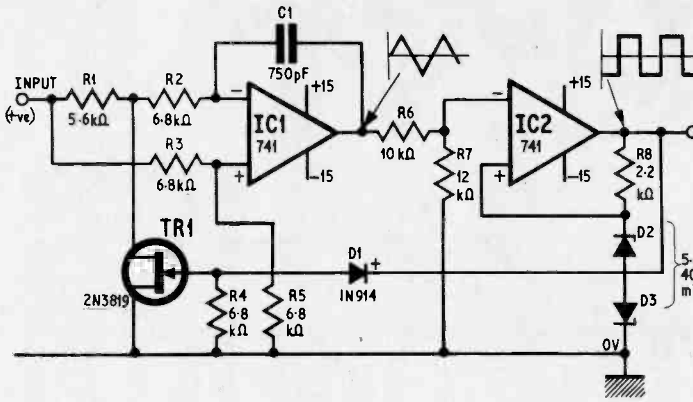


Fig. 1

To obtain a log law there is no reason why the transistor oven described in PE could not be adapted to drive this VCO.

J. S. Broadhurst
Winnington
Cheshire

RANDOM IMPULSE GENERATOR

The circuit described here was designed as a novelty light flasher, but it may be used to control higher power devices, or in conjunction with a TTL divider to replace a low frequency impulse generator. Noise pulses are generated at about 1 to 10Hz.

The noise generator TR1 (Fig. 1) is a transistor which generates a low frequency flicker noise. All transistors do this to some extent.

The best source of suitably noisy transistors appears to be the widely advertised packs of unmarked, untested transistors. The type used in the prototype were BFY50/51/52.

Suitable transistors may be selected using the circuit of Fig. 2; they generally have a leakage of a few microamps to ¼mA and the flicker noise is visible as a very slight irregular vibration of the meter needle.

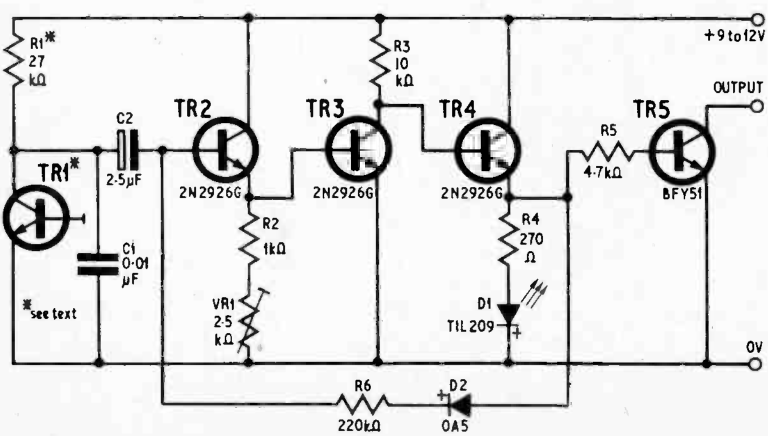
Resistor R1 (Fig. 1) is selected to give a collector voltage of about 6V for TR1. C1 removes high frequency noise, and the signal is coupled to the amplifier by C2.

The emitter follower TR2 presents a high impedance to the signal.

Negative pulses from TR2 emitter cut off TR3 and illuminate l.e.d. D1 which provides a visual display. Negative feedback via D2 and R6 provides thermal stability for the amplifier and also limits pulse length (determined by R6, C2 and VR1). VR1 adjusts the bias of TR3 providing some measure of threshold and therefore repetition rate. If the degree of control provided by VR1 is insufficient, R6 must be altered.

TR5 and R5 may be added as shown if the circuit is to drive TTL in which case a Schmitt trigger (e.g. 7413) should be used to obtain fast rise and fall times. If TR5 is connected as an emitter follower, a power transistor, thyristor or triac may be driven to control larger loads.

J. S. Jolley
Preston
Lancs



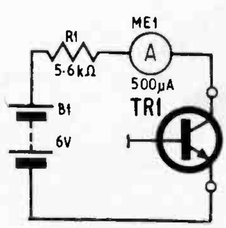


Fig. 2

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NEW DEVICES ...APPLICATIONS

PRECISION WAVEFORM GENERATOR/VOLTAGE CONTROLLED OSCILLATOR

WHAT WILL probably prove to be a very useful integrated circuit has been produced by Intersill, the 8038 precision waveform generator and voltage controlled oscillator. This is a monolithic device capable of providing the user with square, sine, triangle, sawtooth and pulse outputs of high accuracy with a minimum of external components.

As the frequency or repetition rate can be varied from 0·001Hz up to above 1MHz and is stable over a wide temperature range, this device will doubtless see applications in audio waveform generation as well as in instrumentation and control circuitry.

The output frequency can be voltage controlled so this makes for simple swept frequency provisions and indeed the frequency can be programmed digitally using either resistors or capacitors.

One important application which will doubtless be useful in view of the current interest in phase locked loops is the ability of the 8038 to interface with such circuitry to reduce temperature drift to below 50 parts per million.

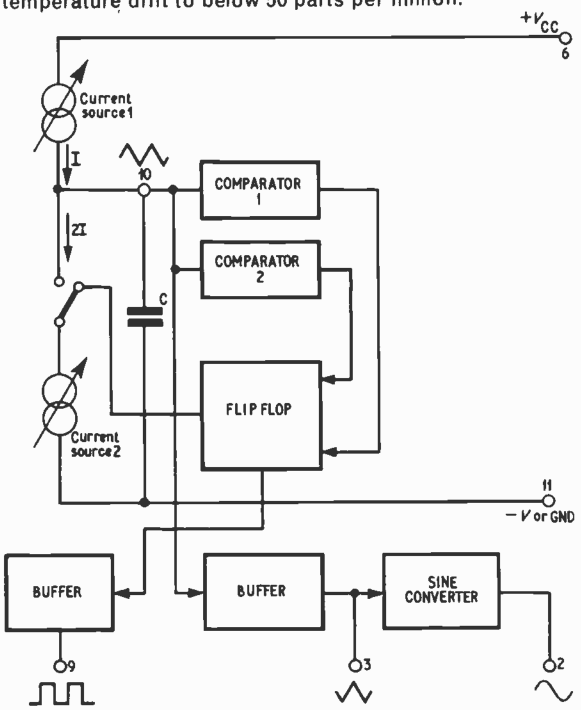


Fig. 1. A simplified block schematic of the 8038 integrated circuit

CIRCUIT DESCRIPTION

A simplified block schematic of the 8038 is shown in Fig. 1. The full circuit includes over 100 devices; it is somewhat complex to reproduce here.

The 8038 can operate from a single or a double power supply of up to $\pm$18V or 36V max., whilst the dissipation is only 750mW. Input to any pin should not exceed the supply voltage and the input current to pins 4 and 5 (those governing duty cycle frequency) should not exceed 25mA.

In fact the duty cycle can be varied between 2 and 98 per cent which means that whilst the chip outputs are in fact basically three, sine, square and triangle, the modification of the square and the triangle by duty cycle variation provide pulse and ramp waveforms. The symmetry of all three basic shapes is varied at the same time so that the sine output is also altered as can be seen in Fig. 2 which shows first a 50 per cent duty cycle (squarewave) and then the effect of adjustment to a 20 per cent duty cycle. The phase relationship of the waveforms remains constant throughout such alterations.

There are several ways in which the timing function can be adjusted dependent on requirements for adjustment of the duty cycle and accuracy of the various components.

Thus Fig. 3 shows a suitable circuit for adjusting the frequency and duty cycle with most accuracy. Here the two timing resistors R_A and R_B are kept separate. R_A controls the rising portion of the triangle and sine wave and the O portion of the square wave.

The magnitude of the triangle waveform is set at $1/3V_{cc}$ so that the rising portion of the triangle becomes:

$$t_1 = \frac{C \times V}{I} = \frac{C \times \frac{1}{3} \times V_{cc} \times R_A}{\frac{1}{5} \times V_{cc}} = \frac{5}{3} R_A \times C$$

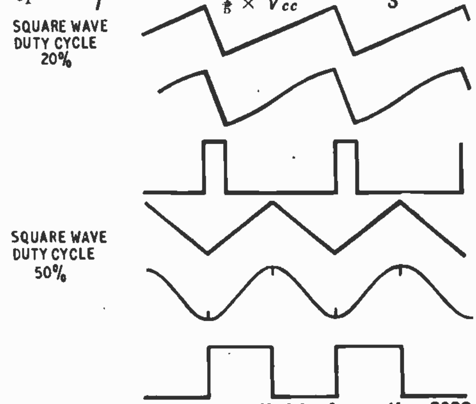


Fig. 2. The waveforms available from the 8038 using a 50 per cent duty cycle and a 20 per cent cycle. The small blips on the sinewave are switching transients from the square wave

The falling portion of the triangle and sine wave and the 1 state of the square wave is:

$$t_2 = \frac{C \times V}{I} = \frac{C \times \frac{1}{3} \times V_{cc}}{\frac{2}{5} \times \left(\frac{V_{cc}}{R_B} - \frac{1}{5}\right) \times \frac{V_{cc}}{R_A}} = \frac{5}{3} \times \frac{R_A R_B C}{2R_A - R_B}$$

Thus a 50 per cent duty cycle is achieved when $R_A = R_B$. If the cycle is to be varied over a fairly small range then the circuit of Fig. 4 can be used and finally if no adjustment of the duty cycle is needed then the circuit of Fig. 5 suits. With this last suggestion there is an inherent variation of the duty cycle which exists which may cause problems.

With two separate timing resistors the frequency is given by:

$$f = \frac{1}{t_1 + t_2} = \frac{1}{\frac{5}{3} R_A C \left(1 + \frac{R_B}{2R_A - R_B}\right)}$$

If $R_A = R_B = R$ then:

$$f = \frac{0{\cdot}3}{RC}$$

for Fig. 3. If a single timing resistor is used as in Figs. 4 and 5 then:

$$f = \frac{0{\cdot}15}{RC}$$

As both currents and thresholds are direct linear functions of the supply voltage their effects cancel out and neither time or frequency are dependent on supply voltage.

SINEWAVE OUTPUT

If the most important output is sinewave then perhaps the circuit of Fig. 6 should be used. Here the 81kΩ resistor wired between pins 11 and 12 is made variable (100kΩ) so that a distortion of less than 1 per cent can be achieved. In fact the introduction of the second 100kΩ potentiometer feeding pin 1 takes the reduction in distortion down to around 0·5 per cent.

SELECTING THE TIMING COMPONENTS

The timing components R_A, R_B and capacitor C can be selected from quite a wide value range bearing in mind one or two constraints which must be applied. The charging current should be controlled for optimum performance so that at the low end it does not fall below 1µA and at the upper end it does not rise above a few milliamps.

In the first place the lower current limit is placed by the effect of other circuit leakage currents and at the upper end the transistor betas and saturation voltages will introduce errors at above 5mA. Thus the best range is between 10µA and 1mA. If pins 7 and 8 are shorted together the charging current for R_A can be determined from:

$$I = \frac{R_1 \times V_{cc}}{R_1 + R_2} \times \frac{1}{R_A} = \frac{V_{cc}}{5R_A}$$

and a similar equation holds for R_B.

VOLTAGE LEVELS

Using a single power supply the average levels of triangle and sine output will be at one half of the supply voltage whilst the square output will move between +V and ground. Using a split supply the waveforms are symmetrical about ground.

As the square output is not committed it may be fed to a different power-supply as long as the applied voltage remains within the breakdown capacity of the chip (30V). Thus the chip may give a TTL compatible square wave output with its load resistor connected to +5V whilst being fed from a much higher voltage.

FREQUENCY MODULATION

As the frequency generated is a direct function of the voltage at pin 8 as measured from $+V_{cc}$ frequency modulation can be achieved by altering this voltage suitably.

Small frequency deviations up to say 10 per cent can be generated by using the circuit of Fig. 7 in which the deviation voltage is fed to pin 8, decoupled with a capacitor. The resistor connected from pin 7 to pin 8 serves to increase input impedance and can be ignored in which case the pins are shorted when the input impedance becomes 8kΩ.

For larger deviations or for frequency sweeping the sweep signal is applied between pin 8 and $+V_{cc}$. Pin 7 is ignored and the circuit is otherwise identical to Fig. 7.

Quite large sweeps can be obtained up to 1,000 : 1 but care must be taken to regulate the supply voltage since in this configuration the frequency becomes dependent on the supply voltage. The potential on pin 8 can be swept from V_{cc} to $2/3V_{cc}$.

APPLICATIONS

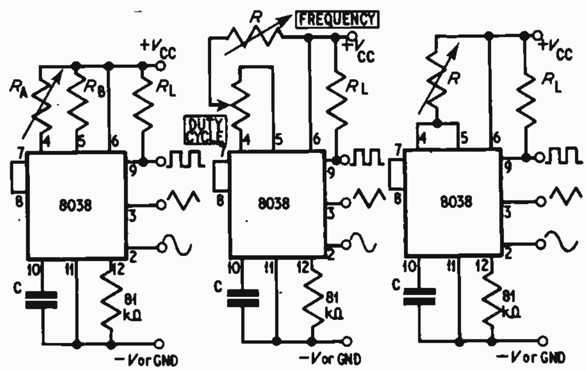
The 8038 has very obvious applications in signal generation areas such as music synthesis, the more so as it lends itself to simple voltage/frequency control and could easily form the basis of a monophonic system as a simple instrument in its own right or in a synthesiser used in conjunction with other envelope generating equipment.

In phase locked loop systems such as are used in f.m. reception it has a valuable role used in conjunction with a phase detector and an amplifier, both of which are available in i.c. form. Whilst several steps have to be taken to assure the alignment of the parts of such a system the benefits are useful.

Not only is a free-running frequency with very low temperature drift provided but a large reconstituted sinewave is available with the frequency of the input.

Finally there are many areas of instrumentation and measurement where the chip should prove invaluable, particularly to the cost-sensitive experimenter and amateur.

These devices and further information are available from Celdis Ltd., 37/39 Loverock Rd., Reading, Berks, priced at £2·85, post and packing 25 pence plus VAT.



Figs. 3 to 5. Three basic circuits giving various control configuration for the 8038

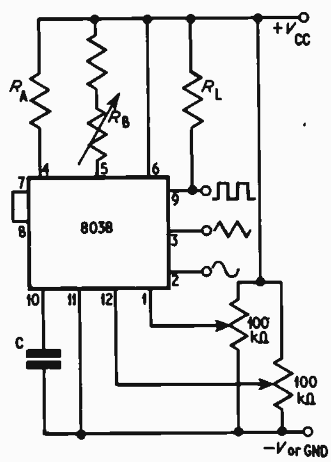


Fig. 6. The way to obtain minimum sinewave distortion

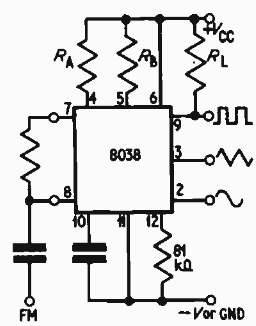


Fig. 7. Using this configuration frequency sweeping is easily obtained

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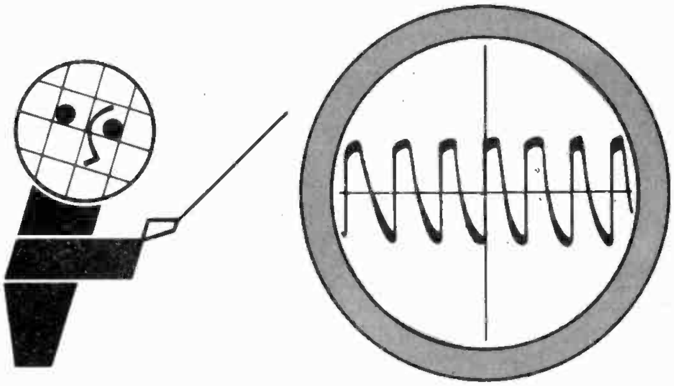

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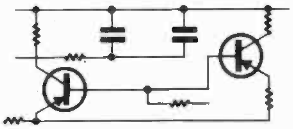

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HYBRID Computers PART TWO

BY D. AL-DABASS*

IN THE first article on hybrid computers the advantages and limitations of both analogue and digital computers were outlined in some detail. From this it is obvious that some combination of these two types of computer would be desirable and the motivations for hybrid computers were then identified and set out in detail. In this part the spectrum of hybrid computing techniques is outlined and the "balanced" hybrid computer is described. Applications are then dealt with in some detail.

THE RANGE OF HYBRID TECHNIQUES

In the broad sense the term "hybrid computing" can be used to envelop a wide variety of computing systems that combine some aspects of both analogue and digital techniques.

The techniques can be broadly divided into three major categories, namely those that are predominantly digital, those that are predominantly analogue, and those having a balanced combination of both computers.

Systems in the first two categories can be further sub-divided into three types, namely those that are purely of one type, those that contain aspects of the other type in concept, and those that contain aspects of the other type in hardware.

PURE DIGITAL COMPUTERS

These include all the large, midi, and mini type machines made by such manufacturers as ICL, IBM, Boroughs, Digital Equipment Corporation, Computer Automation, Scientific Data Systems, and so on. The larger type is often provided with a number of remote keyboard terminals to provide a time-shared service to schools, colleges and other users. They are generally provided with programme packages to enable users to write their problem in a high level language such as Fortran, Algol, PL1, Basic, etc. A high level language approaches the written word, the higher—the nearer. The lower the language the more like a machine code it becomes. This latter is the language of the computer itself. Those that have remote terminals are usually operated "on-line" so that the user can feed his problem and get the results in a matter of minutes.

DIGITAL WITH ANALOGUE LANGUAGES

Some of the large computers mentioned above are supplied with high level simulation languages that can perform integration. This enables the user to write his problem as a set of differential equations without the need to write integration routines himself. Among the many such languages are Speed, SL1, and CSMP.

DIGITAL DIFFERENTIAL ANALYSERS

These are digital computers deigned to perform integration in a similar way to analogue computers. "digital hardware integrator" is another term used to describe them. They include the serial, parallel and hybrid types. The serial type handles one integration at a time, while the parallel type is provided with a number of these integrators to perform many integrations simultaneously in a similar way to an analogue computer. The hybrid type include both digital and analogue hardware for faster integration.

DIGITAL WITH ANALOGUE ELEMENTS

These are conventional general purpose digital computers connected to a number of analogue integrators and other analogue elements to speed up simulation.

DIGITAL WITH ANALOGUE SUBROUTINES

This is a further extension of the previous type where a complete portion of analogue simulation is connected to the digital computer. The analogue simulation acts as a subroutine in this case, which is then called up by the digital computer programme when required.

BALANCED HYBRID

This is perhaps the most powerful combination of hybrid computers, consisting of a general purpose digital computer connected to a general purpose analogue computer. Both computers can be used on their own to solve a variety of problems, and by interconnecting them an even more powerful computer system is created.

*North Staffordshire Polytechnic

Most modern hybrid computers employ the smaller type digital computer due to their lesser cost and ease of interfacing to analogue computers.

ANALOGUE USING DIGITAL FOR SPECIAL TASKS

In such systems an extensive analogue computer utilises the mathematical power of a small digital computer to perform special calculations.

ANALOGUE WITH DIGITAL SUBUNITS

The majority, if not all, of modern analogue computers are provided with digital voltmeters for precise measurements of variables. Digital memory devices and function generators are used occasionally to supplement the power of the analogue computers.

ANALOGUE WITH DIGITAL CONTROL LOGIC

Most modern analogue computers include digital logic circuits to control the analogue simulation. These include counters, flip-flops, gates, comparators, etc. which are terminated in an auxiliary patch board to facilitate connections.

ANALOGUE PROGRAMMED BY DIGITAL

In simulations involving a large number of equations the problem of scale factor calculations becomes somewhat tedious. To overcome this, special digital computer programs have been developed to process the given set of equations and produce scale factors, potentiometer settings, patchboard connections etc. Examples of these programs are Apache and Apse, standing for analogue programming and checking, and analogue programming and scaling of equations, respectively.

