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Our July issue will be published on Friday, June 13, 1975

TRANSFORMERS

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

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·[illegible] × 6·0 × 6·0	2·80	38
149	60	3	12	9·9 × 7·7 × 8·6	4·37	45
150	100	5	8	9·9 × 8·9 × 8·6	4·89	45
151	200	8	0	12·1 × 9·3 × 10·2	8·13	53
152	250	13	12	12·1 × 11·8 × 10·2	9·83	73
153	350	15	0	14·0 × 10·8 × 11·8	11·88	73
154	500	19	8	14·0 × 13·4 × 11·8	13·65	91
155	750	29	0	17·2 × 14·0 × 14·0	20·51	*
156	1000	38	0	17·2 × 16·6 × 14·0	29·15	*
157	1500	46	0	21·6 × 13·4 × 18·1	33·23	*
158	2000	60	0	21·6 × 15·3 × 18·1	37·07	*

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	1·67	30
64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·90	38
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	4·12	45
66	300	6	4	9·9 × 9·6 × 8·6	,, ,,	5·82	53
67	500	12	8	12·1 × 11·2 × 10·2	,, ,,	8·82	67
84	1000	19	8	14·0 × 13·4 × 14·3	,, ,,	13·68	91
93	1500	30	4	14·0 × 15·9 × 14·3	,, ,,	18·31	*
95	2000	32	0	17·2 × 16·6 × 14·0	,, ,,	24·20	*
73	3000	40	0	21·6 × 13·4 × 18·1	,, ,,	35·09	*

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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	1·47	23
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·74	30
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·29	38
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·86	38
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	4·12	45
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	4·56	45
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	5·14	53
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·52	53
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	7·28	60
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	10·39	73
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	13·59	85
226	60	30	32	0	17·2 × 15·3 × 14·0	0·12V at 30A × 2	16·83	*

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	1·81	30
79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	2·40	38
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·49	38
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	4·53	45
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	5·13	53
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	6·41	53
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	7·15	60
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	9·90	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	9.87	73

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	2·58	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	3·38	38
104	2·0	5	8	7·9 × 8·9 × 8·6	,, ,,	4·68	45
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·81	53
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	7·60	67
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	12·10	67
118	8·0	18	0	14·0 × 12·7 × 11·8	,, ,,	12·98	85
119	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	16·99	*

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	2·33	38
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·41	38
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	5·08	45
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	7·52	60
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	8·75	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	9·75	73
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	11·30	85
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	15·00	*
122	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	17·52	*
189	12·0	29	00	17·2 × 14·0 × 14·0	,, ,,	19·98	*

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	1·54	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·84	30
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·41	13
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·56	19
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	1·92	30
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	3·30	38
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·43	19
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·93	30
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	2·17	38
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·46	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	3·00	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	3·85	38

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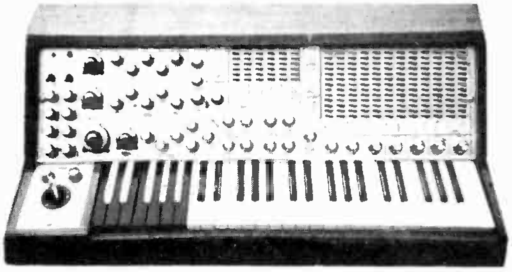

