PRACTICAL

ELECTRONICS

OCTOBER 1974

FREE!

24 PAGE BOOKLET

PE TRANSISTOR GUIDE... 74

Over 400 transistors are listed in this booklet. An attempt has been made to include most of the types that are readily available through the usual retail channels. While this list is obviously not exhaustive, it should satisfy the majority of normal amateur requirements.

All possible care has been taken in the preparation of this booklet and no responsibility can be accepted for any errors or omissions that may have occurred inadvertently.

Presented free with the October 1974 issue of PRACTICAL ELECTRONICS

SELECTION MADE EASY

Plus these Simple Projects...

... AND the PE CCTV CAMERA — PART TWO

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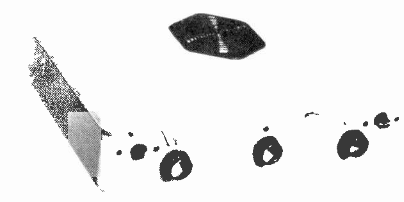
COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER



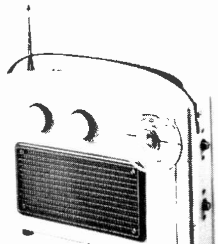
- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN —PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless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

TOTAL BUILDING COSTS

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

Components include:
- 24 Resistors ● 21 Capacitors ● 10 Transistors ● 3½" Loudspeaker ● Earpiece ● Mica Baseboard
- 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs
- Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc.
- Parts price list and plans 50p (free with parts)

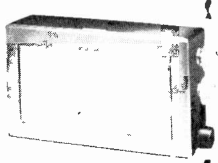
NEW ROAMER NINE
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9½in × 7in × 2½in approx. Parts price list and plans **30p** (FREE with parts)

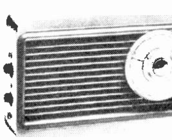
TOTAL BUILDING COSTS **£6·95** (+8% VAT 55p) P.P. & INS. 44p (OVERSEAS P. & P. £1·85)

POCKET FIVE
NOW WITH 3" LOUDSPEAKER



3 Tunable wavebands, MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½in × 1¼in × 3½in approx. Plans and parts price list **15p** (FREE with parts).

Total Building Costs **£2·50** (+8% VAT 20p) P.P. & Ins. 26p (Overseas P.P. £1·25)



TRANSONA FIVE NOW WITH 3" LOUDSPEAKER

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

NEW EVERYDAY SERIES

Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, **and now with 3" loudspeaker.** Attractive case with red speaker grille. Size 9in × 5½in × 2½in approx. Parts price list and plans **15p** (FREE with parts).

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

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

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

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

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

ROAMER EIGHT Mk. I
NOW WITH VARIABLE TONE CONTROL

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

TOTAL BUILDING COSTS **£6·98** (+8% VAT 56p) P.P. & INS. 47p (OVERSEAS P. & P. £1·85)

ROAMER TEN
WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS. ALSO AIRCRAFT BAND Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in × 7in × 4in. Easy to follow instructions and diagrams. Parts price list and plans **30p** (FREE with parts).

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

EDU-KIT

Build Radios Amplifiers, etc., from easy stage, diagrams.

Five units including master unit to construct.

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine tone 3" moving coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three ½in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans **25p** (FREE with parts).

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

TRANS EIGHT 8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW. and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 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).

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

ROAMER SIX

CASE AND LOOKS AS TRANS EIGHT 6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in × 5½in × 2½in approx. Plans and parts price list **25p** (FREE with parts).

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

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PE10

PRACTICAL
ELECTRONICS

VOLUME 10 No. 10 OCTOBER 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

FREE INSIDE THIS ISSUE: ***24-page booklet P.E. TRANSISTOR GUIDE '74***

Our November issue will be published Mid-October. This issue will be in big demand and readers are advised to place an order with their newsagent—NOW!

ERSIN Multicore 5 CORE SOLDER

for fast, easy reliable soldering

Ersin Multicore Solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.

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Size 5 Savbit alloy 18 swg, **30p** (illustrated).
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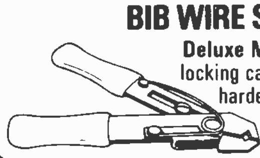
Size 1 cartons in 40/60, 60/40 and Savbit alloys in 7 gauges **46p**

Size 12 REEL for Service Engineers and Electricians. 18 swg
Savbit alloy, **£1·46**

BIB WIRE STRIPPER AND CUTTER



Deluxe Model 9 Automatic opening spring, locking catch, plastic-covered handles. Case hardened and precision ground. Adjusts to most wire sizes. Cuts and strips flex, splits plastic twin flex. **90p**

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SAVE £1! CAMBRIDGE KIT £13·95!
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7408–9	0·20	7440	0·20	7483	1·25	72710	0·37	IN4003	0·07
7410	0·20	7442	0·86	7485	1·65	72723	0·80	IN4006	0·09
7412	0·26	7445	1·60	7486	0·46	72741	0·30	IN4007	0·12
7413	0·38	7447	1·30	7489	4·95	72747	1·00	IN4148	0·05
7416	0·44	7450	0·20	7490	0·66	72748	0·36	OA47	0·07
7417	0·30	7451	0·20	7491	1·10	ZN414	1·25	OA90	0·06
7420	0·20	7453	0·20	7492	0·70	TAA350	2·10	OA91	0·06
7422	0·28	7454	0·20	7493	0·66	LM301B	0·75	OA200	0·06
7425	0·36	7460	0·20	7494	0·90	CA3046	0·70	OA202	0·09
7427	0·45	7470	0·34	7495	0·82	CA3036	1·00	IN916	0·06
7428	0·45	7472	0·34	7496	0·99	CA3028	1·20	BB105	0·45
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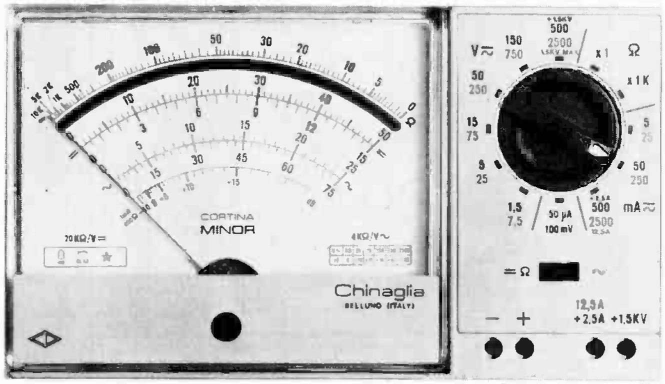

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160V: 0·01μF, 0·015μF, 0·02μF, 3p. 0·047μF, 0·068μF, 3½p. 0·1μF, 4½p. 0·15μF, 5p. 0·22μF, 5½p. 0·33μF, 6½p. 0·47μF, 8½p. 0·68μF, 12p. 1μF, 14p.

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¼	CF	22-2M2	1	0·75	0·60	0·55	3·9 × 10·5
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¼	MF	10-2M7	2	1·54	1·32	1·1	3 × 7
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1·0μF	63V	6½p	68μF	16V	6½p
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2·2μF	63V	6½p	100μF	10V	6½p
3·3μF	63V	6½p	100μF	25V	6½p
4·0μF	40V	6½p	100μF	63V	14p
4·7μF	63V	6½p	150μF	16V	6½p
6·8μF	63V	6½p	150μF	63V	15p
8·0μF	40V	6½p	220μF	6·4V	6½p
10μF	25V	6½p	220μF	10V	6½p
10μF	63V	6½p	220μF	16V	8p
15μF	16V	6½p	220μF	63V	21p
15μF	63V	6½p	330μF	16V	12p
16μF	40V	6½p	330μF	63V	25p
22μF	25V	6½p	470μF	6·4V	9p
22μF	63V	6½p	470μF	40V	20p
32μF	10V	6½p	680μF	16V	15p
33μF	16V	6½p	680μF	40V	25p
33μF	40V	6½p	1000μF	16V	20p
32μF	63V	6½p	1000μF	25V	25p
47μF	10V	6½p	1500μF	6·4	15p
47μF	25V	6½p	1500μF	16V	25p
47μF	63V	6½p	2200μF	10V	25p
			3300μF	6·4	26p

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

TRANSISTORS

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

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

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IN4002	7½p
IN4003	9p
IN4004	9½p
IN4005	12p
IN4006	14p
IN914	7p
IN916	7p
BA100	10p
OA5	42p
OA47	9p
OA81	11p
OA200	8p

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

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

ELECTROLYTIC CAPACITORS. Tubular & Large Cans (μF/V): 1/25, 2/25, 4/25, 4·7/10, 5/25, 8/25, 10/10, 10/50, 16/25, 22/63, 25/25, 25/50, 32/25, 50/25, 100/10, 100/25, 6½p. 50/50, 8p. 100/50, 200/25, 11p. 250/50, 18p. 500/10, 11p. 500/25, 15p. 500/50, 18p. 1000/10, 15p. 1000/25, 22p. 1000/50, 40p. 2000/10, 20p. 1000/100, 90p. 2000/25, 30p. 2000/100, 95p. 2500/25, 38p. 2500/50, 62p. 3000/50, 80p. 5000/25, 66p. 5000/50, £1·10.
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μA741C	55p
μA723C	£1
ZN414	£1·32

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BC109	12p	BFY44	50p	OA5	20p	TIP29B	50p	2N1303	18p	2N4061	12p
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BC148	12p	BFY51	25p	OA47	10p	TIP31B	70p	2N1305	25p	2N4286	15p
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Type H-202 Features· Mono/stereo switch. Volume controls on each channel Freq response 20–20 000Hz Impedance 4–16 ohms £4·50.

TEAK VENEERED SPEAKER CABINETS

	Size	
For 8 × 5in Speaker	9½ × 13½ × 5¼	£3·50
8in + Tweeter	7¾ × 11¼ × 5¼	£5·00
13 × 8in	10¼ × 17 × 6	£5·75
13 × 8in + Tweeter	12 × 18½ × 8¼	£7·50
12in + Tweeter	15¾ × 18 × 8¼	£9·00

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Robust units suitable for most PA Disco uses

5 watt 2 inputs. Vol Treble Bass Controls	£12·50
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150 watt 4 inputs with separate vol controls plus master vol. treble bass	£75·90
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PRICES INC VAT

FF1	4 Channel Mono Mixer and Preamplifier with individual slide controls Battery operated	£20·96
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TRANSFORMERS

SAFETY MAINS ISOLATING TRANSFORMERS
Prim. 120/240V. Sec 120/240V Centre Tapped and Screened

ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·0 × 6·0 × 6·0	2·55	30
149	60	3	12	9·9 × 7·7 × 8·6	3·79	36
150	100	5	8	9·9 × 8·9 × 8·6	4·17	52
151	200	8	0	12·1 × 9·3 × 10·2	7·39	52
152	250	13	12	12·1 × 11·8 × 10·2	9·25	67
153	350	15	0	14·0 × 10·8 × 11·8	11·35	82
154	500	19	8	14·0 × 13·4 × 11·8	13·20	*
155	750	29	0	17·2 × 14·0 × 14·0	21·20	*
156	1000	38	0	17·2 × 16·6 × 14·0	27·40	*
158	2000	60	0	21·6 × 15·3 × 18·1	49·25	*

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20	1	0	5·8 × 5·1 × 4·5	0-115-210-240	1·34	22
64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·64	30
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	3·18	36
66	300	6	4	9·9 × 9·6 × 8·6	" "	6·19	52
67	500	12	8	12·1 × 11·2 × 10·2	" "	8·33	67
84	1000	19	8	14·0 × 13·4 × 14·3	" "	13·50	82
93	1500	30	4	14·0 × 15·9 × 14·3	" "	17·50	*
95	2000	32	0	17·2 × 16·6 × 14·0	" "	25·35	*
73	3000	40	0	21·6 × 13·4 × 18·1	" "	32·80	*

CASED AUTO TRANSFORMERS
115 500W enclosed transformer, with mains lead and two 115V outlet sockets, £9·49, P & P 67p. 20W version, £2·02, P & P 22p.

LOW VOLTAGE SERIES (ISOLATED)
PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		8	4·8 × 2·9 × 3·5	0-12V at 0·25A × 2	1·34	22
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·58	22
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·09	22
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·95	36
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·52	42
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	3·96	52
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·67	52
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·61	52
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	7·22	52
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	9·20	67
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	16·94	82
226	60	30	32	0	17·2 × 15·3 × 14·0	0-12V at 30A × 2	22·50	*

30 VOLT RANGE

Ref. No.	Amps	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	6·1 × 5·8 × 4·8	0-12-15-20-24-30V	1·56	22
79	1·0	2	4	7·0 × 6·7 × 6·1	" "	2·11	36
3	2·0	3	4	8·9 × 7·7 × 7·7	" "	3·18	36
20	3·0	4	8	9·9 × 8·3 × 8·6	" "	3·96	42
21	4·0	6	4	9·9 × 9·6 × 8·6	" "	4·67	52
51	5·0	6	12	12·1 × 8·6 × 10·2	" "	5·83	52
117	6·0	8	0	12·1 × 9·3 × 10·2	" "	6·94	52
88	8·0	12	0	12·1 × 11·8 × 10·2	" "	9·00	67
89	10·0	13	12	14·0 × 10·2 × 11·8	" "	11·36	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	2·09	30
103	1·0	2	12	8·3 × 7·4 × 7·0	" "	3·08	36
104	2·0	5	8	7·9 × 8·9 × 8·6	" "	4·26	42
105	3·0	6	12	9·9 × 10·2 × 8·6	" "	5·79	52
106	4·0	10	0	12·1 × 10·5 × 10·2	" "	7·69	52
107	6·0	12	0	14·0 × 10·2 × 11·8	" "	11·38	67
118	8·0	18	0	14·0 × 12·7 × 11·8	" "	12·40	97
119	10·0	25	0	17·2 × 12·7 × 14·0	" "	18·62	*

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60V	2·12	36
126	1·0	3	4	8·9 × 7·7 × 7·7	" "	2·97	36
127	2·0	6	4	9·9 × 9·6 × 8·6	" "	4·67	42
125	3·0	8	12	12·1 × 9·9 × 10·2	" "	7·11	52
123	4·0	13	12	12·1 × 11·8 × 10·2	" "	9·20	67
40	5·0	12	00	14·0 × 10·2 × 11·8	" "	10·83	67
120	6·0	15	8	14·0 × 12·1 × 11·8	" "	13·35	82
121	8·0	25	00	14·0 × 14·7 × 11·8	" "	15·01	*
122	10·0	25	0	17·2 × 12·7 × 14·0	" "	19·60	*
189	12·0	29	00	17·2 × 14·0 × 14·0	" "	21·60	

MINIATURE TRANSFORMERS WITH SCREENS

Ref. No.	mA	Weight lb	oz	Size cm.	Volts	P & P £	p
238	200		2	2·8 × 2·6 × 2·0	3-0-3	1·44	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·67	22
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·23	10
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·67	10
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	2·23	22
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	3·00	30
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·67	10
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·76	22
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	1·55	30
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	4·05	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	3·10	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	3·15	38

*Carriage via B.R.S.

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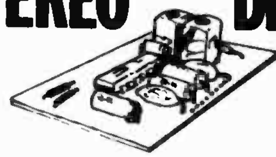

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Ready built unit, ready for connection to the I.F. stages of existing FM Radio or Tuner. A tell tale light can be connected. The unit is a small printed circuit, no further alignment necessary. L.E.D. is recommended as the indicating light, suitable device available from us at 25p. Instructions included.

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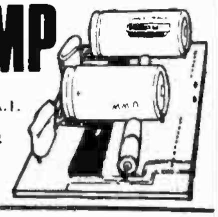

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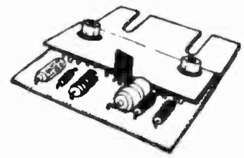
On P.C. Board with all components or 2 on one board for £2·60. Order Code I.C.A.I/5.
These amps. are supplied with a free booklet on connecting up, specifications and easy-to-build projects using the I.C.A.I.

5W & 10W AMPS



5W ONLY £1.80
10W ONLY £2.26

incl. P. & P.

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

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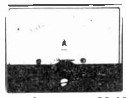
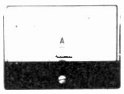
CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm



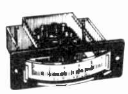
50uA	£3.80		
100uA	£3.75		
200uA	£3.70		
500uA	£3.65		
50-0-50uA	£3.75		
100-0-100uA	£3.70		
1mA	£3.65		
5mA	£3.65		
10mA	£3.65		
50mA	£3.65	10V DC	£3.65
100mA	£3.65	20V DC	£3.65
500mA	£3.65	50V DC	£3.65
1A DC	£3.65	300V DC	£3.65
5A DC	£3.65	15V AC	£3.75
10A DC	£3.65	300V AC	£3.75
5V DC	£3.65	VU Meter	£3.90

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



50uA	£4.60		
100uA	£4.50		
500uA	£4.30		
50-0-50uA	£4.50		
100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30	150V AC	£4.45
50V DC	£4.30	300V AC	£4.45
300V DC	£4.30	VU Meter	£4.90

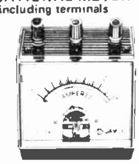
EDGWISE MODEL PE70
Size: 90 x 34mm



50uA	£4.15
100uA	£4.10
200uA	£4.05
500uA	£3.90
50-0-50uA	£4.10
100-0-100uA	£4.05
1mA	£3.85
300V AC	£3.95
VU Meter	£4.30

MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

A 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.

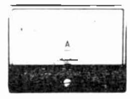


50uA	£8.50		
100uA	£7.90		
50-0-50uA	£7.90		
1mA	£7.60	20V DC	£7.60
1-0-1mA	£7.60	50V DC	£7.60
1A DC	£7.60	300V DC	£7.60
5A DC	£7.60	500mA/5A DC	£8.60
5V DC	£7.60	5V/50V DC	£8.60
10V DC	£7.60	6V/15V DC	£8.60
15V DC	£7.60	1/5A DC	£8.60
		1A/15A DC	£8.60

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

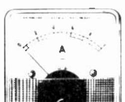
50uA	£5.45		
100uA	£5.40		
200uA	£5.35		
500uA	£5.25		
50-0-50uA	£5.40		
100-0-100uA	£5.35		
500-0-500uA	£5.20		
1mA	£5.20		
1-0-1mA	£5.20		
5mA	£5.20		
10mA	£5.20		
50mA	£5.20		
100mA	£5.20	300V DC	£5.20
500mA	£5.20	15V AC	£5.30
1A DC	£5.20	300V AC	£5.30
5A DC	£5.20	S Meter 1mA	£5.20
15A DC	£5.20	VU Meter	£5.55
30A DC	£5.40	1A AC	*£5.20
10V DC	£5.20	5A AC	*£5.20
20V DC	£5.20	10A AC	*£5.20
50V DC	£5.20	20A AC	*£5.20
150V DC	£5.20	30A AC	*£5.20

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



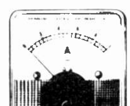
50uA	£4.30		
100uA	£4.25		
200uA	£4.20		
500uA	£4.15		
50-0-50uA	£4.25		
100-0-100uA	£4.20		
1mA	£4.10		
5mA	£4.10		
10mA	£4.10		
50mA	£4.10	10V DC	£4.10
100mA	£4.10	20V DC	£4.10
500mA	£4.10	50V DC	£4.10
1A DC	£4.10	300V DC	£4.10
5A DC	£4.10	15V AC	£4.20
10A DC	£4.10	300V AC	£4.20
5V DC	£4.10	VU Meter	£4.40

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



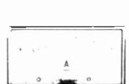
50uA	£3.20		
100uA	£3.15		
200uA	£3.10		
500uA	£3.00		
50-0-50uA	£3.15		
100-0-100uA	£3.10		
500-0-500uA	£2.95		
1mA	£2.95		
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95	300V AC	£3.05
1A DC	£2.95	S Meter 1mA	£2.95
5A DC	£2.95	VU Meter	£3.40
10V DC	£2.95	1A AC	*£2.95
20V DC	£2.95	5A AC	*£2.95
50V DC	£2.95	10A AC	*£2.95
300V DC	£2.95	20A AC	*£2.95
15V AC	£3.05	30A AC	*£2.95

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



50uA	£3.10		
100uA	£3.05		
200uA	£3.00		
500uA	£2.85		
50-0-50uA	£3.05		
100-0-100uA	£3.00		
500-0-500uA	£2.80		
1mA	£2.80		
1-0-1mA	£2.80		
2mA	£2.80		
5mA	£2.80		
10mA	£2.80		
20mA	£2.80		
50mA	£2.80	20V DC	£2.80
100mA	£2.80	50V DC	£2.80
150mA	£2.80	100V DC	£2.80
200mA	£2.80	150V DC	£2.80
300mA	£2.80	300V DC	£2.85
500mA	£2.80	500V DC	£2.85
750mA	£2.80	750V DC	£2.90
1A DC	£2.80	15V AC	£2.90
2A DC	£2.80	50V AC	£2.90
5A DC	£2.80	150V AC	£2.90
10A DC	£2.80	300V AC	£2.90
3V DC	£2.80	500V AC	£3.00
10V DC	£2.80	S Meter 1mA	£2.80
15V DC	£2.80	VU Meter	£3.20

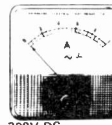
CLEAR PLASTIC MODEL SO460
Size: 59 x 46mm



50uA	£3.50		
100uA	£3.45		
200uA	£3.40		
500uA	£3.35		
50-0-50uA	£3.45		
100-0-100uA	£3.40		
1mA	£3.30		
5mA	£3.30		
10mA	£3.30		
50mA	£3.30	10V DC	£3.30
100mA	£3.30	20V DC	£3.30
500mA	£3.30	50V DC	£3.30
1A DC	£3.30	300V DC	£3.30
5A DC	£3.30	15V AC	£3.45
10A DC	£3.30	300V AC	£3.45
5V DC	£3.30	VU Meter	£3.65

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm



50uA	£3.95		
100uA	£3.85		
200uA	£3.80		
500uA	£3.75		
50-0-50uA	£3.85		
100-0-100uA	£3.80		
500-0-500uA	£3.70		
1mA	£3.70		
1-0-1mA	£3.70		
5mA	£3.70		
10mA	£3.70	300V DC	£3.70
50mA	£3.70	15V AC	£3.80
100mA	£3.70	50V AC	£3.80
500mA	£3.70	150V AC	£3.80
1A DC	£3.70	300V AC	£3.90
5A DC	£3.70	500V AC	£3.80
10A DC	£3.70	S Meter 1mA	£4.10
15A DC	£3.70	VU Meter	£3.70
20A DC	£3.80	1A AC	*£3.70
30A DC	£3.85	5A AC	*£3.70
50A DC	£4.05	10A AC	*£3.70
5V DC	£3.70	20A AC	*£3.70
10V DC	£3.70	30A AC	*£3.70
15V DC	£3.70	50mA AC	*£3.70
20V DC	£3.70	100mA AC	*£3.70
50V DC	£3.70	200mA AC	*£3.70
150V DC	£3.70	500mA AC	*£3.70

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£4.50
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£3.70		
100uA	£3.50		
500uA	£3.35		
50-0-50uA	£3.50		
100-0-100uA	£3.45		
1mA	£3.30		
5mA	£3.30		
10mA	£3.30		
50mA	£3.30		
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30	S Meter 1mA	£3.30
10V DC	£3.30	VU Meter	£3.80
20V DC	£3.30	1A AC	*£3.30
50V DC	£3.30	5A AC	*£3.30
300V DC	£3.30	10A AC	*£3.30
15V AC	£3.40	20A AC	*£3.30
300V AC	£3.40	30A AC	*£3.30

BAKELITE MODEL MR 65 Size: 80 x 80mm

25uA	£5.25		
50uA	£4.00		
100uA	£3.95		
500uA	£3.65		
50-0-50uA	£3.95		
100-0-100uA	£3.90		
500-0-500uA	£3.60		
1mA	£3.60		
1-0-1mA	£3.60		
5mA	£3.60		
10mA	£3.60		
50mA	£3.60	300V DC	£3.60
100mA	£3.60	30V AC	*£3.60
500mA	£3.60	50V AC	*£3.60
1A DC	£3.60	150V AC	*£3.60
2A DC	£3.60	300V AC	*£3.60
5A DC	£3.60	500V AC	*£3.60
10A DC	£3.60	VU Meter	£4.10
15A DC	£3.60	1A AC	*£3.60
30A DC	£3.60	5A AC	*£3.60
50A DC	£3.80	10A AC	*£3.60
5V DC	£3.60	20A AC	*£3.60
10V DC	£3.60	30A AC	*£3.60
15V DC	£3.60	50A AC	*£3.60
20V DC	£3.60	500mA AC	*£3.60
50V DC	£3.60	50mV DC	£3.75
150V DC	£3.60	100mV DC	£3.75

240° Wide Angle 1mA METERS

MW1-8 80 x 80mm
£6.90 P&P 15p

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Excellent quality at low cost. Input: 230V 50/60Hz. Output 0–260V.

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1A	£10.50	50p
2.5A	£12.00	50p
5A	£17.50	50p
8A	£30.35	£1.00
10A	£33.75	£1.00
12A	£35.40	£1.00
20A	£85.00	£1.50
25A	£95.00	£1.50
40A	£120.00	£1.50

MODEL S260B PANEL MOUNTING

1A	£10.00
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382 EDGWARE RD. W2	01-723 4194
109 FLEET ST. EC4	01-353 5812
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10 TOTTENHAM CT. RD.	01-637 2232
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½W Iskra high stability carbon film—very low noise—capless construction
⅓W Mullard CR25 carbon film—very small body size 7·5 × 2·5mm. ½W 2% ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1·3p	1·1p
½	10%	3·3MΩ–10MΩ	E12	1·3p	1·1p
½	2%	10Ω–1MΩ	E24	3·5p	3p
⅓	10%	1Ω–3·9Ω	E12	1·3p	1·1p
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0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
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Carbon track 5kΩ to 2MΩ, log or linear (log ½W, lin ½W).
Single, **14p.** Dual gang (stereo), **49p.** Single D.P. switch **28p.**

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

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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.**

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Mains operated with audible alarm, **£5·60.**
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NOTE—The battery operated kits incorporate our patented circuit to minimise battery drain. Typically 120mA for 12V. These kits contain all parts required with the exception of case. Suitable case. Mains operated kit, **£1·60.** Battery operated kits, **£5.**

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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.**

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MYLAR FILM CAPACITORS 100V
0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **3p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **4p.**

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

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

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2½ × 3¾	26p	22p
2½ × 5	28p	28p
3¾ × 3¾	28p	28p
3¾ × 5	34p	34p
17 × 2½	95p	77p
17 × 3¾	130p	108p
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17 × 2½ (plain)	—	57p
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Pin insertion tool	62p	62p
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Standard screened	28p	2·5mm insulated	12p
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Stereo screened	40p	3·5mm screened	18p
Standard socket	20p	2·5mm socket	10p
Stereo socket	30p	3·5mm socket	11p

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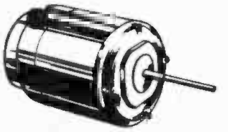
2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin, 7 pin
Plug 12p. Socket 8p.
4 way screened cable, **25p**/metre.
6 way screened cable **30p**/metre.

BATTERY ELIMINATOR **£1·70**
9V mains power supply. Same size as PP9 battery.

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

"SLO-SYN" 3-LEAD SYNCHRONOUS STEPPING MOTOR



Type SS15. These fine motors are easily reversed, starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC. to winding for a maximum holding torque of 300oz/in with 35v at 0·35 amps through winding. For AC. (synchronous) operation at 120r., 50Hz. Speed 60 rpm at 60Hz., 72 rpm. STEPPING. Holding torque at 50 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0·1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4", body length 4½", spindle length 2½" × ¼" dia. Weight 6½ lbs. BRAND NEW in maker's packing. Offered at less than ½ maker's price.
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Fibre-glass copper-clad laminate. Finest quality epoxy resin base. Heat resistant. Ideal for P.C.'s. Size: 12" × 12"; 24" × 12"; 24" × 24"; FULL SHEET 43" × 37" (11 sq. ft.). Single-sided Copper with thickness of 1/16", 3/64", 1/32". Also double-sided 1/16", 1/16", 1/32". £1 per sq. ft. Cut sizes (1–10 sq. ft.) 25p. P. & P. Full Sheet £8 each. Carr. £1 for 1st sheet plus 25p each additional sheet.

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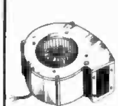
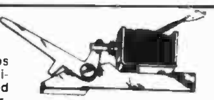
Impedance approx. 200Ω, output 60 or 80 DB at 1 Kc. As used in deaf aids, bugging device, etc. Size (60 DB) 1/16" × 1/16" × ½", (80 DB) ½" 1/16" ½". Ex-equipment, all tested. £1·20 each. P. & P. FREE.

Ultra PRECISION CENTRIFUGAL BLOWER by Air Control Ltd.



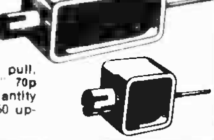
30 segments individually balanced in heavy cast alloy case. 2,300 r.p.m. 240 V a.c. Very powerful and silent running. 5½" dia. 3" Inlet dia. Outlet flange 3" × 2½". Limited number only £8·95. P. & P. 40p.

MAINS SOLENOID



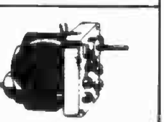
This little unit gives vertical lift of approximately 1" through hinged "elbow". Bracket incorporates 2 fixing screws. Length of arm, 2½". 240V AC. Pull at coil is approximately 1lb. £1. FREE P. & P. Special quotes for quantities.

SOLENOIDS by WESTOOL



240AC type MM6. 3lb. pull, 2½" × 1" × 1½". Travel 1". 90p. each. P. & P. 10p.
240AC type MM4. 2lb. pull, 1½" × 1¾" × 1". Travel ½" 70p each. P. & P. 10p. Quantity discounts: 10–50 10%, 50 upwards 25%.

OPEN FRAME shaded pole GEARED MOTORS



(Dural gear case) 240 AC., 28rpm. NEW HIGH TORQUE. approx. overall size: 3½" × 3½" × 2½" + spindle ½" dia. as illustrated. £2·70. P. & P. 30p.
Similar to above, 19rpm. £2·70. P. & P. 30p.
110rpm with pressed steel gear case (similar to above but SLIGHTLY SMALLER) £2·70. P. & P. 30p.

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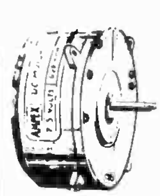
Now complete with reference magnet!

A magnetically activated switch, vacuum sealed in a glass envelope. Silver contacts, normally closed. Rated 3amp at 120v, 1½amp at 240v. Size: (approx.) 1⅛" long × ⅛" dia. Ideal for burglar alarms, security systems etc., and wherever non-mechanical switching is required. 10 for £2·10; P. & P. 15p. 50 for £8; 100 for £15·50. FREE P. & P. over 10.

AMPEX 7·5V. D.C. MOTOR



An ultra precision tape motor designed for use in the AG20 portable recorder. Torque 450GM/CM. Stall load at 500ma. Draws 60ma on run. 600rpm ± speed adjustment. Internal AF/RF suppression. ⅛" dia. × 1" spindle, motor 3" dia. × 1½". Original cost £16·50. OUR PRICE £3·30. P. & P. 25p. Quantities available. Mu-metal enclosure available 75p each. FREE P. & P.

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Whilst we welcome official orders from established companies and Educational Departments, it is no longer practical to invoice goods under £5. Therefore, please remit cash with orders below this amount.

