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JAN. 74

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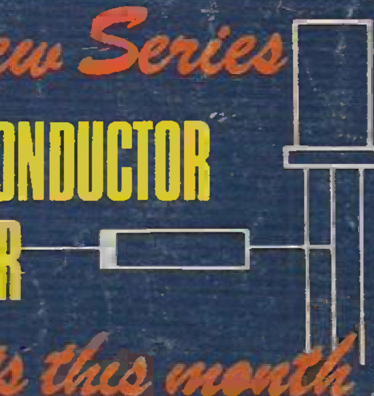

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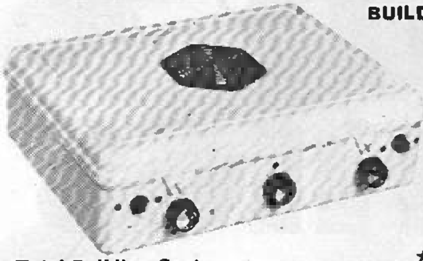

★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester NPN-PNP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 5 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal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

★ 24 Resistors ★ 21 Capacitors ★ 10 Transistors ★3½ loudspeaker ★ 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 ★ 6½ yards of wire ★ 1 yard of sleeving, etc. ★Parts price list and plans 50p (FREE with parts).

Total Building Costs £7·23 P P & Ins. 44p. (Overseas P & P £1·85p.)
(+ 10% VAT 72p)

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 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9½" × 7" × 2½" approx. Parts Price list and Plans 30p (FREE with parts)

Total Building Costs £6·95 P P & Ins. 44p. (Overseas P & P £1·85p)
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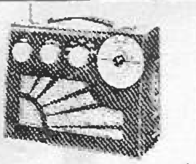
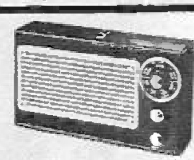
ROAMER TEN



with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers. 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car Aerial and Tape Recording Sockets. 10 Transistors plus 3 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs £8·50 P. P. & Ins. 52p (Overseas P. & P. £1·85)
(+ 10% VAT 85p)

NEW EVERYDAY SERIES



Build this exciting New series of designs

E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" × 5½" × 2½" approx.
Parts price list and Plans 15p. Free with parts.

Total Building Costs £2·73 P P & Ins. 30p (Overseas P & P £1·25p)
(+ 10% VAT 27p)

E.V. 6 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 (Overseas P & P £1·25p)
(+ 10% VAT 36p)

E.V. 7 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 (Overseas P & P £1·85)
(+ 10% VAT 40p)

"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 3" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: 2 Plugs and Sockets: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ½" 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).

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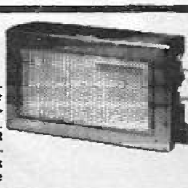
(+ 10% VAT 55p)

POCKET FIVE

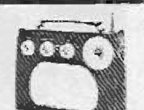


3 Tunable wavebands. M.W./L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5½" × 1¼" × 3½" approx. Plans and parts price list 15p. (Free with parts).

Total Building Costs £2·28 P P & Ins. 26p (Overseas P & P 1·25p)
(+ 10% VAT 22p)

ROAMER EIGHT Mk 1

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. Retractable chrome plated Telescopic aerial for Short Waves. 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 Loudspeakers. 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 × 7 × 4in. 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 (Overseas P. & P. £1·85)
(+ 10% VAT 69p)

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).

Total Building Costs £2·50 P P & Ins. 26p (Overseas P & P 1·25p)
(+ 10% VAT 25p)

ROAMER SIX

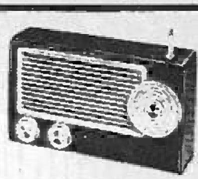
Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs £3·98 P P & Ins. 31p (Overseas P. & P. £1·85)
+ 10% VAT 39p)

TRANS EIGHT

8 TRANSISTORS and 3 DIODES



6 Tunable Wavebands; MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. 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 × 5½ × 2½in. 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).

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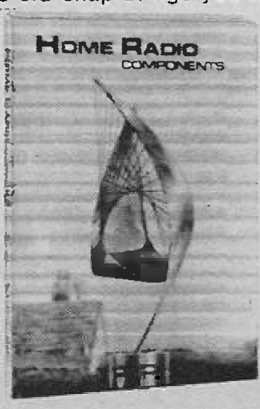

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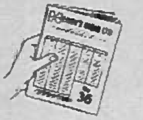

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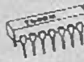
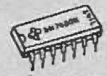

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SN7407N	0·40	0·38	0·35	SN7475N	0·59	0·55	0·51	SN74157N	1·09	1·09	0·95
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SN7409AN	0·44	0·44	0·38	SN7481N	1·25	1·10	0·95	SN74161N	1·58	1·58	1·38
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SN7420N	0·20	0·18	0·16	SN7493N	0·75	0·70	0·68	SN74173N	1·66	1·66	1·45
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SN7428N	0·43	0·43	0·37	SN74105N	0·60	0·53	0·45	SN74181N	5·18	5·18	4·53
SN7430N	0·20	0·18	0·16	SN74107N	0·51	0·51	0·45	SN74182N	1·44	1·44	1·26
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BAX13	5p	BFY51	20p	OA202	10p	TIL209	25p	2N3053	20p	40362	40p
BC107	12p	BFY64	45p	OC16	85p	TIP29A	49p	2N3054	45p	40408	50p
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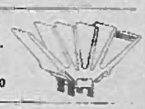

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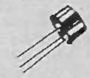
ZN414 IC



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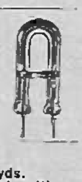

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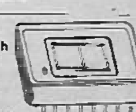
TA960 IC with socket £1·80

3015F 7 SEG.



I.C. size complete with data price £2 each or 4 for £7 (digital clock circuits ref. No. 31, 15p)

TRANSISTORS SPECIAL OFFER

2N3055
25 ......47p ea
100 ......42p
500 ......39p
1000 ......34p

AF117
25 ......15p ea
100 ......13p
500 ......12p
1000 ......10p

BY127
25 ......12p ea
100 ......10p
500 ...... 9p
1000 ...... 8p

OC35
25 ......46p ea
100 ......42p
500 ......38p
1000 ......34p

ZENER DIODES

400 m/w BZY88/BZX83. From 3·3 volt – 33 volts 10p each

1·3 watts 5% Miniature Tubulars IN4700 series. From 3·3 volt – 33 volt 18p each.

10 watts. Stnd Mounting. ZS series 6·8 volts – 100 volts 5% 40p each.

LINEAR I.C.

702C (T05)	75p
709C (T05)	39p
709C (D.I.L.)	39p
723C (T099)	90p
723C (D.I.L.)	90p
728C (D.I.L.)	45p
728C (T099)	45p
741C (T05)	50p
741C (D.I.L.)	50p
747C (T099)	£1·0p
748C (O.I.L.)	61p

SILICON RECTIFIERS

1 amp series IN4001 to IN4007 From 6p ea
1·5 amp PL4001 to PL4007 From 8p ea
3 amp PL7001/IN5400 From 14p ea
Send for full list 36

MORE OF EVERYTHING AT HENRY'S

See pages 7 & 8, and Back Cover of this magazine.

BEST VALUE

Semi-Conductor QUANTITY DISCOUNTS

10% 12—, 15% 25+, 20% 100+

Any one type except where quantity discounts shown.

Min. order £1·00 please.

TRIACS – Stnd. mounting with accessories

3Amp T048

Type	P.I.V.	1–11 Price ea.
3 AMP RANGE		
SC35A	100v	80p
SC35B	200v	85p
SC35D	400v	90p
SC35E	500v	£1·20
6 AMP RANGE		
SC40A	100v	90p
SC40B	200v	95p
SC40D	400v	£1·20
SC40E	500v	£1·50
10 AMP RANGE		
SC45A	100v	£1·05
SC45B	200v	£1·15
SC45D	400v	£1·45
SC45E	500v	£1·85
15 AMP RANGE		
SC50A	100v	£1·45
SC50B	200v	£1·65
SC50D	400v	£1·95
SC50E	500v	£2·25

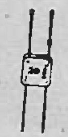
TRIACS – Additional Types
40430 TRIAC (T066) 85p
40669 TRIAC (Plastic) 90p
40486 TRIAC (T05) 75p

NEW RANGES BRIDGE RECTIFIERS

FEATURES SMALL SIZE AND LOW COST Sizes. are approx.

250M/A QUARTER AMP
B025/05 50 PIV 16p
B025/10 100 PIV 18p
¼ x ¼ x ¼" dia.

½ AMP 1-11 Pricing



Type	P.I.V.	Price ea.
B05/05	50v	20p
B05/10	100v	22p
B05/20	200v	23p
B05/40	400v	25p
B05/60	600v	27p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	28p
B1/60	600v	30p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

W005	50v	29p
W01	100v	30p
W02	200v	32p
W06	600v	35p

⅜ x ⅜" Tubular

2 AMPS P.I.V.

B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
B2/100	1000v	55p

½H x ½L x 3/16" dia.

4 AMPS P.I.V.

B4/100	100v	55p
B4/200	200v	59p
B4/400	400v	65p
B4/600	600v	75p
B4/800	800v	£1·00

½H x ½L x 3/16" dia.

6 AMPS P.I.V.

B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/6x0	600v	£1·00

½H x ½L x 3/16" dia.

SILICON CONTROLLED RECTIFIERS

Type	P.I.V	1–11
ONE AMP (T05)		
CRS 1/05AF	50v	30p
CRS 1/10AF	100v	30p
CRS 1/20AF	200v	35p
CRS 1/40AF	400v	45p
CRS 1/60AF	600v	55p
THREE AMP (T048)		
CRS 3/05AF	50v	40p
CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
FIVE AMP		
CRS 5/400	400v	60p
SEVEN AMP (T048)		
CRS 7/100	100v	60p
CRS 7/200	200v	67p
CRS 7/400	400v	85p
CRS 7/600	600v	95p

All types offered subject to availabilty. Prices correct at time of press E. & O. E. 10% VAT to be added to all orders. UK post, etc, 15p. per order.

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EDGWARE ROAD, W2

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354-356 High Fidelity and Tape Equipment 01-402 5854/4736
309 PA-Disco-Lighting High Power Sound 01-723 6963
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IRONS · TOOLS · VALVES · POT CORES MOST TYPES OF COMPONENTS
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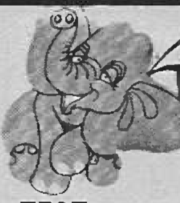
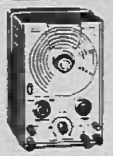


UK's LARGEST RANGE OF KITS & GADGETS

TEST EQUIPMENT



MULTIMETERS

(carr. etc. 30p)

M210	20K/Volt Slimline	6·75
TLH33D	2K/Volt Robust	7·50
U437	10K/Volt Steel case. AC up to 40 KHz	4·95
U4324	20K/Volt with AC current ranges	8·00
AF105	50K/Volt	11·95
U4313	20K/Volt AC current. Steel case	10·50
U4341	Plus Built in transistor tester	10·50
Model 500	30K/Volt	9·95

OTHER EQUIPMENT

SE250B	Pocket Signal Injector	2·10 carr. 15p
SE500	Pocket Signal Tracer	1·70 carr. 15p
TE15	Grid Dip meter 440kHz–280mHz	15·00 carr. 30p
TE40	AC Millivoltmeter 1·2mHz	18·95 carr. 35p
TE65	28 Range valve voltmeter	19·95 carr. 40p
TE20D	120kHz–500mHz RF Generator	17·95 carr. 40p
TE22D	20Hz–200kHz Audio Generator	18·95 carr. 40p
SE350A	Deluxe Signal Tracer	12·50 carr. 20p
SE400	Volts/ohms/R-C sub./RF field/RF gen.	14·75 carr. 20p

New Revolutionary Supertester 680R

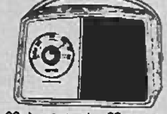
680R Multi-tester
£18·50

Accessories	
Transistor tester	11·00
Electronic voltmeter	18·00
Ampclamp	11·95
Temperature probe	11·95
Guass meter	11·95
Signal Injector	5·95
Phase Sequence	5·95
EHT Probe	5·95
Shunts 25/50/100A	4·50 each

A SELECTION OF INTERESTING ITEMS

C3025	Compact transistor tester	5·50 p & p 15p
E1300	Mono mag. cart. preamp.	1·95 p & p 15p
E1310	Stereo mag. cart. preamp.	4·95 p & p 25p
	Easiphone telephone amplifier	6·15 p & p 25p
D1203	Teleamp. with PU coil	3·60 p & p 20p
LL1	Door Intercomm. and chime	11·95 p & p 25p
	Chattalite (lights as you talk)	13·90 p & p 20p
	1 Kw, Dimmer/controller	3·00 p & p 10p
	9" Twin spring unit For Reverbs	2·75 p & p 15p
	16" Twin spring unit For Reverbs	6·50 p & p 25p
	Car Tachometer Electronic	7·50 p & p 15p
	VHF 105 Aircraft Band Corrector	3·95 p & p 15p
B2005	4 Ch. mic. mixer	2·95 p & p 15p
B2004	2 ch. Stereo mixer	4·75 p & p 15p

BUILD THIS RADIO



Portable MW / LW radio kit using Mullard RF/IF module. Features MW — bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts £7·98 (battery 22p), carr. etc. 32p.

EXCLUSIVE: SPECIAL OFFERS

MW/LW CAR RADIO
+ or — Earth with speaker and fixings. £6·50 carr./packg. 30p.

8 TRACK CAR STEREO
(— Earth) with speakers in Pods & fixings. £12·50 carr/packg. 40p.

HANIMAX HC1000
Battery cassette recorder. £10·50 carr/packg. 25p.

HANIMAX HC2000
Battery/Mains cassette recorder. £13·50 carr/packg. 30p

AKAI GXC40
Stereo cassette recorder. £59·95 carr/packg. 50p.
Pair Akai ADM microphones. £6·95 carr/packg. 20p.

5 WAVEBAND PORTABLE TWIN SPEAKER RADIO.
FM/MW/SW/AIRCRAFT—PUBLIC SERVICES. £10·45 carr/packg. 30p.

PORTABLE CASSETTE TAPE PLAYER—
for car or carry around. £7·25 carr/packg. 20p.

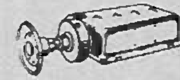
HANIMAX BC808 POCKET CALCULATOR WITH % KEY. £28·95.

SPECIAL PURCHASES

AVOMETER MOVEMENTS

AVO 8 or 9 50mA MOVEMENTS. Ex Brand New AVO's £3·50 Post 20p.

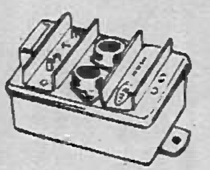
UHF TV TUNERS CHANNELS 21 TO 64



Brand new transistorised geared tuners for 625 Line Receiver IF output. £2·50, Post 20p.

EASY TO BUILD KITS BY AMTRON—EVERYTHING SUPPLIED

Model No.		
310	Radio control receiver	2·98
300	4-channel R/C transmitter	5·95
345	Superhet R/C receiver	5·95
455	AM signal generator	12·33
65	Simple transistor tester	1·40
115	8 watt Amplifier	3·90
120	12 watt amplifier	4·70
125	Stereo control unit	5·70
130	Mono control unit	3·60
605	Power supply for 115	4·55
610	Power supply for 120	4·55
615	Power supply for 2 x 120	5·73
230	AM/FM aerial amplifier	2·93
240	Auto packing light	5·90
275	Mic. preamplifier	6·08
570	LF generator 10Hz–1mHz	15·80
575	Sq. wave generator 20Hz–20Khz	14·60
590	SWR meter	12·85
620	NI-CAD Charger 1·2–12v	8·00
630	STAB Power supply 6-12v 0·25-0·1A	8·15
690	DC motor speed Gov.	2·87
700	Electronic Chaffinch	7·00
705	Windscreen wiper timer	6·80
760	Acoustic switch	10·75
780	Metal Detector (electronics only)	9·65
790	Capacitive Burglar alarm	6·85
835	Guitar preamp.	4·25
840	Delay car alarm	6·15
875	CAP. Discharge ignition for car engine (–Ve Earth)	13·15
80	Scope Calibrator	2·25
255	Level indicator	6·15
525	120–160mHz VHF timer	11·30
715	Photo cell switch	7·70
795	Electronic continuity tester	4·30
860	Photo timer	13·25
871	Slide projector auto feed control	7·15
235	Acoustic Alarm for driver	7·60
465	Quartz XTAL checker	8·75
220	Signal Injector	2·30
390	VOX	15·50
432	Testakit	19·30
670	Buffer Battery Charger	6·55
885	Capacitive Contact Alarm	6·25
850	Electronic Keyer	18·75
820	Electronic Digital Clock	58·50



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

BUILD THIS TUNER

MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2¾" x 3½". All parts £4·85, carr. 15p.

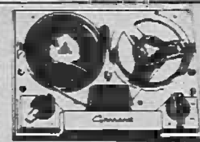
MULTI-USE & RADIONIC KITS

10–1	10 Projects	3·60
50–1	10 Projects	8·00
150–1	150 Projects	13·20
Telephone Communicator		7·20
X20	20 (Elec.) Projects	4·95
X40	40 (radio) Projects	9·45

(carr./packing 40p)

All transistor circuits with hand books

All types offered subject to availability. Prices correct at time of press E & OE. 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.



GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits.
£9·50 carr. 30p

TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity).

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. 45p each.

Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 65p each. (Quantity discounts available)

Complete with knobs.

MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO
'17' High Impedance £2·00
'18' Med. Impedance £2·00
R730/E73 2 track mono Record/Erase low imp. 75p pair.
Erase Heads for '17' and '18' 75p
'63' 2 track mono, Hi Imp. £1·75
'43' Erase Head for '63' 75p
(Post. etc. 15p any quantity).

SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER

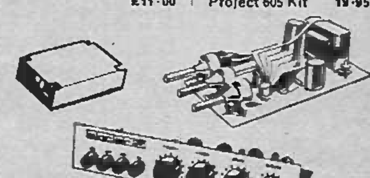
AMPLIFIERS (carr., etc. 20p)

4-300, 0·3 watt 9 volt	1·75
104, 1 watt 9 volt	2·20
304, 3watt 9 volt	2·50
555, 3 watt 12 volt	2·85
E1208, 5 watt 12 volt	4·50
608, 10 watt 24 volt	4·10
410, 10 watt 28 volt	4·95
Z30, 15 watt 30 volt	3·57
E1206, 30 watt 45 volt	9·75
Z50, 30 watt 50 volt	4·37
E1210, 2½ + 2½ watts 12 volt	5·25
RE500, 5 watt IC mains operated Amplifier with controls	£6·30
SAC14, 7 + 7 watt Stereo with controls	£8·00
SAC13, 15 + 15 watt Stereo with controls	£11·00

SINCLAIR (carr. 20p)
PROJECT 60
Z30 3·57 Z50 4·37
Stereo 60 Preamp. 7·97
PZ5 £3·97, PZ6 £8·37
PZ8 (for Z50) £4·77 (TRANS £2·95)
AFU £4·45

New SINCLAIR PROJECT 80

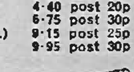
Stereo Preamp.	11·95
Audio Filter Unit	6·95
Z40 15 Watt Amp.	5·45
Z60 25 Watt Amp.	6·95
PZ5 Mod. for 1 on 2 Z40	4·98
PZ6 Mod. (S Tab) 1 on 2 Z40	7·98
PZ8 Mod. (S Tab) 1 on 2 Z60	7·98
TRANSFORMER FOR PZ8	2·95
Project 605 Kit	19·95



POWER SUPPLIES FOR EVERY PURPOSE

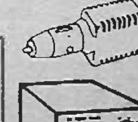
(All cased unless stated chassis)

470C 6/7½/9 volt 300 MA (Includes Multi-Adaptor for Tape Recorders, etc.)	1·95 post 20p
Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7½v, 9v)	1·95 ea. post 25p
SC202 3/6/7½/9 volt 400mA	3·25 carr. 30p
HC244R Stabilised version	4·25 carr. 30p
P500 9 volt 500mA	2·90 post 20p
P11 24 volt 500mA (chassis)	2·90 post 20p
P15 26/28 volt 1 amp (chassis)	2·90 post 20p
P1080 12v 1 amp (chassis)	3·25 post 20p
P1081 45v 0·9 amp (chassis)	4·40 post 20p
P12 4½–12 volt 0·4–1 amp	6·75 post 30p
SE101A 3/6/9/12 volt 1 amp (Stab.)	9·15 post 25p
RP164 6/7½/9/12 1 amp (Stab.)	9·95 post 30p



FIBRE OPTICS

0·01 Diam. Mono Filament £1·50 per 25 metre reel
0·13 Diam. 64 Fibres Sheathed. £1·00 per metre
SPRAYS 15mm Diam. Mares Tails £9·50.



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STEREO AMPLIFIERS
(carr./packing 50p)

AKAI	AA5200	61·70
	AA5500	78·50
	AA5800	117·50
AMSTRAD	1C2000 Mk. II	29·50
	4000 Mk II	23·95
EAGLE	TSA149	25·10
	TSA151	34·85
	AA2	30·80
	AA4	42·45
	AA6	55·95
HOWLAND WEST	DA1000	22·45
HENELEC TEXAN	Kit	28·50
HENELEC TEXAN	Built	35·00
NIKKO	TRM300	25·95
	TRM400	32·50
PIONEER	SA500A	34·25
ROTEL	RA 211	32·65
	RA311	41·15
	RA611	60·80
	RA810	75·75
	RA1210	92·50
SINCLAIR	2000	22·95
	3000	28·95
TANDBERG	TA300	68·60
TELETON	SAQ206B	22·50
	SAQ307	22·50
	GA202	28·50

STEREO RADIO TUNERS
(carr./packing 50p)

AKAI	AT550	60·50
	AT580	94·50
AMSTRAD	3000	23·55
EAGLE	AA8	40·50
	TST152	29·45
HENELEC Stereo Kit		21·00
HENELEC Stereo Built		24·95
HOWLAND WEST	DA1000T	25·35
PIONEER	TX500A	48·75
ROTEL	RT222	32·65
	RT322	43·75
	RT622	65·40
SINCLAIR	2000	26·95
	3000	26·95
TELETON	GT202	30·50

DECODERS / SYNTHESIZERS (carr. etc. 30p)

DYNACO QUADRATOR		16·90
EAGLE	AA10	12·00
	AA26	16·35
TATE 1	Chassis	7·95
TATE 3	Chassis	15·75
TATE 4	Chassis	19·95
TATE 7	Boxed	25·95

MATCHED SPEAKER SYSTEMS
Recommended pairs 8 ohms (Carr. / Packing £1·50 pair)

RANK DOMUS		
150		26·95 pr.
175		33·75 pr.
250		53·75 pr.
MARSDEN HALL		
110	10 watt	22·50 pr.
150	15 watt	27·50 pr.
200	20 watt	34·50 pr.
DYNACO		
A10	20-60 watts	43·00 pr.
A25	20-60 watts	69·00 pr.
A35	20-60 watts	79·00 pr.
WHARFEDALE		
Denton 2	18 watt	27·20 pr.
Linton 2	20 watt	32·65 pr.
Melton II	25 watts	51·80 pr.
Triton	25 watt	40·80 pr.
LEAK		
150	18 watt	32·65 pr.
250	18 watt	44·30 pr.
CELESTION		
120	20 watt	37·80 pr.
COUNTY	25 watt	33·60 pr.
15	30 watt	50·40 pr.
44	44 watt	81·20 pr.

UK's largest stockists for KEF Acoustic Research, Mordaunt Short & Cambridge Audio speakers. In stock and on demonstration. Phone for keenest price.

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Amerex	100	11·00
Wien	ET1008	11·00
Philips	EL3302	14·40
	N2203	16·60
	N2211	19·95
Sanyo	M1101	14·65
	M1102	12·95

STEREO MAGNETIC CARTRIDGES (carr. etc. 15p)

SHURE		M44G	4·20
M3Dm	3·20	M75/6/11B	6·75
M44.7	3·95	M75 EDII	8·50
M44E	4·25	M75 EJII	7·95
M55E	4·95	M75GII	7·25
GOLDRING			
G850	2·85	G800SE	10·00
G800	3·95	G820	6·70
G800H	3·95	G820E	10·00
G800E	5·95	G820SE	13·35
ADC			
Q36	10·70	Q30	5·90
Q32	8·70		
GRADO			
FTR	5·25	FTE	8·25
F3E	11·25	F2	18·75
EMPIRE		999TEX	14·95
		999REX	3·70
		999QUX	4·80
		999XEX	8·50
RONETTE		SM500/7	4·60
		SM500/5	4·60
		SM500/E	6·95

STEREO COMPACTS
Complete with Speakers (c./p. £1·25)

Fidelity	UA3	39·90
Sanyo	G2601KL	125·50
Sanyo	G2615N	71·50
Sanyo	GXT4520KL	103·50
Sanyo	GXT4730KL	97·50
Philips	GF908	102·75
Philips	RH802	159·95
Philips	RF836	57·20
Philips	GF826	41·75
Philips	RH811/RH421	84·95
Philips	RF839	55·95
Philips	GF829	39·95
Philips	GF815	47·75
Philips	GF808	65·75
Philips	RH814/RH411	96·75
Philips	GF603	19·95

8 TRACK STEREO HOME UNITS (carr/packing 70p)

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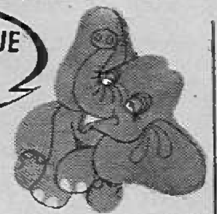

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* Four operators (+, —, x, ÷), with constant on all four.
* Constant acts as last entry in a calculation.
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* Operates for weeks on four U16-type batteries. (MN 2400 recommended.)

everyday electronics

PROJECTS... THEORY....