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8130	1·20	8552	1·37	8836	27
8200	1·42	8554	1·37	8880	73
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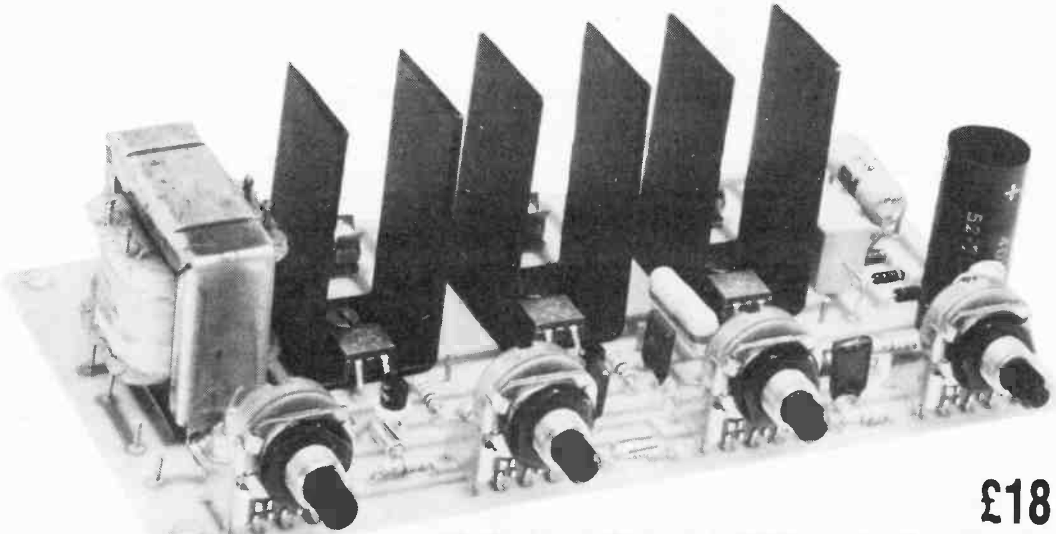

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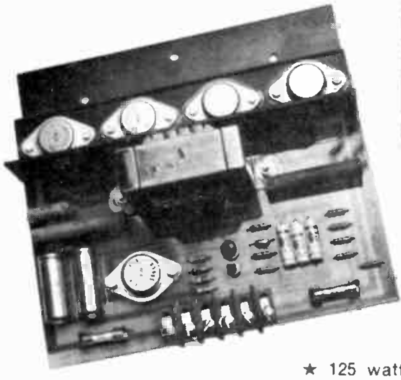
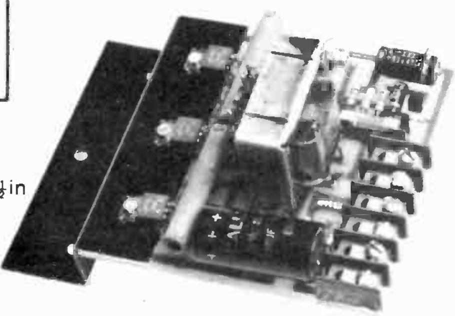


TP125
7 × 6½ × 3in
£22·50

★ 125 watts RMS continuous sine wave output

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

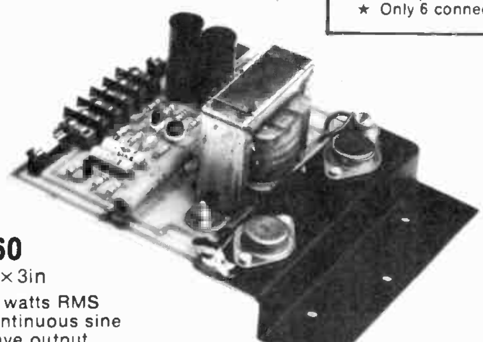


TL30
4 × 5¼ × 2½in
£9·00

★ 30 watts RMS continuous sine wave output

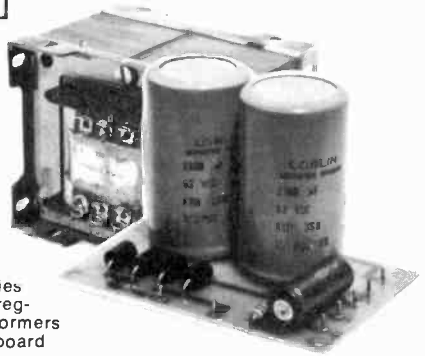
★ 2 R.C.A. 40 watt output transistors

★ 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. 110 watt 15 amp transistors
£14·50

TL100
5 × 5 × 3in
★ 100 watts R.M.S. continuous sine wave output
★ 2 R.C.A. 150 watt 15 amp transistors
£17·50