ANALOGUE USING NUMERICAL ANALYSIS

The majority of modern analogue computers include facilities for operating in a repetitive mode. They often include provisions for memorising data from one repetitive cycle for use in subsequent cycles. This permits the use of numerical analysis techniques, such as derivative calculation, in pure analogue computers.

PURE ANALOGUE COMPUTERS

These include the basic forms of analogue computers such as the one-shot type, and the repetitive type mentioned above. They are mainly used as teaching aids for the general principles of analogue computing theory.

BALANCED HYBRID COMPUTERS

The words "balanced" and "true" are some of the terms used when the hybrid system consists of an appreciable amount of digital and analogue hardware, particularly when the system contains general purpose digital and analogue computers linked together. A typical form of this link, or interface, is shown in Fig. 2.1.

As can be seen the interface between the two computers must allow for the passing of data and control signals in both directions. Data processed within the digital computer must be passed on to the analogue computer, together with control signals, such as the setting of potentiometers and analogue mode selection.

Similarly the solution of the equations patched on the analogue computer must be easily accessible to the digital computer. Control signals generated within the analogue computer such as results of comparisons, logic outputs, and interrupts requesting the attention of the digital programme, must all be passed to the digital computer in a fast and reliable manner.

To convert the data from analogue to digital forms and the reverse, analogue-to-digital (A-to-D) and digital-to-analogue (D-to-A) convertors are employed. Generally only one of each of these convertors is employed, but extensive use is made of multiplexers and demultiplexers to provide multi-channel communications between the two computers.

Analogue sample-and-hold devices are usually used with the A-to-D convertors to maintain the signal level at a constant value for a sufficiently long enough time to permit reliable conversion. Hold devices are also employed at the output of the D-to-A convertor to provide a continuous signal level between successive conversions.

Buffers are used to adjust the level of the signals to be compatible with that of the signals within the digital and analogue computers. Control and timing circuits are also required to synchronise the overall communications of data and control signals between the various units of the hybrid system.

HYBRID SOFTWARE

Another important aspect of hybrid computers is that of the "software". This is the programme that converts the electronic hardware into a usable entity. The user is not so much interested in how the computer actually works, but in getting results in a convenient and speedy way.

This, in general, means that either the user has to know the machine code, the most basic of programming techniques, or the machine has to understand the user's language.

High level computer languages, such as Fortran, present an attempt to make the machine easier to use by the problem designer. Similarly, in hybrid computers suitable software must be provided. This will have the prime function of operating and maintaining the analogue part of the system, as well as the usual facilities of performing mathematical and logical operations within the digital computer.

One such language is that based on Fortran and named Hytran (Hybrid Fortran). Apart from the usual features of a high level language, a hybrid language performs operations that can be said to belong to one of two areas, namely operational and diagnostic.

Operational features include communication of data and control information, and synchronisation of the operations of the analogue and digital computers. In advanced hybrid installations special programme packages are written to optimise computation time. This is very important in "real-time" simulations, such as missile and spacecraft simulators.

The optimisation programme carries out a process of partitioning the set of differential equations between the analogue and digital parts in order to achieve the best possible combination of speed, accuracy and stability of solution.

DIAGNOSING TROUBLE

The diagnostic aspect of hybrid software enables the servicing engineer and problem designer to easily locate hardware and programming faults in the sys-

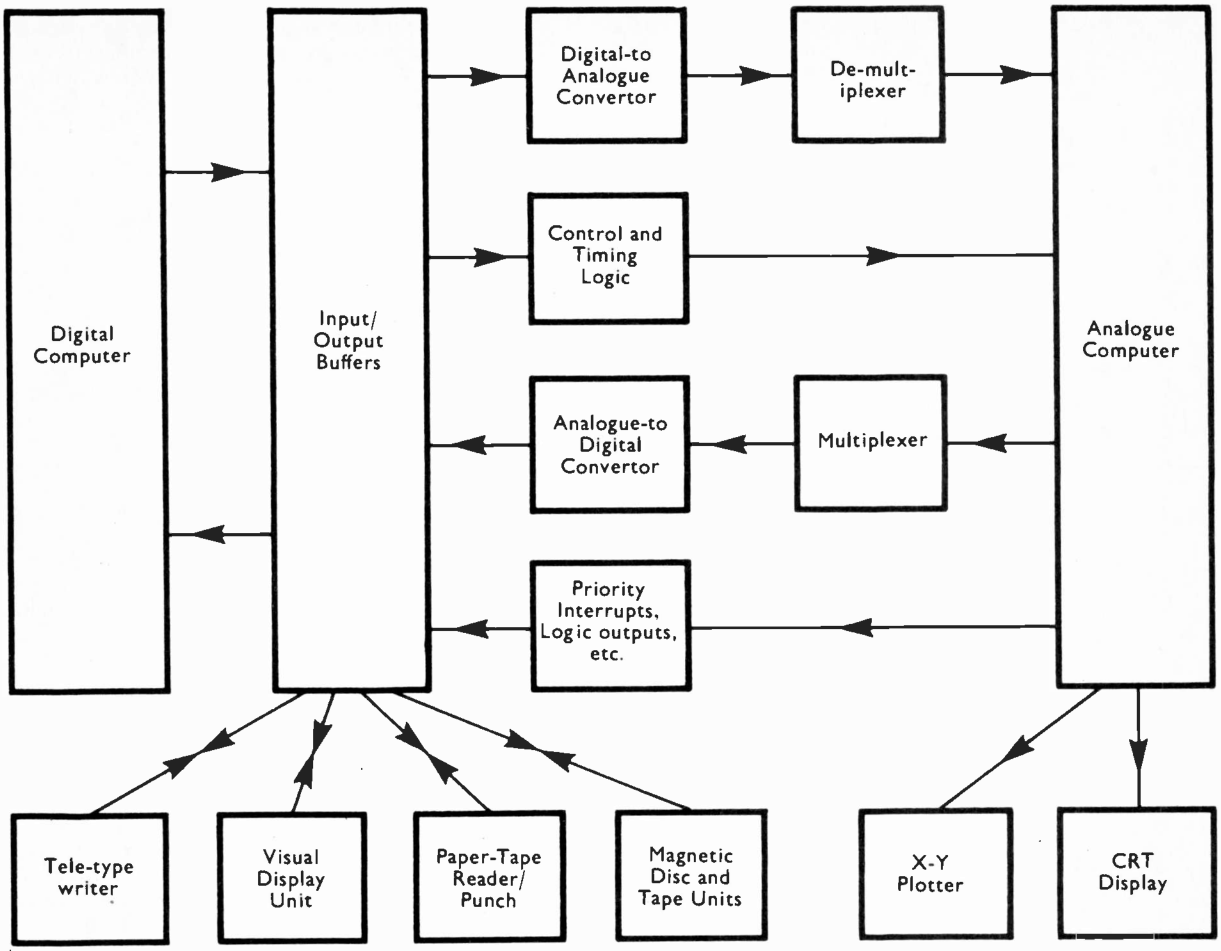


Fig. 2.1. A typical balanced hybrid system showing the interlinking between the various parts

tem. The hardware faults will generally fall into one of three areas namely, digital computer, interfacing hardware, and analogue computer. The diagnostic programme helps isolate the faulty sub-unit by a gradual process of elimination. Programme faults will either be digital or hybrid in nature.

The diagnostic programme will enable the problem designer to examine memory locations and introduce break points in the digital programme to test the response to parameter changes. It will also enable him to test portions of the analogue programme on-line, to modify the programme and change variables as necessary.

The digital computer part of the hybrid language may contain special facilities for simulation. These may include integration routines, function generators, and variable time delay. These are often needed when the analogue computer is fully utilised and more integration capacity is required. Another use is to provide the solution to very slowly varying equations, where the analogue integrator usually suffers from low signal-to-noise ratio due to integrator drift.

HYBRID APPLICATIONS

Simulation of engineering and scientific systems is perhaps the most widespread application for hybrid computers. The essence of simulation is the formation of a mathematical model representing the system under study by a set of differential equations. These equations are then solved on the hybrid computer for varying initial conditions, parameter values, input excitations, and so on to provide a detailed knowledge of the behaviour of the system under study.

OPTIMISATION

The car suspension example referred to in Part 1 is typical of those in the area of system optimisation. Optimisation is generally used for the determination of a set of values for system parameters which will minimise, or maximise, a given function. Here this involved the determination of a set of values for the spring stiffness, shock absorber damping, and friction coefficient that will minimise the extent and duration of car bounce.

In general, the function to be minimised, or maximised, is called the performance or cost function, and can indeed in some cases represent £'s and P's such as the cost of fuel. An example of this is that of moving a satellite from one orbit to another with the minimum of fuel. The sequence of manoeuvres that will achieve this can be determined by using a hybrid computer.

The satellite dynamic equations are set up on the analogue part. while the digital computer is programmed to carry out a series of optimisation procedures to deduce the best sequence of manoeuvres in terms of minimum fuel.

SPACE VEHICLE GUIDANCE

The determination of the trajectory of a long range ballistic missile represents a formidable task to engineers and scientists. Hybrid computers are used extensively in the simulation of these systems to study, as well as the complete trajectory, the behaviour of on-board control units. The high frequency dynamic equations requiring only modest accuracy are generally patched up on the analogue computer, while those slowly varying equations representing the trajectory and requiring very high accuracy, are solved numerically by the digital computer.

The division of the problem between the digital and analogue computers will therefore depend on the speed and accuracy of the individual equations, as well as the availability of sufficient units on the analogue computer, and sufficient memory and computing time on the digital computer.

SIMULATORS FOR MAN/MACHINE SYSTEMS

Many hybrid computer systems are specially designed to behave as the "real" machine in a man/machine system. Examples of man/machine systems range from driver/car, captain/ship, engineer/power-station, to pilot/aircraft and astronaut/spaceship. The value of these simulators in the training of human operators cannot be over estimated, particularly in situations where human safety and/or high cost are involved.

The training of new aircraft pilots will involve both risk and cost, which can be reduced or eliminated by the use of aircraft simulators. Fig. 2.2 shows a typical flight simulation.

Similarly submarine and tank simulators are used in the training of operators to avoid the high cost and general inconvenience incurred in these operations. Inconvenience to the general public is avoided by using simulators when training pilots for supersonic aircrafts creating sonic booms, or low flying aircrafts generating an unacceptable high level of noise. Power station simulators are used in the training of operating engineers to cope with abnormal and other situations, such as various faults on the Grid, start-up and shut-down sequences of generators and turbines, and other procedures.

RANDOM DISTURBANCES

The ability to determine the effect of manufacturing tolerances of components on the overall behaviour of a system is useful. By modelling the system with a suitable set of equations, and patching those up on the analogue part of the hybrid computer the response of the system can be examined when various parts of the model are subjected to random effects.

These effects can in general be in the form of random initial conditions, random excitation on the input, or random parameter variations. Examples of such randomness may arise in the study of the variations of aircraft engine thrust with small deviations in fan blade angle due to manufacturing and assembly tolerances, or in investigation of the effects of thrust misalignment on the path of a missile.

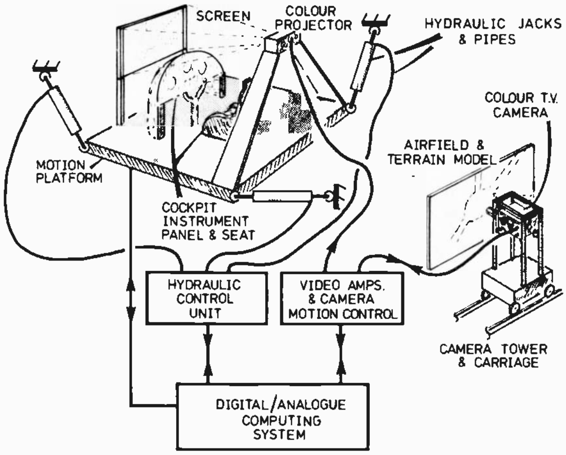


Fig. 2.2. Use of a hybrid system in a man/machine environment showing the various linkages allowing communication

OTHER APPLICATIONS

A large number of other applications exist for hybrid computers including both theoretical and practical aspects of engineering and science. Solutions of problems represented by partial differential equations can be conveniently carried out using hybrid computers. In non-linear equations of more than one independent variable considerable advantages in speed and accuracy can be achieved over the purely analogue and digital computer solutions.

The simulation of industrial process control systems is ideally suited to hybrid computers. In such simulations the equations representing the process under consideration, e.g. a chemical reactor, a steel mill, etc. are patched on the analogue computer, while the control system hardware is simulated by a programme in the digital computer.

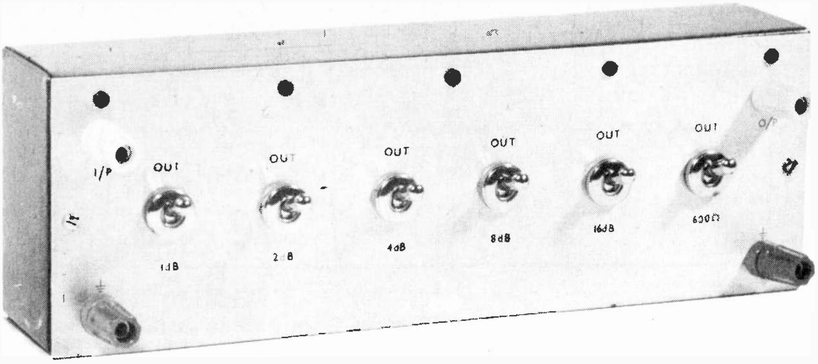
The control system parameters can then be investigated by easily modifying the digital programme to obtain an optimum design of the control system.

MEDICAL AND ECONOMIC STUDIES

Applications of a lesser engineering nature include the study of biological and economic systems. Studies of the chemical reactions and dynamic forces taking place in animal muscles can be carried out on a hybrid computer as both discrete and continuous signals are involved in live tissues. Analysis of medical records and electrocardiogram (ECG) signals can be speeded up, and even performed in real-time, by the use of hybrid computers.

"Analogue Pre-processing" carried out on ECG signals on-line enables the reduction of data to eliminate redundant information and thus facilitate data storage in moderate memory sizes.

Simulation of economic systems is another area of application in hybrid computing techniques. Mathematical economic models are formulated to represent the state of a company, a country, or even recently the entire resources and drains of the economy of the whole world. These models are usually characterised by a set of difference differential equations ideally suited for hybrid computer solution. ★



A.F. ATTENUATOR

By H. T. KITCHEN

MANY of the measurements that have to be made on audio equipment involve the use of ratios, usually of one voltage to another, and for this purpose many engineers prefer the use of a calibrated attenuator to a millivoltmeter.

An indicator is required, but it does not have to be particularly accurate, provided it has a flat frequency response over the bandwidth to be measured. A datum point has to be established, but then the attenuator takes over, and it is surprising how quickly and easily measurements can be made simply by adjusting the attenuator to re-establish the datum every time it changes, whatever the reason.

The attenuator to be described was built to fulfil such a function, and has been found to be a most useful instrument.

THE PI NETWORK ATTENUATOR

The attenuator is based on a series of π (pi) networks in cascade; the elements of this are shown in Fig. 1. The attenuation afforded by a single section is dependent on the ratios of R1 to R2, and R2 to R3, and can be calculated by the following expressions:

$$R1 = R\left(\frac{n+1}{n-1}\right) \text{ and } R2 = R\left(\frac{n^2-1}{2n}\right)$$

When the input impedance is equal to the output impedance, as it usually is, then R1 = R3, and there are only two resistances to calculate.

When these expressions are used, R is equal to the characteristic impedance required, i.e. 600 ohms, and n is the attenuation required, i.e. V_i/V_0, where V_i is the voltage being fed into the attenuator, and V_0 is the voltage coming out of the attenuator. The output will therefore be less than the input, and is always expressed as a ratio in terms of decibels.

ATTENUATORS IN CASCADE

A single attenuator, as described, can be fairly easily constructed and is sometimes used to provide any given amount of attenuation. It is more usual, however, to use a number of such attenuators to provide a number of attenuation ratios, and if the characteristic impedance remains fixed, and the attentuation ratios are in equal steps, then it is a fairly simple matter to connect a number of individual attenuators in cascade.

If we consider the case of a number of attenuators of the Fig. 1 type in cascade, then, since there are now two resistors of equal value (R1 and R3) connected in parallel, all that is required is to replace them with a single resistor having half the value, giving Fig. 2.

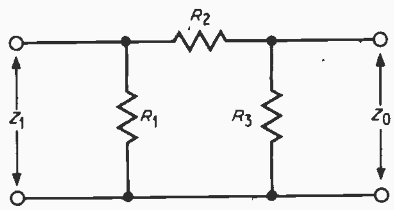


Fig. 1. Simple pi network whose attenuation and impedances are determined by the following relationships:

If $Z_i = Z_o$, then $R_1 = R_3 = R.\frac{n+1}{n-1}$ and

$$R_2 = \frac{n^2-1}{2n}$$

where R is the characteristic impedance (=600 Ω) and $n = V_i/V_o$

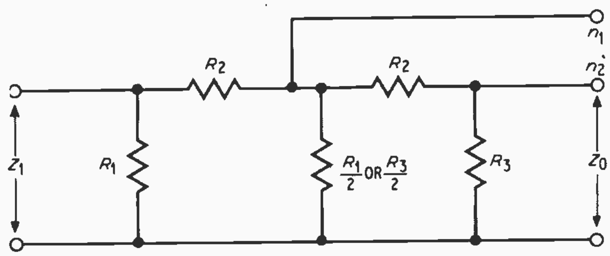


Fig. 2. Connecting attenuators in cascade produces further steps of attenuation. This type of compound attenuator is found in the output stages of signal generators giving ratios of 10:1, 100:1, 1,000:1 etc.

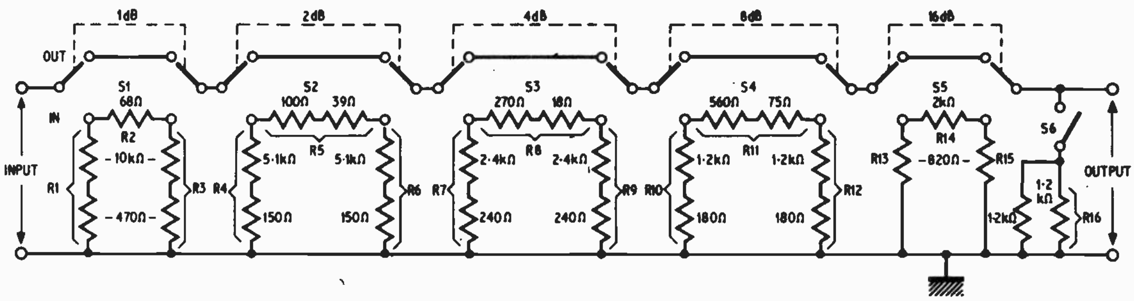


Fig. 3. Circuit of the complete attenuator giving attenuation in 1dB steps from 0dB to 31dB. If ½dB accuracy is required an extra stage may be added at the input end using resistor values given in the components list

Such a compound attenuator is often found in the output stage of a signal generator giving attenuation ratios of 20dB, 40dB, and 60dB, i.e. 10:1, 100:1, and 1,000:1.

VARIABLE STEP ATTENUATOR

For frequency response plotting purposes, such an attenuator has to be replaced with a different type of attenuator in which the steps are not of the constant variety, but must be variable in much smaller steps, each step being different from the preceding, and following one. This is the attenuator illustrated in Fig. 3.

In this, the smallest step is 1dB, the next is 2dB, doubling up to a maximum of 16dB, giving a total attenuation of 31dB, more than adequate for its intended purpose.

The smallest step of 1dB is not small enough for really precise measurements, although it is possible to make an educated guess as to the precise attenuation when it falls outside the 1dB limit.

The reader who decides to construct the attenuator, can, if he so feels inclined, include the ½dB step.

CONSTRUCTION

The attenuator was constructed in an aluminium cabinet 10½in long, 3½in deep, and 2in high, all the switches and the terminal posts being mounted on an L-shaped piece of aluminium. This forms the top and front of the cabinet, and was given an attractive "brushed" appearance by means of a piece of steel wool drawn repeatedly across the aluminium. The rest of the cabinet was painted matt black.

COMPONENTS ...