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AC113	20
AC115	22
AC117K	32
AC122	13
AC125	19
AC126	19
AC127	20
AC128	20
AC132	16
AC134	16
AC137	16
AC141	20
AC141K	32
AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACY34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39

Type	Price p
AD162	39
AD161 and	
AD162MP	75
ADT140	55
AF114	27
AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY56	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	14
BC108	14
BC109	15
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
BC126	20
BC132	13
BC134	20
BC135	13
BC136	17
BC137	17
BC139	44
BC140	33
BC141	33
BC142	33
BC143	33
BC145	50
BC147	11

Type	Price p
BC148	11
BC149	13
BC150	20
BC151	22
BC152	19
BC153	31
BC154	33
BC157	20
BC158	13
BC159	13
BC160	50
BC161	55
BC167	13
BC168	13
BC169	13
BC170	13
BC171	16
BC172	16
BC173	16
BC174	16
BC175	24
BC177	21
BC178	21
BC179	21
BC180	27
BC181	27
BC182	16
BC182L	16
BC183	16
BC183L	16
BC184	22
BC184L	22
BC186	31
BC187	31
BC207	12
BC208	12
BC209	13
BC212L	14
BC213L	14
BC214L	18
BC225	28
BC226	39
BC301	30
BC302	27
BC303	35
BC304	40
BC440	34
BC460	40
BCY30	27
BCY31	29
BCY32	33
BCY33	24
BCY34	28
BCY70	16
BCY71	22
BCY72	16
BCZ10	22
BCZ11	28
BCZ12	28
BD115	68
BD116	88

Type	Price p
BD121	66
BD123	72
BD124	76
BD131	55
BD132	66
BD133	72
BD135	44
BD136	44
BD137	50
BD138	55
BD139	61
BD140	66
BD155	88
BD175	66
BD176	66
BD177	72
BD178	72
BD179	72
BD180	77
BD185	72
BD186	72
BD187	77
BD188	77
BD189	83
BD190	83
BD195	94
BD196	94
BD197	99
BD198	99
BD199	£1·05
BD199	£1·05
BD200	£1·05
BD205	88
BD206	88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
BDY20	£1·10
BF115	27
BF117	50
BF118	77
BF119	77
BF121	50
BF123	55
BF125	50
BF127	55
BF152	61
BF153	50
BF154	50
BF155	77
BF156	53
BF157	61
BF158	61
BF159	66
BF160	44
BF162	44
BF163	44
BF164	44
BF165	44
BF167	24
BF173	24

Type	Price p
BF176	39
BF177	39
BF148	33
BF179	33
BF180	33
BF181	33
BF182	44
BF183	44
BF184	28
BF185	33
BF187	30
BF188	44
BF194	18
BF195	18
BF196	16
BF197	16
BF200	50
BF222	£1.05
BF257	50
BF258	66
BF259	94
BF262	61
BF263	61
BF270	39
BF271	33
BF272	88
BF273	39
BF274	39
BFW10	66
BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
BFY50	22
BFY51	22
BFY52	22
BFY53	19
BSX19	17
BSX20	17
BSY25	17
BSY26	17
BSY27	17
BSY28	17
BSY29	17
BSY38	20
BSY39	20
BSY40	31
BSY41	31
BSY95	14
BSY95A	14
Bu105	£2·20
C111E	55
C400	33
C407	28
C424	28
C425	55
C426	39
C428	22
C441	33

Type	Price p
C442	33
C444	39
C450	24
MAT100	21
MAT101	22
MAT120	21
MAT121	22
MJE2955	95
MJE3055	62
MJE3440	55
MPF102	46
MPF104	41
MPF105	41
OC19	39
OC20	70
OC22	52
OC23	54
OC24	62
OC25	42
OC26	32
OC28	55
OC29	55
OC35	46
OC36	55
OC41	22
OC42	27
OC44	17
OC45	14
OC70	11
OC71	11
OC72	16
OC74	16
OC75	17
OC76	17
OC77	28
OC81	17
OC81D	17
OC82	17
OC82D	17
OC83	22
OC139	22
OC140	22
OC169	28
OC170	28
OC171	28
OC200	28
OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
OC309	44
OCP71	48
ORP12	48
ORP60	44
ORP61	44
P20	55
P346A	22
P397	46
ST140	14
ST141	19

Type	Price p
TI843	33
UT46	30
ZN414	£1·20
2G301	21
2G302	21
2G303	21
2G304	27
2G306	44
2G308	39
2G309	39
2G339	22
2G339A	18
2G344	20
2G345	18
2G371	18
2G371B	13
2G373	19
2G374	19
2G377	33
2G378	18
2G381	18
2G382	18
2G401	33
2G414	33
2G417	28
2N388	39
2N388A	61
2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
2N706	09
2N706A	10
2N708	13
2N711	33
2N717	39
2N718	27
2N718A	55
2N726	31
2N727	31
2N743	22
2N744	22
2N914	16
2N918	33
2N929	23
2N930	23
2N1131	22
2N1132	24
2N1302	16
2N1303	16
2N1304	19
2N1305	19
2N1306	23
2N1307	23
2N1308	26

Type	Price p
2N1309	26
2N1613	22
2N1711	22
2N1889	35
2N1890	50
2N1893	41
2N2147	79
2N2148	63
2N2160	66
2N2192	39
2N2193	39
2N2194	39
2N2217	24
2N2218	22
2N2219	22
2N2220	24
2N2221	22
2N2222	22
2N2368	19
2N2369	16
2N2369A	16
2N2411	27
2N2412	27
2N2646	52
2N2711	23
2N2712	23
2N2714	23
2N2904	19
2N2904A	23
2N2905	23
2N2905A	23
2N2906	17
2N2906A	20
2N2907	22
2N2907A	24
2N2923	16
2N2924	16
2N2925	16
2N2926G	14
2N2926Y	12
2N2926O	11
2N2926R	11

Type	Price p
2N2926B	11
2N3010	77
2N3011	16
2N3053	19
2N3054	51
2N3055	55
2N3391	16
2N3391A	18
2N3392	16
2N3393	16
2N3394	16
2N3395	19
2N3402	23
2N3403	23
2N3404	31
2N3405	46
2N3414	17
2N3415	17
2N3416	31
2N3417	31
2N3525	83
2N3614	74
2N3615	82
2N3616	82
2N3646	10
2N3702	13
2N3703	13
2N3704	14
2N3705	13
2N3706	13
2N3707	14
2N3708	09
2N3709	10
2N3710	10
2N3711	10
2N3819	31
2N3820	55
2N3821	39
2N3823	31
2N3903	31
2N3904	33
2N3905	31

Type	Price p
2N3906	30
2N4058	13
2N4059	11
2N4060	13
2N4061	13
2N4062	13
2N4284	19
2N4285	19
2N4286	19
2N4287	19
2N4288	19
2N4289	19
2N4290	19
2N4291	19
2N4292	19
2N4293	19
2N5172	13
2N5294	60
2N5457	35
2N5458	35
2N5459	44
2N6121	75
2S301	55
2S302A	46
2S302	46
2S303	61
2S304	77
2S305	86
2S306	86
2S307	86
2S321	62
2S322	46
2S322A	46
2S323	62
2S324	77
2S325	77
2S326	77
2S327	77
2S701	46
40361	44
40362	50

DIODES AND RECTIFIERS

Type	Price p
AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BA173	16
BY100	17
BY101	13
BY105	19
BY114	13

Type	Price p
BY124	13
BY126	16
BY127	17
BY128	17
BY130	18
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31

Type	Price p
CG62 (OA91Eq)	6
CG651 (OA70-OA79)	7
OA5	39
OA5 short leads	23
OA10	15
OA47	8
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8

LINEAR INTEGRATED CIRCUITS

Type No.	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	50p	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

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3015F Minitron .. .. £1·50
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Type	Price 1	25	100+
BP930	15p	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

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only.)

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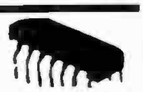
TO3 Plastic 1·5 Amps

μA 7805/L129 5V (Equiv. to MVR5V) £1·76
μA 7812/L130 12V (Equiv. to MVR15V) £1·76
μA 7815/L131 15V (Equiv. to MVR15V) £1·76

74 Series T.T.L. I.C's



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Type	Quantities £p 1	£ p 25	£ p 100+
7406	0·39	0·34	0·31
7407	0·39	0·34	0·31
7408	0·25	0·24	0·23
7409	0·25	0·24	0·23
7411	0·28	0·27	0·26
7412	0·30	0·29	0·28
7413	0·32	0·31	0·30
7416	0·40	0·39	0·38
7417	0·40	0·39	0·38
7422	0·30	0·29	0·28
7423	0·40	0·39	0·38
7425	0·40	0·39	0·38
7426	0·40	0·38	0·36
7427	0·40	0·38	0·36
7428	0·45	0·42	0·40
7432	0·40	0·38	0·36
7433	0·42	0·40	0·38
7437	0·45	0·42	0·40
7438	0·45	0·42	0·40
7441	0·74	0·71	0·64
7442	0·74	0·71	0·64
7443	1·20	1·15	1·10
7444	1·20	1·15	1·10
7445	1·98	1·95	1·90
7446	1·20	1·15	1·10
7447	1·10	1·07	1·05
7448	1·10	1·07	1·05
7470	0·32	0·29	0·27
7472	0·32	0·29	0·27
7473	0·41	0·39	0·35
7474	0·41	0·39	0·35

Type	Quantities £ p 1	£ p 25	£ p 100+
7475	0·60	0·58	0·56
7476	0·44	0·43	0·42
7480	0·74	0·71	0·64
7481	1·30	1·25	1·20
7482	0·90	0·85	0·80
7483	1·20	1·15	1·05
7484	1·10	1·05	1·00
7485	2·00	1·90	1·80
7486	0·35	0·34	0·33
7489	4·00	3·75	3·50
7490	0·74	0·71	0·64
7491	1·10	1·05	1·00
7492	0·74	0·71	0·64
7493	0·74	0·71	0·64
7494	0·85	0·82	0·75
7495	0·85	0·82	0·75
7496	0·96	0·93	0·86
74100	1·50	1·45	1·40
74104	0·70	0·68	0·66
74105	0·70	0·68	0·66
74107	0·44	0·42	0·40
74110	0·60	0·55	0·50
74111	0·95	0·92	0·90
74118	1·10	1·05	1·00
74119	1·50	1·40	1·30
74121	0·50	0·48	0·45
74122	0·88	0·86	0·84
74123	1·58	1·54	1·50
74141	0·85	0·82	0·79
74145	1·58	1·54	1·50
74150	2·50	2·40	2·30

Type	Quantities £ p 1	£ p 25	£ p 100+
74151	1·10	1·05	1·00
74153	1·20	1·10	1·00
74154	1·98	1·90	1·75
74155	1·20	1·15	1·10
74156	1·20	1·15	1·10
74157	1·20	1·15	1·10
74160	1·73	1·70	1·65
74161	1·73	1·70	1·65
74162	1·73	1·70	1·65
74163	1·73	1.70	1·65
74164	2·20	2·10	2·00
74165	2·20	2·10	2·00
74166	2·35	2·30	2·25
74174	2·00	1·95	1·90
74175	1·40	1·35	1·30
74176	1·60	1·55	1·50
74177	1·60	1·55	1·50
74180	1·60	1·55	1·50
74181	5·00	4·50	4·00
74182	1·50	1·45	1·40
74184	2·40	2·30	2·20
74190	2·15	2·10	2·00
74191	2·15	2·10	2·00
74192	2·15	2·10	2·00
74193	2·15	2·10	2·00
74194	1·90	1·80	1·70
74195	1·60	1·50	1·40
74196	1·73	1·70	1·65
74197	1·73	1·70	1·65
74198	3·45	3·35	3·20
74199	3·10	3·00	2·90

Devices may be mixed to qualify for quantity price. (TTL 74 series only) data is available for the above series of I.C.s in booklet form. Price 35p.

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Comprises three 66-bit 20 dynamic shift registers with independent inputs and outputs. TTL compatibility and buffered clock lines to reduce the capacitive load presented at the clock pins. A bootstrapped buffer ensures a full logic swing at the output. **£2·50** each

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T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
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Q27	2	10A 600 PIV Silicon rectifiers IS425R	0·55
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Q30	7	Silicon switch transistors 2N706 *npn*	0·55
Q31	6	Silicon switch transistors 2N708, *npn*	0·55
Q32	3	*pnp* Silicon transistors 2 × 2N1131, 1 × 2N1132	0·55
Q33	3	Silicon *npn* transistors 2N1711	0·55
Q34	7	Silicon *npn* transistors 2N2369, 500MHz (code P397)	0·55
Q35	3	Silicon *pnp* TO-5. 2 × 2N2904 & 1 × 2N2905	0·55
Q36	7	2N3646 TO-18 plastic 300MHz *npn*	0·55
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U47	10	TO220AB plastic triacs 50V 6A	1·10
U48	9	NPN Sil. power transistors like 2N3055	1·10
U49	12	NPN Sil. plastic power trans. 60W like 2N5294/5296	1·10

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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APPROXIMATELY 200 PIECES ASSORTED MANUFACTURERS' FALL-OUT INTEGRATED CIRCUITS INCLUDING LOGIC 74 SERIES LINEAR and AUDIO AMPLIFIERS. MANY CODED also SOME UNKNOWN TYPES—YOU TO IDENTIFY.

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PRICE £1·25 per PAK including P. & P. and VAT

FREE
One 55p Pak of your own choice free with orders valued £4 or over

CADMIUM CELLS
ORP12 48p

SIL. RECTS. TESTED

PIV	300mA (DO7)	750mA (SO16)	1A Plastic	1·5A (SO16)	3A (SO10)	10A (SO10)	30A (TO48)
	p	p		p	p	p	p
50	05	06	1N4001	05	08	15	21	60
100	05	07	1N4002	06	10	17	23	75
200	06	10	1N4003	07	12	22	25	1·00
400	08	15	1N4004	08	15	30	38	1·35
600	09	17	1N4005	10	18	36	45	1·90
800	12	19	1N4006	11	20	38	55	2·10
1000	14	30	1N4007	12	25	48	65	2·50
1200	—	35			30	58	75	3·00

1974 CATALOGUE NOW READY 10p

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	=12×7400	0·55	UIC46	=5×7446	0·55	UIC86	=5×7486	0·55
UIC01	=12×7401	0·55	UIC48	=5×7448	0·55	UIC90	=5×7490	0·55
UIC02	=12×7402	0·55	UIC50	=12×7450	0·55	UIC91	=5×7491	0·55
UIC03	=12×7403	0·55	UIC51	=12×7451	0·55	UIC92	=5×7492	0·55
UIC04	=12×7404	0·55	UIC53	=12×7453	0·55	UIC93	=5×7493	0·55
UIC05	=12×7405	0·55	UIC54	=12×7454	0·55	UIC94	=5×7494	0·55
UIC06	=8×7406	0·55	UIC60	=12×7460	0·55	UIC95	=5×7495	0·55
UIC07	=8×7407	0·55	UIC70	=8×7470	0·55	UIC96	=5×7496	0·55
UIC10	=12×7410	0·55	UIC72	=8×7472	0·55	UIC100	=5×74100	0·55
UIC20	=12×7420	0·55	UIC73	=8×7473	0·55	UIC121	=5×74121	0·55
UIC30	=12×7430	0·55	UIC74	=8×7474	0·55	UIC141	=5×74141	0·55
UIC40	=12×7440	0·55	UIC76	=8×7476	0·55	UIC151	=5×74151	0·55
UIC41	=5×7441	0·55	UIC80	=5×7480	0·55	UIC154	=5×74154	0·55
UIC42	=5×7442	0·55	UIC81	=5×7481	0·55	UIC193	=5×74193	0·55
UIC43	=5×7443	0·55	UIC82	=5×7482	0·55	UIC199	=5×74199	0·55
UIC44	=5×7444	0·55	UIC83	=5×7483	0·55	UICXI	=25 Assorted 74's	1·65
UIC45	=5×7445	0·55						

Paks cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

NEW LOW PRICED TESTED S.C.R.'S

	PIV	50 £p	100 £p	200 £p	400 £p	600 £p	800 £p
1A	TO5	0·22	0·27	0·27	0·32	0·42	0·63
3A	TO66	0·27	0·27	0·32	0·42	0·52	0·70
5A	TO66	0·39	0·52	0·54	0·59	0·75	0·88
5A	TO64	0·39	0·52	0·54	0·62	0·75	0·88
7A	TO48	0·52	0·55	0·62	0·67	0·84	0·99
10A	TO48	0·55	0·63	0·67	0·83	1·07	1·32
16A	TO48	0·58	0·62	0·67	0·77	0·97	1·50
30A	TO48	1·27	1·54	1·76	1·93	—	4·40

DIACS
FOR USE WITH TRIACS.
BR100 (D32) 25p each

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 99p each

TRIACS

VBOM	2A TO-6	6A TO-66	10A TO-48
	p	p	£p
100V	33	55	88
200V	55	66	99
400V	77	83	1·21

2N3055
115 WATT SIL POWER NPN 55p EACH

2 Amp. BRIDGE RECTS.

50 v RMS	35p each
100 v RMS	40p ,,
200 v RMS	45p ,,
400 v RMS	50p ,,
1,000 v RMS	55p ,,

Size 16 mm × 16 mm.

D1699 NPN SILICON DUAL TRANSISTOR
(Similar to 2N2060)

1	25	100+
0·28	0·26	0·23

LINEAR INTEGRATED CIRCUIT PAKS

Pak No.	Contents	Price
ULIC709	10×709	0·55
ULIC710	7×710	0·55
ULIC741	7×741	0·55
ULIC747	5×747	0·55
ULIC748	7×748	0·55

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TRANSISTORS

AC153K pnp germanium low power 37p
AC176K npn germanium low power 38p
AD161 npn germanium medium power 42p
AD162 pnp germanium medium power 40p
AF139 pnp germanium UHF 57p
BC107 15p; BC108 14p; BC109 18p; BC167 15p; BC168 14p; BC169 13p each } npn
BC177 25p; BC178 23p; BC179 26p; BC257 14p; BC258 12p; BC259 14p } pnp
Standard groupings available
BD135 npn med. power 37p
BD136 pnp med. power 39p

DIODES
OA90, OA91, OA95 each 6p
OA202 11p

Other semiconductors
AC128 17p; AF117 37p
BFY51 23p
Full lists and technical data will be found in Catalogue No. 7.

RESISTORS

Code	Watts	Ohms	1 to 9	10 to 99 (see note below)	100 up
C	1/3	4·7–470K	1·3	1·1	0·9 nett
C	1/2	4·7–10M	1·3	1·1	0·9 nett
C	3/4	4·7–10M	1·5	1·2	0·97 nett
C	1	4·7–10M	3·2	2·5	1·92 nett
MO	1/2	10–1M	4	3·3	2·3 nett
WW	1	0·22–3·9	11	10	8 nett
WW	3	1–10K	9	8	6 nett
WW	7	1–10K	11	10	8 nett

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

Values: All E12 except C ⅓W, C ½W, and MO ½W.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Tolerances:
5% except WW1 10%
±0·05 Ω below 10 Ω and MO ½W 2%

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) Prices for 100 up in units of 100 only.

MINITRON DIGITAL INDICATORS

3015F Seven segment filament, compatible with standard logic modules. 0–9 and decimal point; 9mm characters in 16 lead DIL, £1·20. Now available in 8mA or 15mA per segment rating.
Suitable BCD decoder driver 7447, **£1·15.**
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GIRO ACCOUNT No. 38/671/4002

CAPACITORS

DALY ELECTROLYTIC
in cans, plastic sleeved
1,000mF/25V, **28p**; 5,000mF/25V, **62p**; 1,000mF 50V, **41p**; 2,000mF/50V, **57p**; 5,000mF/50V, **£1·18**; 50,00mF/100V, **£2·91**; 2,200mF/100V, **£1·56**.

POLYESTER TYPE C280
Radial leads for P.C.B. mounting. Working voltage 240V d.c.
0·01, 0·015, 0·022, 0·033, 0·047, **3p** each; 0·068, 0·1, 0·15, **4p** each; 0·22, **5p**; 0·33, **7p**; 0·47, **8p**; 0·68, **11p**; 1·0, **14p**; 1·5, **21p**; 2·2, **24p**.

SILVERED MICA
Working voltage 500V d.c.
Values in pF—2·2 to 820 in 32 stages, **6p** each; 1,000, 1,500, **7p** each; 1,800, **8p**; 2,200, **10p**; 2,700, 3,600, **12p** each; 4,700, 5,000, **15p** each; 6,800, **20p**; 8,200, 10,000, **25p** each.

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0mF/35V, **14p** each. 2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V, **14p** each. 4·7/35V, 10/16V, 22/6·3V, **18p** each. 10/25V, 22/16V, 47/6·3V, 100/3V, 6·8/25V, 15/25V, **20p** each.

POLYCARBONATE TYPE B32540
Working Voltage 250V.
Values in mF: 0·0047, 0·0068, 0·0082, 0·01, 0·012, 0·015, **3p** each. 0·018, 0·022, 0·027, 0·033, 0·039, 0·047, 0·056, 0·068, 0·082, 0·1, **4p** each.

CERAMIC PLATE
Working voltage 50V d.c.
In 26 values from 22pF to 6,800pF, **2p** each.

ELECTROLYTIC Axial Leads

uF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	9p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

POTENTIOMETERS

ROTARY, CARBON TRACK.
Double wipers for good contact and long working life.
P20 SINGLE linear 100 ohms to 4·7M Ω, **14p** each.
P20 SINGLE log. 4·7k Ω to 2·2M Ω, **14p** each.
JP20 DUAL GANG linear 4·7k Ω to 2·2M Ω, **48p** each.
JP20 DUAL GANG log. 4·7k Ω to 2·2M Ω, **48p** each.
JP20 DUAL GANG log/antilog 10K, 22K, 47K, 1M Ω only, **48p** each.
JP20 DUAL GANG antilog 10k only **48p**.
2A DP mains switch with any of above **14p** extra.
Decades of 10, 22 and 47 only available in ranges above. **SKELETON CARBON PRESETS 6p** each.

SLIDER
Linear or log, 4·7k Ω to 1M Ω in all popular values, **30p** each.
Escutcheon plates, black, white or light grey, **10p** each.
Control knobs blk/wht/red/yel/grn/blue/dk. grey/lt grey, **7p** each.

JACKS AND PLUGS

Sockets
2-circuit, unswitched, S1/SS **11p**
2-circuit/2 break contacts, S1/BB **13p**
3-circuit, unswitched (not GPO), S3/SSS **15p**
3-circuit with 3 break contacts, S3/BBB **20p**
2 circuit with chrome nut and black/white/red/green or grey unswitched, S5/SS **14p**
2 circuit with chrome nut and black/white/red/green with 2 break contacts, S5/BB **17p**
Miniature, 3·5mm, 2-circuit (black), 2 br. cont., S6/BB **8p**

Plugs
2 circ. screened, top entry, P.1 **24p**
2 circ. screened, side entry, SEP1 **36p**
Line socket, mono, 231 **40p**
Line socket, stereo, 244 **45p**
3-circuit, unscreened, bl/grey/wh. P.4 **46p**
2-circuit, unscreened, bl/whi/red/bl/grn/grey. P2 **18p**
3-circuit, screened, top entry, P3 **53p**
3-circuit, screened, side entry, SEP3 **55p**
Miniature, 3·5mm, 2-cir., screened, P5 **13p**
Miniature, 3·5mm, 2-circ., unscreened, various colours, P6 **10p**

INSULATED SCREW TERMINALS

In moulded polypropylene, with nickel plate on brass. With insulating set, washers, tag and nuts. 15A/250V. In blk/brwn/red/yel/grn/bl/grey/wh, Type TP.1, **14p** each.

ZENER DIODES full range E24 values: 400mW: 2·7V to 36V, **14p** each; 1W: 6·8V to 82V, **21p** each; 1·5W: 4·7V to 75V, **67p** each; 7·5V to 75V, **94p** each. Clip to increase 1·5W rating to 3 watts (type 266F) **5p.**

VEROBOARD

Copper clad 0·1 in. matrix—2·5 × 3·75 ins. **32p.** 3·75 × 3·75 ins., **35p.** 2·5 × 5 ins., **35p.** 3·75 × 5 ins., **39p.**
Copper clad 0·15 in. matrix—2·5 × 3·75 ins., **24p.** 3·75 × 3·75 ins., **35p.** 2·5 × 5 ins., **35p.** 3·75 × 5 ins., **44p.**
Vero spot face cutter (any matrix), **53p.** 0·040 pins (for 0·1 matrix) per 100, **35p.** 0·052 pins (for 0·15 matrix) per 100, **35p.**

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In a great variety of modern types, for ¼ in. shaft, from plastic to solid aluminium, from typically **63p** per pack of two (Catalogue 7, page 62).

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DIN from 2-way to 7-way plugs and sockets; phono types, mains connectors, etc. (Catalogue 7, page 88).

SIEMENS THYRISTORS

0·8A 400V, **65p**; 600V, **94p**; 3A 400V, **£1·06**; 600V, **£1·50.**

DESOLDERING BRAID

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EV CATALOGUE 7

2nd Printing *(Green and yellow cover)*

112 pages, thousands of items, illustrations, diagrams, much useful technical information. The 2nd printing of this catalogue has been updated as much as possible on prices. It costs only 25p post free and includes a refund voucher for 25p for spending when ordering goods list value £5 or more.

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AF115	13p
AF116	13p
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BC159	14p
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BC183	10p
BC184	11p
BC212	11p
BC213	10p
BC214	12p
BC307	11p
BC308	11p
BC309	12p
BCY70	18p
BCY71	22p
BD115	45p
BD121	100p
BD123	100p
BD124	65p
BD131	40p
BD132	45p
BD153	65p
BD156	60p
BDY60	75p
BDY61	65p

BF115	22p
BF167	23p
BF170	23p
BF173	25p
BF177	26p
BF178	28p
BF179	33p
BF180	33p
BF181	33p
BF184	22p
BF185	22p
BF194	11p
BF195	12p
BF196	14p
BF197	15p
BF200	32p
BF244	38p
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BFX30	30p
BFY50	14p
BFY51	14p
BFY52	14p
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BFX88	24p
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MJE521	80p
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MPF103	36p
MPF104	35p
MPF105	36p
OC26	43p
OC28	48p
OC35	45p
OC36	52p
OC41	15p
OC42	15p
OC44	11p
OC45	11p
OC70	11p
OC71	11p
OC72	11p
OC73	50p
OC74	30p
OC81	12p
OC82	12p
OC83	18p
OC84	18p
OC200	43p

OC201	80p
TIS43	28p
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ZTX108	12p
ZTX109	13p
ZTX300	14p
ZTX301	14p
ZTX302	18p
ZTX303	15p
ZTX304	24p
ZTX500	15p
ZTX501	15p
ZTX502	18p
ZTX503	45p
2N404	26p
2N696	15p
2N697	13p
2N698	15p
2N706	12p
2N708	18p
2N914	18p
2N918	40p
2N929	20p
2N930	18p
2N1131	18p
2N1132	18p
2N1302 3	17p
2N1303 4	21p
2N1306 7	28p
2N1308 9	29p
2N1613	20p
2N1711	20p
2N2160	70p

2N2218	21p
2N2219	20p
2N2220	18p
2N2221	20p
2N2222	20p
2N2369	14p
2N2484	30p
2N2646	32p
2N2904	20p
2N2905	18p
2N2906	20p
2N2926RB	7p
2N2926O	8p
2N2926YG	9p
2N3053	18p
2N3054	45p
2N3055	40p
2N3441	80p
2N3442	120p
2N3525	80p
2N3702 3	11p
2N3704	11p
2N3705 6	10p
2N3707	11p
2N3708 9	9p
2N3771	170p
2N3772	180p
2N3773	230p
2N3819	22p
2N3820	50p
2N3823	48p
2N3866	70p
2N3903 4	15p
2N3905 6	15p
2N4058	15p

2N4059	10p
2N4060	13p
2N4871	35p
2N4444	180p
2N5457	36p
2N5458	35p
2N5459	46p
3N140	100p
3N141	90p
40360	35p
40361	35p
40362	38p
40409	50p
40410	50p
40411	200p
40594	65p
40595	75p
40600	69p
40603	58p

BRIDGE RECTIFIERS

	50V	400V	600V
250mA	14p	—	—
1A	20p	25p	25p
2A	30p	45p	45p
4A	48p	60p	70p
6A	50p	78p	100p

SCR-THYRISTORS

	30V	50V	400V	600V
0 5A	25p	31p	—	—
1A	—	35p	45p	55p
3A	—	40p	55p	65p
7A	—	60p	84p	110p
16A	—	70p	90p	95p

TRIACS

	30V	50V	400V	500V
800mA	52p	58p	—	—
3A	—	85p	99p	120p
6A	—	88p	120p	150p
10A	—	109p	154p	165p
16A	—	145p	180p	200p

RECTIFIER DIODES

BY100	15p
BY126	12p
BY127	12p
BY133	20p
BYZ10	35p
BYZ11	32p
BYZ12	30p
BYZ13	35p
1N4001	5p
1N4004	6p
1N4007	7p
PL4004	10p
PL7004	20p

OTHER DIODES

Tunnel	
AEY11	50p
LED	
TIL209	17p
Varicap	
BA145	15p
DIAC	
ST2	25p

SIGNAL DIODES

BA100	10p
OA47	7p
OA70	8p
OA79	7p
OA81	7p
OA85	9p
OA90	6p
OA91	6p
OA95	7p
OA200	6p
OA202	7p
1N914	4p
1N916	6p
1N4148	4p

ZENER DIODES

3·3V to 33V ±5%

400mW	9p
1·3W	18p
1·5W	25p
10W	40p

ACCESSORIES

Mica Washers + 2 Bushes (For TO3 and TO66) 8p

DIL Sockets 8 pin. 14p; 14 pin. 16p; 16 pin 17p.

AUDIO AND RADIO INTEGRATED CIRCUITS

	£
CA3028 Mixer RF IF Oscillator	1·00
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CA3090 FM Stereo Decoder	4·00
LM377 Stereo Amplifier 2W channel	2·90
MC1303 Stereo Preamplifier	1·30
MC1304 FM Stereo Decoder	1·60
MC1310 Coilless FM Stereo Decoder	2·70
MC1312 Four Channel SQ Decoder	2·10
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MFC6010 IF Amplifier Non-saturating Limiter	0·80
TAA263 Audio Amplifier	0·85
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TBA800 5 Watt Audio Amplifier	1·00
TBA810 7 Watt Audio Amplifier	1·25
TBA820 2 Watt Audio Amplifier	0·80
ZN414 TRF Radio Receiver	1·10
Sinclair Super IC12 6W Amplifier	2·20

LINEAR INTEGRATED CIRCUITS

CA3046 Transistor Array	0·70
LM301 Op. Amp with Ext Comp	0·40
LM307 Op Amp with Int Comp	0·50
MC1455 Timer (similar to NE555)	0·72
MC3401 Quad Op Amp + ve rail only	0·70
NE555 Timer	0·60
709 Op Amp with Ext Comp	0·28
710 Differential Voltage Comparator	0·35
741 Op Amp with Int. Comp	0·29
747 Dual Op Amp	0·70
748 Op Amp with Ext Comp	0·38

Fixed Output Positive Voltage Regulators

	£
650mA	
LM309K 5V	1·48
1A	
MC7805 5V	1·40
MC7812 12V	1·40
MC7815 15V	1·40
MC7818 18V	1·40
MC7824 24V	1·40

Variable Output Voltage Regulator

ML723	0·70

OPTO-ELECTRONICS

Photo-Transistors		Light Dependent Resistors	
OCP70	50p	ORP12	55p
OCP71	65p	ORP60	45p
2N5777	50p	ORP61	50p

Light Emitting Diodes

Red 20p. Green 35p. Yellow 35p.

Seven Segment Displays

3015F (Filament) 120p MAN3M (LED) 130p

TTL INTEGRATED CIRCUITS

7400	15p	7430	17p	7480	65p
7401	17p	7441	75p	7486	41p
7402	17p	7447	95p	7489	380p
7404	16p	7448	120p	7490	52p
7408	20p	7470	30p	7492	68p
7410	17p	7472	30p	7493	65p
7413	30p	7473	36p	74107	45p
7414	72p	7474	34p	74121	45p
7416	33p	7475	52p	74122	76p
7420	17p	7476	37p	74141	85p

C-MOS LOGIC ICs

CD4001	50p
CD4009	120p
CD4011	50p
CD4012	50p
CD4018	300p
CD4027	170p
CD4029	420p
CD4037	210p
CD4047	165p

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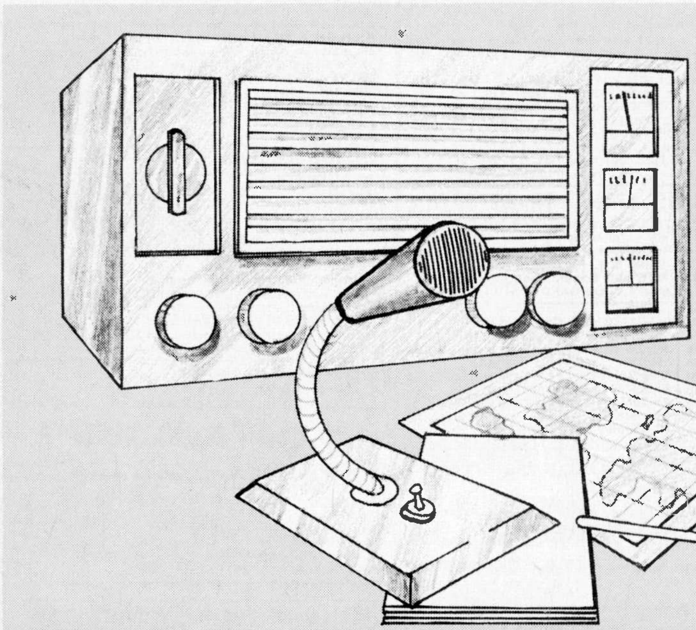

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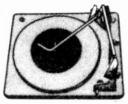
ALL OUR PRICES INCLUDE V.A.T.

BSR HI-FI AUTOCHANGER
STEREO AND MONO



Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.C. 200/250V Size 13½ × 11¼in.
Above motor board 3¼in. below motor board 2½in.

with STEREO and MONO XTAL £6·75 Post 45p.

PORTABLE PLAYER CABINET

Modern design. Black rexine covered. Silver front grille. Chrome fittings.

Motor board cut for above BSR deck £4·50 Post 45p.

COMPACT PORTABLE STEREO HI-FI

Two full size loudspeakers 13½ × 10 × 3¼in. Player unit clips to loudspeakers making it extremely compact, overall size only 13½ × 10 × 8¼in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls 240V a.c. mains.

Attractive Teak finish Weight 13 lb.

Bargain Price £25 85p carriage

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

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and fully guaranteed. £1·95 Post 25p

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RA2W Ferrite Aerial	85p	Driver Trans. LFDT4	65p
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3rd I.F. P50/3CC	40p	J.B. Tuning Gang	65p
Spare Cores	3p	Weyrad Booklet	10p
		OPT1	65p

Mullard Ferrite Rod 8 × ⅜in., 20p. 6 × $\frac{5}{16}$in, 20p. 3 × ⅜in, 10p.

VOLUME CONTROLS
5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K.S.P. Transistor 25p.

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

8in. or 10×6in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 c/s. Bass resonance 55 c/s. 8 ohm impedance, 10 watts. music power. £3·75 Post 25p

E.M.I. 13½ × 8in. SPEAKER SALE!