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

PS 125 ± 50 volts for one TP125	£14·25
PS 100 ± 45 volts for one TL100	£13·00
PS60 ± 40 volts for one TL60	£11·50
PS 30 ± 50 volts for one TL30	£7·00
PSU 2 for supplying disco mixer	£5·50

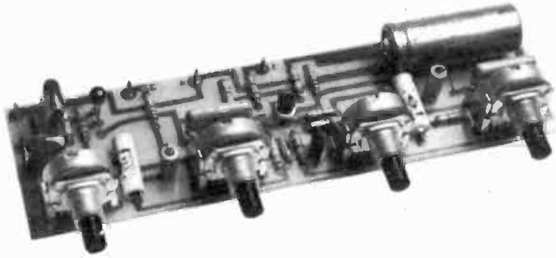
PREAMPLIFIERS

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 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 16 kHz. Mid + 20 − 15dB at 1Hz Bass + 20 − 10dB at 40Hz. **£6·75**

VAO6 Vol. Treble and Bass controls. Sensitivity 8mV. Treble + 28 − 15dB at 12kHz. Bass − 18dB at 40Hz **£5·75**

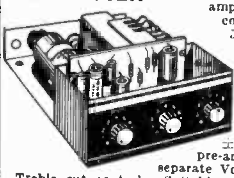
SVAO1 Stereo Pre Amp Vol. Treble. Mid and Bass controls. Hi. IMP. FET. I/P suitable Mid. Guitar. Radio. Crystal/Ceramic P.U. Sensitivity 4mV. Treble + 35dB at 16kHz. Mid + 20 − 15dB at 4kHz. Bass + 20 − 10dB at 40Hz. Plus Full Balance Control **£12·75**



ALL PRICES INCLUDE V.A.T. (25%) AND POSTAGE AND PACKING

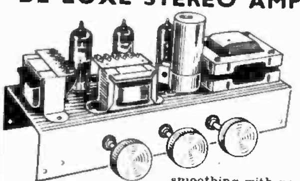
ACCESS & BARCLAY CARDS ACCEPTED JUST SEND OR PHONE US YOUR NUMBER · H.P. ARRANGED THROUGH PAYBONDS

SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £12·50. P. & P. 65p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £10·75. P. & P. 85p.

POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on lead.
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers etc. etc. Ready built and tested. **Price £5·20. P. & P. 55p.**

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £1·30 yd. length. P. & P. 30p per yd. (min. 1 yd.). S.A.E. for samples.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully solated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide × 3in. deep × 6in. high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with good quality output transformer.
P. & P. 60p. BARGAIN PRICE **£4·20**

FEW ONLY. High grade mains transformer with grain orientated lamination. Primary 200/240. Secondary 18·5 volts at 0·6 amps and 4·6 volts at 0·3 amps. Size 2in. long × 2¼in. wide × 2in. deep overall. £1·35 plus 35p P. & P.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations 0–5–10–15–20–25–30–35–40–60v. half wave at 1 amp. or 10–0–10, 20–0–20, 30–0–30v. at 2 amps fulls wave. Size 3in. long × 3½in. wide × 3in. deep. Price £2·60. P. & P. 65p.

MAINS TRANSFORMER. For transistor power supplies.
Pro. 200/240v. Sec. 9–0–9 at 500 mA. £1·25. P. & P. 30p.
Pri. 200/240v. Sec. 12–0–12 at 1 amp. £1·40. P. & P. 30p.
Pri. 200/240v. Sec. 10–0–10 at 2 amp. £2·00. P. & P. 40p.

3 VOLT RELAY. 100 m/a single pole normally closed. 2 for 60p. P. & P. 15p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER

For P.U. Tape, Mike, Guitar, etc. and suitable for use with valve or transistor equipment. 9-18v. battery or from H.T line 200/300v. Frequency response 15Hz—25KHz. Gain 26dB. Solid encapsulation size 1¾" × 1¼" × ½". Brand new complete with instructions. Price £1·20. P. & P. 15p.