Resistors

R1, R3	10k Ω in series with 470 Ω (2 off)
R2	68 Ω
R4, R6	5·1k Ω in series with 150 Ω (2 off)
R5	100 Ω in series with 39 Ω
R7, R9	2·4k Ω in series with 240 Ω (2 off)
R8	270 Ω in series with 18 Ω
R10, R12	1·2k Ω in series with 180 Ω (2 off)
R11	560 Ω in series with 75 Ω
R13, R15	820 Ω (2 off)
R14	2k Ω
R16	1·2k Ω in parallel with 1·2k Ω

All resistors 2% ½W carbon

For ½dB section use circuit of Fig. 1 with R1, R3 = 68 Ω in parallel with 68 Ω, and R2 = 18k Ω in series with 3k Ω (or 21k Ω)

Switches

S1—S5	Double pole double throw, toggle (5 off)
S6	Single pole on/off

Miscellaneous

Insulated terminal posts (4 off)
Aluminium for case

Toggle switches were used, as these are much more easily operated than the much cheaper slide switches, and were mounted in a straight line configuration; this has the advantage of greatly reducing stray capacitances between sections, and the response at 100kHz was only ½dB down compared to that at 1kHz.

An 18 s.w.g. busbar runs from end to end, connecting the two earth terminals. All the resistors are connected directly to the switches, their earthy ends connecting conveniently to the busbar (see Fig.

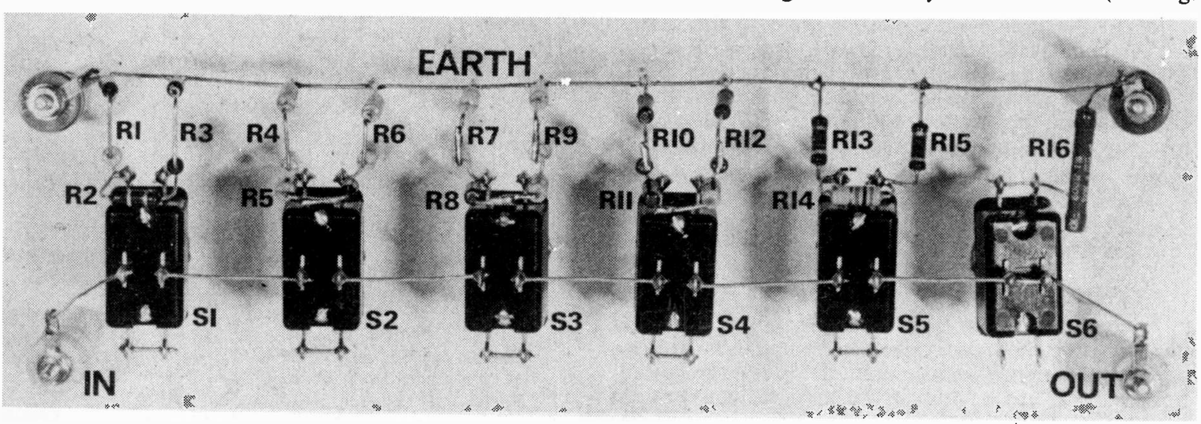


Fig. 4. Construction of the attenuator showing the layout of the resistors and the busbars

4). This form of construction also reduces stray capacitances, this time to earth (cabinet), thus preserving the high frequency response.

RESISTOR VALUES

The resistance values, as calculated, are sometimes non-standard, but a very close approach to the required value can be obtained by series connecting easily available two per cent carbon film resistors.

Any discrepancies between measured and calculated values will be slight, and should be easily restored by a change in one or more of the associated resistors. This is clearly a valuable facility, as it enables a very accurate attenuator to be constructed, the ultimate accuracy then being dependent on the checking facilities available.

For checking, say, tone control response the procedure is to set the attenuator at zero attenuation and then feed in a signal at 1kHz to provide a suitable output from the amplifier, and the meter reading, or index mark, is noted. The tone controls must be set at the position supposed or believed to provide a level response.

One of the tone controls, let us say the bass control, is turned to the position providing maximum boost.

If the turnover frequency is around 1kHz, the output should not alter significantly.

The oscillator frequency is then reduced in steps of an octave to the lowest frequency of interest. At each octave reduction, the meter reading will increase, and the attenuator must be adjusted to

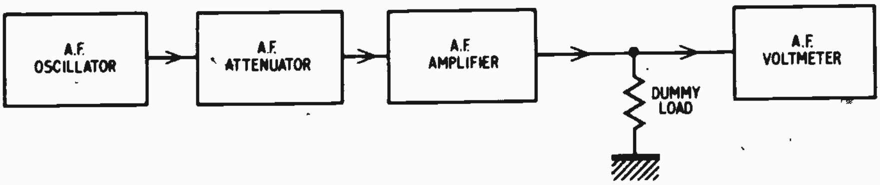


Fig. 5. Block diagram showing placement of attenuator in a set-up to measure frequency response of an audio amplifier

When the resistors are being connected into the switches, the use of a heat shunt is essential; overheated resistors are liable to change in value, even if by only a small amount.

The attenuator was designed to work into a load of 600 ohms, as most of them are. Since such a load is not always available, it was decided to build one in; this is R16, switched in and out of circuit, as required, by S6.

CHECKING THE ATTENUATOR

When complete, the attenuator must be checked for overall accuracy; any discrepancy can be corrected by a resistance change as described earlier. An *accurate* a.c. voltmeter is essential, to monitor the attenuation ratios actually produced.

An a.f. signal generator is also desirable; failing this the 50Hz mains can be used, suitably reduced by a transformer. The voltage input, whilst testing, and in subsequent use, must *never* exceed the rating at which the resistors will be damaged, bearing in mind that they are half watt types, and that wattage is given by E^2/R.

If, after due calculation of the voltages required in testing, it is found that half watt types are not sufficiently rated, then it is essential that one watt types, or even higher if required, are used. The attenuation ratios that should be obtained are shown in Table 1.

THE ATTENUATOR IN USE

In use, the attenuator is placed between the oscillator and the equipment under test, with the equipment output feeding the voltmeter, and, if required, a suitable dummy load. The set up for measuring an a.f. amplifier is shown in Fig. 5.

return the meter reading to its original mark. The amount of attenuation required is also noted at each reduction. The bass control is then returned to its *original* position.

The treble control is then turned to provide maximum treble boost. This time the frequency is increased in octave steps to the maximum frequency of interest.

At each increase of frequency, the meter reading will increase, and, as before, the attenuator is adjusted to restore the original meter reading, and the amount of attenuation noted.

BASS AND TREBLE CUT

Bass and treble cut can be checked in exactly the same way, only this time the attenuator is set to provide a predetermined amount of attenuation before any measurements are made. This is because bass and treble cut effect a reduction in output and therefore attenuation—via the attenuator—must be *removed* in order to determine the amount of cut.

The overall frequency response of an amplifying system, or part of a system, can also be checked in exactly the same way, by setting up a datum point

Table 1: ATTENUATION RATIOS

$-\frac{1}{2}$db	0·944
−1dB	0·891
−2dB	0·794
−4dB	0·631
−8dB	0·398
−16dB	0·159

at 1kHz, and then increasing and decreasing the frequency in octave steps. Since any given system *may* contain both peaks and troughs in its response, it is customary to introduce a small amount of attenuation at the commencement of the test; this can then be removed if troughs exist, or increased if peaks exist.

UNDERSTANDING THE DECIBEL

The first fact to firmly grasp is that the decibel, or dB, is a ratio of something to something else. The ratio can be relative sound levels, relative voltages, or currents, or powers. But it *is* a ratio, and to mention "x" number of dB's without saying in relation to what can be grossly misleading, since a listener can interpret the "dB's" in his own way.

Possibly the simplest way of using decibels is by reference to dB tables, or to a dB graph of which a typical example is shown in Fig. 6.

Thus, if a ratio is known, it is simply a matter of looking up the table, or running a rule from one axis to the other, and it is at this point that uncertainty can arise, for there are two lines on the graph, one for power (watts) only, and the other for voltage or current.

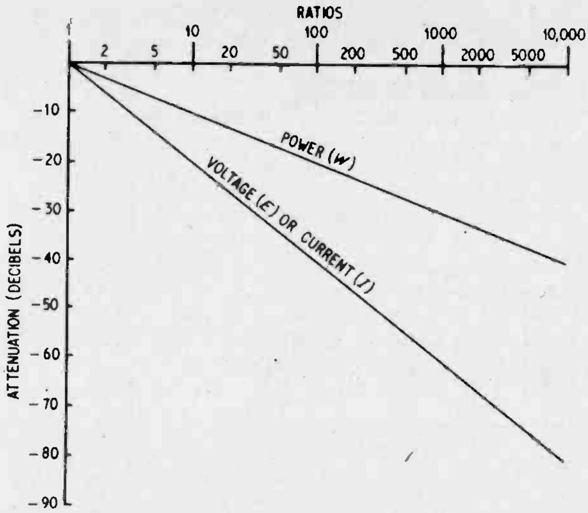


Fig. 6. Graph showing conversion of ratios into decibels for power and current or voltage

CALCULATING DECIBELS

If two power ratings are given by P_1 and P_2 then the ratio between the two (in decibels) is given by

$$\text{Power gain (dB)} = 10 \log P_1/P_2$$

However for current or voltage ratios the formula becomes

$$\text{Voltage gain (dB)} = 20 \log E_1/E_2$$

$$\text{or Current gain (dB)} = 20 \log I_1/I_2$$

The difference in magnitude is due to the equation for power $P = I^2R$ (or $P = V^2/R$). When logs are taken one obtains $\log I_1^2/I_2^2 = 2 \log I_1/I_2$ (similarly with voltage).

Where the ratio is less than unity there is a loss and the dB figure is preceded by a minus sign; if greater than unity the decibel figure is positive.

The graph of Fig. 6 is a straight line because one axis (the decibel) has been made logarithmic.

HANDLING DECIBELS

Supposing two amplifiers are connected in cascade, one having a gain of 30 and the other a gain of 40. To get the total gain we simply multiply the two giving a total of 1,200.

Looking at the situation in terms of decibels we see from the chart that a gain of 30 equals 30dB and 40 is 32dB. As with logs, to get the total gain we simply add the two figures giving a total gain of 62dB which, on checking with the graph is seen to equal 1,200.

Similarly, if we had two attenuators in series, one with a "gain" of 1/30 and the other with a "gain" of 1/40, to get the total gain we again add the relevant decibel figures (which are now negative quantities). Thus total gain is -30dB + -32dB which is -62dB (i.e. $-1/1,200$).

To generalise, we can calculate the total gain of a number of stages in cascade by simply adding all the gains, remembering that stages which produce a loss will have a negative decibel figure.

The vital point to always remember is that the datum point, the 0dB level, is an arbitrary level that can be set anywhere it is desired, *and that after that everything else is in relation to this.* 0dB can be zero output, or it can be maximum output, or anywhere in between.

This makes it delightfully versatile, but danger lies hidden under the cloak of versatility, for misunderstandings can so very easily arise unless 0dB is clearly defined.

THE IMPORTANCE OF IMPEDANCE

The equation for voltage gains and losses of 20 log E_1/E_2 applies only when the impedances across which E_1 and E_2 are measured are the same, and this is a point which is so very easily overlooked, but one which can nullify any results obtained.

If the impedances are different the equation becomes $20 \log E_1/E_2 + 10 \log R_2/R_1$ where R_1 and R_2 are the resistive parts of the impedances.

This correction *must* be applied when attempting to measure the dB gain of a high input impedance amplifier with a low output impedance, an exercise as futile as it is misleading. ★

THE NEXT DECADE ?

What does the future hold in store for electronics in general, and for electronics constructors in particular?

Your views and predictions concerning likely developments in the next 10 years are invited.

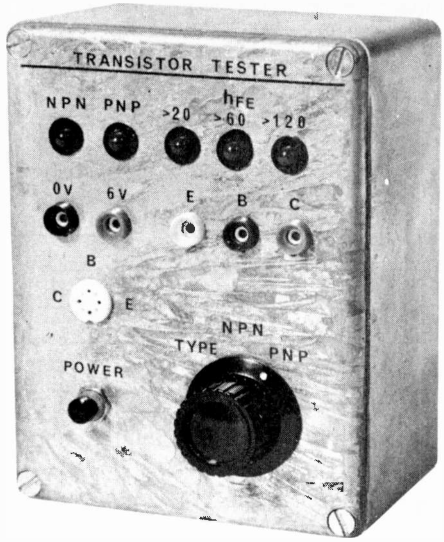
Due to delayed publication dates readers' contributions will now appear in our December and January issues to mark the completion of this magazine's first 10 years of publication.

Contributions (not exceeding 300 words and entitled "The Next Decade") should be addressed to *The Editor, Practical Electronics, Fleetway House, Farringdon Street, London, E.C.4* and posted in time to reach our offices by November 10, 1974.

A payment of £5 will be made for each letter published. Selection will be based upon originality of thought, technical credibility and general presentation.

A NOVEL TRANSISTOR TESTER

By D. C. BLACKFORD



Most constructors have a box of odd transistors with a lack of markings or dubious working capability. Add to this the fact that bargain packs containing, for example, "50 untested and unmarked transistors for 55p" are widely advertised, and it can be seen that a quick and simple transistor tester would be of great value.

The device described in this article has the ability to determine the polarity of the transistor under test (*pnp* or *npn*) and to show the approximate d.c. gain (h_{FE}) in four groups: under 20, over 20, over 60 and over 120. Diodes can also be tested and their cathode ends identified.

The device may be constructed for under £5 including case and using all new components.

CIRCUIT DESCRIPTION

The circuit consists of two main parts: the type indicator and the gain indicator. The type indicator is shown in Fig. 1a and the gain indicator in Fig. 1b.

The two inverters IC1a and b are connected to form a multivibrator running at about 2kHz. The two outputs are buffered by the second two inverters IC1c and d. The emitter and collector of the transistor under test is connected to the outputs of these two inverters.

The signal applied to the base of the transistor via IC2a and R3 is always of the same phase as the signal applied to the collector so that the transistor, whether it is *pnp* or *npn*, will always be turned hard on every half cycle of the clock pulse.

The 7400 series of logic i.c.s are current limited by means of resistors in the positive side of the push-pull output stage. Therefore if, as in this circuit with the transistor under test turning on every half cycle, a positive output is connected to an output driven to 0V then the positive going output will be pulled down to 0V.

With an *npn* transistor in the test position, the transistor will be on when the emitter is connected to 0V by the circuit so that the collector of the transistor will be at almost 0V; on the second half of the clock cycle the collector will be switched to 0V by the circuit and the emitter to the supply voltage. Thus it can be seen that the collector will always be near 0V if a working *npn* transistor is connected in the circuit.

With a *pnp* transistor in the circuit the action will be similar except that the emitter terminal will be held near to 0V.

The final two inverters, IC1e and f are used to detect which terminal is being held at 0V and then to drive one of the l.e.d.s D1 or D2 via the appropriate current limiting resistor R4 or R5.

The polarity detector could have been constructed using a single SN7404N hex inverter but since a spare inverter was available in IC2 it was decided to buffer the base drive to the transistor under test.

GAIN INDICATOR

The gain indicator part of the circuit shown in Fig. 1b uses a Zener diode and resistor (D3 and R6 or D4 and R20, depending on the polarity) to give a base current of about 100μA for the transistor under test. A current sensing chain consisting of three resistors each connected to the base of a transistor forms the collector load.

If the transistor is *npn* and has a gain of over 20, insufficient voltage to turn on TR1 and TR2 will be developed across R8 and R9 but the total voltage across R8, R9 and R10 will turn on TR3 causing a logic 1 to be applied to the input of IC3c so that its output falls to near 0V causing l.e.d. D7 to conduct and light.

If the transistor has a gain of over 60, both TR2 and TR3 will conduct so the logic gate IC3b lights D6 but the connection to pin 9 inhibits IC3c so that only one l.e.d. lights.

Similarly for a gain of over 120 all three transistors conduct but the logic ensures that only D5 lights.

Operation of the circuit for *pnp* transistors is similar except that the outputs from the transistors are inverted before being fed to IC3 because of the opposite voltages being used.

The standard resistor values will give reasonable accuracy even allowing for the variation in base-emitter voltages of the transistors.

Switching is shown in Fig. 1c. Two outputs are provided to a transistor under test, one via a standard socket and the other via three sockets to flying leads.

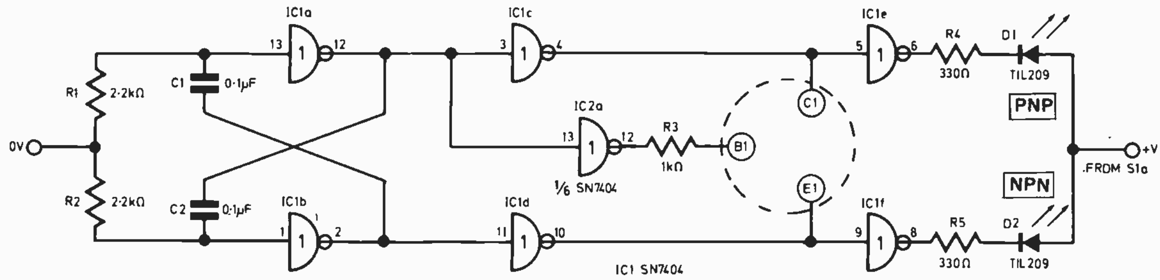


Fig. 1a. Circuit diagram of the polarity indicator

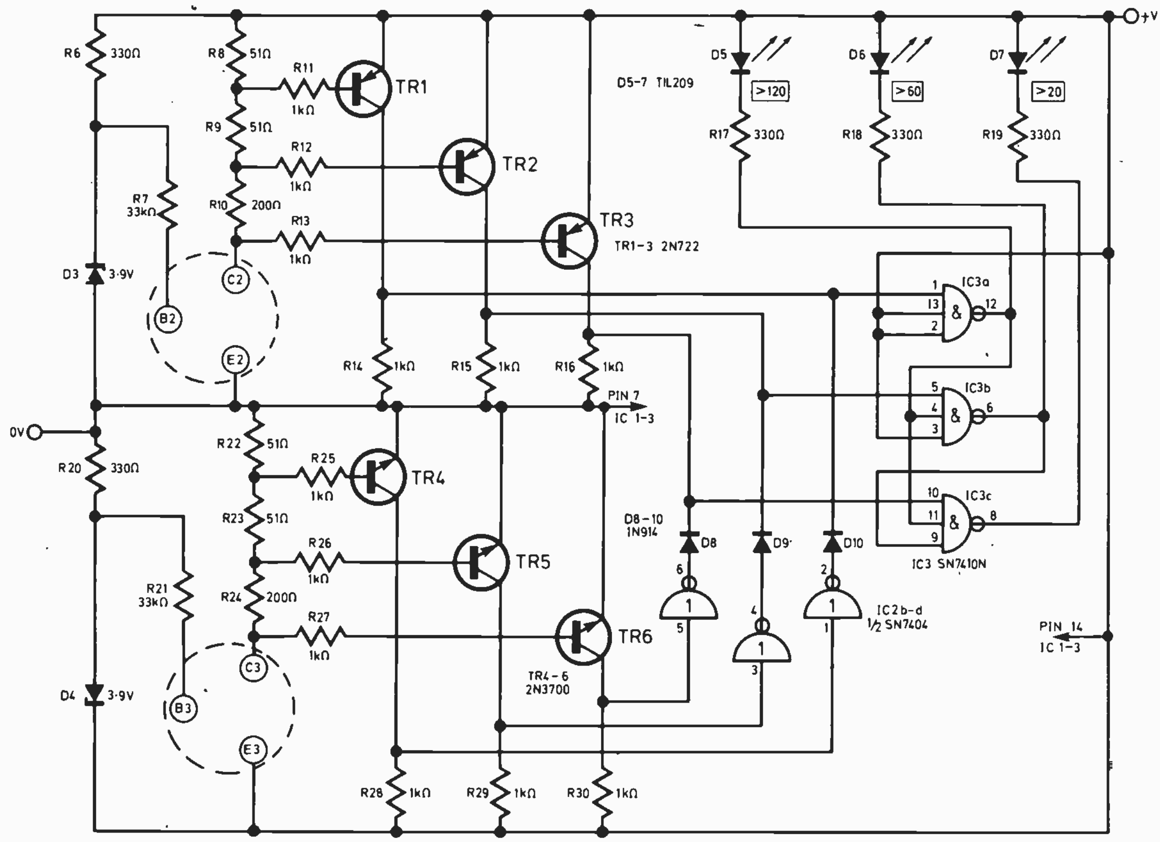


Fig. 1b. Circuit diagram of the gain indicator. In both the above diagrams the circled designations are connections from the circuits to the switching in Fig. 1c

