

PRACTICAL

# ELECTRONICS

NOVEMBER 1974

25p

PE  
**MINISONIC**

miniature  
battery operated  
sound  
synthesiser



**Inexpensive • Easy to build**

**... STARTS THIS MONTH**

# NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT  
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER

- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN -PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loud-speaker Radio MW/LW
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier

TOTAL BUILDING COSTS

**£7-23** P.P. & INS. 44p  
(+8% VAT 57p) (Overseas P.P. £1-85p)

Components include:

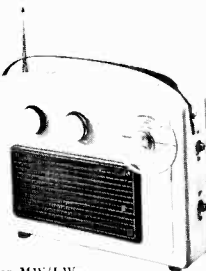
- 24 Resistors ● 21 Capacitors ● 10 Transistors ● 31" Loud-speaker ● Earpiece ● Mica Baseboard
- 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs
- Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 64 yards of wire ● 1 yard of sleeving, etc.
- Parts price list and plans 50p (free with parts)

## NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT

Nine Transistors, 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600mW transistors. 9 Transistors and 3 diodes, tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wave-change controls. Attractive all white case with red grille and carrying strap. Size 9 1/2" x 7 1/2" x 2 1/2" approx. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS **£6-95** P.P. & INS. 44p  
(+8% VAT 55p) (OVERSEAS P. & P. £1-85)



## NEW EVERYDAY SERIES

Build this exciting New series of designs

**EV5** 5 Transistors and 2 diodes. MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9 1/2" x 5 1/2" x 2 1/2" approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS **£2-95** P.P. & INS. 30p  
(+8% VAT 23p) (OVERSEAS P. & P. £1-25)

**EV6** Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, 3" loudspeaker, etc. MW/LW coverage, Push Pull Output. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS **£3-60** P.P. & INS. 30p  
(+8% VAT 29p) (OVERSEAS P. & P. £1-25)

**EV7** Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. 3" Loudspeaker. Parts price list and easy build plans 20p. Free with parts.

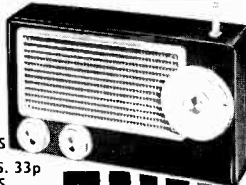
TOTAL BUILDING COSTS **£4-08** P.P. & INS. 31p  
(+8% VAT 32p) (OVERSEAS P. & P. £1-85p)

## ROAMER EIGHT Mk. I

NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Chrome plated telescopic aerial can be angled and rotated for peak short-wave listening. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 1/2" x 7 1/2" x 4 1/2" approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£6-98** P.P. & INS. 47p  
(+8% VAT 59p) (OVERSEAS P. & P. £1-85)

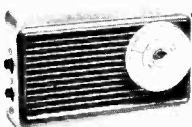


## POCKET FIVE

NOW WITH 3" LOUDSPEAKER

3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 3 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5 1/2" x 1 1/2" x 3 1/2" approx. Plans and parts price list 15p (FREE with parts).

Total Building Costs **£2-50** P.P. & Ins. 26p  
(+8% VAT 26p) (Overseas P.P. £1-25)



Total Building Costs **£2-75** P.P. & Ins. 26p  
(+8% VAT 21p) (Overseas P. & P. £1-25)

## TRANSONA FIVE

Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (FREE with parts).

## TRANS EIGHT 8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 1/2" x 5 1/2" x 2 1/2" approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£4-48** P.P. & INS. 33p  
(+8% VAT 36p) (OVERSEAS P. & P. £1-25)

**ROAMER SIX** CASE AND LOOKS AS TRANS EIGHT  
6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—8 transistors and 2 diodes, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 1/2" x 5 1/2" x 2 1/2" approx. Plans and parts price list 25p (FREE with parts).

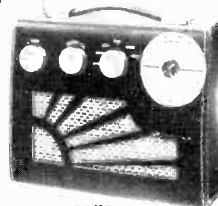
TOTAL BUILDING COSTS **£3-98** P.P. & IN. 31p  
(+8% VAT 32p) (OVERSEAS P. & P. £1-85)

## ROAMER TEN WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS, 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND

Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9 1/2" x 7 1/2" x 4 1/2".

TOTAL BUILDING COSTS **£8-50** P.P. & INS. 52p  
(+8% VAT 68p) (OVERSEAS P. & P. £1-85)



## EDU-KIT

Build Radios Amplifiers, etc., from easy stage, diagrams. Five units including master unit to construct.

Components include: Tuning Condenser; 2 Volume Controls; 2 Slider Switches; Fine Tune 3" moving coil Speaker; Terminal Strip; Ferrite Rod Aerial; Battery Clips; 4 Tag Boards; 10 Transistors; 4 Diodes; Resistors; Capacitors; Three 1/2in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS **£5-50** P.P. & INS. 33p  
(+8% VAT 44p) (OVERSEAS P. & P. £1-85)

## RADIO EXCHANGE LTD

\*Callers side entrance "Lavelis" shop  
\*Open 10-1, 2.30-4.30. Mon.-Fri. 9-12 Sat.

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Tel. 0234 52367 Reg. No. 788372

I enclose £..... for.....  
Name.....  
Address.....

# PRACTICAL ELECTRONICS

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## CONSTRUCTIONAL PROJECTS

- P.E. MINISONIC** *by D. Shaw*  
A miniature, battery-operated sound synthesiser 952
- ANTI-THEFT ALARM** *by B. A. Anderson*  
Protect and immobilise your car with this simple-to-build security device 959
- A.F. ATTENUATOR** *by H. T. Kitchen*  
A useful addition to your test-gear for simple voltage measurements 975
- NOVEL TRANSISTOR TESTER** *by D. C. Blackford*  
Gives instant indication of transistor type and approximate gain 979
- P.E. CCTV CAMERA—3** *by A. V. Flatman*  
Final construction and setting-up procedure 986
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Enables your cassette player to run from the car battery 991

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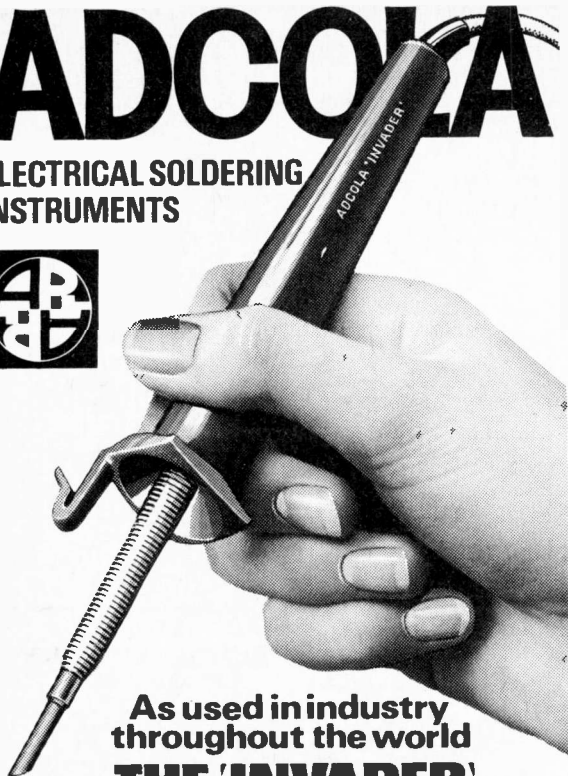
**Our December issue will be published mid-November. This issue will be in large demand and readers are advised to place an order with their Newsagent NOW!**

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# ADCOLA

ELECTRICAL SOLDERING  
INSTRUMENTS

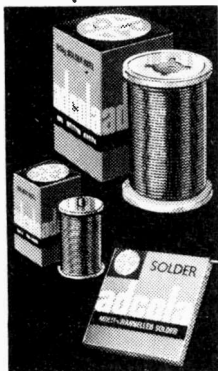


As used in industry  
throughout the world  
**THE 'INVADER'**

**BRITISH MADE, HAND BUILT, PRECISION INSTRUMENT**

'Invader' low leakage, high efficiency professional soldering instruments as used in industry worldwide, and why not you! Precision designed handle moulded of flame resistant material (SE1) and european safety standards. Stainless steel construction throughout with elements precision wound, earthed at two points, test run and finally flash tested at 2,000 v A/c. Low cost internally fitted bits with large range of bit faces for your future use. Can you afford not to have the 'Invader'.

MODEL 706 £2.88, 646 £3.13, 1076 £3.22  
 1/2in Bit 19W      3/4in Bit 23W      1in Bit 27W



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Adcola have designed solder packs to fulfil all your needs—manufactured to B.S.I. 44.1 60/40/18 swg. Multi channelled resin cored. If your need is small the dispenser or the three oz reel will do you if you are keener try the 1/2 kilo reel.

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SOLDER Dispenser      3 oz. REEL      1/2 Kilo REEL

Price include V.A.T.      Add 10p for postage and packing  
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PE1

## ★ ELECTRONIC PIANO KIT

## ★ SYNTHESISER KIT

## ★ ELECTRONIC ORGAN KITS



There are five superb Electronic Organ kits specially designed for the D-I-Y enthusiast. With the extreme flexibility allowed in design, you can build an organ to your requirements, which will compare with an organ commercially built costing double the price.

★ Portable organ with 4 octave keyboard, £145.29. ★ Console organ with 5 octave keyboard, £269.90. ★ Console organ with 2 x 4 octave keyboards and 13 note pedal board, £470.65. ★ Console organ with 2 x 5 octave keyboards and 32 note pedal board, £665. ★ Console organ with 3 x 5 octave keyboards and 32 note pedal board, £770. ★ W/W Sound Synthesiser Kit, £130. ★ W/W Touch Sensitive Electronic Piano, £100.

All components can be purchased separately, i.e., semiconductor devices, M.O.S. master oscillators, coils, keyboards, pedal boards, stop tabs, draw bars, key-contacts, etc.

Send 50p for catalogue which includes 5 x 10p vouchers or send your own parts list, enclosing S.A.E. for quotation.

## ELVINS

ELECTRONIC MUSICAL INSTRUMENTS

Designers and component suppliers to the musical industry.  
12 Brett Road, Hackney, London, E8 1JP. Tel. 01-986 8455.

## INTRODUCTORY OFFER

A

## V.C.O. by Fhachi

1Hz to 100kHz

FOR £3-85. P. & P. 15p

Size: 2in long x 1 1/2in wide x 1/2in high.

Input: 12-24V d.c. (not centre tapped). 18V input giving 10 volt constant amplitude output.

Requires only a 1 MΩ pot to tune entire range—or can be swept with a saw tooth input.

Enormous possibilities—music; synthesisers; filters; communications; frequency modulation, etc.

Detailed application sheet with all purchases.  
Sole Distributor.

## LOW FREQUENCY WOBBLATOR

Primary intended for the alignment of AM Radios; Communication Receivers; Filters, etc., in the range of 250kHz to 5MHz, but can be effectively used to 30MHz. Can be used with any general purpose oscilloscope. Requires 12V a.c. input. Three controls—RF level; sweep width and frequency. Price £8.50.

A second model is available as above but which allows the range to be extended down in frequency to 20kHz by the addition of external capacitors. Price £11.50.

Both models are supplied connected for automatic 50Hz sweeping. An external sweep voltage can be used instead. These units are encapsulated for additional reliability, with the exception of the controls (not cased, not calibrated).



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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

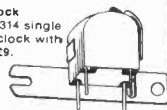
## CASH & CARRY PRICES

For CALLERS or BY POST  
(GB carr/Pack 15p per item)

Ref. No.	Price
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	8.95
5 T1406 4 station intercom	12.50
6 T1A1 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 Diac mic.	12.40
23 DF50B 50K Communications mic.	5.75
24 Car lighter plug 1W voltage adaptors 300mA (each) (state 6/7/9V)	1.95
25 STC Time delay module	1.50
26 Gravenire 931A photo-electric unit (with data)	3.50
27 3 cw 3x500W sound to light	21.50
28 3 cw 3 x 1,000W sound to light + override	41.25
29 150W light display projector with wheel	12.40
30 MM1 (BZ005) 4 channel 9V mixer	2.40
31 MX100 deluxe 4 channel mixer	8.78
32 H67(G1320) Stereo headphone amplifier	10.50
33 MP12 G-C Slide control mixer	27.95
34 RE209 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 sets	0.60
40 Crystal label microphone	1.00
41 E1052 Car speakers front/rear fader	1.75
42 Bib groove clean (Ref. No. 42)	2.20
43 Bib Record care kit (Ref. No. 43)	1.98
44 Bib cassette recorder care kit (Ref. No. 26A)	1.64
45 BASF reel-reel hobby box	2.40
47 2000 OHM Headphones	1.50
48 4000 OHM Headphones	1.55
49 Cassette recorder mic. (2 1/2mm & 3 1/2mm plugs)	1.85
50 420 ES Microscope	5.70
51 UP050 Low cost 5V eliminator	2.25
52 HE 527 Tape head	1.70
53 Cambridge pocket calculator	17.95
54 BC809 Percentage pocket calculator	21.95
55 BC417 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 (SK1)	3.30
61 Bib record care kit (Ref. No. 59)	1.77
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	4.28
69 4 Dec breadboard	7.50
70 7 Dec breadboard	3.85
71 Instant head soldering gun	2.30
72 40W soldering iron	1.90



Ceramic Filters  
Miniature 10.7 mHz filters  
40p pair  
IC IF Unit  
CA3089 10.7 MHz IC  
£2.94



Sinclair 8W 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  
ES-90 pair  
Strobe tubes  
ZF78A (similar to 4A)  
£4.  
ZFT12A £5.  
7 segment  
indicators  
3015F with data  
£1.70 each



## ELECTRONIC COMPONENTS

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

Spring delay units  
HP42 9in twin spring £3.30  
(P & P.) 20p HRF1 6in twin  
spring £8-85 (P. & P.) 25p.

Fibre optic  
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 hand-  
sets brand new complete  
Replacement for most  
with diagrams for intercoms  
£3 pair.

MARRIOTT 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  
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	3 for	6 for	10 for	25 for
C60	1.10	2.00	3.15	7.50
C90	1.47	2.85	4.85	11.37
C120	1.83	3.54	5.80	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	£7.87	
157 Private TV loop trans	£5.65	
525C 120-160mHz VHF tuner	£11.31	
310 Radio-R/C control receiver	£3.29	
300 4-channel R/C transmitter	6.61	
345 Superet receiver	6.61	
65 Simple trans-istor 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	4.18	
605 Power supply for 115	5.31	
610 Power supply for 120	5.31	
615 Power supply for 2 x 120	6.84	
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	
630 STAB Power supply 6-12V 0.25-0.1A	9.24	
690 DC motor speed Gov.	3.31	
700 Electronic Chaf-finch	7.92	
760 Acoustic switch	12.57	
780 Metal Detector electronics only	10.91	
790 Capacitive Burg-lar 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	2.85	
255 Level indicator	6.98	
525 120-160mHz VHF timer	11.31	
715 Photo cell switch	8.97	
795 Electronic con-tinuity tester	4.97	
860 Photo timer	15.51	
235 Acoustic Alarm for driver	8.61	
465 Quartz XTAL checker	9.90	
220 Signal Injector	2.85	
390 VOX	13.82	
432 Testkit	21.83	
670 Buffer Battery Charger	7.59	
850 Electronic Keyer	16.37	

## TEST EQUIPMENT

(Carr. packing 35p) £

U4324 20kV with case	9.25
U435 20kV with steel case	8.75
U4313 20kV with steel case	12.50
U4317 20kV with case	16.50
U4341 33kV plus transistor tester steel case	10.50
U4323 20kV plus 1kHz 465kHz OSC with case	7.70
ITI-2 20kV slim type	5.95
THL33D (L33D) 2kV Robust	7.50
TP55N 20kV (Case t2)	6.25
TP105 2kV	8.25
TW205 20kV	10.00
TW50K50kV	11.25
EP10K10kV	9.95
AF105 50kV Deluxe (case £1 90)	12.50
S100TR 100kV Plus transistor tester	22.50



## GENERAL TEST EQUIPMENT

(1 Carr. packing 50p. 1 Carr. packing 30p) unless stated  
NEW REVOLUTIONARY  
SUPERTESTER 680R  
680R Multi-tester £

NEW REVOLUTIONARY SUPERTESTER 680R	18.50
680R Multi-tester	18.50
Accessories	
Transistor tester	11.00
Electronic voltmeter	18.00
Amplclamp	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
*13100 IMA Strip chart recorder	44.00
*TT40 AC Multivoltmeter	15.75
*TT15 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
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4.7µF 63V	61p	150µF 16V	61p
6.8µF 63V	61p	150µF 63V	18p
8.0µF 40V	61p	220µF 6V	41p
10µF 25V	61p	220µF 10V	41p
10µF 63V	61p	220µF 16V	8p
15µF 16V	61p	220µF 63V	21p
15µF 63V	61p	330µF 16V	12p
16µF 40V	61p	330µF 63V	25p
22µF 25V	61p	470µF 6V	8p
22µF 63V	61p	470µF 10V	20p
32µF 10V	61p	680µF 40V	15p
33µF 16V	61p	680µF 40V	25p
33µF 40V	61p	1000µF 16V	20p
32µF 63V	61p	1000µF 25V	25p
47µF 10V	61p	1500µF 6V	15p
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### 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.

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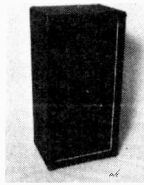
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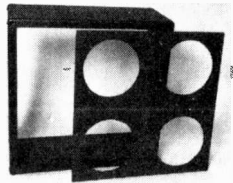
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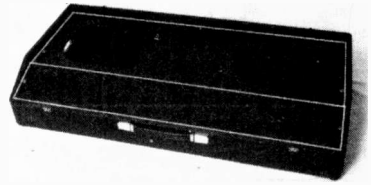
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2' x 12" Cabinet



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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 :-

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- 2) P.V.C. cut to size for frame and back, plus false front and back timbers, white front piping and speaker cloth
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ERC 100 watt power amplifier

- \* Electrolytic capacitors and second generation ICs
- \* Fully protected against short or open circuit
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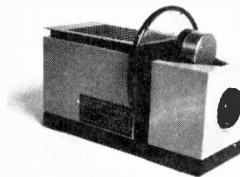
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- \* Concorde mono M400 mixer
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(Black Vinyl covered)

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BA3	4"	x 2½"	x 1½"	42p
BA4	3½"	x 4"	x 1½"	50p
BA5	4"	x 2½"	x 2"	42p
BA6	3"	x 2"	x 1"	34p
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BA8	8"	x 6"	x 3"	90p
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P. & P. 10p on each box

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Open Mon.—Sat. 9–5.30 p.m. Tel. 61893

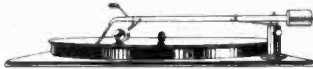
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Chrome Finish

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Bits No.

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1101 For model CCN240 1" 42p

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C9 3 Micro Switches 0-55

C10 15 Assorted Pots & Pre-Sets 0-55

C11 5 Jack Sockets 3 x 3.5m 2 x 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 1" Plastic 0-15

PS 12 Jack 1" 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 1" Plastic 0-30

PS 28 Jack 1" Screened 0-85

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 1" 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

CP 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

47K, 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 100K anti-Log 0-46

## HORIZONTAL CARBON PRESETS

0-1 watt 0-08 each

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240V. Primary. Secondary voltages available from selected tapings 4V, 7V, 8V, 10V, 14V, 15V, 17V, 19V, 21V, 25V, 31V, 33V, 40, 60 and 25V–0–25V.

Type	Amps	Price	P. & P.
MT50/1	1	£1.83	30p
MT50/1	1	£2.42	35p
MT50/2	2	£3.30	40p

## CARTRIDGES

ACOS

GP91-18C 200mV at 1.2cm/sec £1-85

GP93-1 280mV at 1cm/sec £1-85

GP98-1 100mV at 1cm/sec £2-80

J-2005 Crystal/Hi Output £1-05

J-2010C Crystal/Hi Output Compatible £1-20

J-2006S Stereo/Hi Output £1-75

J-2105 Ceramic/Med Output £1-95

J-2203 Magnetic 5mV/cm/sec, including stylus £4-95

J-2203S Replacement stylus for above £3-00

AT-55 Audio-technica magnetic cartridge 4mV/cm/sec £2-90

## CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors, ¼ watt available in PAKS of 50 pieces, assorted into the following groups:

R1 50 Mixed 100 ohms–820 ohms 50p

R2 50 Mixed 1k Ω–8.2k Ω 50p

R3 50 Mixed 10k Ω–82k Ω 50p

R4 50 Mixed 100k Ω–1M Ω 50p

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

## BI-PAK SUPERIOR QUALITY LOW-NOISE CASSETTES

C60, 86p; C90, 48p; C120, 60p.

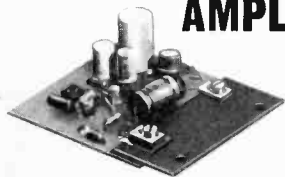


# -the lowest prices!

## BI-PAK QUALITY COMES TO AUDIO!

### AL10/AL20/AL30 AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.



Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0-25%
LOAD IMPEDANCE	—	8-16Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE -3dB	Po = 2 WATTS	50 Hz-25KHz
SENSITIVITY for RATED O/P	Vs=25V, R1=8Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3" x 2½" = 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

#### AUDIO AMPLIFIER MODULES

AL 10. 3 watts	£2-19
AL 20. 5 watts	£2-59
AL 30. 10 watts	£3-01

#### POWER SUPPLIES

PS 12. (Use with AL10, AL20, AL30) 88p	
SPM 80. (Use with AL60)	£3-25
FRONT PANELS PA 12 with Knobs	£1-00

#### PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4-35
PA 100. (Use with AL30 & AL60)	£13-15

#### TRANSFORMERS

T461 (Use with AL10)	£1-38 P & P 15p
T538 (Use with AL20, AL30)	£1-93 P & P 15p
BMT80 (Use with AL60)	£2-15 P & P 25p

#### PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with \*Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm.

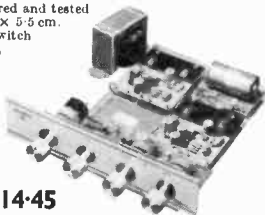
Frequency response—  
20Hz-50KHz (-3dB)  
Bass control—  
± 12dB at 60Hz  
Treble control—  
± 14dB at 14KHz  
\*Input 1. Impedance  
1 Meg. ohm  
Sensitivity 300mV  
†Input 2. Impedance  
30 K ohms  
Sensitivity 4mV

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## The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0-25% at 1 watt. Treble con. ± 14dB at 14kHz.



£14-45

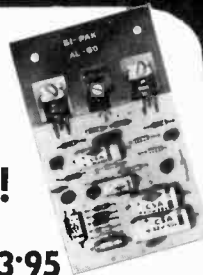
#### TC20 TEAK VENEERED CABINET

For Stereo 20 (front board undrilled) Size 10½" x 8½" x 3". £3-95 plus 30p postage.