NATURAL RESOURCES

The energy crisis has tempered the fulsome spending traditionally indulged in at this time of year. By strange irony, during the Christmas run-up period we have been compelled to think in terms of economising with our use of natural resources.

In view of this rather alarming picture of shortages, real or impending, it is salutary to look at electronics. Considering the great contribution this technology makes in all areas of human affairs, the demands upon natural resources directly arising from the electronics industry are meagre in the extreme. Maybe it is significant in some sort of way that the heart of the normal electronics circuit is made of silicon—the most abundant element in the earth.

COMPONENT SHORTAGE

Yet, currently, shortages are being experienced in the field of electronic components, as elsewhere. But such shortages seem to arise mainly because of the overtaxing of production facilities rather than from any real shortage of basic raw materials.

Electronics is a science based industry, and highly advanced and elegant processes are necessary to transform base materials into components such as transistors and integrated circuits. The available skills and technical resources are often stretched to the limit by the increasing demands imposed by the world wide expansion in electronics in general. So inevitably shortages in particular lines occur from time to time. And this brings us to a particular case directly affecting EVERYDAY ELECTRONICS readers which has recently come to light.

DISINTEGRATION

The *Four-Band T.R.F. Receiver* described in the November issue uses an integrated circuit as audio amplifier. This i.c. is a highly efficient device, and is capable of being used in many different applications. Not surprisingly therefore, it has become exceedingly popular and the demand at present exceeds supply. No doubt within a short time (perhaps even before these words appear in print) an adequate supply will once again be in circulation.

But if not, all is not lost. The Four-Band Receiver can be completed by substituting a "handmade" amplifier for the i.c. originally specified. Full details are given this month.

From i.c.'s to discretes—does this seem a move against the tide? We don't think so. Actually it is a matter of belt *and* braces. In this day of increasing integration it is a wise constructor who knows his discretes! In cases such as the one mentioned the constructor can be independent, roll his own, and forget that waiting queue.

Here's wishing all our readers a happy and shortage-free New Year.

Fred Bennett.

Our February issue will be published on Friday, January 18

Everyday Electronics, Fleetway House, Farringdon Street, London, E.C.4. Phone: *Editorial* 01-634-4452; *Advertisements* 01-634-4202.

..EASY TO CONSTRUCT
..SIMPLY EXPLAINED

VOL. 3 NO. 1 JANUARY 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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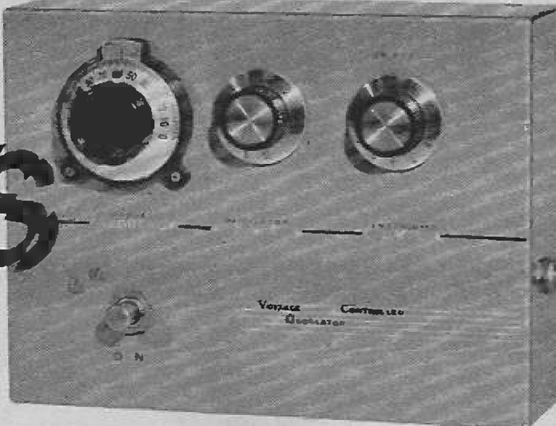
For more details see page 49

VCO EFFECTS UNIT



BY C. EVANS

Add weird effects to drum solos or use this unit as an instrument or warning device on its own.

THIS unit has been designed to fulfill a number of requirements, the major one being a musical effects unit for use with most instruments. The unit is basically an audio preamplifier, a voltage controlled oscillator and a mixing network (Fig. 1).

If a guitar, organ, microphone or an oscillator is plugged into the a.c. input the output frequency will vary with the loudness of the input signal; at the same time the input signal can be mixed with the output. Using a microphone to pick up the sound of a drum kit the mixed output of drums and oscillator adds a new dimension to the basic sound. The unit can be easily turned on and off with a foot switch which allows the input to pass to the amplifier but disconnects the oscillator.

OSCILLATOR CIRCUIT

The circuit is basically a wide range audio oscillator. The oscillator overcomes two main problems found with other circuits:

1. It has a wide frequency range.
2. Power supply requirements are very simple.

The range of the oscillator covers approximately 10Hz to 10kHz, the output is a square wave.

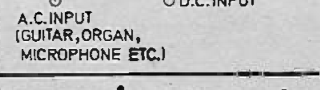
The unit has two inputs, the d.c. input is used with potentiometers, l.d.r.s. etc. to control the oscillator and the a.c. input, which is used to control the oscillator from audio signals see Fig. 1.

CIRCUIT DESCRIPTION

The oscillator part of the circuit comprises TR5 and TR6 operating as a relaxation oscillator (Fig. 2). Usually, in a relaxation oscillator circuit C6 would be grounded to the negative supply line. In this circuit C6 is taken to the emitter of TR6 thereby increasing the frequency range. The overall frequency range is controlled by VR3, which also controls the mark to space ratio of the oscillator. The range may vary considerably with different makes of capacitors for C6 so to ensure the widest frequency range, various types of capacitors can be tried for C6.

Transistor TR4 acts as a voltage controlled

Fig. 1. Block diagram of the V.C.O. Effects Unit.



Approximate cost of components including V.A.T.

£3.80 plus case

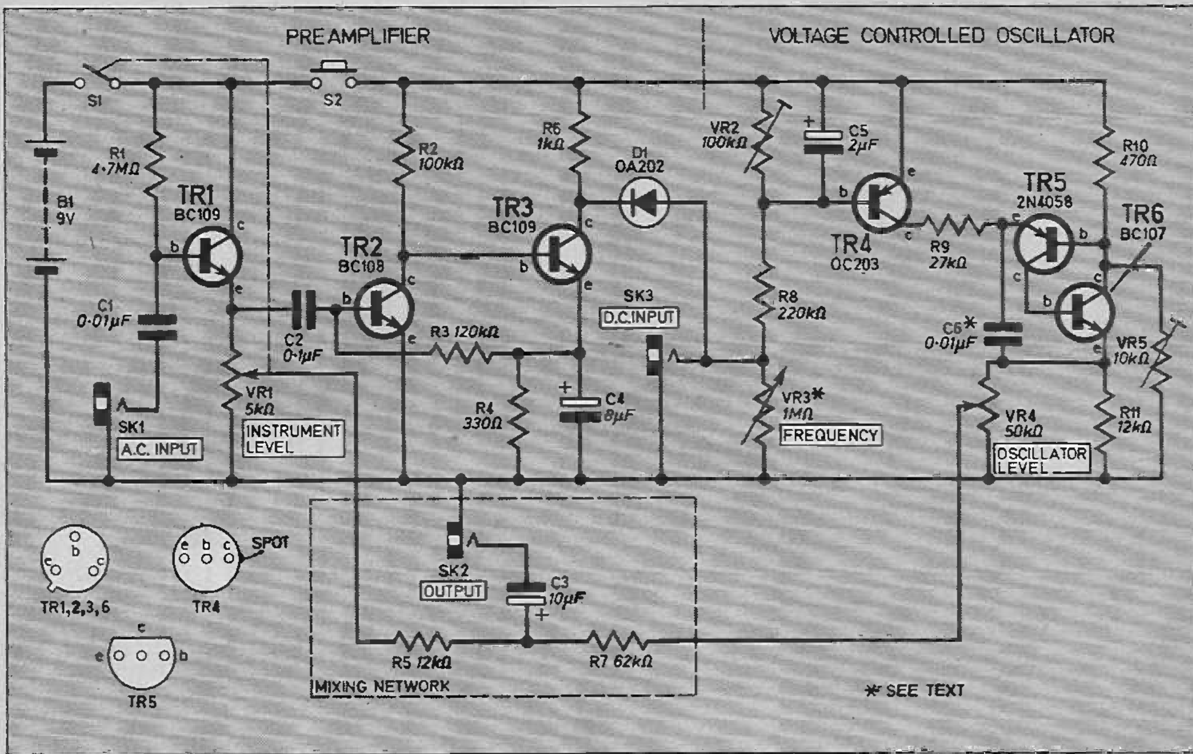


Fig. 2. Complete circuit diagram of the V.C.O. Effects Unit.

resistance between the supply and the emitter of TR5. Trimmer VR2, the bias resistor for TR4, is necessary because of differences in transistor gain, it is set for the lowest frequency required. The control voltage is fed to the base of TR4 via R8. The d.c. input jack SK3 and manual frequency control VR3 are also connected to R8. The output is taken from TR6 emitter via VR4, R7, C3 to the output jack SK2.

A.C. PREAMPLIFIER

Audio signals are fed through C1 to the base of emitter-follower TR1. The signal is then amplified by TR2 and TR3, some distortion occurs in these stages but since the signal is only used to control the oscillator this is not important. The output is taken from TR3 collector and rectified by D1. It is then fed to

Components....

Resistors

R1	4·7MΩ	R6	1kΩ
R2	100kΩ	R7	62kΩ
R3	120kΩ	R8	220kΩ
R4	330Ω	R9	27kΩ
R5	12kΩ	R10	470Ω
All ±10% ¼W carbon		R11	12kΩ

SEE SHOP TALK

Potentiometer

VR1 5kΩ log. with ganged switch
VR2 100kΩ skeleton preset
VR3 1MΩ lin. carbon (or 2MΩ see text)
VR4 50kΩ lin. carbon
VR5 10kΩ skeleton preset

Capacitors

C1 0·01μF
C2 0·1μF
C3 10μF elect. 12V
C4 8μF elect. 12V
C5 2μF elect. 12V
C6 0·01μF

Semiconductors

D1 OA202 or similar silicon diode
TR1 BC109 silicon *npn*
TR2 BC108 silicon *npn*
TR3 BC109 silicon *npn*
TR4 OC203 silicon *pnp*
TR5 2N4058 silicon *pnp*
TR6 BC107 silicon *npn*

Miscellaneous

B1 9V PP6 battery and clips
SK1, 2, 3 jack sockets (3 off)
S2 s.p.s.t. foot switch
Vernier dial for VR3 (if required), knobs, Veroboard 0·15 inch matrix 25 holes x 17 strips, 4BA fixings, case (see text) connecting wire and screened lead

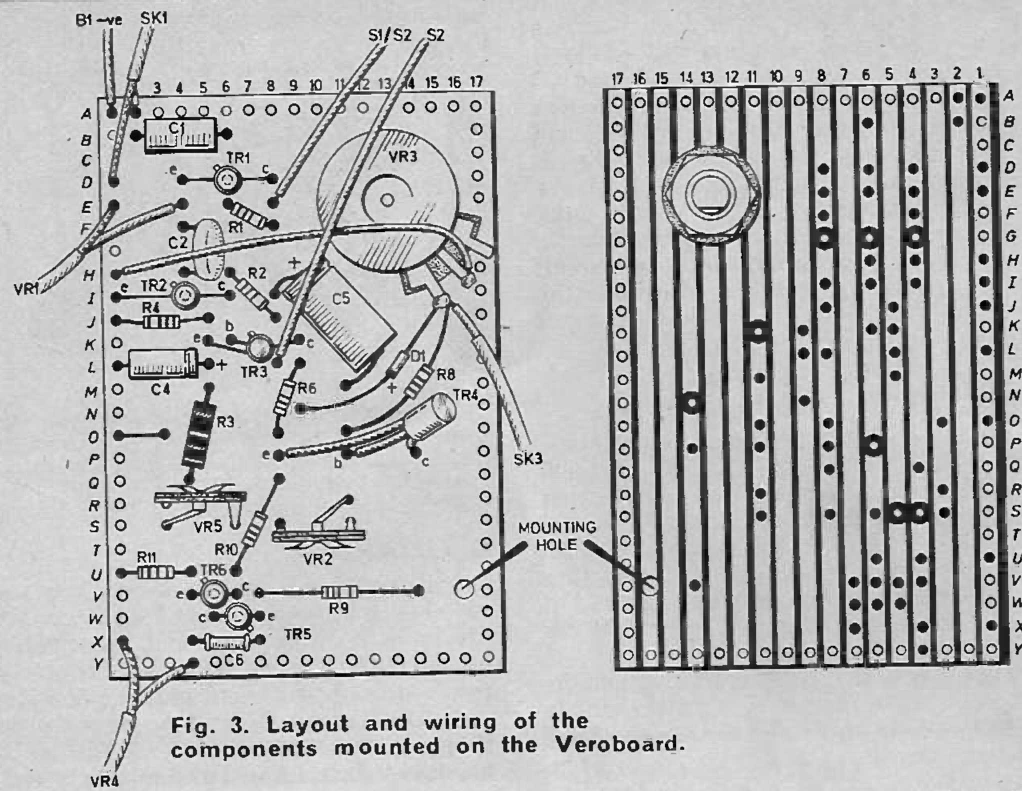


Fig. 3. Layout and wiring of the components mounted on the Veroboard.

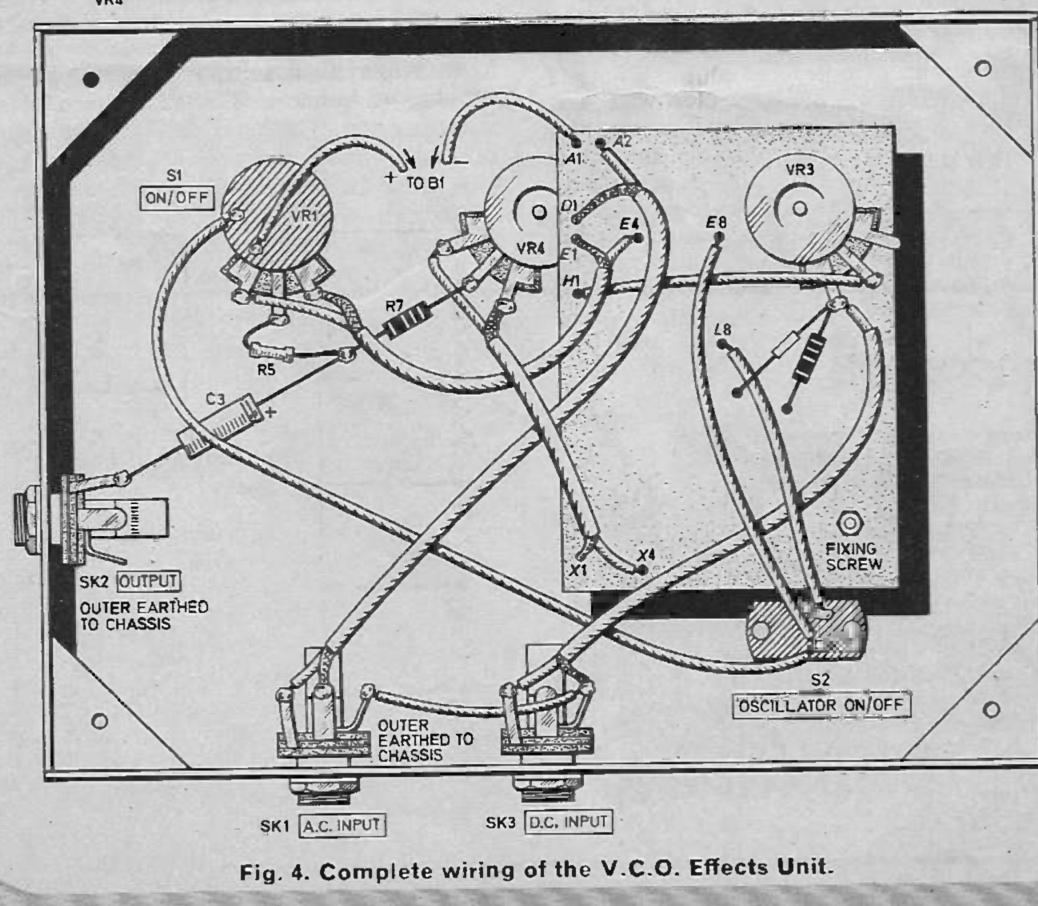


Fig. 4. Complete wiring of the V.C.O. Effects Unit.

TR4 base via R8, C5 filters out any a.c. reaching the base of TR4. The input signal and oscillator signal are mixed via VR1, R5, VR4, R7 and C3 and fed to the output jack SK2. The foot switch S2 switches off all of the circuit except TR1 and associated components. The battery on-off switch S1 is linked to VR1. Due to the gain of the preamplifier, a jack socket that grounds the input to the negative line when a.c. control is not in use, must be used. If the input is left open circuit it will pick up hum etc. and this will trigger the oscillator. The d.c. input jack socket must not be connected in this way.

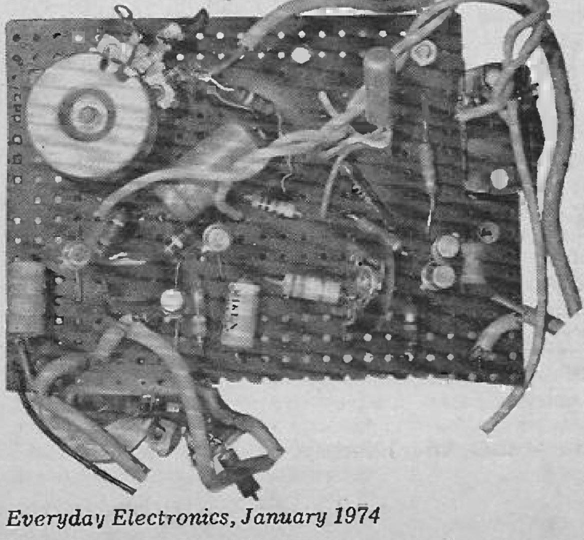
CONSTRUCTION

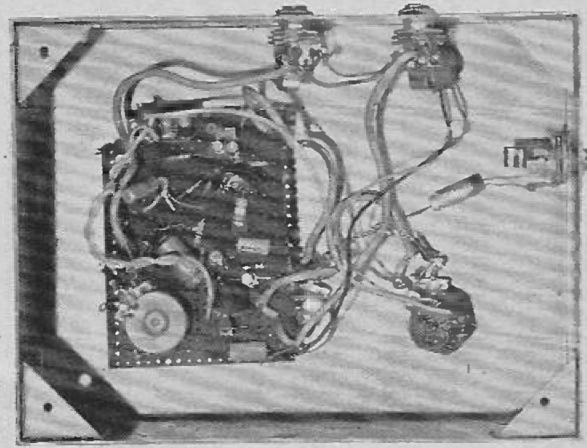
Component layout is not critical, the prototype was assembled on Veroboard (Fig. 3) although any type of assembly could be used. If a Vernier dial is used for the manual frequency control VR3 should be a 2 megohm linear potentiometer. This is because the Vernier dial will only turn the potentiometer through 180 degrees and if a 1 megohm potentiometer is used it will not travel the full length of its track.

Once the Veroboard is complete it can be mounted in a case measuring approximately 200 by 150 by 60mm and wired to the remaining components as shown in Fig. 4.

SETTING UP

When the circuit is assembled plug the output into an amplifier. Set VR3 fully clockwise and VR5 midway along its track, switch on, the circuit should now be oscillating. Turn the slider of VR5 until the highest possible frequency is reached, VR3 should now sweep the oscillator over its entire range. If VR5 is turned too far oscillation will cease and the whole operation must be repeated. Trimmer VR2 should be set to provide the lowest required oscillation. If an audio source is connected to the a.c. input the oscillator frequency will follow the volume of the source.





If a Vernier dial is fitted the frequency can be finely adjusted and tuned to other instruments.

D. C. INPUT

The d.c. input can be used with a row of switches and potentiometers. It can then be played in a similar manner to an organ, bearing in mind that the oscillator is purely a melodic (one note at a time) instrument (Fig. 5).

An ORP12 l.d.r. (light dependent resistor) can be plugged into the d.c. input, by moving ones hands between the ORP12 and a light source the oscillator frequency can be controlled. By wavering ones hand the oscillator will have a vibrato tone. When used in this way the sound and method of control is similar to a theremin (Fig. 6).

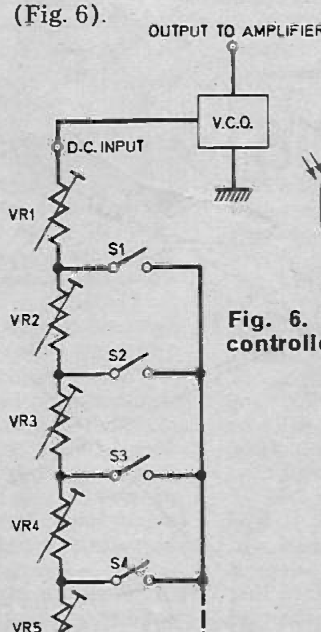


Fig. 5. Set-up for a simple organ.

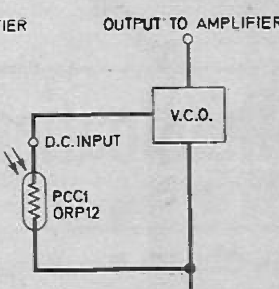


Fig. 6. Frequency controlled by light

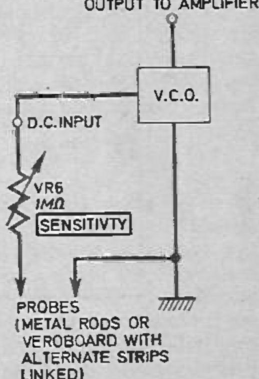


Fig. 7. Bath or rain alarm wiring.

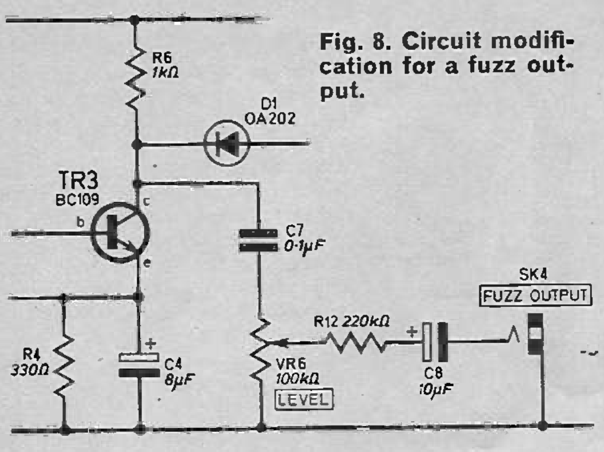


Fig. 8. Circuit modification for a fuzz output.

The simplest method of control is to plug a lead in to the d.c. input and hold the ends of the lead with both hands. The frequency of oscillation is then determined by the body resistance and thus by how tightly the leads are held. The circuit can also be used as a bath/rain alarm. When the ends of the lead are placed in water the circuit will oscillate (Fig. 7).

The d.c. input can also be used as a sustain input. By plugging an electrolytic capacitor into the input and switching on the oscillator the capacitor will charge up and when the trigger is removed the capacitor will sustain the note for a time before it discharges. The value of capacitor can be anything from 2µF to 250µF depending on the sustain time required.

A.C. INPUT

The a.c. input is used to control the oscillator by audio signals such as electric guitar or microphone or another oscillator. The footswitch is used to switch on the oscillator signal.

If a switch is used in series with capacitor C3 and the capacitor is switched out of the circuit the a.c. signal will no longer be filtered and strange modulating effects will take place in the oscillator circuit.

CIRCUIT MODIFICATION

With an instrument plugged into the a.c. input a "fuzz" output can be taken from the collector of TR3 via an attenuating network (Fig. 8). The sound is not as harsh as a "Schmitt type fuzz" and gives good sustain on guitar notes.

When using an a.c. input a capacitor of between 2µF and 250µF can be plugged into the d.c. input to produce a siren effect, controlled by the loudness of the a.c. input. This is due to the capacitor taking time to charge and discharge.

CONCLUSION

The prototype oscillator has been in constant use for three months and there has been little drift in the oscillator frequency. When the oscillator is switched on by the footswitch there is a short delay before oscillation begins. ▣

Ruminations

By Sensor

An Outside Broadcast

As I write, the wedding of Princess Anne and Mark Philips is being televised and transmitted to a potential 500 million viewers. By cable, microwave link and satellite, the pictures will be passed to Europe, Scandinavia, India, Australasia, America and Japan.

The picture quality, as judged on my old black and white set, is near perfection and demonstrates the high performance that the system can achieve when all resources are made available. The whole exercise must have been well planned and reflects great credit on all concerned, I am, of course talking about the television broadcast of the event and have no intention of entering into any controversy concerning the event itself.

The sheer scale of the operation is staggering, thirty cameras in the Abbey alone, each with its crew and associated equipment plus all those on the route between the Palace and the Abbey (plus one or two at Great Somerford)—and no apparent breakdowns! It says much for the reliability of the components.

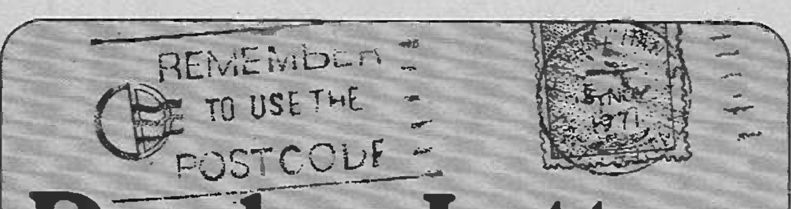
There were also, I hear, a large number of colour television sets distributed around the Abbey so that guests could watch the ceremony along with the millions of viewers in their own homes throughout Britain and a great part of the world.