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

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45–60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. £2·75 Post 25p

Bookshelf Cabinet Teak finish 16 × 10 × 9in. £6·60 Post 45p
13in × 8in Bass Woofer, 20 watts, 15 ohms, £5·50

SET OF 3 MOTORS FOR COLLARO STUDIO 115 VOLT TAPE DECK
£2·50 Post 50p

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1.
ALUMINIUM BOXES, 3 × 3 × 3in 60p; 4 × 4 × 4in 70p; 6 × 4 × 4in 80p; 9 × 4 × 4in £1; 12 × 4 × 4in £1·30.
ALUMINIUM PANELS 18 s.w.g. 6 × 4in 12p; 8 × 6in 19p; 14 × 3in 20p; 10 × 7in 24p; 12 × 5in 25p; 12 × 8in 34p; 16 × 6in 34p; 14 × 9in 40p; 12 × 12in 47p; 16 × 10in 60p.
S.R.P.B. PAXOLIN PANEL 10 × 8in 20p.

ANOTHER R.C.S. BARGAIN!
ELAC 9 × 5in HI-FI SPEAKER TYPE 59RN
This famous unit now available, 10 watts, 8 ohm.
Price £3·30 Post 25p

R.C.S. STABILISED POWER PACK KITS
All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less.
PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1¼ × 1¼in. £2·20 Post 25p

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

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Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9–12V or H.T. line 200–300V d.c. operation. Size: 1½ × 1¼ × ½ in. Response 25 c/s to 25 kc/s. 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. 99p Post 20p

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1·5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. 95p Post 20p

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88 to 108 M/CS British made. 2 Transistors ready aligned requires 10·7 M/CS I.F. Complete with tuning gang. Connections supplied but some technical experience essential. Our price £3·95 Post 20p

MAINS TRANSFORMERS
ALL POST 25p each

Eagle MT12 12–0–12V 50 mA	90p
250–0–250 80 mA, 6·3V 3·5A 6·3V 1A or 5V 2A	£2·50
350–0–350 80 mA, 6·3V 3·5A, 6·3V 1A or 5V 2A	£3·00
300–0–300V 120 mA, 6·3V 4A C.T.; 6·3V 2A	£3·95
MINIATURE 200V 20 mA, 6·3V 1A 2½ × 2½ × 2in	75p
MIDGET 220V 45 mA, 6·3V 2A 2½ × 2½ × 2in	90p
HEATER TRANS. 6·3V 1·5A	85p

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £3·00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £3·00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6·00
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
5, 8 and 13V; 5 amp. £1·20. 3 amp. 3, 5, 8, 10, 13 or 5–0–5V £1·30, Ditto 5 amp. £1·50; 6–0–6V 500mA 90p 9V 1 amp. 95p, 12V 300mA 75p, 12V 500 mA 85p, 12V 750 mA 95p, 40V 1 amp. £1·75.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £3·00; 500W £6·25; 750W £10; 1000W £15
CHARGER TRANSFORMERS. Input 200/250V, for 6 or 12V, 1½ amp £1·50; 2 amp £1·80; 4 amp £2·50
BATTERY CHARGERS. Ready built with leads and clips 1½ amp £2; 4 amp £4; 5 amp £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs, 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER
Primary 0–110–240V. Secondary 0–240V. 3A. 720W. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19). OUR PRICE £10 Carr. 50p
Can be used as 800W auto transformers 240–110V.
IDEAL FOR COLOUR T.V. OR GARDEN TOOLS.

NEW ELECTROLYTIC CONDENSERS

2/350V	14p	250/25V	14p	50 + 50/300V	50p
4/350V	14p	500/25V	20p	60 + 100/350V	85p
8/450V	18p	1000/25V	35p	32 + 32/250V	20p
16/450V	22p	1000/50V	47p	32 + 32/450V	60p
32/500V	50p	8 + 8/450V	22p	350 + 50/325V	55p
25/25V	10p	8 + 16/450V	25p	100 + 50 + 50/350V	55p
50/50V	10p	16 + 16/450V	40p	32 + 32 + 32/350V	65p
100/25V	10p	32 + 32/350V	40p		

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.

TRIMMERS 10pF, 30pF, 50pF, 5p. 100pF, 150pF, 10p.
CERAMIC, 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V–0·1 4p, 0·5 13p; 1mF 150V 15p; 2mF 150V 15p.
500V–0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
MICRO SWITCH LEVER ACTION 20p.
SUB-MIN MICRO SWITCH 25p.
TWIN GANG, "0–0" 208pF + 176pF, 85p; 500pF standard 75p. 365pF + 365pF with 25pF + 25pF, Slow motion drive 50p.
SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ⅛W, ¼W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each.
TAPE OSCILLATOR COIL Valve type 35p.

NEW MODEL "BAKER LOUDSPEAKER", 12IN 50 WATT. GROUP 50/12. 8 OR 15 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. £16

BAKER MAJOR 12" £9·90
Post free

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

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. £12·50
Please state 3 or 8 or 15 ohms. Post free

BAKER "BIG-SOUND" SPEAKERS Post free

'Group 25'	'Group 35'	'Group 50/12'
12in. 25W £8·80	12in. 35W £9·90	12in. 50W £16
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER AND CABINETS

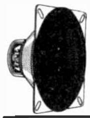
For 12in or 10in dia. speaker	20 × 13 × 9in, £10·50. Post 50p
For 13 × 8in or 8in speaker	16 × 10 × 9in, £6·60. Post 35p
For 8 × 5in speaker	16 × 8 × 6in, £5·00. Post 25p
For 6in and Tweeter	12 × 8 × 6in, £4·00. Post 25p

LOUDSPEAKER CABINET WADDING 18in wide. 20p ft

GOODMANS 6½in. HI-FI WOOFER

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

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3¼ × 3¼ × 2in deep. Rating 10W. 3 ohm. Crossover £1·25 £1·90 Post 20p.

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £2·25.
De Luxe Horn Tweeters 2-18kc/s, 15W, £3·50.
CROSSOVERS, TWO-WAY 3,000 c/s 3 or 8 or 15 ohm £1·25.
LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in., £1·25; 6½in., £1·50; 8 × 5in., £1·60; 10in., £2·00; 8in., £1·75; 10 × 6in., £1·90.
SPECIAL OFFER: 80 ohm, 2½in, 2½in; 35 ohm, 2in, 3in, 25 ohm, 2½in dia., 3in dia., 5in dia.
15 ohm, 3½in dia, 6 × 4in, 7 × 4in, 8 × 5in, £1 each.
3 ohm, 2½in, 2½in, 3½in, 5in dia. (6 × 4in 8 ohms £1·50.)
RICHARD ALLAN TWIN CONE LOUDSPEAKERS.
8in diameter 4W £2·50. 10in diameter 5W £2·50;
12in diameter 6W £2·95. 3/8/15 ohms, please state.
VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p.
Mike trans. mu metal 100:1 £1·25.
Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. ¼in spindle. 65p each, Post 15p.

MAJOR 100 WATT ALL PURPOSE GROUP AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm, a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. £49 Carr. £1·00
PROFESSIONAL VALVE MODEL, 100W, callers only, £69.

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. £4·50
TWO CHANNEL STEREO VERSION £5·95

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume. Treble and bass controls. 18 volt d.c. £4·50

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p.
OUTLET BOXES, SURFACE 25p. FLUSH 60p. TWIN 85p.
BALANCED TWIN RIBBON FEEDER 300 ohms. 7p yd.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead-Socket 45p. Phono Plugs 5p. Phono Socket 5p.
JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p. DIN SOCKETS lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS, 5p; CERAMICS 10p; CANS 5p.

REVERSIBLE 4 POLE MOTOR

1,400 r.p.m. Reversible 42 Watt, spindle 1½" × $\frac{3}{16}$", size 3¼" × 3", As illustrated. With Cooling Fan. a.c. 240V. £2·20 Post 25p

E.M.I. TAPE MOTORS. 120V or 240V a.c. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187 × 0·75in. Size 3½ × 2½ × 2½in (illustrated). Post 25p. £1·85

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TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO.LTD.
163 MITCHAM RD·LONDON SW17 9PG 01·672 3137/9080

TUAC DISCOTHEQUE MIXER WITH AUTO FADE

Designed for the discerning D.J. of professional standard. Offering a vast variety of functions. Controls: Mic Vol; Tone, over-ride depth; auto/Manual Sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off Sw. Max output 1V RMS.

Specification: Deck Inputs—50mV into 1MΩ; Deck Tone Controls—Treble +28 −15dB at 12kHz, Bass +22 −15dB at 40Hz; Mic Input—200 ohms upwards, 2mV into 10kΩ; Mic Tone Control—Total Variation Treble 15dB, Total Variation Bass 10dB; Tape Input —30mV into 47kΩ; Power Requirements—30–45 volts at 150mA.

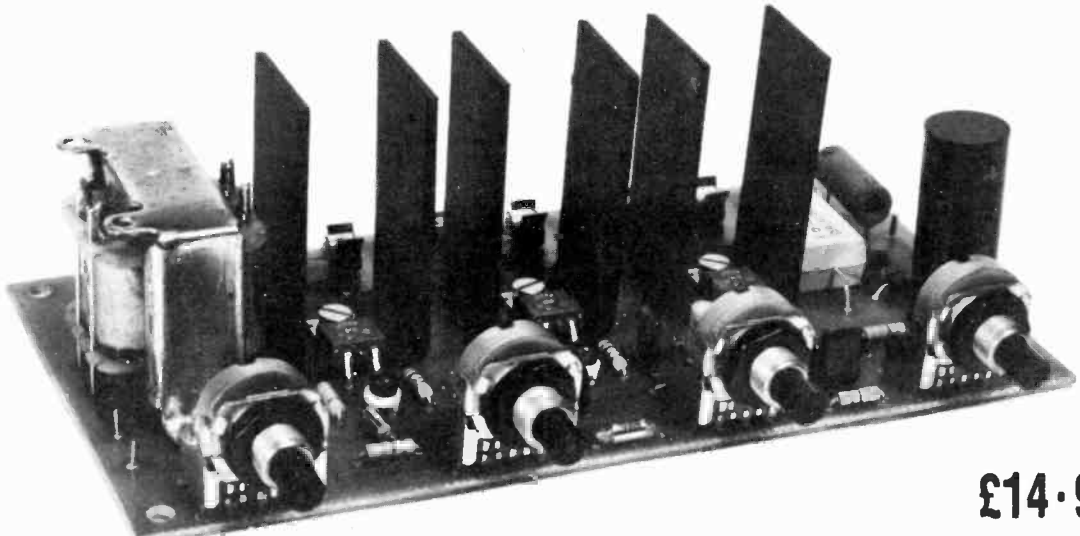
£26·50
PANEL SIZE
18 × 4½in.
DEPTH 3in.

TUAC MAIN DEALERS

BRISTOL DISCO CENTRE, 86 Stokes Croft, Bristol 1. Tel. Bristol 41666.
CALBARRIE AUDIO, 38 Cromwell Road, Luton, Beds. Tel. Luton 411733.
SOCODI, 9 The Friars, Canterbury, Kent. Tel. Canterbury 60948.
WEC LIGHTING, 35 Northam Road, Southampton, Hants. Tel. Southampton 28102.
CALLERS ONLY

NEW! 3 CHANNEL LIGHT MODULATOR

- R.C.A. 8 Amp Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control—12 easy connections



£14·90

Single Channel Version **£6·60**

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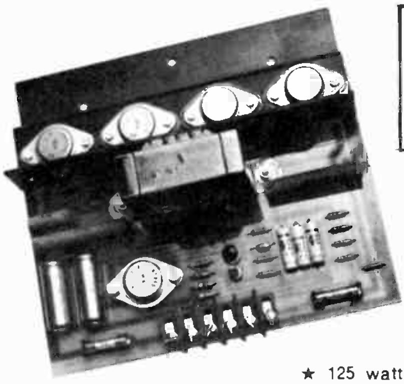
SPECIALISTS IN QUALITY TRANSISTOR EQUIPMENT·OPEN 6 DAYS A WEEK 9·30am-6.00pm

TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO.LTD.
163 MITCHAM RD·LONDON SW17 9PG 01·672 3137/9080

NEW TUAC POWER MODULES offering more power and quality than ever before.



Specification on all power modules: All output power ratings ± 1dB; Output impedance 8–15 ohms; THD at full power 2% typically 1%; Input sensitivity 60mV into 10kΩ; Frequency response 20Hz–20kHz ± 2dB; Hum and noise better than –70dB.

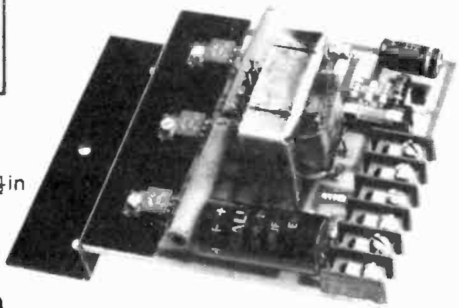
TP125

7 × 6½ × 3in

£17·00

★ 125 watts RMS continuous sine wave output

★ 4 R.C.A. 150 watt 15 amp output transistors



TL30

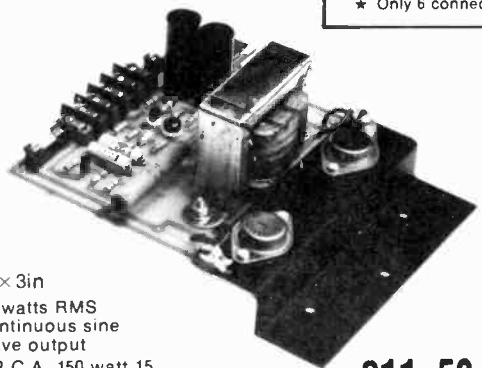
4 × 5¼ × 2½in

£9·30

★ 30 watts RMS continuous sine wave output

★ 2 R.C.A. 40 watt output transistors

★ Rugged layer wound driver transformer
★ Short—Open—and Thermal overload protection
★ Only 6 connections

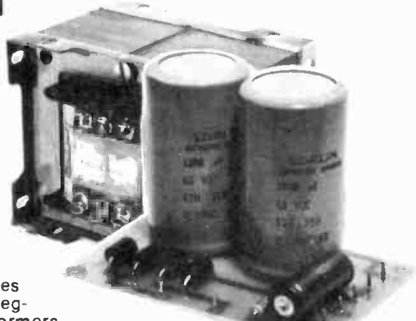


TL60
5 × 5 × 3in
★ 60 watts RMS continuous sine wave output
★ 2 R.C.A. 150 watt 15 amp transistors

£11·50

TL100
5 × 5 × 3in
★ 100 watts R.M.S. continuous sine wave output
★ 2 R.C.A. 150 watt 15 amp transistors

£13·20



Power supplies vacuum impregnated Transformers with supply board incorporating pre-amp supply:

PS 125 ± 50 volts for one TP125	£11·50
PS 100 ± 45 volts for one TL100	£10·50
PS 60 ± 40 volts for one TL60	£9·30
PS 30 ± 50 volts for one TL30	£6·85
PSU 2 for supplying disco mixer	£4·65

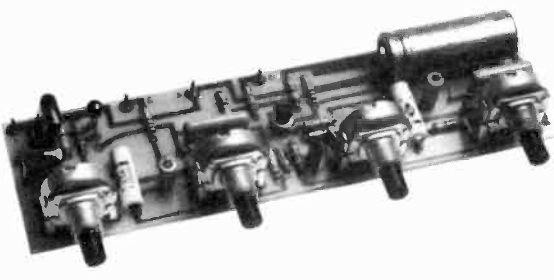
PREAMPLIFIERS

All TUAC audio modules are constructed on glass fibre P.C. board, are ready assembled and fully tested. Low noise silicon and FET transistors together with H.S. carbon film resistors are used throughout. Extensive research has gone into various wide range tone control circuits producing superb sound quality from any signal.

VAO8 Vol. Treble. Mid and Bass controls. Hi. IMP. FET. I/P. suitable Mid. Guitar. Radio. Crystal/Ceramic P.U. Sensitivity 4mV. Treble + 35dB at 16kHz. Mid + 20–15dB at 1Hz Bass + 20–10dB at 40Hz. **£4·90**

VAO6 Vol. Treble and Bass controls. Sensitivity 8mV. Treble + 28–15dB at 12kHz. Bass + 18dB at 40Hz. **£4·15**

AMF01 TUAC Auto Fade Unit fades music when you speak. Auto Mic Over-ride for Disco use. Feed Deck and Mic Pre-amps in. Auto fade O/P to main Amp. 38mV operating level. Depth and Vol Controls. **£4·90**



ALL PRICES INCLUDE V.A.T. (8%) AND POSTAGE AND PACKING

ACCESS & BARCLAY CARDS ACCEPTED JUST SEND US YOUR NUMBER H.P. ARRANGED THROUGH PAYBONDS

PE

OUR FIRST DECADE

WHEN this magazine was launched ten years ago, we were confident that a bright and stimulating future was in store for the home constructor. The transistor had by then revolutionised radio receiver design and was patently crying out for further useful exploitation in other areas. This was to be our main objective.

Yes, our early years were exciting enough, with those original germanium devices soon to be all but superceded by those of silicon. Then a seemingly endless procession of new semiconductor devices for a variety of applications, including power control, as well as optoelectronic devices, emerged.

This technological explosion brought about almost an embarrassment of possibilities for designers and builders alike. Those first two or three years kept us all very busy and yet few of us then realised that another tremendous breakthrough in solid state technology was on its way. The integrated circuit was written about and talked about for some time before the first few devices trickled through to the amateur market. A cautious start was made with these devices—firstly linear amplifiers. Then gradually the full potential of i.c.'s became apparent—this was a revolution within a revolution! Now, over the last three years or so, the i.c. has become as universally popular and commonplace with amateurs as its discrete ancestor.

Those who have followed technical progress over the last ten years will agree that the pace has been hot, each new device developed inspiring, in its turn, a variety of new and frequently highly versatile project designs. Thus the frontiers of electronics have been pushed on and out in all directions, and today the amateur can become involved in practically any area that takes his fancy.

Ten years ago we were convinced that electronics would become the most versatile, exciting, and rewarding of spare time pursuits for those with a technical and a practical bent. The latest technology would be brought literally right to the table top, and the opportunities for its use would be almost limitless.

This has become true. And we like to feel that PRACTICAL ELECTRONICS has been responsible in some degree for this opening up of new vistas to Mr. Everyman. But any credit in this respect must be shared with those many designers and authors who have contributed to these pages. Amongst these contributions have been many unique and trail-blazing projects and ideas.

Also it is right to acknowledge the great service provided by those most essential people the component suppliers, without whom there would be no hobby and whose support as advertisers has been vital to a magazine such as P.E.

Finally, to all our regular readers we express our thanks for their loyal and enthusiastic support—and we know quite a number have been with us since our very first issue.

Yes, we are all ten years older. However, electronics is a great rejuvenator; it keeps us all on our toes in eager anticipation of what tomorrow may bring forth. So we look towards our second decade with confident expectation of a continuance of exciting and stimulating developments that will contribute to our enjoyment of life and help keep our minds young and active.

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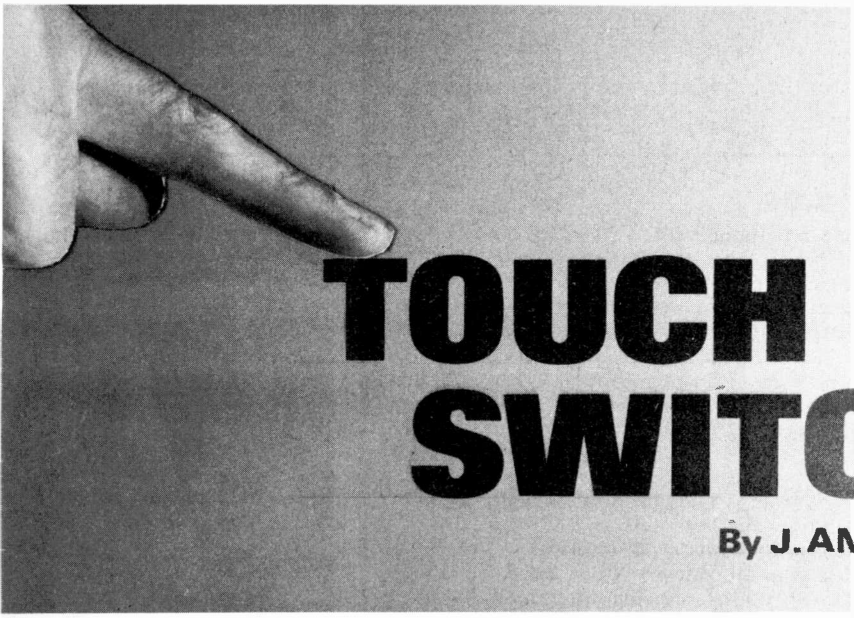


TOUCH SWITCH

By J. ANDREWS

THE radio frequency Touch Switch to be described operates by hand capacity, that is to say, it operates by sensing hand proximity to a metal plate. Low r.f. leakage coupled with sensitivity and speed of operation make this unit suitable for many applications.

The large touch plate area and speed of operation suggests use as an emergency stop on machinery such as lathes or drills or as a safety interlock. Applications at home include touch operation of lights, heating or ventilation.

Apart from novelty value the unit does enable switching operations to be readily carried out, even in the dark. Other applications could include security systems for use in cars.

R.F. LEAKAGE

Many touch or capacity switches use an r.f. oscillator, the tuned circuit of which is damped by the object to be sensed; this causes a current change in the oscillator which after suitable amplification is used to drive a relay or other switching device. A disadvantage here is the amount of r.f. radiated by the oscillator which could cause interference.

The circuit to be described overcomes this objection by allowing the oscillator to run continuously, and arranging that upon being touched, the touch plate reduces the level of r.f. fed to a detector, the output of which drives a Schmitt trigger. This approach allows a much smaller level of r.f. to be present on the plate, typical levels being from 75–100 millivolts.

CIRCUIT ACTION

TR1 in Fig. 1 forms with T1 a 470kHz oscillator. D.c. bias conditions to TR1 are set by R1 and R2 and feedback occurs via L1 to base of TR1. Due to the high Q of T1 a sine wave of over 20 volts appears at the collector of TR1. The phase of the winding of L1 is important, and if the oscillator fails to operate then the connections should be reversed.

R3 is not bypassed; this introduces negative feedback and helps to maintain a good sine wave at the collector of TR1. The output of the collector is

COMPONENTS . . .

Resistors

R1	4·7kΩ
R2	39kΩ
R3–R4	1kΩ (2 off)
R5	5·6kΩ
R6	3·3kΩ
R7	10Ω
R8	680Ω
R9	100kΩ
R10	2·2kΩ
R11–R12	47kΩ
R13	2·2kΩ
R14	100kΩ
R15	33kΩ
R16	220Ω

All ¼ watt 10% carbon

Capacitors

C1	0·01μF
C2*	Integral to i.f. transformer can
C3*	See text
C4	1,000pF
C5	0·1μF
C6–C7	2,000pF (2 off)
C8	0·1μF

Transistors

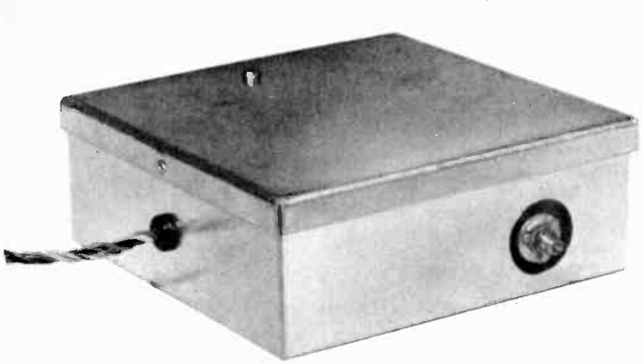
TR1–TR6	BC108 (6 off)
TR7	BFY51

Diodes

D1–D5	OA91 (5 off)

Miscellaneous

T1 470kHz i.f. transformer, RLA 6v 410Ω coil (type 912 R.S.) Metal box 4in × 4in × 1½in, plastic sleeving (see text)



View of the touch switch showing the sensitivity capacitor C3

fed via C3 to the detector circuit formed by D1/D2 but because of loss introduced by these components and the stray capacity associated with the touch plate, the result is only a low level signal appearing at the latter.

Now, if the touch plate is approached, the loss increases, and the voltage from the detector falls, operating the following Schmitt trigger circuit.

Because the value of C3 sets the signal level on the touch plate, this means that its value determines the sensitivity of the switch. An increasing value results in lower sensitivity as greater loss must then be introduced at the touch plate, to reduce the output of the detector, to a point where the Schmitt trigger operates.

When using a small touch plate the total loss is small. In order to reduce the signal level at the detector, a very low value of C3 is required; 1–2pF approximately.

This is conveniently achieved with a twisted wire capacitor made up of two 1½in lengths of 20 s.w.g. tinned copper wire sleeved with neoprene or plastic sleeving and twisted together for a length of about 1in. To adjust the capacity carefully, untwist from the end.

If a larger touch plate were used then the value C3 will need to be increased, a Philips "Beehive" trimmer of 3–30pF should prove satisfactory. A little experimenting will reveal the most sensitive setting.

C4 is provided to prevent hum operating the circuit.

SCHMITT TRIGGER

The output current of the detector holds the Schmitt trigger transistor TR2 on, this means TR3 is off, and the collector voltage is high. Now, when the touch plate is approached the voltage output of the detector falls, this causes TR2 to turn off. As TR2 turns off the collector voltage rises and TR3 turns on so that the trigger produces a rapid negative going output pulse. When the hand is removed

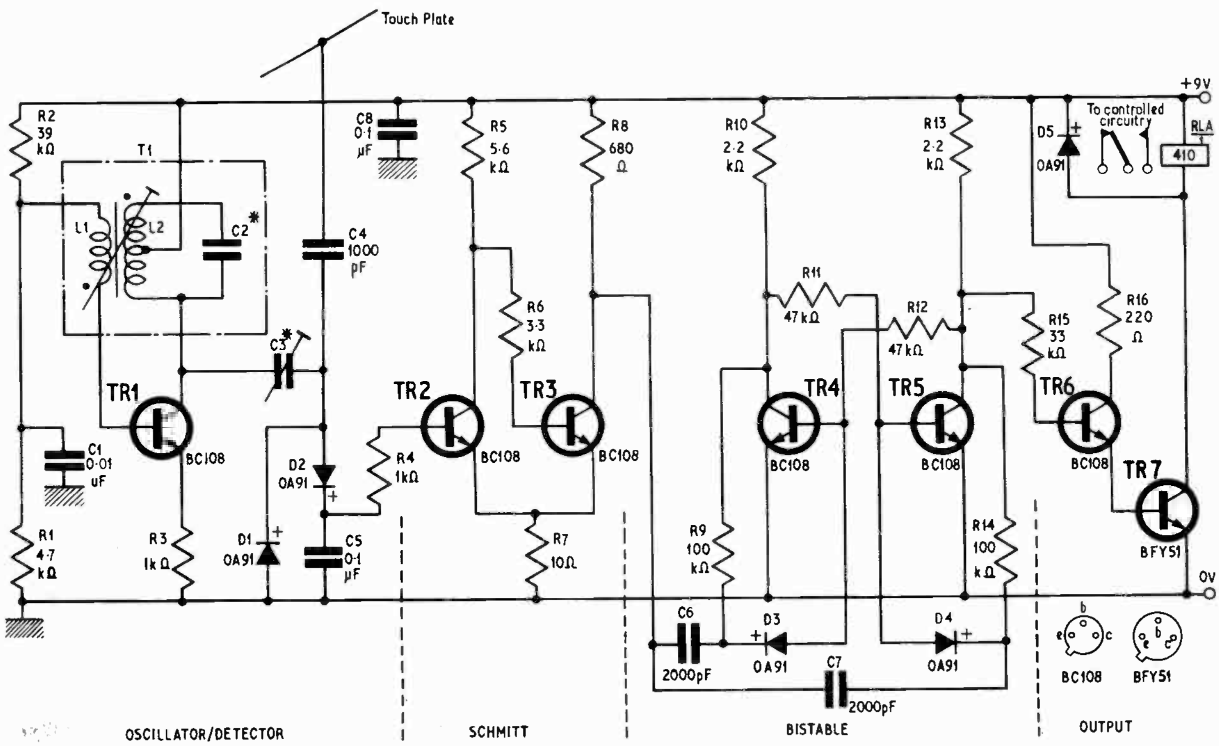


Fig. 1. Circuit diagram of touch switch

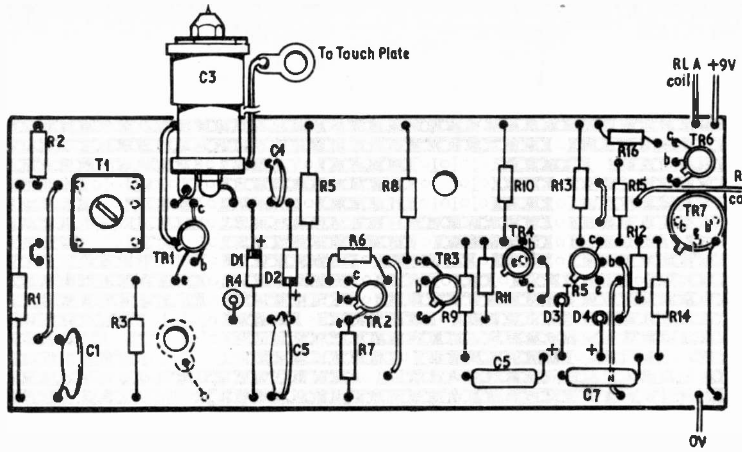


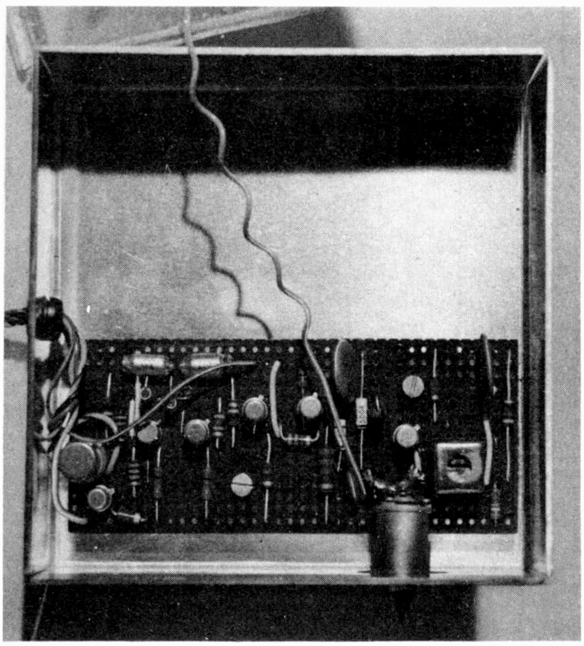
Fig. 2. Veroboard component layout. Note that the chassis connection is made by using a solder tag (shown dotted) held in position by one of the board mounting screws

the current output of the detector is restored and the trigger returns to its former state.

BISTABLE

If the Schmitt trigger output were connected directly to R15, any load at the collector of TR7 would be switched off if the touch plate was approached. This state of affairs is obviously wasteful of battery power so a bistable, or toggle, switch is interposed giving a positive on/off action to the output load as required.

The load driver consists of a pair of compound connected transistors to obviate loading the bistable and affecting its operation.



Interior view of the touch switch showing positioning of the Veroboard and capacitor C3. Note that the touch plate (lid) must be insulated from the edges of the case

CONSTRUCTION

The basic Veroboard construction for the switch is shown in Fig. 2. This layout should be adhered to for correct circuit operation.

The completed circuit board was mounted in a 4in × 4in × 1½in metal box. Although this is a prototype, dimensioning the whole thing could be arranged to fit into a wall conduit box. A plastic blank could then carry a touch plate made of aluminium foil. This would make a novel and attractive wall switch.

In the prototype the touch plate is formed by the box lid. This means that the lid must be electrically insulated from any connections to the circuit apart from C4. This is achieved by running thick plastic sleeving around the lip of the box by carefully slitting it along its edge. The lid is held in place by nylon screws.

Since final testing means having access to C3, a hole should be cut in the box to facilitate this.

TESTING

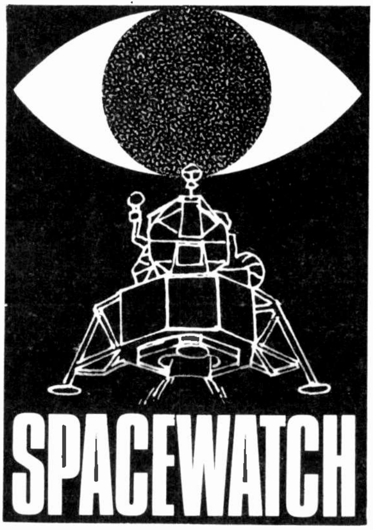
When assembly is complete a final check should be made on correct diode and transistor polarities.

To test, adjust C3 for minimum capacity and screw in the core of T1 to ensure that the oscillator frequency is not a 470kHz i.f.

Connect the 9V supply and connect a voltmeter to TR3 collector. When set to 10V d.c. if all is in order this should read about 0·5V.

Now adjust C3 until a point is found where the level rises to about 9V which indicates the trigger changing state and correct functioning of the oscillator and detector.

C3 should now be backed off until TR3 collector voltage falls to 0·5V. If this is now advanced carefully the voltage should rise. This should be the most sensitive point of operation. Upon approaching the touch plate the collector volts at TR3 should fall and with the hand removed rise again. ★



BY FRANK W. HYDE

A SOVIET VIEW OF JUPITER

One of the greatest difficulties in setting up new theories of the Solar System origin is the amount of angular momentum in the planetary paths. In fact, almost all the angular momentum is in the planetary section while the Sun itself continues to rotate quite slowly.

From the Physical-Technical Institute of the Academy of Sciences of the USSR, a celestial dynamicist, E. M. Drobyshevski has revived the theory that Jupiter was the original core of a primordial nebula. There is a tendency to think that the Sun must be the core mainly because it is now at the centre of the system. Drobyshevski suggests that a binary system composed of the Sun and Jupiter appeared.