#### SHP80 STEREO HEADPHONES

4-16 ohms impedance. Frequency response 20 to 20,000Hz. Stereo/mono switch and volume controls, £4-95

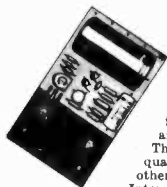
## NOW WE GIVE YOU 50w PEAK (25w R.M.S.) PLUS THERMAL PROTECTION! The NEW AL60 Hi-Fi Audio Amplifier FOR ONLY £3-95



- Max Heat Sink temp 90°C.
- Frequency Response 20Hz to 100KHz
- Distortion better than 0.1% at 1KHz
- Supply voltage 15-50 volts
- Thermal Feedback
- Latest Design Improvements
- Load — 3, 4, 8 or 16 ohms
- Signal to noise ratio 80dB
- Overall size 63mm x 105mm x 13mm

Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

### STABILISED POWER MODULE SPM80



SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p

PRICE £3-25  
TRANSFORMER BMT80 £2-15 p. & p. 28p

### STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL60 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages. Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



#### SPECIFICATION

Frequency Response 20Hz-20KHz ± 1dB  
Harmonic Distortion better than 0.1%  
Inputs: 1. Tape Head 3-25 mV into 50K Ω  
2. Radio, Tuner 75 mV into 50K Ω  
3. Magnetic P.U. 3 mV into 50K Ω  
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.  
Bass Control ± 15dB at 20Hz  
Treble Control ± 15dB at 20KHz  
Filters: Rumble (High Pass) 100Hz  
Scratch (Low Pass) 8KHz  
Signal/Noise Ratio better than -65dB  
Input overload + 26dB  
Supply + 35 volts at 20mA  
Dimensions 292mm x 82mm x 35mm

ONLY £13-15

#### MK 60 AUDIO KIT

Comprising: 2 x AL60, 1 x SPM80, 1 x BMT80, 1 x PA 100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets. Complete Price: £23-75 plus 30p postage.

#### TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16½" x 11½" x 3½", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc. Kit price: £9-95 plus 30p postage.

Giro No. 388-7006

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The people we find will be trained by Control Data and helped to find new jobs by Control Data with all of the backing which a Company of our size and influence can give them. They will then be working in a growth industry which is at the forefront of human advance.

We need 35 people, aged 19-35 with a mechanical aptitude and the ability to think logically.

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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SPECIAL EXPRESS MAIL ORDER SERVICE  
Express postage 5p for first transistor, 1p thereafter, over 6p per post free. INTEGRATED CIRCUITS 6p + 1p each added

Sp	Sp	Sp	Sp	Sp	Sp
1N21	0-17	FAZ11	0-45	0A2205	0-29
1N23	0-35	ASV12	2-00	0A2206	0-45
1N85	0-88	ASV96	0-25	0A2207	0-45
1N253	0-80	ASV27	0-20	0A2208	0-40
1N256	0-60	ASV28	0-25	0A2209	0-40
1N646	0-16	ASV29	0-20	0A2210	0-40
1N725A	0-20	ASV36	0-25	0A2211	0-40
1N914	0-06	ASV30	0-20	0A2212	0-45
1N4007	0-12	ASV33	0-20	0A2223	0-45
18113	0-25	ASV33	0-20	0A2244	0-25
18131	0-13	ASV62	0-25	0A2242	0-15
18202	0-23	ASV66	0-23	0A2244	0-25
2G371	0-40	ASZ21	1-00	0A2246	0-15
2G381	0-22	ASZ23	0-75	0A2290	0-28
2G414	0-30	AU101	1-50	OC16	1-00
2G417	0-25	AU101	1-00	OC18T	1-00
2N404	0-22	BC107	0-12	OC19	0-50
2N697	0-15	BC108	0-12	OC20	2-00
2N698	0-20	BC109	0-12	OC22	1-00
2N706	0-10	BC113	0-18	OC23	1-25
2N708A	0-12	BC115	0-20	OC24	1-10
2N708	0-15	BC116	0-20	OC25	0-40
2N709	0-40	BC15A	0-23	GD12	0-10
2N1091	0-55	BC118	0-20	GET102	0-50
2N1131	0-25	BC121	0-20	GET103	0-40
2N1132	0-25	BC122	0-20	GET113	0-35
2N1302	0-18	BC125	0-68	GET114	0-30
2N1303	0-22	BC126	0-65	GET115	0-75
2N1305	0-22	BC147	0-12	GET116	0-85
2N1306	0-28	BC148	0-10	GET120	0-50
2N1307	0-28	BC149	0-12	GET872	0-30
2N1308	0-28	BC157	0-14	GET875	0-40
2N2147	0-75	BC158	0-12	GET880	0-55
2N2148	0-60	BC160	0-53	GET881	0-25
2N2180	1-00	BC169	0-58	GET882	0-58
2N2181	0-28	BCY31	0-45	GET885	0-40
2N2219	0-25	BCY32	1-20	GEX44	0-08
2N2369A	0-18	BCY33	0-28	GEX45/1	0-45
2N2444	1-99	BCY34	0-45	GEX941	0-45
2N2813	0-28	BCY38	0-55	GJ3M	0-50
2N2646	0-50	BCY39	1-00	GJ3M	0-50
2N2904	0-20	BCY40	0-30	GJ3M	0-25
2N2904A	0-25	BCY42	0-20	GJ7M	0-50
2N2905	0-20	BCY70	0-15	HG1005	0-60
2N2907	0-23	BCY71	0-20	H8100A	0-20
2N2925	0-18	BCZ10	0-60	MAT100	0-20
2N2926	0-10	BCZ11	0-65	MAT101	0-25
2N3054	0-50	BD121	1-00	MAT120	0-25
2N3055	0-60	BD124	0-80	MJE520	0-65
2N3072	0-11	BDY11	1-45	MJE2955	1-10
2N3705	0-15	BDY11	1-25	MJE3055	0-75
2N3706	0-11	BF115	0-25	MJE340	0-60
2N3707	0-13	BF117	0-20	MFF102	0-40
2N3709	0-10	BF167	0-50	MFF103	0-45
2N3710	0-11	BF181	0-35	MFF104	0-35
2N3711	0-11	BF184	0-22	MFF105	0-45
2N3819	0-35	BF185	0-22	NKT128	0-45
2N3909	0-20	BF185	0-22	NKT129	0-30
2N6027	0-53	BF194	0-13	NKT211	0-25
2N6088	0-33	BF195	0-13	NKT213	0-25
28301	0-59	BF196	0-15	NKT214	0-25
28304	1-15	BF861	0-25	NKT216	0-40
28801	0-75	BF888	0-25	NKT217	0-45
28703	1-00	BF898	0-25	NKT218	1-13
AA129	0-20	BFX12	0-20	NKT219	0-38
AA212	0-75	BFX13	0-25	NKT222	0-30
AA213	0-10	BFX29	0-28	NKT224	0-25
AAO17	0-35	BFX30	0-28	NKT251	0-24
AC126	0-25	BFX35	0-98	NKT271	0-20
AO127	0-25	BFX63	0-50	NKT272	0-20
AO128	0-20	BFX84	0-25	NKT273	0-20
AC187	0-20	BFX85	0-28	NKT274	0-20
AC188	0-20	BFX86	0-25	NKT276	0-25
AOY18	0-35	BFX87	0-25	NKT277	0-20
AOY19	0-27	BFX88	0-22	NKT278	0-25
AOY20	0-22	BFY10	1-00	NKT301	0-85
AOY21	0-25	BFY11	0-50	NKT304	0-75
AOY22	0-16	BFY18	0-45	NKT403	0-70
AOY27	0-25	BFY19	0-55	NKT404	0-60
AOY28	0-25	BFY24	0-45	NKT408	0-80
AOY39	0-85	BFY44	1-00	NKT713	0-30
AOY40	0-22	BFY51	0-20	NKT773	0-25
AOY41	0-22	BFY52	0-20	NKT777	0-38
AD140	0-50	BFY53	0-17	OA5	0-80
AD149	0-60	BFY64	0-45	OA6	0-12
AD161	0-38	BFY90	0-75	OA7	0-08
AD162	0-38	BFX60	0-98	OA71	0-20
AF106	0-20	BFX76	0-18	OA73	0-15
AF114	0-25	BFX76	0-17	OA74	0-15
AF116	0-25	BFX76	0-17	OA79	0-10
AF117	0-20	BFX76	0-17	OA81	0-10
AF118	0-50	BFX76	0-17	OA85	0-15
AF119	0-20	BFX76	0-17	OA86	0-15
AF124	0-50	BFX76	0-17	OA88	0-15
AF125	0-20	BFX76	0-17	OA90	0-07
AF126	0-20	BFX76	0-17	OA91	0-07
AF127	0-30	BFX76	0-17	OA95	0-07
AF139	0-33	BFX76	0-17	OA95	0-07
AF178	0-55	BFX76	0-17	OA95	0-07
AF179	0-65	BFX76	0-17	OA95	0-07
AF180	0-55	BFX76	0-17	OA95	0-07
AF181	0-50	BFX76	0-17	OA95	0-07
AF186	0-40	BFX76	0-17	OA95	0-07
AFY19	1-13	BFX76	0-17	OA95	0-07
28170	0-29	28271	0-18	28272	0-25
28273	0-15	28274	0-25	28275	0-10
28276	0-12	28277	0-12	28278	0-12
28279	0-12	28280	0-12	28281	0-12
28282	0-12	28283	0-12	28284	0-12
28285	0-12	28286	0-12	28287	0-12
28288	0-12	28289	0-12	28290	0-12
28291	0-12	28292	0-12	28293	0-12
28294	0-12	28295	0-12	28296	0-12
28297	0-12	28298	0-12	28299	0-12
28300	0-12	28301	0-12	28302	0-12
28303	0-12	28304	0-12	28305	0-12
28306	0-12	28307	0-12	28308	0-12
28309	0-12	28310	0-12	28311	0-12
28312	0-12	28313	0-12	28314	0-12
28315	0-12	28316	0-12	28317	0-12
28318	0-12	28319	0-12	28320	0-12
28321	0-12	28322	0-12	28323	0-12
28324	0-12	28325	0-12	28326	0-12
28327	0-12	28328	0-12	28329	0-12
28330	0-12	28331	0-12	28332	0-12
28333	0-12	28334	0-12	28335	0-12
28336	0-12	28337	0-12	28338	0-12
28339	0-12	28340	0-12	28341	0-12
28342	0-12	28343	0-12	28344	0-12
28345	0-12	28346	0-12	28347	0-12
28348	0-12	28349	0-12	28350	0-12
28351	0-12	28352	0-12	28353	0-12
28354	0-12	28355	0-12	28356	0-12
28357	0-12	28358	0-12	28359	0-12
28360	0-12	28361	0-12	28362	0-12
28363	0-12	28364	0-12	28365	0-12
28366	0-12	28367	0-12	28368	0-12
28369	0-12	28370	0-12	28371	0-12
28372	0-12	28373	0-12	28374	0-12
28375	0-12	28376	0-12	28377	0-12
28378	0-12	28379	0-12	28380	0-12
28381	0-12	28382	0-12	28383	0-12
28384	0-12	28385	0-12	28386	0-12
28387	0-12	28388	0-12	28389	0-12
28390	0-12	28391	0-12	28392	0-12
28393	0-12	28394	0-12	28395	0-12
28396	0-12	28397	0-12	28398	0-12
28399	0-12	28400	0-12	28401	0-12
28402	0-12	28403	0-12	28404	0-12
28405	0-12	28406	0-12	28407	0-12
28408	0-12	28409	0-12	28410	0-12
28411	0-12	28412	0-12	28413	0-12
28414	0-12	28415	0-12	28416	0-12
28417	0-12	28418	0-12	28419	0-12
28420	0-12	28421	0-12	28422	0-12
28423	0-12	28424	0-12	28425	0-12
28426	0-12	28427	0-12	28428	0-12
28429	0-12	28430	0-12	28431	0-12
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28453	0-12	28454	0-12	28455	0-12
28456	0-12	28457	0-12	28458	0-12
28459	0-12	28460	0-12	28461	0-12
28462	0-12	28463	0-12	28464	0-12
28465	0-12	28466	0-12	28467	0-12
28468	0-12	28469	0-12	28470	0-12
28471	0-12	28472	0-12	28473	0-12
28474	0-12	28475	0-12	28476	0-12
28477	0-12	28478	0-12	28479	0-12
28480	0-12	28481	0-12	28482	0-12
28483	0-12	28484	0-12	28485	0-12
28486	0-12	28487	0-12	28488	0-12
28489	0-12	28490	0-12	28491	0-12
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28495	0-12	28496	0-12	28497	0-12
28498	0-12	28499	0-12	28500	0-12
28501	0-12	28502	0-12	28503	0-12
28504	0-12	28505	0-12	28506	0-12
28507	0-12	28508	0-12	28509	0-12
28510	0-12	28511	0-12	28512	0-12
28513	0-12	28514	0		

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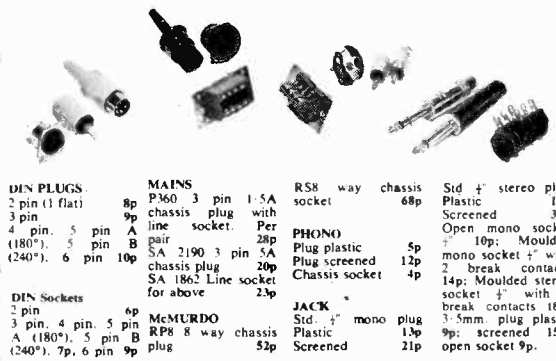
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Sub-miniature Axial lead electrolytic

Mfd V	Price	Mfd V	Price
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1.5 63 6p	68	16 6p	6p
2.2 63 6p	68	63 14p	6p
3.3 63 6p	100	4 6p	6p
4.7 63 6p	100	10 6p	6p
6.8 40 6p	100	25 6p	6p
6.8 63 6p	100	40 6p	6p
10 25 6p	100	63 16p	6p
10 63 6p	150	6.3 6p	6p
15 16 6p	150	16 6p	6p
15 40 6p	150	25 6p	6p
15 63 6p	150	40 14p	6p
22 10 6p	150	63 16p	6p
22 25 6p	220	4 6p	1000
22 63 6p	220	10 6p	1000
33 6.3 6p	220	16 6p	1000
33 16 6p	220	25 14p	1500
33 40 6p	220	40 16p	1500
47 4 6p	220	63 25p	1500
47 10 6p	300	4 6p	2200
47 25 6p	300	10 6p	2200
47 40 6p	300	16 14p	3200
47 63 6p	300	63 28p	4700



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3 pin 9p  
4 pin, 5 pin A 14p  
(180°), 5 pin B 16p  
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MFC9020. 10-lead case. 2W Audio Power Amp 41.37  
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Four Pole DT 3A 240V a.c. 41.37

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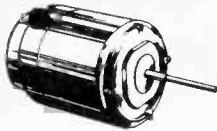
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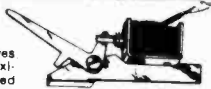
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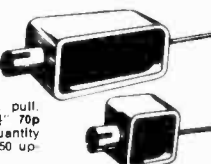
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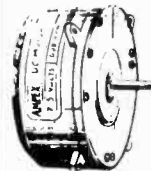
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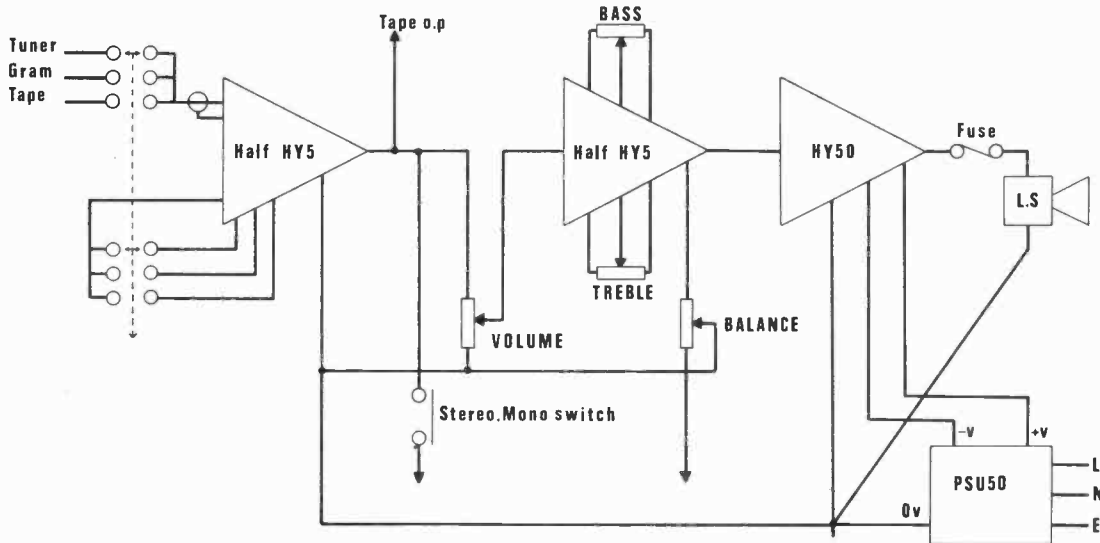
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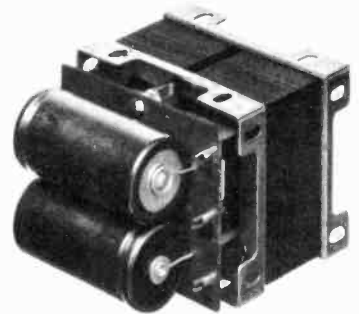
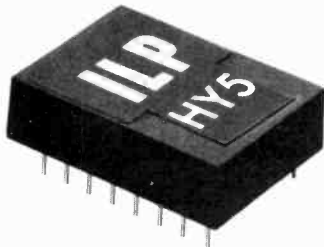


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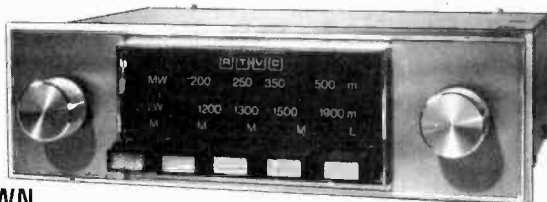
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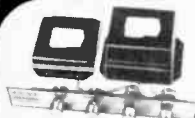
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For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

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## 8 TRACK CARTRIDGE PLAYER\*



Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21. Technical specification Mains input, 240V. Output sensitivity 125mV. Comparable unit sold elsewhere at £24.00 approx. Yours for only

**£11.95 + 90p p & p.**

# COMPLETE\* STEREO SYSTEM



## System 1. £51.00

40 Watt Amplifier. Viscount III - R102 now 20 watts per channel.

System 1 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. 13 3/4" x 9" x 3 3/4".

Garrard SP 25 Mk III deck with magnetic cartridge, de luxe plinth and hinged cover.

Two Duo Type II matched speakers - Enclosure size approx. 17 1/2" x 10 1/4" x 6" in simulated teak. Drive unit 13" x 8" with parasitic tweeter. 10 watts handling.

Complete System £51.00

## System 2. £69.00

Viscount III amplifier (As System 1)

Garrard SP 25 Mk III deck (As System 1)

Two Duo Type III matched speakers - Enclosure size approx. 27" x 13" x 11 1/2"

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
<b>total:</b>	<b>£59.20</b>

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
<b>total:</b>	<b>£84.20</b>

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# EMI SPEAKERS AT FANTASTIC REDUCTIONS



### 20 WATT SPEAKER SYSTEM

System consists of a 13" x 8" (approx) elliptical woofer unit with a 8" x 5" (approx.) mid range unit incorporating parasitic tweeter and crossover components.

Technical Specification:

Bass Unit

Flux density-100 K, speech coil-1 1/2"

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

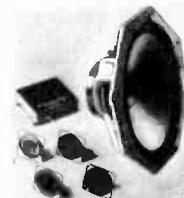
frequency response. Resonance 30 Hz. Flux

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" x 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.

The four 10,000 gauss tweeters, each 3 1/2" 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...





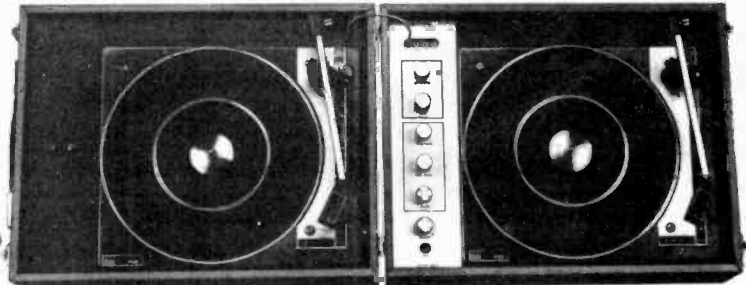
# PORTABLE DISCO CONSOLE

**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 -  $17\frac{1}{2}'' \times 13\frac{3}{4}'' \times 8\frac{3}{4}''$  (approx.)  
Unit Open -  $35\frac{1}{2}'' \times 13\frac{3}{4}'' \times 4\frac{1}{2}''$  (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.

**Yours for only £45.00 + £3.50 P. & P.**

# 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 470K. Size:  $19\frac{1}{4}'' \times 10\frac{3}{4}'' \times 8''$  (approx.) | Amplifier £27.50 + £1.50 p. & p.



# DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).

Inputs \*4 electrically mixed inputs. \*3 individual mixing controls.

\*Separate bass and treble controls common to all 4 inputs.

\*Mixer employing F.E.T. (Field Effect Transistors) \*Solid State circuitry.

\*Attractive styling.

### INPUT SENSITIVITIES

-Input - 1.) Crystal mic, guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity).

-Inputs - 2), 3), 4). Medium output equipment - ceramic cartridge, tuner, tape recorder, organs, etc. - all 250mV sensitivity. AC Mains, 240V operation. Size approx:  $12\frac{1}{2}'' \times 6'' \times 3\frac{1}{2}''$ .

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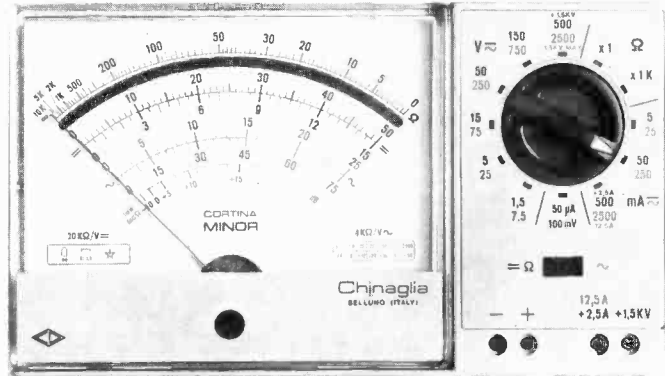


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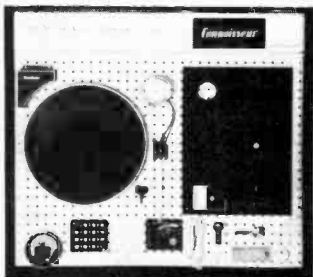
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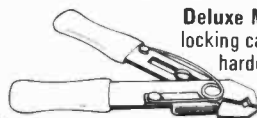
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For automatically reducing music volume during talk-over—particularly useful for Disco work, or for home-movie shows

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<b>Main Amplifier:</b>	
Set of resistors, capacitors and presets	£5.96
Stereo printed circuit board	£1.28
<b>Pre-Amplifier:</b>	
Sets of resistors, capacitors, potentiometers and switches—	
Standard Tolerance Set	£10.57
Superior Tolerance Set	£16.04
Stereo PCB (as Published)	£2.20
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Set of resistors, capacitors and preset	£4.58
Printed circuit board	72p

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Power supply component set	£3.72
Stereo main PCB	£2.50
Stereo sub-assembly PCB	86p

## TAPE-NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings

Component set (incl. PCB)	£2.30
Regulated power supply (including printed circuit board)	£3.71

## PROJECT Q4

Multi-system Quadraphonic Decoder

Decoder component set	£13.74
Power supply components	£3.22
Set of PCBs	£2.80

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A simple but effective manually controlled unit for introducing the phasing sound into live or recorded music.