How many cathodes were emitting, how many collectors were collecting a replica of the original signal I just could not begin to estimate — perhaps around 8,000 million? Probably more I don't know. How many soldered joints were involved? I leave these conjectures to those who have a mind for such things!

Watts Up

The threat of power cuts is with us again and we face the prospect of a gloomy and chilly winter. Those fortunate enough to have an open fire and something to burn on it and an old fashioned hot water bottle can avoid the worst of it but my sympathy goes out to those who are solely dependant on electricity for cooking and heating. I always think at these times of the major difference between electronics and power engineers.

The electronics engineers, concerned with microvolts, milliwatts and milliamps and the power engineer with his megavars (mega volt-amps) and kilovolts. When the electronics man thinks big, his currents may be around five amperes, while the power engineer would consider that to be a leakage current! However, your electricity meter will faithfully measure very much less than five amps so don't think that you will get anything for nothing.



Readers Letters

Projects Past and Future

Many thanks for a brilliant magazine. I have bought every copy so far. I have made several of your projects and found them very useful. I am very grateful for designs such as the *Signal Injector* and *Audible Warning Alarm*, as they fit my budget perfectly.

I wish to construct the *Bit Saver* in the December 1972 issue, but as yet I cannot find any advertisement for the 100mA diodes (would 300mA ones do)?

Secondly, have you any future plans for publishing a circuit for an amplifier of about 5 watts? I have already a three watt amplifier but now require an amp with a few watts more power.

Keep up the very good work.

P. A. Hawkins,
Innsworth, Gloucester.

Any 400V or higher diodes with a rating of at least 100mA will be suitable. Both the 400V and 100mA are minimum ratings, e.g. a 500V, 1A diode would be suitable.

We will probably be publishing more amplifier designs in future issues and we are sure one of them will meet your needs.

Aquarium Thermostat

We are going round in circles. We started with a good idea, then introduced an expensive meter. This leads you to say that we might as well have a thermometer in the tank, to which I reply: why not a bi-metallic strip?

The facts are simple, and I have made some tests. The normal heater current was 300mA at 240V. A pilot lamp (6·5V, 300mA) connected in series with the heater will carry a constant current of 300mA. If the heater is on, 6·5V appears across the lamp—but this link in the chain might also break.

If we run the lamp at half power by shunting it with a resistor, both the neon and the lamp should be on. If only the neon is on, the system has failed. To do this, use a shunt of 22 ohms at 2·5 watts minimum (because the lamp's running resistance is $6{\cdot}5 \div 0{\cdot}3 = 21{\cdot}66$ ohms).

Simon St. J. Beer,
West Byfleet, Surrey.

The original article was designed to do away with the inaccuracy and unreliability of the bi-metallic strip—it does this and performs the same function. The thermometer is necessary to set the temperature in the first place and will be necessary should the temperature be altered at a later date, so why not use it to check that the temperature is constant i.e. the heater has not failed. As far as we can see your monitoring system is quite good but if heaters other than 75W ones are used the lamp and resistor will need to be recalculated. Most aquarists have thermometers in their tanks but many require a more accurate and reliable thermostat, we hope we have provided this.

Gas

I cannot praise you too highly for publishing the circuit of the *Gas Alarm* in the November issue of Everyday Electronics.

I have a 44,000 B.Th.U. output gas fired warm air furnace in my home which I never previously left switched on whilst my family was asleep for fear of carbon monoxide poisoning, despite generous provision for combustion air supply. Now we can all sleep soundly at night with a raucous alarm and automatic shut down control over the furnace.

As Mr. M. H. Keene says in his article, the uses of the *Gas Alarm* are only limited by imagination, and I am making a second one as a sophisticated "toy" to discover uses not suggested in his article. The *Gas Alarm* is yet one more example of how forward looking is your magnificent magazine. Could I suggest another field in which I have never seen articles in any popular magazine and that is the subject of underwater sound.

You may be aware that many animals make underwater calls and those made by marine animals have been extensively studied due to their significance as background noise in submarine warfare. However, the study of the sounds made by freshwater fishes and insect larvae has been neglected and the amateur could make very valuable contributions to scientific knowledge in the sphere.

Many aquarium fishes make calls and there must be thousands of aquarists who would welcome a device that enabled them to listen in on their fish.

I know that a battery operated transistorised device is marketed in the U.S.A. and I have made such a device incorporating a modified crystal microphone insert with a preamplifier hooked up to a one-watt amplifier. This works well, and I have learnt a lot about acoustic impedance but I would like to see what one of your expert contributors could come up with. Is there any chance of such an article being published in a future copy of E.E.?

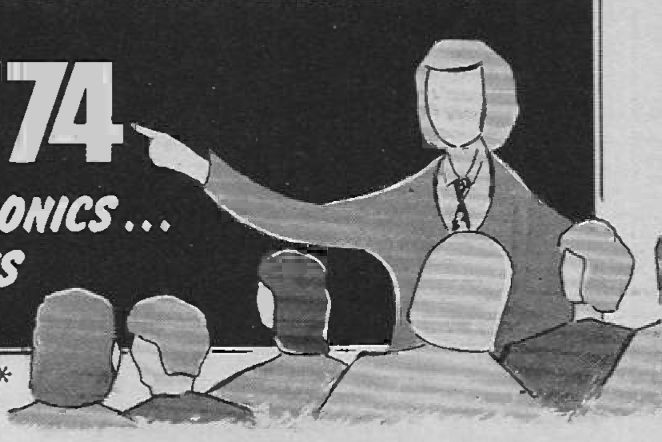
Peter Revell
Hemel Hempstead
Herts.

We will keep the subject in mind regarding a future project.

"That burglar alarm I made— its been stolen!"

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS ... THEORY AND EXPERIMENTS



TUTOR: PHIL ALLCOCK*

LESSON 4 The Transistor

IN order to extend our knowledge of electronics it is necessary to introduce a new and very important component, the transistor. This does not mean that we have finished with our earlier components, such as the resistor, capacitor and diode, but rather that the range of applications for these components can be widened by using the transistor in conjunction with them.

PHYSICS

A lot of articles have been written about the transistor and its associated physics but the author is of the opinion that this is not necessary in a first encounter with the device. In fact for a newcomer to the field of electronics a detailed study of transistor physics would be confusing and mask the inherent simplicity of the basic device behaviour.

In this series, we shall treat the transistor as an electronic component that can be bought for a few pence and we shall, at least initially, examine its operation from the point of view of a potential user rather than the device manufacturer.

This does not mean that the device physics are unimportant, for this is not the case. As the newcomer builds up his storehouse of knowledge he will acquire a deeper insight into the device operation. After all, the present day transistor, in discrete or integrated-circuit form, has reached its present level of sophistication as a result of intensive research and development over more than twenty years.

TRANSISTOR FAMILIES

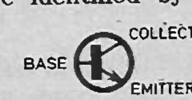
A glance at some of the manufacturers catalogues or the advertisement pages of E.E. reveals an enormous array of transistor types and numbers. Fortunately they are all members of a few families and it is a well known fact that the majority of general applications can be satisfied by the use of just a few of the many different types listed.

The BC107 transistor is a very popular and well known member of the family group known as bipolar transistors. The term bipolar stems from the fact that the device operation relies on current flow due to the action of both electrons and "missing" electrons. The latter are usually called holes. Members of this family are split into two groups depending on the voltage polarity or current direction that is used in normal operation.

The two groups are called *npn* and *pnp*. The letters *n* and *p* representing the type of semiconductor used in the various sections of the transistor and indicate that the material possesses either extra electrons (*n*egative) or extra holes (*p*ositive). The BC107 is an *npn* transistor and the current symbol is shown in Fig 4.1 and on the Data Sheet.

The three sections or regions have leads connected to them and are identified by the

Fig. 4.1. (right) Symbol for an *npn* transistor.



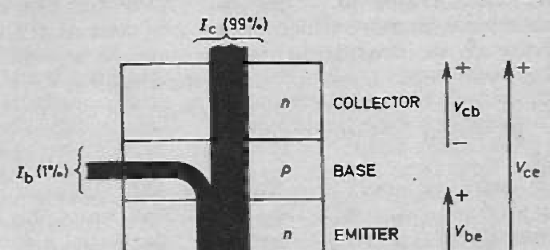


Fig. 4.2. Current flow diagram for an *npn* transistor.

* North Staffordshire Polytechnic (*Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4*)

names emitter, base and collector. These names are usually abbreviated to simply e, b and c. The arrow head on the emitter indicates the direction of conventional current flow when in normal use. A *pnp* type uses the same symbol but the arrow direction is reversed.

Another important family group contains the so called field effect devices and has several subdivisons. These need not concern us here and will be covered in a later part of the series.

Other more specialised devices such as the unijunction transistor, thyristor and triac are also available and have evolved mainly from applications involving the control of relatively large current or power levels.

BASIC TRANSISTOR OPERATION

This month we concentrate on the bipolar device family and in particular the BC107 *npn* transistor. All transistors behave as a form of electronic control valve whereby current in one part of a circuit can be made to change or depend in value on the current in another part of the circuit.

Consider the current flow diagram shown in Fig. 4.2 in which the width of the shaded arrow represents the amount of current flowing in a particular region of the *npn* transistor. If we take the total current leaving the emitter as 100 per cent we see that this is made up from the two currents entering at the base and collector. The base current is typically 1 per cent ($\frac{1}{100}$th) of the total emitter current which means that the collector current accounts for the remaining 99 per cent as the total current entering the device must always equal the current leaving.

The base region of a modern transistor is very thin, typically a few millionths of a metre (called microns) and this is one of the main factors in ensuring that the base current is only a small fraction of the total emitter current. However, apart from this, the ratio of the base current to the emitter current is almost fixed and for the time being we shall assume this ratio to be perfectly constant for a given transistor sample.

The ratio does vary, however, between samples of the same transistor type. Thus one device may have a base current which is one per cent of the emitter current whilst a second sample of the same type may have a corresponding current ratio of only $\frac{1}{2}$ per cent. Certain departures from this idealised relationship will be considered later.

To achieve current flow in the manner indicated in Fig. 4.2 the transistor must be connected into a circuit containing batteries and resistors in such a way that the voltage differences between the various regions are as shown. In a typical *npn* transistor the voltage between base and emitter, V_{be}, will be about $+0{\cdot}5$ volts and will only vary slightly if the emitter current level is changed over quite a wide range.

The voltage between collector and base, however, shown as V_{cb}, can have any value from about zero up to say +20V or more. The actual voltage will be dependent on the external circuit conditions such as resistor values and battery voltage. In essence the voltage V_{cb} will adjust itself to the conditions imposed by the Ohm's law requirements of the collector circuit. To see the implications of this let us examine the behaviour of the transistor when connected in a simple circuit such as Fig. 4.3.

If we assume that the voltage V_{be} is say $+0{\cdot}5$V, the voltage across the resistor R_b must be $(4{\cdot}5-0{\cdot}5)$ i.e. $4{\cdot}0$ volts. If R_b has a value of 1 megohm (a million ohms) the current flowing in R_b will be $4\mu A$ and this is the current that enters the transistor via the base lead. If we further assume that the base current is exactly one per cent of the emitter current, for the transistor sample used, then we would expect I_e to be $400\mu A$ and the corresponding collector current I_c to be $396\mu A$.

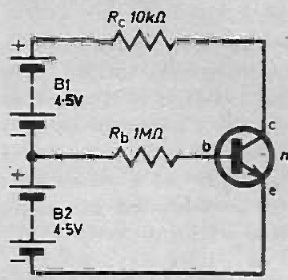
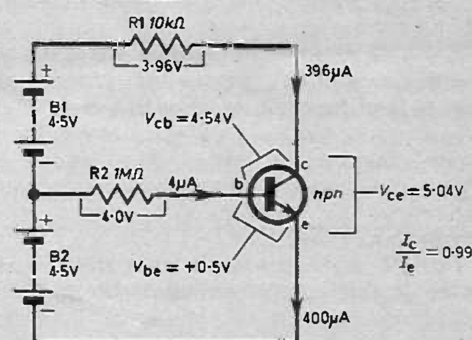


Fig. 4.3. (left) An *npn* transistor connected in a simple circuit.

Fig. 4.4. (below) Values calculated from Fig. 4.3.



We now have sufficient information to work out the voltage V_{cb}, since the voltage across the 10 kilohm collector resistor R_c must be equal to $I_c \times R_c = 0{\cdot}396\ (mA) \times 10\ (k\Omega) = 3{\cdot}96$ volts. To satisfy the voltage conditions round any circuit loop (Kirchhoff's law) we find that V_{cb} must be equal to $+4{\cdot}54$ volts. Fig. 4.4 shows the results of all our calculations for the given conditions. Readers should check these results and then satisfy themselves that the voltages around any closed loop "balance out" i.e. the voltage differences must add up to a value equal to the total battery e.m.f. acting in the chosen loop.

ASSUMPTIONS

In the above discussion we made two assumptions. The first of these was that $V_{be} = 0{\cdot}5$V approximately and this can be justified theoretically and measured using a practical circuit. (This is covered in this month's tests.) The second assumption was that the base current was exactly one per cent of the emitter current. These currents should be measured but as already mentioned the ratio does vary between samples of the same type.

The manufacturer controls the current ratio during the production of the transistor and usually gives a specification or data sheet which lists all the important parameters. These sheets are available for each transistor type and nowadays most manufacturers publish their data sheets in book form. The parameter that interests us here is the current gain and this can be measured in different ways. At one time it was common to quote the ratio of I_c/I_e, sometimes given the symbol α (alpha) and for our example this would be 0·99.

Since I_c is always less than I_e the parameter α must always be less than unity. As circuits improved it became apparent that a more useful way of specifying the current gain would be to quote the ratio of I_c/I_b, and this ratio is sometimes given the symbol β (beta). These two forms give the same information in two different ways and it is possible to change from one method to the other quite easily.

For the case given our sample would have $\beta = 0{\cdot}99/0{\cdot}01 = 99$ which simply tells us that the collector current is ninety-nine times the value of the base current irrespective of the actual current levels involved. (In fact the values of α and β vary, both between samples and with emitter current level, but this latter effect will be ignored for the time being.)

TRANSISTOR EQUATIONS

Though not absolutely necessary it is very convenient to express some of the above details in the form of simple equations as these will be useful in understanding the behaviour of the transistor in any given circuit. The "continuity of current" condition is expressed by:

$$I_e = I_c + I_b \qquad (1)$$

whilst the devision of emitter current, between base and collector, can be written as:

$$I_c = \alpha\, I_e \qquad (2)$$

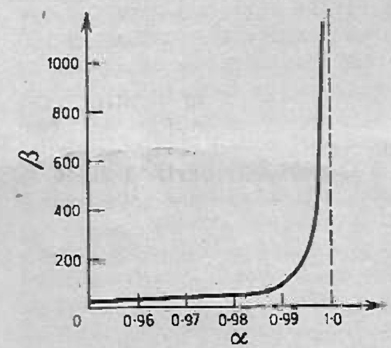
$$I_b = (1 - \alpha)\, I_e \qquad (3)$$

Dividing equation (2) by equation (3) gives a useful relationship, namely:

$$\frac{I_c}{I_b} = \frac{\alpha}{(1-\alpha)} = \beta \qquad (4)$$

Since the value of α is usually very close to unity, especially for present day transistors, the value of β varies over a wide range for quite small changes in α. This is illustrated in Fig. 4.5.

Because the parameter α depends on the width of the very thin base region, the manufacturing problems involved in controlling this width force the manufacturer to quote a spread or range



α	β
0·95	19
0·98	49
0·99	99
0·995	199
0·999	999

$\beta = \frac{\alpha}{(1-\alpha)}$

Fig. 4.5. Variations in β for change in α.

Table 4.1: Useful Transistor Parameters

Parameter Symbol	Meaning	Value for BC107
V_{ceo} (max)	Maximum c/e voltage with base open circuit	+45V
I_{CM} (max)	Maximum collector current (peak value)	200mA
V_{cbo} (max)	Maximum c/b voltage with emitter open circuit	50V
I_c (max)	Maximum average collector current	100mA
V_{ebo} (max)	Maximum e/b (reverse) voltage with collector open circuit	6V
P_{tot} (max)	Maximum total power dissipation at specified temperature of 25°C (or less)	300mW for $T_{ambient}$ ≤ 25°C
V_{ce} (sat)	Collector/emitter saturation voltage at specified current levels. Typical and maximum values may be quoted	Max. 600mV at I_c=100mA, I_b=5mA (Typical 200mV)
f_t	Transition frequency (a measure of transistor's usefulness at high frequencies)	300 MHz (Typical)
h_{FE}	Static forward current ratio (similar to $\beta = I_c/I_b$). Test conditions usually quoted	240 (Typical) at I_c=2mA, V_{ce}=5V
h_{fe}	Small—signal gain (change of I_c for unit change in I_b)	125 → 500 at I_c=2mA, V_{ce}=5V
I_{cbo}	Collector/base leakage current with emitter open circuit	15μA (max) at V_{cb} 20V and junction temperature of 150°C

of values for β. This range may be as high as 5:1 (maximum to minimum) and for some types the transistors are colour coded to indicate that the current gain β lies within a specified range.

TRANSISTOR RATINGS

In addition to α and β other symbols are used and Table 4.1 lists some of these together with an indication of their meanings. It will be noticed that some of the symbols relate to maximum ratings of voltage, current and power and on no account should these be exceeded. Failure to observe this point can lead to permanent transistor damage or a change in the device characteristics.

Power dissipation in a transistor causes the temperature of the semiconducting material to rise and if this rise is excessive a process known as thermal runaway can occur. This results when the temperature rise itself causes increased dissipation and a regenerative build-up takes place. If the current is not limited by external resistance this thermal runaway will damage the transistor.

The emitter-base junction is particularly vulnerable since the current-voltage characteristic is very similar to that of a forward biased diode. Even with the large emitter currents that occur in power transistors the voltage between base and emitter, V_{be}, rarely exceeds about one volt. The variation of emitter current I_e with V_{be} is illustrated in Fig. 4.6. The curve could equally well represent the variation of base current if a different vertical scale is used to indicate the lower current levels. The curve shows that for a silicon transistor the current rises rapidly once V_{be} exceeds about 0·5 volt.

If we connected a 4·5 volt battery directly across the base-emitter junction the transistor would be destroyed since the current would rise to an excessive level. When experimenting with transistors this point should be watched since the damage is not discernable from the outside. Always include a series resistance of say 1 kilohm to limit the current flow to a few milliamps. A simple method of checking transistors is covered in the experimental tests this month (Test 11).

TRANSISTOR LEAD CONFIGURATIONS

Modern transistors are usually mounted in hermetically sealed metal cases or encapsulated in special epoxy material. The arrangement of the leads can take one of several forms as shown in Fig. 4.7 and in some of the metal cased types the case is electrically joined to the collector. This applies to the BC107 transistors used with the Tutor Board.

MOUNTING FOR TUTOR BOARD

The BC107 transistors must be mounted using the 3-way connector blocks that were reserved for this purpose in Teach-in '74, Part 1. The leads are quite short and must be carefully spread out to match the connector spacing. They must not be allowed to touch the metal case of the transistor and as the lead-out wires are fairly thin the connector screws should be tightened carefully so that the wires are held firmly under the end of the screws. **Excessive pressure will tend to fracture the leads.**

The transistors should be left permanently mounted in these blocks and all other connections brought in on the opposite side of the block as required. The emitter and collector can be colour coded by using small spots of paint on the block, red for the collector and blue for the emitter. Alternatively, small lengths of plastic insulation can be slipped over the emitter and collector leads before mounting the transistor in the block. The general arrangement is shown in Fig. 4.8.

We are now in a position to carry out some simple tests.

Next month we shall continue our study of the transistor and introduce some simple circuit applications.

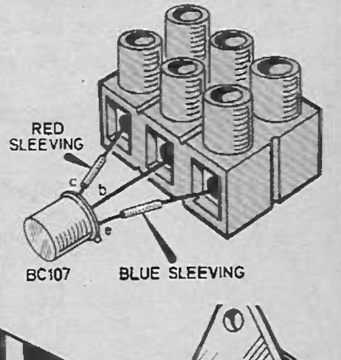


Fig. 4.8. Mounting of the BC107 in a connector block for use on the Tutor Board

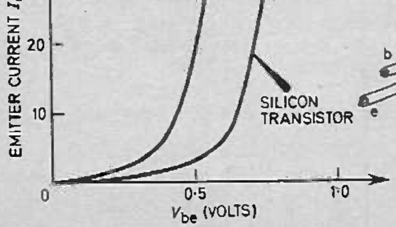


Fig. 4.6. Variation of emitter current with V_{be}

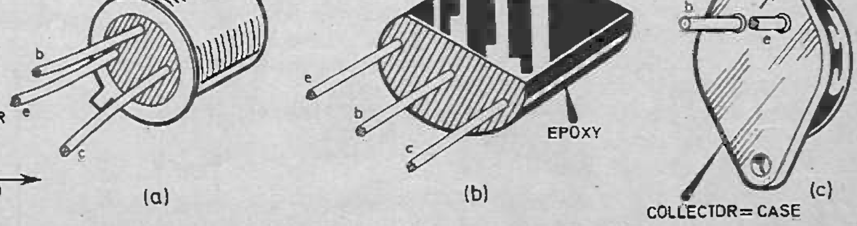


Fig. 4.7. Lead arrangements on some modern transistors.

Test No. 11

The experimental work this month has been designed to demonstrate the main features of transistor operation as described in the article. The schematic circuit is shown in Fig. 4.9 and a suggested Tutor Board layout is given in Fig. 4.10. The 0-10V voltmeter circuit is required for this test and has the negative lead permanently connected to the emitter (e). Only one probe is required, for the positive lead, and this can be held in position when a measurement is made.

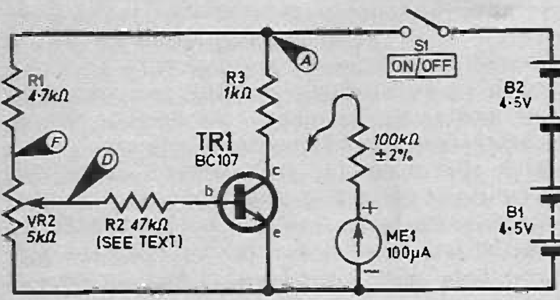


Fig. 4.9. (above, left) Schematic circuit diagram for Test No. 11.

Before switching on check all wiring carefully. Remember that the metal case of the BC107 is electrically connected to the collector (internally).

When using the voltmeter avoid touching the metal probe with the fingers as this can give a leakage path and produce false readings if some other part of the hand touches another part of the circuit, such as the transistor case! When you are satisfied that all wiring is correct and firmly held in the connector blocks, set potentiometer VR2 fully anticlockwise so that the slider is at the end which is joined to e, and switch on the circuit.

Using the voltmeter probe check the total battery voltage V_{Ae} at point A, the collector voltage V_{ce} at point c and the voltages V_{Fe} and V_{De} at points F and D. If everything is operating correctly the readings will be approximately:

$$\left.\begin{aligned} V_{Ae} &= 9\cdot 2 \text{ volts} \\ V_{ce} &= 9\cdot 2 \text{ volts} \\ V_{De} &= 0\cdot 0 \text{ volts} \\ V_{Fe} &= 4\cdot 8 \text{ volts} \end{aligned}\right\} \text{typical values}$$

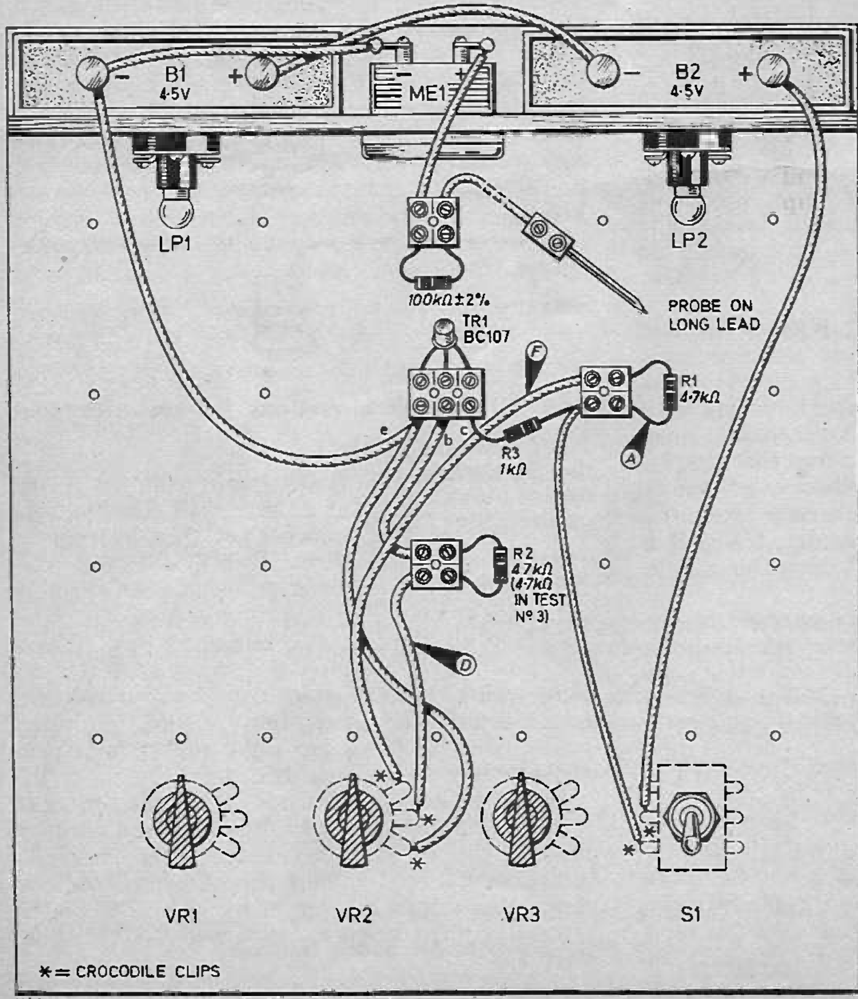


Fig. 4.10. Layout on the Tutor Board for the circuit shown in Fig. 4.9.