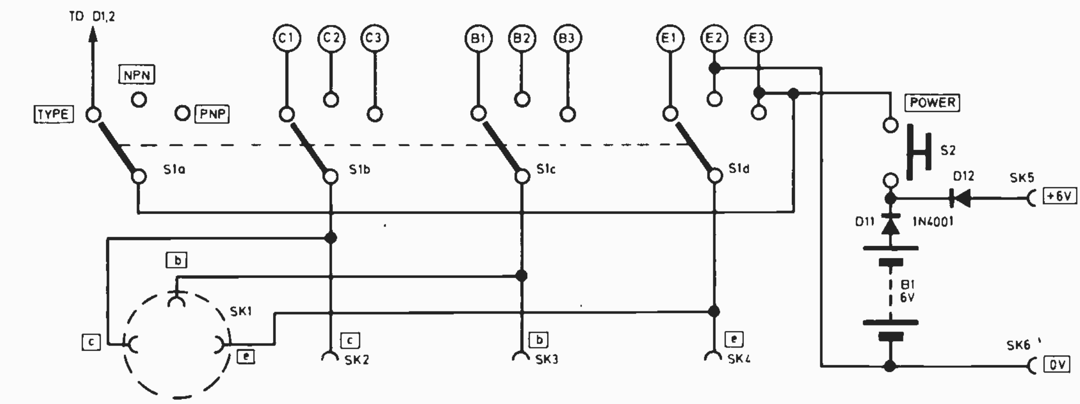


Fig. 1c. Power supply and switching system. The battery can be used to make the unit self-contained or an external power source can be used

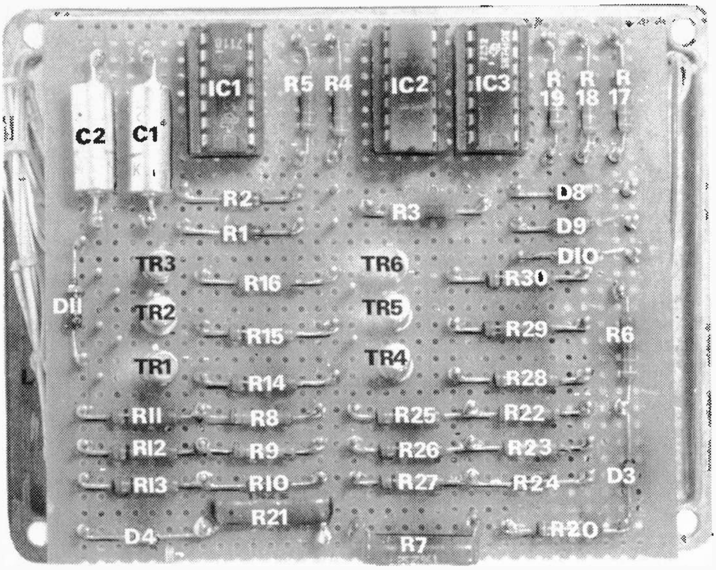


Fig. 2. Layout of the components on the perforated board

COMPONENTS . . .

Resistors

R1, R2	2·2k Ω (2 off)	R11–R16	1kΩ (6 off)
R3	1k Ω	R17–R20	330Ω (4 off)
R4–R6	330 Ω (3 off)	R21	33kΩ
R7	33k Ω	R22, R23	51Ω (2 off)
R8, R9	51 Ω (2 off)	R24	200Ω
R10	200 Ω	R25–R30	1kΩ (6 off)

All ¼W ±5% carbon

Capacitors

C1, C2 0·1μF (2 off)

Semiconductors

D1, D2 TIL209 (2 off)
D3, D4 3·9V 400mW Zener (2 off)
D5–D7 TIL209 (3 off)
D8–D10 1N914 (3 off)
D11, D12 1N4001 (2 off)
TR1–TR3 2N722 *or* similar (3 off)
TR4–TR6 2N3700 *or* similar (3 off)
IC1, IC2 SN7404N (2 off)
IC3 SN7410N

Switches

S1 4-pole 3-way rotary
S2 Push on, release off pushbutton

Miscellaneous

SK1 Transistor socket
SK2–SK6 2mm sockets (5 off)
0·1in matrix perforated board 3¾in × 3¼in
Diecast box 4½in × 3½in × 2in
14 pin integrated circuit sockets (optional)
2mm plugs and leads
B1 6V battery (see text)

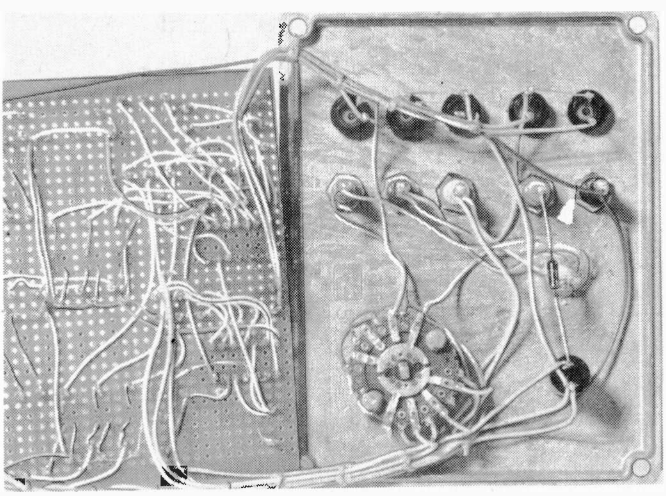
CONSTRUCTION

The layout of the components on a piece of perforated board is shown in Fig. 2 and the arrangement of the components on the front panel can be seen in the photographs. A standard diecast box measuring 3½in × 4½in was used to house the board.

POWER SUPPLY

The unit draws a maximum current of approximately 110mA and since the power is only used for short periods at a time, batteries would be fairly economical to use. However, the prototype has always been used within easy reach of a 6V power supply so the unit was fitted with external sockets rather than a battery holder. The constructor can choose which method better suits his purpose.

The unit will function with 4·5V to 6V at the board (5V to 6·5V at the input terminals of the safety diodes D11 or D12).



The layout of the front panel showing arrangement of l.e.d.s and sockets

OPERATION OF THE TRANSISTOR TESTER

When the wiring has been checked and the power supply or battery connected, the operation of the unit may be checked in the following manner.

Set the function switch S1 to TYPE and connect a transistor to the test sockets. When the POWER button is pressed either the NPN or the PNP lamp should light indicating the polarity of the transistor.

Now set the function switch to whichever type of transistor was indicated and again press the POWER button. One of the lamps should light indicating the approximate gain of the transistor. If none of the lamps light this could be due to the fact that the transistor has a gain of below 20.

If, with the function switch in the TYPE position, both the NPN and the PNP lamps light, it indicates that the transistor under test is open-circuited; if neither lamp lights then it is short-circuited.

TESTING DIODES

A diode may be tested by connecting it between the emitter and collector sockets and setting the function switch to TYPE. If the PNP lamp lights then the end of the diode connected to the collector socket is the cathode and if NPN lights then the cathode is to the emitter. As with the transistor, if both or neither lamp lights then the device is open- or short-circuited. ★

BRITISH MUSICAL INSTRUMENT TRADE FAIR

A look at the Musical Industries showcase at Brighton

By G. M. Harvey

THE move to Brighton this year of the British Musical Instrument Trade Fair (7th 11th July) has added more than just a breath of sea air. In previous years covering the show meant an exhausting "walkabout" of hotels in the environs of Russell Square. The present siting at the well equipped and spacious exhibition hall of Brighton's Hotel Metropole was evidently welcomed by the trade as demonstrated by the number of exhibitors 45 companies—and volume of musical merchandise on display.

AMPLIFIERS

Judging by product representation the solid state low or medium power "combo" amplifier (a complete integrated amplifying system in one box) is a significant sales growth area. Most of these have reverb, tremelo and sustain either singly or in combination. For the amateur group musician these are attractive buys combining portability with typical power ranges from 30 to 130W. Some companies such as Hornby Skewes and Carlsbro offer beginners practice amplifiers in the 3 to 25W range.

There are still many musicians who refuse to be weaned off the "bottle" to solid state as indicated by the number of valved power amps available. Top Gear, which handles Peavey amplification, introduced three new valved amplifiers in the 100W plus range. On the other side of the coin, Cleartone Musical Instrument have converted their CMI line of valved amps to solid state which probably indicates where the future lies.

SYNTHESISERS

Last year Boosey and Hawkes provided a scintillating display of what man, three ARP synthesisers and an organ could accomplish. To have repeated this performance this year with the addition of the new ARP "Explorer" would have defeated the ability of the most agile demonstrator, I am sure.

Of the ARP range to my mind the most fascinating is the Pro-Soloist. This provides 30 preset instrumental and electronic effects at the touch of a key. Using memory circuits the recreated instrumental sounds are truly amazing. Used with an organ it is an ideal "second" solo keyboard.

With an eye to the obvious market Yamaha have introduced a similar instrument, the SY-1. The three octave keyboard provides touch control for vibrato, wah-wah and volume. Instrumental voices available number 26, but synthesiser "sounds" can be readily created with either selectable presets or continuously adjustable controls. Although I marvel at all things Japanese I still prefer the Pro-Soloist.

The Bentley Organ showcase included the Solina String-Ensemble described as a polyphonic portable "mini-orchestra". Voices offered are viola, violin, trumpet, horn, contra-bass and cello. The instrument name derives from the fact that violin and viola registers can be played polyphonically as can trumpet and horn. Contra-bass and cello are monophonic only.

Tone generation is digital with only one master oscillator which enables easy transposition with other instruments.

PIANOS

Of the electronic pianos probably the most interesting is the new Compton-Edwards Pianotron. It offers as much as the genuine article with an 88 note keyboard, velocity sensitive key action and soft and loud pedals with all the additional advantages that electronics can add such as three additional voices: Honky-Tonk, Harpsichord and Synthesiser all with available vibrato and reverberation effects.

Keeping the instrument in tune should never be a problem as a pitch slider enables this to be done over the whole keyboard in one adjustment.

As a musician who finds transposing at sight a difficult task, I found the 12-position switch transposer very gratifying. Each step of this changes the pitch by a semitone.

The internal amplifier provides a cracking peak power of 150W (?).

Bentley were also showing a new piano covering six octaves with an additional Harpsichord voice and pitch control. This, however, is an add-on unit to a main console.

ORGANS

Every year one expects more "Easy-Play" organ gimmicks to be added to the now considerable list.

The Compton-Edwards Pianotron home model

With so much organ sales literature aimed at making the most callow amateur sound like a pro, we have seen a whole new vocabulary grow up.

There have been "Autochord" . . . just make a chord and the organ does the rest for you; "Walking Bass" . . . play the root note on the pedal and all of the rest of the notes are automatically produced in sequence in perfect pitch and tempo to the music being played on the keyboard; "Fantom Fingers" . . . providing cascades of arpeggios for little effort; "Musi-Computer" . . . this is a form of electronic piano roll. A computer tape records digital pulses on playing and on playback these voltages are applied to the key contacts so that the sounds are reproduced. Obviously this is a useful teaching aid particularly as the notes that are sounding can be visually indicated and new registrations added at will.

There are other novelty features aimed at selling self-generated home entertainment.

New entrants to this market include the Lowrey Teenie Genie organ with an accompaniment offering "Genie Chords" which can be played with one finger of the left hand and the Baldwin Fun Machine.

Baldwin also include a new "Real Rhythm" feature on their Encore and Bravo organs. This I found particularly exciting as the strict tempo feature of the electronic rhythm box has been modified. Here manually selected rhythm voices are programmed to follow playing on the accompaniment manual and pedals. Alternatively automatic patterns may be played or complex patterns with the automatic and manual facilities.

In the "Easy-Play" market, Wurlitzer were strongly represented with seven models incorporating "Spectra-Sound", illuminated keyboard, notefinder, bass riff, walking bass, touch tone programmed accompaniment, "Swingin' Rhythms", etc., etc.

Hammond had their "dynamic duo" Regent and Concorde on display and two new models, the 7100 and 5200 models.

EFFECTS

I discovered a box which produced some very satisfying noises when hooked to an organ on the Kentucky stand. This, the Multimate, provided controlled frequency shifting proportional to input frequency which when re-mixed with the original input provided a curious spatial effect completely different from reverberation. Kentucky state that the device would be compatible with any input.

A stunning effects box in combination with an organ is the Mellotron 400 from Dallas Musical. This is best described as a tape machine manipulated by a keyboard. The standard instrument provides three basic sounds of flutes, violins and cellos recorded on tape. However, other tape frames can be easily added to extend the repertoire to provide a unique instrument as evidenced by the many famous groups using it. ★

The new SY-1 solo synthesiser from Yamaha

The new Compton-Edwards Symphonia organ

The new CSY-1 Electone organ from Yamaha with synthesised instrumental sounds and shaping controls

Now-two fascinating ways to enjoy saving money!

NEW! Sinclair Scientific kit £19.95 (INC. VAT)

Britain's most original calculator now in kit form
The Sinclair Scientific is an altogether remarkable calculator.

It offers logs, trig, and true scientific notation over a 200-decade range – features normally found only on calculators costing around £100 or more.

Yet even ready-built, the Sinclair Scientific costs a mere £32.35 (including VAT).

And as a kit it costs under £20!

Forget slide rules and four-figure tables!
With the functions available on the Scientific keyboard, you can handle *directly*

sin and arcsin,
cos and arccos,
tan and arctan,
automatic squaring and doubling,
$\log_{10}$, antilog_{10}, giving quick access to x^y (including square and other roots),
plus, of course, addition, subtraction, multiplication, division, and any calculations based on them.

In fact, virtually all complex scientific or mathematical calculations can be handled with ease.

So is the Scientific difficult to assemble?
No. Powerful though it is, the Sinclair Scientific is a model of tidy engineering.

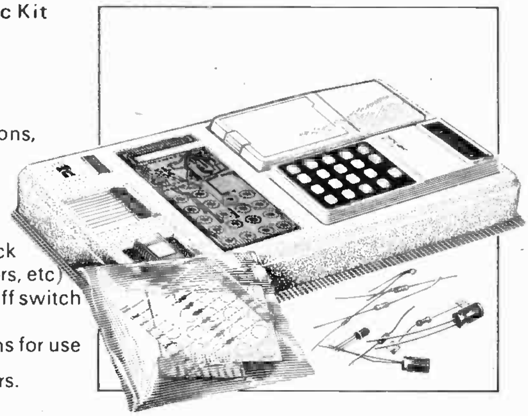
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

Of course, we'll happily supply the Scientific or the Cambridge already built, if you prefer – they're still exceptional value. Use the order form.

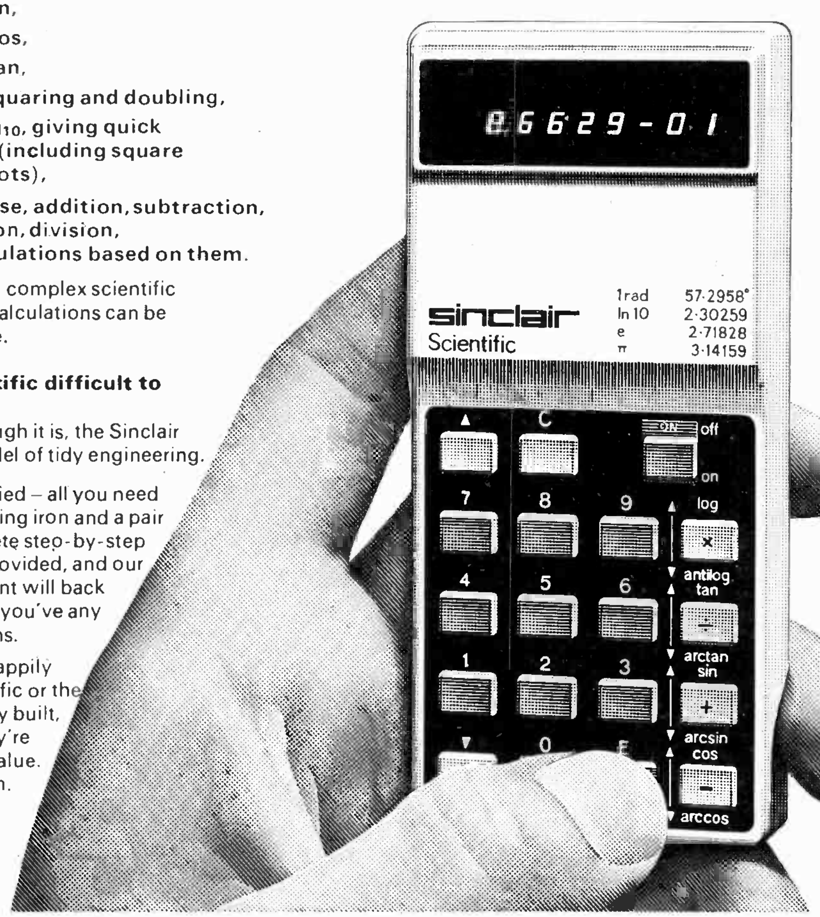
Components for Scientific Kit (illustrated)

1. Coil
2. LSI chip
3. Interface chips
4. Case mouldings, with buttons, windows and light-up display in position
5. Printed circuit board
6. Keyboard panel
7. Electronic components pack (diodes, resistors, capacitors, etc)
8. Battery assembly and on/off switch
9. Soft carrying wallet
10. Comprehensive instructions for use

Assembly time is about 3 hours.



Features of the Sinclair Scientific



● **12 functions on simple keyboard**
Basic logs and trig functions (and their inverses), all from a keyboard as simple as a normal arithmetic calculator's. 'Upper and lower case' operation means basic arithmetic keys each have two extra functions.

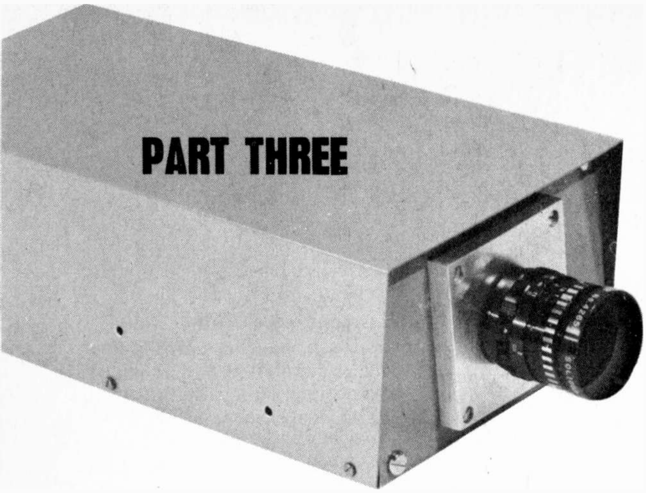
● **Scientific notation**
Display shows 5-digit mantissa, 2-digit exponent, both signable.

● **200-decade range**
10^{-99} to 10^{+99}.

● **Reverse Polish logic** Post-fixed operators allow chain calculations of unlimited length – eliminate need for an = button.

● **25-hour battery life**
4 AAA manganese alkaline batteries (e.g. MN2400) give 25 hours continuous use. Complete independence from external power.

● **Genuinely pocketable**
4 1/3" x 2" x 11/16". Weight 4 oz. Attractively styled in grey, blue and white.



PART THREE

PE CCTV MONOCHROME CAMERA

BY A.V. FLATMAN * B.Sc.

Ideally suited for:

❋ Home Entertainment ❋ Lecturing ❋ Remote Monitoring ❋ Surveillance

PREVIOUS articles in this series have discussed all the electronic aspects of the C.C.T.V Camera. This month case construction, final wiring and setting up procedures are discussed. The Modulator required for interfacing with a domestic Television receiver will be described next month.