Such a binary system would form by reason of the convective processes in the nebula as it condensed. When the matter concentrates toward the centre there will be a change in the outer layers. The speed of the concentration would result in centrifugal forces causing the immense outer ring to separate. This is possible because the centrifugal force exceeds the gravitational force. However, there is a stage where the ring becomes unstable and the matter may disintegrate to form separate bodies.

Drobyshevski is of the opinion that the amount of condensed matter was such that a body the size of the Sun could be formed as one of those bodies. These other bodies would have, therefore, become the other planets. Under these conditions Jupiter would have been made up of the original condensation caused by gravity.

If these two bodies formed a binary pair then since Jupiter is less massive than the Sun the centre of rotation would be nearer to the Sun than to Jupiter. Thus Jupiter would appear as a planet of the Sun. This theory gets round the difficulty of the angular momentum and puts the Sun as the centre of the system and allowing it the slower rotation.

The rest of the planets and satellites would have been formed from the debris when matter would be flung out from the ring as it disintegrated. This also offers an explanation for both the positions and the composition of the planets.

MULTI-PROBE VENUS MISSION

Two *Pioneer* spacecraft will visit Venus in 1978 if the plans of NASA are successful.

Both the vehicles will be spin stabilised and derive their power from the Sun. The mission is complex and will be directed toward studies of the Venusian atmosphere.

One of the two vehicles will be an orbiter which will go as close as 125 miles to the planet. It will arrive about a week earlier than its companion and will act as preliminary surveyor of the prevailing conditions. The orbiter, which is lighter than the companion spacecraft, is expected to reach Venus 190 days after launch. The companion spacecraft will carry four probes and will take some 125 days to reach the planet. Data from the first vehicle will be received before the second is launched.

The four probes carried by the second vehicle will be ejected some ten to twenty days before arrival. They will consist of one large probe carrying about 62lb of equipment and three small probes with about 5lb of instruments.

The probes will take about an hour to drop through the dense atmosphere to the surface. These probes have an extensive task to look at the composition of the atmosphere, to examine the structure of the total height of the atmosphere, and the circulation of the gas envelope. They will also measure the intensity of radiation from outside the planet at the various levels.

The equipment aboard the probes will include temperature and pressure sensors, an accelerometer, a gas chromatograph and various spectrometers. A special piece of apparatus called a "nephelometer" will measure the cloudiness of the atmosphere.

The orbiter will have its own on-board equipment such as particle probes, a magnetometer, a cloud photo-polarimeter, a solar wind gauge, an electric field detector, a mass spectrometer and equipment to measure gamma-ray transients. One of the important instrumental experiments will deal with the radio occultation measurements and the radar altimeter.

The vehicle that carries the probes will itself continue to send back data until it finally burns up in the Venusian atmosphere.

Altogether a most sophisticated mission and an extension to the new generation of technology of getting more data from multiple units. Some 39 scientists have been invited to design the experiments, including one each from France and Germany.

MAN ON THE MOON

The official report of the *Apollo* programme offers certain conclusions about the Moon.

Before man landed on the Moon two explanations for the craters on the Moon, both hotly defended, were that they were of volcanic origin, or caused by impacting matter from outside. These theories were limited by the fact that only Earth based instruments could be used.

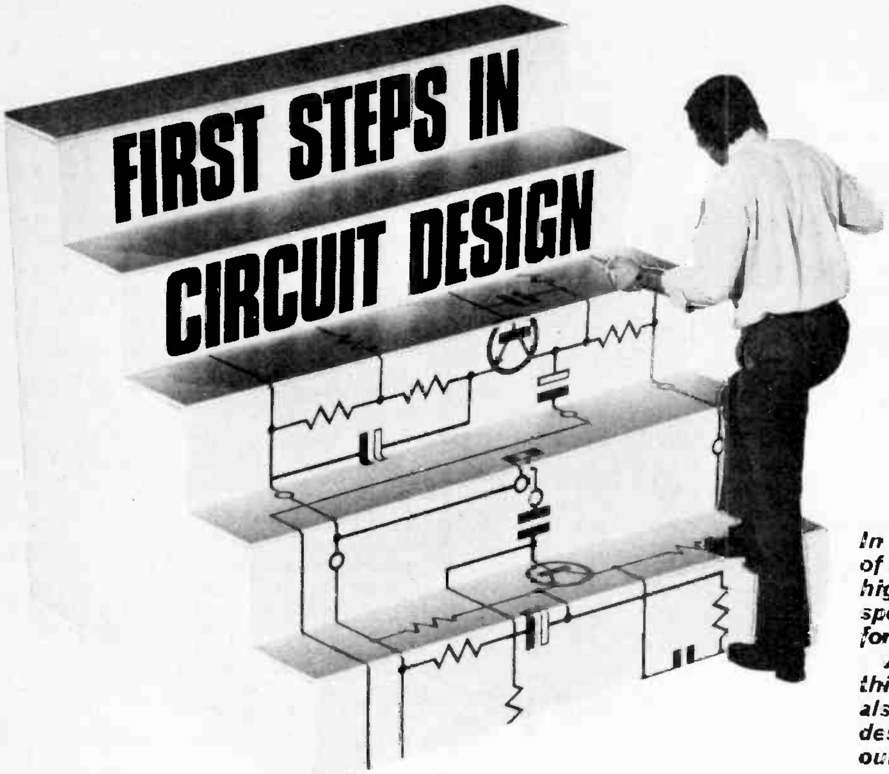
Looking back over the six landings on the lunar surface certain facts emerge. It can be said with some confidence that the filling of the maria took place some 3,200 million to 3,800 million years ago. Since these maria represent a major feature of the lunar surface, it has been inferred that the time of formation of about 90 per cent of craters on the Moon, was at least 4,000 million years ago. The oldest rocks so far discovered on Earth are not older than 3,000 million years.

There is strong evidence that there may well be rocks on the Moon which approach 4,600 million years though not many rocks so far recovered have shown this possibility.

It would seem that from the heat caused by the intense bombardment of the surface by "projectiles" which ranged in size from microscopic to tens of kilometres, was effective in "setting" the "clocks" which determine the absolute age of rocks. It would also seem certain that the dark maria contain underlying lava flows. Generally, it would seem that all or almost all the craters were from bombardment. In this sense volcanism is not answered.

Generally, the moon is quiet seismically but does have miniature quakes which originate at depths of 800 kilometres below the surface. At a depth of 1,000 kilometres the Moon is slightly molten. This is consistent with the theory that volcanism and tectonic movement are rare from about 2 or 3,000 million years. Seismology has shown that the crust is about 60 kilometres thick or more. It would seem from these facts that there was a time when the Moon was very active.

It is very unlikely that the Moon was formed from part of the Earth. The rocks are too dissimilar.



In this, the concluding article of the series, we take a look at high power amplifiers and the special techniques necessary for their successful operation.

As a practical follow-up to this series the Home Intercom, also in this issue, has been designed using the principles outlined in these articles.

LAST month the general principles of class B amplifier design were described and so we begin this month with a design example and the techniques necessary for successful operation.

Though designs under 1W are relatively easy to produce, more problems occur as the output power is raised. We will take a look at some of these problems and how they are overcome in a practical design.

7.1. DESIGN EXAMPLE

Problem: Design suitable component values for a class B stage delivering 150 milliwatts into 35 ohms load.

Step 1. Calculate currents required in the output transistors

We require 0·15 watts into a 35Ω load.

Therefore the r.m.s. voltage across load = $\sqrt{P \times R_L} = \sqrt{0{\cdot}15 \times 35} = 2{\cdot}3$V

Peak voltage across load = $\sqrt{2} \times 2{\cdot}3 = 3{\cdot}25$V

Peak-to-peak volts = 6·5V, and since we have a 9V rail there is a comfortable voltage margin.

Peak power = twice average power = 0·3W

Therefore peak current required =

$$\sqrt{\text{Peak power} \div R_L} = \sqrt{0{\cdot}3 \div 35} = 0{\cdot}09\text{A} = 90\text{mA}$$

A BC108 could just about make with it and a suitable *pnp* version for its opposite half, say a BC214.

Step 2. Calculate currents in the driver transistor TR3

The h_{FE} of a BC108 is much lower at an I_C of 90mA so we had better be pessimistic and assume it is 100 worse case.

Thus we require at least 0·9mA base currents for the outputs which means the collector current of TR3 must be capable of supplying, say, 1mA.

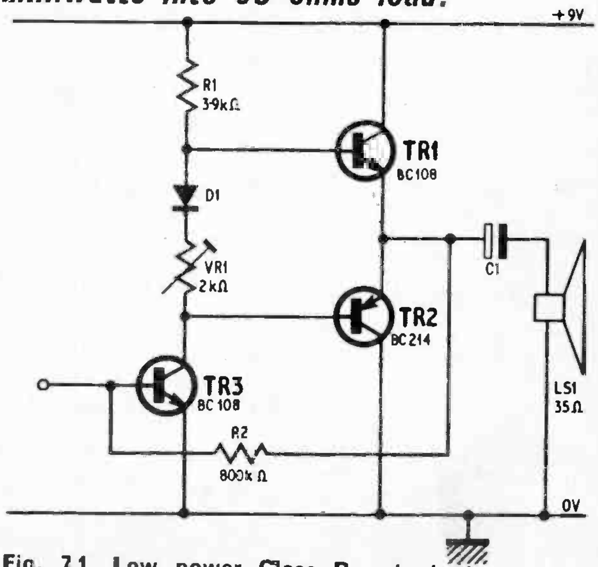


Fig. 7.1. Low power Class B output stage showing typical component values

This fixes R1 at 3·9V ÷ 1mA = 3·9kΩ.

VR1 must be large enough to drop at least 0·6V at 1mA so, allowing for suitable range of adjustment, make VR1 = 2kΩ (anything from 1kΩ to 5kΩ would do).

Step 3. Calculate R2

The base current of TR3 would be 1mA ÷ h_{FE}.

Using a BC108 at 1mA we can take this to be I_b = 1mA ÷ 200 = 5μA.

The voltage across R2 = 4·5 − 0·6 = 3·9V

Hence R2 = 3·9V ÷ 5μA = 800kΩ

Step 4. Calculate sensitivity and voltage gain A

Input resistance of the output transistors is

$R_{IN} = h_{FE} \times$ speaker resistance = $100 \times 35 = 3{,}500\Omega$

(h_{FE} rather than h_{fe} because this is a "large signal" swing)

This resistance is the signal load of TR3 thus the gain of TR3 is

$A = R_{IN} \div r_e = 3{,}500 \div 25/I_C(\text{mA}) = 3{,}500/25 = 140$

Sensitivity for full output = peak output volts ÷ A = 4·5 ÷ 140 = 32mV peak

Input resistance = $h_{fe} \times r_e$ = 200 × 25 = 50kΩ in parallel with R2/A = 800kΩ/140 = 6kΩ (approx.)

The complete circuit is shown in Fig. 7.1.

7.2. SETTING–UP PROCEDURE

Before switching on it is vital to set VR1 to its minimum resistance value. Check and double check this because of the dangerously high quiescent current which can flow. (BC108's are cheap but not cheap enough to use as room heaters!)

Measure the d.c. output volts to ground to confirm the half-way resting position (i.e. around 4·5V).

If an oscilloscope is available and a signal generator apply a sine wave at about 1kHz and adjust VR1 slowly until the crossover distortion disappears. Do not increase VR1 above this point.

If no such test equipment is available the setting up must rely on the ear.

7.3. HIGHER POWER AMPLIFIERS

Although the design of high power amplifiers is strictly an expert's job there are always a few adventurous amateurs willing to risk a few pounds for the sake of personal satisfaction or pride.

Let us suppose for example that we are thinking in terms of supplying 50W r.m.s. power into an 8 ohm load.

Preliminary calculations will reveal rather disquieting figures for supply rail voltage and collector currents.

Supply rail voltage required = $2\sqrt{2}\sqrt{PR}$ (where P = r.m.s. power and R = speaker impedance)

$$V_{CC} = 2{\cdot}82\sqrt{50 \times 8} = 2{\cdot}82 \times 20 = 56{\cdot}4\text{V}$$

However, some safety margins must be included to allow room for the collectors to swing within the limits of saturation. Allowing at least three or four volts for this, and the same for possible tolerance variations in power supply, we arrive at the round figure of 65V (minimum).

The r.m.s. current required is $I = \sqrt{P/R} = \sqrt{50/8}$ = 2·5A and peak current = 3·53 amps.

High power transistors are notoriously low in h_{FE}. As a typical example the complementary pair with the type number 2N3055 (which would be suitable for the above requirements) has h_{FE} between 20 and 70. Using "worst-case" principles the minimum value of 20 must be assumed and the base drive current must be 3·53/20 = 180mA.

This is a lot of base current and will require a small power stage again to supply it!

We cannot hope to produce this kind of drive current by simple circuits previously described.

7.4. POWER DARLINGTONS

The base current for the outputs can be buffered or "geared down" by using small power transistors in Darlington configuration. Fig. 7.2 shows typical h_{FE} and current values.

A very useful device has recently appeared in the semiconductor data manuals called the "power Darlington".

As far as the user is concerned, they behave as a single high power transistor having an h_{FE} in the order of 1,000. (In reality they are integrated Darlington pairs with two bleeder resistors across base and emitter to improve the stability.)

They can be purchased in *npn* or *pnp* (and in matched pairs) so are really the answer to a designer's prayer. Fig. 7.3 shows the internal construction.

Although the devices are not cheap, they compare favourably in cost with discrete pairs (remember that no current driver transistor is required).

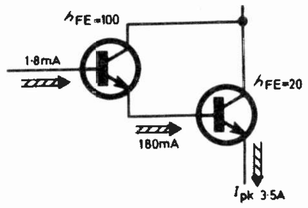


Fig. 7.2. A Darlington pair showing typical currents and transistor gains

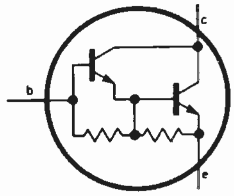


Fig. 7.3. Internal construction of an integrated Darlington pair transistor type MJ3001

Table 7.1: Guide to Power Transistors

Type		Power Dissipation	$I_{C(max)}$	V_{CEO}	$h_{FE(min)}$	$V_{CE(sat)}$
Metal Case	BD266 *pnp* / BD267 *npn*	50W	12A	60V	750	2V
Plastic Case	MJE1100 *npn* / MJE1090 *pnp*	70W	5A	60V	750	2V
Metal Case	MJ3001 *npn* / MJ2501 *pnp*	150W	10A	80V	1,000	2V

Table 7.1 is a guide to current types.

Be careful that you do not fall into a trap when choosing power transistors—the power dissipation column, even though it may appear simple is not sufficient in itself. For example, the MJE1100/1090 can dissipate 70 watts, but only for voltages not exceeding 60 volts. To safely drive 50 watts into 8 ohms requires at least 65V as shown in previous calculations.

7.5. TEMPERATURE EVILS

High power output stages generate considerable quantities of heat. Unless this heat is dissipated by adequate heatsinking, the temperature of the semiconductor junctions will rise higher and higher, eventually entering the fatal region of "thermal runaway".

It is necessary for designers to be well acquainted with the mechanism of thermal runaway in general and, in particular, the special problems it creates for Class B amplification.

All silicon semiconductors "leak" a little even at room temperatures, but the current (due to the release of thermal electrons from the crystal lattice) is small enough to be neglected.

The leakage, unfortunately, rises sharply with increase of temperature which means more current and therefore yet more heat. In other words, the process is a kind of thermal chain reaction which could turn expensive transistors into useless blobs of metal.

Such disasters can be prevented by bolting the output transistors to a large area of metal which radiates most of the heat and keeps the temperature below the thermal runaway zone.

The metal heatsink should be large in area and preferably matt black to aid radiation. There must be no rough edges around the drill holes or the surfaces will not be in good thermal contact; silicone grease helps to increase the effective contact area.

One important point which must be mentioned is the electrical connection between the outer metal case and the collector. The heatsink must therefore be insulated or alternatively a mica insulation disc must be fitted between the case and the heatsink.

TRANSISTOR TURN-ON VOLTAGE

Having dealt with the general effects of temperature, there now remains a rather more subtle problem which we have discussed previously but only in connection with relatively low power output stages.

The turn-on voltage of a silicon transistor, V_{BE} is about 0·6V at normal room temperature but decreases by 2mV for every degree C rise. For example, suppose the output transistors are being driven fairly hard by a large signal. The junction temperature, if such a condition was maintained, could easily and quite safely reach a temperature 50°C higher which would cause the *required* V_{BE} for this particular collector current to be only 0·5V. This is another vicious circle which could be described as "thermal modulation" of the signal.

7.6. DIODE TEMPERATURE TRACKING

To avoid crossover distortion in large power amplifiers, the quiescent current (output stage under zero signal input) should be in the order of 20mA. The forward bias on the bases of the Darlingtons must be around 1·2V instead of 0·6V because there are two V_{BE} drops to account for. The voltage difference across the two bases is therefore about 2·4V at *room temperature*.

However, as we have seen, this voltage must be automatically reduced as the temperature rises to ensure the stability of the quiescent current. In small power stages, such as our earlier example using BC108's the automation was accomplished using one silicon diode and a variable resistor to adjust the quiescent current. If a pair of Darlingtons are used we could use three diodes and a resistor as shown in Fig. 7.4.

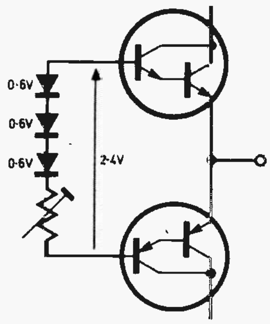


Fig. 7.4. One method of stabilising the bias on a Darlington output stage using three diodes and a preset potentiometer

Providing the diodes are on the same heatsink as the output transistors the forward bias will tend to fall in the same manner as the Darlington V_{BE}.

With "tongue in cheek" it is hoped that the V_{BE} drops will temperature track equally.

The diode method of temperature tracking, although reasonably efficient, lacks the essential finesse demanded by hi-fi addicts.

What is needed is a more delicate control method. Can we, for instance, use a transistor as a temperature variable resistance and benefit from its amplification properties? Such a device is quite commonly employed as an alternative to diode tracking and may be aptly described as a "V_{BE} multiplier".

7.7. THE V_{BE} MULTIPLIER

The circuit of a V_{BE} multiplier is shown in Fig. 7.5.

A voltage, dependent on the setting of VR1, is developed across the resistor chain and the transistor.

Assume VR1 is adjusted under cold, zero signal conditions for the correct 20mA quiescent current in the outputs. The *normal* voltage across the two output base drives will be 2·4V (4 × V_{BE}).

As the temperature rises, the *required* V_{BE} for this current is reduced and more base current flows. The collector current will rise h_{FE} times as much, causing a heavier shunt load across the resistor chain. The original 2·4V is now reduced and the quiescent current is prevented from rising. Providing the outputs and the V_{BE} multiplier are close together on the same heatsink, the system tracks beautifully over the complete temperature range.

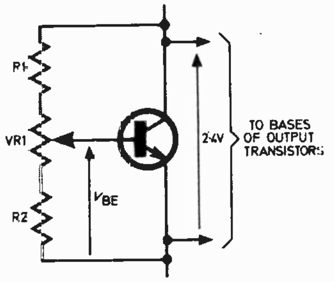


Fig. 7.5. The V_{BE} multiplier—a more economical and efficient method of stabilising output bias

DESIGN DETAILS

Current down the resistor chain should be less than one tenth quiescent output transistor current, which means less than 20mA ÷ 10 – say ½mA as a reasonable figure.

The voltage across R2 should be at half-way (ignoring the transistor).

So R2 = 1·2V/0·5mA = 2·4kΩ (2·2kΩ nearest preferred value).

Allowing for VR1 "twiddle factor", R1 = 1·8kΩ and VR1 = 1kΩ completes the chain.

Any silicon transistor is suitable providing its h_{FE} is at least 100.

7.8. THE CONSTANT CURRENT SOURCE

To keep distortion low, the base current drive to the output transistors should be derived from a high impedance source (ideally a constant current source). The method of obtaining this by bootstrapping has already been covered. There are, however, some objections to this.

Firstly, bootstrapping increases the gain by using some positive feedback which tends to increase the distortion.

Secondly, the frequency response is slightly reduced.

A far more elegant method is to achieve a high impedance drive by using a transistor connected as a constant current source to replace the collector resistor in the drive chain.

It is more convenient to use a *pnp* driver when this method is used.

7.9. DETAILS OF 50W AMPLIFIER

The circuit Fig. 7.6 shows a simple power amplifier capable of delivering 50W into 8 ohms and embodying most of the techniques described.

Transistor TR4 is the constant current source because the base voltage is held constant by two stabilising diodes. This stage can be considered as a very high collector resistor for TR2 which prevents the current down the chain TR2, TR4 from changing when the signal is causing large voltage swings.

The centre rail is maintained at 32·5V above ground by heavy d.c. negative feedback. Notice that the first amplifier stage TR1 is placed between the 65V rail and the centre rail.

The open loop gain of the amplifier is high, most of it coming from TR2 which has no emitter resistor. Its open loop gain is thus about 20 × V_{cc} = 20 × 65, or around 60dB.

The signal gain of the amplifier is determined simply by the ratio of R_E and R_x in the emitter circuit of TR1. Since R_E is fixed for d.c. purposes at 5·6kΩ the gain can be decided by the choice of R_x.

It is not good design practice to squeeze high gain from a power amplifier—be satisfied with a sensitivity of 1V for a 28V peak output swing. A gain of 28 is required which would mean R_x = 5·6kΩ/28 = 200Ω.

The relevant voltage drops are shown and serve as a

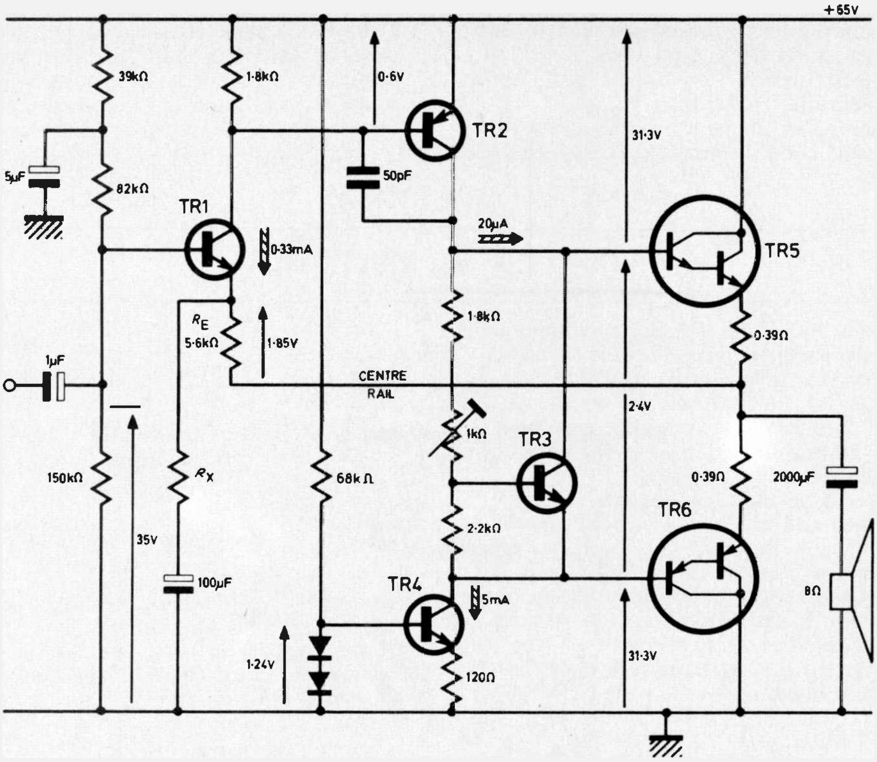


Fig. 7.6. A complete 50W amplifier using the principles described in the article. All voltages and currents are measured under quiescent (no-signal) conditions

AMPLIFIER SPECIFICATION

Input sensitivity for 28V peak output	$= 1\text{V}$ ($R_X = 200\Omega$)
Input resistance	$= 50\text{k}\Omega$ (approx)
Maximum total harmonic distortion at all power levels	$= 0{\cdot}2\%$
Frequency response	= 20Hz to 50kHz
Idling current	= 25mA total

valuable exercise for the amateur designer to try out on paper to see if his calculations agree.

Because TR2 has a large gain there is an instability problem which requires a 50pF capacitor across the base and collector to restrict the upper frequency limit to about 50kHz.

CHOICE OF TRANSISTORS

The outputs could be MJ3001 (*pnp*) and MJ2501 (*pnp*).

TR3 should have a very high h_{FE}—MPSA13 is a low power Darlington having $h_{FE} = 1{,}000$.

TR1 and TR4 could be any 80V general purpose types, MPSA06 would do well.

TR2 should be *pnp* complement of TR4—MPSA56.

The double diode on the base of TR4 is obtainable as the MZ2361. ★

* see page 887

ESP etc

By Brian Baily...

What Is Your Potential?

This month I am going to offer some more food for thought, which some of you may be able to combine with a practical experiment or two. Unfortunately, the material on this page does not form a complete subject, as research into its possible implications is not yet complete. However, I thought you may care to hear of the results obtained to date.

It all started when I had the fortune to be offered an AVO digital multimeter at an extremely reasonable price. The meter is powered by rechargeable internal batteries, making it quite portable and useable completely isolated from the mains.

Normally, this last feature would not have interested me, since most of my work involves mains-powered test equipment and a good earth is all you need to avoid hum effects. But it occurred to me that for ESP verification one needs to eliminate all likely (and unlikely) sources of interference, or there is still the chance of some red herrings creeping in. At best, some sceptic is likely to suspect the mains of causing the witnessed "paranormal" effect.

Mind you, I invite such suggestions, as it is the duty of the investigator to rule out every possible normal cause of unusual effects.

I took the digital meter along to the Paraphysical Laboratory at Downton on more than one occasion, and the first time we busied ourselves comparing one another's body potentials. Body potentials have received much serious treatment in recent years, perhaps the better-known measurements being ECG and EEG (heart and brain electrical rhythms in layman terms). But there are also other measurements of a d.c. form, and some of very low-frequency which merit attention. On the occasion mentioned we satisfied ourselves with d.c. voltage measurements taken from hand to hand of the subject. I set the DMM to its lowest d.c. voltage range, and set to divide-by-ten, so enhancing the range by a further decade.

Method Of Measurement

The method adopted for measurement was to ask the subject to take the two test leads from the meter, one in either hand. The leads were fitted with the crocodile clip terminations, but these were not used in their normal mode (fortunately for the subject). Instead, they were held firmly in the hands with reasonable grip pressure. The clips, being of identically-plated metal and uninsulated, provided a good electrical contact with the palms of the hands, but not touching signet rings, if worn. The identical metal plating is of considerable importance, since if the clips were dissimilar in this respect, an electrical cell action would be produced by the perspiration acting upon the two dissimilar metals, so producing a small, but significant potential difference which might mislead us in our results.

My own hand-to-hand potential was about 10 millivolts, with positive at the left hand. This was in keeping with one or two others whose potential was measured. Oddly enough, some people displayed a reversed polarity, but I was unable to relate this to left-handedness.

Human Battery

The most startling reading obtained that evening was that of a young lady I have mentioned before in this series, Suzanne Padfield. This young lady seems to possess remarkable abilities in the field of mind over matter. Her reading on this occasion was first of all just over 100mV, positive on left hand. "Gosh," I said, "you make ten of us!"

It was then that someone had the idea that we form a "human battery" by joining hands, each positive hand to the next subject's negative hand and so on, and comparing results with the individual readings taken previously.

Like good scientists, we decided to take this step by step, so as to detect any errors as they occurred. So Suzanne and I held hands, her right and my left, and the spare hands held the meter clips. We expected to get something like 10mV + 100mV = 110mV. Well, try as we might, we got only a row of zeros.

I then took both leads to check my own potential, and this checked o.k. as before. I then handed the leads to my partner and we noted that her reading was very much lower than 100mV, but was climbing. When it had reached about 100, I asked her for one lead, and in reaching for it touched the back of her hand. Almost immediately the meter fell!

Now, it is not unusual to find sudden discharges of electricity when charged objects are touched with the hand of an earthed body, but this was ridiculous, as we were not measuring electrostatic charge, but a definite "terminal potential difference" across a (relatively) low-impedance source (possibly on average 30 kilohm or so, allowing for contact area of crocodile clips and pressure exerted). So how could my touching the lady's hand cause the voltage to drop? (Incidentally, the impedance of the meter even at the low range setting is still extremely high, so contact resistance would play very little part in readings in the millivolt range. This was borne out by experiment.)

To return to the falling reading, I noted what had happened and took my hand away from hers. The meter reading slowly returned to her "normal" 100mV. Thinking that the strange effect might possibly be something to do with me, in particular, I suggested that another male present should take my place. I must say that I was relieved when the same result was obtained.

Power From The Healer

The lady involved in these experiments happens to be a well-known healer, and she performs this feat by placing her hands near to, or actually on, the patient. It would seem reasonable to assume that, given that there is a positive healing effect (which I would not doubt in view of evidence received) she produces some sort of energy or power which flows, perhaps like an electric current, from her to the sick person, whose "health potential" may be lower.

Again, referring back to an earlier article in this series, the "Phantom Photos" of the Kirlians. It has been observed that the points of over-exposure on the film around the fingers of a healer after he/she had performed healing on a patient are greatly diminished in intensity. I have seen reproductions of such photographs (1973, *Daily Telegraph Magazine*). I wonder if our findings of hand-potentials could possibly indicate the transfer of power from a healer, when touched by someone with lesser power?

It is noteworthy that the use of conventional voltmeters would lead to difficulties and severe inaccuracies in the mentioned experiments: partly because of sensitivity, but mainly because the internal resistance of such meters is comparatively low. Hence, the contact resistance between electrodes and skin, which would vary with pressure and moisture present, would be comparable or even exceed greatly the internal resistance of the meter, and pressure would vary readings considerably. Only meters with electronic circuitry of very high resistance are suitable for the kind of experiments described here.

HOME INTERCOM

BY L. WISE

An INTERCOM is a device which can be put to many uses throughout the home: as a simple room-to-room communicator; as a doorphone whereby one can speak to callers before opening the door; or as a remote baby-minder.

The simple master/slave intercom to be described uses circuits whose principles were described in the series *First Steps in Circuit Design.*

THE INTERCOM SYSTEM

Before describing circuit details, a brief summary of the overall system should help to clarify matters.

The intercom consists of two units known as "master" and "slave", which can be separated by up to 50ft.

Simultaneous two-way conversations are not possible with the intercom described: the direction of communications is controlled by a LISTEN/TALK switch on the master unit. This saves a large number of components since each loudspeaker takes on a dual role depending on the position of the switch: either as a speaker or a microphone (see Fig. 1). The master unit has an ON/OFF switch but the slave unit cannot speak to the master even with the other switch in the LISTEN position. This problem is overcome by leaving the master unit in a state whereby its amplifier will oscillate when a CALL button on the slave unit is pressed.

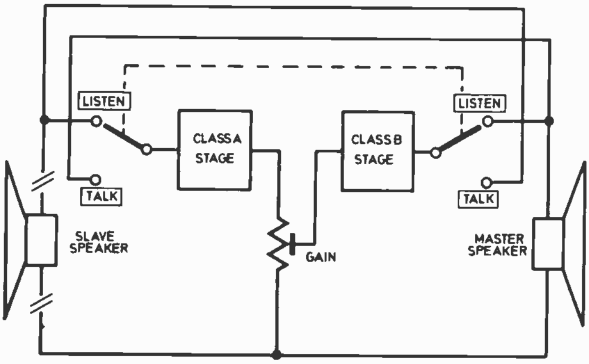


Fig. 1. Block diagram of Intercom system

REQUIREMENTS OF THE AMPLIFIER

As well as the two speakers the other main unit is the amplifier which must be capable of taking the tiny signal from the "microphone" (in fact a speaker)

COMPONENTS . . .

Resistors
R1 390kΩ
R2 180Ω
R3 2·2kΩ
R4 1kΩ
R5 10kΩ
R6 330Ω
R7 330Ω
R8 56kΩ
All ± 5% ¼W carbon

Potentiometers
VR1 4·7kΩ sub-miniature vertical skeleton preset
VR2 250Ω sub-miniature vertical skeleton preset

Capacitors
C1, C2 0·01μF disc ceramic (2 off)
C3–C5 25μF 10V elect (3 off)
C6, C7 0·01μF disc ceramic (2 off)
C8, C9 25μF 10V elect (2 off)
C10 22μF 16V tantalum

Semiconductors
TR1–TR3 BC108 (3 off)
TR4 BC214L
D1 1N914

Switches
S1 Double pole changeover slide
S2 Double pole changeover biased push button
S3 On/off push button

Speakers
LS1, LS2 35Ω 2¼in (2 off)

Miscellaneous
Veroboard, 0·1in matrix, 2·7in × 2·5 in
B1 9V PP6 battery and connector
Two plastic boxes
Lightweight twin core connecting wire

and amplifying it sufficiently to produce an easily audible sound in the other speaker.

It was decided to design the amplifiers with an output of 100mW. This is more than loud enough for domestic use. The next thing to be decided which influences circuit design is battery voltage. For convenience this was set at 9V.

Speaker impedance is a vital factor also. Too high an impedance means a large output voltage swing is necessary while too small an impedance means high output transistor currents. Therefore 35 ohms was chosen as a good compromise.

We require the amplifier to be efficient, i.e. to draw current only when needed, thus a class B output seemed the obvious choice.