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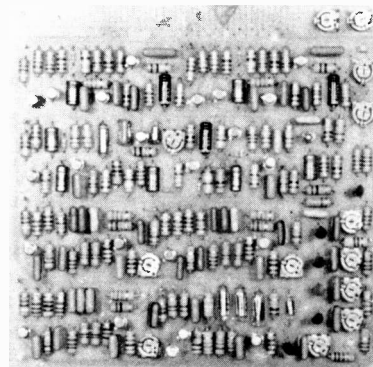
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PCB details in List

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## HOME INTERCOM

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Printed circuit board £1.44

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Component set (excl spring unit) £6.44  
Printed circuit board £1.40

## MINISONIC

Details in List

## 8W AMPLIFIER

A moderately powered amplifier of more than average performance

<b>Main Amplifier</b>	
Mono component set	£4.18
Stereo component set	£8.36
Mono printed circuit board	72p
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Stereo component set	£6.46
Stereo PCB	£1.66
<b>Power Supply</b>	
Component set	£3.90

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Component set and PCB	£3.48
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Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feedback lamp driver circuits	£4.96
<b>Audio Amplifier Module</b>	
Type PC7	£5.20

## PHOTOPRINT PROCESS CONTROL

For colour and B & W, an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage

Component set (excl meter) £8.85  
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## ENLARGER EXPOSURE METER AND THERMOMETER

Dual-purpose dark-room unit with good accuracy

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## WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds

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Semiconductors	Integrated Circuits	Zeners	Electrolytic Capacitors (µF/V)	Polyester (µF)	Tantalum (µF/V)
AC128 20p MJE3055 75p 2N3823E 39p	709 TOS 40p	3 3V 400mW 12p	0 47/63V 5p 47/63 7p 470/40 20p	0 01 3p	0 1.35 12p
AC176 20p NK70033 112p 2N4870 36p	723 TOS 85p	4 7V 1W 25p	1 0.63V 5p 50 6.4 46p	0 015 3p	0 22/35 12p
BC107 13p OC28 65p 2N4871 36p	741 8-pin DIL 40p	747 14-pin DIL 115p	1 5.63V 5p 100/10 6p 680/6.3 10p	0 022 3p	0 47/35 15p
BC108 13p OC71 14p 2N5777 45p	748 TOS 63p	748 TOS 63p	6 2V 400mW 15p 2 2.63V 5p 100/25 6p 680/40 20p	0 033 31p	1 0.35 12p
BC109 13p OC84 25p	748 8-pin DIL 63p	748 8-pin DIL 63p	9 1V 400mW 15p 4 7.63 5p 100/40 6p 100/63 12p	0 047 31p	1 5.35 18p
BC147 12p ORP12 12p	748 4-pin DIL 50p	7400 20p	6 6/40 5p 100/63 12p	0 1 46p	4 7.35 15p
BC148 12p TX107 12p	7402 20p	7402 20p	10/25 5p 150/16 25p	0 068 31p	2 2.35 12p
BC149 12p ZTX503 15p	7420 20p	7420 20p	15/25 5p 150/16 25p	0 158 11p	10 1.18 12p
BC157 13p ZTX531 23p 1N4002 7p	7420 20p	7420 20p	10/25 5p 150/16 25p	0 22 5p	10 2.25 18p
BC158 13p 2N706 13p 1N4004 8p	7447 175p	7447 175p	100/40 6p 1000/40 40p	0 33 7p	15 6.3 16p
BC159 13p 2N914 22p 1N4005 8p	7473 44p	7473 44p	6p 220/16 6p 220/16 6p	0 47 11p	22 16 15p
BC182L 12p 2N1304 22p 1006 8p	7489 575p	7489 575p	10p 220/25 45p 0 47 11p	0 47 11p	47 6.3 12p
BC204 14p 2N2219 27p BA145 23p	µA7815 TO3 250p	µA7815 TO3 250p	10p 2200/40 50p 14p 2800/100 350p	0 68 11p	47 6.3 12p
BC209c 14p 2N2905 27p OA91 7p	µA7815 TO220 250p	µA7815 TO220 250p	21p 3300/63 133p 6p 3300/100 350p	1 0 14p	47 6.3 12p
BC212L 15p 2N2907 22p OA290 8p	CA3046 88p	CA3046 88p	2 2 24p	0 1 46p	4 7.35 15p
BC478 20p 2N3054 36p 1G97 12p	MFC6040 95p	MFC6040 95p	6p 470/6 3 60p	0 1 46p	47 6.3 12p
BCY71 22p 2N3055 50p 1S,50 11p	PA263 168p	PA263 168p	6p 470/10 6p 470/10 6p	0 1 46p	47 6.3 12p
BF50 22p 2N3702 12p 21J 66p	SG3402N 168p	SG3402N 168p	18p 4700/25 75p 4p 470/25 14p	0 1 46p	47 6.3 12p
BF152 23p 2N3703 12p	Minitron 3015F 225p	Minitron 3015F 225p			
BSY95A 10p 2N3704 12p					
MJE2955 110p 2N3819 35p					

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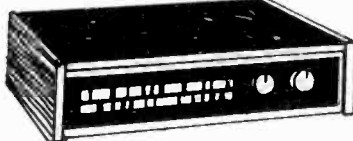
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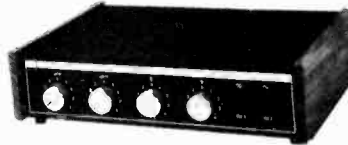
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Very detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E. AMPLIFIER KIT £11.34 P. & P. 30p (Magnetic input components 33p extra) POWER PACK KIT £3.46 P. & P. 40p CABINET £3.46 P. & P. 40p (Post Free if all 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, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

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Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2" w x 4 1/2" d x 4 1/2" h. Incorporates EOC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 8 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback control. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., and tested for only £6.90. P. & P. 45p.

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**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.

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Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo 1/4 inch 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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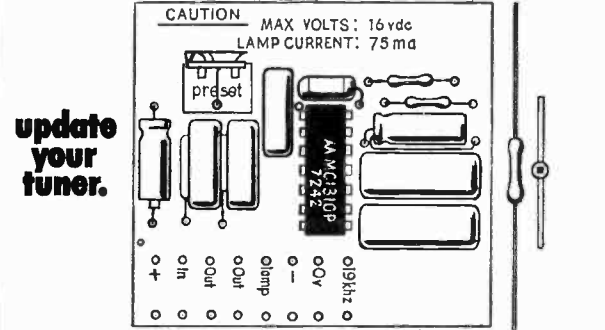
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Jermyn now offer a stereo decoder module that simply and easily converts your existing mono tuner for stereo reception. Multiplex output equipped tuners simply have the module plugged in, older types need the de-emphasis capacitor disconnected. The unit will do justice to the most expensive equipment and has the following specification.

Channel separation: Typically 40dB  
 Distortion: Typically 0.3% at 560mV RMS  
 Composite input signal  
 Stereo switching: Automatic with lighted indicator  
 Power supply: 10-16 volts.

Assembled and fully tested with a no-strings 12 month guarantee the module costs an astonishing £6.90. Excluding VAT. (Also available as a Kit at £4.90.) Beat that!

To Jermyn Industries 169 Vestry Road Sevenoaks, Kent

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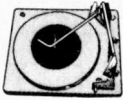
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Plays 15", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250V. Size 13 1/2 x 11 1/2 in. Above motor board 3 1/2 in. Below motor board 2 1/2 in. with STEREO and MONO XTAL. **£6.75** Post 45p.



## PORTABLE PLAYER CABINET

Modern design. Black rexine covered. Silver front grille. Padded lid. Chrome fittings. Size 17 in x 15 in x 7 in. Few only in red rexine. **£4.50** Post 50p

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



## R.C.S. DISCO DECK SINGLE RECORD PLAYER

Fitted with auto stop. Stereo/mono cartridge. Baseplate. Size 11 in x 8 1/2 in. Turntable. Size 7 in diameter. A.C. mains. 200/250V motor has separate winding 14 volt to power a small amplifier. Three speeds. Plays all records. **£5.50** Post 25p

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With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Size 12 1/2 x 14 1/2 x 7 1/2 in. **£5.95** Post 45p

## COMPACT PORTABLE STEREO HI-FI

Two full size loudspeakers 13 1/2 x 10 x 3 1/2 in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13 1/2 x 10 x 3 1/2 in. 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. 240V AC Mains. **£25** Bargain Price 85p Carriage



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BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2 1/2 in sides 6 x 4 in 45p; 8 x 6 in 55p; 10 x 7 in 65p; 12 x 8 in 85p; 14 x 9 in 90p; 16 x 6 in 90p; 12 x 3 in 50p; 16 x 10 in £1. ALUMINIUM BOXES 3 x 3 x 3 in 60p; 4 x 4 x 4 in 70p; 6 x 4 x 4 in 80p; 9 x 4 x 4 in £1; 12 x 4 x 4 in £1.30. ALUMINIUM PANELS 18 s.w.g., 6 x 4 in 12p; 8 x 6 in 19p; 14 x 3 in 20p; 10 x 7 in 24p; 12 x 5 in 25p; 12 x 8 in 34p; 16 x 8 in 34p; 14 x 9 in 40p; 12 x 12 in 47p; 16 x 10 in 60p. PAXOLIN PANEL 10 x 8 in 20p. 1 1/2 inch DIAMETER WAVELENGTH SWITCHES, 45p ea. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way. 1 p. 1. 2-way, or 4 p. 2-way, or 4 p. 3-way. TOGGLE SWITCHES, 2p. 20p; dp. 25p; dp. dt. 30p. Sub-miniature, sp. 35p; dp. dt. 50p.

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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  
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NEW TUBULAR ELECTROLYTICS	CAN TYPES
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LOW VOLTAGE ELECTROLYTICS.  
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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.  
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SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. 100pF. **50p** each

NEON PANEL INDICATORS 250V AC/DC. Amber 30p.  
RESISTORS. 1/4 W, 1/2 W, 1W, 2W, 5W, 10W to 10M.  
HIGH STABILITY. 1/4 W 2%, 10 ohms to 8 meg., 10p.  
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Long spindles. Midget Size 5 K. Ohms to 2 Meg. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.F. 75p. Edge 5K. S.P. Transistor 15p.  
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With twin tweeters. **£4.50**  
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With flared tweeter cone and ceramic magnet. 10 watt. Basses 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 25p  
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Teakwood strips mounted on cloth backing, easily glued on to baffle to modernise cabinets. **75p**  
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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. Suitable Cabinet 12 x 8 x 6 1/4 Suitable Tweeter £2 **£4**



## 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 3 1/2 x 3 1/2 in 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, 2 1/2 in; 2 1/2 in; 3 in; 5 in.  
8 ohm, 2 1/2 in; 2 1/2 in; 5 in x 3 in; 3 in; 4 in; 5 in.  
15 ohm, 2 1/2 in; 5 in; 6 x 4 in; 5 x 3 in; 7 x 4 in; 8 x 5 in.  
25 ohm, 2 1/2 in; 3 in; 5 x 3 in; 5 in.  
30 ohm, 2 1/2 in; 5 in.  
80 ohm, 2 1/2 in; 2 1/2 in. 120 ohm 3 in. **£1 EACH**

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RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8 in diameter 4W £2.50, 10 in diameter 5W £2.50; Post 25p.  
12 in diameter, 6W, £2.95; 3 or 8 or 15 ohm models.  
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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 **£1.95** 3,000 cps.

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Impedance Standard 8 ohms  
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Bass Resonance 45 cps

**SUITABLE ENCLOSURE 20 x 13 x 9 in.**  
MODERN DESIGN. TEAK WOOD FINISH.



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ELAC 9 x 5 in. HI-FI SPEAKER TYPE 59RN  
This famous unit now available, 10 watts, 8 ohm.

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## 8" or 10" x 6" ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 10 watts.

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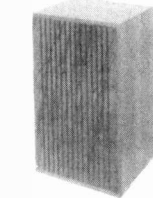
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Medium Wave.

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Ferrite aerial. 9 volt. **£5.50**

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MIXER. Add musical

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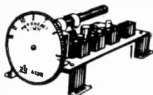
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Push-Pull Ready built with volume, treble and

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ERASER & HEAD DEMAGNETISER.

Suitable for cassettes, and all sizes of

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OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse factory (available in manufacturing quantities). Approx size 10 1/2 x 8 1/2 in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photocopiers and print drying equipment.

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30-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwell. Bass resonance 40 c/s Rated 20 watts. NOTE: 3 or 8 or 15 ohms must be stated.

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Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful response 30-13,000 cps. Bass Resonance 55 cps.

GROUP "25" **£7.75**  
12in 25 watt  
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All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm a.c. Mains. Separate treble and bass controls. Guaranteed. Details S.A.E.



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CALLERS ONLY! DE-LUXE 100 WATT AMPLIFIER CHASSIS. 7 Valve version, 4 inputs, 10 wide range controls. For Mixes, Discos, Organs, Guitars, etc. 4, 8 and 15 ohm Loudspeaker matching. **£69**

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British made. Ready aligned and tested. Complete with instructions. Size 3in x 2in. **£4.95**

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DELUXE 4 POLE MOTOR  
1,400 r.p.m. reversible 42 Watt, spindle 1 1/2 x 7/32 in, size 3 1/2 in x 3 in. As illustrated. 240V a.c. mains. **£2.25**  
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12in. 15 watts

An inexpensive unit for the beginner in high fidelity and for general purposes. May be used to improve any Radio, Amplifier, Hi-Fi or Television receiver.

Bass Resonance 45cps  
Flux Density 12,000 gauss  
Useful response 45-13,000cps  
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## DE-LUXE Mk II 12in. 15 watts

Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

Bass Resonance 30cps  
Flux Density 14,000 gauss  
Useful response 25-16,000cps  
8 or 15 ohms models.

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## SUPERB

12in. 20 watts

A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance 25cps  
Flux Density 16,500 gauss  
Useful response 20-17,000cps  
8 or 15 ohms models.

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## AUDITORIUM

12in. 25 watts

A full range reproducer for high power, Electric Guitars, public address, multi-speaker systems, electric organs, Ideal for Hi-Fi and Discotheques.

Bass Resonance 35cps  
Flux Density 15,000 gauss  
Useful response 25-16,000cps  
8 or 15 ohms models.

**£12.95** Post Free

## AUDITORIUM

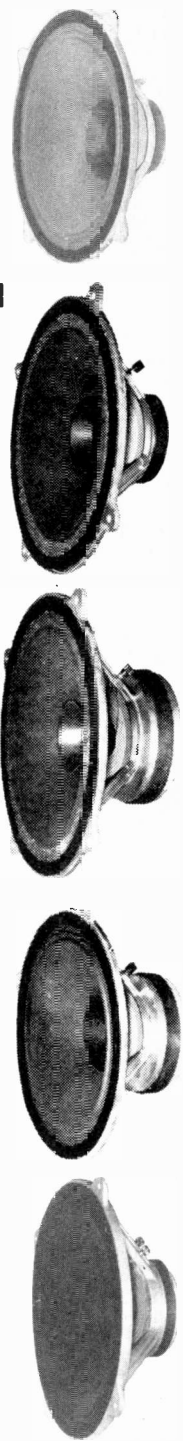
15in 35 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home.

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Hi-Fi Enclosure Manual containing 20 plans, designs, crossover data and cubic tables. 63p.



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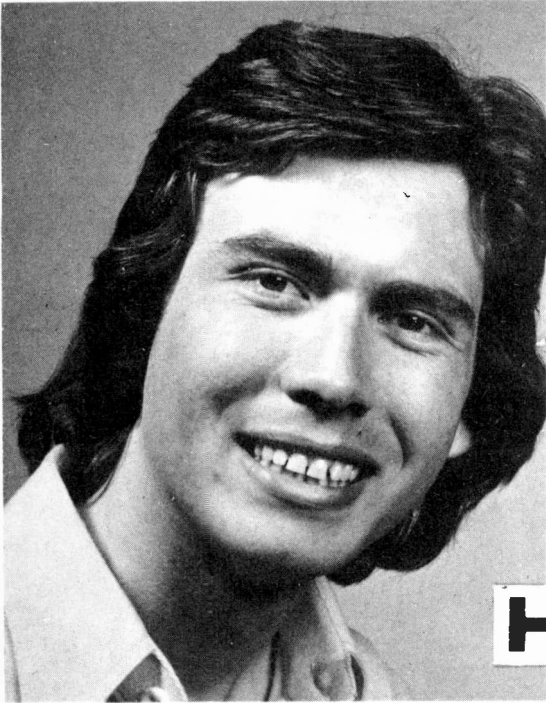
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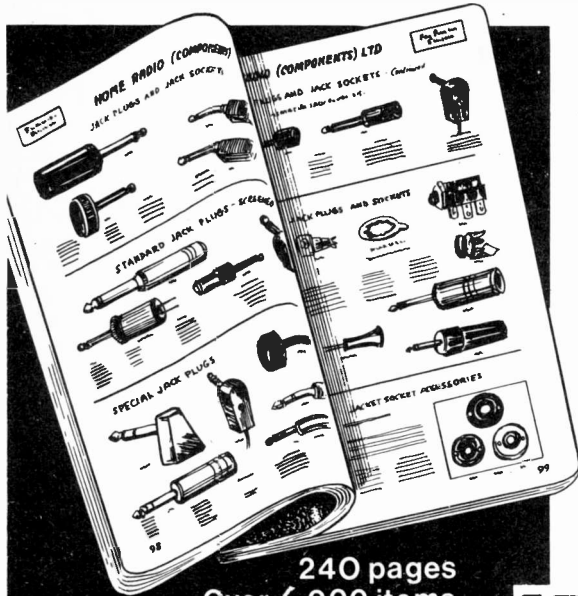
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## SONIC SPIN-OFF

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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**T**HE 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.

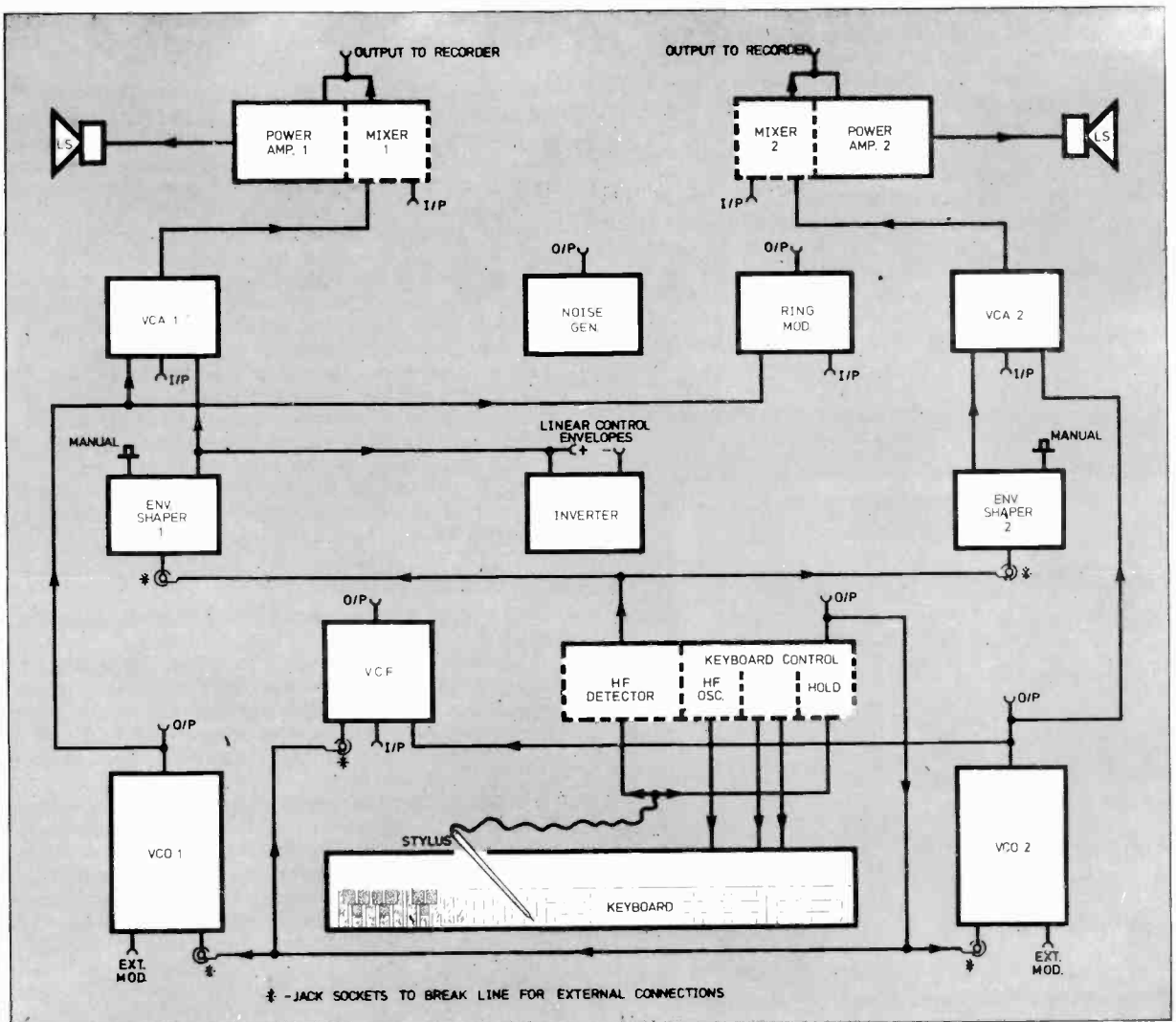


Fig. 1.1. Block diagram of the P.E. Minisonic showing the internal connections between modules

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.

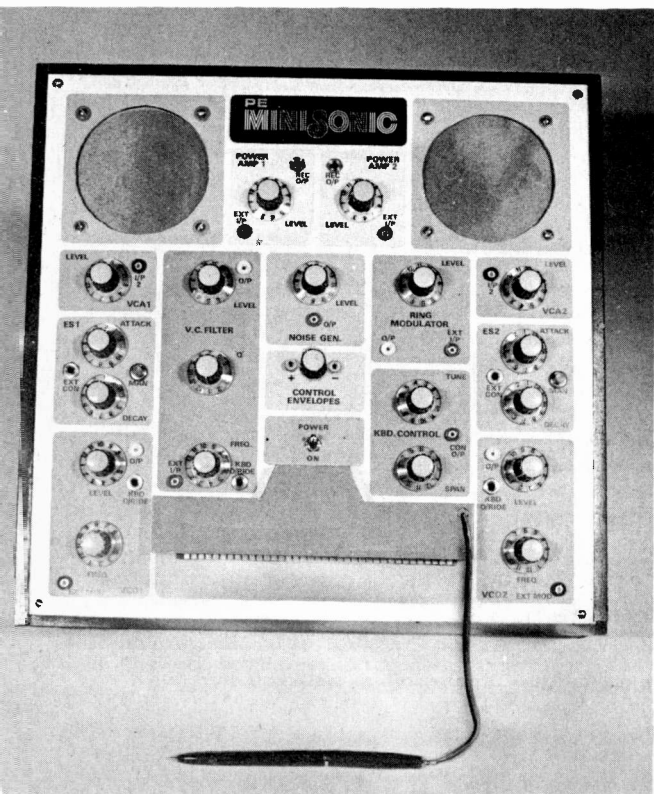
### MINISONIC DESIGN

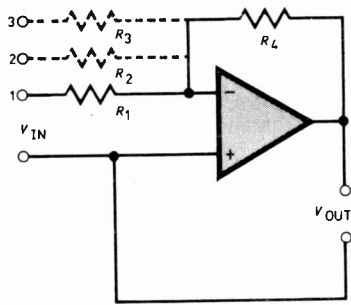
The overall scheme of the P.E. Minisonic is shown in Fig. 1.1.

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.