THE LENS

Several factors are to be considered in the choice of a lens for a TV Camera. The fundamental requirements of the lens which is to transmit the viewing scene to the Vidicon may be summed up by considering the following four points—

(a) the dimensions of the maximum usable area of the photoconductive target,

(b) the sensitivity of the Camera tube,

(c) the viewing angle required,

(d) the depth of focus required.

EMI specify a maximum usable area of their type 9677 Vidicon target as being the central $\frac{1}{2}$in × $\frac{1}{2}$in, and a minimum illumination of 2 lux for full video signal current. Factors (a) and (b) are hereby fixed by the Vidicon characteristics, however, flexibility of factors (c) and (d) is made possible by the optical properties of the chosen lens.

Illumination of the required scene must be controlled before it is transmitted to the Vidicon target by the lens. Only when this is achieved will the video signal faithfully represent the dynamic range of the picture. An aperture stop is incorporated in all camera lenses expressly for this purpose, and a target illumination of approximately 2 lux is made possible by a simple manual adjustment.

The chosen lens is required to produce an image of the scene onto the specified $\frac{1}{2}$in × $\frac{1}{2}$in area of the target, and therefore calls for precise positioning in relation to the target. The lens must be either a 16 mm, or 35mm size and have a relatively short focal length.

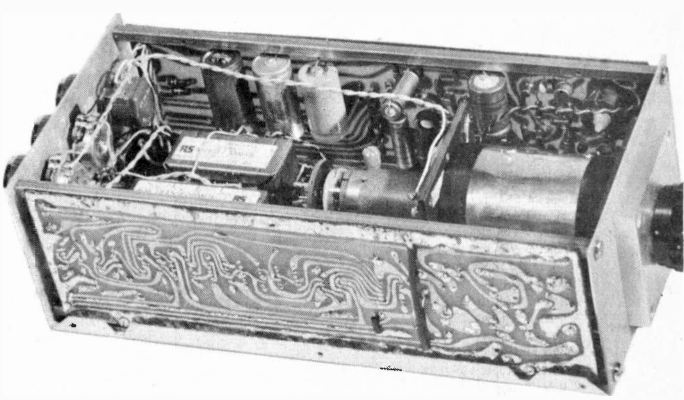
One point to remember when using any lens is that a deeper depth of focus is obtained by using smaller apertures, e.g. f11, f16, f22). To achieve this, of course, we require brightly lit scenes.

CAMERA ENCLOSURE

All the mechanical details of the enclosure are shown in Fig. 3.1. The chassis is made from 18 s.w.g. aluminium and strengthened by four square cross section bars which run front-to-back near the corners of the enclosure. Each horizontal bar has two 6BA tapped holes to enable the p.c.b.s to be mounted vertically at the sides of the chassis and provide a good chassis earth p.c.b. connection.

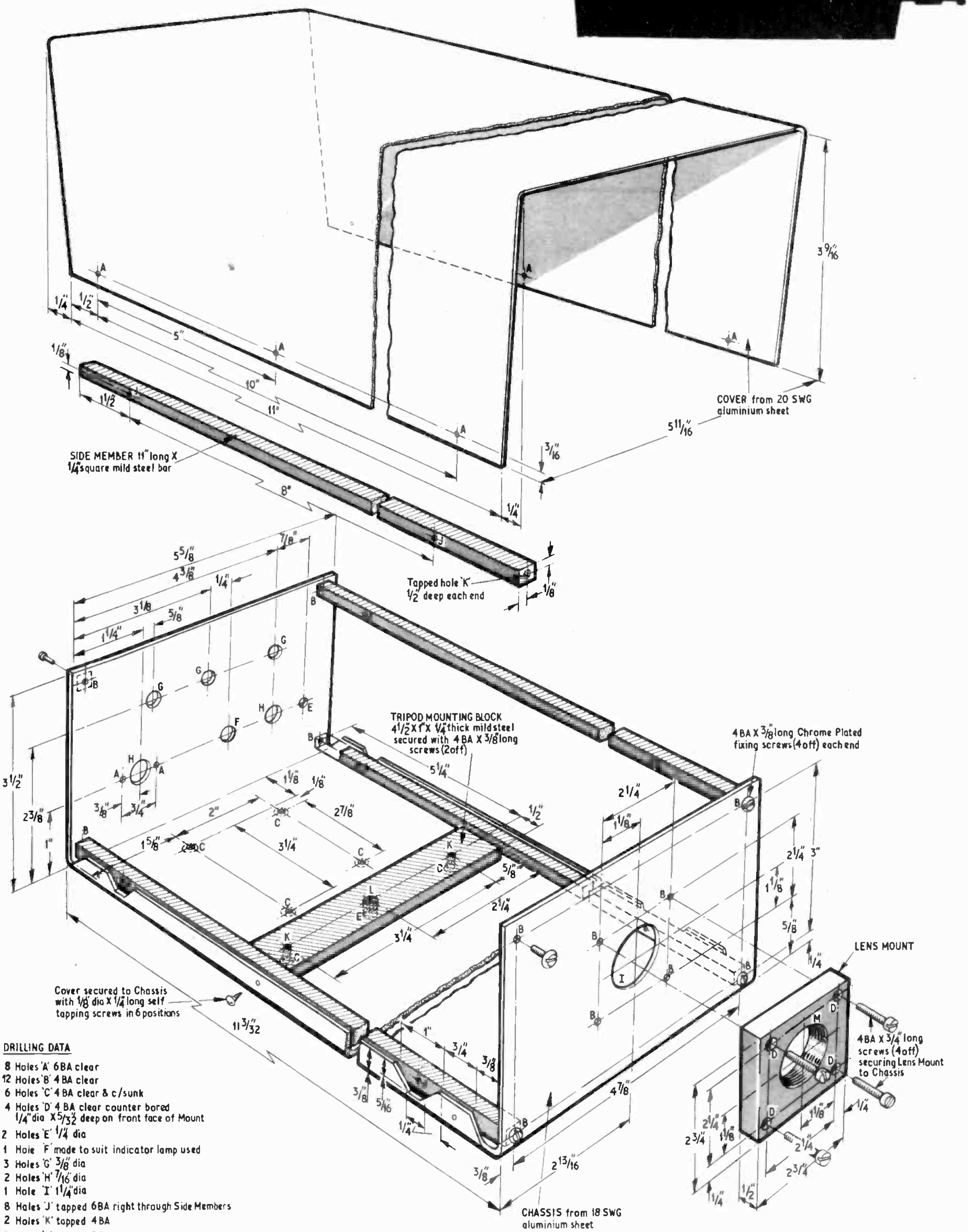
Standard photographic tripod mounting is facilitated by introducing a further strengthening bar to the base of the chassis. A $\frac{1}{4}$in × 1in cross sectional bar of aluminium is mounted at the centre of gravity of the TV Camera for a well-balanced $\frac{1}{4}$in BSW thread tripod attachment. The lens is screwed into a square aluminium block which is then mounted onto the front panel by 4BA bolts. These four mounting bolts will clear the aluminium front plate and screw into the scan coil assembly.

Four additional holes are drilled in the base of the chassis and countersunk from the bottom to



*North Staffordshire Polytechnic

CASE DETAILS . . .



DRILLING DATA

8 Holes 'A' 6BA clear
12 Holes 'B' 4BA clear
6 Holes 'C' 4BA clear & c/sunk
4 Holes 'D' 4BA clear counter bored 1/4" dia X 5/32" deep on front face of Mount
2 Holes 'E' 1/4" dia
1 Hole 'F' made to suit indicator lamp used
3 Holes 'G' 3/8" dia
2 Holes 'H' 7/16" dia
1 Hole 'I' 1 1/4" dia
8 Holes 'J' tapped 6BA right through Side Members
2 Holes 'K' tapped 4BA
1 Hole 'L' tapped 2BA
1 Hole 'M' tapped 1" X 32 t p i

Fig. 3.1. Mechanical details of camera enclosure

NOTE: We understand that some difficulty may be experienced in obtaining the specified scanning coils. Next month, after trials, a suitable alternative type and source of supply will be given.

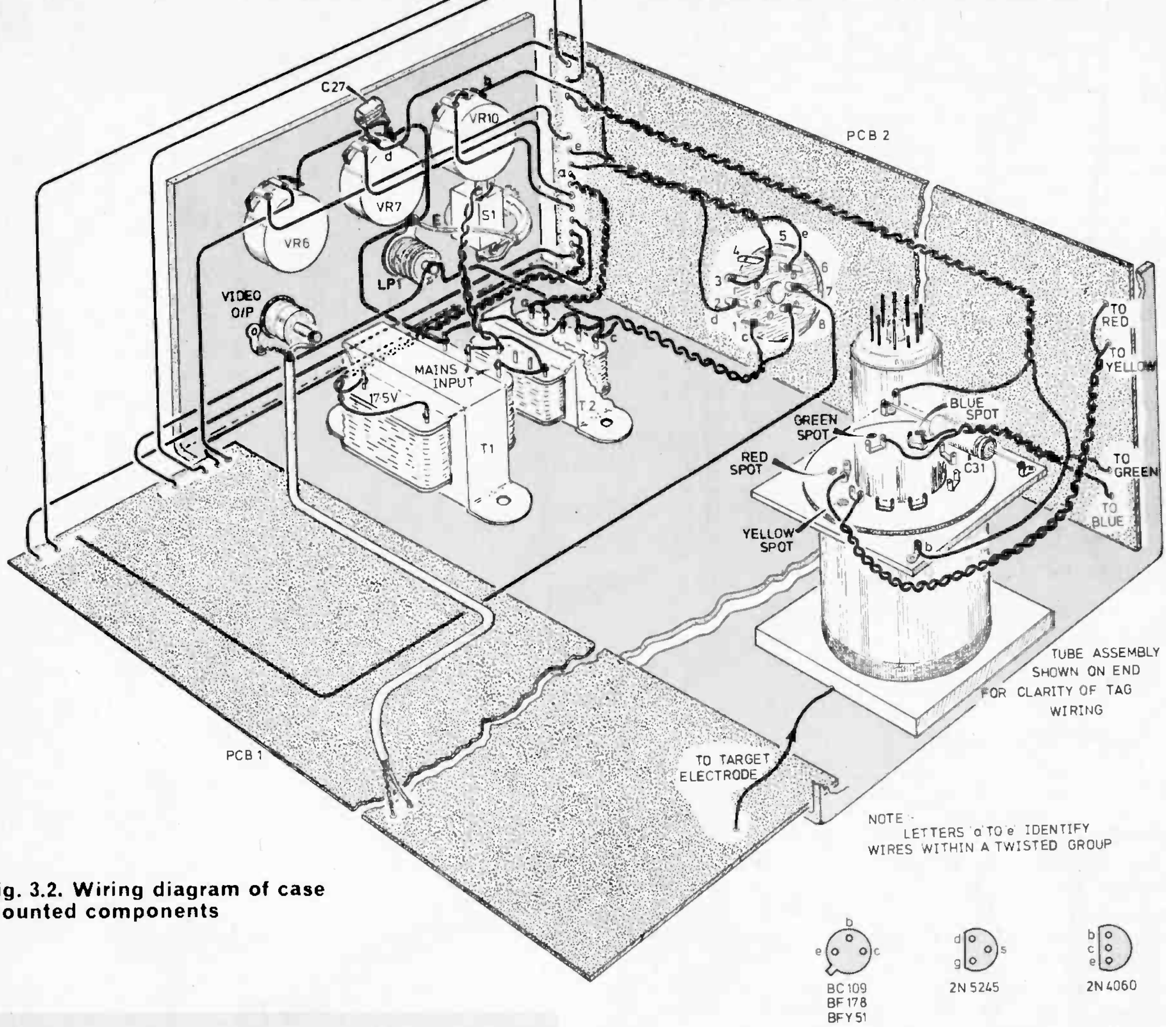


Fig. 3.2. Wiring diagram of case mounted components

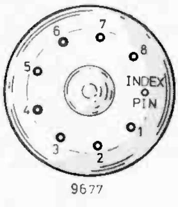


TABLE 3.1

Pin No.	Connection
1	Heater
2	Modulator
3	Mesh G4
4	Internally connected
5	Limiter G2
6	Wall anode G3
7	Cathode
8	Heater
Index pin	Internally connected

Pin details for (left) vidicon tube and transistors (above)

enable the two mains transformers to be firmly secured at the rear of the Vidicon and scan coils. The relative positioning of these components is quite critical due to the sensitive nature of the camera tube and the magnetic fields generated by the transformers.

The cover is made from 20 s.w.g. aluminium and secured with 6 BA self-tapping screws.

WIRING DETAILS

The majority of connections exist at the rear of the Camera assembly—between the p.c.b.s. control panel, transformers and along to the Vidicon pin connector (Fig. 3.2). Fortunately, a large percentage of the system wiring is not critical and a series of bundled cables may be used to give very neat results. In the prototype, for example, the full colour range of solid, p.v.c. covered 1/·024in wire was used (the coloured wire certainly helped in tracing connections!)

There are, however, four connections within the system that should be made to the following instructions in order to prevent undesirable signal pickup—

(a) The composite video output signal should be connected from the Video Amplifier to the coax socket via coaxial cable, whose outer braiding is earthed at both ends.

(b) The line and field scan coil connections should be made with tightly twisted cable and be as short in length as possible.

(c) The Vidicon target connection should be the shortest possible length (ie. made with P.C.B. 1 screwed in position).

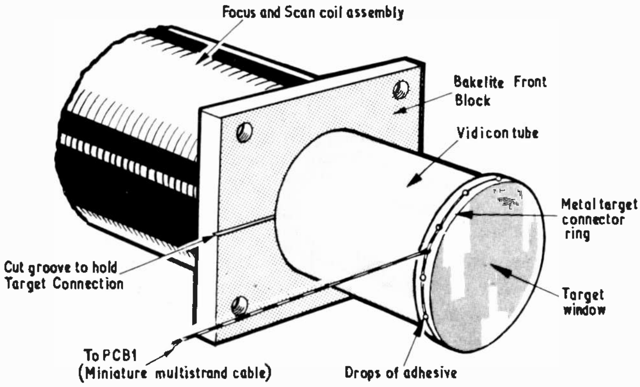


Fig. 3.3. Target connection details

HANDLING THE VIDICON

As the Vidicon is enclosed in a thin glass envelope, this device must be handled with care during the construction of the project. No harm should come to this rather expensive and fragile component if the following hints are observed—

(a) Take great care not to scratch the target window—this is made of a very soft glass and would scratch very easily.

(b) Never solder any connections to the electrode pins of the Vidicon—use the available pin connector and refer to Fig. 3.3 for target connection details.

(c) Do not overtighten the metal clamp located on the coil assembly—this could contract in low temperatures to break the neck of the camera tube.

(d) Never operate the Vidicon in a face-down position--small granules sometimes break free from the cathode and may collide with the target with detrimental effect.

The target connection may be made by carefully wrapping a length of thin wire around the metal target connector ring, adding a few tiny drops of adhesive to secure the wire.

SETTING UP

It would be a shame to damage the Vidicon, or for that matter—any component at this final stage. So upon the initial application of power, with the Vidicon pin connector carefully disconnected from the tube, check that all electrode potentials are reaching their designated points. Once you are confident that this is so, then replace the connector and proceed with the setting-up of the TV Camera.

The first aspect of setting up is the adjustment of the power regulators, so—

(a) Set both +15V and +5V levels by adjusting presets VR8 and VR9 respectively. Camera alignment may then be achieved by suitable coupling to a TV Monitor/Receiver.

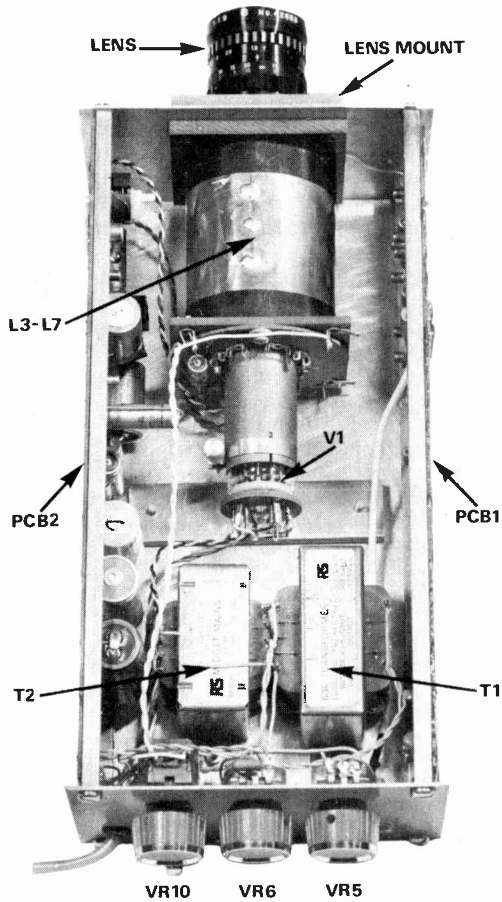
(b) Choose a well illuminated scene of a large, well defined, dark shape (a square for example) against a light background and direct your TV Camera toward it from a distance of 10-20ft.

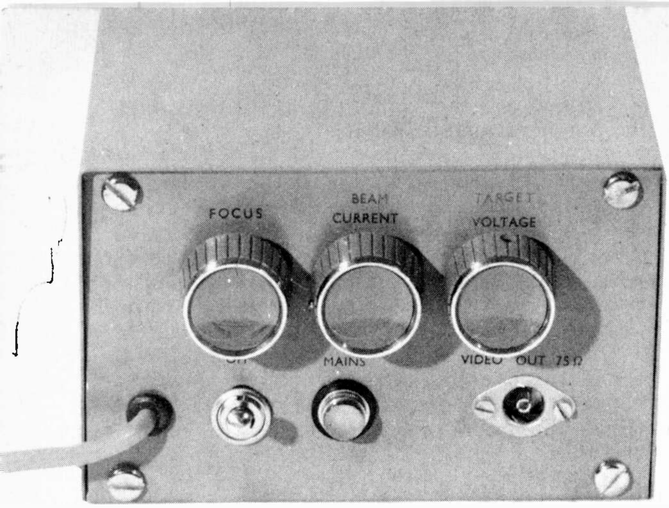
(c) Set the lens focus to correspond with the scene distance and adjust the aperture setting to f4.

(d) Adjust presets VR2, VR3, VR4, VR5 and focus and beam current controls to their mid-positions.

(e) Adjust the vertical hold control on the TV Monitor/Receiver to synchronise the camera fields.

(f) Adjust the line frequency preset VR1 to synchronise the scanning lines and achieve a fully synchronised raster on the Monitor/Receiver screen. If any difficulty is experienced in synchronising the camera picture to the Monitor/Receiver, adjust the sync level preset VR3 clockwise to increase the height of the sync pulse outputs.





Showing rear panel controls used for setting up camera

(g) With the TV Monitor/Receiver brightness and contrast controls turned to their maximum positions, adjust the camera target voltage control to give the Vidicon a workable sensitivity to light. The camera should now be able to sense moving objects.

(h) Adjust the width preset VR4 and height preset VR5 to their fully clockwise positions. In doing this you should obtain a TV picture of the greater portion of the Vidicon target—showing dark areas in each corner of the Monitor/Receiver screen.

(j) Now carefully adjust presets VR4 and VR5 to enlarge the TV picture of the Vidicon target (by reducing the actual scanned area of the target) until the dark areas in the corners have completely disappeared. This adjustment ensures that all scanning is performed within the target working area.

(k) Adjustment of the lens focus and electrical focus should now enable the scene to be focused quite sharply.

(l) Suitable adjustment of beam current, brightness, contrast and aperture controls will then give a well defined picture with a good dynamic range (reproduction of halftones or shades of grey).

(m) The perspective of the TV picture may now be adjusted by using a straight piece of wood (a 12 inch rule). Position the wood at a convenient distance in front of the TV Camera and focus it sharply. Turning its direction from horizontal to vertical, adjust presents VR4 and VR5 to give equal lengths of wood in the TV Camera. In doing this adjustment, try not to deviate too much from the settings achieved in (j).