PRELIMINARY CALCULATIONS

Having decided on 100mW output and 35Ω speakers we can calculate the required output current and voltage. Using $P = V^2/R$ we obtain $V = \sqrt{PR}$ where P and V are r.m.s. power and voltage respectively.

This gives $V = \sqrt{0{\cdot}1 \times 35} = \sqrt{3{\cdot}5} = 1{\cdot}9$V.

Now in a class B output each of the transistors produces half the output voltage so the peak voltage produced by each is $\sqrt{2} \times 1{\cdot}9 = 2{\cdot}7$V peak or 5·4V peak-to-peak. This is well within the limits of the 9V supply rail.

Using $P = I^2R$ we obtain $I = \sqrt{P/R}$. Again I and P are r.m.s. values.

Hence $I = \sqrt{0{\cdot}1/35} = 54$mA.

The peak current i.e. the maximum current to be supplied by each of the output transistors is $\sqrt{2} \times 54 = 75$mA.

Table 1: VOLTAGE MEASUREMENTS

Location		Voltage
TR1	b	0·7V
	c	4·5V
TR2	b	0·7V
	c	3·8V
TR3	e	4·5V
	b	5·2V
	c	9V
TR4	e	4·5V
	b	3·8V
	c	0V

The $I_{C(max)}$ of a BC108 is 100mA so we may use it in the output. Its near complement the BC214 also with an $I_{C(max)}$ of 100mA can form the other output.

We have calculated the peak-to-peak output required as about 5·4V. Now, when used as a microphone the speakers used had an r.m.s. output of about 2mV. Thus we require an amplifier with a gain of at least 1,000.

Since speaker outputs do vary it was decided to include a preset gain control. This also makes design less critical.

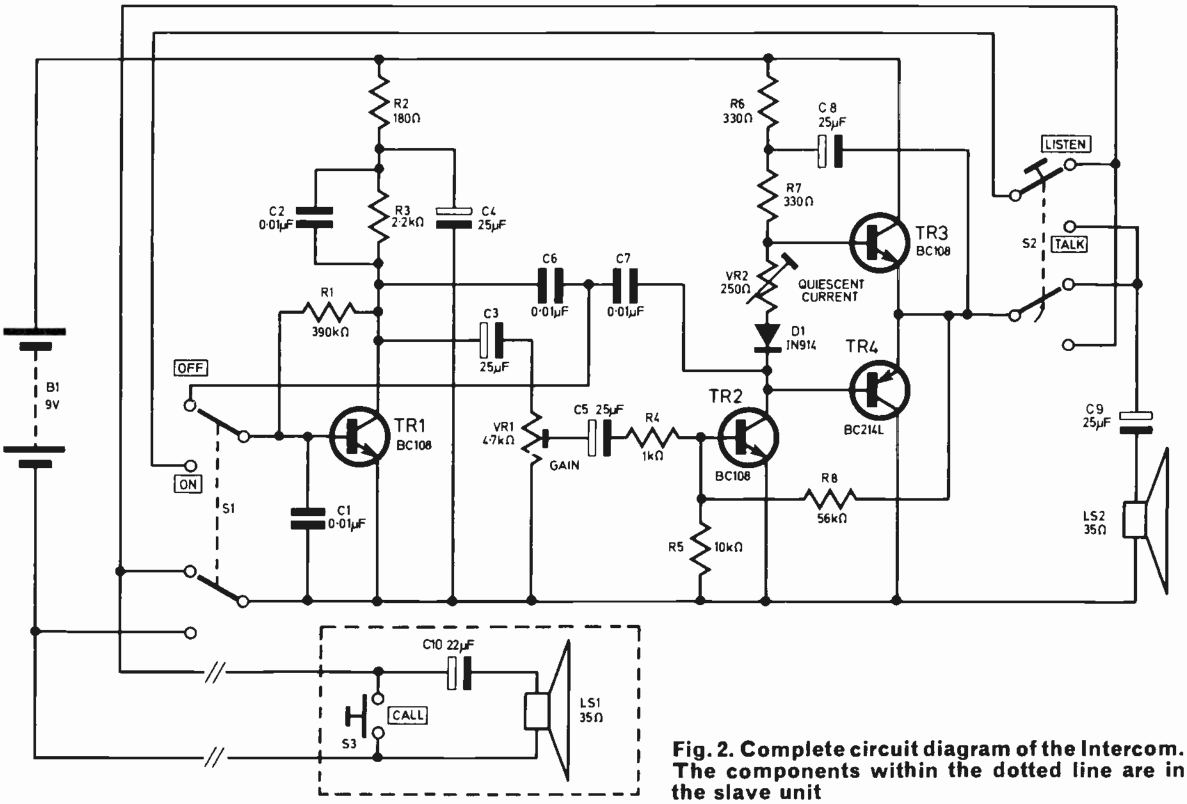
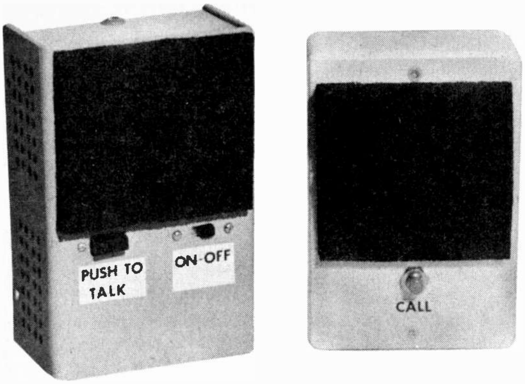


Fig. 2. Complete circuit diagram of the Intercom. The components within the dotted line are in the slave unit



Photograph showing the completed Intercom

CIRCUIT DESIGN

The final circuit can be seen in Fig. 2. It will be seen that it consists of two main stages: a class A voltage amplifier comprising TR1 and associated components, and a class B output comprising TR2 to TR4. The two are linked by the gain control VR1.

Taking the input stage first we see that TR1 has simple collector-to-base bias. The collector current was chosen at 2mA and the quiescent collector voltage as 4·5V. This gives R3 = (4·5 ÷ 2) kΩ = 2·2kΩ (nearest preferred value). Taking the typical h_{FE} as 200 we obtain R1 =

$$\frac{3{\cdot}8 \times h_{FE}\ \mathrm{k}\Omega}{2} = 390\ \mathrm{k}\Omega$$

(nearest preferred value).

Now the input impedance of this stage is $h_{fe} \times r_e$ where $r_e = 25/I_C = 25/2 = 12\Omega$. So typically the input impedance is 100 × 12 = 1200Ω. The "microphone" has a source impedance of about 35Ω so the R_{IN} of TR1 will have very little attenuating action.

As in section 4.2 "First Steps" the gain of this stage is 180 (though this will vary since changes in h_{FE} will mean that the quiescent collector will not be exactly 4·5V). This gain will also be reduced by the shunting effect of the gain control and class B input impedance.

This first stage is decoupled from the supply line by C4 and R2. This prevents oscillation caused by feedback from the output stage.

Capacitors C1 and C2 prevent radio frequency pickup and eliminate the risk of high frequency oscillation.

OUTPUT STAGE

Moving now to the output stage we see that bootstrapping of TR2 collector resistor is used. This increases gain and reduces the effects of gain variations in TR3 and TR4.

The maximum output current was calculated as 75mA which, assuming a maximum h_{FE} of 100, means that the base current that must be supplied by TR2 is 0·75mA.

TR2 must also supply base current required to establish the quiescent current needed to overcome crossover distortion.

We do not want TR2 current to be high as this will only drain the battery and since we can stand some distortion in voice communication, a choice of 5mA TR2 collector current was made.

This gives R6 = R7 = 3·8/2 ÷ 5 = 380Ω. In fact 330Ω was used.

The preset VR2 must produce 0·7V at 5mA so at centre setting (where there is greatest freedom of adjustment) its resistance = 0·7/5 = 140Ω. A 250Ω preset was used.

Resistors R5 and R8 form a divider chain which set the output voltage at 9/2 = 4·5V. Their ratio is about 5·5:1 which equals 3·8:0·7, 3·8V being the voltage across R8 and 0·7V across R5.

The value of R8 is made as high as possible (whilst supplying sufficient base current for TR2) since the gain of the output stage is roughly R8/R_s where R_s is the source impedance of previous stages.

We now come to the choice of gain control resistance and R4. If VR1 is too high the gain of the output stage will be reduced (R_s increased); if it is too small the gain of TR1 will be reduced.

The 4·7kΩ value finally chosen gives an overall gain of over 4,000. This can be reduced by means of VR1.

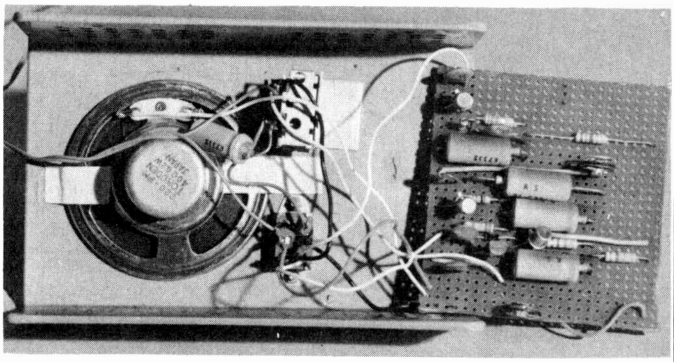
All coupling capacitors were chosen as 25µF for convenience. At the lowest frequency of interest (in the voice about 300Hz) these have an impedance of less than 30Ω which is sufficient for use in all positions.

OSCILLATOR

The only components not forming part of the amplifier proper are C6 and C7. When the switch is put in the OFF position C7 is connected from the collector of TR1 to the input and C6 across R1. This causes the amplifier to produce a penetrating oscillation when the battery is connected.

The CALL button on the slave could be connected by using a third wire from the master but it is cheaper to use twin-core wire.

To overcome the problem it was found that by placing the coupling capacitor in series with the slave speaker only a tiny leakage current would flow; not enough to drive the amplifier. When this



Photograph of the component layout on the Veroboard and other components in the master unit

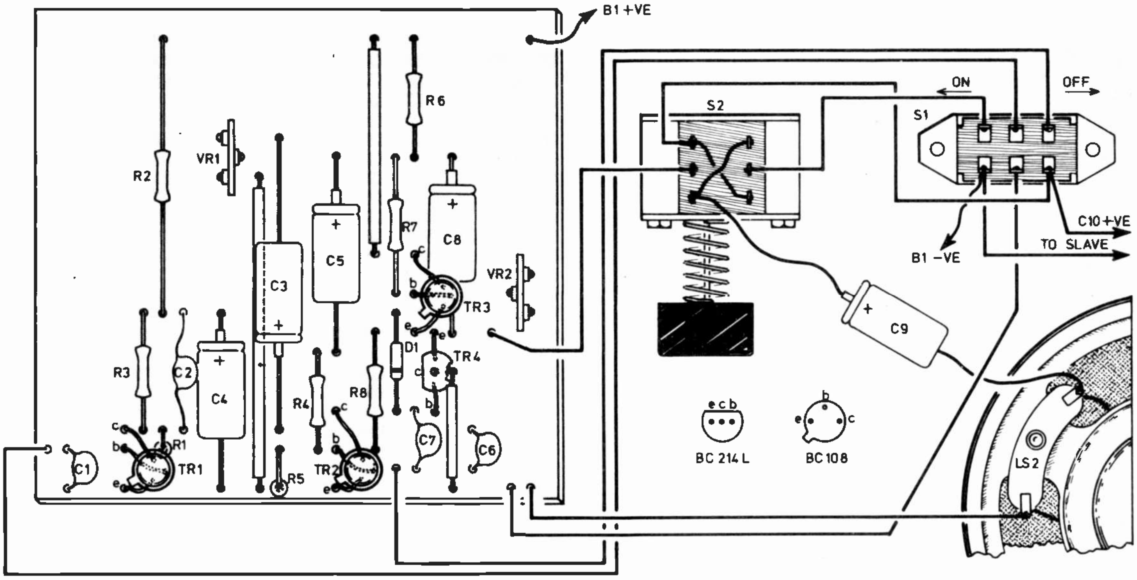


Fig. 3. Layout of the components on the Veroboard and interwiring details

was shorted out by the CALL button the amplifier would receive the full battery potential and the call tone would be produced.

A tantalum capacitor was used to reduce leakage current.

CONSTRUCTION

The amplifier was built up on a piece of Veroboard as shown in Fig. 3.

The master unit was mounted in a plastic case approximately 5in × 3in × 2in which comfortably holds Veroboard, battery, and speaker and switches.

Switch S2 was a "press-to-test" two-pole changeover type but should this prove hard to obtain a biased toggle could be used. An ordinary toggle could be used providing it is always left in the LISTEN position when switched OFF.

Holes were drilled for the speaker and covered with a piece of foam which generally improves the appearance.

Speaker LS1, C10 and S3 are mounted in a plastic box in the slave as shown in the photograph (Fig. 4).

Lightweight twin-core wire is used for interconnections.

Speaker impedance is not critical any value between 25Ω and 40Ω being sufficient.

Transistor type is not critical either; any transistors with a gain of 200 or more will do. Note that lead connections for a BC214L are shown in Fig. 2. If the "L" type is not obtained base and collector leads are *reversed.*

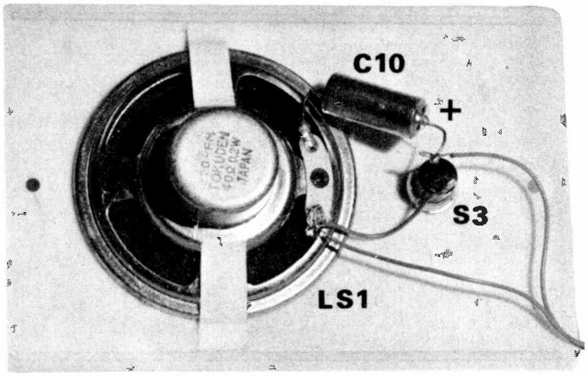


Fig. 4. Photograph showing the disposition of components within the slave unit

TESTING

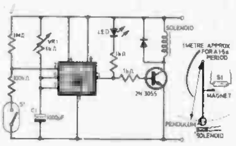
Before testing VR2 *must* be set to minimum resistance. Set the GAIN control to about mid-way. The two units should be separated or oscillation will occur due to acoustic feedback.

VR2 is adjusted to give the minimum quiescent current consistent with low distortion. The quiescent current through TR3 and TR4 in the prototype was about 5mA. This can be simply measured by putting a milliameter in the battery lead, remembering the TR2 takes about 5mA, anything greater than this being in TR3 and TR4.

Do not turn VR2 to maximum setting for any length of time as this will damage the output transistors.

VR1 is adjusted to give enough gain without causing clipping—audible as a harshness in the output. Test the CALL facility by switching the master OFF and pressing the CALL button.

If any faults are found they can be easily located using the quiescent voltages given in Table 1. ★



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

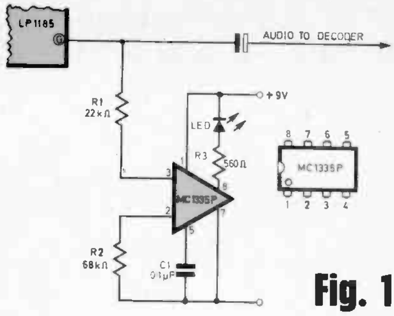


Fig. 1

VARICAP TUNER TUNING INDICATOR

After the publication of my article last May (Push-button Varicap Stereo Tuner, May 1973) I received many letters requesting details of a tuning indicator of some description. Criticism has been aimed at the small tuning potentiometers used for tuning on the domestic prototypes, non-technical personnel have found tuning difficult, more so using an a.f.c. on/off switch.

Obviously with the a.f.c. on the tuning is broader than with it off due to the pull in and holding range. Multiturn potentiometers have been tried but the cost of these is around £1 each and represents a 15 per cent price increase on a complete tuner.

Recently Motorola have introducer a tuning indicator i.c., the MC1335P for f.m. and colour TV purposes. To devise a method of operation from the LP1185 was not too easy and it was necessary that it did not interfere with the a.f.c. loop and the circuit of Fig. 1 was evaluated. The MC1335P is a differential amplifier with lamp drive and the lamp illuminates when inputs 2 and 3 are balanced at the same voltage, any unbalance extinguishes the lamp.

A d.c. voltage appears at the audio output of the LP1185 which reaches a maximum on tune. This voltage varies with the signal level and may not operate on weak stations. Conversely the lamp may light if the noise level between stations is high.

The level of d.c. on tune with a good signal is about 2V. This is fed to input 3 via a blocking resistor R1 to prevent unnecessary loading of the audio. R2 is chosen to provide a balancing current to input 2, thus subject to tolerances the lamp will illuminate on a tuning peak providing $1\frac{1}{2}$ to 2V.

Those wishing to add this to an existing tuner should use an l.e.d. consuming very low currents as the mains transformer may not provide enough output for this and the stereo pilot lamp.

A few further words about tuner problems dealt with so far may be useful to intending constructors or those with any difficulties.

If the a.f.c. is erratic and the noise level seems high, 58dB is not unusual with a good signal, check the following. Any a.f.c. switch wiring should be done in single screened cable. Add extra decoupling to the station selector wiring, for example connect a 0·1µF between the common tuning line and chassis on the pushbuttons.

S. R. Beeching
Balderton
Notts

SOUND/LIGHT MODULATOR

The three-channel light modulator circuit of Fig. 1 uses 3 BFY51's to modulate current through the secondaries of sub-miniature mains transformers. The mains sine-wave is therefore modulated in sympathy and so the voltage to the gates of the thyristors is varied.

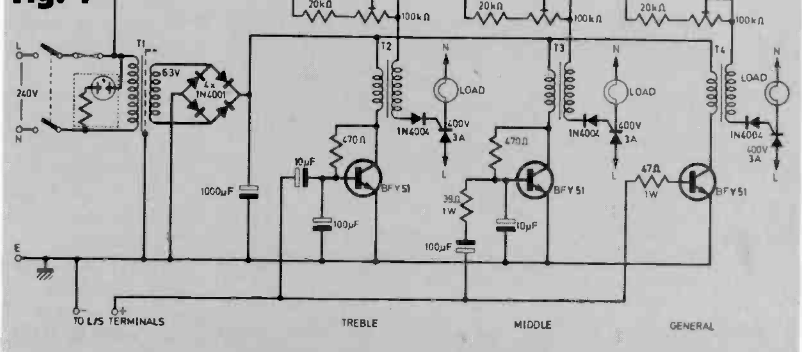
Transformers T2, T3, T4, should all be l.t. transformers with 6·3V or 9V secondaries, and a minimum current of 250mA. Instead of having the normal treble, middle and bass, the circuit was designed to have one channel responding to any frequencies, in fact responding to the most predominant.

Transformer T1 must be a 6·3V mains transformer with a minimum rating of 2A. The bridge rectifier should be 2A 50 p.i.v. The circuit will work off amplifiers of 5 to 10W output. For using higher powers more resistance must be added in series with the bases of the transistors.

With the specified thyristors, 500W of light can be used on each terminal.

P. R. Strutt
Tibenham, Norfolk

Fig. 1



PHASING CONTROL

THE enclosed diagram Fig. 1, is for a control circuit for the Phasing Unit (Sept. 73).

Two ORP 12 photocells are wired in place of the ganged potentiometer VR2a, b. The resistance of these is then controlled by the lamp LP1 which is made to switch gradually on and off. TR1 and TR2 form a multivibrator which gives a square wave output of about 1 to 2s mark, 1 to 2s space. TR3 is used as a buffer amplifier so the pulses may be used without affecting the multivibrator.

These square pulses appearing at the collector of TR3 are allowed to charge and discharge the large capacitor C3 via the diode and resistor network D1. D2. VR3. VR4. The diodes allow separate adjustment of charge and discharge times of the capacitor, as it will charge via D1. VR3 and discharge via D2, and VR4.

The 6·8kΩ resistor R4 is to lengthen the discharge time to compensate for the load of TR4 which switches slowly on or off as the capacitor is slowly charged and discharged. The lamp LP1 is thus controlled by TR5 from the rising and falling collector current through TR4.

D1 and D2 were silicon diodes from the junk box, their characteristics are not critical. LP1 is a miniature 6V "pea bulb" from a panel indicator light.

The power supply was 6V winding of a mains transformer with half wave rectification and simple RC smoothing. A separate 9V winding, bridge rectifier and smoothing capacitor was used to supply power to the phase unit itself.

The complete unit was assembled on Veroboard. The photocells and bulb were secured by their connecting wires, and positioned so that the cells were either side of the bulb, just touching. A small piece of aluminium foil was glued to the Vero and folded over the bulb as a reflector.

SETTING UP

Set VR1 and VR2 to maximum. Adjust VR3 and VR4 till the bulb is gradually but regularly brightening and darking.

Now VR1 and VR2 can be adjusted to alter the speed and ratio of the multivibrator, if necessary. Best results will be obtained when the bulb just reaches full brightness and full darkness but lingers in either state no longer than the thermal inertia of the bulb demands.

Final adjustments should be made with the unit running and music being played through it, bearing in mind that the unit can take two or three cycles to settle down after an adjustment has been made.

R. J. Goodwin
Stockport

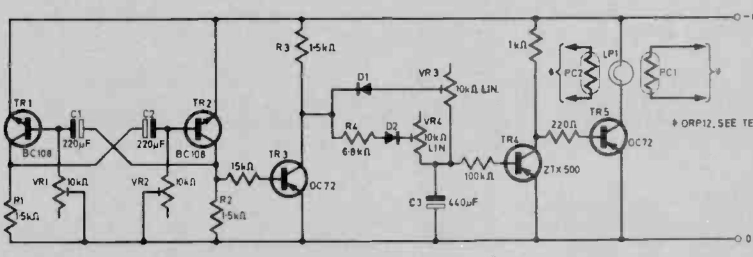
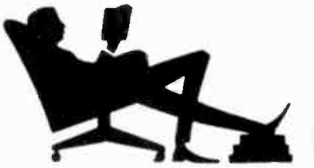


Fig. 1



BOOK REVIEWS

ELECTROTECHNOLOGY — 3rd EDITION

By M. G. Say
Published by Newnes-Butterworths
176 pages, 14 × 22cm. Price cased £1·70

THIS book of basic theory and circuit calculations for electrical engineers is primarily directed to second and third year electrical engineering students but similar level students in other allied arts will find it equally of value, as will professional engineers and all others looking for a useful source of reference.

The avowed aim of the book is to present the fundamental concepts of electricity, electric and magnetic fields and basic electrotechnology in as concise a form as possible. In this it succeeds admirably with an opening chapter devoted to the various main and derived SI units, a must for all at present.

A great deal of the book is devoted to networks starting from the simplest concepts and working through to a series of examples demonstrating the solutions discussed. To anyone not too happy with this area alone the book will be useful, setting aside the value of the other reference material it contains.

R.D.R.

HIGH FIDELITY DESIGNS

Prepared and Published by Wireless World, IPC Business Press Ltd.
112 pages, A4 format. Price £1·00

THIS soft-backed A4 format booklet is a bound set of reprints of some of the most popular articles published in Wireless World in the last few years on the subject of Audio. Including as it does articles by such well-known names as Nelson-Jones, Bailey, Linsley-Hood, Stuart and Ockleshaw it will certainly fill the requirements of many for information on such areas as tape recording, loudspeaker design, amplifier and pre-amplifier design and so on.

In view of the problems facing many of us today in obtaining back numbers of our favourite publications or articles from those publications, any effort such as this to supply the more demanded items in bound form must meet with approval.

However, it is perhaps just a very small shame that whilst each item has been reprinted in full together with any follow-up material in both article or "Letters to the Editor" form, no real effort has been made to rationalise the texts into one cohesive unit. Thus the reader is still faced with the requirement that he read all, but all, of any particular text in order to be certain of clarifying that particular exercise.

One is forced to ask if it would not have been possible to present each article in a more unitary form. After all the only reason for the inconsistency in the first place is chronological and in a reprint this no longer matters.

R.D.R.

MARKET PLACE

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

AMPLIFIER MODULES

For the reader who likes to experiment with amplifier construction, a range of four new **Sanken** audio amplifiers, suitable for hi fi and power amplifier output stages, is available from **Armon Products Ltd,** should prove most useful.

These amplifiers are available with class B output powers of 10 to 50W r.m.s and are contained in a small flat-pack package. Coded types SI-1010G (10W), SI-1020G (20W) SI-1030G (30W) and SI-1050G (50W), the amplifiers are claimed to give $\pm\frac{1}{2}$dB response from 20 to 100,000Hz and less than 0·5 per cent harmonic distortion at full power.

The 30 and 50W circuits have built-in current limiting and differential input stages, and feed 4 to 8 ohm output loads. The 10 and 20W versions do not have differential inputs and are for 8 ohm loads only. All four amplifiers can operate from single or split power supplies and all versions claim an input impedance of 40kΩ.

The latest retail prices (time of going to press), of these amplifier modules is: 10W version £3·30 each: 20W version £6·60; 30W £8·40; and 50W version £13; all prices subject to VAT.

Full technical details and units may be obtained from Armon Products Ltd, 54 George Street, London, W.1.

COMPONENTS

Component availability is an ever-present problem for the constructor. Be he professional or amateur he always needs ready access to parts for his latest project. Thus any commercial venture which might ease the situation with a reliable and constant flow of components is to be welcomed.

The latest supply house to enter the field of small-order component business is RS Components Ltd., who have launched a companion company, **Doram Electronics Ltd.**

The new company will operate from Wellington Road Industrial Estate in Leeds on a postal basis. They expect to be able to offer not only the basic RS range of products but an extension of this range into the type of component more often used by the amateur, such as the less common values of resistor and capacitor.

The aim is to create a "by return of post" cash with order mail service for components, kits and accessories. Something in the region of 4,000 product lines will be stocked and a catalogue is now available to the customer at a charge of 25 pence including postage. There will be no minimum order charge.

It is understood that the catalogue will include information on products such as operating parameters, photographs and drawings and, where necessary, circuit details. In addition it is hoped to include kits of many of the projects published in various technical and leisure area journals as soon after their publication as possible.

Information on pricing is not available at present but it is understood that most if not all prices will bear comparison with other suppliers.

With the announcement of Doram it now seems to indicate the willingness of suppliers to acknowledge the existence of a growing market in the amateur and leisure area. Indeed, RS are not the first to show a willingness to deal in this area, several of the semiconductor distributors already accept small orders now and it is to be hoped that the trend will continue.

LITERATURE

It is at this time of the year that most readers will be taking stock of their components and searching for the new catalogue releases before ordering items for their autumn projects.

Unfortunately, this year industrial disputes, component price increases, and now VAT changes have delayed many of these catalogues appearing. Readers are advised to keep a close eye on all advertisements for latest releases and where possible price changes.

So far only the **Electrovalue** Catalogue No. 7 has arrived at the office. This catalogue does not contain any of the new VAT price adjustments.

This excellent catalogue contains 112 pages and lists a very large stock of i.c.s and transistors together with their case outlines, and in many cases their working parameters. Other items available vary from a fuse to complete soldering kits.

Copies of the Electrovalue No. 7 Catalogue can be obtained from: Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.

As an introduction for the first time buyer of hi fi equipment, **Sinclair Radionics** have recently published a 12-page booklet entitled "The Sinclair Introduction to Hi Fi".

The object of the booklet, apart from advertising the well known range of Sinclair products, is to help unravel the often baffling technical terms thrown at the would be purchaser by salesmen.

The booklet is divided into five sections starting with a page devoted to a simple explanation of the difference between hi fi and stereo. Subsequent sections cover what equipment is needed and how much will it cost?, where to locate the equipment, and can the equipment be built? The final part of the booklet is an alphabetical glossary of the 20 most common words and phrases used to describe hi fi equipment.

Copies of the free booklet are available from your local hi fi dealer or direct from Sinclair Radionics Ltd., Hi Fi Division, London Road, St. Ives, Huntingdonshire, PE17 4HJ.

Also just released is the new **Heathkit** Catalogue. This 64-page catalogue is claimed to contain details of the world's largest range of electronic kits, many available for the first time in this country.

This comprehensive catalogue talks about kit building and lists kits ranging from a large selection of audio equipment, electronic calculators, digital clocks, thermometers, an ultrasonic burglar alarm, to a large range of test gear for the home and car.

New kits include an f.m. tuner with digital readout and "computer tuner", a 4-channel SQ amplifier and a digital electronic clock with alarm.

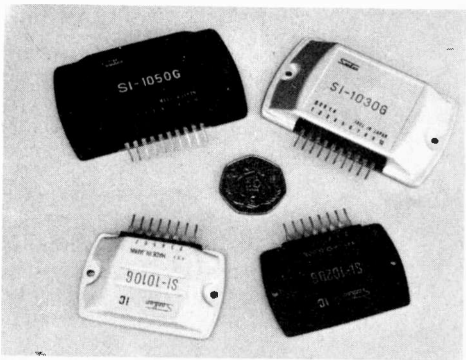
The catalogue is available free from: Heath (Gloucester) Ltd., Bristol Road, Gloucester, GL2 6EE.

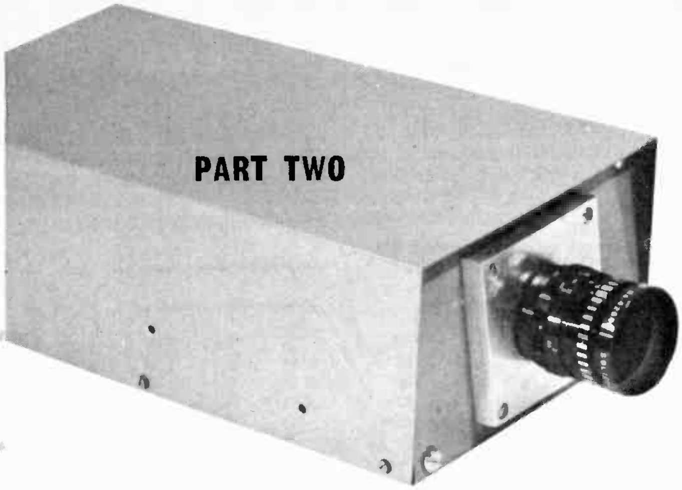
PRINTED CIRCUIT BOARD SERVICE

We understand that **W.K.F. Electronics** are now able to offer a printed circuit board service to readers for most of our current projects.

For further details readers should write to W.K.F. Electronics at 42 Welbeck Street, Whitwell, Worksop, Notts.

Sanken amplifiers from Armon Products





PE CCTV MONOCHROME CAMERA

BY A.V. FLATMAN * B.Sc.

Ideally suited for:

❋ Home Entertainment ❋ Lecturing ❋ Remote Monitoring ❋ Surveillance

This month we give constructional details for the composite video signal circuitry together with the remaining power supplies and scanning circuits.

P.C.B. 1

The printed circuit board P.C.B. 1 is designed to hold the Master Logic, Video Amplifier, Sync Mixer and Cathode Switch circuits and is shown in Fig. 2.2. Component placement is detailed in Fig. 2.1. Due to the high packaging density of parts on the board area it is somewhat unfortunate that a series of wire links have had to be made to complete the circuitry. For reasons of economy these are preferred rather than a double-sided board.

VIDICON SCANNING

The EMI 9677 Vidicon is manufactured to close tolerances and is therefore quoted as being "self-centring". This statement simply means that the electron beam will be accurately focused onto the centre of the photoconductive target in the absence of any deflection force. Self-centring Vidicons are indeed convenient when considering the design of suitable deflection systems, as no centring adjustment is necessary.

Deflection of the electron beam relies upon the force produced by a magnetic field. In practice, this is implemented by the use of two pairs of coils, situated outside the Vidicon tube, to provide radial fields (outward from the tube axis) at right-angles to one another. Horizontal and vertical beam deflection distances are then governed by the current passed through each pair of coils.

In TV terminology, coils concerned with vertical deflection are known as field scan coils, whilst coils concerned with horizontal deflection are called line scan coils. As highly inductive coils generally resist the passage of high frequency currents, the line scan coils are designed to possess low inductance. This design aspect enables the high line scanning velocity we require. The field scanning velocity is, however, less demanding, and proportionately higher inductance field scan coils may be used.