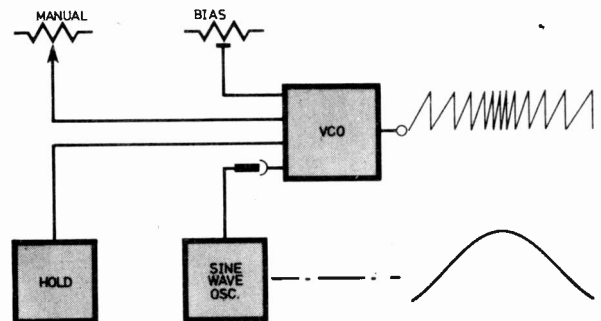
All four inputs may be driven at the same time and, in combination, "programme" the oscillator to give a specific frequency or effect. When all the inputs are d.c. the output frequency of the oscillator is unvarying but if, say, a sine wave signal is applied to the external modulation input then the 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  $\frac{1}{8}$ in

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

C 1ft  $\frac{3}{8}$ in  $\frac{3}{8}$ in

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

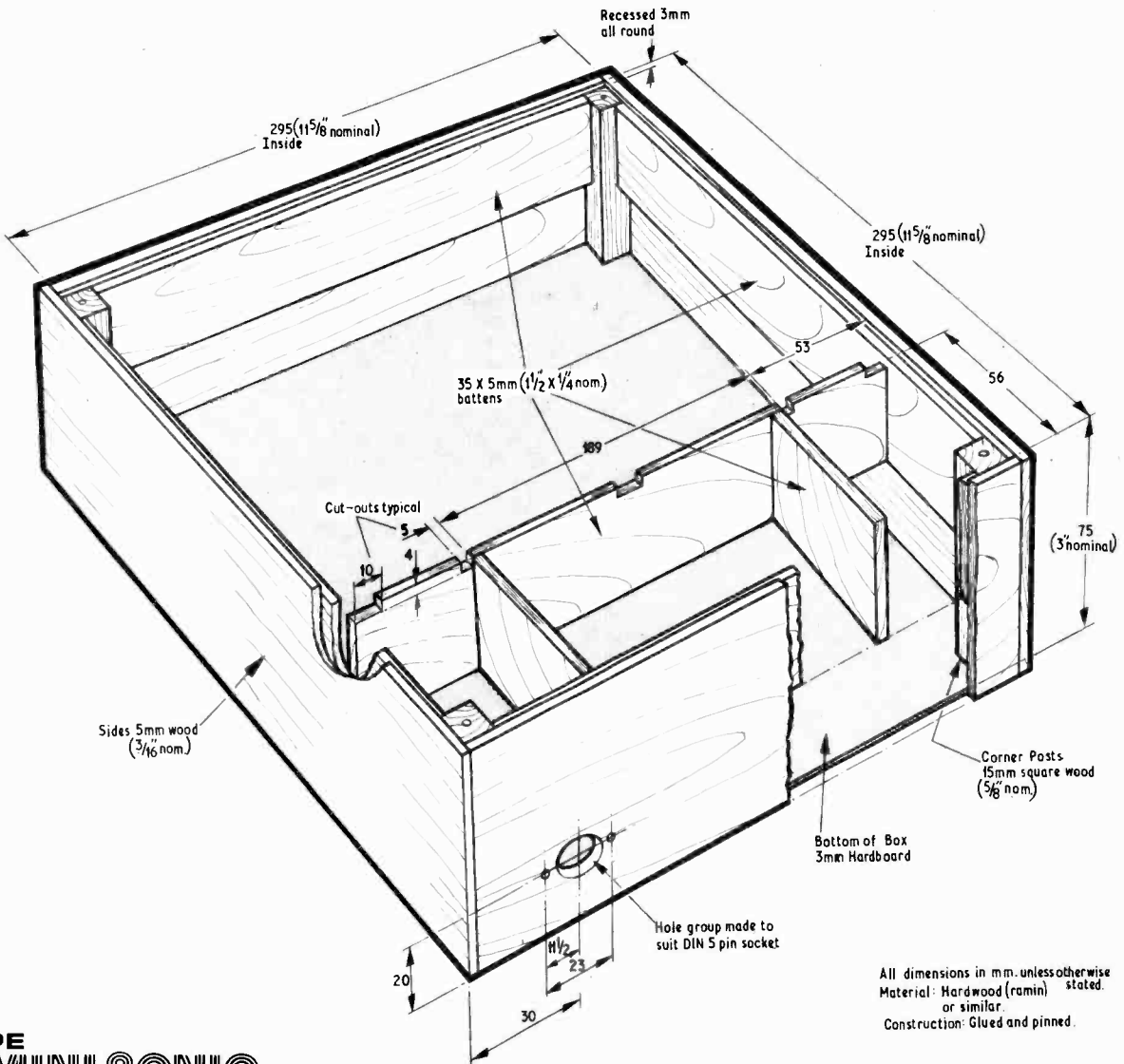
Cut B into four pieces  $10\frac{3}{8}$ in, one piece  $11\frac{1}{8}$ in and two pieces 2in length.

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

### Hardboard

Two pieces measuring  $11\frac{3}{8}$ in  $\times$   $11\frac{3}{8}$ 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.



All dimensions in mm, unless otherwise stated.  
Material: Hardwood (ramin) or similar.  
Construction: Glued and pinned.

PE  
MINISONIC

Fig. 1.4. Details of the case assembly. Major dimensions are shown in inches (1in = 25.4mm)

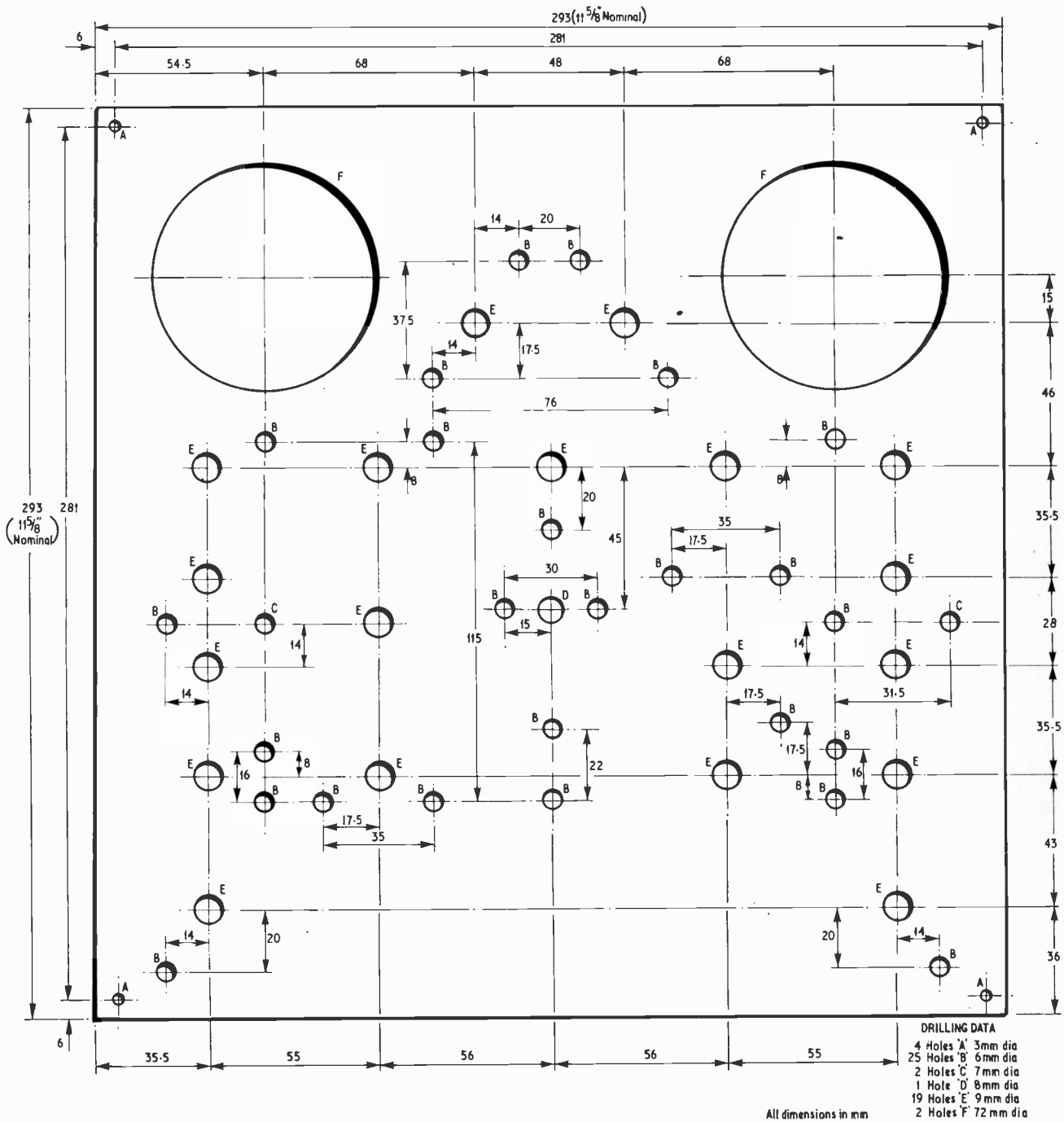


Fig. 1.5. Details of the front panel drilling required for use with scheme shown in block form in Fig. 1.1

# NEWS BRIEFS

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**

## 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

**D**ESPITE 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 re-triggering 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  $V_{ce0}$  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

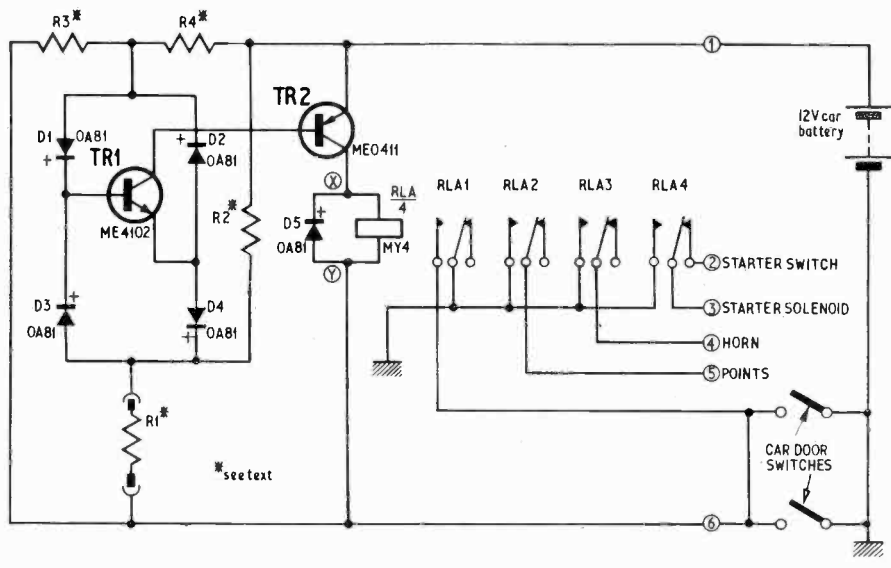
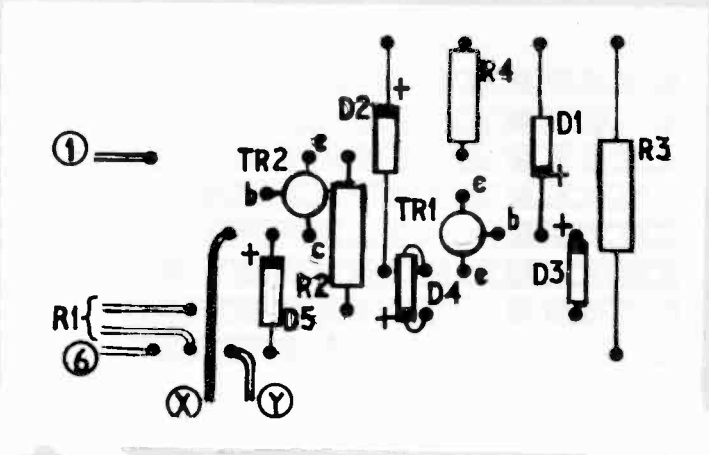


Fig. 1. Circuit diagram of the Anti-theft alarm (above) and the Veroboard and component layout (below)



### COMPONENTS . . .

- |   |                          |
|---|--------------------------|
| <b>Resistors</b>  |                          |
| R1 to 4   | See Text, 5%, 1/4 W      |
| <b>Semiconductors</b>   |                          |
| TR1   | ME4102                   |
| TR2   | ME0411                   |
| D1 to D5  | OA81                     |
| <b>Miscellaneous</b>  |                          |
| RLA   | Omron type MY4, 12V d.c. |
| Veroboard, wire, terminals, terminal strip if required, box, etc. |                          |

**ANTI-THEFT  
ALARM**

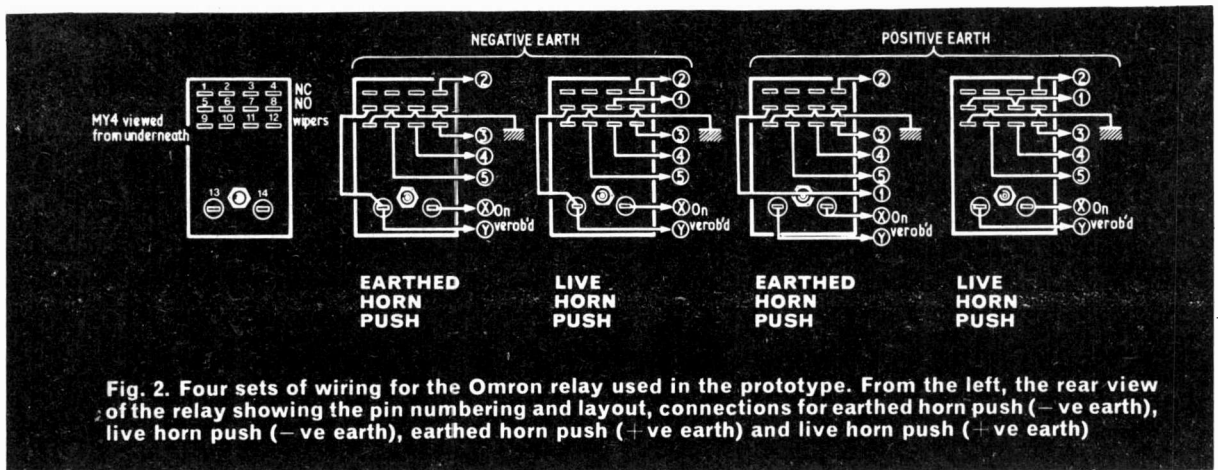


Fig. 2. Four sets of wiring for the Omron relay used in the prototype. From the left, the rear view of the relay showing the pin numbering and layout, connections for earthed horn push (-ve earth), live horn push (-ve earth), earthed horn push (+ve earth) and live horn push (+ve earth)

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 inter-connecting 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 positive 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

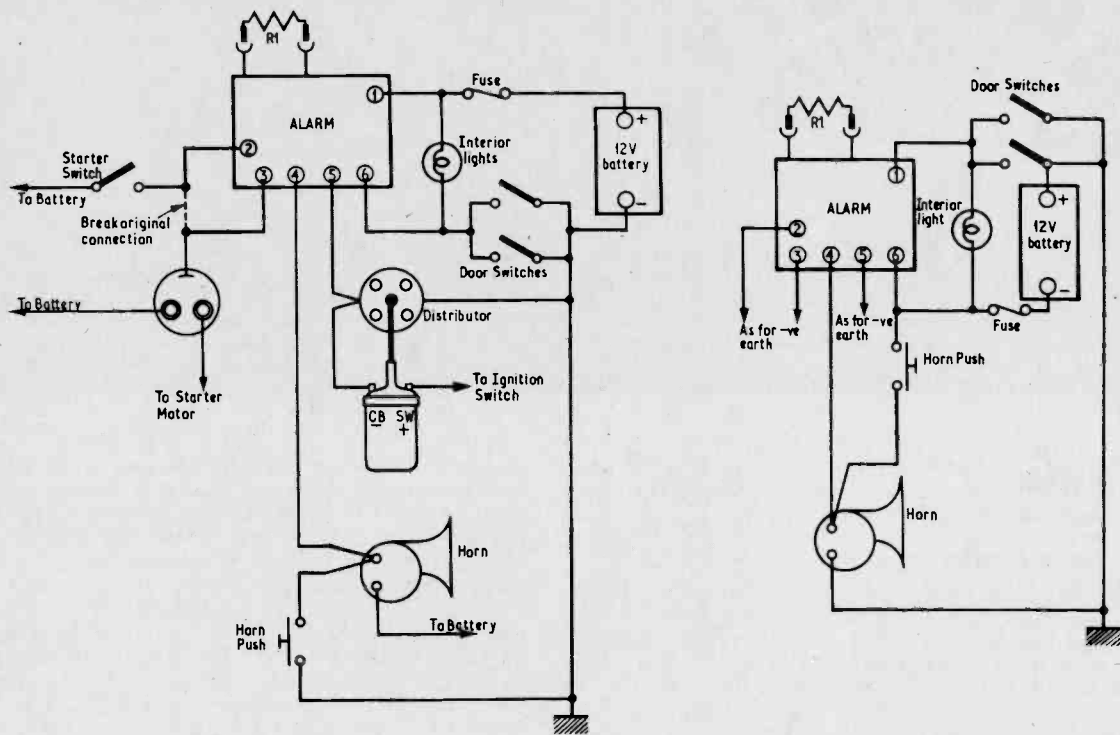


Fig. 3. Interconnections to the car wiring harness for negative (left) and positive (right) earth systems, showing the two variations of horn wiring as well

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  $47\Omega$  to  $4.7k\Omega$  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  $2k\Omega$  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  $\frac{1}{2}$ in 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

## 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 end of the pendulum swing.

The timer is triggered and stays high for  $1.1 \times C1 \times VR1$  seconds

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?

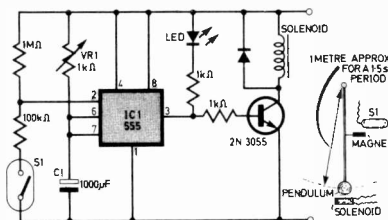


Fig. 1

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 Electrovalve Ltd.

R. J. Wyld  
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 x 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.

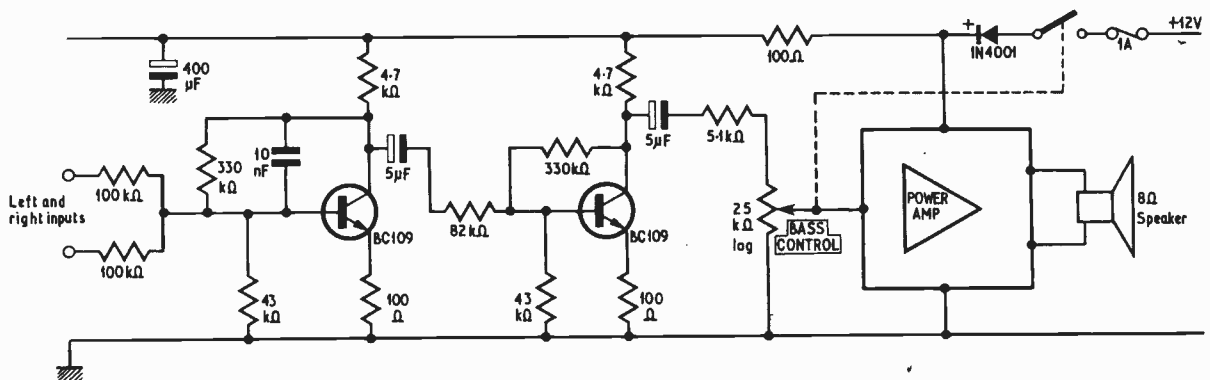


Fig. 1

## 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 approximately 6.3V and as soon as its inverting input rises above this level IC2 rapidly switches to -6.3V

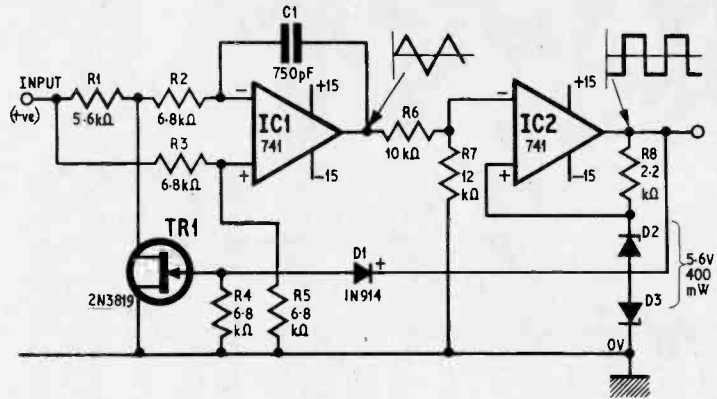


Fig. 1

causing TR1 to act as a near open circuit. The output of IC1 then begins ramping in the opposite direction.

Thus the frequency of oscillation depends on the input voltage.

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 1mA 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

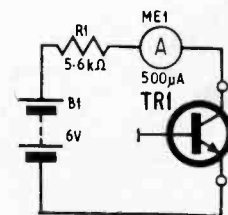
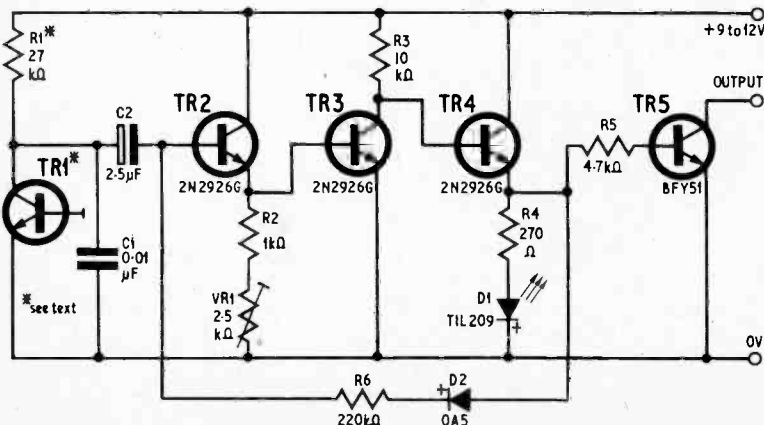


Fig. 2

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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.