(n) Set the focal length of the lens to infinity and point the TV Camera to a distant object (greater than 50 feet away). Adjust the target voltage and aperture to obtain good contrast and brightness and carefully move the Vidicon along the scan coil assembly in order to obtain a sharp focus of the distant object. The focal distances marked on the lens should now be calibrated, so lock the Vidicon tube firmly in this position—remember, not too tight.

CAMERA OPERATING HINTS

Once the TV Camera has been aligned and is boxed up and ready for use, we then consider the correct settings of the camera unit controls to suit a wide variety of scenes.

Beam current and electrical focus controls have been set during the alignment process and should remain at their established positions. The remaining one electrical and two optical controls are then set to establish good picture brightness, contrast and focus.

Brightly Lit Conditions

You will have to prevent most of the light intensity from reaching the Vidicon target by limiting the aperture size of f11–f22. Assuming the target image to be correctly illuminated to give a good dynamic range (contrast) the brightness may be set by adjusting the target voltage. Again, you will probably have to operate a brightly-lit scene at minimal sensitivity (target voltage control more clockwise).

Avoid rapid panning with the TV Camera under bright-light conditions, as the bright highlights may cause picture lag (a smearing effect as the scene moves across the screen).

One distinct advantage of using well lit scenes is the large depth of focus which results from small operating apertures.

Poorly Lit Conditions

For indoor use under average domestic lighting conditions, for example, the lens aperture will have to be increased towards f1·9. The sensitivity of the Vidicon may also have to be increased (an anticlockwise movement of the target voltage control) to give sufficient picture brightness.

If a good depth of focus is required for a poorly lit scene, the aperture may be decreased in size and target voltage increased accordingly to give the same working sensitivity.

Night Light Conditions

The camera video amplifier has been designed to have sufficient gain to operate the Vidicon in very poorly-lit conditions.

To enable operation under moonlight conditions, turn the video gain preset VR2 fully clockwise, open the lens aperture to f1·9 and turn the target voltage control anticlockwise. It may also be necessary to make full use of the brightness and contrast controls in the TV Monitor/Receiver.

TV MONITOR/RECEIVER

As previously mentioned, we are faced with using our TV Camera in conjunction with either a TV Monitor or domestic TV Receiver (via a u.h.f. Modulator). The TV Monitor has the advantage of being devoted to the use of displaying camera pictures, whilst the domestic receiver presumably already exists and simply becomes twofold in application.

The TV Monitor is an expensive but useful item to add to your CCTV equipment—Japanese models being available in the price range £50–£100.

In Fig. 2.8 R44 (680Ω) should be connected between VR8 and the 15V line

Because of imperfect reproduction of printed circuit board Fig. 2.2, we have decided to make available a free reprint of this diagram. Readers requiring copies should send a large stamped addressed envelope to the Editorial Offices.

Next month: The modulator will be described

CAR CASSETTE POWER SUPPLY

By A. RUSSELL

IT is often required to run a cassette recorder during long car journeys. This can prove very expensive in dry batteries and it would obviously be desirable to run the recorder from the car battery if possible. The unit to be described here gives a stabilised 7·5V output at just over 1A (suitable for most cassette recorders) from a standard 12V car battery.

The prototype was built for about £1·50, approximately half the cost of the cheapest available commercial unit.

Instructions are also included for modifying the unit to operate from the mains, or to give a 9V stabilised output, suitable for operating some transistor radios.

CIRCUIT DESCRIPTION

The circuit is based on the 723 voltage regulator integrated circuit, using a 2N3055 external current pass transistor (Fig. 1). The prices of these components have fallen rapidly recently, and it should be possible to obtain both for less than £1.

The 723 has three separate internal sections; a voltage reference amplifier providing a stable reference voltage of nominally 7·15V, an error amplifier, and an internal current pass section (with a current limiting transistor) which will give an output current of up to 150mA. As we require an output current of up to 1A, we must use this output to drive an external current pass transistor, TR1.

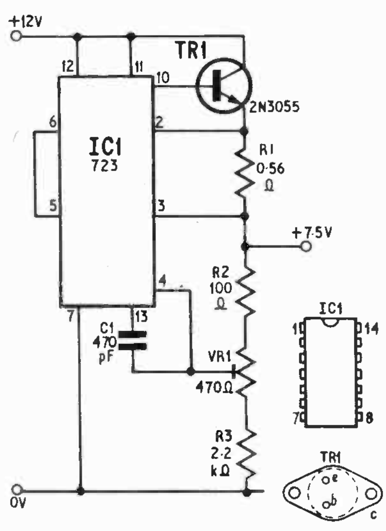


Fig. 1. Circuit for p.s.u.

COMPONENTS . . .

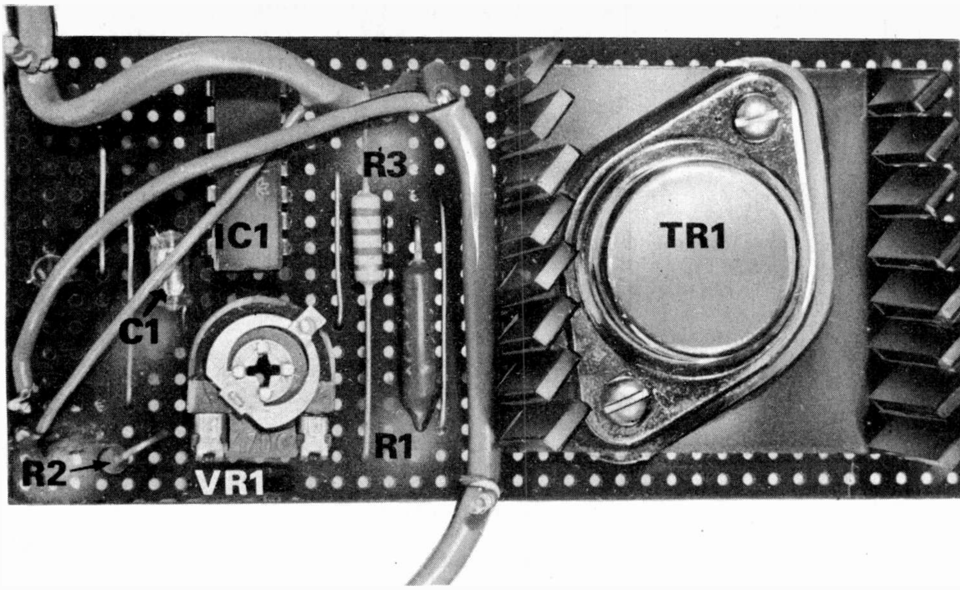
Resistors
R1 0·56Ω 1W
R2 100Ω ⅛W
R3 2·2kΩ ⅛W
All 10%

Potentiometers
VR1 470Ω linear horizontal preset

Capacitors
C1 470pF polystyrene

Semiconductors
TR1 2N3055
IC1 723 voltage regulator

Miscellaneous
0·1in Veroboard 3·75in × 1·75in, Heatsink for TO3 transistor



The assembled unit

The reference voltage (pin 6) is connected directly to the non-inverting input (pin 5) of the error amplifier, while R2, VR1 and R3 form a resistive divider to tap off a portion of the output to feed to the inverting input (pin 4). Variations of this voltage compared to the reference cause IC1 to vary the current applied to TR1 base, so tending to hold the output voltage constant. Hence, varying VR1 allows us to set the output to precisely 7·5V.

Current limiting is accomplished by R1 and the internal current limiting transistor. This turns on so preventing any further current being drawn, in the event of a short circuit on the output. Here the voltage across R1 is about 0·65V, and so the maximum available current in the design will be approximately 1·1A. This should be more than adequate for most portable recorders.

CONSTRUCTION

The unit is constructed on a piece of 0·1in matrix Veroboard, 3¾in × 1¾in. The layout is shown in Fig. 2.

A small heatsink was used for TR1 in the prototype, although this is probably not strictly necessary since a 2N3055 should be able to dissipate up to 10 watts without a heatsink, and it is only required to dissipate about 5 watts maximum in the present design. However, without the heatsink, there would be a fairly large temperature rise when running at full output, which would not be desirable, especially if the unit was mounted in a hot place, for example near a heater outlet, or possibly near the engine, and so the heatsink was used as a safety measure.

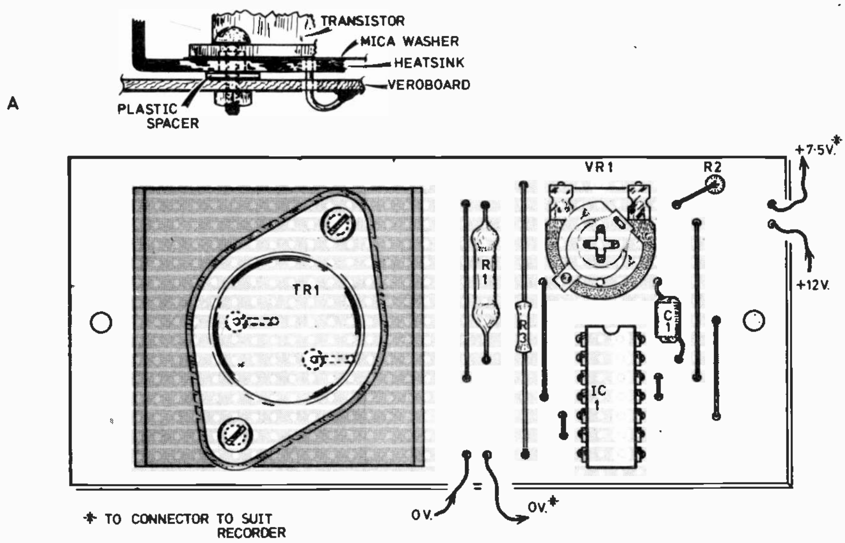
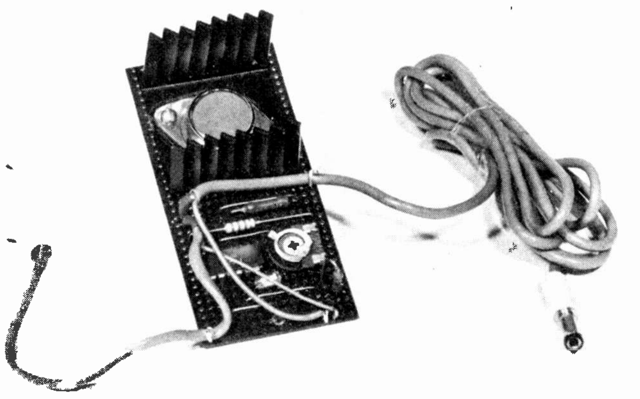


Fig. 2. Component layout and wiring detail



The cassette p.s.u. complete with connectors

Provision is normally made on the recorder for an external 7·5V supply to be connected via a five pin DIN plug; no details of pin connections are included, however, since these may vary with different makes of recorder.

TESTING

After rechecking the board the unit can be connected to a 12V supply and tested. The output should be somewhere near 7·5V. This can then be set precisely by adjusting VR1. The unit should then be ready for installation.

No details of casing for the unit have been given, since the board is small enough to be hidden away unobtrusively somewhere behind the dashboard or possibly in the glove compartment. A 12V supply may also be conveniently available from a cigar lighter, if one is fitted.

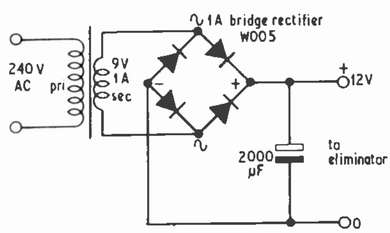
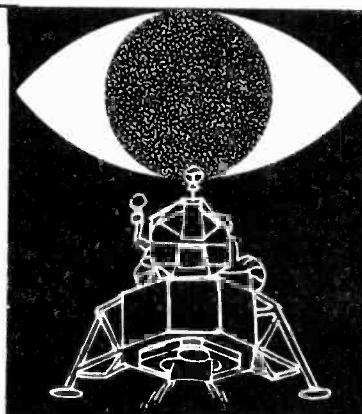


Fig. 3. Rectifier circuit for mains use

MODIFICATIONS FOR 9V

The unit can be readily modified to give a 9V output by changing the values of R2, R3 and VR1 to 750Ω, 2·7kΩ and 1kΩ respectively.

Either the 7·5V or 9V version can be operated from the mains by use of a simple rectified power supply, as shown in Fig. 3. ★



SPACEWATCH

BY FRANK W. HYDE

JUPITER ORBITER

The success of the *Pioneer 10* mission has led to a study, by the NASA-ESRO group, of the possibilty of launching an orbiter spacecraft to Jupiter. It seems that they are of the opinion that the back up facilities that are provided for the *Pioneer* missions could be employed for this purpose.

Data already examined showed that there were two parts to the magnetic field and that this alone could justify a closer look. There are a number of problems raised by this anomalous magnetic field. While the off-set field, first noted by Warwick and confirmed by others, explains some of radiation phenomena. *Pioneer 10* also confirmed these data but in addition detected a field reaching out to 108 Jupiter radii. This field has a special relationship with the equator of the planet.

The high energy electrons and protons that were measured by the spacecraft indicated a magnetosphere quite different from that of the Earth. The sudden burst of electrons from Jupiter remains unexplained at the moment. An orbiting vehicle could help to resolve this. The design of such a craft would have to take into account the high radiation hazard, shielding would be important for the vehicle will be in the magnetic belt a long time. The spin stabilised *Pioneer* is a better choice than the *Mariner* type for this project.

It is thought that the gravitational fields of Jupiter's satellites would help to retard the spacecraft and could also be used to change trajectory. The payload could consist of detectors for particles and fields. These would make up about 70 per cent of the total payload. The remainder would provide for visual, ultra-violet and infra-red monitoring. The vehicle would also carry a probe that could be dropped through the Jovian atmosphere. Launching would need to await a favourable Jupiter position. The probable time would be during the 1980's.

MORE ABOUT MERCURY

Some of the data received from *Mariner 10* on Mercury has now been processed and adds to our understanding of this planet. The magnetic field of Mercury seems to be very much weaker than that of the Earth. Though a magnetosphere was recognised as being like that surrounding the Earth there are certain peculiarities.

Particle detectors on *Mariner 10* indicated that there were protons at energy levels of 550 keV and electrons at levels of 300 keV, inside the magnetosphere. These particles were not trapped in the magnetosphere but seem to respond to some special mechanism.

There are large oscillations in the electron density having an apparent period of change of the order of 6 seconds. Sometimes there are active burst of protons at the same time. The weak field of the planet precludes the trapping of radiation in the form of belts around it. The presence of the magnetic field was rather a surprise for the small size and the slow rotation period of 58·5 days did not seem to support the idea.

However, the field does not seem to be generated by the effect of the solar wind and must therefore be intrinsic. If this is the case then it could be that there was once a core like the Earth's and that a dynamo system exists now or there are the remains after an original active dynamo ceased to function. If this should prove to be the case it would mean that Mercury once rotated much faster on its axis.

The planet is found to have an extremely high density of 5·44 g/cu.cm. This points to the condition of Mercury being more akin to the Earth and Venus than Mars or the Moon. From the density of the planet, and the strength of the field it would seem likely that Mercury has a core which extends out from the centre to as much as 70 per cent of its radius.

MAGNETIC FIELD

The magnetic field is almost parallel to the axis of rotation but offset by a quarter of the planet's diameter. This fact could have a very significant bearing on the history of the Solar System. The solar wind measurements showed that "ram pressure" of the wind was equal to a field strength of 170 gammas. The magnetometer recorded at nearest approach a field of 98 gammas.

The ultra-violet analysis of the atmosphere showed that it is made up of inert gases such as helium, neon, argon and xenon. Perhaps the first two of these have been captured from the solar wind. Some at least could come from radioactive minerals in the crust. The pressure of the atmosphere is extremely low being about 2×10^{-9} millibars.

The surface of Mercury seems to be dry powdery silicates, very similar to the Moon. The craters also resemble those of the Moon and are filled with lavas. It is possible that the silicates go down for 500 600km. The possible age of the planet is of the order of 4 to 4·5 thousand million years. The cameras have shown unusual ridges and scarps and this could mean that there have been internal shrinkages, causing buckling of the crust.

INFRA-RED TELESCOPE

The Science Research Council will build and operate 3·8m (152in) infra-red flux collector on Mauna Kea in Hawaii. There is already an observatory on the summit of the mountain which rises to 4,200m (13,780ft).

The telescope will be the largest purpose built unit in the world and the site is probably the best in the world. The water vapour, an absorber of infra-red radiation is far less at this site and the position allows the galactic centre to be observed. The cost will be about £1·25 million at present day prices.

The infra-red region lies between 1 micron and 2 millimetres. Over the last ten years or so research activity has increased steadily in this area. The technology mainly responsible for these advances has been solid state electronics, cryogenics and thermal detectors.

The science of infra-red astronomy is still in its infancy yet some dramatic discoveries have been made. There is already a 1·5m flux collector on Tenerife. This was designed and built by Imperial College with the aid of funding from the S.R.C. Valuable experience has been gained on this project apart from the scientific experiments.

The design of the 3·8m flux collector makes use of the 1·5m experience and also the design studies by Sir Howard Grubb Parsons and Dunford Hadfields Ltd. The improvement in facilities of the 3·8m instrument will be considerable, not least the fact that observation times will be reduced by a factor of 40. This will give considerable improvement in angular resolution.

The Director of the Royal Observatory, Edinburgh (Professor H. A. Bruck) is in overall control of the project, the project manager being G. J. Carpenter of ROE. The project manager will be advised by a steering committee under the chairmanship of Professor J. Ring of Imperial College. It is expected that the construction phase will last about three years.

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This chart will prove an invaluable aid to the constructor with both configuration and connection details on over 700 transistors presented in a clear and concise manner.

Motorists... get in tune for the winter!

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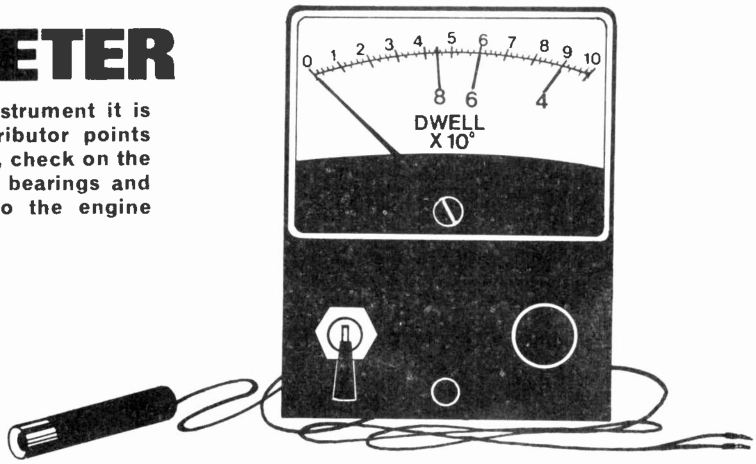
With this simply constructed instrument it is possible to set your car's distributor points accurately and, at the same time, check on the state of wear of the distributor bearings and shaft. Only two connections to the engine electrics are required.



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A very simple project giving a flexible circuit capable of providing the various basic pulses needed to operate and test i.c. logic.

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Make up a thermometer or temperature controller using the circuits and suggestions in this constructional project.

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PRACTICAL ELECTRONICS

DECEMBER ISSUE ON SALE NOVEMBER 15, 1974

INDUSTRY NOTEBOOK

By Nexus

SLOWDOWN?

While reporting increased sales and earnings, Fairchild Camera and Instrument Corporation gives warning that tough times may lie ahead. Fairchild's views are worth noting because they were learnt the hard way. In the mid-1960's Fairchild was the greatest in semiconductor technology and a huge producer but it still got itself in a mess. So much so that C. Lester Hogan, then heading up the commercially successful Motorola semiconductor operation, was invited to take over, at Fairchild and put matters to right. When he joined Fairchild he took with him no less than seven top managers from Motorola, which caused quite a stir in semiconductor circles.

When Hogan joined Fairchild with his ex-Motorola team in 1968, Fairchild was still the leader in technology but was heavily dependent on digital circuits and the computer industry with a base of only 600 customers and a bank balance well in the red. This year's results show Fairchild back again in the black, and with a much wider product range selling to 5,000 customers so that the company is no longer too dependent on any one market sector which might suffer temporary setbacks.