If V_{De} is not zero the potentiometer may be incorrectly wired or set at the wrong end. This condition would also give an incorrect value for V_{ce} which may be approximately zero under certain fault conditions.

If all is well, record the voltmeter readings in your log book and proceed with the rest of the experiments step by step. Try to understand what is happening at each stage before passing to the next test.

Test No. 12

Measure V_{ce} with the probe at point c and slowly turn VR2 in a clockwise direction. Note that V_{ce} does not change until VR2 has been turned through a few degrees. As VR2 is turned further clockwise V_{ce} will fall until it becomes almost zero. By turning VR2 "to and fro" satisfy yourself that the voltage V_{ce} can be made to rise, fall or swing about a given value anywhere in the range 0 to +9 volts approximately. Return VR2 to the fully anti-clockwise position.

Test No. 13

With the probe at point c turn VR2 clockwise until $V_{ce}=8 \cdot 0$V. Without disturbing VR2, transfer the probe to point *D* and record the voltage V_{De} (about $+0 \cdot 7$V). Return the probe to point c and turn VR2 further clockwise until $V_{ce}= +1 \cdot 0$V. Without disturbing VR2 measure V_{De} again and record the new value. On the prototype this second reading for V_{De} was $+1 \cdot 4$ volts but the value obtained will depend on the current gain (β) of the transistor sample used. The results can be used to calculate the voltage gain of the circuit which is a "one-transistor" amplifier.

Voltage gain (between points c and *D*) =

$$\frac{\text{change in } V_{ce}}{\text{change in } V_{De}} = \frac{(8 - 1)}{(1.4 - 0.7)} = \frac{7}{0.7} = 10$$

These results show that an increase in V_{De} of approximately $0 \cdot 7$ volts causes a decrease in V_{ce} of $7 \cdot 0$ volts. The collector voltage change is ten times larger than the change in V_{De} and is in the opposite sense since V_{ce} falls as V_{De} increases.

Because of the variation (or spread) in the parameter β, between transistor samples, the voltage gain obtained may be lower than 10. (For BC107 transistors the range will be about 2 to 10 in this circuit.) Restore VR2 to the fully anti-clockwise position.

Test No. 14

For this test we require a voltmeter covering a range of about 0-1 volt and this can be made up by connecting a 10 kilohm ±5 per cent resistor in parallel with the 100 kilohm ±2 per cent voltmeter resistor. The effective resistance of 10 kilohm in parallel with 100 kilohm is $9 \cdot 09$ kilohm which together with the additional series resistance of the 100µA moving coil meter gives approximately the correct value for a 0-1V voltmeter (i.e. 10 kilohm). See Fig. 4.11.

With the batteries switched off, change the base resistor from 47 kilohm to $4 \cdot 7$ kilohm and replace the 1 kilohm collector resistor with a 100 ohm resistor connected in series with one of the 6V 60mA lamps. Check all wiring carefully before switching on. Check that the lamp lights when VR2 is rotated clockwise. See Fig. 4.11.

Connect the positive probe of the 0-1V voltmeter to point b and slowly rotate VR2 clockwise until the lamp filament just begins to glow. Note the meter reading remembering that the full scale deflection now represents $1 \cdot 0$ volt, not 10V as previously. Continue to rotate VR2 whilst observing the meter reading. The change in meter reading will be relatively small even though the increasing light output shows that the collector current is still increasing.

This demonstrates that V_{be} is almost constant once the transistor is turned on. With the prototype Tutor Board the lamp started to glow at

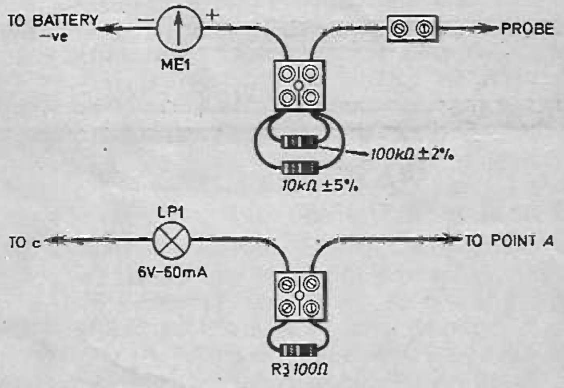


Fig. 4.11. Circuit alterations for use with Test No. 14.

$V_{be}=0 \cdot 6$V and with the lamp fully on $V_{be}= 0 \cdot 72$V, an increase of only $0 \cdot 12$V! The voltage V_{De} will change by more than this (as can be checked using the normal 0-10V voltmeter circuit) and rises to about $+3 \cdot 4$V when VR2 is fully clockwise.

Before dismantling this circuit return VR2 to the position at which the lamp just starts to glow whilst the 0-1V voltmeter probe is held on b. Observing the lamp, remove the voltmeter probe from b. The lamp light output increases considerably. Why does this happen?

When you have finished the experimental work dismantle the Tutor Board. Remember to remove the 10 kilohm resistor from the voltmeter circuit and to put the shorting lead on the meter terminals, for protection. Additional transistor experimental work will be given in Part 5.

PICKUPS & TURNTABLES

By GORDON J. KING

THIS second and final part deals with sources of distortion and performance.

TRACING DISTORTION

The least error is deliberately arranged at the end of the record because it is here that another type of distortion increases, called *tracing distortion*. This results from the difference in shape of the cutting and replay styli such that the path traced by the replay stylus differs from that traced originally by the cutting stylus.

At the end of the record the modulation waveforms tend to compress in the groove since then the groove-stylus velocity is at its lowest. This makes it even more difficult for the replay stylus exactly to follow the modulation waveforms, hence the distortion rises. The same effect occurs when the frequency of the modulation rises at a given or increasing recording level.

TIP DIMENSIONS

Owing to its nature, therefore, it follows that the smaller the radius of the tip of the stylus the less will be the tracing distortion. This is in fact perfectly true to a large degree, but other factors tend to become involved.

In an endeavour to reduce tracing distortion, particularly at the inner diameters of a record, *biradial* or *elliptical* tips are being fitted to the better class of cartridge. The major axis of the tip is arranged to fall across the groove, thereby avoiding "bottoming" in the groove which can result in a high replay noise level, while the minor axis actually defines the modulation waveforms. Major and minor axes are commonly 0·7 and 0·3 thousandths of an inch.

Non-elliptical or non-biradial tips are spherical with radii of 0·7 and 0·5 thousandths of an inch. From the "definition" and least tracing distortion aspects, therefore, the elliptical or biradial tip is better than the 0·5 thousandths of an inch spherical, while the 0·5 thousandths of an inch spherical is better than the 0·7 thousandths of an inch spherical. The latter is really a "compromise" tip, suitable for playing early mono L.P.s (which carry a groove more suitable for a tip of 1 thousandth of an inch) without scraping up too much muck from the bottom of the groove, as well as the latest stereo records.

SIDE-THRUST

We must now return to the arm to examine a by-product effect of the head offset angle. Obviously, the stylus is kept in contact with the groove modulation by a downward force, commonly called the *tracking weight*, the value of which is dependent on the mechanical quality of the cartridge and arm partnership and on the level of the groove modulation. The stylus is thus subjected to a frictional drag in the groove, and because of the offset angle of the head a force is developed which tends to draw the arm towards the centre of the disc, see Fig. 7.

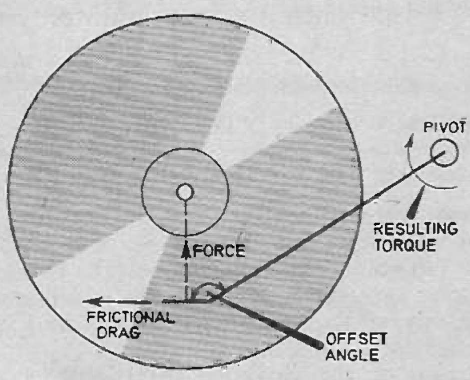


Fig. 7. Basic illustration of side-thrust (see text).

This is called side-thrust, and when the bearing friction of the arm is small it can be significant and thus cause the stylus to bear more heavily on the wall of the groove carrying the left channel than the other.

Because such imbalance can affect both the channel separation and the tracking performance, many arms are nowadays equipped with a scheme for combating the side-thrust. This is achieved merely by the application of an approximately equal force in the opposite direction provided by (i) a small weight dangling on a fine thread (SME, Audio-Technica), (ii) a spring arranged to introduce a countering torque at the pivot (Micro-Seiki), (iii) a system of permanent magnets (Decca).

The dangling weight idea on the SME 3009 short arm is shown in Fig. 8, while Fig. 9 shows the spring arrangement adopted by Micro-Seiki on the MA77/II arm, where the adjustment is provided by the small knob at the bottom left of the base.

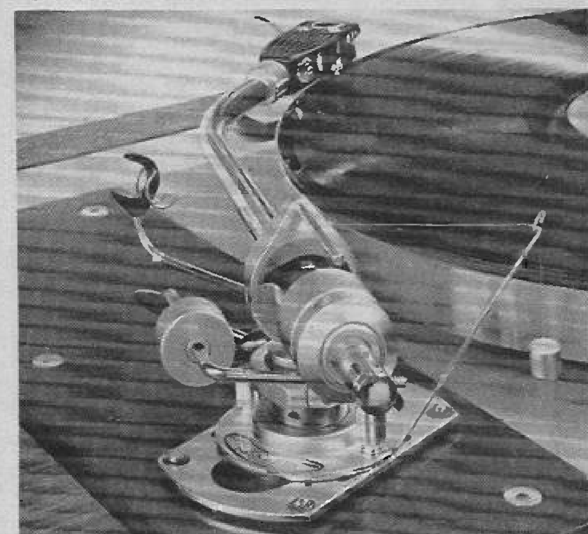


Fig. 8. The SME 3009 short arm showing dangling weight (side thrust correction) and counterbalancing and tracking weight system.

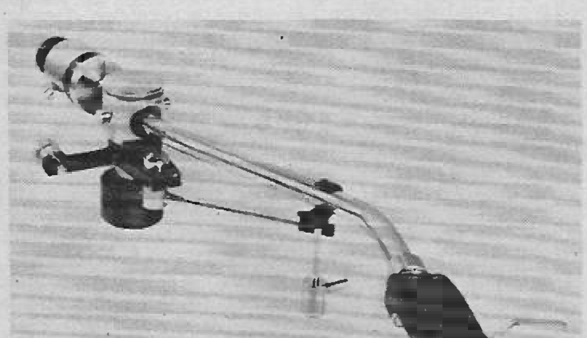


Fig. 9. Micro-Seiki MA77/II arm with spring arrangement for side thrust correction.

Since there is a likelihood of the side-thrust changing mildly with diminishing groove/stylus velocity, as the record plays out, and with changes in recording level, accurate correction over the entire disc is impossible. Nevertheless, the application of a nominal value of correction can enhance the channel balance and separation and reduce the tracking weight by as much as 20 per cent in some cases.

The required nominal value will depend on the chosen tracking weight and the type and dimentions of the stylus tip, which is why it is adjustable on many arms.

OTHER ADJUSTMENTS

The arm must also embody a method for counterbalancing the weight of the shell-mounted cartridge (often by a sliding weight or weights at the end of the arm) and an adjustment for the tracking weight, either a small rider weight or a spring system.

The arm illustrated in Fig. 8 employs weights for counterbalancing and tracking, the latter sliding along the main part of the arm against gramme calibration marks.

The arm in Fig. 9 also employs end weights for both functions.

Another arm fitment is an automatic or manually operated lifting and lowering device, such as shown on the Micro-Seiki MA77/II arm in Fig. 9, which is operated by the lever at the side.

We must now turn our attention to the chief pick-up parameters, of which there are three: (i) tracking ability, (ii) frequency response and (iii) channel separation.

TRACKING ABILITY

This refers to the least tracking weight required for the pick-up to handle modulation of a specific frequency and amplitude, usually translated to velocity, v, such that

$$v = 2\pi f A,$$

where f is the frequency in hertz and A the amplitude in centimetres of the modulation waveform.

Velocity is given in centimetres per second (cm/s), and because some of the latest discs have peak levels approaching 30cm/s at mid-spectrum, the pickup should be able to cater for such a velocity within its tracking weight range.

Sadly, few makers specify absolute tracking ability in this way (Shure being an exception by adopting the term 'trackability'). Most makers, though, specify the required tracking weight, sometimes in terms of minimum and maximum values.

One should not exceed the maximum, but whether the minimum weight will track modern records realistically will depend on the arm and side-thrust correction.

The tracking at high amplitudes is governed by the *compliance* of the cartridge. Compliance is the reciprocal of stiffness and is measured as the distance of millionths of a centimetre that the stylus is displaced by a force of 1 dyne (approximately equivalent to a force of 1 milligram). Modern cartridges boast vertical and lateral compliances of 20×10^{-6} centimetres per dyne (cm/dyne) or better.

However, a high compliance cartridge does not necessarily imply a good tracking because the high frequency tracking ability is dependent on the effective mass at the stylus tip. When tracking high-frequency, high velocity modulation, the stylus tip can undergo an acceleration in excess of 1000g (g being Earth's gravitational pull). So by having a large tip mass, rapid change of motion will be impossible at a realistic tracking weight and without groove destruction. Top-flight cartridges have an effective tip mass of less than one milligram.

Tracking ability is also dependent on the mechanical damping built into the cartridge to tame overshoot and resonance effects, etc, thus the three factors of compliance, tip mass and damping combine to yield the tracking ability.

FREQUENCY RESPONSE

The output over the frequency spectrum should be free from violent changes if colouration of the reproduction is to be avoided; Fig. 10 shows the frequency response of a good quality cartridge. The slight undulations can be tolerated, but cartridges with violent changes in output within an octave are unsuitable for high quality reproduction.

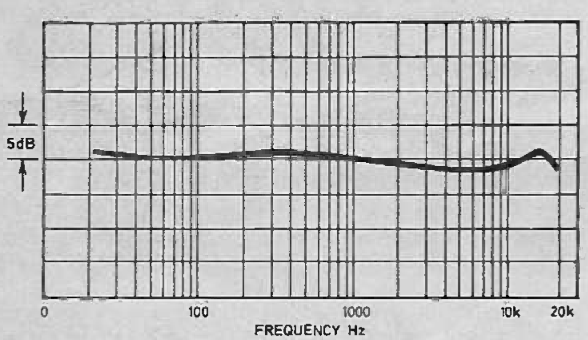


Fig. 10. Typical frequency response curve obtained with a good magnetic cartridge.

Magnetic pick-ups not uncommonly exhibit the "suck-out" around 5 to 8 kilohertz, while the mild rise at the bass end can be encouraged by the effective mass of the arm resonating with the compliance of the cartridge. It is thus necessary for a high compliance cartridge to be partnered with an arm of low effective mass.

Resonance, and thus a rise in output, occurs at the bass end because the resonant frequency is equal to $\pi/2mC$, where m is the effective mass of the arm and C the compliance of the cartridge. The resonant frequency is a little over 11 hertz when the compliance is 20 x 10^{-6} centimetres per dyne and the mass is 10 grammes.

If the resonance is too low the system will be unstable and if too high rumble from the motor and other acoustic effects may prove troublesome.

CHANNEL SEPARATION

A separation curve compatible with the frequency response curve is shown in Fig. 11. Notice the high separation (almost 30 decibels (dB), equal to a voltage ratio of just over 31 to 1) at the middle of the spectrum.

At the bass and treble ends the separation normally falls off, but provided it holds around 10 decibels at 100 hertz and 10 kilohertz, with a maximum of at least 20 decibels at mid-spectrum, the stereo 'image' on replay should be reasonable.

Violent separation changes are sometimes noticed at the high treble due to stylus system resonances, and they often correlate with peaks and troughs in the response curve.

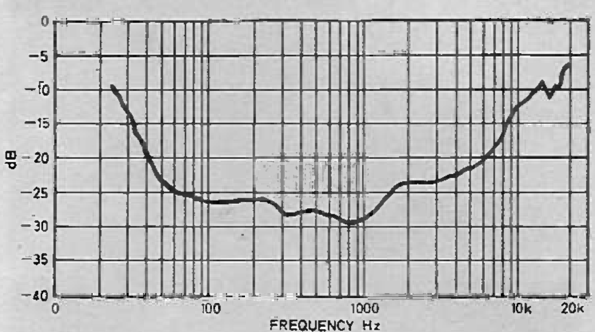


Fig. 11. Typical separation curve—magnetic pick-up.

EQUALISATION AND LOADING

Generally, magnetic cartridges are capable of better tracking, frequency response and separation than piezoelectric types. However, because the output from a magnetic is geared to velocity of modulation and because a modern disc is recorded with velocity rising with frequency, the output rises with frequency. This calls for *equalisation* at the amplifier input stage.

Actually, the recording is to the RIAA characteristics, with a velocity slope of 4 decibels per octave average (eg, almost constant amplitude). A reciprocal curve is required for equalisation, as shown in Fig. 12.

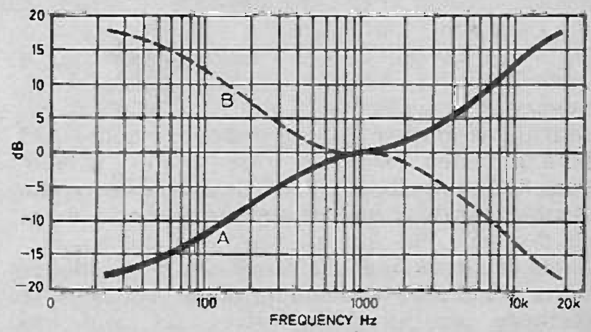


Fig. 12. Curves approximating the RIAA recording (A) characteristics and replay equalisation (B).

On the other hand, piezoelectric type cartridges give an output geared to the amplitude of the modulation, so the output is almost "flat" from an RIAA recording when the cartridge is loaded properly into the stipulated high resistance (about 2 megohms). Some piezoelectric species feature inbuilt equalisation to take into account the deviation from true constant amplitude recording.

It is possible to run a piezoelectric cartridge into an RIAA equalised input (eg. magnetic pickup).

The low value load here and the capacitance of the piezoelectric element result in a "tilt" in output so *approximately* simulating the velocity output of a magnetic cartridge. When running like this an input attenuator may be required to avoid the high piezoelectric output from overloading the RIAA equalised preamplifier.

A recent record deck from Scan-Dyna, type 1400.

TURNTABLES

We have already seen that the turntable must be responsible for the least wow and flutter. These are usually quoted as a percentage referred to an average frequency from a test record. One per cent is acceptable, but quality units might not produce much more than 0·1 per cent wow and flutter, depending on the method of measurement.

Another parameter is *rumble*. This arises from motor and bearing noises being transmitted through the turntable, motor board and disc to the pickup. It manifests like the low grumble of distant thunder or the movement of furniture in the room above!

As already noted, it can be emphasised by a critical pickup bass resonance. The slip-frequency of some drive motors is about 22 hertz, so if the resonance is close to that, rumble could be aggravated. Amplifiers often feature a high-pass filter to roll-off the sub-bass and hence the rumble signals. An unweighted value is about 40 decibels, but quality turntable units sometimes boast as high as 50 decibels (or higher when weighted), depending, again, on the test method.

Rotational speed should be adjustable to suit at least $33\frac{1}{3}$ and 45 r.p.m. discs. If there is a likelihood of old 78's being played, then of course the speed should be adjustable to this. Some turntable units also cater for 16 r.p.m. speech (talking book) discs.

Goldring-Lenco turntable units have a continuously variable drive. A motor board knob regulates the speed, and on some models the "standard" is indicated by a neon-illuminated stroboscope.

Recent models have "click" positions corresponding to the standard speeds. Fine speed control is useful for musicians and can avoid frustration when one is blessed (or otherwise!) with perfect pitch.

Photograph of a Goldring-Lenco turntable, type GL75 with variable speed control.

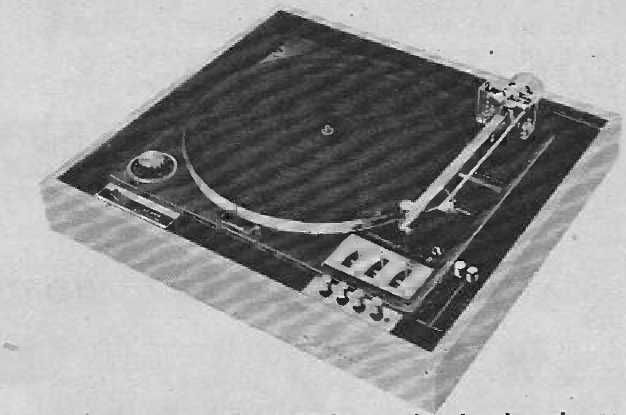
Speed change and variable control (when fitted) are related to the method of motor-to-turntable drive. The idler wheel type of drive, where the wheel picks up energy from the motor spindle (stepped to give speed changes) and couples it to the inside surface of the turntable, is still popular.

Belt drive is also being seen more these days. Here drive is coupled from the motor spindle or pulley (again stepped for speed change) to a larger diameter flange on the turntable or to a flywhel upon which the main turntable is placed (Micro-Seiki and Thorens respectively).

Automatic turntable are also liked in some quarters though rarely by the hi fi hierarchy for reasons of adjustment compromise and possible disc changes.

Motors commonly used for turntable drive are the small shaded pole variety, though sometimes a more "synchronous" device is adopted. When

The Connoisseur BD2 deck with arm; two speed belt driven unit.



The Garrard QZ 100SC quadraphonic player system with built-in decoders. Can also be used for stereo or enhanced four channel modes.

the mechanics are accurately balanced, the bearing friction low and the turntable mass high, it requires only a relatively small torque for constant speed drive.

THE FUTURE

The gramophone record will remain a long time yet the medium for high quality two-channel stereo and, seemingly, for the latest four-channel (quadraphony) reproduction. Discs are already available with the information of four channels in the single groove.

One scheme (Victor Company of Japan) incorporates four discrete channels of information by the use of frequency-modulation "multiplex" on a carrier frequency around 30 kilohertz, with sidebands towards 50 kilohertz.

Other schemes are based on the "matrixing" of ambient information relative to the normal left and right stereo channels, this being essentially a function of signal phasing by the encoding matrix. A reciprocal matrix at the reproducing end decodes the information into the original four channels.

It seems as though the magnetic pickup will retain its popularity, and species are available which respond up to 50 kilohertz (for the Victor discrete four-channel discs). Tracking weight is now down to one gramme (and less if you can handle it!).

To conclude, mention must be made of those cartridges which work on different principles, such as strain gauge (Miniconic), and photoelectric cartridges.

The magnetic family, incidentally, includes at least one make based on the ribbon principle—like a ribbon microphone.

There is certainly much more in record playing than meets the eye! ■

TEACH-IN '74

QUESTION TIME ANSWERS

1. Electrons have a fixed *negative* charge.
2. Current, in amperes, is a measure of the "rate of flow" of charge. One ampere equals one coulomb per second.
3. Current equals voltage divided by resistance.
4. Effective resistance is $\frac{10 \times 22}{10 + 22} = \frac{220}{32} = 6{\cdot}875\ k\Omega$.
5. For one watt power dissipation $V^2 = 1000$ and so $V = 31{\cdot}6$ volts. The current is therefore 31·6 mA.
6. Brown (±1%), Gold (±5%), Silver (±10%).
7. 270,000 ohms ± 5%.
8. Providing the two battery voltages are the same the voltage difference will be zero for this method of connection.
9. Capacitance increases.
10. Time constant is 220 mS. (i.e. 0·22 seconds).
11. At the maximum working voltage of 100 V the energy will be 5 joules.
12. Resistor can be placed in either lead.
13. Cathode.
14. A reverse biased diode would give a voltage slightly less than the battery voltage. A good diode, in the forward bias direction would give a voltage reading of less than 1 volt.
    An open circuit diode would give a voltage reading slightly less than the battery voltage due to the current taken by the voltmeter. A diode having appreciable leakage current in the reverse direction would also give a voltage reading less than the battery voltage. To distinguish between these last two cases it would be necessary to test the diode for both possible directions. If open circuit, the two readings will be the same. Hence both (b) or (c) could be correct.
15. 40mA when operating as a Zener.
16. Effective capacitance is $\frac{5}{6}\mu F$.
17. No. The "cold" resistance is lower than the operating resistance.

A new series ...

SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

1 ■ DEVELOPMENT OF THE TRANSISTOR

The transistor was invented on Christmas Eve 1947 in the Bell Telephone Laboratories U.S.A. The two scientists concerned were Bardeen and Brittain, working under the direction of Dr. Shockley.

The original experimental hookup was as Fig. 1.1. Two "catswhiskers" were pressing on a crystal of germanium, XI. It was noticed that if the current through ME1 was varied, the current through ME2 altered a *slightly greater* amount.

This was the first time in history that **amplification** was achieved in a **solid state device**.

This device was named the **point-contact transistor**. Its creation launched an orgy of research throughout the world.