### 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:

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

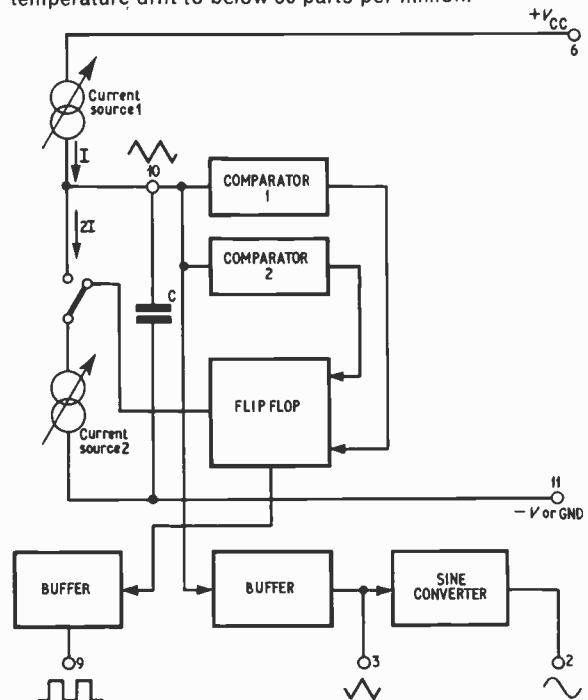


Fig. 1. A simplified block schematic of the 8038 integrated circuit

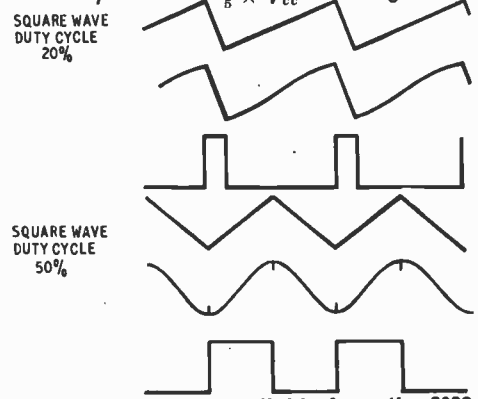


Fig. 2. The waveforms available from the 8038 using a 50 per cent duty cycle and a 20 per cent cycle. The small blips on the sinewave are switching transients from the square wave

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

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

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:

$$f = \frac{0.3}{R C}$$

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

$$f = \frac{0.15}{R C}$$

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<sub>cc</sub> 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<sub>cc</sub>. 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

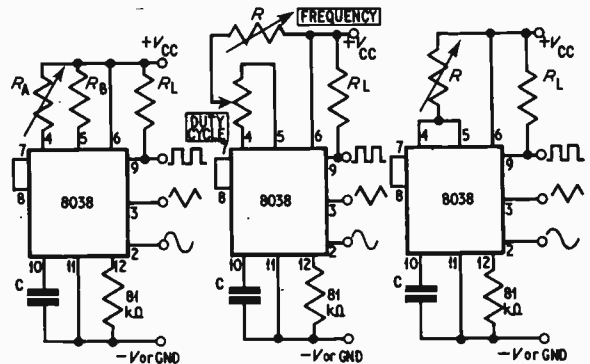
The 8038 has very obvious applications in signal generation areas such as music synthesis, the more so as it lends itself to simple voltage/frequency control and could easily form the basis of a monophonic system as a simple instrument in its own right or in a synthesiser used in conjunction with other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

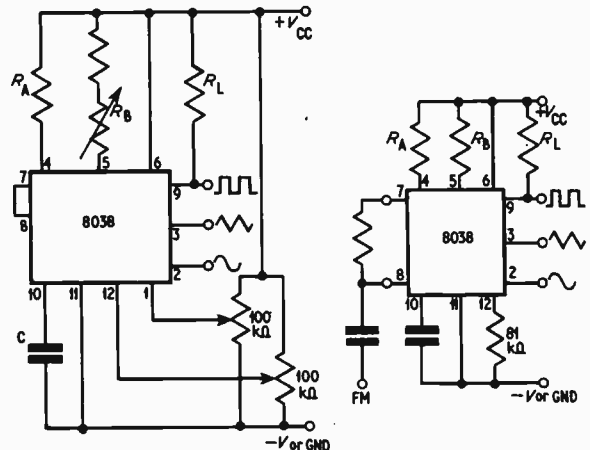
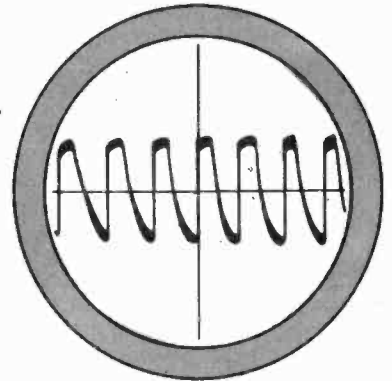


Fig. 6. The way to obtain minimum sinewave distortion  
Fig. 7. Using this configuration frequency sweeping is easily obtained

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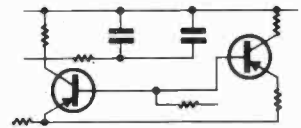
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# HYBRID

# PART TWO

# Computers

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, Burroughs, 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, PLI, 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, SLI, and CSMP.

## DIGITAL DIFFERENTIAL ANALYSERS

These are digital computers designed 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, patch-board 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-

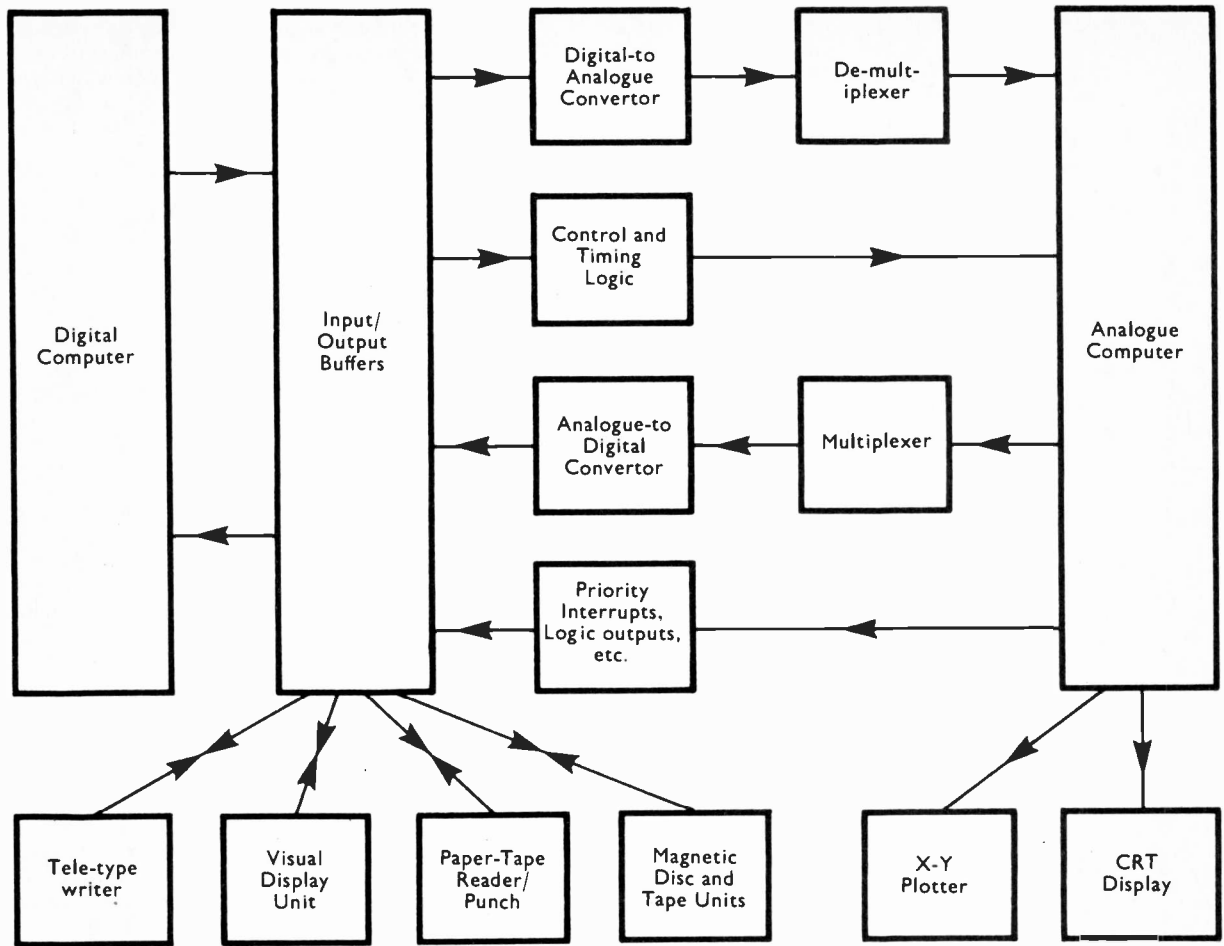


Fig. 2.1. A typical balanced hybrid system showing the interlinking between the various parts

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.

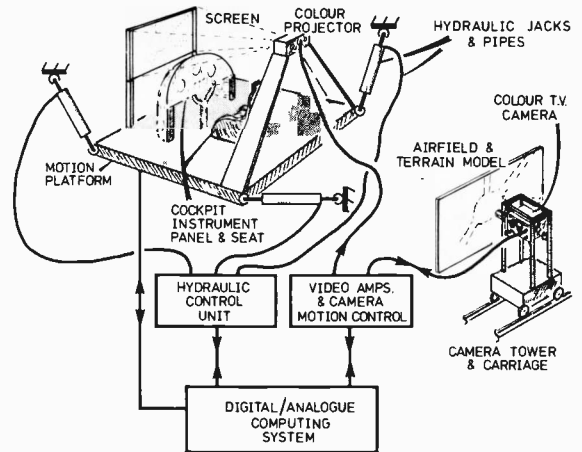


Fig. 2.2. Use of a hybrid system in a man/machine environment showing the various linkages allowing communication

### 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.

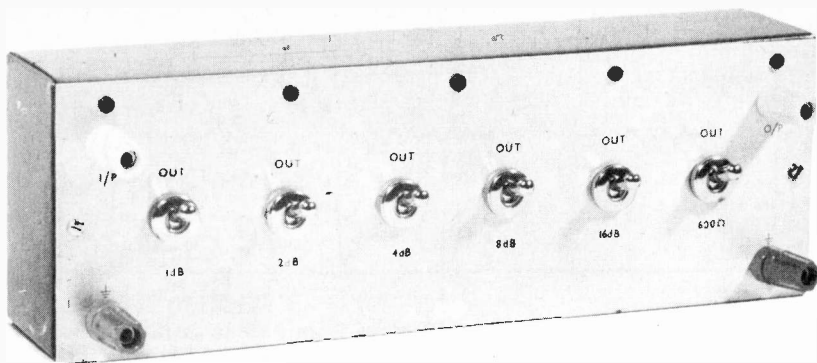
### MEDICAL AND ECONOMIC STUDIES

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

**M**ANY 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  $\pi$  (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  $R_1$  to  $R_2$ , and  $R_2$  to  $R_3$ , and can be calculated by the following expressions:

$$R_1 = R \left( \frac{n+1}{n-1} \right) \text{ and } R_2 = R \left( \frac{n^2-1}{2n} \right)$$

When the input impedance is equal to the output impedance, as it usually is, then  $R_1 = R_3$ , 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.  $V_1/V_0$ , where  $V_1$  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

attenuation 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 ( $R_1$  and  $R_3$ ) connected in parallel, all that is required is to replace them with a single resistor having half the value, giving Fig. 2.

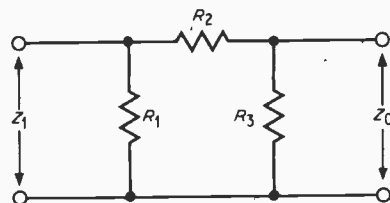


Fig. 1. Simple pi network whose attenuation and impedances are determined by the following relationships:

If  $Z_1 = Z_0$ , then  $R_1 = R_3 = R \cdot \frac{n+1}{n-1}$  and

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

where  $R$  is the characteristic impedance (=600  $\Omega$ ) and  $n = V_1/V_0$ .

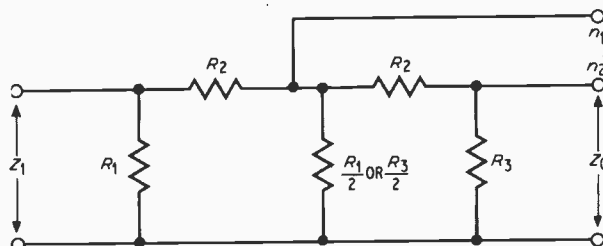


Fig. 2. Connecting attenuators in cascade produces further steps of attenuation. This type of compound attenuator is found in the output stages of signal generators giving ratios of 10:1, 100:1, 1,000:1 etc.

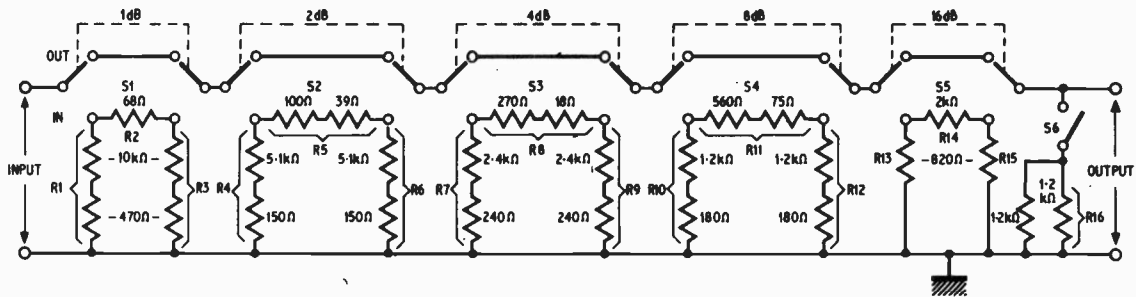


Fig. 3. Circuit of the complete attenuator giving attenuation in 1dB steps from 0dB to 31dB. If  $\frac{1}{2}$ dB accuracy is required an extra stage may be added at the input end using resistor values given in the components list

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  $\frac{1}{2}$ dB step.

### CONSTRUCTION

The attenuator was constructed in an aluminium cabinet 10½in long, 3¼in 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  $\Omega$  in series with 470  $\Omega$  (2 off)
- R2 68  $\Omega$
- R4, R6 5.1k  $\Omega$  in series with 150  $\Omega$  (2 off)
- R5 100  $\Omega$  in series with 39  $\Omega$
- R7, R9 2.4k  $\Omega$  in series with 240  $\Omega$  (2 off)
- R8 270  $\Omega$  in series with 18  $\Omega$
- R10, R12 1.2k  $\Omega$  in series with 180  $\Omega$  (2 off)
- R11 560  $\Omega$  in series with 75  $\Omega$
- R13, R15 820  $\Omega$  (2 off)
- R14 2k  $\Omega$
- R16 1.2k  $\Omega$  in parallel with 1.2k  $\Omega$

All resistors 2%  $\frac{1}{2}$ W carbon

For  $\frac{1}{2}$ dB section use circuit of Fig. 1 with R1, R3 = 68  $\Omega$  in parallel with 68  $\Omega$ , and R2 = 18k  $\Omega$  in series with 3k  $\Omega$  (or 21k  $\Omega$ )

### 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  $\frac{1}{2}$ dB 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.

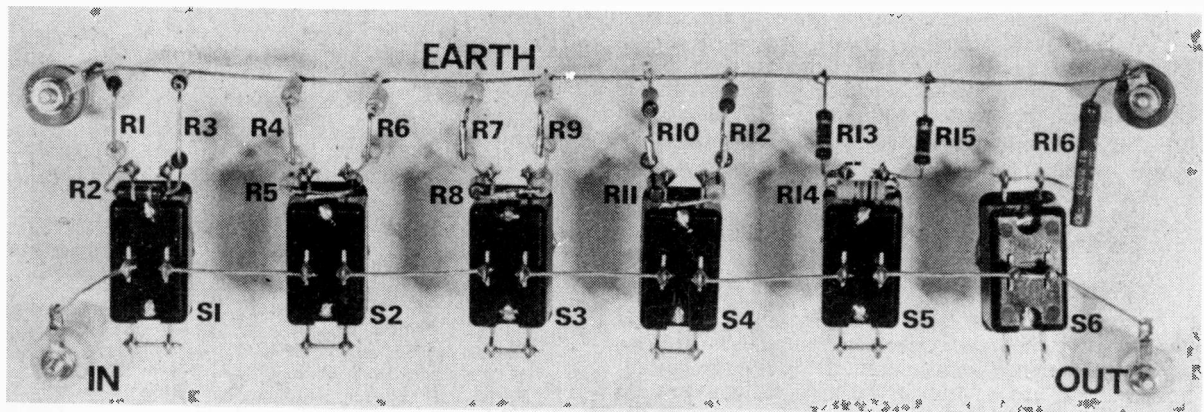


Fig. 4. Construction of the attenuator showing the layout of the resistors and the busbars

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.

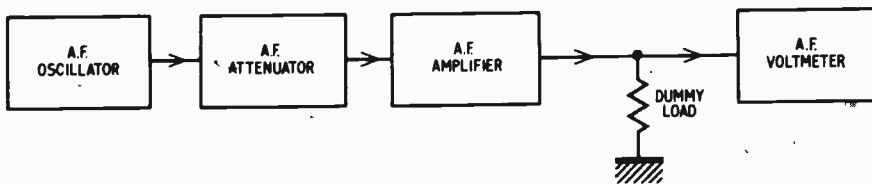


Fig. 5. Block diagram showing placement of attenuator in a set-up to measure frequency response of an audio amplifier

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.

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

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

—½dB	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.

## 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  $-30\text{dB} + -32\text{dB}$  which is  $-62\text{dB}$  (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

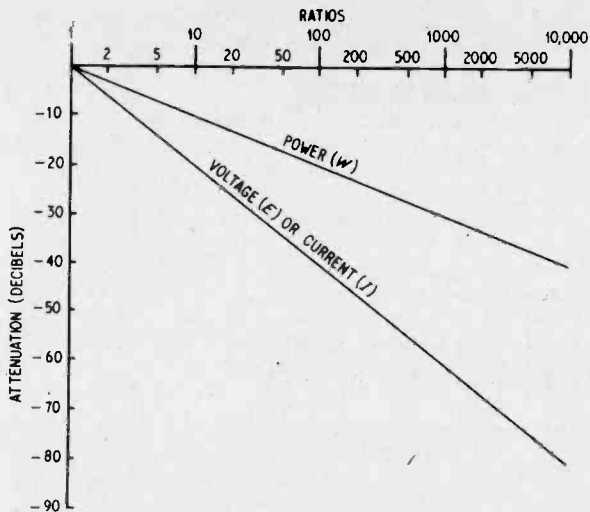


Fig. 6. Graph showing conversion of ratios into decibels for power and current or voltage

everything else is in relation to this. 0dB can be zero output, or it can be maximum output, or anywhere in between.

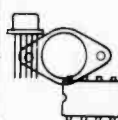
This makes it delightfully versatile, but danger lies hidden under the cloak of versatility, for misunderstandings can so very easily arise unless 0dB is clearly defined.

## 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



**M**OST 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 (*npn* 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 *npn* 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 *npn* 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 100 $\mu$ A 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 *npn* 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.

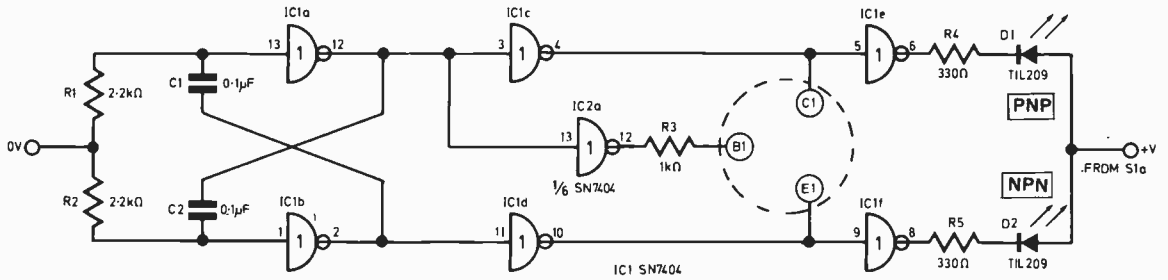


Fig. 1a. Circuit diagram of the polarity indicator

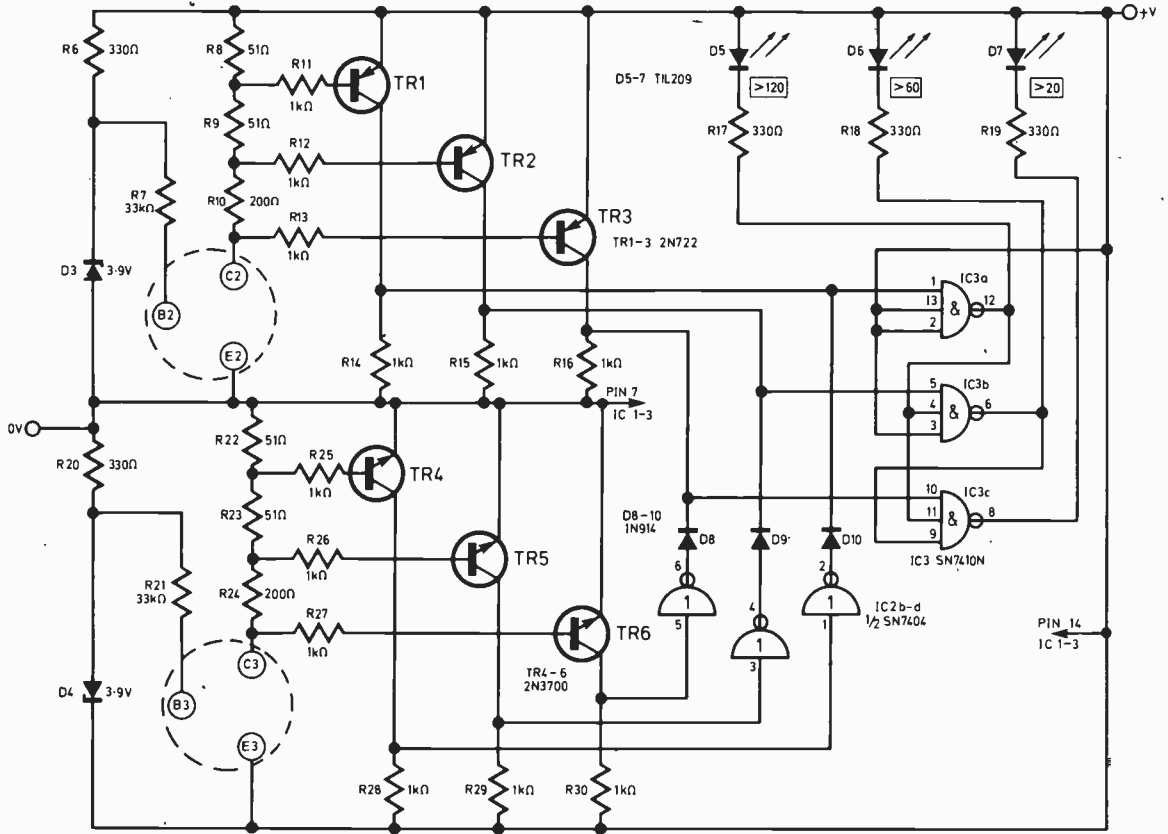


Fig. 1b. Circuit diagram of the gain indicator. In both the above diagrams the circled designations are connections from the circuits in Fig. 1c

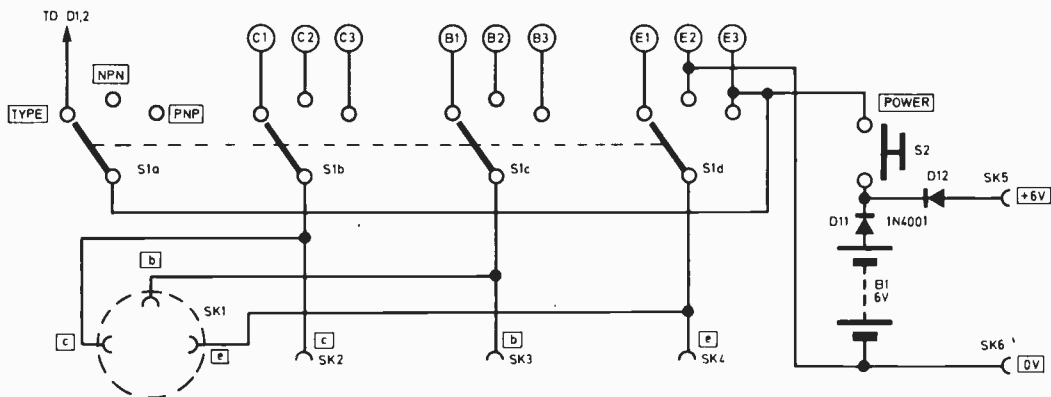


Fig. 1c. Power supply and switching system. The battery can be used to make the unit self-contained or an external power source can be used

## COMPONENTS . . .

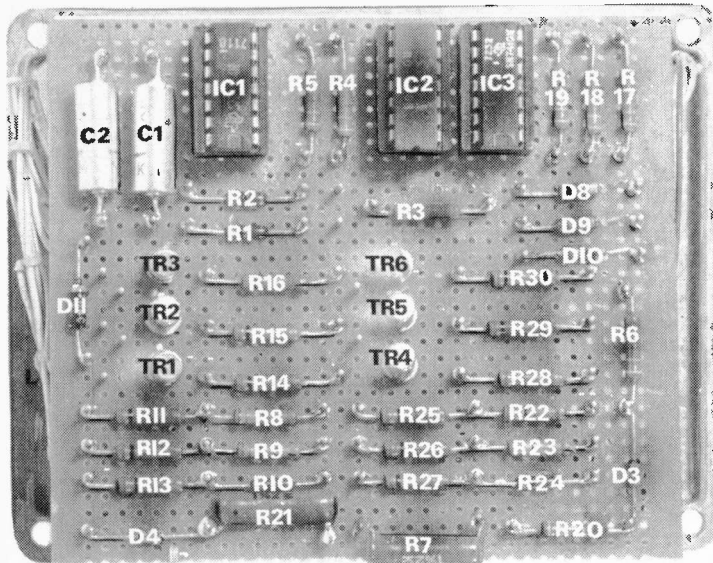


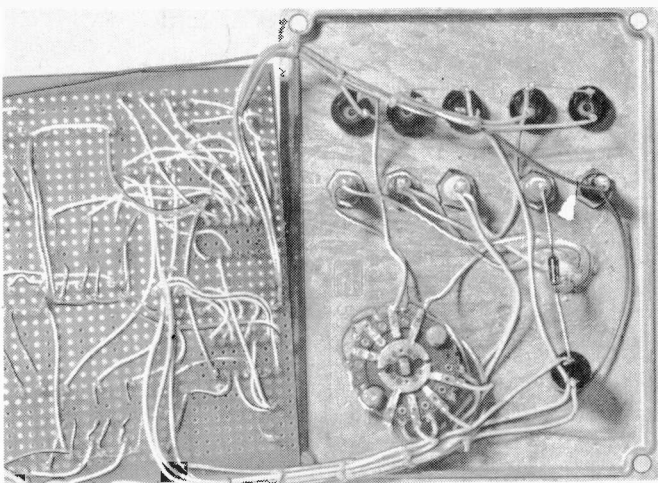
Fig. 2. Layout of the components on the perforated board

### 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  $3\frac{1}{2}$ in  $\times$   $4\frac{1}{2}$ in 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 layout of the front panel showing arrangement of i.e.d.s and sockets

Resistors	
R1, R2	2.2k $\Omega$ (2 off)
R3	1k $\Omega$
R4-R6	330 $\Omega$ (3 off)
R7	33k $\Omega$
R8, R9	51 $\Omega$ (2 off)
R10	200 $\Omega$
R11-R16	1k $\Omega$ (6 off)
R17-R20	330 $\Omega$ (4 off)
R21	33k $\Omega$
R22, R23	51 $\Omega$ (2 off)
R24	200 $\Omega$
R25-R30	1k $\Omega$ (6 off)
All $\frac{1}{4}$ W $\pm$ 5% carbon	

### Capacitors

C1, C2 0.1 $\mu$ F (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  $3\frac{1}{2}$ in  $\times$   $3\frac{1}{2}$ in  
 Diecast box  $4\frac{1}{2}$ in  $\times$   $3\frac{1}{2}$ in  $\times$  2in  
 14 pin integrated circuit sockets (optional)  
 2mm plugs and leads  
 B1 6V battery (see text)

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).