Hogan, his major task completed, has just stood down as Chairman and promoted one of his ex-Motorola proteges, Wilfred J. Corrigan, into the hot seat. Hogan remains with Fairchild as vice-chairman so will still be available for advice and it could be that Corrigan will need it.

For Corrigan, in his first annual report as Chief Executive, is already talking of a slowdown in growth. The forward order book is declining and therefore there are already steps to cut back employment, production rates, stocks and to spread capital investment over a longer period.

Prudent measures, no doubt, especially as some market analysts are already predicting a fall in demand for semiconductors of as much as 25 per cent by mid-1975 which could lead to yet another big round of competitive price-cutting as device manufacturers struggle to keep their production lines filled.

CAKE NOW

Company reports in the UK still make good reading though, here again, there are many warnings for the future. Thorn reported record turnover and record profits, helped considerably by overseas operations, but see a "very difficult trading year in the UK". GEC had record profits, improved productivity and good order intake but Lord Nelson is forced to conclude that ". . . we are surrounded by so many uncertainties that it is virtually impossible to predict the future".

Smaller companies, too, have been doing well. Multitone had a record turnover, largely from increased business in pocket paging. Unitech, who control a number of bright young companies, has never had it so good. Membrain, another vigorous stripling building automatic test equipment report deliveries up to 80 per cent during the first half of 1974.

We can say for certain that companies with a major interest in consumer electronics will have a tough time ahead. Those with widely spread exports will be less badly hit. One silver lining to the cloud overhead is that a slump in home demand for colour TV could well put British electronics balance of trade back in the black because many observers believe that a very large proportion of the components currently imported go into domestic TV sets and, of course, many TV sets, tape recorders and domestic radios are imported as complete units.

SALVATION?

With so much uncertainty at home there is more emphasis on consolidating overseas. Thus, Plessey now has a good base in the United States, in Australia and elsewhere in the Commonwealth and ex-Commonwealth, and is stiffening up its businesses in South America including establishment of a new telecommunications plant in Venezuela.

Ferranti is moving into Brazil in a joint deal to set up an indigenous computer industry. Those who shout down exports of military equipment should note that Ferranti moved into this important commercial activity on the back of exports of FM1600 military computers supplied to the Brazilian Navy for action information systems on submarines and warships.

Expect to see more companies expanding into overseas manufacturing. It may not be complete salvation but it's a step in the right direction and it's right in fashion these days. It happens in reverse, too, with the Japanese in particular. Sony started its TV production line in Wales last July and Matsushita will be churning out colour TV sets in Wales by early 1976.

HARBOUR RADAR

Decca Radar have long been the world's major supplier of marine radar on ships. The total score of deliveries is now well over 60,000 and the current order rate is something like 10,000 sets a year. Over 90 per cent of the orders are from overseas.

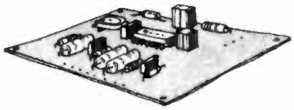
What is not so well publicised is Decca's equally effective stranglehold on the harbour radar industry. The score here is over 200 installations world wide and increasing fast. Some of them are big installations involving up to three radars with raw radar data being fed by microwave link to an operations centre where there are multiple displays and computer-assisted tracking systems. Others are less complex but all need careful planning and design to meet the peculiar needs of the pattern of traffic, the local topography and navigable channels.

The overseas list is a real Cook's tour. Installations just being completed are at Halifax, Vancouver, Placentia Bay, Capetown, Ras Tanura, Doha, Malmo, Hvasser and Tanager, but the total list is as long as your arm.

The reason for Decca's remarkable success in this specialised field is speed. The policy is to use off-the-shelf radars and displays as used at sea and re-package them for shore use. The radars are generally mounted on towers, perhaps 100ft tall, on headlands so that the whole area is covered with good overlap. The microwave links for transmitting radar data and VHF radio systems for talking to the ships are all bought-in items. So Decca can quickly tailor a system for an individual port or harbour.

A change of circumstances can suddenly demand a fairly quick installation. Who would have imagined five years ago that Aberdeen would need a harbour radar? The huge upsurge in traffic movements now comes from North Sea Oil. Decca harbour radar marshall's the traffic, safely and, one imagines, to the profit of all.

Audio Bargains



STEREO DECODER £4.50

incl. P. & P.

Ready-built unit, ready for connection to the IF stages of existing FM Radio or Tuner. The very latest 2nd Generation rail less integrated circuit design, operating on this phase locked loop system, offering even better stereo separation.
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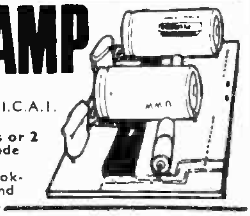
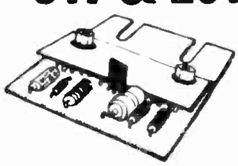
Order Code I.C.A.I.



On P.C. Board with all components or 2 on one board for £2·60. Order Code I.C.A.I/S.
These amps. are supplied with a free booklet on connecting up, specifications and easy-to-build projects using the I.C.A.I.

5W & 10W AMPS



5W ONLY £1.80
10W ONLY £2.26

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These matchbox size amplifiers have an exceptionally good tone and quality for the price. They are only 2¼in × 1¾in. The 5W Amp will run from a 12V car battery making it very suitable for portable voice reinforcement such as public functions. Two amplifiers are ideal for stereo. Complete connection details and treble, bass, volume and balance control circuit diagrams are supplied with each unit. Discounts are available for quantity orders. More details on request. **Cheapest in the U.K. Built and tested.**

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Pre-assembled printed circuit boards 2in × 3in available in stereo only, will fit 0·15 edge connector.
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............Stereo Pre-Amps 2............Stereo Tone Controls
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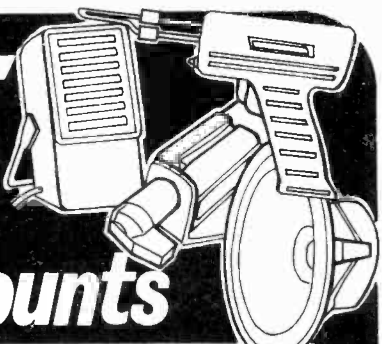

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BAKER GROUP 25 12in, 8 or 15 ohm, 25W 7·95
P. & P. 0·30
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UD130 50K/600 ohm, uni-dir, ball metal 5·95
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CONDENSER MIKE 600 ohm, uni-dir 9·35
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PATENTS REVIEW...

AUTOMATIC CHOKE CONTROL FOR CARS

In BP 1 334 532 Joseph Lucas (Industries) Ltd. describes circuitry suitable for alternately operating a pair of electromagnets to allow the step-by-step movement of a car choke cable back into an "off" position depending on engine temperature.

In Fig. 1 operation of electromagnets 1 and 2 is dependent on the temperature sensed by thermistor R1, the resistor having a sharply decreasing resistance with increasing temperature.

When the choke knob is pulled out the wipers of the rotary switch S1a and S1b move into engagement with fixed contacts. When the engine starts, the generator speed increases and the vehicle voltage regulator closes contact S2 in conventional manner. Electromagnet 1 is now energised by contact 5, S1a wiper and moves the choke cable back towards its inoperative position. Additionally the wiper is moved onto contact 4a and S1b wiper onto contact 4b. Thus the circuit to electromagnet 1 is broken; electromagnet 2 is effectively inoperative because the current flowing through it via resistors R2 and R3, diode D1 and VR2 is insufficient to energise it.

When the temperature sensed by R1 rises further its resistance falls and transistor TR1 turns off. Current now flows via R6 and D2 to turn on thyristor CSR1. The current flows through D4 to energise electromagnet 2 and the choke cable now moves further back towards its inoperative position. At the same time the wiper of S1b is moved onto contact 3b and the wiper of S1a onto contact 3a. This breaks the circuit to electromagnet 2 and electromagnet 1 receives insufficient current to energise it via VR4. The thyristor is "off", its circuit being broken upon movement of S1b away from contact 4.

When the engine temperature rises further the resistance at R1 drops further and the CSR1 turns "on". Electromagnet 1 is energised, via D6, and S1a. b moves onto the contacts 2a and 2b. The sequence continues with electromagnet 2 energised via D3 when the engine temperature rises further and the S1a and S1b move into the position shown in Fig. 1.

As a final step, electromagnet 1 is energised, via D5, bringing the choke cable into its inoperative position.

The setting of potentiometers VR1 to VR4 determines the temperature at which the cable moves back step by step; a thermistor R5 compensates for changes in ambient temperature.

BP 1 334 532

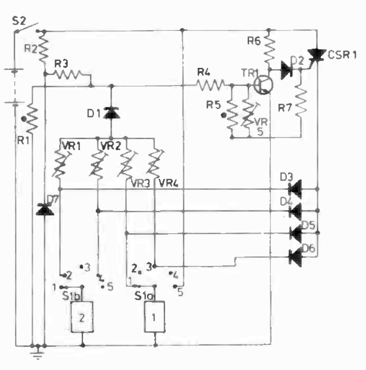


Fig. 1

VARIABLE TONE AUDIBLE ALARM

Various audible alarm generators are known but few of them have the facility to produce a wide range of different sounds. But a tonal range may be highly desirable, for instance, to signal different conditions, e.g. smoke warning, flame warning, gas warning.

In BP 1 341 842 A. J. Whetton and Company (Manufacturing) Ltd. describes a fairly simple circuit which will emit different sounds depending on the condition of any suitable external switching system.

The circuit, Fig. 1, uses a relatively low frequency multivibrator, a high frequency multivibrator, an output amplifier and a loudspeaker. The two multivibrators and amplifier are of known type except that the second multivibrator has a gate in the form of TR4 arranged between the base of TR3 and the negative line. Thus, when a sufficient voltage is applied to TR4 base to drive it into conduction, the operation of the multivibrator is inhibited.

The frequency of the multivibrators is adjusted by potentiometers VR1 and VR2. The alarm circuit can function in five different manners depending on the externally switched inter-connections between the inputs.

A slow warbling sound will be produced when input 3 is switched to input 4 so that the square wave output of first multivibrator causes a periodic frequency shift in the second multivibrator. In this condition the mean or basic frequency of the sound produced is adjustable by potentiometer VR2 and the frequency of warble by VR1.

A fast warbling sound is produced by connecting input 2 to input 1 to short out VR1. The mean or basic frequency can still be adjusted by VR2 although the frequency of warble can no longer be adjusted.

A slow intermittent pipping sound is produced if inputs 5 and 3 are connected so that the operation of the second multivibrator is periodically inhibited by the operation of the first multivibrator. The frequency of the sound is adjustable at VR2 and the frequency of the pip at VR1. For a fast pipping sound input 2 is switched to input 1 to short out VR1.

Finally a continuous note may be produced by connecting input 6 to the positive supply line to cause continuous operation of the second multi-vibrator, TR3/5. The frequency of the note is adjusted at VR2. In this mode diode D1 prevents operation of the first multivibrator.

BP 1 341 842

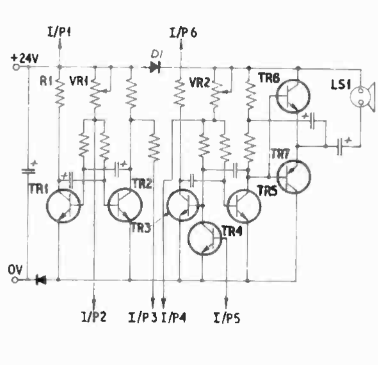


Fig. 1

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. All quoted prices are those at the time of going to press.

WIRING AID

It is always rewarding to bring to the attention of readers a new product that will be used just as much, if not more, by the amateur as the professional.

This should certainly be the case with the new self-adhesive wiring staples from **Special Products Distributors Ltd.** Known as the Brandauer staple they are ideal for all types of wiring both domestic and equipment wiring.

By peeling off the protective backing from the adhesive pad the staples can be positioned and pressed into place. The adhesive pad is such that it will adhere to most surfaces. Once in position the wire is placed across the clamping fingers which are easily bent up over the wire to hold it in place.

In use the staples have been found particularly useful where groups of wires have to be routed to control panels. Also, they helped to improve wiring layouts and made it far easier for lead tracing when using this method.

One obvious use for these staples that comes to mind is for tidying up the masses of wiring used in projects like an electronic piano or an electronic organ.

Further details and addresses of nearest stockists can be obtained from Special Products Distributors Ltd, 81 Piccadilly, London, W1V 0HL.

VAT CALCULATOR

Readers who have trouble with VAT may be interested in the Vatman pocket calculator from **Decimo Ltd.**

Aimed at the businessman who needs to save time working out his VAT returns when doing his monthly accounts, the calculator is a four function machine with a fairly large, clear readout display. Operation of the percentage key gives an instant per cent readout and can cover any percentage should the present 8% rate change.

With the incorporation of the percentage key it is claimed that at £21·95 (plus VAT) the Vatman is one of the cheapest calculators of its kind on the market. The price of the calculator includes a mains adaptor unit.

Full details of its capabilities can be obtained from Decimo Ltd., Park House, 96–98 Park Street, Luton, LU1 3RX.

The Vatman calculator with a percentage key from Decimo

LOUDSPEAKER KIT

Designed to suit a choice of different cabinet sizes from bookshelf to floor standing types the XLK-30 Super loudspeaker kit from **Helme Audio Products** seems to be a reasonable investment at just over £16.

The heart of the kit is an 8in bass/mid-range driver which has a special plastics coated cone claimed to give a much better bass response than previous kits. The kit also includes an 4in tweeter, ready-built crossover network, fixing screws, terminal panel, connecting leads and one piece of BAF sound absorbent material. Full assembly instructions are also included.

According to size of enclosure, the kit has a claimed frequency response of 40 to 18kHz, and a maximum power output of 20 to 30 watts. The impedance of the speakers is 8 ohms.

The kit does not include a cabinet or speaker grille fabric. Should you not want to make your own enclosure and are prepared to spend more on the cabinet than on the speakers a cabinet kit consisting of, a teak veneer finished cabinet shell, a ready-cut front baffle and all materials is available as an extra. The price of the speaker cabinets (types XLC-30 and XLC-22) is approximately £30 to £40.

Further information and full details of the complete range of speaker kits and enclosures can be obtained from Helme Audio Products Ltd., Summerbridge, Harrogate, HG3 4DR.

LOW VOLTAGE FLUORESCENT LIGHT KIT

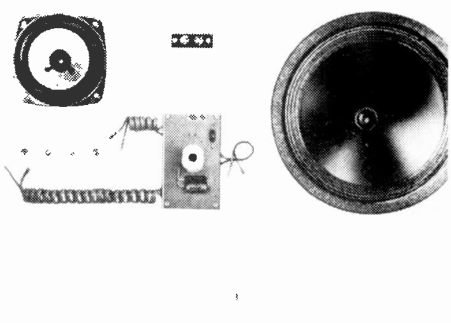
It now seems to be an annual event at this time of the year for industrial relations to become very strained and an investment in any form of emergency lighting is a wise precaution against any power cuts. With this in mind **Electronic Design Associates** are now producing an 8W 12V fluorescent lighting kit.

The kit consists of a printed circuit board, components, pre-drilled metalwork, clips, end caps, cable, the tube, nuts and bolts and full constructional instructions.

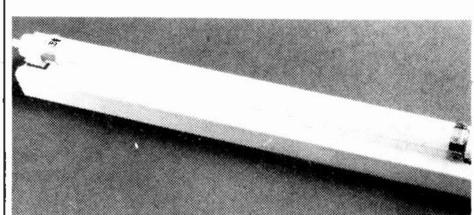
The light is ideally suited as a caravan and camping light, for garage or workshop lighting, as an inspection light, and for general home use. In use the light is reverse polarity protected and takes approximately 0·6A from the battery.

Available from Electronic Design Associates, 82 Bath Street, Walsall, WS1 3DE, the cost of the kit is £3·19 including VAT, postage and packing. A light diffuser is available as an extra for 59p including VAT and p&p.

It is only fair to point out that several of our advertisers also produce excellent 12V fluorescent lighting kits from 8W to 13W.



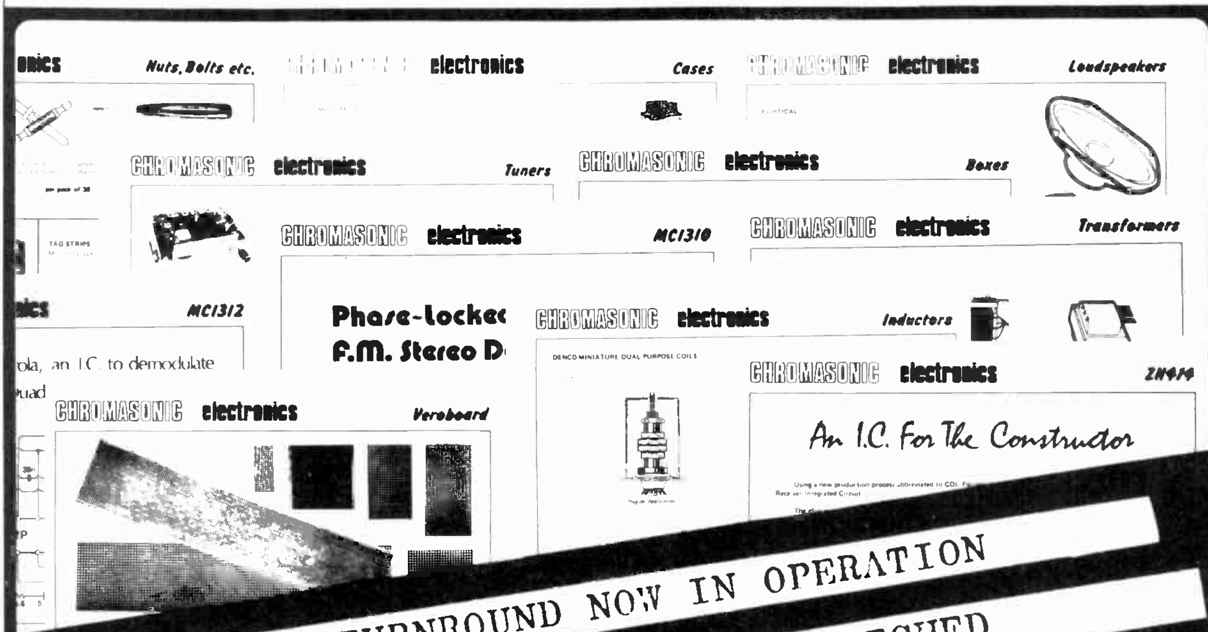
Helme speaker kit type XLK-30



8W Fluorescent light from Electronic Design Associates

CHROMASONIC electronics

Dept. 2
56, Fortis Green Road, London, N10 3HN.
telephone: 01-883 3705



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Character Height 0.3"

RED	(Led 7)
GREEN	(Led 18)
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0.125" diameter — TIL209 size			
10	RED	~~£2.40~~	£1.99
10	GREEN	~~£4.10~~	£3.49
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10	WHITE	~~£3.60~~	£3.39
0.2" diameter — MLED650 size			
10	RED	~~£2.80~~	£2.39
10	GREEN	~~£4.50~~	£3.99
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H65	4	40361 Type NPN Sil. transistors TO-5 can comp. to H66	50p
H66	4	40362. Type PNP Sil. transistors TO-5 can comp. to H65	50p

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H67	10	3819N Channel FET's plastic case type.	50p

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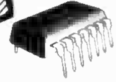
Our new vastly improved Mark Two Cross Hatch Generator is now available.

Will align the colour guns on a colour TV receiver. Featuring plug-in ICs and a more sensitive sync. pick-up circuit. The case is virtually unbreakable—ideal for the engineer's toolbox—and only measures 3in × 5½in × 3in.

Ready built unit only **£9·95** Complete Kit **£7·75**

(includes **P. & P. but no batteries**)



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Brand new by a famous manufacturer

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Plastic Power Transistors

NOW IN TWO RANGES

These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

Range 1	VCE Min. 15	HFE Min. 15	
	1–12	13–25	26–50
40 watt	20p	18p	16p
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40 watt	30p	28p	26p
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Please state NPN or PNP on order.

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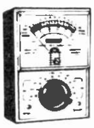
AUDIOTRONIC Model ATM1
Top value 1,000 opv pocket multimeter. Ranges: – 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistence: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.