The original point-contact version was soon abandoned in favour of the **junction transistor**, which was essentially a sandwich of three semiconductor materials known as *p*-type which was doped germanium, rich in positive charge carriers called **holes** and *n*-type which was rich in **electrons**. The sandwich could be *pnp* or *npn*.

Silicon eventually displaced germanium, because of its much lower **leakage current** and its ability to withstand much higher temperatures (about 180°C instead of 75°C).

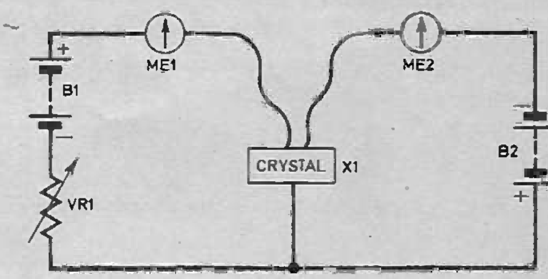


Fig. 1.1. The circuit used in the discovery of the transistor.

Manufacturing methods have continually improved, and the variety of techniques and sales gimmickry has now reached bewildering proportions.

The "in" type at present is the **Planar Epitaxial** as far as bipolar junction transistors are concerned. **Bipolar** means that the current is conducted through the device by two types of carriers, **electrons** and holes.

There is another entirely different type of transistor called the f.e.t. (**Field Effect Transistor**).

The transistor has triggered off the greatest technological revolution of all times.

2 ■ THE SEMICONDUCTOR BARRIER POTENTIAL

Two slabs of material, one *n*-type and the other *p*-type, are joined together to form a *pn* junction diode.

The circuit symbol and the relation to *p* and *n* material is shown in Fig. 2.1.

The diode is an easy path for current *in one direction only*. In the other direction it is practically an *open circuit.*

If the applied voltages are as indicated in Fig. 2.1 the diode is said to be **forward biased** and will pass current. (This is easily remembered by noting that *positive* must go to *p*). When forward biased there is about 0.6 volts across a silicon diode, but about 0.2 volts, if germanium. Any attempt to push this voltage much higher will usually result in destruction of the device, because the current will rise rapidly.

A graph, showing this behaviour, is given in Fig. 2.2.

These two voltages, 0.2 for germanium and 0.6 for silicon, are called the **barrier potentials** for the materials.

Note that current is small if voltage across diode is less than the barrier potential.

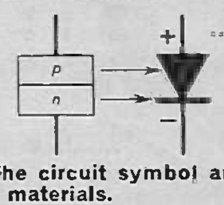


Fig. 2.1. The circuit symbol and relation to *p* and *n* type materials.

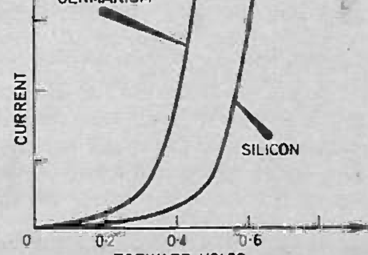
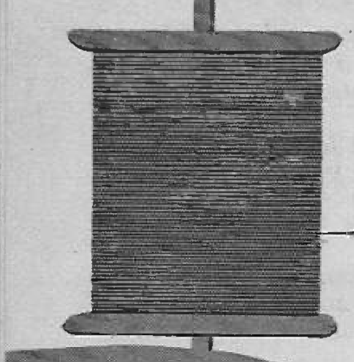


Fig. 2.2. Typical forward characteristics of silicon and germanium diodes.



SEWING MACHINE SPEED CONTROL

BY J. A. BRETT

Enables finer speed control with standard foot control.

This article describes a simple power controller for use on the domestic mains supply. It can handle up to 750 watts and be used to control the power fed to electrical appliances.

A very useful application, proved by the authors wife, is to use it with an electric sewing machine. Set at about half power it gives a finer speed adjustment with the standard foot control than can normally be obtained. A big advantage when machining intricate shapes in fine fabrics.

By reducing the power to electric motors as used in drills, food mixers and other appliances with series wound motors, the speed can be adjusted. The controller can also be used to dim lights provided they are conventional filament lamps, it will not work with fluorescent or other discharge lamps.

With the electric drill a well controlled speed reduction enables coil and transformer winding to be attempted.

The circuit uses a triac which, although rated for a maximum current of 6 amperes, should not be allowed to run continuously at more than 3 amperes. The size of the heat sink and the fact that it is enclosed prohibit the sustained higher current use. On 240 volt a.c. mains supplies this gives a load rating up to approximately 750 watts, enough for most applications.

The circuit has been designed for the constructor with limited access to tools and uses, for the housing, a domestic MK Ivy base readily available from the local electrical contractor. With the exception of the triac the other components should be able to be supplied by the local electrical and radio shop. The triac can be obtained from several of the London based component houses by mail order.

CIRCUIT DESCRIPTION

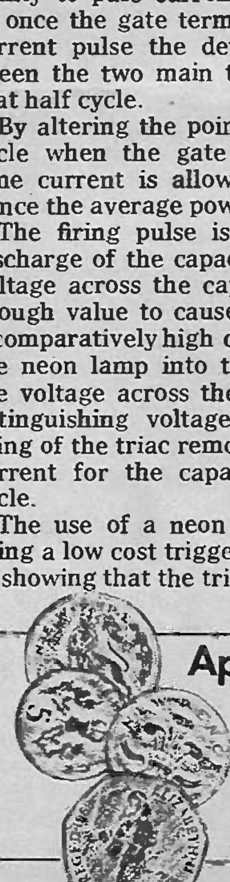
The complete circuit diagram of the Sewing Machine Speed Control is shown in Fig. 1.

The actual power is controlled by a triac which is a semiconductor device similar to the controlled silicon rectifier (CSR) but with the ability to pass current in both directions. That is, once the gate terminal has been pulsed by a current pulse the device conducts current between the two main terminals until the end of that half cycle.

By altering the point in time during that half cycle when the gate is pulsed or "fired" the time current is allowed to pass is varied and hence the average power to the load is varied.

The firing pulse is produced by the partial discharge of the capacitor C1 into the gate. The voltage across the capacitor C1 rises to a high enough value to cause the neon lamp to strike, a comparatively high current then flows through the neon lamp into the gate of the triac until the voltage across the capacitor C1 falls to the extinguishing voltage of the neon lamp. The firing of the triac removes the source of charging current for the capacitor until the next half cycle.

The use of a neon lamp, has, in addition to being a low cost triggering device, the advantage of showing that the triac is being triggered also.



Approximate cost of components including V.A.T.

£1.45 plus case

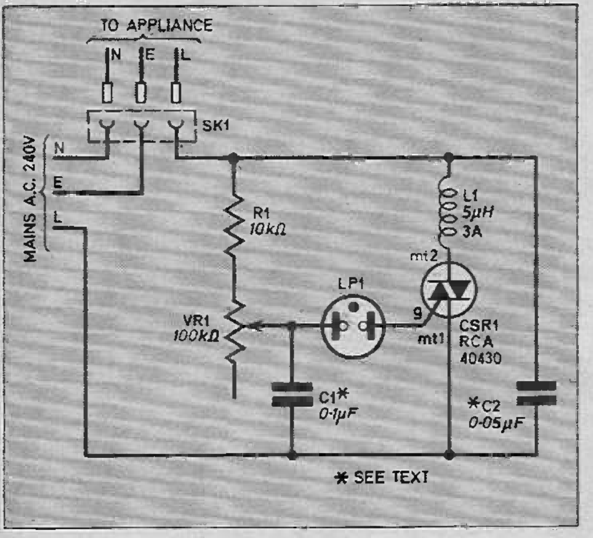


Fig. 1. The complete circuit diagram of the Sewing Machine Speed Control.

The point at which this triggering pulse occurs is determined by the rate by which the capacitor C1 is charged through the resistors R1 and VR1. With VR1 set to the minimum resistance, the capacitor C1 is charged at almost the same rate as the rate of rise of that half cycle of the mains supply.

As the typical striking voltage of the neon lamp is 90 volts, only a small percentage of the half cycle is not conducted through the triac. By increasing the value of the setting of VR1 the rate of charging C1 is lowered and hence the neon strikes later in the half cycle.

With VR1 set to the maximum resistance of 100 kilohms, a value of C1 is needed which is just too large to be charged to the neon striking voltage. The value required for this circuit lies between 0·1 and 0·15 microfarads and may be made up from a 0·1 microfarad capacitor in parallel with a lesser value determined on test of the finished unit. By selecting this apparently too large value capacitor, the neon will not strike and pulse the triac; hence the unit will be in a fully turned off condition.

Although the voltage across C1 does not rise to more than about 100 volts, the polarity reverses 50 times a second causing high stressing of the dielectric and a working voltage of *at least* 400 volts is needed. This is also the reason for specifying a 1200 volt d.c. rating for the interference suppression capacitor C2, if one with an a.c. rating of at least 350 volts is not used.

The small inductance L1 limits the rate of rise of current through the triac. This is most important when the triac is switching at half power, that is, switching on when the mains supply is at its peak value.

In addition to switching the maximum value of inrush current for the load, the triac has to discharge the suppression capacitor C2. The triac junction will be destroyed if the rate of current is allowed to build up much in excess of 20 amperes per microsecond.

An inductance of about 5 microhenries will limit the rise in this circuit to a safe value. This value of inductance is typical of the TV interference suppression chokes sold in most radio and electrical shops.

The circuit with these suppression components does not appear to cause any TV interference as it has been used as a lamp dimmer alongside a working TV receiver.

Components....

SEE **SHOP TALK**

Resistor
R1 10kΩ ½W carbon ±10%

Potentiometer
VR1 100kΩ ½W linear composition type

Capacitors
C1 0·1μF 400V d.c. working
C2 0·05 400V a.c. or 1200V d.c. working plastic foil.

Semiconductor
CSR1 Triac 400V 6A type RCA 40430 or similar

Miscellaneous
SK1 MK Ivy mains socket
LP1 Panel or wire ended neon lamp
L1 Interference suppression choke 3A 5μH
Enclosure made from MK items: Ivy plate, base, divider; knob for VR1, insulated with internal retainer or deep set grub screw; aluminium 2 x 80 x 25mm (heat sink); 6BA nuts, bolts and solder tags.

CONSTRUCTION

The circuit is built up using point to point wiring as shown in Fig. 2.

Begin by making up the heat sink as shown in Fig. 3 and paint matt black.

The heat sink with mounted triac should be held in position inside the MK box, against the divider, as near to the side as possible, and then the drilling holes in the divider are marked out.

Drill these two holes and the two holes to take the 6BA terminal nuts and bolts at the other end of the divider, see Fig. 2. These two terminal nuts and bolts make the connection between the socket section and the control section. If the case shown is not used the triac should be insulated from the heat sink and the bolts insulated from each other and the case. The case should be earthed if metal.

Drill the blank cover plate centre hole and hole to suit the diameter of the neon lamp holder as shown in Fig. 4. If a neon lamp not mounted in a holder is used, drill the appropriate

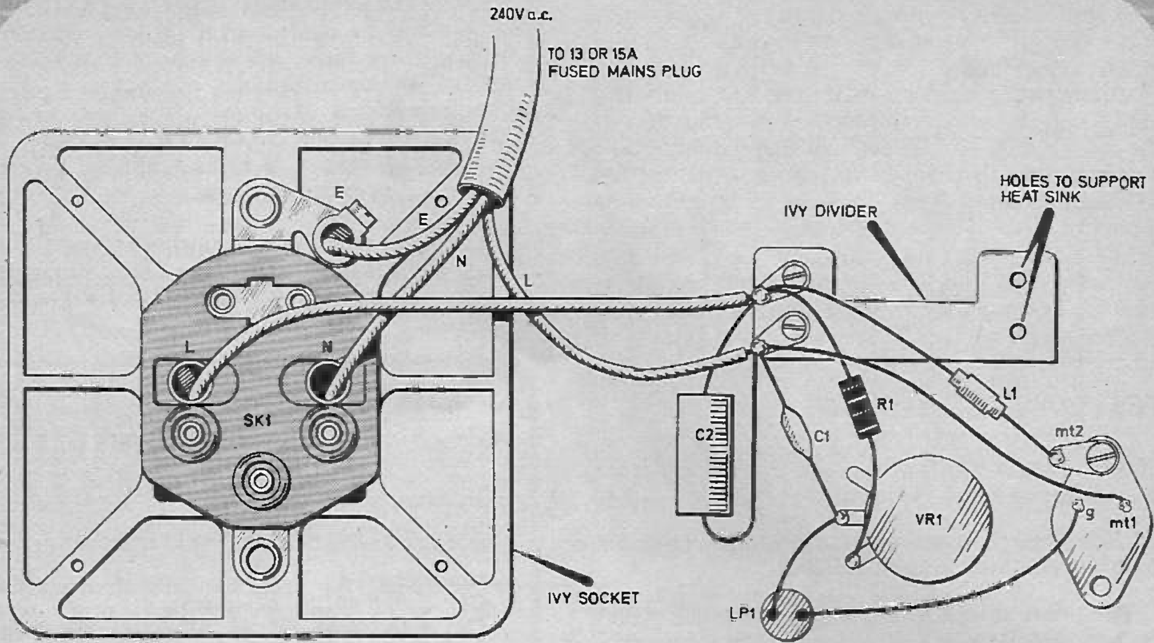


Fig. 2 (above). The wiring up diagram and layout of the components in the MK Ivy base.

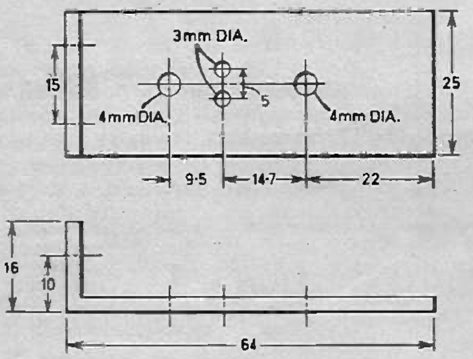


Fig. 3 (left). Details of the heat sink for mounting CSR1. Use at least 1mm thick aluminium.

SEWING MACHINE SPEED CONTROL

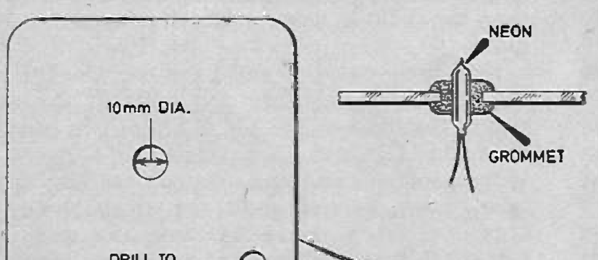


Fig. 4. Details of fixing the neon lamp.

hole to hold the neon in a grommet as shown in Fig. 4. Both the neon lamp and grommet should be glued in position.

Mount the assembled heat sink to the divider plate and wire up the other components as shown in Fig. 2. Sleeve all component tails bearing in mind that the 0·1μF capacitor at the C1 location may have to have a small value capacitor fitted in parallel later.

The whole assembly can now be fitted into the enclosure and the mains socket wired in. Finally fit the knob, ensuring that the grub screw is well below the surface if the type with an internal retaining spring is not available.

TEST AND OPERATION

Connect a mains lamp load and switch on. Check that the output can be varied and that it will fall to zero. If the output will not fall to zero an additional small value capacitor, such as 0·022 microfarad or 0·05 microfarad should be fitted in parallel with C1.

In use always check that the motor, lamp or other load is not short circuit as the average 3 amp fuse, which should be fitted to the mains plug, will not blow quickly enough to save the triac from permanent damage.

In use, the unit is plugged into the mains and the appliance to be "controlled" such as the sewing machine, via its foot pedal, is plugged into the socket of the unit.

Clockwise rotation of the control knob increases the power (speed) to the appliance. The control knob should be adjusted in conjunction with the foot pedal-control to give much finer control than with the pedal alone. ▣

Sewing machine shown on the front cover was kindly loaned by John Lewis.

SHOP TALK

By Mike Kenward

SUPPLY seems to be becoming non existent with regard to some components. In our November issue, we published the *4 Band T.R.F. Receiver* and this design used a Motorola MFC 4000B integrated circuit amplifier. At the time this device was being advertised by many suppliers and all seemed to be well, however, by the time the issue was on sale virtually all stocks of the device had been sold and, after phoning all the Motorola appointed distributors—who supply the retailers—we could only find fifty of these devices in the whole of the British Isles, not nearly enough to meet readers' needs.

What was even worse was the fact that the distributors told us that they were not expecting any further supplies until February or March and there was no way of speeding delivery, which is controlled from Geneva. Faced with this situation we had only one alternative—to ask the author to design a simple discrete component stage to replace the original integrated circuit. It seems a backward step (backward in the terms of technology anyway) but, as far as we can see it is the only way out unless you, the reader and constructor, are willing to wait possibly until the end of March to complete the unit.

We hope we have now solved the problem with this particular article, so let's look at this month's particular problems.

Fetset

The *Fetset MW Receiver* derives its name from the f.e.t. (field effect transistor) used in the first stage. This transistor and the BC169C should both be readily available, as shonld the remainder of the components used in this project. The tuning capacitor can be almost any miniature variable type of about 250pF. The case must be plastic and there are a number of small ones available from the various retailers.

Sewing Machine Speed Control

All components for the *Sewing Machine Speed Control* should be readily obtainable, the MK parts are sold by many electrical shops and should be easy to obtain almost anywhere, the suppressor coil L1 is also obtainable from such shops.

V.C.O. Effects Unit

We have probably never before published a design that is so versatile as the *V.C.O. Effects Unit*, the applications stated in the text are probably not the only ones and no doubt ingenious readers will find many others.

One or two rather special components are used, in particular the Vernier dial (although this is by no means essential) and the foot switch. The dial is available from most of the larger suppliers, they are available in a number of sizes, the 50mm (2 inch) size being used on the prototype, this costs about 85p and this price was not included in the cost box.

The foot switch on the prototype is simply a heavy duty push on, push off pushbutton and is quite suitable. Henry's Radio show a rather more sophisticated foot-switch in their catalogue which is free standing and could be linked to the unit by a lead and plug, however this switch costs more than £1 and is not necessary unless the unit cannot be placed on the floor. The foot operation is only required when the unit is used as an effects box with drums or other instruments.

Other points to watch when buying for this unit, are the notes in the text referring to the jack sockets, and also the pot value if the Vernier drive is used.

fetset mw RECEIVER

A two transistor m.w. receiver using an f.e.t. for increased performance

By R.A.PENFOLD

THIS receiver covers the m.w. band, and uses only two transistors, including one field effect type. The use of a f.e.t. (field effect transistor) gives the circuit a low noise level, and low current consumption. It also helps to give extremely sharp selectivity. While the set is quite compact, the prototype measuring 133 by 73 by 38mm, it has purposely not been miniaturised in order that construction should be very simple, and standard, readily available components can be used. The output is for a crystal earpiece.

As a regenerative detector is used, no alignment is required, and only one simple adjustment to optimise performance has to be made before the completed device is ready for use.

Apart from the normal B.B.C. stations, a few continental ones can be received at an adequate volume. After dark a larger number of continental stations can be received, including Radio Luxembourg which has been received very well in the south east of England.

The unit is very economical to run as the current consumption from the PP3 battery is only about 650 microamps. Even with heavy use this will give a battery life of many months.

THE CIRCUIT

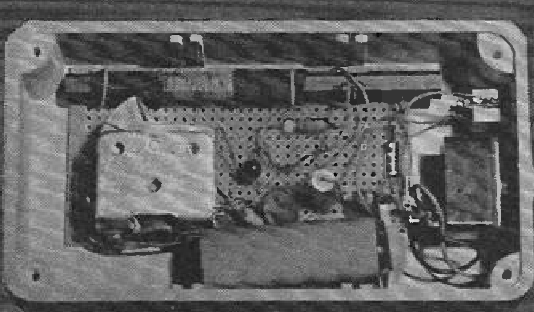
A circuit diagram of the receiver is shown in Fig. 1, TR1 is a field effect transistor, and this type of component is very different from an ordinary bipolar transistor. An ordinary transistor has a very high resistance between its collector and emitter terminals unless a small forward bias is applied to its base, whereupon its resistance will drop, and it can be used for linear amplification. An f.e.t. however, has a relatively low impedance across its drain and source terminals (equivalent of the collector and emitter of a bipolar transistor), and it is necessary to give it a small reverse bias in order to bring it into linear operating conditions.

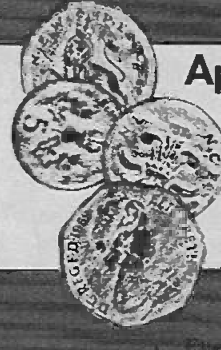
Referring to Fig. 1 it will be seen that the drain and source terminals of TR1 are connected as part of a potential divider network across the 9 volt supply. A small voltage will therefore appear at TR1 source. The gate of TR1 has to be held at earth potential so as to give the required reverse bias.

As the input impedance to the f.e.t. is extremely high, normally a very high value resistor would be used to fulfil this function. In this case though, the tuning coil, L1, has a dual function, and also acts as this biasing component.

REGENERATION

Coil L1, which is wound on a ferrite rod, forms the aerial, and the signals received by this are coupled into the gate of TR1. Capacitor C1 is the tuning capacitor, L2 is a regenerative feed-





Approximate cost of components including V.A.T.

£2.00 plus case

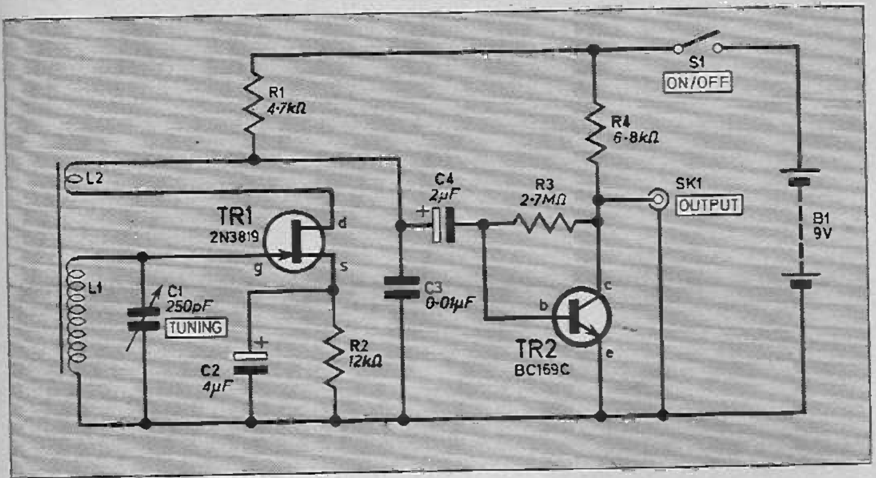


Fig. 1. Complete circuit diagram of the Fetset

back winding, and couples some of the amplified signal at TR1 drain back to the input of the circuit. This winding is adjusted to the point just below that at which the circuit breaks into oscillation. It is at this point that the maximum effective regeneration is applied, and the circuit is at its most sensitive.

In this particular application, TR1 is not biased into true linear operating conditions, as it is essential that it should amplify one half cycle of the r.f. (radio frequency) signal more than the other half in order to detect the signal, and produce an a.f. (audio frequency) output. The use of regeneration heightens this effect, and thus greatly increases the detectors efficiency. It also increases the r.f. gain of the circuit, and thus gives a large overall increase in sensitivity.

It is important that the type of regenerative circuit used gives a fairly even amount of feedback over the entire range of frequencies covered, so as to give the maximum sensitivity over the entire band. It is also important that the regeneration is not seriously affected by the drop in supply voltage caused by ageing of the battery. This circuit is very good in both these respects.

Capacitor C2 is the bypass capacitor for R2. The audio output of the detector is developed across R1, and C3 decouples the r.f. signal. The audio signal is fed to TR2 via C4.

Transistor TR2 forms a straightforward high gain audio amplifier stage, which has collector load resistor, R4, and base bias resistor, R3. The output is taken from TR2 collector, and is suitable for a crystal earpiece **only**. Switch S1 is the on/off switch.

FERRITE AERIAL

The ferrite aerial is home made, and Fig. 2 illustrates the construction of this. The coil is wound on a 102mm by ¼ inch diameter ferrite rod. If a rod of the correct length cannot be obtained, the length can be cut from a longer piece. At the point at which the rod is to be cut, a deep V shaped groove is made around the circumference of the rod using a triangular file. The rod is then given a sharp tap with the edge of the file at this point to break it in two.

If the end of the rod is left a little rough, this does not really matter. Care should be taken when handling the rod, as these are very brittle, and can easily smash if accidentally dropped.

Coil L1 consists of 65 turns of 32 s.w.g. wire (enamelled or double cotton covered) wound in a single layer. In order to prevent the coil

Components....

SEE **SHOP TALK**

Resistors
R1 4·7kΩ
R2 12kΩ
R3 2·7MΩ
R4 6·8kΩ
All ¼W ± 10% carbon

Capacitors
C1 250pF (approx.) miniature variable
C2 4µF elect. 9V
C3 0·01µF disc ceramic or Mullard C280 type
C4 2µF elect. 9V

Transistors
TR1 2N3819 or PN3819 f.e.t. *n* channel
TR2 BC169C silicon *npn*

Miscellaneous
S1 s.p.s.t. toggle or slide switch
SK1 3·5mm jack socket
B1 9V PP3 battery and clip
Ferrite rod 103mm x ¼ inch diameter, 32 s.w.g enamelled or double cotton covered copper wire (for L1), crystal earpiece, 0·1 inch matrix plain perforated Veroboard 90mm x 50mm, plastic case (see text) large diameter control knob, wire, fixing screws for C1 if needed.

fetset
MW RECEIVER

Photograph of the complëted Fetset, with earpiece.