LINE GENERATOR

The simplest technique of producing the linear sawtooth current waveform necessary to scan an

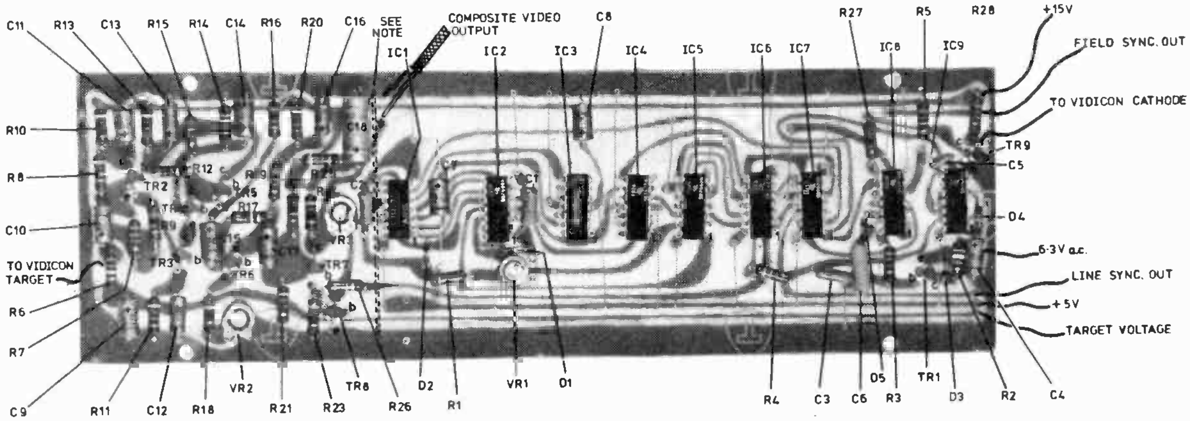


Fig. 2.1. Component layout for P.C.B. 1

*North Staffordshire Polytechnic

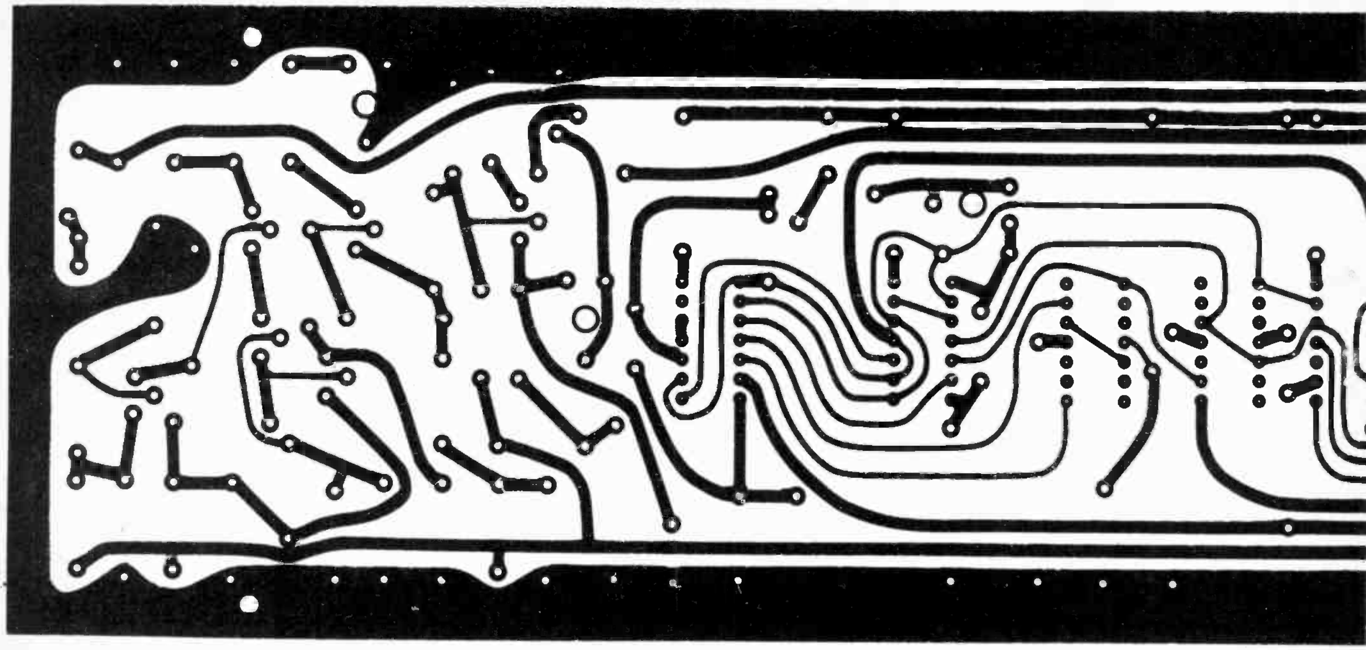


Fig. 2.2. P.C.B. 1 copper side conductor pattern

active line and flyback is to apply a voltage step to the line scan coils. This stems from the integrating property of an inductor, which is expressed as—

Coil current $= -\int \frac{1}{L} V dt$, where L is the scan coil inductance and V is the applied voltage.

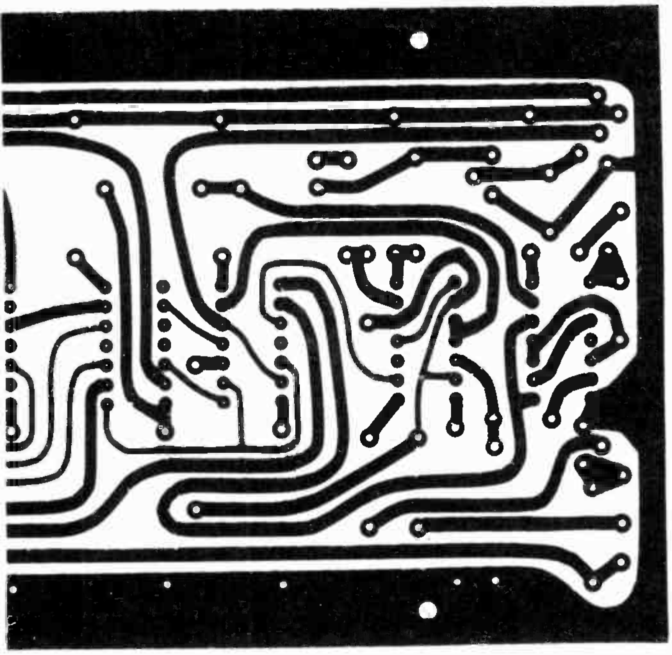
In simple terms, if a d.c. potential is applied to a coil, then the current in that coil is initially zero and will increase linearly with time, reaching saturation at V/R amps, where V is the applied potential and R the d.c. resistance of the coil.

Let us now examine the operation of the Line Generator circuit, shown in Fig. 2.3, with the help of the waveforms shown in Fig. 2.4.

Line sync pulses are used to drive TR10 as a current switch, allowing drive current derived by R30 to be sinked to earth for the duration of the line sync pulse, and into the base of TR11 in the absence of line sync pulses.

The leading edge of the line sync pulse marks the completion of an active line scan and initiates a flyback. Now TR11 is switched off in the presence of line sync pulses, causing the current in the scan

Fig. 2.11. P.C.B. 2 copper side conductor pattern



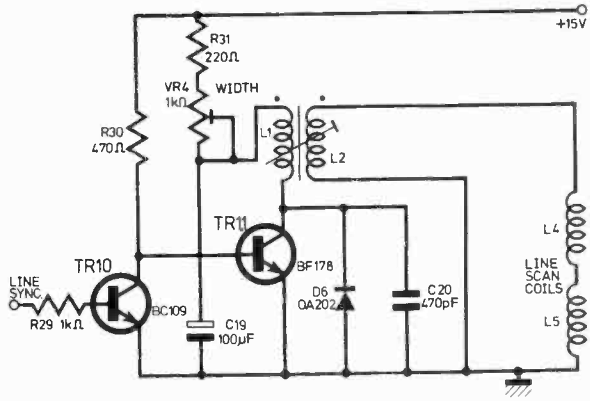


Fig. 2.3. Circuit of Line Generator

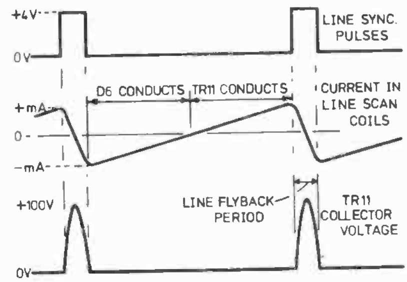


Fig. 2.4. Line Generator waveforms

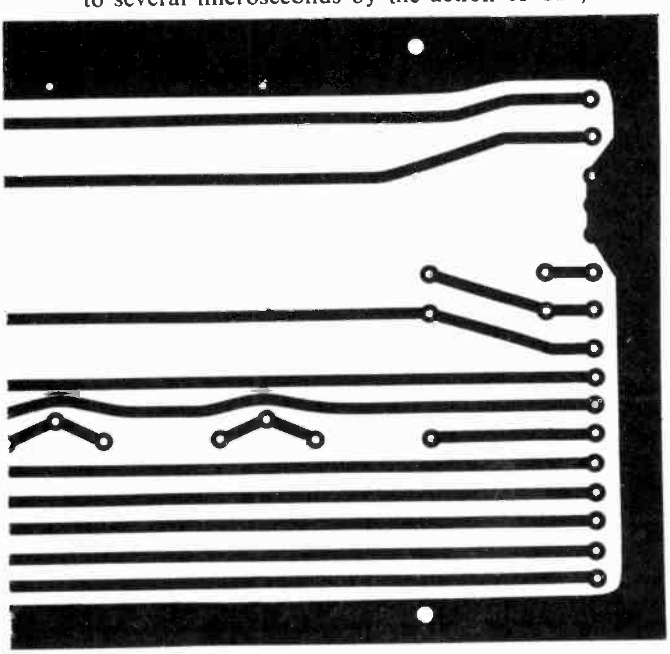
coils to collapse freely, the time required to do this may be calculated as being—

$$t = \frac{L}{R} \text{ seconds.}$$

Where L and R are the inductive and resistive components of the coils.

t then becomes $\frac{1\text{mH}}{2.6\Omega}$, or 400$\mu$S (equivalent to about 6 lines of a 625-line picture).

This surprisingly long recovery time is shortened to several microseconds by the action of C20, which



acts with the circuit inductors to give a critically-damped oscillation at a frequency of approximately 200kHz. The current is in fact returned to its starting level within one cycle of the frequency of oscillation.

The back emf induced by this rapid flyback may be estimated from Lenz's Law to be of the order of 100 volts above the working collector voltage of TR11. This feature obviously then has some bearing upon the choice of TR11.

When the line sync pulse has ended, and its level fallen to 0V, TR11 will be biased to conduct. However, at this point in time, the current flowing in the line scan coils will be negative and TR11 conduction is impossible. Alternatively, D6 will conduct to enable a controlled potential to be developed across L1. The current in L1 will increase linearly with time until it crosses the zero axis, where TR11 will take over conduction as D6 becomes reverse-biased for the remainder of the line scan. In this way, conduction is achieved over the required period of time.

CURRENT GRADIENT

The gradient of the current waveform, or the line scanning width, is determined by the potential developed across L1 during the conduction of D6 and TR11. This potential is set by the combination of R31 and VR4, and is given a signal earth by C19 to ensure that the scanning current is devoted wholly to L1.

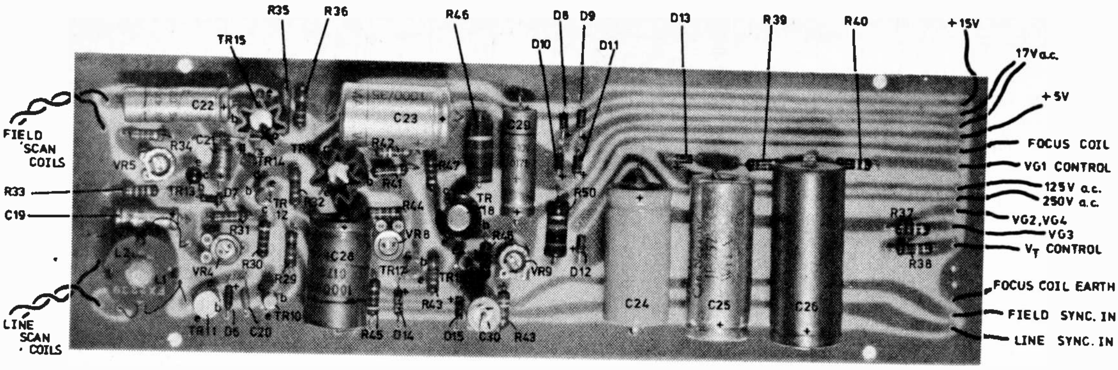
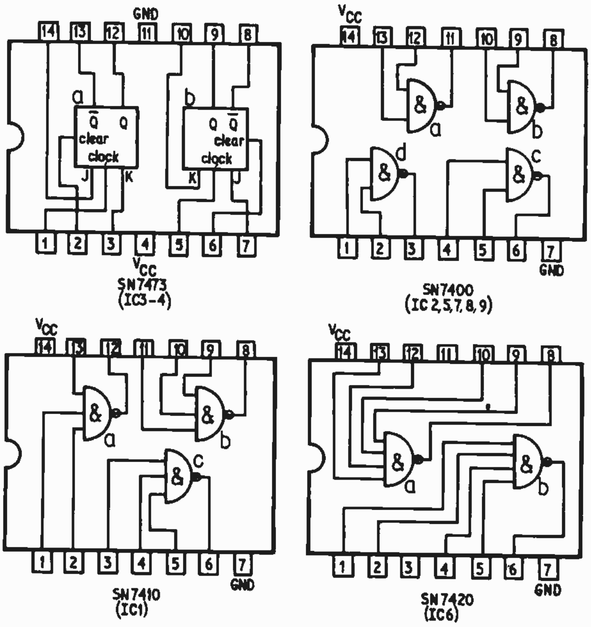


Fig. 2.12. Component layout for P.C.B. 2. Note that VG1, VG2, etc., refer to the grids on the Vidicon tube (See Fig. 1.5)



Pin assignments for Master Logic i.c.s given in Part 1

The transformer comprising L1 and L2 is designed to match the low impedance line scan coils to the line drive transistor TR11, and are wound on a ferrite core to ensure efficient operation at working line frequencies of up to 15·625kHz (625 lines at 25 times per second).

As conduction for 50 per cent of the active line scan is performed solely by D6, the apparent efficiency of the line drive transistor TR11 is increased. A BF178, video transistor is employed in the line drive stage to cater for the large e.m.f.s induced within the scan coils and deliver sufficient power to enable the required beam deflection. The use of diode D6 is a generally accepted technique in the television circuitry world, and, for obvious reasons, carries the title of efficiency diode.

FIELD GENERATOR

As the field scanning rate is as low as 50 fields/second, no difficulties are experienced in driving the field scan coils. The field scan coils have 52mH inductance and 150 ohms resistance and may therefore be safely considered as a resistive load to a voltage waveform generator. Such a circuit and its relevant waveforms are shown in Figs. 2.5 and 2.6 respectively.

Switch TR12 is non conducting in the absence of field sync pulses and capacitor C21 is allowed to charge via the constant current generator, comprising TR13 and associated components. The potential across C21 during charging will rise linearly with time until the arrival of a field sync pulse, when

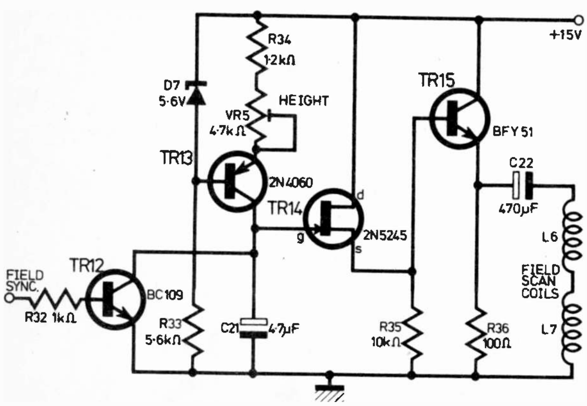


Fig. 2.5. Circuit of Field Generator

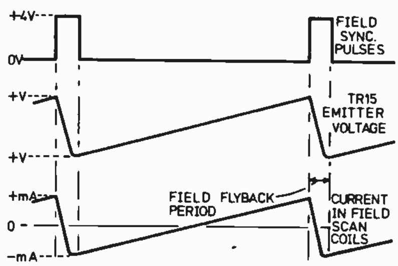


Fig. 2.6. Field Generator waveforms

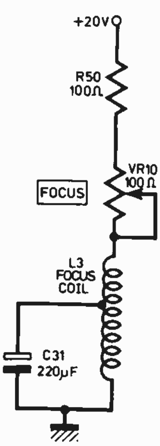


Fig. 2.10. (right) Supply circuit for focus coil

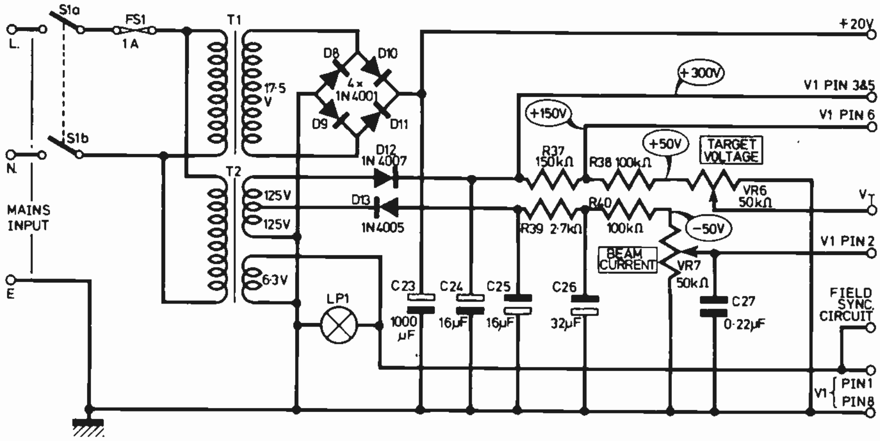


Fig. 2.7. Power supply circuit for camera. Transformer T2 provides high potentials for the Vidicon tube

switch TR12 will conduct to rapidly discharge C21. Active field scanning corresponds to the charging of C21, whilst flyback corresponds to the rapid discharge.

The directly coupled f.e.t. TR14 acts as a high input impedance source follower and develops an exact replica of the charging potential across its load, R35. This sawtooth waveform is finally buffered into a low impedance output impedance by the emitter follower, TR15 and R36.

The voltage waveform present at TR15 emitters (Fig. 2.6) is seen to have only a positive going sense. This is not yet suitable to drive the field scan coils, as drive requirements call for a sawtooth waveform which is symmetrical about the zero axis. Coupling the output voltage to the field scan coils via C22 will perform the necessary level shifting and enable the field scan coils to be driven correctly.

As field scanning time and C21 are fixed, the gradient of the resultant waveform depends solely upon the current delivered by the constant current source. Field height adjustment is therefore simply accommodated by VR5.

VIDICON SUPPLIES

All the high potentials required to operate the Vidicon are derived from transformer T2 (Fig. 2.7). Positive mesh, wall anode, limiter anode and target potentials are obtained from different points of the + 300V potential divider, comprising R37, R38 and VR6. Sufficient smoothing is made possible by C24 alone.

The beam current control potential must be negative and possess a greater degree of smoothing due to the sensitive nature of the control grid electrode. This supply is derived via D13 and smoothed by a π filter.

Both the + 15V and + 5V Regulator circuits (Figs. 2.8, 2.9) are standard series voltage regulators with the possible exception of R41 and R46.

These resistors are designed to share the power dissipation demands of the control devices TR16 and TR18, and introduce a maximum current availability to the TV Camera circuitry.

The BFY51's used in both Regulators operate near their region of maximum power and therefore require additional cooling. Small, clip-on heatsinks are found to cool these devices sufficiently, whilst maintaining the general compactness of component layout.

A d.c. focus coil current of approximately 100mA is made available from the unregulated 20V supply by the combination of R50 and VR10. Due to the possible high power dissipation, the potentiometer should carry a 1 watt rating (Fig. 2.10).

P.C.B. 2

The second printed circuit board, P.C.B.2 (Fig. 2.11) is designed to hold the electronic circuitry required to complete our TV Camera System—the line and frame generators and various power supply circuits. Component disposition for the board is shown in Fig. 2.12.

Next month : Camera enclosure, final wiring and setting up procedure

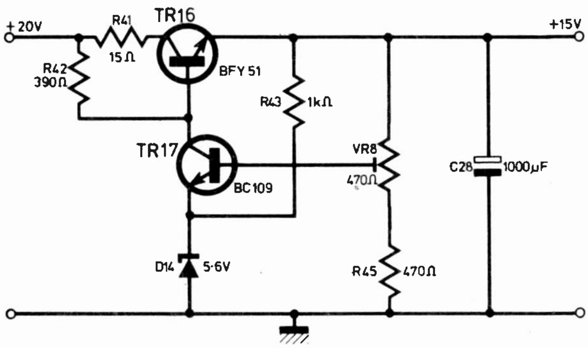


Fig. 2.8. 15V Regulator circuit

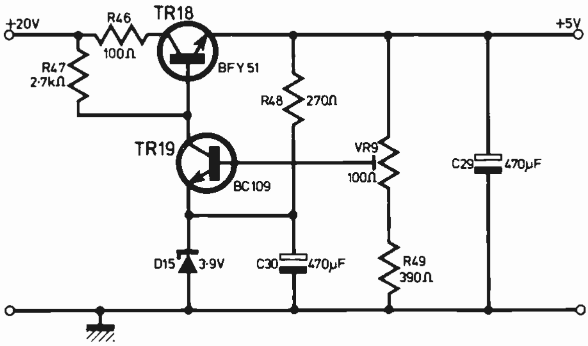


Fig. 2.9. 5V Regulator circuit

VOLTAGE CONTROLLED FILTER

BY R. GWINN

A VOLTAGE controlled filter can be used to alter dramatically the tonal quality of any sound put through it. It does this by removing some parts of the frequency spectrum and boosting others.

The filter to be described was specifically designed for use in a synthesiser but it can also be used for guitar treatment or in modifying any audio signal not necessarily electronic in origin. It is basically a low-pass filter, the frequency of which can be voltage controlled.

LADDER FILTER

The heart of the filter is a ladder of diodes D3 to D16 in the collectors of the differential pair TR2 and TR3 (Fig. 1). This arrangement is popular with commercial synthesisers because it is efficient and has a very wide range.

Ignoring the feedback for the moment, the signal enters via C1 and TR2 and tries to make its way up the ladder. If it is a high frequency, the reactance of the capacitors C2 to C5 is small in comparison with the dynamic resistance of the diodes and it is lost after four stages of filtering. If it is a low frequency, however, it can climb the ladder with relatively little attenuation.

The actual cut-off frequency is that at which the reactance of the capacitors equals the dynamic resistance of the diode. This can be changed over a very wide range by controlling the current through the ladder, which changes the dynamic resistance of the diodes. The current through the ladder is proportional to its cut-off frequency.

LOGARITHMIC FREQUENCY CONTROL

For musical purposes a logarithmic function is required so that a voltage change at the input corresponds to a musical interval change in cut-off frequency. Use is made of the logarithmic properties of TR4 where the log of the collector current is proportional to V_{BE}. It is also temperature sensitive but, unlike oscillators where stability is very important, no temperature compensation has been found necessary. However, if this circuit is used with the P.E. Synthesiser keyboard, there is a spare temperature stabilised transistor, Q3, in the ML3046P IC, which may be used as TR4, see Figs. 10.2 and 10.6, November 1973, PRACTICAL ELECTRONICS.

SPECIFICATION . . .

Frequency Range	**100Hz to 5kHz**
Input Required	**Up to 2V, peak-to-peak. Limited at lower end by noise at about 50mV**
Power Requirements	**±15V**
Inputs	**Control, virtual earth and voltage. Full control swing obtainable with ±2V with 2·7kΩ in virtual earth input**
Gain	**Approx. 1**
Output Impedance	**0 to 5kΩ**
Input Impedance	**About 2kΩ**

RESPONSE

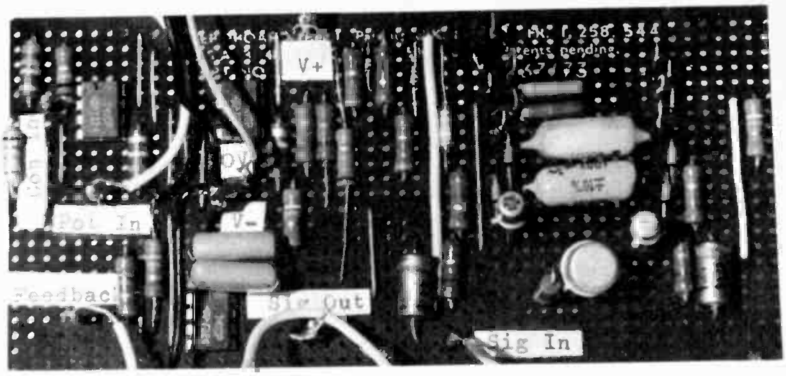
The response control VR3 in the feedback loop of IC3 has the effect of changing the characteristics of the filter from low-pass, when fully anticlockwise, to low-pass with a peaking response at the cut-off frequency. Turning it fully clockwise forces the filter into oscillation.

VIRTUAL EARTH MIXING

The control signal is processed by IC1 and IC2 to give a virtual earth at the control input. This is very useful as it enables any number of control voltages to be mixed in without any interaction. This is a current input and all voltages must be fed in via a resistor R23, the value of which determines their individual gain.

The manual frequency control voltage is fed via R23 into this input and is mixed with any external control voltages.

If a patchboard is being used, the virtual earth is connected to the filter control input busbar and



Photograph of board assembly

the 2·7kΩ resistor is contained in the patchpin so that many inputs can be mixed without interaction.

USE WITH A SYNTHESISER

If the filter is used with a keyboard the note voltage, as well as going to the oscillators, should go to the filter. If it did not, the higher harmonics of higher notes would be lost and low notes would have more harmonics present.

The preset VR2 adjusting how much effect the note voltage has on the filter should be set so that one octave on the keyboard shifts the filter frequency by an octave.

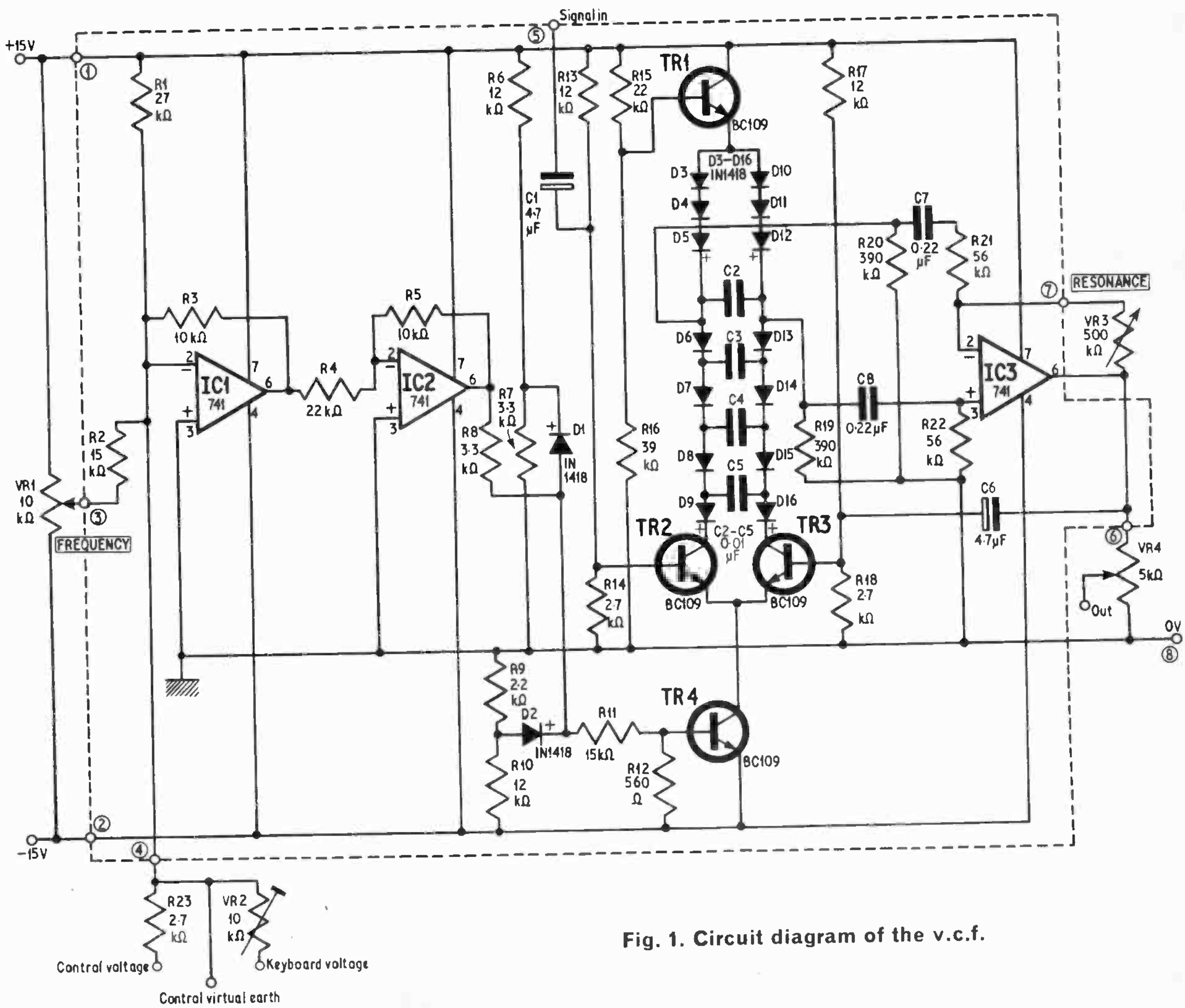


Fig. 1. Circuit diagram of the v.c.f.

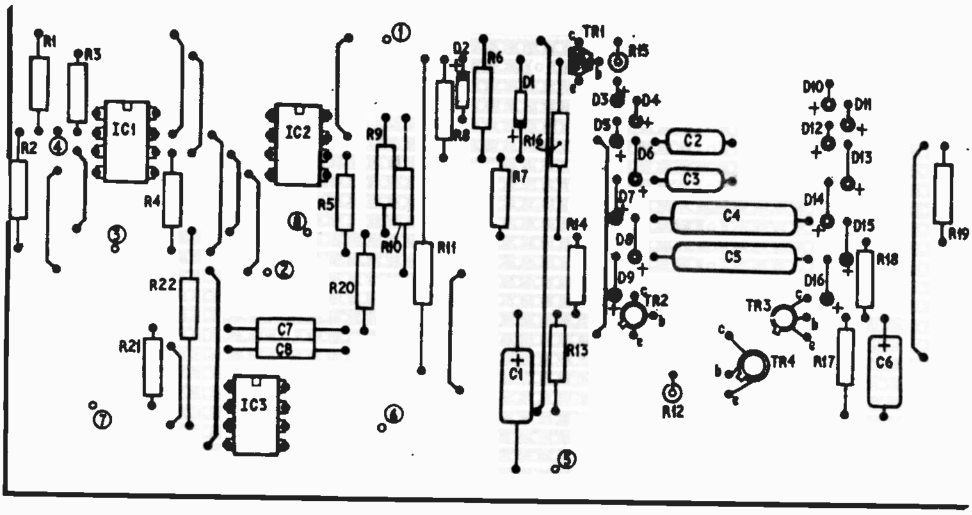


Fig. 2. Details of Veroboard component layout and copper track breaks required

This need not be too precise and is most easily set by ear, listening for the same harmonic structure for both low and high notes. The value of VR2, nominally 10kΩ, may need to be changed depending on the keyboard arrangement with which it is used.

CONTROL INPUT

Putting the trapezoid output of an envelope into the control input produces the typical "Moog sound" when the filter is given an input rich in harmonics such as a square or pulse waveform. The sound is even brighter when there are two square waves either in unison or an octave apart.

As the filter cuts out all sound when the cut-off frequency is below the lowest frequency present in the input, it can be used between the oscillators and the output, without a v.c.a., and it is completely silent during pauses.

Other possible control inputs are slow-running oscillators of any waveform. This produces effects from an automatic Waa-Waa at 5Hz, to a bubbling sound with several oscillators at about 20Hz. When the control frequency is in the audio range, modulation effects are produced.

CONSTRUCTION

In the prototype Veroboard was used and a layout and cutting diagram is supplied in Fig. 2. All components shown outside the dotted area of Fig. 1 should be mounted, ideally, on a control panel. ★

COMPONENTS . . .

Resistors

R1	27kΩ	R9	2·2kΩ	R17	12kΩ
R2	15kΩ	R10	12kΩ	R18	2·7kΩ
R3	10kΩ	R11	15kΩ	R19	390kΩ
R4	22kΩ	R12	560Ω	R20	390kΩ
R5	10kΩ	R13	12kΩ	R21	56kΩ
R6	12kΩ	R14	2·7kΩ	R22	56kΩ
R7	3·3kΩ	R15	22kΩ	R23	2·7kΩ
R8	3·3kΩ	R16	39kΩ		

All 5% ¼ watt

Potentiometers

VR1 10kΩ lin
VR2 10kΩ preset
VR3 500kΩ lin
VR4 5kΩ log

Capacitors

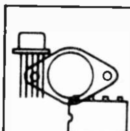
C1 4·7μF, 10V electrolytic
C2 to 5 0·01μF (4 off)
C6 4·7μF, 10V electrolytic
C7 to 8 0·22μF (2 off)

Semiconductors

IC1 to 3 741 (8-pin) (3 off)
D1 to 16 1N1418 or equivalent (16 off)
TR1 to 4 BC109 (4 off)

Miscellaneous

Veroboard 2½in × 5in, wire, solder, etc.



THE NEXT DECADE ?

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

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

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

Contributions (not exceeding 300 words and entitled "The Next Decade") should be addressed to *The Editor, Practical Electronics, Fleetway House, Farringdon Street, London, E.C.4* and posted in time to reach our offices by November 1, 1974.

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

HYBRID Computers

PART ONE

BY D. AL-DABASS*

To many the computer is still a source of mystery, a box which magically produces information from facts fed into it. This series should dispel much of the haze which exists particularly in that area dealing with the hybrid, the marriage of the digital and analogue machine

COMPUTERS are now a firmly fixed part of our way of life and whilst most people still tend to associate them with the issue of gas bills and things economic there is in fact a massive area of technology in which they are used to great advantage both for basic design and in research.

Indeed, in these areas the computer forms a very important tool since it can, in its various forms, take over both much of the tedium of lengthy mathematical operations and provide hypothetical models of an engineering design without the labour of actually building the equipment.

ANALOGUE AND DIGITAL

There are two basic types of computer or computing machine, the digital version which tends to have massive powers as a "Number crunching" device. That is, it is capable of dealing with endless mathematical activities such as addition or subtraction and, through these, multiplication or division, which would normally be totally beyond a man's ability simply because of the sheer time-consuming work involved.

The second sort of machine is the analogue device which, whilst not at all as apparently complex as the digital machine, is in fact capable of carrying out very complex abstract mathematical functions with the aid of the now fairly well accepted operational amplifier. Whilst an analogue machine is not anything like as powerful as a digital in terms of sheer numbers it does have distinct advantages in cost and flexibility terms.