### 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.

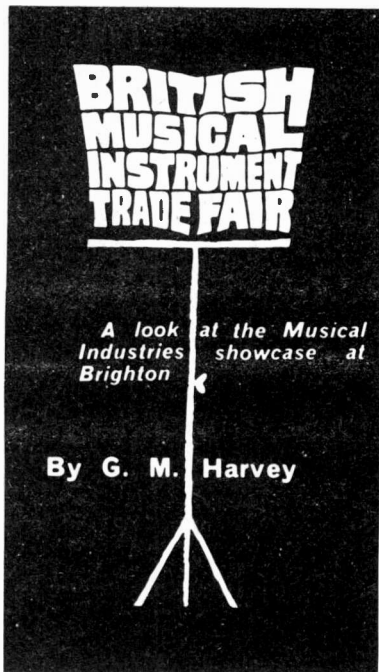
Set the function switch S1 to TYPE and connect a transistor to the test sockets. When the POWER button is pressed either the NPN or the PNP lamp should light indicating the polarity of the transistor.

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.



**T**HE 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 sitting 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 re-produced. 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

### The new SY-1 solo synthesiser from Yamaha



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, Wurli-tzer 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 Multi-mate, 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 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<sub>10</sub>, antilog<sub>10</sub>, giving quick access to x<sup>Y</sup> (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.

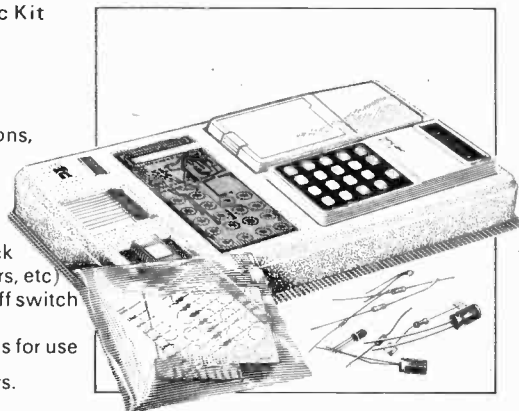
All parts are supplied — all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our Service Department will back you throughout if you've any queries or problems.

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.

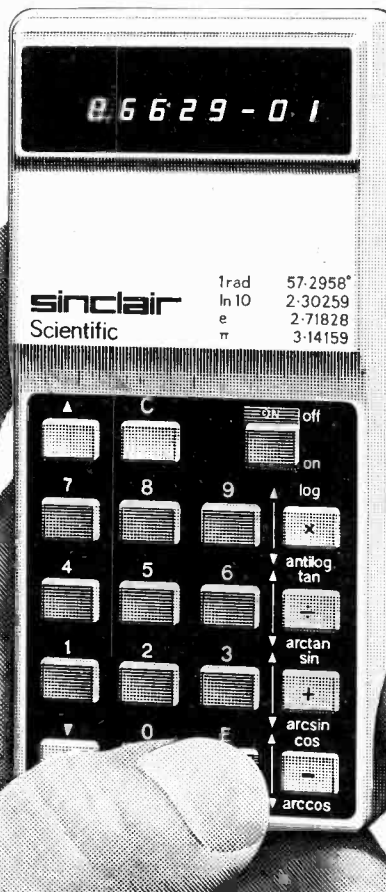
## Components for Scientific Kit (illustrated)

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<sup>-99</sup> to 10<sup>+99</sup>.

- **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.

# Sinclair Cambridge kit

**Now only**  
**£14.95**  
 (INC. VAT)

At its new low price, the original Sinclair Cambridge kit remains unbeatable value.

In less than a year, the Cambridge has become Britain's most popular pocket calculator.

It's not surprising. Check the features below – then ask yourself what other pocket calculator offers such a powerful package at such a reasonable price.

## Components for Cambridge Kit

1. Coil
2. LSI chip
3. Interface chip
4. Thick film resistor pack
5. Case mouldings, with buttons, window and light-up display in position
6. Printed circuit board
7. Keyboard panel
8. Electronic components pack (diodes, resistors, capacitors, transistor)
9. Battery clips and on/off switch
10. Soft wallet

Assembly time is about 3 hours.

## Take advantage of this

### money-back, no-risk offer today

The Sinclair Cambridge and Scientific kits are fully guaranteed. Return either kit within 10 days, and we'll refund your money without question.

All parts are tested and checked before despatch – and we guarantee any correctly-assembled calculator for one year. (This guarantee also applies to calculators supplied in built form.)

Simply fill in the preferential order form below and slip it in the post today.

### Scientific

Price in kit form £19.95 inc. VAT.

Price built £32.35 inc. VAT.

### Cambridge

Price in kit form £14.95 inc. VAT.

Price built £21.55 inc. VAT.

## Features of the Sinclair Cambridge



- Uniquely handy package. 4 1/3" x 2" x 11/16", weight 3 1/2 oz.
- Standard keyboard. All you need for complex calculations.
- Clear-last-entry feature.
- Fully-floating decimal point.
- Algebraic logic.
- Four operators (+, -, x, ÷), with constant on all four.
- Powerful constant with separate 'K' button.
- Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £15.
- Calculates to 8 significant digits.
- Clear, bright 8-digit display.
- Operates for weeks on four AAA batteries.

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 Huntingdon, Cambs. PE17 4BR

- Please send me
- Sinclair Scientific kit at £19.95
  - Sinclair Scientific built at £32.35
  - Sinclair Cambridge kit at £14.95
  - Sinclair Cambridge built at £21.55

All prices include 8% VAT.

\*I enclose a cheque for £....., made out to Sinclair Radionics Ltd, and crossed.

\*Please debit my \*Barclaycard/ Access account. Account number

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\*Delete as required.

Signed \_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

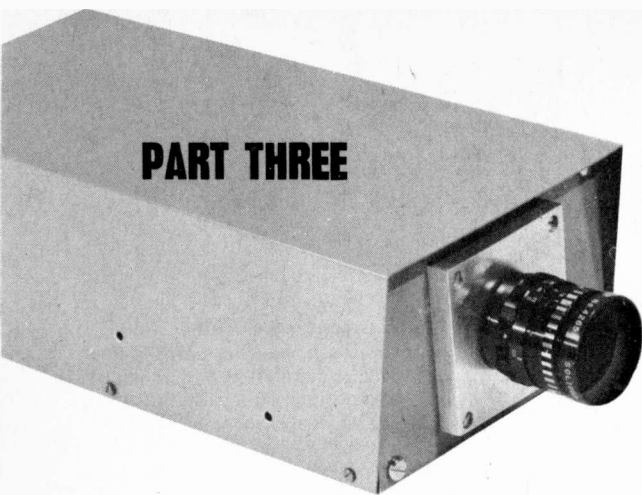
Please print. FREEPOST – no stamp needed.

PE/11/74

# sinclair

Sinclair Radionics Ltd,  
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 Huntingdon, Cambs. PE17 4BR.

Reg. No: 699483 England. VAT Reg. No: 213 8170 88.



# 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  $\times$   $\frac{1}{2}$ 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  $\times$   $\frac{1}{2}$ 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.

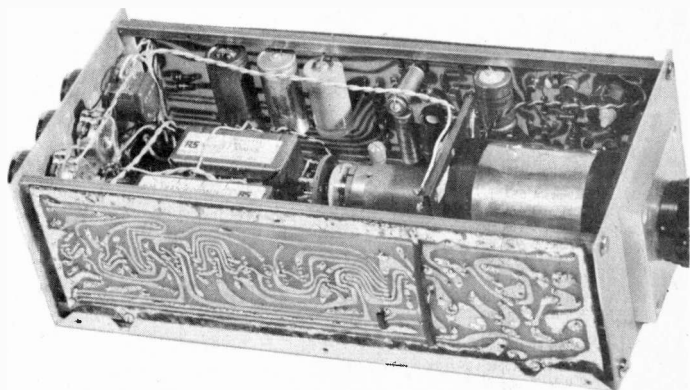
One point to remember when using any lens is that a deeper depth of focus is obtained by using smaller apertures, e.g. f11, f16, f22). To achieve this, of course, we require brightly lit scenes.

## 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.

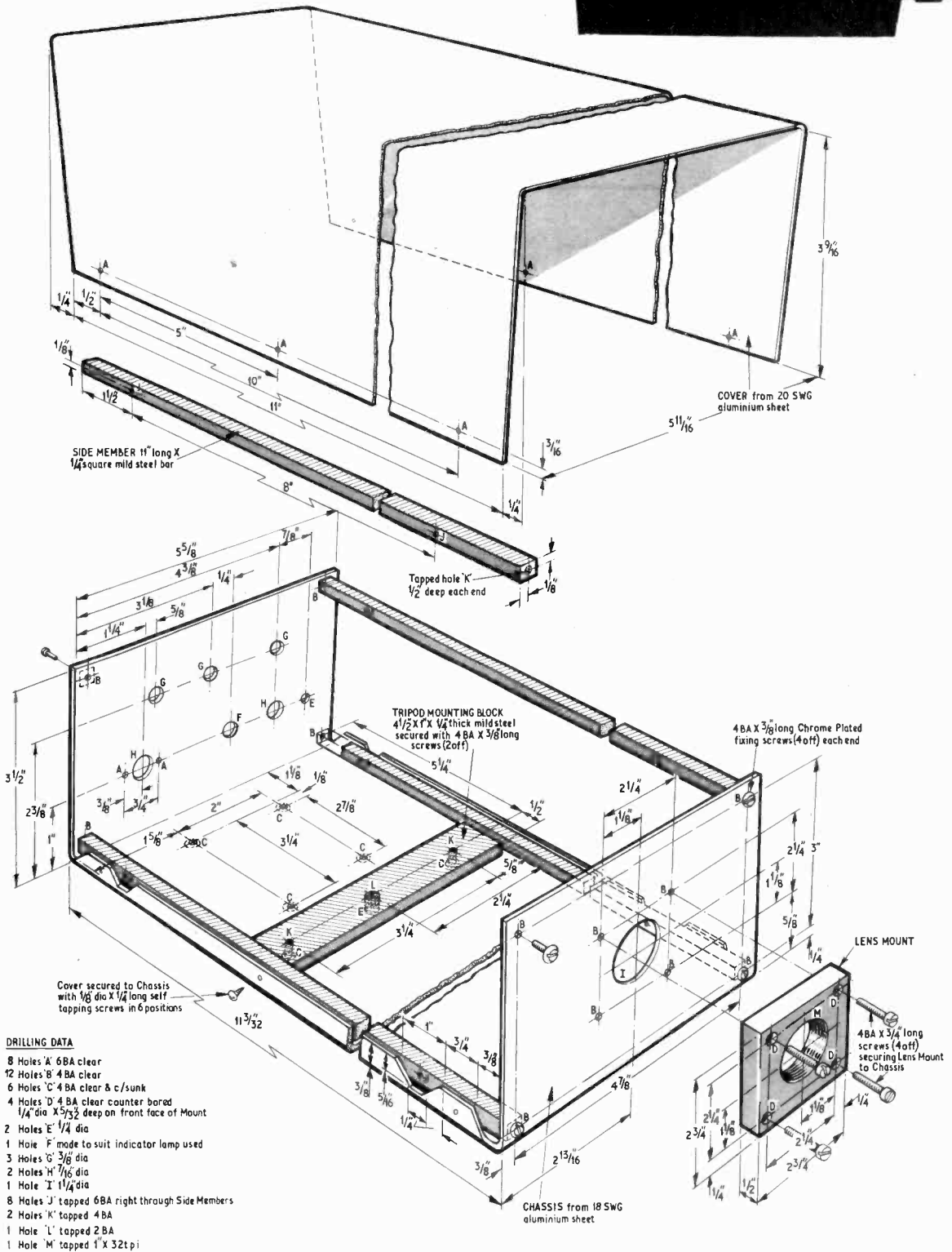
Standard photographic tripod mounting is facilitated by introducing a further strengthening bar to the base of the chassis. A  $\frac{1}{2}$ in  $\times$  1in cross sectional bar of aluminium is mounted at the centre of gravity of the TV Camera for a well-balanced  $\frac{1}{2}$ in BSW thread tripod 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 . . .



**Fig. 3.1. Mechanical details of camera enclosure**

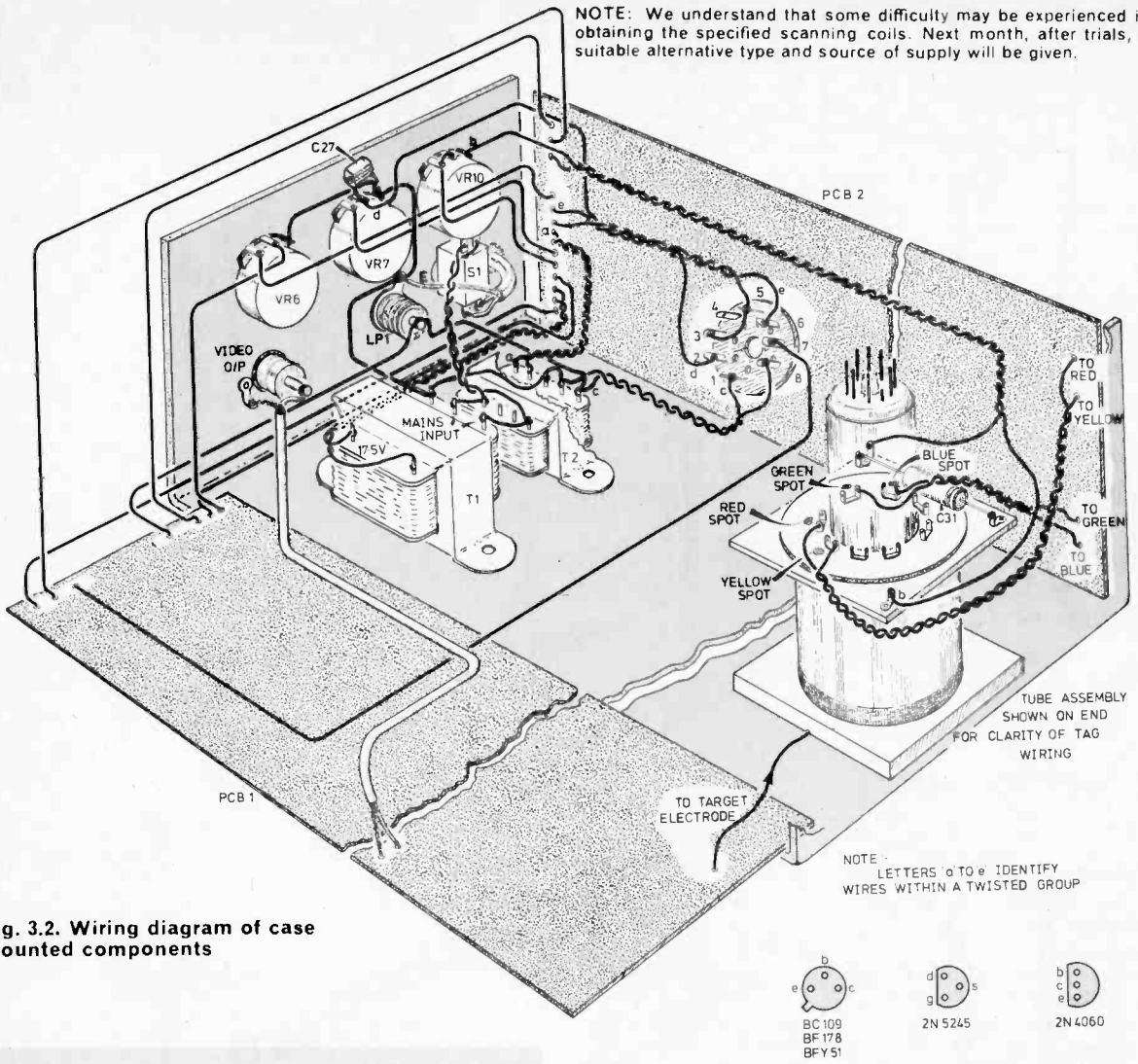


Fig. 3.2. Wiring diagram of case mounted components

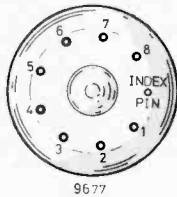


TABLE 3.1

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).

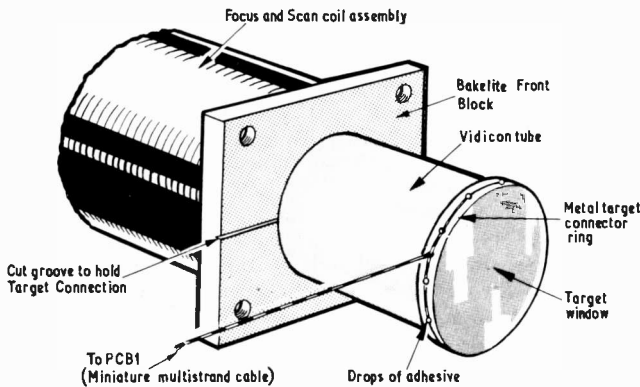


Fig. 3.3. Target connection details

## 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.

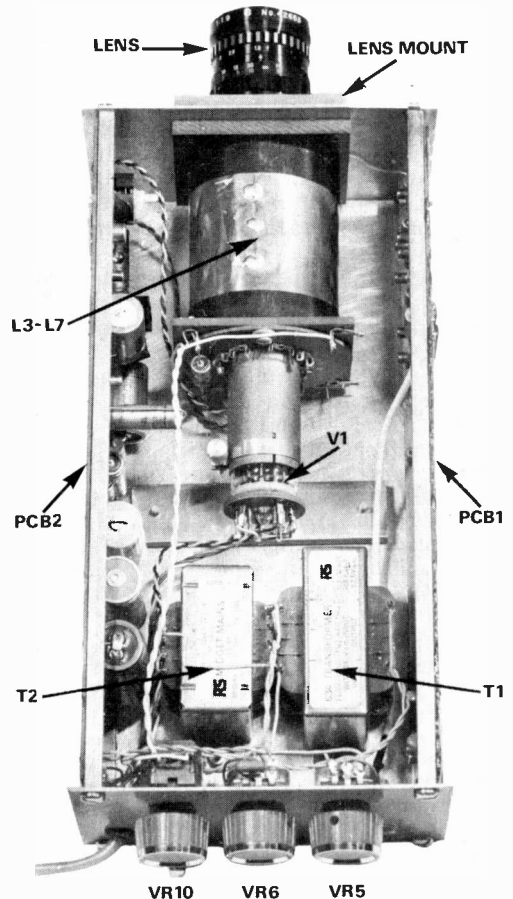
(b) Choose a well illuminated scene of a large, well defined, dark shape (a square for example) against a light background and direct your TV Camera toward it from a distance of 10-20ft.

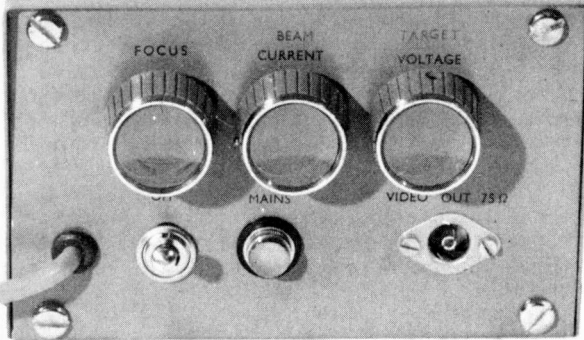
(c) Set the lens focus to correspond with the scene distance and adjust the aperture setting to  $f_4$ .

(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.

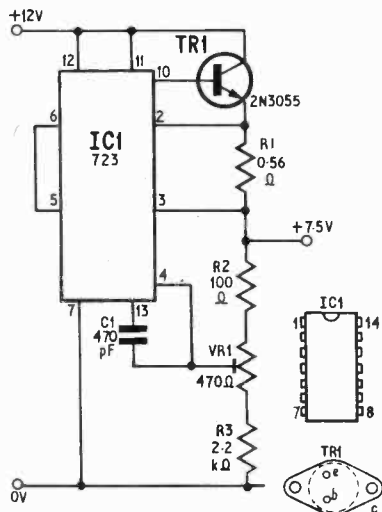


Fig. 1. Circuit for p.s.u.