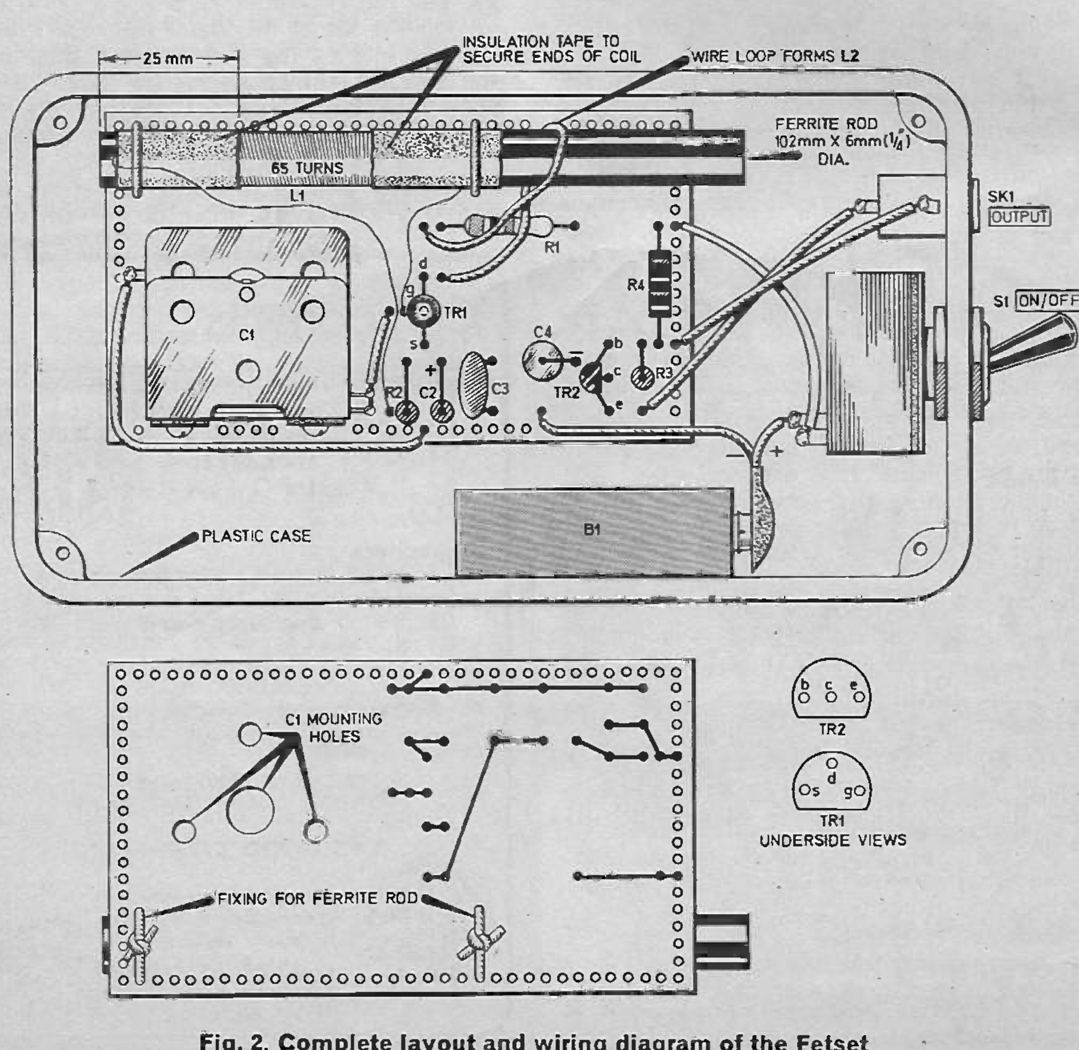


Fig. 2. Complete layout and wiring diagram of the Fetset

from unwinding, the lead out wires are taped to the rod using ordinary insulation tape (not Sellotape). Try to keep the winding reasonably neat, with the turns wound side by side, avoiding overlaps if possible. Ensure that the lead out wires are made sufficiently long (at least 80mm).

COMPONENT PANEL

Most of the wiring is on a 0·1 inch matrix perforated paxolin panel measuring 90mm x 50mm. Fig. 2 shows a diagram of the board.

The first task is to drill the mounting holes for C1. Some variable capacitors require a single $\frac{3}{8}$-inch diameter mounting hole, but others require a $\frac{5}{16}$-inch diameter hole for the component's spindle, and three smaller holes for three 4BA countersunk fixing screws (not normally supplied with the component). The ferrite aerial is tied to the board by two loops of thin p.v.c. sleeving or string.

Next the small components are mounted on the board and wired together. These are mounted in the positions shown in the diagram, and their lead out wires are bent over at right angles and cut to length. The leads are then directly soldered to one another, this underside wiring also being shown in Fig. 2.

Connections to C1, S1, SK1, etc., should be left until last. Three 50mm long insulated leads are connected to the board where the connections to S1, and SK1 are to be made. The connections to S1 and SK1 are not made until both these, and the component panel are mounted in the case.

Coil L2 consists of a 130mm length of single core p.v.c. insulated wire. This has a loop made in the middle, and this is slipped on, and pushed a little way onto, the ferrite rod. This in effect forms a single turn coil on the ferrite rod.

THE CASE

The prototype receiver is housed in a commercially produced fibreglass case with a removable aluminium back. There are several plastic boxes of about this size available (130 x 73 x 38mm), any of which is suitable for this project. A metal case cannot be used as this would screen the aerial, and so prevent the receiver from working.

The general layout of the components inside the case is also shown in Fig. 2. A mounting hole is required for SK1, and S1. The front panel of the case is drilled with mounting holes for C1. The component panel is secured inside the case by being trapped between C1 and the front of the case, C1 in effect being used to bolt the panel to the inside of the case.

ADJUSTMENT

Once construction has been completed it is only necessary to adjust the reaction coil (L2) for optimum results before the set is ready for use. With the earpiece connected and the receiver turned on, it should be possible to tune a few stations. If these are very weak, or none can be received at all, providing the set has been wired correctly, this means that L2 has incorrect phasing. To correct this, L2 is removed from the ferrite rod, twisted through 180 degrees, and then replaced on the rod.

For maximum sensitivity and selectivity, L2 is pushed as far onto the rod as possible without the set breaking into oscillation, at any setting of C1. When the set is oscillating there is a noticeable increase in background hiss, and a whistle will be heard as the set is tuned across a station.

In practice it is probably best not to take L2 too close to the threshold of oscillation, as the tuning will be so sharp that it will be difficult to tune a station properly, and the audio quality may suffer. It should, however, be possible to find a setting for L2 which gives good sensitivity, selectivity, and audio quality, just below this setting.

It should be found that L2 is firmly held in place by being trapped between the ferrite rod and the component panel, but if any further fixing should be found necessary, a small strip of insulation tape can be used to secure it to the rod.

As a finishing touch a simple dial can be marked around the control knob of C1, showing the station positions. Should it be found that tuning is difficult the size of the knob can be increased. ▣

AMPLIFIER FOR...

4 BAND T.R.F. RECEIVER

BY F.G.RAYER

A replacement amplifier for the circuit published in November 1973

THE *4 Band T.R.F. Receiver* in the November 1973 issue used a small integrated circuit audio amplifier, the MFC4000B. In view of delays which may be encountered in obtaining this IC due to the fact that most suppliers have sold out and a new consignment is not due for some months, a suitable substitute amplifier is described here. Though particularly intended for this receiver, it can of course be used for other purposes where a small amplifier of this kind is required. The amplifier replaces the *audio board* originally used.

CIRCUIT

The circuit is shown in Fig. 1, and both transistors are easily obtained, high gain types, VR1 is the volume control present in the original receiver, providing the required level of audio signals via capacitor C1 for the base of TR1. This is a high gain stage, stabilised by taking the base resistor R1 to the collector side of the load resistor R2.

The base of the second stage TR2 is capacitor coupled by C3. Working conditions in this stage are arranged for a collector current of about 15mA. This easily gives more than adequate headphone volume, while allowing modest volume reception with a loudspeaker, while not imposing a heavy drain for the PP9 type of 9V battery used.

Resistor R6 is the collector load for this stage, with audio output taken from C5, and this arrangement means that working conditions do not depend on the direct current resistance of the headphones or speaker which may be plugged into the output jack socket. It will be found that best results are obtained with medium impedance phones, or a speaker of about 75 ohms impedance, but other loads are satisfactory.

CIRCUIT BOARD

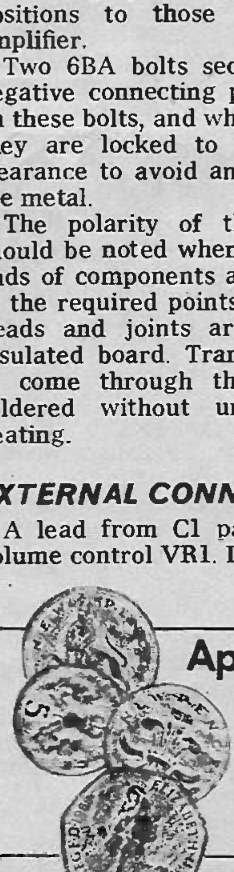
Both sides of the circuit board are shown in Fig. 2. It can be of the same size as originally used in the receiver, and input and other circuit connecting points are arranged in similar positions to those used with the original amplifier.

Two 6BA bolts secure tags which form the negative connecting points. Extra nuts are put on these bolts, and when the amplifier is finished they are locked to the chassis, with enough clearance to avoid any possible short circuit to the metal.

The polarity of the electrolytic capacitors should be noted when inserting these. The wire ends of components are bent over and soldered to the required points, excess being snipped off. Leads and joints are kept close against the insulated board. Transistor leads are arranged to come through the holes shown, and are soldered without unnecessary or prolonged heating.

EXTERNAL CONNECTIONS

A lead from C1 passes to the wiper of the volume control VR1. If the amplifier is not being



Approximate cost of components including V.A.T.

60p for extra components

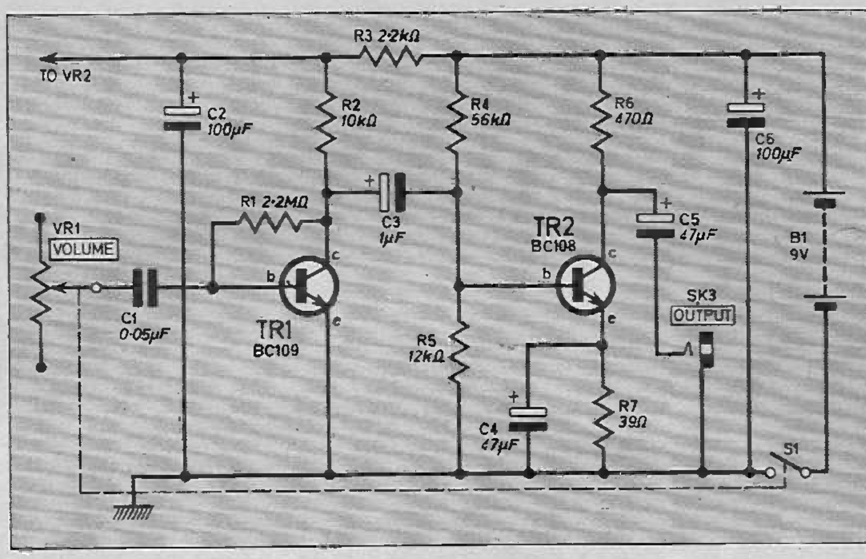


Fig. 1. Circuit of the new audio section for the 4 Band T.R.F. Receiver.

used with the receiver, but for some other purpose, connect the lower end of the volume control element to amplifier negative line.

A lead runs from positive of C2 to VR2, which is one of the regeneration controls of the receiver. If the amplifier is used alone for some other purpose, no connection is required here.

Battery positive goes to positive of C6, and battery negative to the negative line, the on-off switch being included here.

Leads from C5 negative and the earth or chassis line run to the output jack. Connect the sleeve contact tag to "earth" or chassis, and the tip contact to C5. ▣

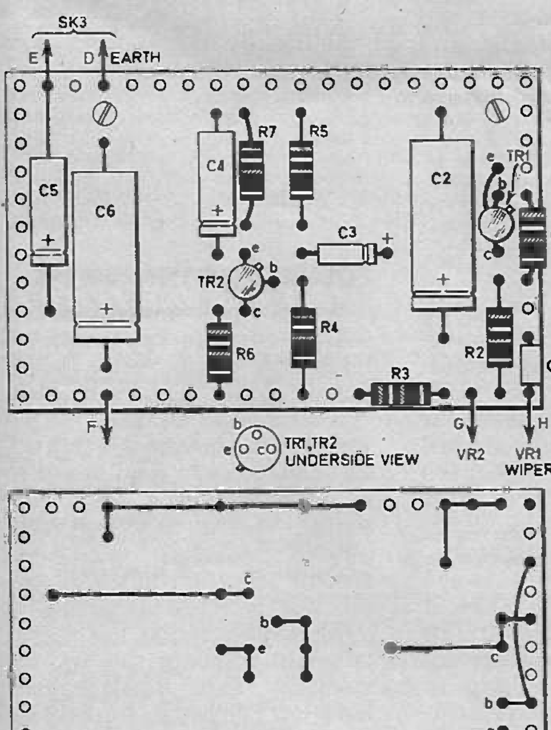


Fig. 2. Board layout and wiring diagram.

Components....

Resistors
- R1 2·2MΩ
- R2 10kΩ*
- R3 2·2kΩ*
- R4 56kΩ*
- R5 12kΩ
- R6 470Ω
- R7 39Ω
- All ¼W ±10% carbon

SEE SHOP TALK

Capacitors
- C1 0·05μF
- C2 100μF elect. 10V*
- C3 1μF elect. 10V
- C4 47μF elect. 10V
- C5 47μF elect. 10V
- C6 100μF elect. 10V*

Semiconductors
- TR1 BC 109 silicon *npn*
- TR2 BC 108 silicon *npn*

Miscellanous

* Veroboard 75 x 51 mm, 0·15 inch matrix plain type, connecting wire.

* Items marked thus may already have been purchased for the original amplifier design and need not be reordered.

DOWN TO EARTH

By GEORGE HYLTON

> "On the one hand, one is told that the decibel rating is a comparative ratio figure with no fixed unit value, and on the other that a decibel is the smallest sound difference audible to the human ear. Can you help?"

Let's get on at the start of the line; in this case a telephone line. The inventor of the telephone was, you'll remember, Alexander Graham Bell.

Long afterwards, when telephone engineers wanted a unit to describe the way signals get attenuated as they travel down a line they decided to honour the inventor by using his name. Being economically minded (or perhaps just bad spellers) they knocked off the final "l" and called the unit the "bel". The bel (B) is inconveniently large for most purposes, so we chop each bel into ten decibels (dB).

Problem: if you pump one milliwatt of audio power into a telephone line and this gives a usable range of 10 miles, what range will you get by increasing the power to 100 milliwatts? Common sense says, 1,000 miles. Practical experience shows that the new range it very much less, about 17 miles!

Common sense evidently looked at the problem the wrong way. Let's try a different approach.

RELATIVE LOSS

The power gets used up as the signals travel along the line. After a certain distance, half the power has gone. Suppose this distance is one mile. So if we start with 100 milliwatts, after one mile we have 50 milliwatts left. After two miles, we have 25 milliwatts, after three, 12·5 milliwatts, and so on, halving for each mile. Somewhere between six and seven miles down the line the power is reduced to one milliwatt.

We know that one milliwatt gives a range of 10 miles, so the range for 100 milliwatts is this plus the 6 to 7 miles it took to reduce the 100 milliwatts to one milliwatt. Total, between 16 and 17 miles.

DECIBELS

In terms of decibels, the telephone line had an attenuation of 3dB per mile. Decibels tell you at what rate something is decreasing (or increasing). A decrease of 3dB means a halving: a decrease of 30 per cent corresponds to 1·5dB.

In a telephone line, what declines is *power*. In electronics, we often want to work in voltage or current rather than power. Because power is proportional to voltage *squared* (doubling the voltage quadruples the power in a particular circuit), the decibel numbers come out differently for voltage and current comparisons than for power comparisons. Doubling the *power* gives a 3dB increase. Doubling the *voltage* gives a 6dB increase.

Why use decibels anyway? They are often used where it would be just as meaningful to use other ways of expressing gain or loss, it's true, but at times they are very convenient.

If a radio receiver has an r.f. gain of 10, an i.f. gain of 20,000, a detector efficiency of 50 per cent, and an audio gain of 400, the overall gain is 10 x 20,000 x 0·5 x 400. Whatever that comes to, it will be a large number with a lot of noughts at the end. In decibels, the gain is

$$20+86-6+52=152\text{dB}$$

which looks a lot tidier. Note that you add the gains of the successive stages when working in decibels (and subtract the losses, which explains the *minus* 6, for the detector).

COMPARISON

Strictly speaking, decibels give only comparisons. They tell how many times weaker or more intense one signal is compared to another. But if you pick on an agreed signal power and call that "0dB", the "0" standing, *not* for zero power but for the agreed reference power, then you can make a decibel figure stand for an actual power.

In telephone engineering, 0dB is usually one milliwatt. On this basis, 100 milliwatts is +20dB.

If the line halves the power every mile, you knock off 3dB per mile. So a power increase of 20dB (from one milliwatt to 100 milliwatts) gives a range increase of 20/3 miles which is 6·67 mile.

LOUDNESS

In loudness measurements 0dB usually refers to the sound intensity which the average person can just hear—the "threshold of hearing". This varies with frequency, but at 1000Hz it's about a millionth of a millionth of a watt per square metre. A very loud (almost painful) sound is around 120dB on this basis, or one watt per square metre. If these figures sound low in relation to amplifier powers, remember that loudspeakers have low efficiency, around *one* per cent!

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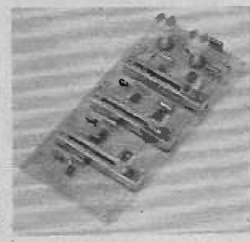
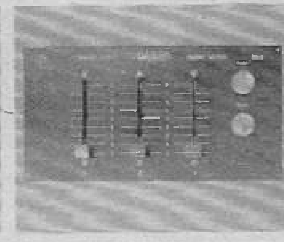




INTRODUCING THE NEW DABAR MINI THREE CHANNEL MIXER KIT WITH THE FOLLOWING FEATURES:

- ★ Three inputs easily adjustable to suit users input requirements, e.g., Mic., Tape, Disc., etc.
- ★ Uses advanced design with five integrated circuits.
- ★ Slider fader volume controls mount directly on P.C. board.
- ★ Full range bass and treble controls.
- ★ Guaranteed top grade components with fibreglass printed circuit board, ready-drilled and tinned.
- ★ Battery operated (2 x PP3) not supplied with kit.
- ★ Easy to follow assembly instructions (available separately 25p).
- ★ Attractive ready punched facia plate, available at extra cost, gives that professional finish to the unit.
- ★ Size: 9·5" x 4·8" x 2".

PRICE: KIT ONLY £11·00
FACIA PLATE £1·50
MANUAL AND ASSEMBLY INSTRUCTIONS 25p
AVAILABLE READY BUILT WITH FACIA £15·00

ALL PRICES INCLUDE V.A.T. & POSTAGE IN U.K.
S.A.E. ALL ENQUIRIES.

DABAR ELECTRONIC PRODUCTS
98, LICHFIELD STREET, WALSALL, STAFFS, WS1 1UZ.

EXPRESS COMPONENTS

17 ALBERT SQ., LONDON E15 1HJ

ELECTRONIC COMPONENTS FOR E.E. PROJECTS

FETSET	*JAN. 74*	**—SEE COST BOX**
TREMOLO	*DEC. 73*	**£1·50**
WAA-WAA	*SEPT. 73*	**£1·50**
GEN. PURP. AMP.	*APR. 73*	**£4·50**
BETA FUZZ-TREBLE	*JAN. 73*	**£1·50**

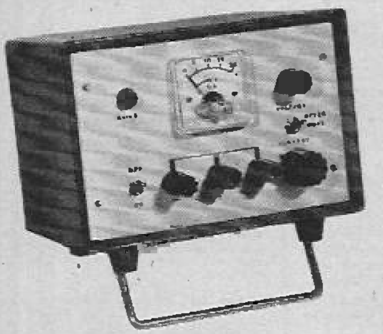
(For Beta Fuzz, Treble, Component board components only).

BETA TRANSFORMER **£1·85**

MAIL ORDER ONLY
S.A.E FOR ALL ENQUIRIES

NEXT MONTH...

The 1st *of* OUR TEST GEAR SERIES IN THE



e e TEST GEAR FIVE

POWER SUPPLY UNIT

A regulated 0 to 20V power supply unit capable of delivering up to 0·5A with current limiting.

Also...

SLIDE PROJECTOR TIMER

Provides automatic changing of slides when used with a suitable projector.

EMERGENCY LIGHTING

Don't be left in the dark. As soon as the mains power is cut, this device automatically switches to an auxiliary lighting system. It can also be used as a 12V battery charger.

everyday electronics

On sale Friday, January 18

YATES ELECTRONICS
(FLITWICK) LTD

DEPT. E.E., ELSTOW STORAGE DEPT.
KEMPSTON HARDWICK,
BEDFORD.

C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

Callers Welcome Mon. to Sat. 9 a.m. 5 p.m.

PLEASE ADD 10% VAT

RESISTORS
½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm.
¼W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7 Ω–2·2M Ω	E24	1p	0·8p
⅓	10%	3·3M Ω–10M Ω	E12	1p	0·8p
¼	2%	10 Ω–1M Ω	E24	3·5p	3p
½	10%	1 Ω–3·9 Ω	E12	1p	0·8p
1	5%	4·7 Ω–1M Ω	E12	1p	0·8p
4	10%	1 Ω–10 Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK
0·5 watt 5% Iskra resistors 5 off each value 4·7 Ω to 1M Ω.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS
Carbon track 5k Ω to 2M Ω, log or linear (log ½W, lin ¼W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS
Linear: 100, 250, 500 Ω and decades to 5M Ω. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

ZENER DIODES
400mW 5% 3·3V to 30V, 12p.

WIRE WOUND POTS.
3W, 10, 25, 50 Ω and decades to 100k Ω. 35p.

DIODES

RECTIFIER

BY127	1250V	1A	12p
1N4001	50V	1A	7p
1N4002	100V	1A	8p
1N4004	400V	1A	8p
1N4006	800V	1A	10p
1N4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
1N4148	5p
BA114	8p

SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. 40p.
DUAL GANG, 10K + 10K etc. log. or lin. 60p.
KNOB FOR ABOVE, 12p.
FRONT PANEL, 65p.
18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

BRUSHED ALUMINIUM PANELS
12in x 6in, 25p
12 in x 2½in. 10p
9in x 2in. 7p

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

ALUMINIUM BOXES

AB7	2½" x 5¼" x 1½"	50p	AB14	7" x 5" x 2½"	84p
AB8	4" x 4" x 1½"	50p	AB15	8" x 6" x 3"	108p
AB9	4" x 2½" x 1½"	50p	AB16	10" x 7" x 3"	122p
AB10	4" x 5¼" x 1½"	50p	AB17	10" x 4½" x 3"	108p
AB11	4" x 2½" x 2"	60p	AB18	12" x 5" x 3"	120p
AB12	3" x 2" x 1"	44p	AB19	12" x 8" x 3"	160p

HEATSINKS—REDPOINT

2W	24p	4W	45p	TO5 Clip	5p	TO1 Single	5p
3W	36p	6W	60p	TO18 Clip	5p	TO1 Double	8p

TRANSFORMERS
All have 240V primary

MT30/2	0–12–15–20–24–30V	2A	£2·85
MT50/½	0–19–25–33–40–50V	½A	£1·90
MT50/1	0–19–25–33–40–50V	1A	£2·55
MT50/2	0–19–25–33–40–50V	2A	£3·50
MT60/½	0–24–30–40–48–60V	½A	£2·10
MT60/1	0–24–30–40–48–60V	1A	£2 80
MT60/2	0–24–30–40–48–60V	2A	£3 80

MULLARD POLYESTER CAPACITORS C296 SERIES
400V: 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 0·0047µF, 2½p. 0·0068µF, 0·01µF, 0·015µF, 0·022µF, 0·033µF, 3p. 0·047µF, 0·068µF, 0·1µF, 4p. 0·15µF, 6p. 0·22µF, 7½p. 0·33µF, 11p. 0·47µF, 13p.
160V: 0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, 0·068µF, 3p. 0·1µF, 3½p. 0·15µF, 4½p. 0·22µF, 5p. 0·33µF, 6p. 0·47µF, 7½p. 0·68µF, 11p. 1·0µF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01µF, 0·015µF, 0·022µF, 3p. 0·033µF, 0·047µF, 0·068µF, 3½p. 0·1µF, 4p. 0·15µF, 0·22µF, 5p. 0·33µF, 6½p. 0·47µF, 8½p. 0·68µF, 11p. 1·0µF, 13p. 1·5µF, 20p. 2·2µF, 24p.

MYLAR FILM CAPACITORS 100V
0·001µF, 0·002µF, 0·005µF, 0·01µF, 0·02µF, 2½p. 0·04µF, 0·05µF, 0·068µF, 0·1µF, 3½p.