Of course, with the advent of the integrated circuit and the extension of this art into the realms of large scale integration some of the mathematical functions can be handled quite easily in digital terms but the cost is still high and often flexibility is lacking.

*North Staffordshire Polytechnic

IN APPLICATION

For example, a car manufacturer embarking on the production of a new suspension system might wish to study the behaviour of his system prior to finalisation of engineering plans. A set of differential equations representing his suspension system can be set up on a computer and then the behaviour studied in terms of the spring and shock-absorber parameters as well as varying road surface conditions and load. Optimum spring stiffness and absorber damping are then determined before committing material and labour to the actual manufacturing of the system.

The suitability of the analogue computer to simulate the sets of differential equations needed in this sort of work stems from the inherent characteristics of the operational amplifier, the heart of the general purpose analogue computer. These characteristics are represented by the ease with which the operational amplifier can be made to perform mathematical integration, function generation and summation of quantities represented by voltage potential and current.

Fig. 1.1 shows the operational amplifier used in three applications; summing, integration and function generation.

The general purpose analogue computer contains many hundreds of these amplifiers allocated to dedicated units, e.g. summers, integrators, multipliers, function generators, and so on. In order to simulate a given equation, the outputs and inputs of these units are suitably interconnected, as for example in Fig. 1.2 which shows a typical set-up for a second order differential equation.

To assist the engineer in his study of the system the output at various stages of the solution may be displayed on a CRT or recorded on a X-Y recorder.

In this way a continuous display can be obtained by iterating the solution between an initial conditions mode and a compute mode using a suitable timer to switch all amplifiers to their initial state after the solution has run for a preset time interval. The solution is then started all over again and the whole cycle repeated to generate a continuous display.

The displayed parameters of any simulated system are related to actual system parameters by use of

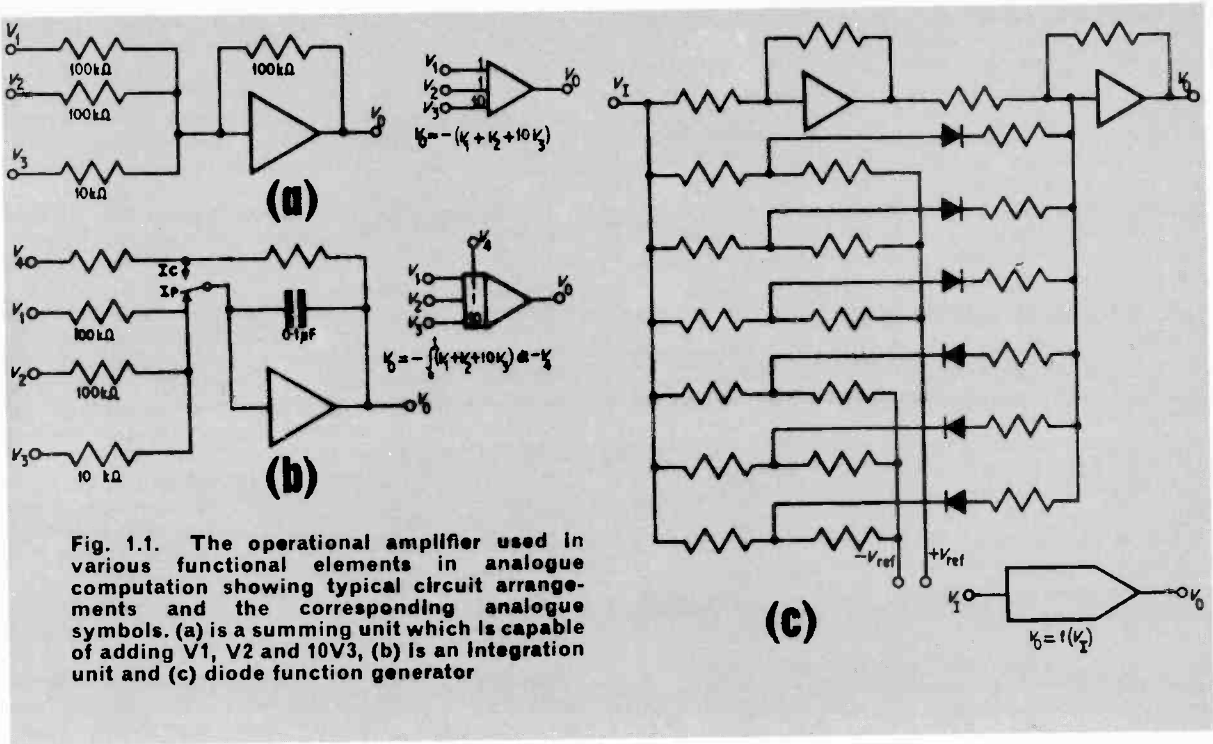


Fig. 1.1. The operational amplifier used in various functional elements in analogue computation showing typical circuit arrangements and the corresponding analogue symbols. (a) is a summing unit which is capable of adding V1, V2 and 10V3, (b) is an integration unit and (c) diode function generator

scaling factors worked out prior to setting up the equations on the computer. This enables the engineer to quickly convert computer units to physical units.

DIGITAL SIMULATION

The simulation of differential equations using a digital computer differ both in concept and implementation from analogue methods. While the analogue computer utilises the natural ability of the operational amplifier to perform mathematical integration, the digital computer depends on numerical analysis techniques in breaking down the integration into a series of simple steps using the basic arithmetic operations of addition and multiplication.

A large number of numerical formulae are available for this purpose ranging from the well known Runge-Kutta to predictor-corrector, and extrapolation methods. These formulae can either be programmed by the engineer using a high level language such as Fortran, or may form a permanent feature of a language specifically written for simulation such as the XDS SL1, and Simulation Council CSSL.

In both cases, however, the engineer has to write a programme to handle his own specific problem, such as the setting up of initial conditions, the listing of output results, changing parameters between runs, etc.

THE ANALOGUE MACHINE

Perhaps the most outstanding features of the general purpose analogue computer stem from its natural ability to perform integration as well as its inherent parallel nature. These two basic features combine to yield a multitude of advantages that has always given the analogue computer an edge over the general purpose digital computer in the simulation of differential equations. These advantages may be divided into two categories, namely operational and technical.

In the first category fall such advantages as those pertinent to the problem-solving designer. Perhaps the most obvious of these is the ease of interaction between problem and designer giving the latter a direct insight into the problem.

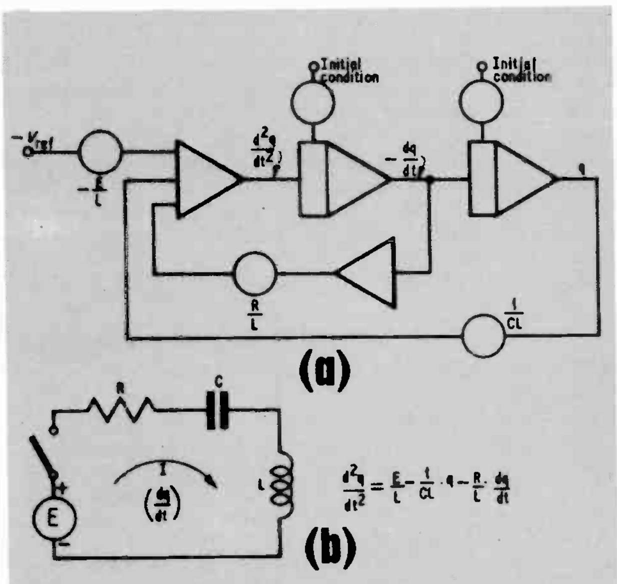


Fig. 1.2. (a) An analogue computer simulation of the second order LCR circuit shown at (b)

The form of presentation of results gives the engineer a direct contact with the problem behaviour, enabling him to thoroughly investigate the system for a wide range of parameter values, and initial conditions.

Other features include ease of programming which mainly consist of substituting analogue computing elements, such as integrators, multipliers, etc. for corresponding elements of the system under study. This usually entails providing analogue elements whose transfer characteristics are analogous to those of the physical system.

HARDWARE INVOLVEMENT

This feature easily facilitates the inclusion of some of the actual system hardware in the simulation to enable a more accurate estimation of the overall system behaviour.

The main advantage of the analogue computer, however, is its speed of operation. Due to its parallel nature of operation, complexity of simulated equations has little or no effect on the time required to obtain the solution.

This enables the computer to handle non-linear and time-varying equations just as easily as linear equations, any added function complexity being tackled by additional computing elements. The significance of this advantage cannot be over emphasised particularly in simulations requiring real-time operations such as in aircraft and space vehicle pilot trainers.

ANALOGUE LIMITATIONS

Like any other machine, the analogue computer has many limitations. The most obvious of these is the level of accuracy achievable in obtaining the solution to a differential equation. This limitation stems from the combined effect of two reasons, the first being the manufacturing tolerances of the basic components used in the design of the analogue computing elements such as resistors, capacitors, and the like.

Although big advances have been made in recent years in the design and manufacture of these components in an effort to minimise the uncertainty in their values, the combined effect of the large number of these components that are required to make each individual analogue computing element have not been greatly reduced.

As a result linear computing elements such as summers and integrators have an accuracy of the order of 0·01 per cent, while those exhibiting non-linear characteristics such as multipliers, square root elements and diode function generators have at best an accuracy of some 0·1 per cent of full scale.

NOISE

The second factor affecting accuracy is that of noise in electronic elements. No component in the analogue computing world whether passive or active escapes this plague. Advances in the design and manufacture of units have nevertheless managed to reduce the overall effect of uncertainty due to noise to a level compatible with that due to manufacturing tolerances of the values of these components.

As a result it is now possible to resolve voltages down to a level of 0·01 per cent of full scale. This level, however, is only sufficient to give a dynamic range of four decades for the system variables. For systems requiring more accuracy analogue computers are obviously inadequate.

This applies equally well for time scales, resulting in a limitation on the dynamic range of the frequency domain to some three or four decades at the most. Due to these limitations the problem of scaling the variables in voltage and time becomes very important indeed. This is particularly so where the magnitudes of the variable vary greatly from one stage to another.

In large systems this requires a great deal of time and effort in the formulation and checking of scale factor to obtain the best possible accuracy out of the computing units.

Another group of limitations of analogue computers includes the storage of intermediate results between runs. Simulation of long time delays and generation of functions of more than one variable are very tedious to implement and plagued by the usual limitation in accuracy and available computing units.

But perhaps the most serious limitation of all is the analogue system's inability to carry out complicated chains of logical decisions and parameter modifications which are required in many aspects of computation in simulation and optimisation.

THE DIGITAL MACHINE

The multitude of advantages associated with the general purpose digital computer can be traced back to two basic features that characterise these machines. The first of these is of course its digital nature which leads directly to the fact that the accuracy of variables expressed within the computer is not so much a function of the electronic hardware tolerances but rather the number of bits used to define the variable. A twenty-four bit word will yield an accuracy of some 10^{-5} per cent of full scale, while a thirty-two bit word gives an accuracy of the order of 10^{-7} per cent. Accuracies of this order are beyond present and foreseeable future generations of analogue computers.

One common form of expressing quantities in a digital computer is that of floating-point arithmetic. This form enables quantities greatly varying in magnitude (the range 10^{-100} to 10^{+99} is usually taken as standard) to be expressed in the same high order of accuracy mentioned above throughout the range. This eliminates one of the most tedious and time consuming operations associated with analogue computers, namely that of scaling factors.

The second group of advantages stems from the stored-programme nature of digital machines. Many thousands of words of data and instructions can be stored indefinitely and subsequently called when and where necessary.

This gives the digital computer, perhaps above all, the flexibility to execute long and complicated chains of instructions to perform hundreds of mathematical and logical tasks.

As far as the simulation of engineering and scientific systems is concerned a number of benefits are directly evident from these features. Numerical and logical data can be memorized indefinitely over many simulation runs and used to alter parts of the system or switch from one set of parameters to another.

Furthermore the limit on the amount of stored data is very large indeed enabling a great multitude of results to be stored for subsequent calculations and analysis which can be carried out by an additional programme written, for example, to sieve through these results to find an optimum set of parameters for a given set of conditions.

The storage capability is also very useful in generating pure delays of signals over precisely controlled durations needed in the simulation of, say, communication lines.

DIGITAL LIMITATIONS

Like the analogue computer, the general purpose digital computer suffers from a number of limitations in the simulation of dynamic systems.

These can be divided into two categories, operational and technical. The first of these include those factors pertinent to the problem designer such as programming techniques and the form of communication with the problem. These two features have always formed in one way or another a barrier between the problem and the designer that have come to characterise the use of digital computers in simulation.

The range of programming techniques is very wide and covers machine code and assembly languages, high level scientific languages (such as Fortran), high level simulation languages (such as CSSL) and more recently special purpose languages for interpreting block diagrams representing the problem into one of the other high level languages.

This last technique represents perhaps the closest the digital computer will ever come to replacing the operational convenience of the analogue computer.

ON- AND OFF-LINE

The second feature of the operational limitations of the digital computer is that of the form of communication between the designer and his problem. This can either be in the "off-line" mode, or the "on-line" mode.

As the title indicates, in the off-line mode the designer is almost completely divorced from the way in which the problem is actually run on the computer. The designer prepares the problem in the form of a flowchart or a program, which he then passes to the data processing staff, who then run his program and return the results in the form of a printed program listing. As the turn-round time in this process can be of the order of 24 hours any additional insight into the problem that is usually gained by working with analogue computers is completely lost in this case. Moreover the ease with which the response to parameter variation is observed using analogue computers is non-existent in this mode of simulation.

In the on-line mode of simulation, however, these limitations are greatly reduced as the designer is able to feed the problem into the computer and get his results back within a few minutes. This is usually carried out using a tele-typewriter, and in computers used specifically for simulation, a graph plotter and a CRT. Perhaps the most advanced form of communication is that where the designer defines his problem on the CRT (using a light pen) in the form of block diagram representation of the system to be simulated.

THE SPEED FACTOR

The second group of limitations associated with digital computers stem from the speed limitation of this machine. Two causes are generally taken to attribute to this.

The first is that the digital computer is a serial machine only capable of executing one instruction at a time. Secondly it is only able to perform a very limited number of arithmetic operations, typically addition and multiplication.

This latter feature means that integration, differentiation and function generation (sin x, log x, etc.) must be performed using numerical techniques which break down these functions into a long and time consuming chain of simple addition and multiplication. This is made even worse by the serial nature of the machine limiting it to perform one addition or multiplication at a time.

Furthermore, numerical techniques such as integration formulae have their own weaknesses, particularly as far as the stability of the solution is concerned. In general this means that small integration step sizes have to be used to ensure stability, leading to a substantial increase in total computation time.

THE HYBRID MACHINE

It should be evident from the foregoing that some form of combination should be possible that will enhance the advantages and reduce the limitations.

The major advantages of analogue machines are ease of interaction with the designer, ease of integrating actual system hardware in the simulation and finally speed.

Those of the digital machine are ease of performing logical and mathematical operations and accuracy.

Perhaps the most obvious justification for hybrid computers is that of combining the speed of the analogue with the accuracy of the digital computer. This situation often arises where the system to be simulated can be partitioned into fast dynamic equations requiring moderate accuracies, and slow response equations requiring very high accuracy.

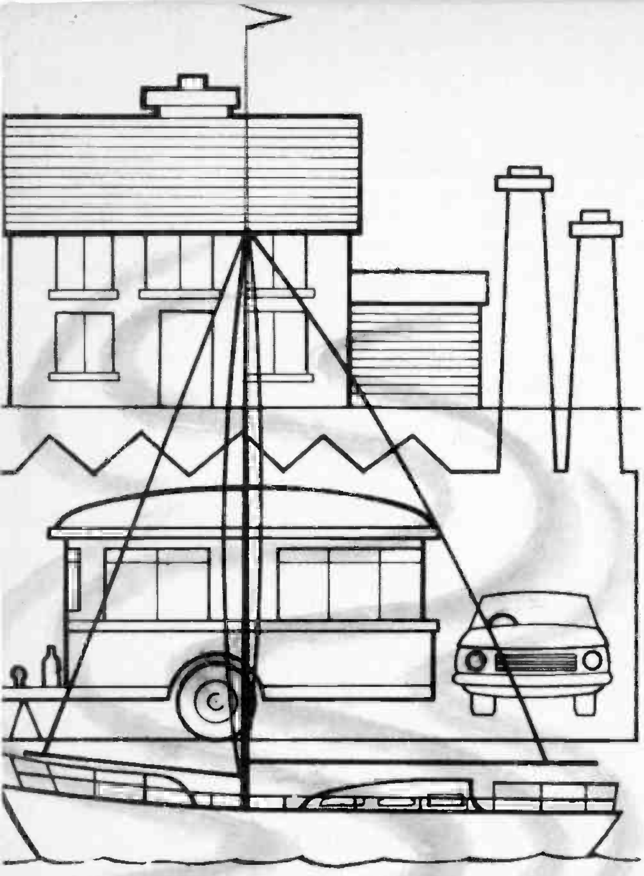
Another justification exists where the performance of a part of the actual system hardware is to be studied. The autopilot of an aircraft, for example, can be connected to the set of aircraft dynamics equations patched on the analogue part of a hybrid computer system.

The flexibility of the digital computer in performing logical and mathematical operations is valuable, particularly in cases where the modest accuracy of the analogue machine is sufficient but a more elaborate control procedure is required. Optimisation is one area where this is so.

The car suspension example mentioned earlier is typical, where the differential equation representing the suspension is set up on the analogue computer while the digital computer may be programmed to optimise the spring stiffness, the shock absorber damping factor, and friction coefficient to produce the most comfortable ride in terms of the amplitude and frequency of bounce.

Other motivations for hybrid computers include those where a high speed analogue sub routine is used in an essentially digital simulation. Partial differential equations representing chemical reactions and transmissions lines may be solved using this technique. Finally, in telemetry applications where signals come both in analogue and digital forms, and high speed processing is required, both analogue and digital computers are used to process the data simultaneously.

Next month: Hybrid computing systems



GAS DETECTORS

. . . FOR HOME · FACTORY CARAVAN · BOAT

PART TWO

By J. C. PERRETT

Several circuit variations using state-of-the-art catalytic gas/smoke detectors to indicate the presence of such dangerous materials as methane, propane or butane

LAST month we described a mains and portable version of the gas detectors. This month we continue with the details of a boat/caravan version, and the setting up procedure for all units.

The circuit of Fig. 9 has been designed for boats, where protection is required in more than one place. For example a sensor is necessary where Calor gas is used, usually in the galley, and protection is also required in the engine room where a petrol leak or carbon monoxide might be present. The unit has been designed so that the alarm may be placed remote from the sensors, perhaps on the bridge or in a cabin.

Here only one alarm is used, common to both sensors. This may be a bell or horn. Also fitted to the control unit are two lamps which indicate which sensor is activating the alarm.

STAND-BY

Whilst the detector is warming it assumes a low impedance state which will cause the alarm to sound. To prevent this during the warming period a "stand-by" switch S2 is fitted which removes the supply from the alarm and also lights a warning lamp as a reminder that the alarm is turned off. The warming period takes approximately 2 to 3 minutes.

An additional circuit has been added to monitor the functioning of the chopper supply. Signals are sampled at the collector of TR4 by passing a portion of waveform through C5, 1,000μF, and d.c. restoring the a.c. coupled waveform. The resulting waveform is applied to an l.e.d., LP4 and as long as the circuit functions LP4 remains alight. This is only capable of "Go-No Go" information about the chopper supply.

The circuit, wired for use from 12V batteries, will accept inputs which extend up to 17V. This is necessary as some large batteries may well reach 15V when undergoing strong charging, particularly from alternators. At the other extreme the device will continue working with the battery voltage falling to 10V, the sensitivity only reducing slightly. In fact tests show the oscillator continues running until the supply falls below 4V.

BOAT/CARAVAN GAS/SMOKE DETECTOR

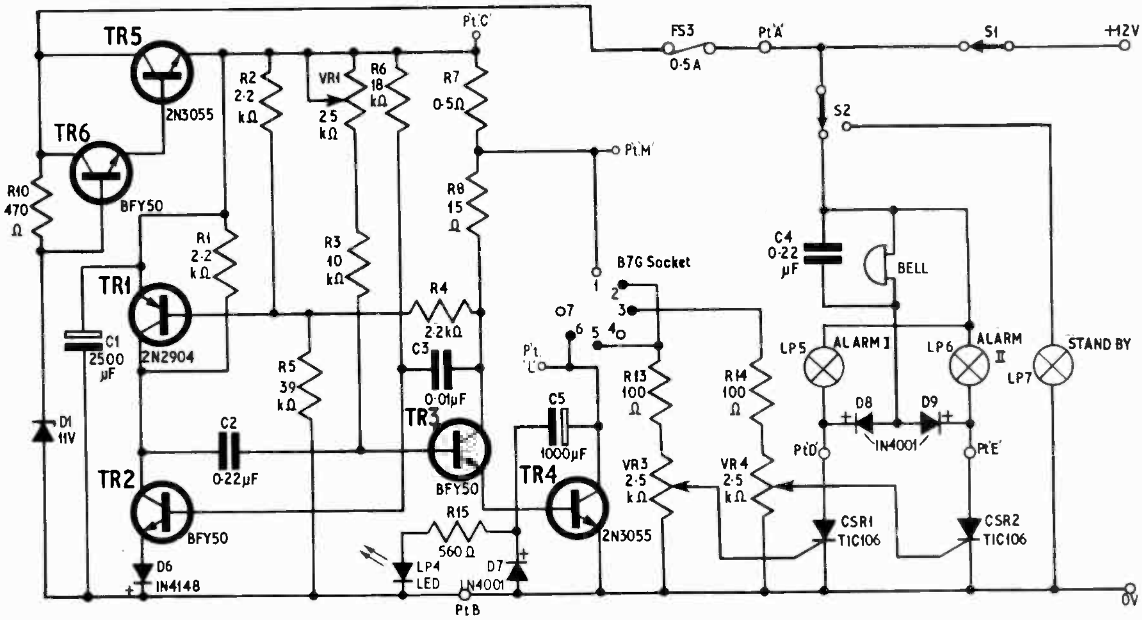


Fig. 9. Circuit diagram of the boat/caravan system incorporating two sensors and double indication of alarm

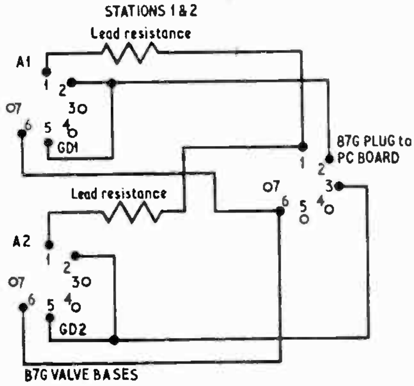


Fig. 10. Details of interwiring between external sensors at stations I and II and the B7G plug engaging with the board mounted socket of Fig. 7 (last month)

Resistors
- R1 2·2kΩ
- R2 2·2kΩ
- R3 10kΩ for 12V supply, 22kΩ for 24V supply
- R4 2·2kΩ
- R5 39kΩ
- R6 18kΩ
- R7 0·5Ω 4W
- R8 15Ω
- R10 470Ω for 12V supply, 1kΩ for 24V supply
- R13 100Ω
- R14 100Ω
- R15 560Ω
- All ½W unless otherwise specified

Potentiometers
- VR1 25kΩ pre-set
- VR3 2·5kΩ pre-set
- VR4 2·5kΩ pre-set

Capacitors
- C1 2,500µF, 25V
- C2 0·22µF, C280
- C3 0·01µF, C280
- C4 0·22µF
- C5 1,000µF, 16V

Diodes
- D1 11V, 400mW Zener for 12V supply, 15V 400mW for 24V supply
- D6 1N4148
- D7 1N4001
- D8 1N4001
- D9 1N4001

Transistors
- TR1 2N2904
- TR2 BFY50
- TR3 BFY50
- TR4 2N3055
- TR5 2N3055
- TR6 BFY50

Thyristors
- CSR1 TIC 106
- CSR2 TIC 106

Lamps
- LP4 Light emitting diode
- LP5 12V bulb and SL90 holder
- LP6 12V bulb and SL90 holder
- LP7 12V bulb and SL90 holder

Miscellaneous
- GD1 TGS 308 and holder
- GD2 TGS 308 and holder
- S1 SPDT on/off switch
- S2 SPDT change-over switch

Alarm bell or Klaxon; 4 test resistors, 1·8Ω ⅛W; case; p.c. board; fuses and holders; B7G plug and socket, tag strips, wire, etc.

However, under approximately 6V current does tend to rise quite quickly.

It is therefore not advisable to test the circuit by slowly increasing the supply from zero on a bench supply. When wired for 24V operation, with the component changes noted in the parts list, the unit will function between the limits of 16 to 32V.

TWO-STATION UNIT

The p.c.b. for the circuit of Fig. 9 is the same as for the last unit. However, a few component changes are required.

C1 should be increased to 2,500μF and the sensitivity controls VR3 and VR4 are pre-set and fitted to the p.c.b. Note that for full sensitivity VR3 must be set fully anti-clockwise and VR4 fully clockwise. Extension lead resistance must be kept negligible at 0·5Ω max. total resistance of the two wires used for heater connection per station, and both sensors. There are tolerances on the heater elements and if there are differences in lead resistance the sensors may be changed between stations to help balance the circuit. The highest resistance heater should be placed in the circuit with the shortest cable run.

The circuit of Fig. 10 shows details of the wiring for the double detector system of Fig. 9.

SETTING UP UNITS

After a careful inspection of all wiring for the circuit of Fig. 4 (last month), a 1·8Ω CR25 ⅛W resistor should be fitted in the place of the heater (pins 1 and 6 of valve base). An ammeter (1A range) should be connected between point A of the board and battery +ve. Several test and connection points on the board have been lettered for convenience. Set VR1 fully clockwise, turn on the battery supply by moving the selector switch to position 2. If the l.e.d. circuit has been included it should immediately light.

Now move VR1 anti-clockwise until battery drain current is 120mA at which point the test resistor should be getting warm. Next reduce the current flow in the resistor by turning VR1 clockwise, check the circuit for bad joints. These will show by either the current flow fluctuating or by the test resistor burning. Check the temperature of all transistors on the panel—they should be at room temperature (TR5 may be slightly warm). The references to clockwise and the reverse apply to the p.c.b. layout shown.

When checks are completed, disconnect supply and test resistor. Insert jack plug into socket, reconnect supply and adjust VR1 to give 120mA current drain.

The sensor should become warm after a short time. Move the selector switch to position 3 and turn the attenuator clockwise to give a high reading on the meter. If sufficient time has been allowed for heating, the meter reading will be low or falling; if the meter reading is increasing some additional time is required for warming up (using a type 308 sensor this will take approximately 2 minutes).

The sensor may now be placed 2 to 3 inches above a cigarette or cigar (non-smokers may wish to use a glass of brandy for this test—recompense for giving away the cigar) and as the smoke curls through the sensor, rapid movement of the meter should be observed. If the readings change very slowly or remain high, slight adjustment of VR1 may be necessary.

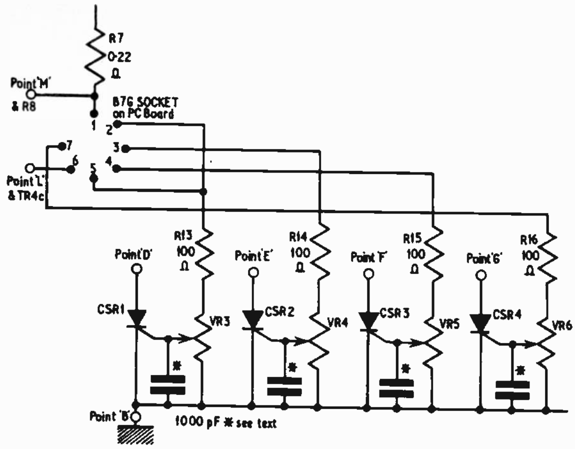


Fig. 11. Modifications of the circuit of Fig. 9 to accept experimental 4-station operation

In general if on turning on the instrument the meter reading increases and stays high even after two minutes, the sensor requires more heater power.

The drain current may be finally set by adjusting VR1 between 100mA and 120mA to obtain the fastest sensor reaction time.

TESTING BOAT/CARAVAN VERSION

The caravan/boat battery driven version of Fig. 9 should be tested under 12V operation by connecting two test resistors in parallel (1·8Ω each) across pins 1 and 6 of the B7G base. Turn VR1 fully clockwise. Insert an ammeter (1A range) in series with point A of the board, and battery +terminal. Ensure the remote sensors are disconnected and the alarm switch is off (stand-by position) and remove stand-by bulb from holder.

Turn on the power switch S1. The l.e.d. should light. Slowly move VR1 in an anti-clockwise direction until a reading of 220mA is obtained. The resistors should be getting hot; reduce current to prevent the resistors from burning and check for poor connections.

When satisfied with this test, disconnect the test resistors and connect both sensors to the barrier strip.

Adjust VR3 and VR4 to minimum sensitivity (VR3 clockwise, VR4 anti-clockwise). Reconnect battery and adjust VR1 for 220mA. Switch off. Disconnect the meter and reconnect it across VR3, set to the 10V range. Reconnect the battery. As the sensor warms up the voltage across VR3 will rise, after a short time the reading will start to fall, when the reading becomes stationary (approximately 2 to 3 minutes) reconnect the meter across VR4, the reading by now should be minimum and steady.

Submit Station II to smoke or gas, the meter reading should rise smoothly to at least 5V returning quickly to a low value when the influence of smoke is removed. Reconnect the meter to VR3 and repeat the test using Station I.

Adjust VR1 to obtain the best results within the limits of 210mA to 230mA. Too much or too little battery current will cause sluggish results.

After completing the test, disconnect the meter and insert the "stand-by" bulb. Move the alarm

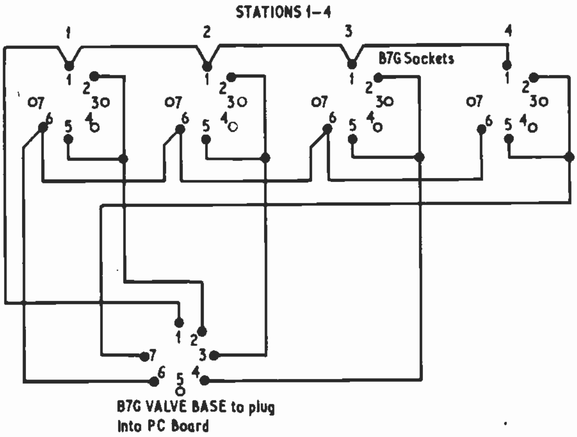


Fig. 12. Wiring details for the four leads of Fig. 11

switch S2 to the Off position and switch on S1. Both l.e.d. and stand-by bulbs should light. Move the alarm switch to the On position, the stand-by light should now extinguish.

Slowly increase VR3 anti-clockwise, if the alarm sounds move VR3 clockwise, turn the alarm off and wait for a further short time for the sensor to become fully warm. Repeat this operation, it should be possible to turn VR3 to full sensitivity without the alarm being triggered.

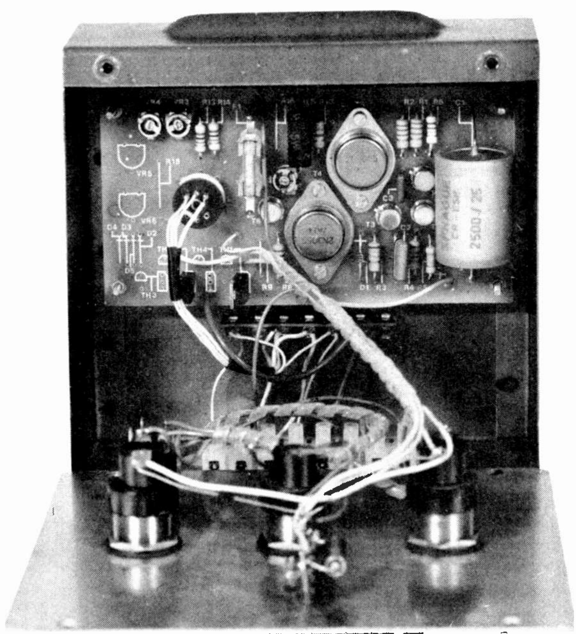
Next submit Station I to gas or smoke, the alarm should sound, and turn on Station I alarm light. Reset the alarm by moving the switch to stand-by position. Station I alarm light should extinguish and the stand-by light should come on. After a short time move the alarm switch back to alarm On position, the stand-by light should go out. Repeat the test for Station II by setting VR4 to maximum sensitivity.

If the audible alarm is a bell then interference from the contact breaker may trigger both alarm lights when only one sensor detects smoke. This may be overcome by fitting a capacitor C4 directly across the points of the bell (suggested value 0·22μF).

If using a bell or buzzer for audible warning of danger make sure the bell or any other device which uses a contact breaker is not in a position where it may be subjected to gas. This includes petrol fumes and the like as any spark source is, of course, an explosion risk. For 24V operation, R10 becomes 1kΩ. D1 becomes 15V, R3 becomes 22kΩ, and LP5, LP6 and LP7 become 24V.

The same test procedure applies as in the 12V version except that VR1 should be adjusted for 120mA nominal. If the circuit of Fig. 9 is used for single station work, wire LP5 in parallel with the alarm and dispense with R14, VR4, D8, D9, LP6, CSR2.

The battery current for 12V operation will be 120mA and for 24V approximately 85mA.



EXPERIMENTAL WORK

The p.c.b. of Fig. 8 (last month) was developed with sufficient room to accept the components for Fig. 4 (last month), Fig. 9 and an experimental 4-detector unit, useful perhaps in industrial environments. It must be emphasised that such an arrangement is experimental and any errors would be costly. It is not recommended for the beginner.