## COMPONENTS . . .

### Resistors

R1	0.56Ω	1W
R2	100Ω	$\frac{1}{8}$ W
R3	2.2kΩ	$\frac{1}{8}$ W
All 10%		

### Potentiometers

VR1	470Ω linear horizontal preset
-----	-------------------------------

### Capacitors

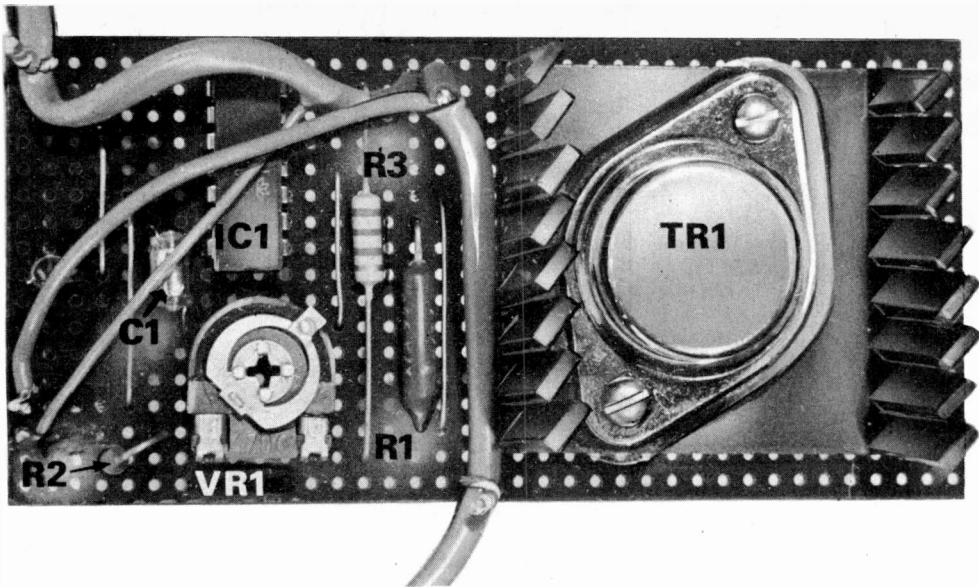
C1	470pF polystyrene
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### Semiconductors

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, 3½in × 1½in. 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.

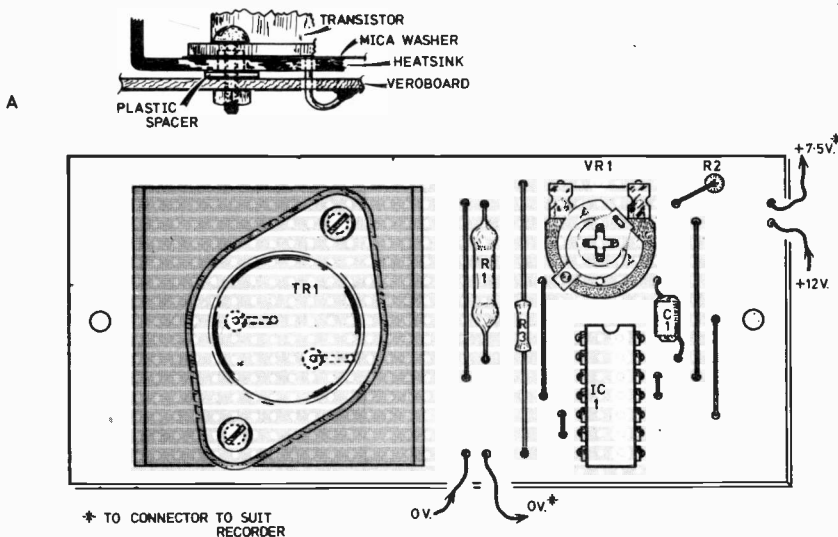
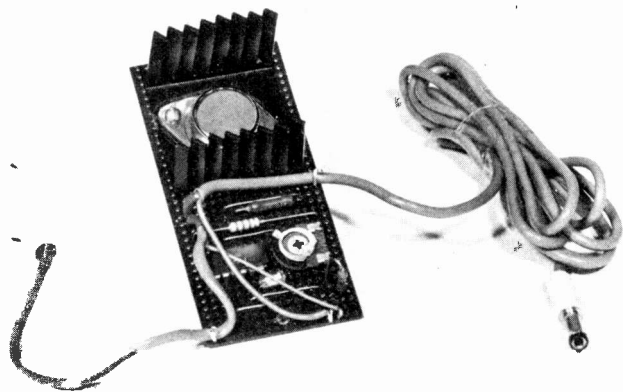


Fig. 2. Component layout and wiring detail



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.

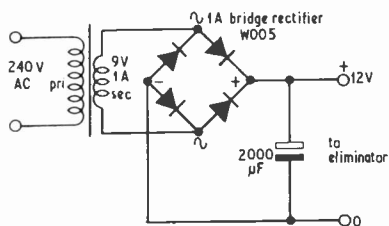


Fig. 3. Rectifier circuit for mains use

### 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. ★

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And very enjoyable.

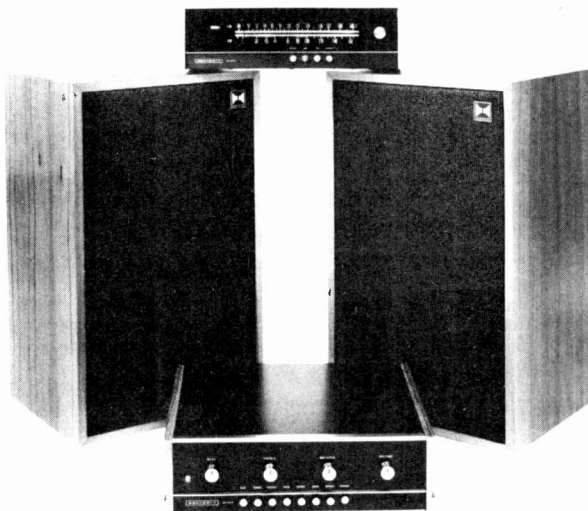
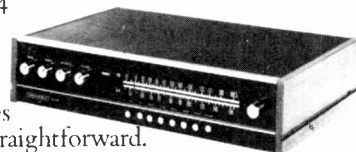
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## JUPITER ORBITER

The success of the *Pioneer 10* mission has led to a study, by the NASA-ESRO group, of the possibility 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.

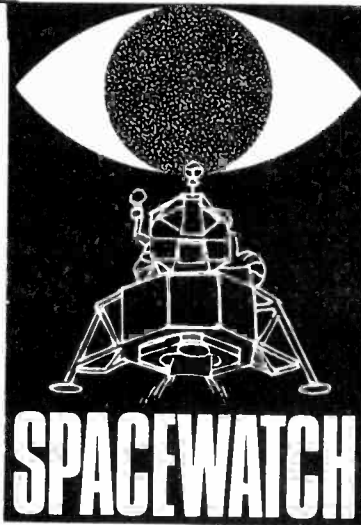
The high energy electrons and protons that were measured by the spacecraft indicated a magnetosphere quite different from that of the Earth. The sudden burst of electrons from Jupiter remains unexplained at the moment. An orbiting vehicle could help to resolve this. The design of such a craft would have 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.



BY FRANK W. HYDE

There are large oscillations in the electron density having an apparent period of change of the order of 6 seconds. Sometimes there are active bursts 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  $2 \times 10^{-9}$  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.

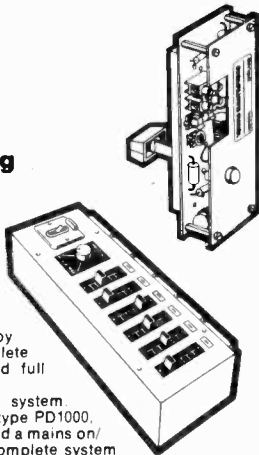
The design of the 3.8m flux collector makes use of the 1.5m experience and also the design studies by Sir Howard Grubb Parsons and Dunford Hadfields Ltd. The improvement in facilities of the 3.8m instrument will be considerable, not least the fact that observation times will be reduced by a factor of 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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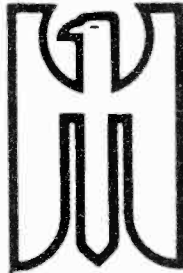
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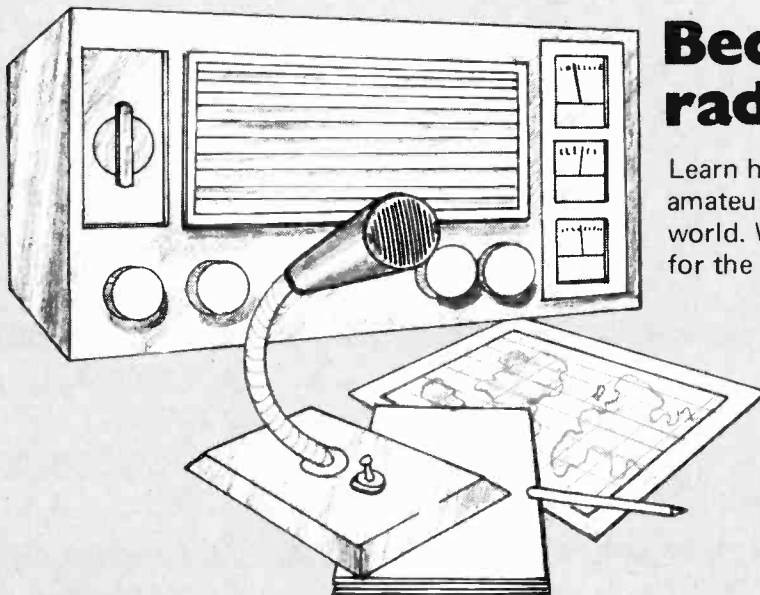
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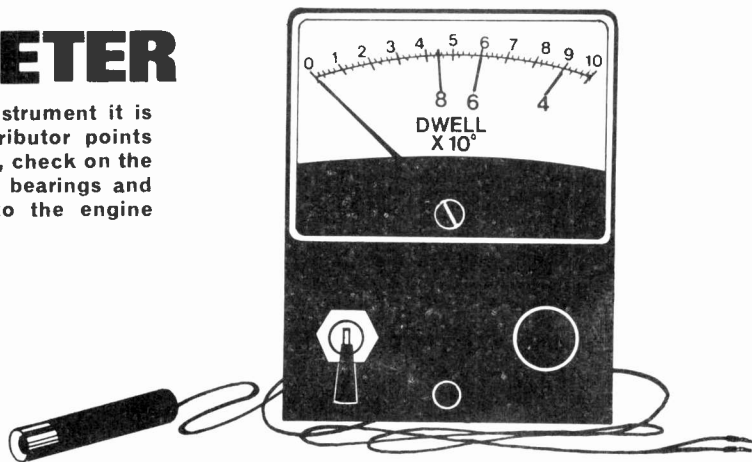
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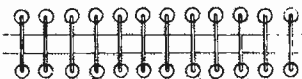
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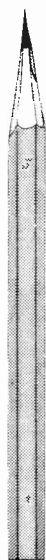
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*By NEXUS*



## 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 Fer-

ranti 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.



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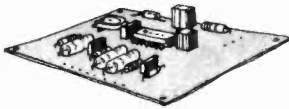


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# Audio Bargains



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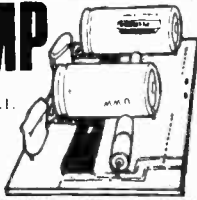
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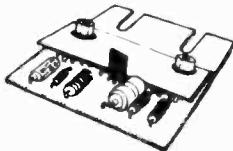
incl. P. & P.  
Order Code I.C.A.1.



On P.C. Board with all components or 2 on one board for £2.60. Order Code I.C.A.1/5.

These amps. are supplied with a free booklet on connecting up, specifications and easy-to-build projects using the I.C.A.1.

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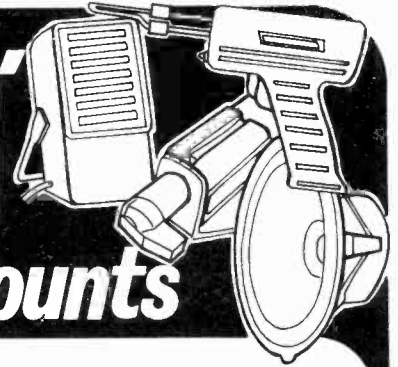
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GP101 Crystal comp.	0-80	(800)	3-85
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		(800E)	3-95
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# PATENTS REVIEW... □□□

## 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.

## 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 1 334 532

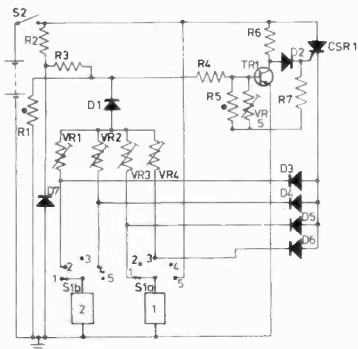


Fig. 1

BP 1 341 842

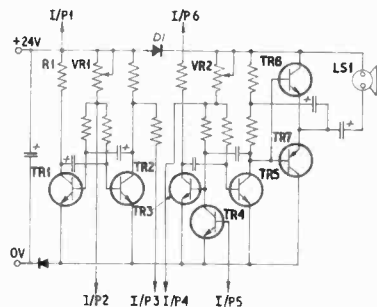


Fig. 1

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each

# 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

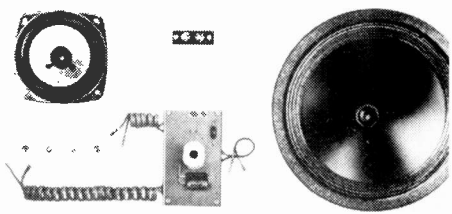
It now seems to be an annual event at this time of the year for industrial relations to become very strained and an investment in any form of emergency lighting is a wise precaution against any power cuts. With this in mind **Electronic Design Associates** are now producing an 8W 12V fluorescent lighting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

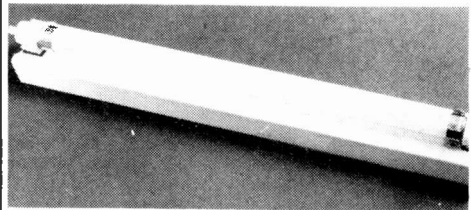
The light is ideally suited as a caravan and camping light, for garage or workshop lighting, as an inspection light, and for general home use. In use the light is reverse polarity protected and takes approximately 0.6A from the battery.

Available from **Electronic Design Associates**, 82 Bath Street, Walsall, WS1 3DE, the cost of the kit is £13.19 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



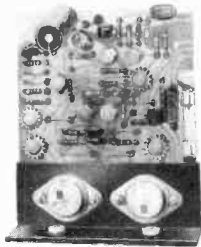
8W Fluorescent light from Electronic Design Associates

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<b>MT45</b>	Transformer for above	<b>£3.50</b>	Carriage 30p
<b>PS70</b>	Suits 2 SA100	<b>£5.45</b>	Carriage free
<b>MT70</b>	Transformer for above	<b>£4.90</b>	Carriage 40p

N.B. PS70 is not suitable for the SA50

## Mk II STEREO DISCO MIXER £22.50 Carr. 30p

This well tried unit mixes two decks, handles any ceramic cartridge, and features mic over-ride plus separate full range bass and treble controls on both mic and deck inputs. Ample headphone power is available for P.F.E. may be used for mono and is mains operated. Fitted with sturdy screening case. Controls: Mic vol, bass, treble. Left/Right fade, deck volume, bass, treble, h/phone select, vol, Mains. Size 17 1/2in x 3in x 4in deep.



## DISCO MODULE £9.50 Carr. 20p

Thousands sold of this extremely popular mono version. A mic input may be fitted using the VA30 (see below). Low consumption from a 9V battery. Features the same high standards of reproduction as the Stereo version. Controls: h/phone select, vol, Left deck vol, Right deck vol, bass, treble, master vol. Size 12 1/2in x 3in x 2in deep.



## 3-CHANNEL SOUND-LITE £22.50 Carr. 30p

Only SAXON can supply such incredible value for money. This unit features 3kW power handling, full-wave control, bass, middle, treble AND master controls. Twin loudspeaker jacks for "through" connections. It may be used free standing or will panel mount next to either of the above. Also features unique CUT-BACK circuitry for extra wide range response. Size 12in x 3in x 2 1/2in deep. Professional standards at a price you can afford!

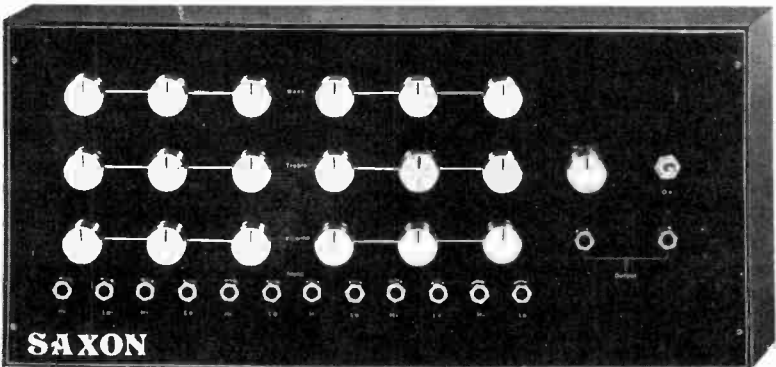


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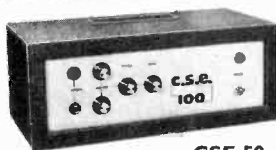


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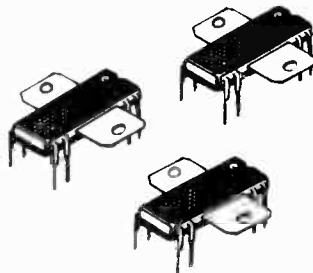
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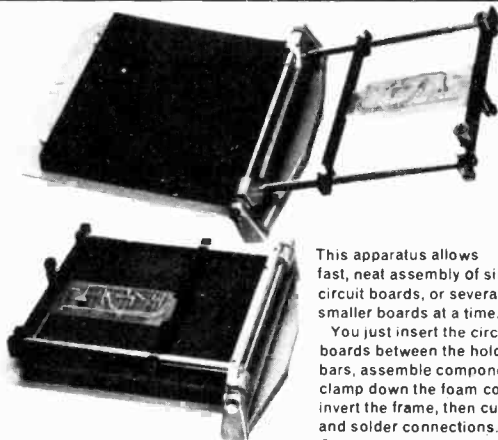
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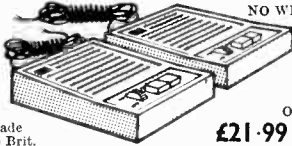
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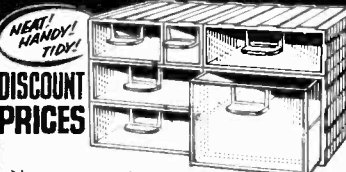


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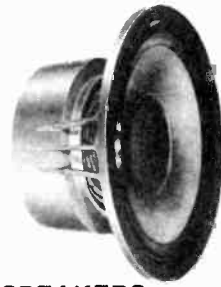
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Fane Crescendo 18in 150W	£49.95
Fane 801T 8in d/c roll surr	£7.00
Fane 807T 8in d/c roll surr	£3.85
Fane 808T 8in d/c	£2.75
Fane 701 twin ribbon horn	£35.00
Fane 910 horn	£12.75
Fane 920 horn	£33.00
Goodmans 8P 8 or 15 ohm	£5.00

Goodmans 10P 8 or 15 ohm	£5.30
Goodmans 12P 8 or 15 ohm	£12.95
Goodmans 12P-D 8 or 15 ohm	£16.75
Goodmans 12P-G 8 or 15 ohm	£15.75
Goodmans Audiomax 12AX 100W	£39.65
Goodmans Audiomax 15AX	£42.00
Goodmans 15P 8 or 15 ohm	£21.00
Goodmans 18P 8 or 15 ohm	£36.00
Goodmans Midax 750	£16.00
Goodmans Axent 100 tweeter	£7.25
Goodmans Audiom 100 12in	£12.00
Goodmans Axiom 401 12in	£17.25
Goodmans Twinaxiom 8	£8.25
Goodmans Twinaxiom 10	£9.00
Kef T27	£5.25
Kef T15	£6.00
Kef B110	£7.00
Kef B200	£8.00
Kef B139	£12.75
Kef DN8	£2.00
Kef DN12	£4.50
Kef DN13	£2.75
STC401G super tweeter	£6.19
Richard Allan CG8T 8in d/c r/surr	£6.35
Wharfedale Super 10RS DD	£9.80
2 1/2in 64 ohm. 70mm 80 ohm. 70mm 8 ohm	£0.65
2 1/2in 75 ohm	£0.50
7in x 4in 3 or 8 ohm	£1.40
8in x 5in 3 or 8 ohm	£1.50
10in x 6in 3 8 or 15 ohm	£2.30

## SPEAKER KITS

Baker Major Module	each £10.75
Fane Mode One	each £9.90
Goodmans DIN 20	each £9.75
Helme XLK25	pair £11.00
Helme XLK30	pair £14.95
Helme XLK50	pair £39.95
Kefkit 2	each £23.50
Kefkit 3	each £34.00
Richard Allan Twinkit	each £8.95
Richard Allan Triple 8	each £13.75
Richard Allan Triple	each £19.95
Richard Allan Super Triple	each £23.75
Wharfedale Linton 2 kit	pair £19.25
Wharfedale Glendale 3 kit	pair £34.50
Wharfedale Dovedale 3 kit	pair £52.50

## PA/DISCO AMPLIFIERS

(carr and ins £1)	
Baker Major 100 watt	£49.75
Linear 30/40	£30.00
Linear 40/60	£35.00
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Eagle PA range in stock—ask for catalogue

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Loudspeakers: Swan Works, Bank Square, Wilmslow, Cheshire, SK9 1HF  
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<b>Agfa Low Noise Cassettes</b>		AT LESS THAN HALF PRICE!			
C60	37p	1	5	10	
C90	50p	£1.80	£2.46	£3.50	
C120	63p	£3.10	£4.95	£6.20	
<b>AGFA HIGH DYNAMIC SUPER</b>		1		5	10
C60 - 6	50p	£2.40	£4.70	£6.80	
C90 - 6	68p	£3.35	£6.60	£9.50	
C120	99p	£4.90	£9.50	£10.80	
<b>AGFA STEREO-CHROM CHROMIUM DIOXIDE</b>		1		5	10
C60	85p	£4.20	£8.30	£10.80	
C90	£1.08	£5.35	£10.80		

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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	
40 watt	1-12	13-25	26-50
90 watt	20p	18p	16p
	<b>24p</b>	<b>22p</b>	<b>20p</b>
Range 2	VCE Min. 40	HFE Min. 40	
40 watt	1-12	13-25	26-50
90 watt	30p	28p	26p
	<b>35p</b>	<b>33p</b>	<b>30p</b>

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### HIGH-SPEED MAGNETIC COUNTERS

4 digit (non-reset) 4 x 1 x 1" 30p.

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## LM380 AUDIO IC

We have just received a large consignment of LM380 ICs. These are specially selected to a higher grade and are marked with the number SL60745.

This fantastic little 3w audio IC only requires two capacitors and two potentiometers to make an amplifier with volume and tone control. The quality is good and has to be heard to be believed.

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TYPE "A" PNP Silicon Alloy, TO-5 can.  
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A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 5 ranges: 1 microhenry-111 henries ± 2% Capacity: 8 ranges: 10pF-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11000 ± 1% Bridge Voltage at 1,000cps. Operates on 9-volt battery. 100 microamp meter indication. Size 7 1/2" x 5" x 2"

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5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the hi-fi man. Operates on 9V battery. Wide easy to read scale. 80kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.

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### 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.

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### TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedance 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.


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### ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output TV maximum 220/240V AC operation. Complete with instructions and leads.