CERAMIC DISC CAPACITORS
100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS
(µF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, 6p. 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, 7p. 68/63, 150/40, 220/40, 330/16, 1000/4, 10p. 470/10, 680/6·3, 11p. 100/63, 150/63, 220/63, 1000/10, 12p. 470/25, 680/16, 1500/6·3, 13p. 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, 18p. 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS
12p

0·1µF	35V	2·2µF	35V	22µF	16V
0·22µF	35V	4·7µF	35V	33µF	10V
0·47µF	35V	6·8µF	25V	47µF	6·3V
1·0µF	35V	10µF	25V	100µF	3V

VEROBOARD

	0.1	0.15
2½ x 3¾	22p	16p
2½ x 5	24p	24p
3¾ x 3¾	24p	24p
3¾ x 5	27p	27p
17 x 2½	75p	57½p
17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS
2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

BATTERY ELIMINATOR
£1.50
9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600µF	64V	74p	2500µF	64V	80p	4500µF	16V	50p
2500µF	40V	74p	2800µF	100V	£2·60	4500µF	25V	£1·68
2500µF	50V	58p	3200µF	16V	50p	5000µF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01µF	10p	0·047µF	13p	0·22µF	20p
0·022µF	12p	0·1µF	13p	0·47µF	22p

POLYSTYRENE CAPACITORS 160V 2½%
10pF to 1,000pF E12 Series Values, 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GD1
The GD1 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 GD1, £2. Kit of parts for detectors including GD1 and P.C. board but excluding case. Mains operated detector £5·20. 12 or 24V battery operated audible alarm £7·30. As above for PP9 battery, £6·40.

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

METERS
1½" Scale-500uA, 1mA, 10mA, 100mA £1·90

BULGIN MAINS CONNECTORS

3 Pin 1½A	Chassis Plug	10p	
	Line Socket	13p	
3 Pin 3A	Chassis Plug	10p	
	Line Socket	14p	
3 Pin 5A	Chassis Plug	16p	
	Line Socket	15p	
3 Pin 1½A	Chassis Socket	18p	
	Line Plug	13p	
3 Pin 3A	Chassis Socket	21p	
	Line Plug	23p	
2 Pin 5A	Line Plug	20p	

THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

WAVECHANGE SWITCH 23p
1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

ROTARY MAINS SWITCH
D.P. 2A 32p

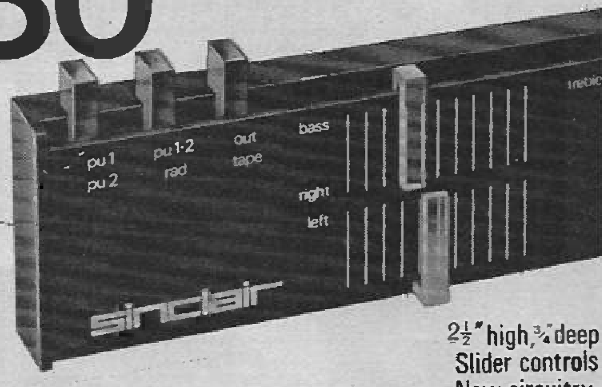
LINEAR IC's

709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	45p

DIL Sockets 14 pin and 16 pin 16p

Project 80

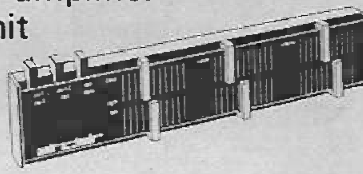
the slimmest, most elegant hi-fi modules ever made



2½" high, ¾" deep
Slider controls
New circuitry

Living with hi-fi takes on new meaning with Project 80 modules. They can be assembled virtually anywhere, creating opportunities to install systems hitherto only dreamed about and never before made practical. Quality and reliability are everything you could wish for. Units are mounted by 6BA bolts at rear passing through drilled holes. cases are in black with white embellishment.

Stereo 80 pre-amplifier and control unit

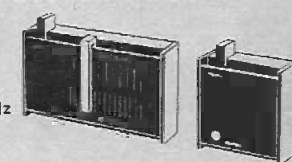


Each channel has independent tone and volume slider controls enabling exceptionally good environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry which includes generous overload margins. Clear instructions with template are supplied.

Size – 260 × 50 × 20mm (10¼ × 2 × ¾ ins)
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U., Radio, Tape
S/N ratio – 60db
Frequency range – 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape, radio and P.U. Sliders for Volume, Bass and Treble.

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder



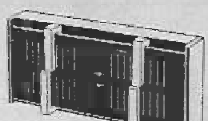
FM Tuner
Size – 85 × 50 × 20mm
Tuning range – 87.5 to 108 MHz
Detector – I.C. balanced coincidence.
AFC – Switchable
One 26 transistor I.C.
Twin dual varicap tuning
Distortion 0.2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Sensitivity – 4 microvolts for 30dB quieting
Output – 300mV for 75 KH deviation

Decoder–
With gallium arsenide tuning beacon and 19-transistor I.C.
Size – 47 × 50 × 20mm

FM tuner R.R.P. £11.95 +£1·19 V.A.T.

Decoder R.R.P. £7.45 +0·45p V.A.T.

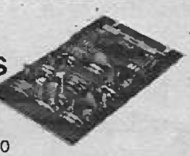
Project 80 active filter unit



Size – 108 × 50 × 20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz, controls minimum
Distortion – at 1KHz 0·03% using 30V
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
LF. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope

R.R.P £6.95 +0·69p V.A.T.

Z.40 & Z.60 power amplifiers



Z.40
Size – 55 × 80 × 20mm
Input sensitivity – 100mV
Output 15W RMS continuous 8 Ω (35V).
Frequency response – 10Hz – 100KHz ±1dB
Signal to noise ratio – 64dB
Distortion – less than 0·1% at 10W into 8 Ω
Power requirements 12-35 volts

R.R.P. £5.45 +0·54p V.A.T.

Z.60
Size – 55 × 98 × 20mm
Input sensitivity – 100-250mV
Output – 25W RMS 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ±1dB
S/N ratio – better than 70dB

R.R.P. £6.95 +0·69p V.A.T.

Sinclair power supply units

PZ.8
The worlds most advanced unit in its class. It is a stabilised unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before incorporated in a commercially available constructor module. Normal working voltage (adjustable) 45V.
R.R.P. £7·98 + 0·79p V.A.T.
Without mains transformer
PZ.5 30V unstabilised
R.R.P. £4·98 + 0·49p V.A.T.
PZ.6 35V stabilised
R.R.P. £7·98 + 0·79p V.A.T.

Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed Stockists also offer this guarantee.
Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a small charge (typically £1·00) will be made.

To SINCLAIR RADIONICS LTD. ST. IVES, HUNTINGDON PE17 4HJ

Please send post paid ____________________

for which I enclose Cash/Cheque for £ ______ including V.A.T.

Name ____________________

Address ____________________

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HIGH QUALITY CONSTRUCTION KITS
Appointed stockists at all branches
Complete with comprehensive, easy to follow instructions, and covered by full guarantee
Post and packing 15p per kit

Josty Electronics Construction Kits

AF20	Mono Transistor Amplifier	£4·80
AF30	Mono Transistor Pre-Amplifier	£2·61
AF310	Mono Amplifier (use two for stereo)	£5·91
AT5	*Automatic Light Control	£2·58
AT30	Photo Cell Switching Unit	£5 70
AT50	400W Triac Light Dimmer/Speed Control	£4·80
AT55	1300W Triac Light Dimmer/Speed Control	£5·70
AT56	2200W Triac Light Dimmer/Speed Control	£6·90
AT60	Psychedelic Light Control, Single Channel	£7·80
AT65	Psychedelic Light Control, 3 Channel	£14·55
HF61	Medium Wave Transistor Radio	£3·33
HF75	FM Transistor Receiver	£2·88
HF310	FM Tuner Unit	£15·81
HF325	Deluxe FM Tuner Unit	£24·12
HF330	Stereo Decoder for HF310/HF325	£9·98
HF395	Aerial Amplifier for AM/FM Bands 1, 2 & 3	£1·77
GP310	Stereo Pre-Amp for use with 2 x AF310	£21·27
GU330	Tremolo Unit for Guitars etc.	£7·50
NT10	Power Supply 100mA. 9V Stab. 12V Unstab.	£6·15
NT300	Professional Stabilised Power Supply 2 x 30 Volt, 2·2 Amp	£12·51
NT305	Transistor Convertor 12/15V AC/DC to 6V, 7·5V or 9V DC	£4·50
NT310	Power Supply 240V AC to 2 x 18V DC at 2 Amps	£4·30
NT315	Power Supply 240V AC to 4·5–15V DC at 500mA	£9·57
AE1	100mW Output Stage	£1·65
AE2	Pre-Amplifier	£1·26
AE3	Diode Receiver	£2·00
AE4	Flasher	£1·09
AE5	Astable Multivibrator	£1·05
AE6	Monostable Multivibrator	£1·02
AE7	RC Generator	£1·06
AE8	Bass Filter	·99
AE9	Treble Filter	·99
AE10	CCIR Filter	·99

IDEAL GIFT FOR ALL AGES!

AMATEUR ELECTRONICS

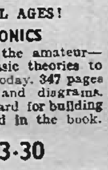
The professional book for the amateur—covers the subject from basic theories to the advanced electronics of today. 347 pages of invaluable information and diagrams. Complete with free circuitboard for building 10 of the projects described in the book. (Components extra).

P. & P. 25p OUR PRICE **£3·30**

"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. All models—Input 230V. 50/60 c/s. Variable output 0–260V.

MODEL S-260 GENERAL PURPOSE BENCH MOUNTING



	£	P.&P.
1 Amp	8·75	30p
2·5 Amp	10·00	35p
5 Amp	14·70	37p
8 Amp	25·30	50p
10 Amp	28·10	75p
12 Amp	29·50	100p
20 Amp	72·50	125p
25 Amp	72·50	130p
40 Amp	103·10	150p

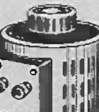
MODEL S-260B

Panel Mounting.

1 Amp	8·75	30p
2·5 Amp	10·00	35p

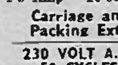
Carriage and Packing Extra

230 VOLT A.C. 50 CYCLES RELAYS



3 sets of changeover contacts at 5 amp rating, 40p each. P. & P. 12p (100 lots £30. Quantities available.

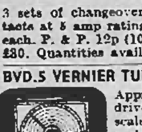
BVD.5 VERNIER TUNING DIAL



Approx. 7–1 ratio planetary drive vernier dials. Log scale 0–180 degrees. Blank scales 1 to 5. Scale width 4¼". Dial size 5" × 3". Overall size 7½" × 4¾" × 1¾" deep including knob and coupling. ¼" dia. shaft.

OUR PRICE **£1·62** P. & P. 15p.

REFLEX HORN SPEAKER RUH.6



Built in driver unit. Impedance 16 ohm. Power rating 10 watt. Response 380–7000Hz. Approx. size 6" × 6". Weatherproof and shock proof.

OUR PRICE **£4·97** P. & P. 30p.

SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVT. DEPTS., EDUCATIONAL AUTHORITIES, ETC.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

Type SW.100 100 x 80 mm.

50μA	£4·15	5 amp. D.C.	£3·60
50–0–50μA	£3·95	300V. A.C.	£3·70
100μA	£3·95	VU Meter	£4·30
100–0–100μA	£3·90		
500μA	£3·70		
1mA	£3·60		
20V. D.C.	£3·60		
50V. D.C.	£3·60		
300V. D.C.	£3·60		
1 amp. D.C.	£3·60		

Type SD.830 82.5mm x 110mm Fronts

50μA	£3·40	10mA	£3·10
50–0–50μA	£3·40	50mA	£3·10
100μA	£3·35	100mA	£3·10
100–0–100μA	£3·35	500mA	£3·10
200μA	£3·30	1 amp.	£3·10
500μA	£3·15	5 amp.	£3·10
1mA	£3·10	10 amp.	£3·10
5mA	£3·10	5V. D.C.	£3·10
		10V. D.C.	£3·10
		20V. D.C.	£3·10
		50V. D.C.	£3·10
		300V. D.C.	£3·10
		15V. A.C.	£3·30
		300V. A.C.	£3·30
		VU Meter	£3·50

Type SD.640 63.5mm x 85mm Fronts

50uA	£3·05	500mA	£2·90
50–0–50μA	£3·05	1 amp.	£2·90
100μA	£3·00	5 amp.	£2·90
100–0–100μA	£3·00	10 amp	£2·90
200μA	£3·00	5V. D.C.	£2·90
500μA	£2·95	20V. D.C.	£2·90
1mA	£2·90	50V. D.C.	£2·90
5mA	£2·90	300V. D.C.	£2·90
10mA	£2·90	15V. A.C.	£3·00
50mA	£2·90	300V. A.C.	£3·00
100mA	£2·90	VU Meter	£3·15

Type MR.45P. 2in. square fronts

50μA	£2·70	5 amp.	£2·40
50–0–50μA	£2·65	10V. D.C.	£2·40
100μA	£2·60	20V. D.C.	£2·40
100–0–100μA	£2·60	50V. D.C.	£2·40
200μA	£2·50	300V. D.C.	£2·40
500μA	£2·45	15V. A.C.	£2·40
500–0–500μA	£2·40	300V. A.C.	£2·40
1mA	£2·40	8 Meter 1mA	£2·60
5mA	£2·40	VU Meter	£2·70
10mA	£2·40	1 amp. A.C. *	£2·40
50mA	£2·40	5 amp. A.C. *	£2·40
100mA	£2·40	10 amp. A.C. *	£2·40
500mA	£2·40	20 amp. A.C. *	£2·40
1 amp.	£2·40	30 amp. A.C. *	£2·40

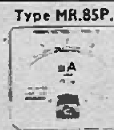
"SEW" EDUCATIONAL METERS

Type ED.107. Size overall 100mm x 90mm x 108mm

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50μA	£6·90	15V d.c.	£5·95
100μA	£6·40	20V. d.c.	£5·95
50–0–50μA	£6·40	50V. d.c.	£5·95
1mA	£5·95	300V. d.c.	£5·95
1–0–1mA	£5·95	Dual range	
1A d.c.	£5·95	500mA/5A d.c.	£7·00
5A d.c.	£5·95	1/15A d.c.	£7·00
5V d.c.	£5·95	5V/50V d.c.	£7·00
10V d.c.	£5·95	5/15V d.c.	£7·00

Type MR.85P. 4¼in. x 4¼in. fronts



50μA	£4·40	100mA	£3·90
50–0–50μA	£4·25	500mA	£3·90
100μA	£4·25	1 amp.	£3·90
100–0–100μA	£4·05	5 amp.	£3·90
200μA	£4·05	15 amp.	£3·90
500μA	£3·90	30 amp.	£3·95
500–0–500μA	£3·90	10V D.C.	£3·90
1mA	£3·90	20V. D.C.	£3·90
1–0–1mA	£3·90	50V. D.C.	£3·90
5mA	£3·90	150V. D.C.	£3·90
10mA	£3·90	300V. D.C.	£3·90
50mA	£3·90	15V. A.C.	£3·95
		300V. A.C.	£3·95
		8 Meter 1mA	£3·90
		VU Meter	£4·55
		1 amp. A.C.*	£3·90
		5 amp A.C.*	£3·90
		10 amp. A.C.*	£3·90
		20 amp. A.C.*	£3·90
		30 amp. A.C.*	£3·90

Type MR.52P. 2¼in. square fronts

50μA	£3·50	10V. D.C.	£2·50
50–0–50μA	£3·05	20V. D.C.	£2·50
100μA	£3·00	50V. D.C.	£2·50
100–0–100μA	£2·95	300V. D.C.	£2·50
500μA	£2·65	15V. A.C.	£2·60
1mA	£2·50	300V. A.C.	£2·60
5mA	£2·50	8 Meter 1mA	£2·60
10mA	£2·50	VU Meter	£3·60
50mA	£2·50	1 amp. A.C. *	£2·50
100mA	£2·50	5 amp. A.C. *	£2·50
500mA	£2·50	10 amp. A.C. *	£2·50
1 amp	£2·50	20 amp. A.C. *	£2·50
5 amp	£2·50	30 amp. A.C. *	£2·50

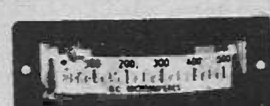
Type MR.65P. 3½in. x 3¼in. fronts

50μA	£3·70	10V. D.C.	£2·60
50–0–50μA	£3·15	20V. D.C.	£2·60
100μA	£3·15	50V. D.C.	£2·60
100–0–100μA	£3·10	150V. D.C.	£2·60
200μA	£3·05	300V. D.C.	£2·60
500μA	£2·75	15V. A.C.	£2·80
500–0–500μA	£2·60	50V. A.C.	£2·80
1mA	£2·60	150V. A.C.	£2·80
5mA	£2·60	300V. A.C.	£2·80
10mA	£2·60	500V. A.C.	£2·80
50mA	£2·60	8 Meter 1mA	£2·85
100mA	£2·60	VU Meter	£6·70
500mA	£2·60	50mA A.C. *	£2·60
1 amp.	£2·60	100mA A.C. *	£2·60
5 amp.	£2·60	200mA A.C. *	£2·60
10 amp.	£2·60	500mA A.C. *	£2·60
15 amp.	£2·60	1 amp. A.C. *	£2·60
20 amp.	£2·60	5 amp. A.C. *	£2·60
30 amp.	£2·80	10 amp. A.C. *	£2·60
50 amp.	£2·90	20 amp. A.C. *	£2·60
5V. D.C.	£2·60	30 amp. A.C. *	£2·60

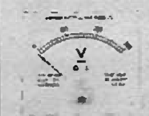
"SEW" EDGWISE METERS

Type PE.70. 3 17/32in. x 1 15/32in. x 2¼in. deep

50μA	£3·75	500μA	£3·20
50–0–50μA	£3·60	1mA	£3·20
100μA	£3·60	300V. A.C.	£3·25
100–0–100μA	£3·50	VU Meter	£3·85
200μA	£3·40		



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



50μA	£2·55	200mA	£2·25
50–0–50μA	£2·50	300mA	£2·25
100μA	£2·45	500mA	£2·25
100–0–100μA	£2·40	750mA	£2·25
200μA	£2·25	1 amp.	£2·25
500μA	£2·25	2 amp.	£2·25
500–0–500μA	£2·25	5 amp.	£2·25
1mA	£2·25	10 amp.	£2·25
1–0–1mA	£2·25	3V. D.C.	£2·25
2mA	£2·25	10V. D.C.	£2·25
5mA	£2·25	15V. D.C.	£2·25
10mA	£2·25	20V. D.C.	£2·25
20mA	£2·25	50V. D.C.	£2·25
50mA	£2·25	100V. D.C.	£2·25
100mA	£2·25	150V. D.C.	£2·25
150mA	£2·25	300V. D.C.	£2·25
		500V. D.C.	£2·25
		750V. D.C.	£2·25
		15V. A.C.	£2·30
		50V. A.C.	£2·30
		150V. A.C.	£2·30
		300V. A.C.	£2·30
		500V. A.C.	£2·30
		8 Meter 1mA	£2·30
		VU Meter	£2·65

Type SD.460 46mm x 59.5mm Fronts

50μA	£2·80	1 amp.	£2·60
50–0–50μA	£2·80	5 amp.	£2·60
100μA	£2·75	10 amp.	£2·60
100–0–100μA	£2·75	5V. D.C.	£2·60
200μA	£2·70	10V. D.C.	£2·60
500μA	£2·55	20V. D.C.	£2·60
1mA	£2·50	50V. D.C.	£2·60
5mA	£2·60	300V. D.C.	£2·60
10mA	£2·60	15V. A.C.	£2·70
50mA	£2·60	300V. A.C.	£2·70
100mA	£2·60	VU Meter	£2·90
500mA	£2·60		

"SEW" BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts

25μA	£4·60	2 amp.	£2·50
50μA	£3·55	5 amp.	£2·60
50–0–50μA	£3·05	15 amp.	£2·60
100μA	£3·00	30 amp.	£2·60
100–0–100μA	£3·00	50 amp.	£2·60
500μA	£2·70	5V. D.C.	£2·60
500–0–500μA	£2·60	10V. D.C.	£2·60
1mA	£2·60	20V. D.C.	£2·60
1–0–1mA	£2·50	50V. D.C.	£2·60
5mA	£2·50	150V. D.C.	£2·60
10mA	£2·60	300V. D.C.	£2·60
50mA	£2·60	50mV. D.C.	£2·90
100mA	£2·60	100mV. D.C.	£2·90
500mA	£2·60	30V. A.C. *	£2·65
1 amp.	£2·60	50V. A.C. *	£2·65
		150V. A.C. *	£2·65
		300V. A.C. *	£2·65
		500V A.C.	£2·65
		500mA A.C. *	£2·60
		1 amp. A.C. *	£2·60
		5 amp. A.C. *	£2·60
		10 amp. A.C. *	£2·60
		20 amp. A.C. *	£2·60
		30 amp. A.C. *	£2·60
		50 amp. A.C. *	£2·60
		VU Meter	£3·65

Type S-80 80 mm. square fronts

50μA	£3·50	5 amp. D.C.	£3·00
50–0–50μA	£3·40	300V. A.C.	£3·00
100μA	£3·40	VU Meter	£3·70
100–0–100μA	£3·30		
500μA	£3·05		
1mA	£3·00		
20V. D.C.	£3·00		
50V. D.C.	£3·00		
300V. D.C.	£3·00		
1 amp. D.C.	£3·00		

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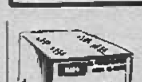
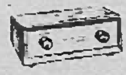


Solid state. Output 6, 9 or 12 volt DC up to 3 amps. Meter to monitor current. Input 220/240v AC. Size 4" × 3½" × 6½". £11·97. P. & P. 25p.

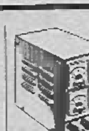
MP7 MIXER PREAMPLIFIER



5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9¼" × 5" × 3". Inputs Mics: 3×3mV 50K; 2×3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.

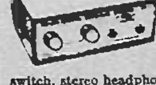
Our Price **£8·97** P. & P. 20p

PS.200 REGULATED P.S.U.



Solid state. Variable output 5-20 volt D.C. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240 V. A.C. Size 7½" × 5¼" × 3¾". £19·95. P. & P. 25p.

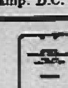
1021 STEREO LISTENING STATION



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6" × 3 × 2¼".

Our Price **£2·25** P. & P. 15p

MCA. 220 AUTOMATIC VOLTAGE STABILISER



Input 88 125 VAC or 176, 250VAC. Output 120VAC or 240VAC. 200VA rating. £11·97. Carr. 50p.

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KITS FOR PREVIOUS PROJECTS

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

If reprint of data is required add 10p

HOME SENTINEL. "Ward off the unwanted intruder"—No elaborate setting up or wiring required. Kit of parts £4·85.
"SNAP" INDICATOR. Press your button first and your opponent is blocked also suitable for Quiz games and reaction testing. Kit of parts £1·10.
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AUDIO TONE GENERATOR. Makes electronic music—covers range from 50—2000 hz. Specifically designed for use with tape recorder. Kit £3·25.
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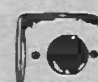
EGG TIMER. Simple timer with audible warning. £4·15.

THYRISTOR LIGHT DIMMER



Domestic model for any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·95. Industrial model 5 amp module with control knob not on switch plate £3·30.

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Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·50 plus 25p P. & P.

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This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £6·55 plus 20p p. & p. Deluxe model with prepared circuit board £7·95. When ordering please state whether for positive or negative systems.

TEACH IN '74

A new beginners series started with the October issue of this magazine, we will be supplying all the parts for this. The initial kit covering all components required for the first 6 months is available post and VAT included—price £7. A special feature about our version of this kit is the 4½" × 3" meter 0–100uA meter. As the author says, a large meter is so much easier to read than a small one.

MIGHTY MIDGET

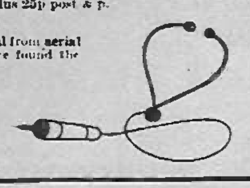
Probably the tiniest possible radio, as described in Practical Wireless, January '73. All electronic parts £2·20 post paid.

DRILL CONTROLLER
NEW IKW MODEL

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions £1·95 plus 13p post and insurance. Made up model also available. £2·95 plus 25p post & p.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2·20—twin stethoset instead of earpiece 88p extra—post and ins. 20p.



V.C.O. EFFECTS UNIT
SEWING MACHINE SPEED CONTROL
F.E.T. RECEIVER

To receive parts for these and other feature projects, send the quoted approximate amounts and any cash adjustment can be made later.

GOOD COMPANION

We can now offer these again in i.c. version using Ferranti ZN414 and Mullard AF Modules 1172. Excellent tone wood cabinet. Cabinet size approx. 11in wide × 8in. high × 3in. deep. Complete assembly instructions £5·75 plus 25p post and ins.