A number of points are identified on the p.c.b. by letters A to M. The following connections apply for the 4-detector unit.

A and H — Battery supply input point.
B — Earth.
C — Regulated HT point (emitter TR5).
D — Anode, CSR1.
E — Anode, CSR2.
F — Anode, CSR3.
G — Anode, CSR4.
JK — Spare track 5 holes.
L — Pin 6 B7G socket.
M — Pin 1 B7G socket.

Fig. 11 shows modifications to Fig. 9 and on the board D2, D3, D4, D5, are redundant, but 1,000pF ceramic capacitors may be added to these positions to help prevent accidental triggering of the thyristors, caused by severe electrical interference.

C1 should be increased to 5,000μF/25V to meet the increased current demands. TR4 and TR5 must be mounted remote from the board on heatsinks; the transistors mounted on mica washers (TO3 type).

Drive for TR4 may be increased by reducing R8 to 10Ω.

To improve efficiency R7 reduces to 0·22Ω. For 24V use TR4 is very close to its current limit and should, therefore, be changed to type BDY57 but must have a minimum h_{fe} of 30. R8 becomes 12Ω.

As the pulse currents are large when using four stations, lead resistance balance becomes very important and the user must carefully calculate the mark/space ratio required for his own particular situation so that the battery drain current may be calculated from the examples given in the article.

The use of four stations has not been fully tested but it was thought worthwhile having the facility on the board. Fig. 12 shows a suggested circuit wiring for interconnecting the 4 leads to the p.c.b. The reader will, of course, appreciate the necessity for extra indicator lamps and associated components not discussed here. ★

PATENTS REVIEW...

TUNING CIRCUIT

The International Standard Electric Corporation of New York describes in BP 1 347 707 a tuning circuit for radio or television which uses voltage variable capacitors.

In Fig. 1 the decoupling diodes D2, D3, D4 are connected together and to the sliders of potentiometers VR1, VR10, VR20. The potentiometers are fed at A1, A2, A3 (to An) with the outputs of any conventional switch bank. The common connection between the diodes goes to voltage variable capacitors VD1, VD2, etc. A compensating diode D1 at the common connection of the "pots" compensates for the temperature-dependent component of the voltage drop across the decoupling diodes. A load resistor R1 enables current to pass through the diodes whatever the direction of operation of VD1, VD2.

The physical location of all the diodes, including the compensating diode, is such that they are all exposed to the same temperature, e.g. all on the same chip.

The inventors suggest that an almost complete compensation for the effect of temperature on the decoupling diodes will follow whenever the slider of an associated potentiometer is nearest the common connection point between the potentiometers. In the opposite position, where the slider is as far remote from the common connection point as possible, there will be very slight compensation, if any. Hence, degree of compensation depends on slider position; compensation is usually arranged to be optimum at the point of greatest voltage sensitivity of the voltage variable capacitors.

BP 1 347 707

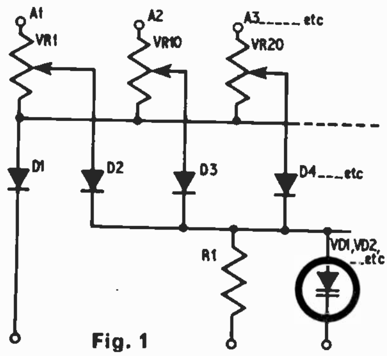


Fig. 1

SOUND CONTROL BP 1 329 518

In BP 1 329 518, Matsushita Electric Industrial Co. describes a contactless control system which can be used for both volume and on/off control of a sound circuit. In practice this is most likely to be used in radio or TV receivers.

A microphone, sensitive to ultrasonic waves, is mounted on the set side and feeds an amplifier and filters having different passbands.

A remote ultrasonic transmitter is selectively operated (when it is wished to switch the set off) and when the signal is received and fed to the amplifier and one filter a transistor is switched on causing a gradual charging of a capacitor. When the transmitter is switched off again the transistor is cut off to open the charging loop for the capacitor.

With the charging and discharging of the capacitor the drain source impedance of a field effect transistor (f.e.t.), and hence the drain voltage is changed which alters the amplification degree of a sound amplifier. Thus, it is possible to gradually change the volume.

To achieve on/off switching an oscillator is connected to the circuit. The ultrasonic signal is then used to switch this oscillator on or off and the oscillator signal is used (after signal amplification and rectification) to control an on/off power supply switch.

In a combination system the patent describes a method where the on/off control is achieved by utilising the control signal for the volume control, the volume being always reduced to minimum at the time of turning off the power and rising again from this minimum when power is restored.

CAR IMMOBILISATION

In BP 1 333 060 an arrangement which, if incorporated in a car, would make it impossible for a driver to start the engine if he had more than the legal limit of alcohol in his bloodstream is described by General Motors. Thus, the temptation to drive after drinking would be removed.

The block diagram, Fig. 1, shows an ignition cut out device (such as a relay or solid state switch) inserted between the car battery and primary winding of the car ignition coil. The power stabiliser is connected between the battery and two resistors R1 and VR1 of a Wheatstone bridge. The other two bridge resistors R2, R3 are connected to earth.

The junctions between resistors R1, R2 and VR1, R3 are connected to the input of a d.c. amplifier. The d.c. amplifier output is connected via a time delay switch to the control terminal of the cut-out device.

The stabiliser also feeds power to the amplifier and the time switch. An alarm indicator (e.g. a buzzer or flashing light) is also connected to the output of the d.c. amplifier.

Resistor R1 of the Wheatstone bridge is a wire coated with finely divided platinum. In the presence of alcohol vapour an exothermc oxidation reaction occurs which heats up and changes the value of the resistor.

In practice R1 is mounted in the head lining of the vehicle or in the vehicle steering wheel and VR1 is adjusted to give a pre-set stable condition. If the amount of alcohol breathed by a driver on to the sensitive resistor causes its resistance to change significantly, the bridge will go out of balance and produce a signal which is amplified and passed via the delay circuit to the cut out device. After the delay introduced by the delay switch the ignition circuit of the vehicle will be interrupted and the vehicle immobilised. The delay introduced enables the warning indicator to operate ahead of ignition interruption.

BP 1 333 060

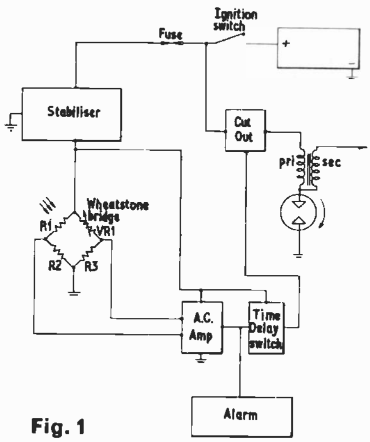


Fig. 1

SUPERSOUND 13 HI-FI MONO AMPLIFIER

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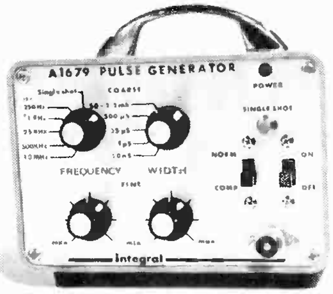

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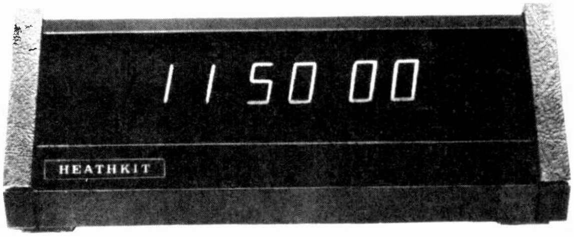

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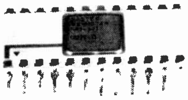

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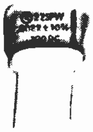

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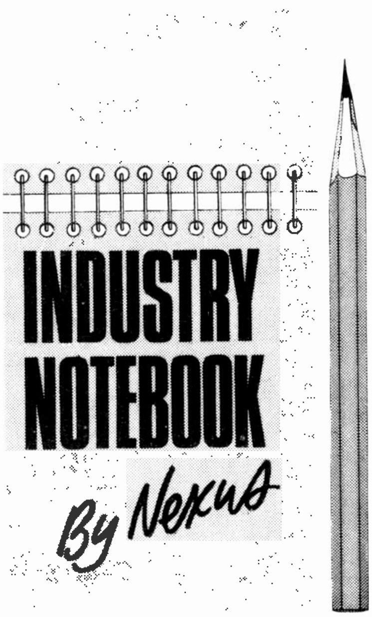

HONOURS

In these days of giant corporations and large research teams it is seldom that individual effort is allowed to shine through. I was pleased, therefore, to see that Donald Pay, head of a design team at Marconi Communications Systems Ltd., has won the Phil Bekeley Award presented by the British Kinematograph Sound and Television Society for work on the B3404 Integrated Telecine.

The equipment has so many ingenious features that it would take the whole of this page to list them and do them justice. Let it suffice that Donald Pay's work and that of his assistants has aleady clocked up more than £2 million of orders for the B3404.

Equally gratifying to me has been the astonishing success of the EMI Brain Scanner. Checking up on progress of this equipment I discovered that in the two years since its introduction to a startled medical world it has won more than £14 million worth of orders, with the great bulk of them from the United States. Just what the doctor ordered for our balance of payments!

The equipment is unique in the medical field being the only computer-aided brain X-ray system in the world. And its latest development quadruples the picture resolution, giving higher accuracy of examination as well as a faster speed of operation.

This great earner of foreign currency was the work of Godfrey Hounsfield of the EMI Central Research Laboratories at Hayes and it won him the MacRobert Award, described as the Nobel Prize for engineering. Hounsfield, who led the design team on Britain's first solid-state business computer, the EMIDEC 1100 (now of hallowed memory), developed the techniques used on the EMI-Scanner from work he was doing on electronic pattern recognition. One thing certainly leads to another.

It was EMI who made the submission for the award adding, after the technical details, "Mr. Hounsfield has been the guiding expert throughout all aspects of the work. The EMI-Scanner was as much a one-man invention as anything can be these days". A nice public tribute from an employer. The MacRobert Award Committee, in awarding the £25,000 prize, included in the citation that, "No comparable discovery has been made in this field since Röntgen discovered X-rays in 1895."

UPLIFT

Röntgen's was a chance discovery as still often happened in the 19th century. He was actually studying fluorescence at the time when he observed that if objects were placed between his cathode ray source and the fluorescent screen they cast shadows. Writing of his discovery he tells of ". . . the exultant feeling that comes with a victory of the mind, which alone can compensate the discoverer for all the struggle and effort, and lifts him to a higher plane of existence."

One wonders how much of that "exultant feeling" is experienced today. Röntgen published his findings within six weeks. Nowadays, when whole teams of researchers are not so much searching for new phenomena but expanding known technology, the time period is nearer six years. But there are exceptions, such as the flutter of excitement in 1967 when Jocelyn Bell, a young lady scientist in the radio astronomy observatory at Cambridge first noticed in the chart recordings the peculiar and precisely timed signals from outer space which, conceivably, were from some other civilisation but were later found to be pulsars.

Four years earlier in 1963 the English scientist J. B. Gunn working in the United States must have got some uplift when he discovered the effect which today is commercially exploited in the Gunn diode and which has transformed microwave technology. I heard Gunn read a paper on his work at a conference in Cambridge soon after his discovery. What enthusiasm! And his name is now immortalised in the device.

Let us give more honours, prizes, distinctions to those who deserve them. Let us encourage that exultancy that I experienced in the 1930's when my first home-built bread-board two-valve short-wave receiver pulled in the famous US station at Schenectady. I had bridged the Atlantic! Nonsense, of course, because nothing was new about it but it was the sort of thrill which I hope is still shared today by thousands of readers when they switch on their newly-built gear for the first time and Eureka—it works.

BIG BAD WOLF?

Although the multinational ITT Corporation appears to be still under a cloud in the United States I can report that ITT Components Group Europe is not only alive and well but prospering mightily. The Group employs some 16,000 people in Europe and current turnover is about 0·5 billion dollars which could double by 1980. In the UK, 6,250 employees are headed by Ken Walton, based in Harlow and, as a regional director, he also looks after Group operations in Spain, Portugal and Scandinavia. And if you add in the UK locations at Harlow, Paignton. Rhyl, Taunton, Milford Haven, Foots Cray and Leeds it's quite an assignment.

During the past three years the biggest expansion has been in capacitor production which will top £10 million in the UK this year. The Valve Division which might reasonably have been expected to run down slightly as solid-state devices infiltrate the market is, in fact, being boosted by new product lines such as fibre-optic laser systems and a big increase in demand for night vision equipment. Thick films are booming, a recent single order for heart pacemaker circuits being worth almost £1 million.

The most exciting commercial area of development is in displays. Production facilities are at Leeds where pilot and small-scale production has already started on light-emitting diodes with full production promised next year. Following on will be liquid crystal displays and other devices which could boost the labour force from its present strength of under 150 to, perhaps, 1,000 people. Good news, indeed, when there is so much talk of stagnation rather than growth.

And if you are imagining that ITT Components Group Europe hums with Yankee or Deep South accents, forget it. In 16,000 people there are only two Americans and neither is a line manager. And who bosses the whole show from Brussels? Doug Stevenson, another Englishman.

Readout—

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Improvements to car monitor

Sir—Mr. Perry's circuit for the "Car Systems Monitor" in the July issue takes no account of the so called automatic voltage control fitted to many British cars, including the B.L.M.C. Mini and 1100.

The automatic voltage control interrupts the current through the instruments by switching off automatically for short periods of time when the voltage from the battery/ignition circuit rises above a predetermined level. The instruments are connected and disconnected bv a bi-metallic strip about 3 times a second with some longer "off" pulses.

As Mr. Perry's device is intended to warn of low voltages and as these short low voltage pulses have to be ignored, a diode and a large capacitor are needed if the device is to be made reliable for all makes of car. The input to the circuit should be modified as shown in Fig. 1.

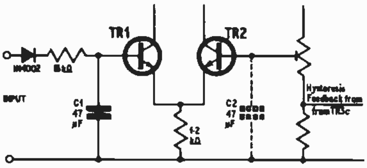

Fig. 1. Circuit alterations to the car systems monitor

The diode 1N4002 is needed to prevent the charge leaking away through the car's temperature probe (thermistor) during these "off" pulses. Even with this modification the input impedance is still rather low, so that a very long "off" pulse from the a.v.c. may still cause a spurious warning pulse.

A second electrolytic, C2 may be needed to get rid of noise coming from the sparking coil. I also note that the author does not include any hysteresis in the form of feedback from TR3, that he needs 3 transistors to make his vibrator, and that he makes no allowance for positive-earth cars!

L. J. Bell,
Worcs.

Sticky end

Sir—With reference to the "Light-Operated Lamps" mentioned in the *Patents Review* page May 1974 issue, I would like to point out that these same lamp adaptors were on sale in Zambia shops almost 2½ years ago. They were made in Hong Kong and were not very successful.

The selling price to start with was approximately £1·50 but in the end shops were selling them off for 5p each—I bought four just for the light sensitive resistors.

The fault with the units were the bi-metal contacts came together and parted so slowly that the light flickered for a good 60 to 90 seconds before going on or off.

F. J. Brown,
Wirral, Cheshire.

Magnesium—not Iron

Sir—I read with interest the letter from your correspondent P. Watson (Bedfordshire) in P.E. July 1974. His theory is interesting but I must take issue with one of the basic reasons quoted.

The green pigment present in plants involved in the process of photosynthesis exists in several forms: chlorophylls a, b, c, d, etc., all the molecules being very similar and all having magnesium and not iron as the central metal atom. The confusion may have arisen from the fact that iron is the central metal atom in hæmoglobin, the red pigment of human blood.

The magnetic susceptibilities of the metallic elements are different, iron exhibiting an extreme form of paramagnetism known as ferromagnetism. The magnetic properties of the elements are, however, modified when they occur in complex porphyrin molecules such as the chlorophylls. In addition, there is evidence showing that during the process of photosynthesis a number of free radicals are involved. These are chemical entities with unpaired electrons and consequently exhibit the property of paramagnetism. All these magnetic properties may well be additive and contribute to the observed phenomenon of plants aligning themselves with a magnetic field.

With reference to the final paragraph of P. Watson's letter where he refers to the possibility of thought controlled machines for the physically handicapped: we may not be very far from such reality. The U.S.A. Defence Department has recently released information regarding thought controlled firing and guidance of rockets from fighter aircraft. Simple "thought commands" are computer interpreted and radio-transmitted to the guidance control mechanism of the rocket.

D. B. Gordon, PH.D., A.R.I.C., M.R.S.H.,
Whitefield,
Manchester.

Exciting future for the Amateur

Sir—I have been engaged in active construction of various types of electronic gear now for around twelve years. Not I admit as long as Mr. Kitchen (see *Readout*, July issue "Good Olde Days!") but long enough to have been able to start my experience during the latter stages of the valve era. Also, when I began, the most significant factor was finance which was very low and therefore meant that I had to do a lot of "making do", as a result of which a lot of used components had to be used and used and reused.

First ventures were, predictably enough, such things as simple single-ended amplifiers, t.r.f. sets, oscillators, etc., progressing on to try things more complex and sophisticated such as an oscilloscope and a s.w. set. While I admit that the enjoyment and excitement obtained from these ventures was enormous, there were certain snags which were apparent at the time and now, in retrospect, even more so.

I refer firstly to the need for having repeatedly to solder and unsolder components, either after having made a test circuit or when pulling a previously made piece of gear apart to release the bits for use in another project. However careful one is during this operation, accidents do occur and besides which no component really benefits from heat, heat and yet more heat. So, we have the problem of damage to parts because of this and as a result of that of course, further expenditure in order to replace them.

Secondly, and perhaps more important, is the matter of all those juicy volts lurking round every corner. Mr Kitchen in fact made

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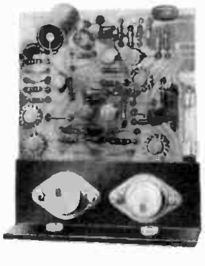

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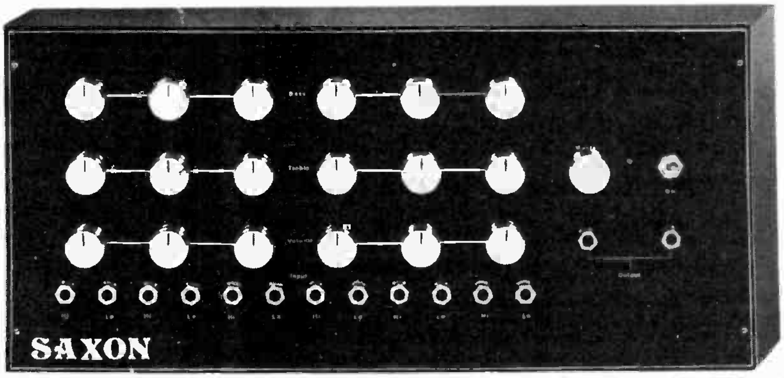

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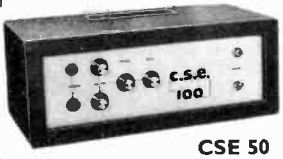

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reference to his need for hospital attention after a valve "bit" hard. Naturally one takes care with any piece of equipment which has high voltages present but mistakes can and unfortunately do happen, the risk potential (so to speak) being at worst lethal. I had a 1kV shock from my first oscilloscope and that sent me a few feet in the other direction but no harm was done and I learned a good lesson. Had it been a higher voltage or had a bit more current handy things may not have been so trivial. However, and let's face it, you have to delve into gear at times if only to take readings for servicing purposes and the like.

Having given the valve era a bashing I should say that I derived enormous pleasure from all my various ventures and were it not for the fact that nowadays there are other alternatives I daresay I would be quite happily continuing in the same vein. But there are alternatives and I must say that I'm very glad to have them.

Consider the transistor, what a remarkable device this is. When you compare the relative sizes of the valve and the transistor and think that the latter can be as good an amplifier in almost all respects (including even the GHz frequencies now) it must be admitted that size for size the transistor is a winner. Consider also the relative cost factors; you can buy a general purpose transistor now for less than the cost of many capacitors but valves can cost you as much or more.

Another factor which I personally find a great boom is that I can "breadboard" my new circuits with great ease and find out, long before putting the soldering iron in use, whether or not the circuit is going to prove satisfactory and if not I can modify it umpteen times until I've got it right. The end result is maintained sanity and fully intact components; I can then go on to solder up the final, proven circuit, and expect it to work first time without the need for further "messing".

Finally I would take Mr Kitchen up on his idea that things are made too simple and that it would be difficult to make up anything that was unique any more. I would say the exact opposite and suggest that with the availability of large scale integrated circuits nowadays there is a vast new field of experiment open to the amateur. There may be the need to learn new facts and ways of thinking but basic principles of electronics are the same.

With a bit of patience it is possible to learn all the necessary facts regarding i.c. theory and then one can go on, quite justifiably, to regard integrated circuits as "black boxes" and use them as building blocks to make many times more sophisticated pieces of equipment than was ever possible in the valve days. The list is endless but the whole point is that the modern amateur does not need to feel that everything is done for him; instead he can cash in on what is made easier and so extend his scope more than has ever been possible.

Let me say in closing that I still have a certain nostalgia for the old valve days but find the present-day possibilities so exciting that I can only look ahead and continue to enjoy the much greater flexibility that is now possible. In order to soften the effect of my words on Mr Kitchen I will amaze him by saying that not only do I still have a store of some two thousand valves still in my attic but a couple of months ago completed a new oscilloscope—yes, you guessed it, using valves!

A. C. Beglin,
Dorking,
Surrey.

Too easy!

Sir—I certainly was not trying to imply that less ingenuity or technical skill is now required for clearly this is not true. If Mr. Seddon (see letter in last month's *Readout* page) cares to read my letter again, he will see that I referred to the passing of both the early valve days, as well as the early transistor days. I do not, of course know Mr. Seddon's abilities or qualifications, but I would venture to state that some of the early transistors required quite a bit of skill to coax into working not to mention downright perseverance and bloodymindedness—sorry Mrs. W. I am not old enough to remember 2LO, but I do remember the pioneering thrill of listening to the LIGHT programme as it was then through a little point-contact regenerative receiver.

One other point that Mr. Seddon seems to have taken wrongly is that of the DIY side. Here I will stick to my guns—in spite of the danger of being outgunned!! The point, Mr. Seddon, is that things are made too easy so that only the true enthusiasts and folk with proper moral fibres take the trouble—and it can be troublesome—to really explore the possibilities that are present. The others—like Instamatic users! with apologies to Kodak—just flirt with a marvellous hobby and can't be bothered to learn a little of what can do them much good. And they have the effrontery to call themselves enthusiasts.

And I still maintain, in closing, that things will not get any better for the true enthusiast. By the nature of progress it is inevitable that more and more will be incorporated into IC's and the individual will have less and less to do for himself. We will end up with my "cubular models", mark my words, we will. You may not like it, I certainly don't like to think about it; the Editor—bless him—might not like it, after all what will there be for him to edit? but we have no choice. Progress dictates what we do to a great extent, and progress is inevitable. Remember Jonah Kitchen's cubular modules when they arrive, for if I'm still around, I'll tell you so.

H. Kitchen.
Bulkington, Warks.

Durham on the Air

Sir—It is proposed to start an amateur radio society at the Durham University and the call sign of G4DUR has been provisionally reserved.

Any readers who are interested in joining our club should contact me at the address below or during term time at the St. Chad's College, South Bailey, Durham.

Peter Whittle, G4BBU (QTHR)
1, Blinco Road, Urmston,
Manchester, M31 1NF.

COURSES . . .

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September, 7 p.m. *Radio Amateurs' Course*, at Eastbourne College of Further Education, St. Annes Road, Eastbourne, Sussex.

GLASGOW
September 10, 7 p.m. *Radio Amateurs' Course* (Fee £3, free if under 18) at Glasgow College of Nautical Studies, 21 Thistle Street, Glasgow, C.5.

GOSFORTH
September, 7 p.m. *Radio Amateurs' Course*, at Gosforth Evening Institute, Gosforth Secondary School, Regent Avenue, Gosforth, Northumberland.

LONDON
September, 7 p.m. *Radio Amateurs' Course*, at Grafton Radio Society, Archway School, Archway Annex, Highgate Hill, London, N.19.

Enrolment, September (commences October) 6.30 p.m. *Colour Television Receivers, Opto-electronics* (Fee £3 per course) at South London College, Knight's Hill, West Norwood, London, SE27 0TX.

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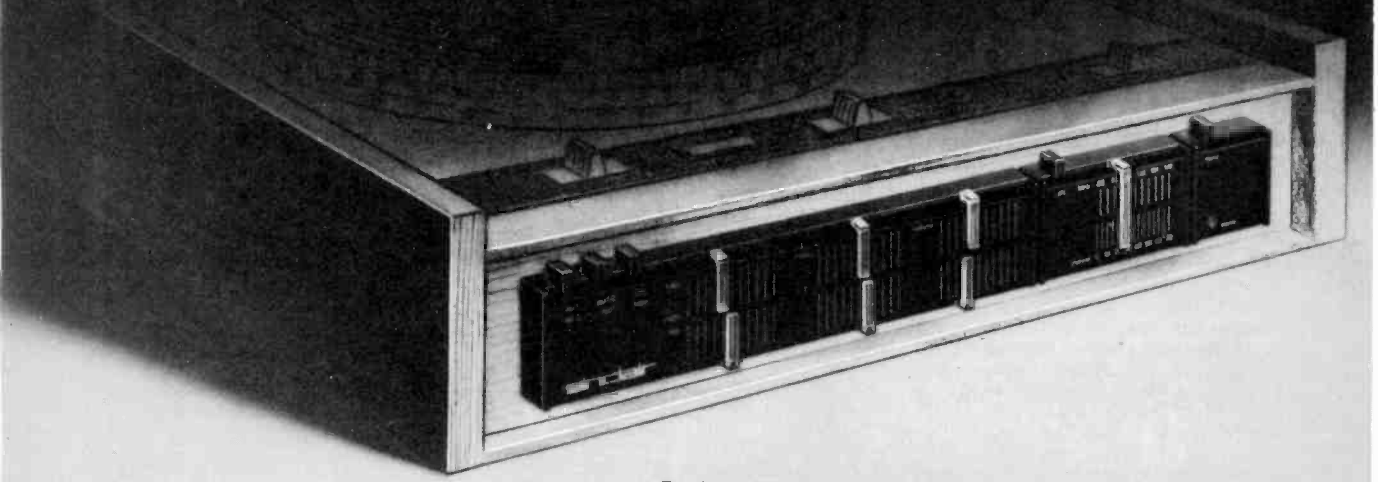

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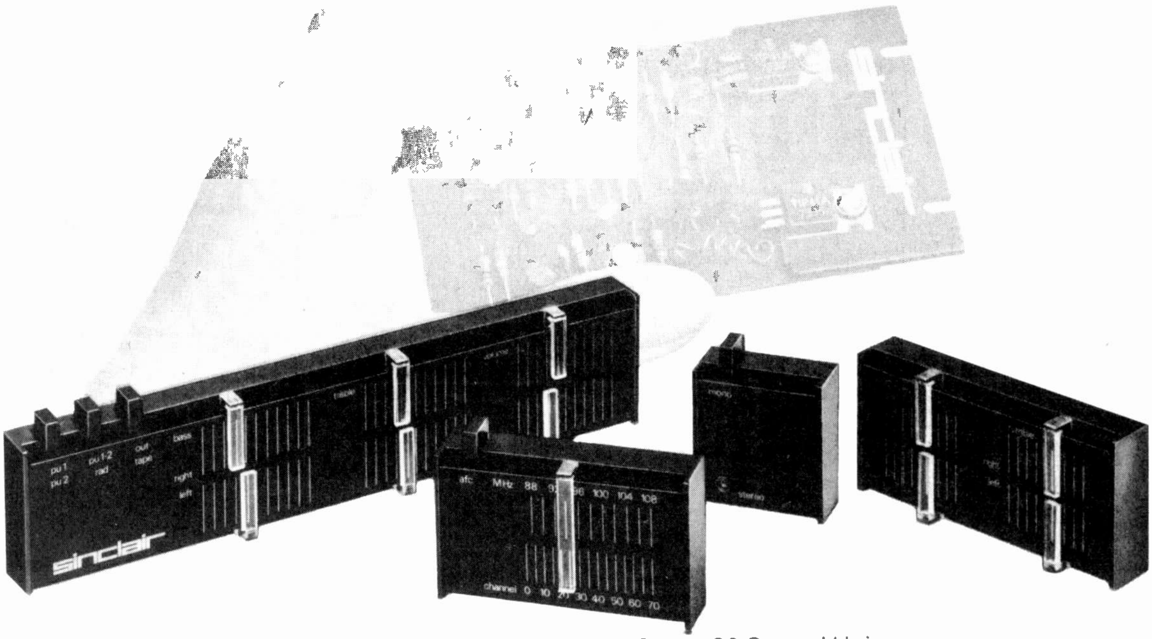
Sinclair Project 80



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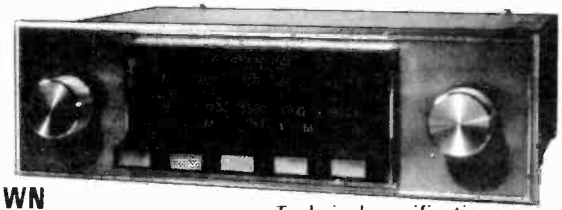

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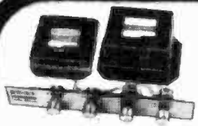
Includes:– **BSR 3 speed deck**, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications: For the technically minded:—
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel.
Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. $15\frac{1}{2}$″ × 8″ × 4″. Complete deck and cover in closed position approx. $15\frac{1}{2}$″ × 12″ × 6″.
Complete only **£18.95** + £1.60 p & p. Extras if required. Optional Diamond Styli **£1.37.**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**
De-luxe model available in white PVC. Incorporates BSR deck with cue/pause control.
price **£20.55** + £1.60 p & p.



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For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
240V. AC only. **£7·64 + 55p p&p**

8 TRACK CARTRIDGE PLAYER*

Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV Comparable unit sold eleswhere at £24.00 approx. Yours for only
£10·95 + 90p & p

COMPLETE * STEREO SYSTEM

System 1. £51·00

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

System I includes:

Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.

Specification

20 watts per channel into 8 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ± 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) −58dB. Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. $13\frac{3}{4}'' \times 9'' \times 3\frac{3}{4}''$.

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

Two Duo Type II matched speakers – Enclosure size approx. $17\frac{1}{2}'' \times 10\frac{3}{4}'' \times 6''$ in simulated teak. Drive unit $13'' \times 8''$ with parasitic tweeter. 10 watts handling.

Complete System £51·00

System 2. £61·00

Viscount III amplifier (As System I)

Garrard SP 25 Mk III deck (As System I)

Two Duo Type IIIA matched speakers – Enclosure size approx. $31'' \times 13'' \times 11\frac{1}{2}''$ Finished in teak veneer. Drive units approx. $13\frac{1}{2}'' \times 8\frac{1}{4}''$ with $3\frac{1}{4}''$ HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69·00

PRICES: SYSTEM 1

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

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

PRICES: SYSTEM 2

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

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

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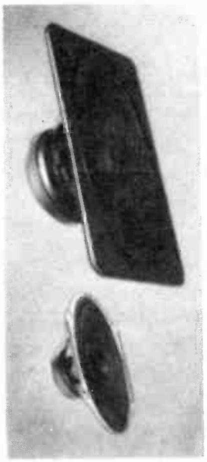

20 WATT SPEAKER SYSTEM

System consists of a $13'' \times 8''$ (approx) eliptical woofer unit with a $8'' \times 5''$ (approx.) mid range unit incorporating parasitic tweeter and crossover components.

Technical Specification:

Bass Unit
Flux density–100 K, speech coil–$1\frac{1}{2}''$.
Cone, Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, speech coil-1" with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.

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

15" 14A/780 BASS UNIT

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

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

950 KIT

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Huge 19" × 14" (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each $3\frac{1}{4}''$ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0·5". Recommended list price £44·00.

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OUR PRICE £19.50 + £1·50 p&p

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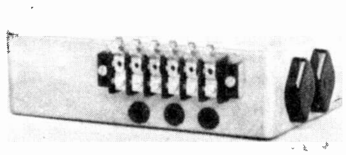

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- All components available separately.—S.A.E. with enquiries.
- Construction manual available separately 25p.

Cost **£11·78** incl. carr. and ins. or ready built and tested **£14·10.**

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ADASTRA 10in, 8 or 15 ohm, 10W	3·45
BAKER GROUP 25 12in, 8 or 15 ohm, 25W	7·50
P. & P.	0·30
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2¾in, 8 ohm or 64 ohm	0·50
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EMI 3½in, 3 or 8 ohm C/Mag.	1·00
Cone Tweeter 8 or 15 ohm, 10W	2·40
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X25 25W (low leakage)	1·90
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C60	35p	33p	30p
C90	45p	43p	40p
C120	55p	52p	50p

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11–20 post free	

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5¾in Reels	0·22
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P. & P. 1–3 each 5p; 4 or more	0·20

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Recording Tape Splicer, Ref. 20	1·15
Cassette Tape, Editing, Ref. 24	1·40
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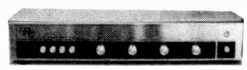

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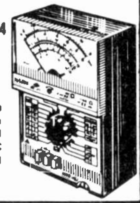

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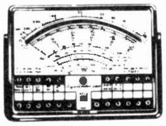

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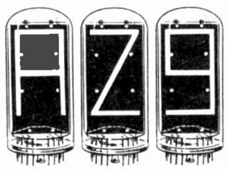

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