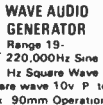
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### MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR

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

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### SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems 25 Watts. 4-8 ohms. 40Hz-18kHz. Size. 560 x 430 x 255mm. approx. Wood grain finish with black feet

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High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Single hole fixing. 1/4" diameter shafts. Bulk quantities available.

**25 WATT 10/25/50/100/500/1000/2500 ohms. £1.15 P & P 10p**

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### KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

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### EMI LOUSPEAKERS

Model 350 13 x 8" with single tweeter/crossover. 20-20,000Hz. 15 watts RMS. Available in 9 or 15 ohms.

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### SPECIAL PURCHASE LIMITED QUANTITY!

Tannoy 12" DR/8 Bass Speakers

8 ohms. 30 watt Heavy duty. ideal for Hi-Fi P.A. Group.


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### 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, Walk 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 cassettes. Manually 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. Beautiful cabinet. Size 7 7/8" x 108mm.

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### LHO2S STEREO HEADPHONES

Light weight head phones with padded ear pieces. 4/16 ohms 20-20,000Hz. Complete with 6' lead and plug.

**OUR PRICE £1.97 P & P 30p**



### DHO2S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedance 8 ohms. 20-12,000Hz. Complete with cable and stereo jack plug.

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### TE103S Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedance. Frequency response 25Hz-18kHz. Complete with cable and stereo jack plug.

**OUR PRICE £2.60 P & P 30p**



### SDHBV MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedance. Frequency response 20Hz-18kHz. Complete with 10ft. coiled lead and jack plug.

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### BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching communications etc. Headphone impedance 18 ohms. Microphone impedance 200 ohms.

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### 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 Playback 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 !! STEREO SOUND SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe oak veneered finish. Size 368 x 225 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 163 x 111 x 63mm 3 IF stages. Double tuned discriminator. Amp/ug in microphone, guitar etc. and output to your amplifier. 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 £ 95 extra



### SPECIAL OFFER! SAVE OVER 50%

AMSTRAD 8000/2 Stereo amplifier 7 watts per channel rms. Inputs for turner tape, phone. Headphone socket. List price £29.95.

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### SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 40 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.

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GOODWIN CONVERTER available separately £3.95 P & P 50p




### Model A1018 FM TUNER

6 transistor high quality unit-3IF stages and double tuned discriminator. For use with most amplifiers. Covers 88-108MHz. Powered by 9V battery.

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Stereo multiplex adapter £5.95 extra.



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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

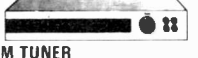
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### FM TUNER

Excellent selectivity and sensitivity Twin dual-varicap tuning. 4 pole ceramic filter. 19 transistor stereo demodulator giving 4dB 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

240 Power Amp	£5.45 P & P 15p
250 Power Amp	£6.95 P & P 15p
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Active Filter Unit	£6.95 P & P 15p
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P25 Power Supply	£4.98 P & P 30p
P26 Power Supply	£7.98 P & P 30p
P28 Power Supply	£7.98 P & P 30p
Transformer for P28.	£4.05 P & P 50p

**SINCLAIR Project 80 Packages**

2 x 240/Stereo 80/P25	£25.00
2 x 240/Stereo 80/P26	£27.75
2 x 260/Stereo 80/P26	£30.45

POST & PACKING 35p each.

### TE1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional volume control facility for stereo headphones. Two gain controls, speakers on-off side switch, stereo headphone socket.

**OUR PRICE £22.25 P & P 15p**



### AUDIOTRONIC LOW NOISE CASSETTES

TYPE	10	25
C60	£1.57	£3.00
C90	£2.24	£4.25
C120	£2.73	£5.17

P & P Cassettes 3p. OVER 10 POST FREE!

### MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Stereo 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 HA101 Stereo Headphone Amplifier

All silicon, transistorised amplifier operates from magnetic, ceramic or turner 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

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
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AF60 0.5W mixer amplifier	£4.86
AF305 Intercom	£7.67
AF310 2 Mono Amplifier	£2.55
M160 Multi-vibrator	£2.18
M1302 Transistor tester	£6.33
M191 UV Meter	£5.37
M192 Stereo balance meter	£5.93
LF380 Quadrasonic device	£ 9.42
AT5 Automatic light control	£5.64
AT30 Photo cell switch unit	£ 6.68
AT50 400W track light dimmer/speed control	£5.18
AT55 2,200W track light dimmer/speed control	£ 6.75
AT60 1 channel light control	£10.82
AT65 3 channel light control	£16.52
GU30 Tremolo unit	£19.10
HF61 Diode detector	£3.87
HF65 FM transmitter	£3.21
HF75 FM receiver	£3.66
HF310 FM tuner	£18.32
HF325 Deluxe FM tuner	£26.33
HF330 Oecoder (HF310/325)	£10.55
GP310 Stereo pre-amplifier	£22.98
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NT10 Stabilised power supply 100mA, 9V	£ 6.27
NT300 Stabilised p. supply	£13.16
NT310 Power Supply 240 V AC	£ 5.64
NT305 Voltage converter	£ 5.64
NT315 Power supply 240V AC 104.5/15V 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 100mV output stage	£1.55
AE2 Pre-amplifier	£1.32
AE3 Diode receiver	£ 2.05
AE4 Flasher	£1.28
AE5 Astable multi-vibrator	£1.14
AE6 Monostable multi-vibrator	£1.11
AE7 RC generator	£1.08
AE8 Bass filter	£1.06
AE9 Treble filter	£1.06
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Also see previous page

## ALL PRICES EXCLUDE VAT

# SEW PANEL METERS

SEW PANEL METERS ARE STOCKED AT OUR  
3 LILE ST., 311 EDGWARE RD., & 152 FLEET  
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## CLEAR PLASTIC MODEL SD640

Size: 86 x 64mm

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200uA	£3.70
500uA	£3.65
50.0-500uA	£3.78
100.0-1000uA	£3.70
1mA	£3.85
5mA	£3.68
10mA	£3.68
50mA	£3.88
100mA	£3.88
500mA	£3.85
1A DC	£3.85
1A AC	£3.85
10A DC	£3.85
10A AC	£3.85
5V DC	£3.85



\*Items with asterisk are Moving Iron type, all others are Moving Coil

## CLEAR PLASTIC MODEL SD830

Size: 110 x 83mm

50uA	£4.30
100uA	£4.25
200uA	£4.20
500uA	£4.15
50.0-500uA	£4.25
100.0-1000uA	£4.20
1mA	£4.10
5mA	£4.10
10mA	£4.10
50mA	£4.10
100mA	£4.10
500mA	£4.10
1A DC	£4.10
1A AC	£4.10
10A DC	£4.10
10A AC	£4.10
5V DC	£4.10



## CLEAR PLASTIC MODEL MR 65P

Size: 86 x 78mm

50uA	£3.95
100uA	£3.85
200uA	£3.80
500uA	£3.75
50.0-500uA	£3.85
100.0-1000uA	£3.80
500.0-5000uA	£3.70
1mA	£3.70
1.0-1mA	£3.70
5mA	£3.70
10mA	£3.70
50mA	£3.70
100mA	£3.70
500mA	£3.70
1A DC	£3.70
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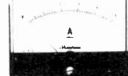
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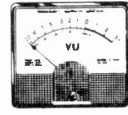


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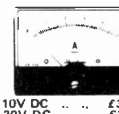
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1.0-1mA	£2.80
2mA	£2.80
5mA	£2.80
10mA	£2.80
20mA	£2.80
50mA	£2.80
100mA	£2.80
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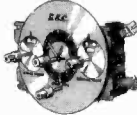
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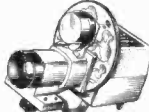
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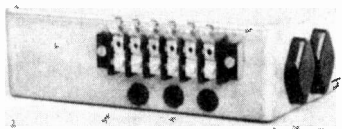
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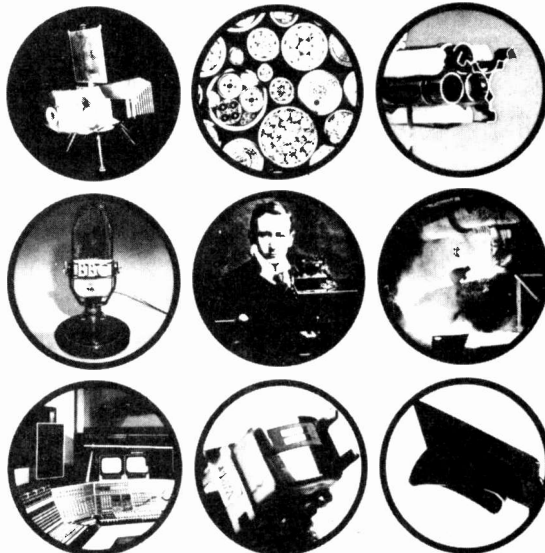
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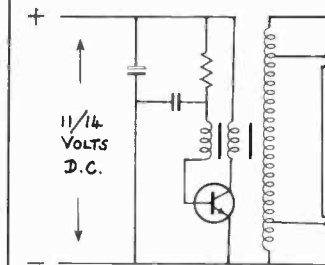
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IN4001	50V	1A	7p	OA90	5p	
IN4002	100V	1A	8p	OA91	5p	
IN4004	400V	1A	8p	OA202	7p	
IN4006	800V	1A	10p	IN4148	5p	
IN4007	1000V	1A	10p	BA114	8p	

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106F	50V	5A	55p
106D	200V	5A	80p

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2 1/2 x 5	28p
3 1/2 x 3 1/2	28p
3 1/2 x 5	34p
17 x 2 1/2	95p
17 x 3 1/2	130p
17 x 3 1/2 (plain)	86p
17 x 2 1/2 (plain)	51p
2 1/2 x 5 (plain)	19p
2 1/2 x 3 1/2 (plain)	15p
Pin insertion tool	62p
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Pkt. 50 pins	20p

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Standard screened	32p	2.5mm insulated	13p
Standard insulated	18p	3.5mm insulated	13p
Stereo screened	44p	3.5mm screened	22p
Standard socket	15p	2.5mm socket	14p
Stereo socket	22p	3.5mm socket	14p

## D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin	72p
Plug 12p, Socket 8p.	
4 way screened cable, 26p/metre.	
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£1.70  
9V mains power supply. Same size as PP9 battery.

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0.01 $\mu$ F	12p	0.047 $\mu$ F	16p	0.22 $\mu$ F	28p
0.022 $\mu$ F	14p	0.1 $\mu$ F	20p	0.47 $\mu$ F	36p

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The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector. Detector GDI £2. Smoke and Gas Detector Kits, mains operated with audible alarm £5.60. Mains operated Meter Indicator £7.90. Mains/Battery Gas Leak Detector £12.60. 12/24V Battery operated £8.40. 12V Battery operated Two Remote Sensors £12.80. NOTE: The battery operated kits incorporate our patented circuit to minimise battery drain. Typically 120mA for 12V. These kits contain all parts required with the exception of case. Suitable case mains operated kit £1.60. Battery operated kits £5.

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97p  
Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

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2" Scale-500 $\mu$ A, 1mA, 10mA, 100mA £3.30

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	Line Socket	22p		Line Plug	24p
3 Pin 3A	Chassis Plug	24p	3 Pin 3A	Chassis Socket	34p
	Line Socket	28p		Line Plug	40p
3 Pin 5A	Chassis Plug	24p	2 Pin 5A	Line Plug	20p
	Line Socket	32p			

## THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
VA1077	15p
RS3	£1.35

## ROTARY MAINS SWITCH

D.P. 2A 35p

## LINEAR IC's

709	14 pin DIL	40p
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723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	45p
DIL Sockets	14 pin and 16 pin	16p

## WAVECHANGE SWITCH 33p

1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

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**SAFETY MAINS ISOLATING TRANSFORMERS**  
Prim. 120/240V, Sec 120/240V Centre Tapped and Screened  
ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	P & P £ p
07	20	1 8	7.0 x 6.0 x 6.0	2.55 38
149	60	3 12	9.9 x 7.7 x 8.6	3.79 45
150	100	5 8	9.9 x 8.9 x 8.6	4.17 45
151	200	8 0	12.1 x 9.3 x 10.2	7.39 53
152	250	13 12	12.1 x 11.8 x 10.2	9.45 73
153	350	15 0	14.0 x 10.8 x 11.8	11.35 73
154	500	19 8	14.0 x 13.4 x 11.8	13.30 91
155	750	29 0	17.2 x 14.0 x 14.0	21.05 *
156	1000	36 0	17.2 x 16.6 x 14.0	27.20 *
158	2000	60 0	21.6 x 15.3 x 18.1	50.25 *

## AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	Auto Taps	P & P £ p
113	20	0	5.8 x 5.1 x 4.5	0-115-210-240	1.34 30
64	75	2 4	7.0 x 6.7 x 6.1	0-115-210-240	2.64 38
4	150	3 4	8.9 x 7.7 x 7.7	0-115-200-220-240	3.29 45
66	300	6 4	9.9 x 9.6 x 8.6	"	5.29 53
67	500	12 8	12.1 x 11.2 x 10.2	"	8.02 67
84	1000	19 8	14.0 x 13.4 x 14.3	"	13.50 91
93	1500	30 4	14.0 x 15.9 x 14.3	"	17.50 *
95	2000	32 0	17.2 x 15.4 x 14.0	"	25.35 *
73	3000	40 0	21.6 x 13.4 x 18.1	"	32.80 *

## CASED AUTO TRANSFORMERS

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Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Windings	P & P £ p
111	0.5	0 5	1 8	4.8 x 2.9 x 3.5 0-12V at 0.25A x 2	1.4 32
113	1.0	0 5	1 8	6.1 x 5.8 x 4.8 0-12V at 0.5A x 2	1.58 30
71	2	1 12	7.0 x 6.4 x 6.1	0-12V at 1A x 2	2.09 38
18	4	2 12	8.3 x 7.7 x 7.0	0-12V at 2A x 2	2.60 38
70	6	3 3	8.9 x 8.0 x 7.7	0-12V at 3A x 2	3.52 45
108	8	4 5	8.9 x 8.9 x 8.6	0-12V at 4A x 2	3.96 45
72	10	5 6	9.9 x 9.6 x 8.6	0-12V at 5A x 2	4.67 53
116	12	6 12	9.9 x 10.2 x 8.6	0-12V at 5A x 2	5.61 53
17	16	8 12	12.1 x 9.9 x 10.2	0-12V at 8A x 2	6.62 60
115	20	10 11	14.0 x 9.6 x 11.8	0-12V at 10A x 2	10.20 73
187	30	15 15	14.0 x 12.1 x 11.8	0-12V at 15A x 2	13.70 85
226	60	30 32	17.2 x 15.3 x 14.0	0-12V at 30A x 2	22.50 *

### 30 VOLT RANGE

Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
112	0.5	1 4	6.1 x 5.8 x 4.8	0-12-15-20-24-30V	1.58 30
79	1.0	2 4	7.0 x 6.7 x 6.1	"	2.18 38
3	2.0	3 4	8.9 x 7.7 x 7.7	"	3.18 38
20	3.0	4 8	9.9 x 8.3 x 8.6	"	4.12 45
21	4.0	6 4	9.9 x 9.6 x 8.6	"	4.67 53
51	5.0	6 12	12.1 x 8.6 x 10.2	"	5.83 53
117	6.0	8 0	12.1 x 9.3 x 10.2	"	6.94 60
88	8.0	12 0	12.1 x 11.8 x 10.2	"	9.00 67
89	10.0	13 12	14.0 x 10.2 x 11.8	"	9.80 73

### 50 VOLT RANGE

Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
102	0.5	1 12	7.0 x 6.4 x 6.1	0-19-25-33-40-50V	2.09 30
103	1.0	2 12	8.3 x 7.4 x 7.0	"	3.08 38
104	2.0	5 8	7.9 x 8.9 x 8.6	"	4.26 45
105	3.0	6 12	9.9 x 10.2 x 8.6	"	5.79 53
106	4.0	10 0	12.1 x 10.5 x 10.2	"	7.41 67
107	6.0	12 0	14.0 x 10.2 x 11.8	"	11.00 67
118	8.0	18 0	14.0 x 12.7 x 11.8	"	13.40 85
119	10.0	25 0	17.2 x 12.7 x 14.0	"	17.60 *

### 60 VOLT RANGE

Ref. No.	Amps	Weight lb oz	Size cm.	Secondary Taps	P & P £ p
124	0.5	2 4	7.0 x 6.7 x 6.1	0-24-30-40-48-60V	2.12 38
126	1.0	3 4	8.9 x 7.7 x 7.7	"	2.97 38
127	2.0	6 4	9.9 x 9.6 x 8.6	"	5.40 45
125	3.0	8 12	12.1 x 9.9 x 10.2	"	7.11 60
123	4.0	13 12	12.1 x 11.8 x 10.2	"	9.20 67
40	5.0	12 00	14.0 x 10.2 x 11.8	"	10.83 73
120	6.0	15 8	14.0 x 12.1 x 11.8	"	13.35 85
121	8.0	25 00	14.0 x 14.7 x 11.8	"	15.01 *
122	10.0	25 0	17.2 x 12.7 x 14.0	"	19.60 *
189	12.0	29 00	17.2 x 14.0 x 14.0	"	21.60 *

## MINIATURE TRANSFORMERS WITH SCREENS

Ref. No.	mA	Weight lb oz	Size cm.	Volts	P & P £ p
238	200	2	2.8 x 2.6 x 2.0	3-0-3	1.40 10
212	1A, 1A	1	6.1 x 5.8 x 4.8	0-6, 0-6	1.67 30
13	100	1	3.9 x 2.6 x 2.9	9-0-9	1.28 13
235	330, 330	4	4.8 x 2.9 x 3.5	0-9, 0-9	1.42 19
207	500, 500	1 00	6.1 x 5.4 x 4.8	0-8-9, 0-8-9	2.23 30
208	1A, 1A	1 12	7.0 x 6.4 x 6.1	0-8-9, 0-8-9	3.00 38
236	200, 200	4	4.8 x 2.9 x 3.5	0-15, 0-15	1.30 19
214	300, 300	1	6.1 x 5.8 x 4.8	0-20, 0-20	1.76 30
225	700 (d.c.)	1	7.0 x 6.1 x 6.1	20-12-0-12-20	1.98 38
206	1A, 1A	2	8.3 x 7.7 x 7.0	0-15-20, 0-15-20	3.78 38
203	500, 500	2	8.3 x 7.0 x 7.0	0-15-27, 0-15-27	3.06 38
204	1A, 1A	3	8.9 x 7.7 x 7.7	0-15-27, 0-15-27	3.27 38

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7410	0 20	7442	0 86	7485	1 65	72723	0 80	IN4006	0 09
7412	0 26	7445	1 60	7486	0 46	72741	0 30	IN4007	0 12
7413	0 38	7447	1 30	7489	4 95	72747	1 00	IN4148	0 05
7416	0 44	7450	0 20	7490	0 66	72748	0 36	OA47	0 07
7417	0 30	7451	0 20	7491	1 10	ZN414	1 25	OA90	0 06
7420	0 20	7453	0 20	7492	0 70	TA4350	2 18	OA91	0 06
7422	0 28	7454	0 20	7493	0 66	LM301B	0 75	OA200	0 06
7425	0 38	7460	0 20	7494	0 90	CA3046	0 70	OA202	0 09
7427	0 45	7470	0 34	7495	0 82	CA3036	1 00	IN916	0 06
7428	0 45	7472	0 34	7496	0 99	CA3028	1 20	BB105	0 45
7430	0 20	7473	0 45	74100	2 20	CA3090C	4 50	IS44	0 05
7432	0 45	7474	0 42	74141	0 99	NE555	0 85	TIL209	0 27
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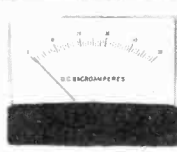
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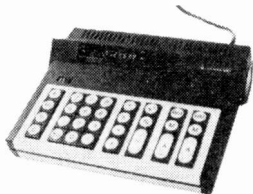
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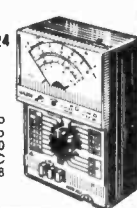
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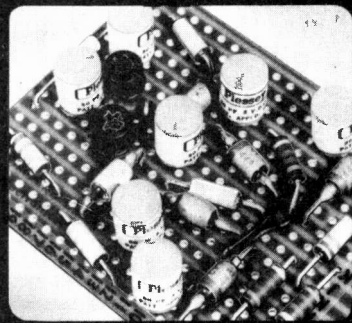
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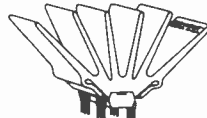
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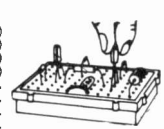
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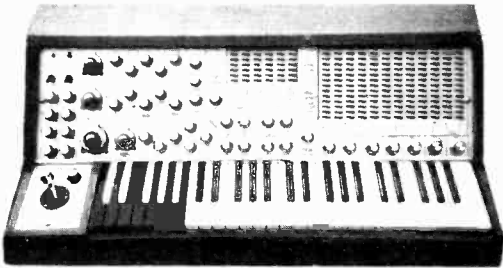


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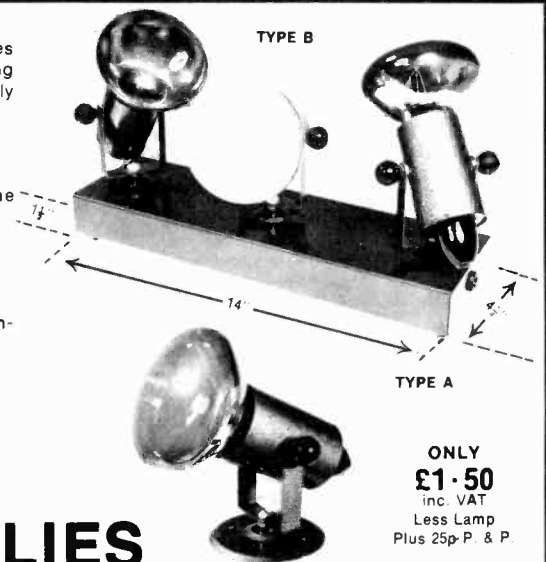
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AD187	33p	BC216	11p	BF187	11p	MJE533	80p	2N2232	20p	2N3881	70p
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AD201	33p	BC230	11p	BF201	11p	MJE547	80p	2N2246	20p	2N3895	70p
AD202	33p	BC231	11p	BF202	11p	MJE548	80p	2N2247	20p	2N3896	70p
AD203	33p	BC232	11p	BF203	11p	MJE549	80p	2N2248	20p	2N3897	70p
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AD207	33p	BC236	11p	BF207	11p	MJE553	80p	2N2252	20p	2N3901	70p
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AD249	33p	BC278	11p	BF249	11p	MJE595	80p	2N2294	20p	2N3943	70p
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ZTX303	15p	2N2906	18p	2N4071	35p
ZTX304	20p	2N2909	18p	2N4072	35p
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ZTX501	15p	2N2926YG	8p	2N4548	35p
ZTX502	18p	2N3053	18p	2N4553	40p
ZTX503	45p	2N3054	45p	3N140	100p
ZTX504	20p	2N3055	40p	3N141	80p
ZTX505	20p	2N3441	80p	40360	35p
ZTX506	20p	2N3442	120p	40381	35p
ZTX507	11p	2N3525	80p	40382	38p
ZTX508	12p	2N3702	31p	40409	50p
ZTX509	12p	2N3703	11p	40410	50p
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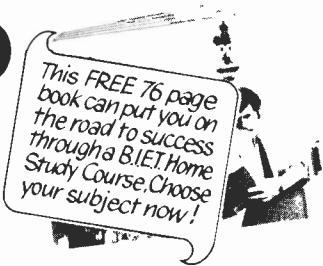
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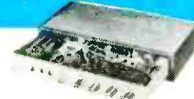
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