STANDARD WAFER SWITCHES

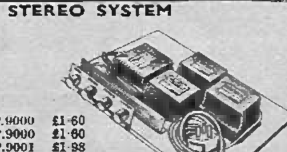
Standard size 1½" wafer—silver-plated 5-amp contact, standard ¼" spindle—2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10way	12way
1 pole	44p	44p	44p	44p	44p	44p	44p	44p	44p
2 poles	44p	44p	44p	44p	44p	44p	44p	77p	77p
3 poles	44p	44p	44p	44p	77p	77p	77p	£1·04	£1·04
4 poles	44p	44p	44p	77p	77p	77p	77p	£1·32	£1·32
5 poles	44p	44p	77p	77p	£1·04	£1·04	£1·04	£1·60	£1·60
6 poles	44p	77p	77p	77p	£1·04	£1·04	£1·04	£1·87	£1·87
7 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·15	£2·15
8 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·42	£2·42
9 poles	77p	77p	£1·04	£1·04	£1·60	£1·60	£1·60	£2·70	£2·70
10 poles	77p	77p	£1·04	£1·32	£1·60	£1·60	£1·60	£3·00	£3·00
11 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·25	£3·25
12 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·52	£3·52

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in £1·69. 13in × 10in £1·21.

MULLARD UNILEX STEREO SYSTEM



There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this:—

1 Unilex Amplifier Ref. EP.9000 £1·60
1 Unilex Amplifier Ref. EP.9000 £1·60
1 Unilex Pre-Amp Ref. EP.9001 £1·98
1 Unilex Power Unit Ref. EP.9002 £2·53
1 Control panel kit with spun aluminium faced knobs .. .. £3·30

Or the complete outfit—£11·30 post paid.

Pair of 15 ohm speakers made by E.M.I. are also available if required, price £3·30 the pair. No extra postage if ordered with the above, otherwise add 25p.

KITS FOR PREVIOUS PROJECTS CONT. FROM LEFT HAND COL.

NEON NOVELTY. Interesting modern ornamental device £1·65.
INDICATOR AUDIBLE WARNING. Add this audible warning device to car indicators or dash panel warning lights and your attention will be instantly drawn to the warning lamp kit. £1·20.
NIGHT LIGHT SWITCH. A simple control to dim a lamp. Kit £1·10.
GENERAL PURPOSE AMPLIFIER. An audio amplifier of reasonable quality for use with radio tuners—audio oscillators, record decks—electric guitars, etc. Kit £4·90.
HOME INTERCOM. Keep in touch with this simple, easily connected good quality two way intercom. Kit £4·00.
FLASHING LIGHT METRONOME. For use in the musical field and the laboratory—where an audible not on click could get lost or become annoying. Kit £1·40.
MINI ORGAN. A three octave, stylus operated organ—neatly and simply constructed on a printed circuit board. Kit £4·75.
RAIN ALARM II. Sounds an audible alarm as soon as the first rain drops fall. Kit £3·00.
CASSETTE AMPLIFIER. Boosts the output from cassette tape recorders and transistor radios. Kit £4·50.
AUDIO SIGNAL MIXER. Where you want to mix speech and music, and to fade them in and out—no tape enthusiast should be without this. Kit £3·90.
AUTO FAN. A thermostatic control for car engine fan, gives quicker warming up time, etc. Kit £2·35.
SLAVE FLASH. Photos taken with a single flash have a "flat" appearance—a second flash correctly positioned overcomes this. This unit enables a second (or third) flash to be automatically triggered. Kit £1·85.
ELECTRONIC DOORBELL. Not in fact a bell but an electronic circuit that produces an unusual sound when the button is pressed. Kit £4·00.
WAA WAA. Add another sound dimension to your guitar or organ. Kit £1·50.
I.C. RADIO. A fantastic personal radio uses a special I.C., is small, easy to build, yet gives excellent results. Kit £3·10.
AQUARIUM THERMOSTAT. A very sensitive electronic thermostat. Can also be used for other applications requiring fine control of temperature. Kit £2·85.
TRAIN CONTROLLER. With most control there is considerable loss of power on low speeds—this unit overcomes this problem and makes slow speed realistic. Kit £3·15.
3 GANG TUNING CONDENSERS. 500pf each section ideal for transmitter or communications receiver. 61p.
STEREO HEADPHONE ADAPTER. Enables one or two sets of stereo headphones to be used with an amplifier. £1·85.
4 BAND TRF RECEIVER. Receives amateur, shipping and normal medium wavebands. £8.
GAS ALARM. A simple alarm detects gases, vapours and smoke. £5·99.
3 BY 3 GAME. Adds fun to any game which uses dice, or is novel game for two players. £2·10.
AUTO-WATERING FOR PLANTS £2·20.
TREMELO UNIT £2·10.
BABY SNATCH ALARM £8·00.

OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS. NOW AVAILABLE. PRICE 30p. POST PAID.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads 50p each.
4 track record playback heads 72p each.
Erase heads are also available separately—2 track 33p—4 track 55p.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1·10 each or £12 per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

HEATERS AND ELEMENTS

Tangential Heater Unit, 2KW, price £2·75 plus 40p post, etc. Tangential Heater Unit, 3KW, price £3·88 plus 40p post, etc. Control Switch for above 44p each. 300 watt Heat and Light Lamp, price 99p plus 25p post. 5KW Blower Heater, price £19·19. 1000 watt Heat and Light Tube (Mullard) with special holder and terry clips, price £2·20 plus 30p post. 2000 watt Mouldable Metal Clad Element, 8 ft. long—£1·10. Radiant Cooker Rings, 2000 watt, 83p each 1000 watt Fire Spirals, 22p each. 750 watt Flat Elements, 33p each. Black Heat Element Metal Clad 900 watt 14" × 1¼"—88p each. Oven Element Metal Clad, 2000, watt, "W" shaped, 14½" long × 9" wide 93p each.

NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. 8p each 10 for 60p. Plastic pushrod suitable for operating. 6p each. 10 for 54p.

TERMS:—10% discount if ten of an item ordered, send postage where quoted—other items, post free if order for these over £6·00 otherwise add 25p.

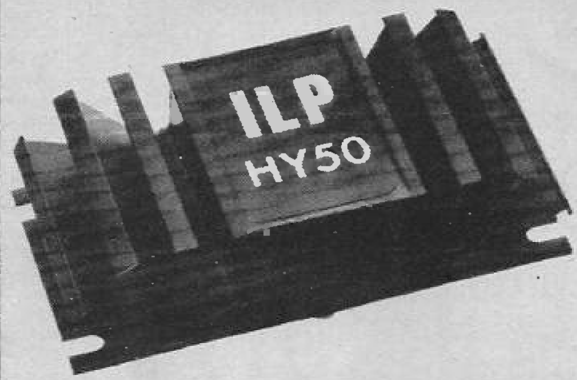
J. BULL (ELECTRICAL) LTD.

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

Callers to: 102/3 Tamworth Road, CROYDON.

I.L.P. (Electronics) Ltd

SECOND GENERATION 25 WATT HYBRID



A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices.
We have now finally reduced the modular amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split line) power supply.
The HY50 takes medium power modules to their logical conclusion by incorporating with it a heatsink, which is designed in special high conductivity alloy, sufficient for normal audio use without additional chassis sinking. All this without significantly increasing the size of the module comparable in size to a packet of 'King-size' cigarettes.

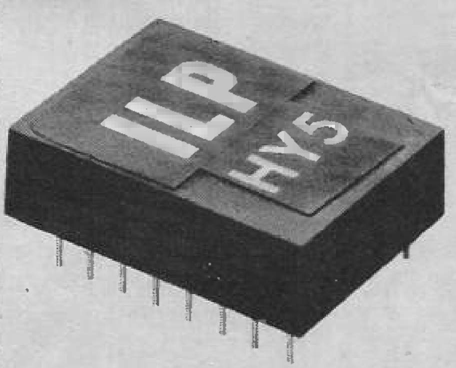
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

	SPEC.
OUTPUT POWER:	25 watts RMS, 50 watts peak music power
LOAD IMPEDANCE:	4-16Ω into 8Ω
INPUT SENSITIVITY:	Odb (0·775 volts RMS)
INPUT IMPEDANCE:	47KΩ
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25 watts typically 0·05
SIGNAL/NOISE RATIO:	better than 75db
FREQUENCY RESPONSE:	10Hz-50KHz ± 1db
SUPPLY VOLTAGE:	± 25 volts
SIZE:	105 x 50 x 25 mm

Price £5·40 mono, £10·80 stereo

Price inclusive of VAT & P & P

NEW HY5 PRE-AMPLIFIER



Unchallenged for two tears, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.
Like the HY50, the new HY5 has no external components & has been redesigned to run off a split power-line with improvements in signal/noise, overload, capability & reduced distortion. The output has been increased to match the power module (Odb), and to share the same power supply.
Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.
When combined with the HY50 & power supply only potentiometers are required to complete a simple mono amplifier with input & output facilities expected to be found on Hi-Fi amplifiers.
The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.

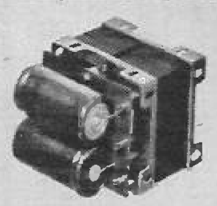
SPEC.

INPUTS
Magnetic Pick-up 3mV (within 1db RIAA curve)
Ceramic Pick-up up to 3mV
Microphone 10mV
Tuner 250mV
Auxiliary 3–100mV
Input impedance 47kΩ 1kHz

OUTPUTS
Tape 100mV.
Main output, Odb (0·775volts)

ACTIVE TONE CONTROLS
Treble ± 12db at 10kHz
Bass ± 12db at 100Hz
OVERLOAD CAPABILITY (equalization stage) 40db on most sensitive input
OUTPUT NOISE LEVEL (below 10mV magnetic input) 68db
DISTORTION 0·05% at 1kHz
SUPPLY VOLTAGE ± 16-25 volts
SUPPLY CURRENT 15mA
Price £4·51 mono, £9·02 stereo
Price inclusive of VAT & P & P

POWER SUPPLY PSU50



The new PSU50 has a low profile look being only 2⅜ inches high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25 volts
INPUT VOLTAGE 210-240 volts
SIZE L. 70, D. 90, H. 60 mm

Price £5·23
Price inclusive of VAT & P & P

CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT

CANTERBURY 63218

Please note we reserve the right to substitute at our discretion updated versions of advertised designs where applicable.

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p	Type	Price p
AC107	22	AD161 and		BC150	20	BD131	55	BF182	44	MAT121	22	2G308	39	2N2192	39	2N3391A	18	2N4062	13
AC113	20	AD162(MP)	75	BC151	22	BD132	66	BF183	44	MJE2955	95	2G309	39	2N2193	39	2N3392	16	2N4284	19
AC115	22	ADT140	55	BC152	19	BD133	72	BF184	28	MJE3055	62	2G339	22	2N2194	39	2N3393	16	2N4285	19
AC117K	32	AF114	27	BC153	31	BD135	44	BF185	33	MJE3440	55	2G339A	18	2N2217	24	2N3394	16	2N4286	19
AC122	13	AF115	27	BC154	33	BD136	44	BF187	30	MPF102	46	2G344	20	2N2218	22	2N3395	19	2N4287	19
AC125	19	AF116	27	BC157	20	BD137	50	BF188	44	MPF104	41	2G345	18	2N2219	22	2N3402	23	2N4288	19
AC126	19	AF117	27	BC158	18	BD138	55	BF194	12	MPF105	41	2G371	18	2N2220	24	2N3403	23	2N4289	19
AC127	20	AF118	39	BC159	13	BD139	61	BF195	13	OC19	39	2G371B	18	2N2221	22	2N3404	31	2N4290	19
AC128	20	AF124	33	BC160	50	BD140	66	BF196	16	OC20	70	2G373	19	2N2222	22	2N3405	46	2N4291	19
AC132	16	AF125	33	BC161	55	BD155	88	BF197	16	OC22	52	2G374	19	2N2368	19	2N3414	17	2N4292	19
AC134	16	AF126	31	BC167	13	BD175	66	BF200	50	OC23	54	2G377	33	2N2369	16	2N3415	17	2N4293	19
AC137	16	AF127	31	BC168	13	BD176	66	BF222	£1·05	OC24	62	2G378	18	2N2369A	16	2N3416	31	2N5172	13
AC141	20	AF139	33	BC169	13	BD177	72	BF257	50	OC25	42	2G381	18	2N2411	27	2N3417	31	2N5294	60
AC141K	32	AF178	55	BC170	13	BD178	72	BF258	66	OC26	32	2G382	18	2N2412	27	2N3525	83	2N5457	35
AC142	20	AF179	55	BC171	16	BD179	77	BF259	94	OC28	55	2G401	33	2N2646	52	2N3614	74	2N5458	35
AC142K	28	AF180	55	BC172	16	BD180	77	BF262	61	OC29	55	2G414	33	2N2711	23	2N3615	82	2N5459	44
AC151	17	AF181	55	BC173	16	BD185	72	BF263	61	OC35	46	2G417	28	2N2712	23	2N3616	82	2N6211	75
AC154	22	AF186	55	BC174	16	BD186	72	BF270	39	OC36	55	2N388	39	2N2714	23	2N3646	10	2S301	55
AC155	22	AF239	41	BC175	24	BD187	77	BF271	33	OC41	22	2N388A	61	2N2904	19	2N3702	13	2S302A	46
AC156	22	AL102	72	BC177	21	BD188	77	BF272	88	OC42	27	2N404	22	2N2904A	23	2N3703	13	2S302	46
AC157	27	AL103	72	BC178	21	BD189	83	BF273	39	OC44	17	2N404A	31	2N2905	23	2N3704	14	2S303	61
AC165	22	ASY26	28	BC179	21	BD190	83	BF274	39	OC45	14	2N524	46	2N2905A	23	2N3705	13	2S304	77
AC166	22	ASY27	33	BC180	27	BD195	94	BFW10	66	OC70	11	2N527	54	2N2906	17	2N3706	13	2S305	86
AC167	22	ASY28	28	BC181	27	BD196	94	BFX29	30	OC71	11	2N598	46	2N2906A	20	2N3707	14	2S306	86
AC168	27	ASY29	28	BC182	11	BD197	99	BFX84	24	OC72	16	2N599	50	2N2907	22	2N3708	09	2S307	86
AC169	16	ASY50	28	BC182L	11	BD198	99	BFX85	33	OC74	16	2N696	14	2N2907A	24	2N3709	10	2S321	62
AC176	22	ASY51	28	BC183	11	BD199	£1·05	BFX86	24	OC75	17	2N697	15	2N2923	16	2N3710	10	2S322	46
AC177	27	ASY52	28	BC183L	11	BD200	£1·05	BFX87	27	OC76	17	2N698	27	2N2924	16	2N3711	10	2S322A	46
AC178	31	ASY54	28	BC184	13	BD205	88	BFX88	24	OC77	28	2N699	39	2N2925	16	2N3819	31	2S323	62
AC179	31	ASY55	28	BC184L	13	BD206	88	BFY50	22	OC81	17	2N706	09	2N2926(G)	14	2N3820	55	2S324	77
AC180	22	ASY56	28	BC186	31	BD207	£1·05	BFY51	22	OC81D	17	2N706A	10	2N2926(Y)	12	2N3821	39	2S325	77
AC180K	32	ASY57	28	BC187	31	BD208	£1·05	BFY52	22	OC82	17	2N708	13	2N2926(O)	11	2N3823	31	2S326	77
AC181	22	ASY58	28	BC207	12	BDY20	£1·10	BFY53	19	OC82D	17	2N711	33	2N2926(R)	11	2N3903	31	2S327	77
AC181K	32	ASY73	28	BC208	12	BF115	27	BPX25	94	OC83	22	2N717	39	2N2926(B)	11	2N3904	33	2S701	46
AC187	24	ASZ21	44	BC209	13	BF117	50	BSX19	17	OC139	22	2N718	27	2N3010	77	2N3905	31	40361	44
AC187K	25	BC107	12	BC212L	12	BF118	77	BSX20	17	OC140	22	2N718A	55	2N3011	16	2N3906	30	40362	50
AC188	24	BC108	12	BC213L	12	BF119	77	BSY25	17	OC169	28	2N726	31	2N3053	19	2N4058	18		
AC188K	25	BC109	13	BC214L	16	BF121	50	BSY26	17	OC170	28	2N727	31	2N3054	51	2N4059	11		
ACY17	28	BC113	11	BC225	28	BF123	55	BSY27	17	OC171	28	2N743	22	2N3055	55	2N4060	13		
ACY18	22	BC114	17	BC226	39	BF125	50	BSY28	17	OC200	28	2N744	22	2N3391	16	2N4061	13		
ACY19	22	BC115	17	BC301	30	BF127	55	BSY29	17	OC201	31	2N914	16						
ACY20	22	BC116	17	BC302	27	BF152	61	BSY38	20	OC202	31	2N918	33						
ACY21	22	BC117	20	BC303	35	BF153	50	BSY39	20	OC203	28	2N929	23						
ACY22	18	BC118	11	BC304	40	BF154	50	BSY40	31	OC204	28	2N930	23						
ACY27	20	BC119	33	BC440	34	BF155	77	BSY41	31	OC205	39	2N1131	22						
ACY28	21	BC120	88	BC460	40	BF156	53	BSY95	14	OC309	44	2N1132	24						
ACY29	39	BC125	18	BCY30	27	BF157	61	BSY95A	14	OCP71	48	2N1302	16						
ACY30	31	BC126	20	BCY31	29	BF158	61	Bu105	£2·20	ORP12	48	2N1303	16						
ACY31	31	BC132	13	BCY32	33	BF159	66	C111E	55	P20	55	2N1304	19						
ACY34	23	BC134	20	BCY33	24	BF160	44	C400	88	P21	50	2N1305	19						
ACY35	23	BC135	18	BCY34	28	BF162	44	C407	28	P346A	22	2N1306	23						
ACY36	31	BC136	17	BCY70	16	BF163	44	C424	28	P397	46	2N1307	23						
ACY40	19	BC137	17	BCY71	22	BF164	44	C425	55	ST140	14	2N1308	26						
ACY41	20	BC139	44	BCY72	16	BF165	44	C426	39	ST141	19	2N1309	26						
ACY44	39	BC140	33	BCZ10	22	BF167	24	C428	22	TIS43	33	2N1613	22						
AD130	42	BC141	33	BCZ11	28	BF173	24	C441	33	UT46	30	2N1711	22						
AD140	53	BC142	33	BCZ12	28	BF176	39	C442	33	ZN414	£1·20	2N1889	35						
AD142	53	BC143	33	BD115	68	BF177	39	C444	39	2G301	21	2N1890	50						
AD143	42	BC145	50	BD116	88	BF178	33	C450	24	2G302	21	2N1893	41						
AD149	55	BC147	11	BD121	66	BF179	33	MAT100	21	2G303	21	2N2147	79						
AD161	39	BC148	11	BD123	72	BF180	33	MAT101	22	2G304	27	2N2148	63						
AD162	39	BC149	13	BD124	76	BF181	33	MAT120	21	2G306	44	2N2160	66						

DIODES AND RECTIFIERS

AA119	9	BY133	23	OA70	8
AA120	9	BY164	55	OA79	8
AA129	9	BYX38/30	46	OA81	8
AAY30	10	BYZ10	39	OA85	10
AAZ13	11	BYZ11	33	OA90	7
BA100	11	BYZ12	33	OA91	7
BA116	23	BYZ13	28	OA95	8
BA126	24	BYZ16	44	OA200	7
BA148	16	BYZ17	39	OA202	8
BA154	13	BYZ18	39	SD10	6
BA155	16	BYZ19	31	BD19	6
BA156	15	CG62		1N34	8
BY100	17	(OA91 Eq.)	6	1N34A	8
BY101	13	CG651		1N914	7
BY105	19	(OA70-OA79		1N916	7
BY114	13	Eq.)	7	1N4148	7
BY126	16	OA5	39	18021	11
BY127	17	OA5SL	23	1S951	7
BY128	17	OA10	39		
BY130	18	OA47	8		

LINEAR I.C's—FULL SPEC.

Type No.	Price 1	25	100+
72702	50p	48p	45p
72709	35p	33p	30p
72710	45p	43p	40p
72741	40p	38p	35p
72741C	45p	43p	40p
72741P	38p	36p	34p
72748P	38p	36p	34p
SL201C	59p	45p	40p
SL701C	50p	45p	40p
SL702C	50p	45p	40p
TAA263	80p	70p	60p
TAA293	£1·00	95p	90p
TAA350A	£1·85	£1·80	£1·70
μA703C	28p	26p	24p
μA709C	35p	33p	30p
μA711	45p	43p	40p

NUMERICAL INDICATOR TUBES

CD66	£1·87
GR116	£1·70
3015F Minitron	£1·60

All indicators 0-9 + Decimal point. All side viewing. Full data for all types available on request.

ZN414 .. .. .. £1·20 each
I.C. Radio Rec. incl. full cir. data.

DTL 930 SERIES LOGIC I.C's

Type	Price 1	25	100
BP930	16p	14p	13p
BP932	16p	15p	14p
BP933	16p	15p	14p
BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

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7401	0·18	0·17	0·16	7450	0·18	0·17	0·16	74123	3·00	2·90	2·80
7402	0·18	0·17	0·16	7451	0·18	0·17	0·16	74141	0·85	0·82	0·79
7403	0·18	0·17	0·16	7453	0·18	0·17	0·16	74145	1·65	1·55	1·45
7404	0·18	0·17	0·16	7454	0·18	0·17	0·16	74150	2·90	2·80	2·70
7405	0·18	0·17	0·16	7460	0·18	0·17	0·16	74151	1·10	1·05	1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	1·30	1·20	1·10
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	1·98	1·90	1·75
7408	0·20	0·19	0·18	7473	0·41	0·39	0·35	74155	1·50	1·45	1·35
7409	0·20	0·19	0·18	7474	0·41	0·39	0·35	74156	1·50	1·45	1·35
7410	0·18	0·17	0·16	7475	0·50	0·48	0·46	74157	2·00	1·90	1·80
7411	0·28	0·27	0·26	7476	0·44	0·43	0·42	74160	2·10	2·00	1·90
7412	0·39	0·34	0·31	7480	0·74	0·71	0·64	74161	2·10	2·00	1·90
7413	0·32	0·31	0·30	7481	1·30	1·25	1·20	74162	4·40	4·15	3·85
7416	0·48	0·44	0·42	7482	0·96	0·95	0·94	74163	4·40	4·15	3·85
7417	0·48	0·44	0·42	7483	1·20	1·15	1·05	74164	2·20	2·10	2·00
7420	0·18	0·17	0·16	7484	1·10	1·05	1·00	74165	2·20	2·10	2·00
7422	0·55	0·53	0·50	7485	3·50	3·30	3·30	74166	3·20	3·10	3·00
7423	0·55	0·53	0·50	7486	0·36	0·34	0·33	74174	2·50	2·40	2·30
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7426	0·50	0·46	0·44	7490	0·74	0·71	0·64	74176	1·85	1·75	1·65
7427	0·50	0·46	0·44	7491	1·10	1·05	1·00	74177	1·85	1·75	1·65
7428	0·55	0·53	0·50	7492	0·74	0·71	0·64	74180	1·50	1·40	1·30
7430	0·18	0·17	0·16	7493	0·74	0·72	0·64	74181	5·00	4·50	4·00
7432	0·50	0·46	0·44	7494	0·85	0·82	0·75	74182	2·00	1·90	1·75
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200	0·39	0·41	0·54	0·54	0·63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
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200	0·06	0·10	0·07	0·16	0·22	0·27	1·10
400	0·07	0·15	0·08	0·22	0·30	0·41	1·35
600	0·08	0·18	0·11	0·26	0·38	0·50	2·05
800	0·11	0·19	0·12	0·28	0·41	0·61	2·20
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UIC10=12×7410	0·55	UIC72–8×7472	0·55	UIC121=5×74121	0·55
UIC20=12×7420	0·55	UIC73=8×7473	0·55	UIC141=5×74141	0·55
UIC30–12×7430	0·55	UIC74–8×7474	0·55	UIC151–5×74151	0·55
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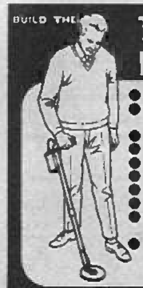

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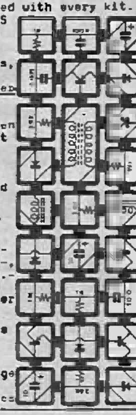

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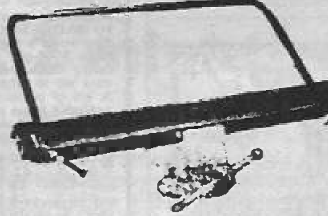

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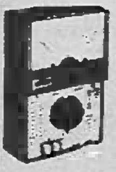

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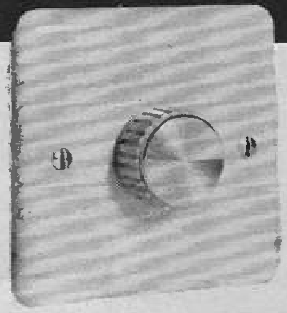

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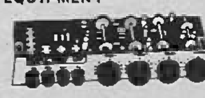

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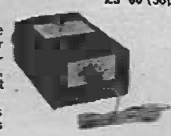

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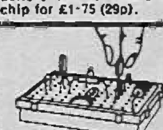

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μ-DEC A	£3·18 (43p)
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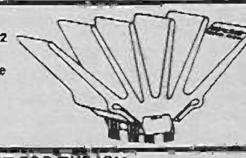
16 dil IC carriers	£1·20 (17p)

SINCLAIR SUPER IC12



With 44 page booklet and printed circuit
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Includes all parts for the printed circuit and volume, bass and treble controls needed to complete the mono version £1·55 (26p). Stereo model with balance control £3·50 (46p)
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Supplies 28V 0·5 Amps £2·47 (50p)
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As featured by Practical Wireless 1972

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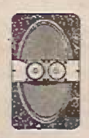

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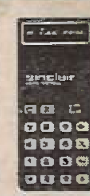

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