OUR PRICE £3.25 P&P 15p

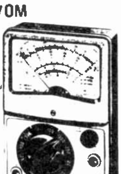
AUDIOTRONIC Model ATM5
Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.95 P & P 20p

MODEL TH12
20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.

OUR PRICE £5.95 P&P 30p

HIOKI 720X VOM
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10, 50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.



OUR PRICE £5.97
P&P 30p

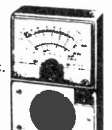
MODEL PL436
20,000 opv DC. 8000 opv AC. Mirror scale 6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. –20 to · 46 dB.

OUR PRICE £6.97 P&P 30p.

U4323 MULTIMETER
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω. 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.70 P&P 30p

HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. –10 to · 63 dB.



OUR PRICE £7.50
P&P 30p

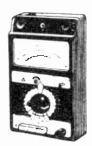
U4324 MULTIMETER
High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £9 .25 P&P 30p

U435 MULTIMETER
20,000opv. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

OUR PRICE £8.75 P&P 30p

U4312 MULTIMETER
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60,150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.



OUR PRICE £10.25 P&P 50p

U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

OUR PRICE £13.50 P&P 30p

MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.

OUR PRICE £13.95 Carr. paid
Leather case for above £1.75

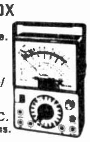
HIOKI 750X VOLT-OHM-MILLIAMETER
43 ranges: 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current: 0–30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence: 0–3/300k/3/30Mohms. Decibels: –10 to +17dB. Output: – 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

TMK MODEL TW50K
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.

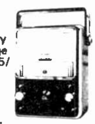
OUR PRICE £12.50 P&P 20p

HIOKI MODEL 700X
100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.



OUR PRICE £14.95 P&P30p

Model HT100B4 MULTIMETER
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistence' 0–20/200k/2/20 Meg. ohms. DC current: – 10/250uA/2.5/25/250 mA/10A. AC current: –0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.



OUR PRICE £17.50 P&P 40p

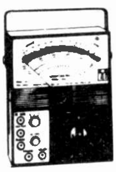
MODEL AS.1000 VOM
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. – 20 to · 17 dB.

OUR PRICE £17.50 P&P 30p.

MODEL C7202EN
20,000 o.p.v DC 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance ×10, ×1000 (30Ω centre scale) DC Current 50uA/2 5mA/250mA. –20 to +68 dB.

OUR PRICE £6.50 P & P 30p

KAMODEN 360 MULTIMETER
High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0,5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.



OUR PRICE £17.50 P & P 40p

TMK MODEL 117 FET ELECTRONIC VOLTMETER
Battery operated. 11 Meg input, 26 ranges. Large 4¼" mirror scale. Size: 149x117x60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistence up to 2000MOhms. Decibels: –20 to +51dB. Supplied complete with leads and instructions.

OUR PRICE £18.50 P&P 20p

TMK 100K LAB TESTER
100,000opv. 6½" scale. 3uzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/100/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.

OUR PRICE £19.95 P&P 30p

KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges: –0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

OUR PRICE £16.50 P&P 40p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter
Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3/7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

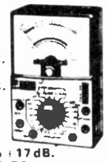
OUR PRICE £52.00 P&P 50p

ALL PRICES EXCLUDE VAT

MODEL C7208FM
30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance ×1. ×10, ×100, ×1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. –20 to +63dB.

OUR PRICE £8.95 P & P 30p

MODEL AF.105 VOM
50,000 opv. Mirror scale. Meter protection. 0/3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. –20 to · 17 dB.



OUR PRICE £12.50 P&P 30p.

LB3 TRANSISTOR TESTER
Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

LB4 TRANSISTOR TESTER
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

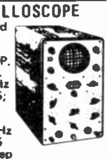
U4341 Multimeter & Transistor Tester
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

OUR PRICE £10.50 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER
100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £19.95 P&P 25p

CI5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.



OUR PRICE £43.00 Carr. paid

RUSSIAN CI16 Double Beam OSCILLOSCOPE
5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

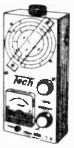
OUR PRICE £87.00 Carr. paid

SWR METER Model SWR3
Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52· Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 30p

Also see following pages

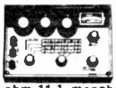
MODEL TE15 GRID DIP METER



Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £19.95 P&P 30p

TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 microamp meter indication. Size 7¼" x 5" x 2"

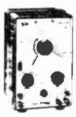
OUR PRICE £25.00 P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the har dy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.

OUR PRICE £8.97 P&P 30p

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. Size 140mm x 215mm x 170mm.

OUR PRICE £17.50 P&P 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sinewave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

OUR PRICE £37.50 P&P 50p

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

Range 19-220,000Hz Sine Wave 19–100,000 Hz Square Wave Output Sine or Square wave 10v P to P Size 180 x 90 x 90mm Operation 220/240v. A.C

OUR PRICE £19.95 P&P 50p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems 25 Watts. 4–8 ohms. 40Hz–18kHz. Size. 560 x 340 x 255mm. approx. Wood grain finish with black fronts

OUR PRICE £22.50 PR. P&P £1

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/500/1000/2500 ohms. **£1.15** P&P 10p

50 WATT 10/50/100/250/500/1500/5000 ohms. **£1.62** P&P 10p

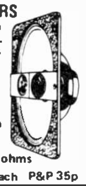
100 WATT 1/5/10/25/50/250/500/2500 ohms.500 Ohms **£2.34** P&P 15p

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

OUR PRICE £5.25 P&P 50p

EMI LOUDSPEAKERS



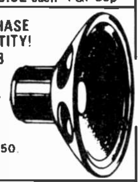
Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.50 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 35p

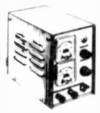
SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers



8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group.

OUR PRICE £12 50 P&P 50p

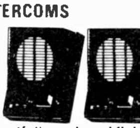
PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P 50p

AUDIOTRONIC LE-102A INTERCOMS



Beautifully made and finished in two tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit Operates on 9V batt Approx 60ft lead.

OUR PRICE £3.95 P & P 30p

TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO

Will play 8 track stereo cartridge monaurally Channel selector switch. Covers medium and long wave bands. Volume and tone controls Earphone socket Battery Mains operation

OUR PRICE £11.95 P & P 50p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beau- walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.

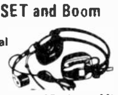
OUR PRICE £2.60 P&P 30p

SDH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.

OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone



Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

OUR PRICE £5.95 P&P 30p

HANIMEX HRC 3075 CASSETTE RADIO

Covers Medium and FM wavebands. Slider volume and tone controls. Battery/Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

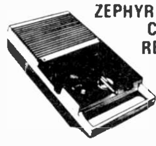
OUR PRICE £24·30 P & P 50p

TRITON CT.555 CASSETTE RECORDER

Battery/Mains. Piano key and slider controls. Automatic level control. Complete with mike and earphone.

OUR PRICE £10.50 P & P 50p

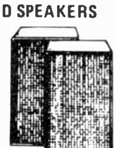
ZEPHYR TC1500B CASSETTE RECORDER



Battery/Mains. Complete with mike, cassette, earphone

OUR PRICE £9.95 P & P 50p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 PAIR P&P 50p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £8.95 P&P 20p

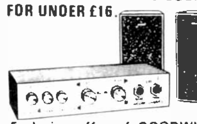
Stereo Multiplex Adaptor £5 95 extra

SPECIAL OFFER! SAVE OVER 50%

AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for tuner tape, phono. Headphone socket. List price £29.95.

OUR PRICE £12.95 P & P 60p

SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16



Exclusive offer of GOODWIN 4-CHANNEL CONVERTER and a pair of AD15 10 watt 8 ohm bookshelf speakers enables you to add 4D sound to your existing system. Complete with simple connection details. Normal retail value £25.50.

OUR PRICE £15.80 P & P £1.

GOODWIN CONVERTER available separately £3.95 P & P 50p

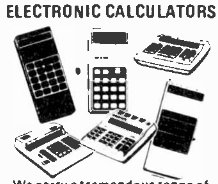
Model A1018 FM TUNER

6 transistor high quality unit– 3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

OUR PRICE £13.50 P&P 30p

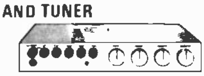
Stereo multiplex adapter £5 95 extra.

ELECTRONIC CALCULATORS



We carry a tremendous range of both pocket and desk calculators from as little as £9. Owing to the demand it is not possible to include them in this advertisement, so send for our latest price list or call into any branch.

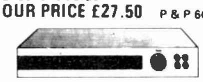
SINCLAIR SYSTEM 2000 STEREO AMPLIFIER AND TUNER



AMPLIFIER

Amplifier output 8 watts per channel RMS Distortion less than 0 06% Silicon transistors. Two pick-up plus radio and tape inputs, tape output and scratch filter. Excellent Value

OUR PRICE £27.50 P & P 60p.



FM TUNER

Excellent selectivity and sensitivity Twin dual-varicap tuning. 4 pole ceramic filter 19 transistor stereo demodulator giving 40 dB separation. Distortion 0 2% output. Fantastic Value.

OUR PRICE £27.50 P & P 60p.

SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER

complete with printed circuit mounting board.

OUR PRICE £1.50 P & P 15p.

SINCLAIR Project 80 Modules

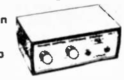
Z40 Power Amp	£5.45	P & P 15p
Z60 Power Amp	£6.95	P & P 15p
Stereo 80 Pre-Amp	£11.95	P & P 15p
Active Filter Unit	£6.95	P & P 15p
Project 805	£26.95	P & P 50p
PZ5 Power Supply	£4.98	P & P 30p
PZ6 Power Supply	£7.98	P & P 30p
PZ8 Power Supply	£7.98	P & P 30p
Transformer for PZ8.	£4.05	P & P 50p

SINCLAIR Project 80 Packages

2 x Z40/Stereo 80/PZ5	£25.00
2 x Z40/Stereo 80/PZ6	£27.75
2 x Z60/Stereo 80/PZ8	£30.45

POST & PACKING 35p each.

TE1021 Stereo Listening Station



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1.57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

P&P Cassettes 3p, OVER 10 POST FREE!

MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

AUDIOTRONIC AHA101 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: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 30p

HIGH QUALITY CONSTRUCTION KITS

JOSTY KIT

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£5 61
AF25 Mixer	£3 29
AF30 Mono pre-amplifier	£3 20
AF35 Emitter amplifier	£2 42
AF80 0.5W mic. amplifier	£4 86
AF305 Intercom	£7 67
AF310 2 Mono Amplifier	£7 55
M160 Multi-vibrator	£2 18
M1302 Transistor tester	£8 33
M191 VU Meter	£5 37
M192 Stereo balance meter	£5 93
LF380 Quadraphonic device	£ 8 42
AT5 Automatic light control	£3 75
AT30 Photo cell switch unit	£6 68
AT50 400W triac light dimmer/speed control	£5 18
AT56 2,200W triac light dimmer/speed control	£6 75
AT60 1 channel light control	£10 82
AT65 3 channel light control	£16 52
GU330 Tremolo unit	£8 10
HF61 Diode detector	£3 87
HF65 FM transmitter	£3 21
HF75 FM receiver	£3 66
HF310 FM tuner	£16 32
HF325 Deluxe FM tuner	£26 33
HF330 Decoder (HF310/325)	£10 55
GP310 Stereo pre-amplifier for use with 2 x AF310	£22 98
GP312 Circuit board	£10 02
GP304 Circuit board	£5 33
HF380 lw/vhf aerial amplifier	£6 02
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NT310 Power Supply 240 V AC or 2 x 18 V D C at 2 amps	£5 64
NT305 Voltage converter	£5 64
NT315 Power supply 240V AC to4,5/15V OC, 500mA	£12 06

Amateur Electronics by Josty-Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

OUR PRICE £3.30 (No VAT)

P&P 25p plus VAT,

AE1 100mW output stage	£1.55
AE2 Pre-amplifier	£1.32
AE3 Diode receiver	£2.05
AE4 Flasher	£1.26
AE5 Astable multi-vibrator	£1.14
AE6 Monostable multi-vibrator	£1.11
AE7 RC generator	£1.08
AE8 Bass filter	£1.05
AE9 Treble filter	£1.08
AE10 CCIR filter	£1 05

Also see previous page

ALL PRICES EXCLUDE VAT

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types
SHROUDED TYPE

200 watt (1 amp) **£9·00**
0·5 KVA (2½ amp) (MAX) **£10·00**
1 KVA (5 amp) (MAX) **£14·70**
2 KVA (10 amp) (MAX) **£28·10**
3 KVA (15 amp) (MAX) **£31·25**
4 KVA (20 amp) (MAX) **£72·50**
37·5 amp (MAX) **£102·50**
CARRIAGE AND PACKING EXTRA
OPEN TYPE 1 amp (panel mount) **£9·00**

L.T. TRANSFORMERS

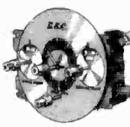
All primaries 220–240V

Type No.	Sec. Taps	Price Post
1	30, 32, 34, 36V at 5A	£7·25+60p
2	30, 40, 50V at 5A	£9·60+65p
3	10, 17, 18V at 10A	£7·55+60p
4	6, 12V at 20A	£9·00+65p
5	17, 18, 20V at 20A	£9·60+65p
6	6, 12, 20V at 20A	£9·00+65p
7	12, 20, 24V at 10A	£7·00+60p
8	4, 6, 24, 32V at 12A	£9·00+65p
9	6 and 12V at 10A	£4·50+55p

300 VA ISOLATING TRANSFORMER

115/230-230/230 volts. Screened. Primary two separate 0-115V for 115 or 230 volt. Secondary two 115V at 150 VA each for 115 or 230 volt output. Can be used in series or parallel connections. Fully tropicalised. Length 13·5 cm. Width 11 cm. Height 13·5 cm. Weight 15 lb.
SPECIAL OFFER PRICE £5. Carr. 80p.

A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm × 130 mm × 60 mm. Price **£2.** Post 20p. (Total incl. VAT and Post **£2·38**).

PROGRAMME TIMERS

230/240V a.c. 15 r.p.m. Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays, etc. Ex equipment tested.
2 cam model. **£2·00** post 30p.
4 cam model. **£2·50** post 30p. 6 cam model. 3 r.p.m.
6 cam model. **£3·25** post 30p. **£3·25** post 30p.

MINIATURE UNISELECTOR SWITCHES

2 Bank, 11 position, 24 volt D.C. operation, full wiper with ancillary contacts. NEW Price **£2·50.** Post 20p. As above but with 5 Bank, 11 position. Price **£3·50.** Post 20p.

COIN MECHANISM (Ex London Transport)

Unit containing, selector mechanism for 1p, 2p and 5p coins. Micro switches, relays, solenoid operated hopper. 24 volt D.C. Precision built to high standard. Incredible VALUE at only **£2·50.** Post 60p.

230/250 VOLT A.C. SOLENOID

Approximately 1½lb pull. Size of feet 1⅜″×1⅛″. Price **£1·00.** Post 15p.

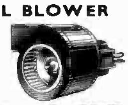
24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ¼ inch travel. 6 × approx. 4oz. pull ¼ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£2·50.** Post 60p. **ABSOLUTE BARGAIN.**

230V FAN ASSEMBLY

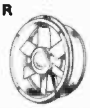
Continuously rated, removable aluminium blades. Price **£1.** Post 20p.

PRECISION CENTRIFUGAL BLOWER



Mfg. Airflow Developments Ltd. Heavy Duty continuously rated, smooth running, 230/240V a.c. motor. Size: 16 × 14cm (case only). OAL 15cm. Aperture 6 × 6cm. **£6·50.** Post 50p.

230/240 VOLT A.C. EXTRACTOR FAN KIT



Comprising of impeller, continuously rated motor, motor housing and fixings as illustrated. Price **£1·75.** Post 25p. (Total incl. VAT and Post **£2·16**).

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 Xenon Tube and instructions **£6·30.** Post 30p.

INDUSTRIAL KIT
Ideally suitable for schools, laboratories, etc. Speed adjustable 1-80 f.p.s.
Approx. ¼ output of Hy-Lyght. Price **£14·00.** Post 50p.

HY-LYGHT STROBE MK III
For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. **£14.** Post 50p.

THE 'SUPER' HY-LYGHT KIT

Approx. four times the light output of our well proven Hy-Lyght strobe.

- Variable speed from 1-13 flash per sec.
- Reactor control circuit producing an intense white light. ONLY **£22.** Post 75p.

ROBUST, FULLY VENTILATED METAL CASE. For Hy-Lyght Kit including reflector **£5·75.** Post 25p.
Super Hy-Lyght case including reflector **£8.** Post 60p.

7-inch POLISHED REFLECTOR
Ideally suited for above Strobe kits. Price **55p.** Post 15p.

COLOUR WHEEL PROJECTOR

Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50.** Post 50p.
6 INCH COLOUR WHEEL
As used for Disco lighting effects, etc. Price **£4·50.** Post 30p.

BIG BLACK LIGHT

400Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. P.F. ballast is essential Price of matched ballast and bulb **£16.** Post **£1.** Spare bulb **£7.** Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES
4ft 40 watt. Price **£5·50.** Post 30p. (4ft to Personal callers only). **2ft 20 watt, £4·25.** Post 25p. (For use in standard bi-pin. MINI. **12in 8 watt, £1·60.** Post 15p. **9in 6 watt, £1·30.** Post 15p. Complete ballast unit and holders for 9in and 12in tube, **£1·70.** Post 25p. (9in and 12in measures approx.)

U.D.I. SINGLE CHANNEL 750 WATT MANUAL/AUTO DIMMER

750W Solid State Fader, with three functions. Manual fade; Auto fade-up; Auto fade-down. Automatic cycling up and down. Functions selected with 'three-position' rocker switch. Two ranges of cycling for 'Flashing' or 'Slow blending'. Ready built module 6″ × 3″ glass fibre board incorporating 10 amp TRIAC. Two or more modules for top quality colour blending and flashing effects. PRICE **£15.** Post 30p.

INSULATION TESTERS *NEW!*

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **1,000V, 1,000 megohms, £34.** Post 60p. **500V,** 500 megohms, **£28.** Post 60p.

TRIACS

GENERAL ELECTRIC POWER-GLAS TRIACS
10 amp. Glass passivated plastic triac. Latest device from U.S.A. Long term reliability. Type SC146E 10 amp, 500 PIV, **£1·00.** Post 5p. (Inclusive of data and application sheet.) Suitable Diac **18p.**

HIGH VISIBILITY PANEL MOUNTING LED's.

0·25 inch mounting, 0·16 inch lens. Typical parameters 2V, 20M amps all type. Supplied complete with snap in mountings and data. Red 4 for **£1,** Green 3 for **£1,** Yellow 3 for **£1.** Post 10p. (in order) (£1).

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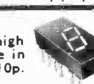

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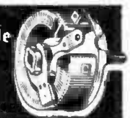

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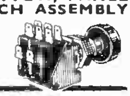

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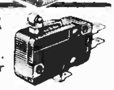

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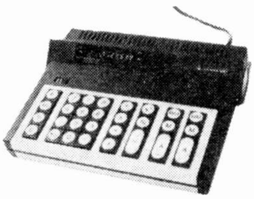

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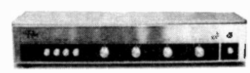

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BC157	14p	BFY90	66p	OA81	10p	TIP34B	£1·68	2N1308	25p	2N4289	15p
BC158	15p	BSW63	65p	OA90	10p	TIP35B	£2·81	2N1309	25p	2N4290	15p
BC159	15p	BSW68	80p	OA91	10p	TIP36B	£3·64	2N1613	25p	2N4444	£1·90
BC169C	14p	BSY95A	12p	OA200	10p	TIP41B	83p	2N1711	25p	2N4871	35p
BC182	14p	C111	50p	OA202	10p	TIP42B	98p	2N2147	70p	2N4920	60p
BC183	14p	C426	40p	OA210	35p	TIP29C	71p	2N2160	65p	2N5191	98p
BC184	14p	BY100	15p	OA211	38p	TIP30C	78p	2N2217	25p	2N5194	£1·10
BC212	14p	BY126	20p	OC16	90p	TIP31C	85p	2N2218	25p	40360	50p
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