HANDBOOK OF TRANSISTOR EQUIVS. AND SUBS. A must for servicemen and home constructors. Including many 1000's of British, U.S.A. European and Japanese transistors. ONLY 40p. Post 5p.

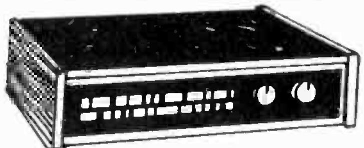
3 Reference Encyclopedias for Electronic Engineers and Designers, covering between them transistor characteristic, diode and transistor equivalents. Many thousands of up to date European types listed.
Diode Equivalents 90p. Transistor Equivalents £1. Transistor Characteristics £1·30. POST FREE
All three together £3.

NEW ISSUE

Thyristor, Triac, Diac etc. encyclopedias £1. Post Free.

8 pole 3 way 2 bank low loss Yaxley type switches 1¼" sections. Standard spindle. 2 switches 64p + 10p P. & P.

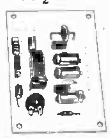
HARVERSONIC MAINS OPERATED SOLID STATE STEREO FM TUNER



Enjoy Fabulous Stereo Radio at this Low Introductory Price!

Designed and styled to match our 10 + 10 amplifier but will suit any other standard stereo amplifier. The design incorporates the very latest circuitry techniques with high-grain, low noise IF stages. Automatic frequency control to "lock on" station and prevent drift. IC stereo decoder for maximum stereo separation. L.E.D. for stereo beacon indicator. Nominal output of tuner 100mV. Approximate size 12¼in wide × 8in deep by 2¾in high. Supplied ready built, fully tested and fully guaranteed (not available in kit form).
Price £23·00. Post and Packing £1·00.

STEREO-DECODER SIZE 2" × 3" × ½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·40 plus 15p P. & P. Stereo beacon light if required 40p extra.

LATEST HI SENSITIVITY UNI-DIRECTIONAL SLIM-LINE CONDENSER MICROPHONE as used by many professionals. Very low acoustic feedback. Available Hi impedance or low impedance. State which required. £13·50. P. & P. 25p.

LATEST ACOS GP91/1SC mono compatible cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. £1·46. P. & P. 15p.
CERAMIC STEREO CARTRIDGE. Universal mounting brackets and turnover stylus. 70mV per channel output. ONLY £1·75. P. & P. 15p.
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. **ONLY £2·27.** P. & P. 10p. Also available fited with twin Diamond T/O stylus for Stereo LP. £2·76. P. & P. 15p.
LATEST RONETTE T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £1·60. P. & P. 15p.
LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £1·47. P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £5·50. P. & P. 75p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £6·70. P. & P. 75p.

HI-FI LOUDSPEAKER SYSTEM MkII

Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10½" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which).

OUR PRICE £9·50 each. Carr. £1·25

Cabinet Available Separately £5·00. Carr. £1·10.
Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £8·00. Carr. £1·25.

LOUDSPEAKER BARGAINS

5in. 3 ohm **£1·25, P. & P.** 15p. 7 × 4in. 3 ohm **£1·40, P. & P.** 25p. 10 × 6in. 3 or 15 ohm **£2·10, P. & P.** 35p. E.M.I. 8 × 5in. 3 ohm with high flux magnet **£1·70, P. & P.** 25p. E.M.I. 13½ × 8in. with high flux ceramic magnet with parasitic tweeter 3. 8 or 15 ohm **£3·50,** P. & P. 35p. E.M.I. 13 × 8in 3, 8 or 15 ohm with inbuilt tweeter and crossover network **£4·65,** P. & P. 35p.
E.M.I. tweeter. Approx. 3½". Available 3 or 8 or 15 ohms, £1·80 + 25p, P. & P.
BRAND NEW. Bakers Loudspeakers at substantial discounts. 12in. 15w. H/D Speakers, 3, 8 or 15 ohms. State which. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£7·50.** Guitar models: 25w. **£7·50.** 35w. **£8·50.** P. & P. 75p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER

Size 11¾" × 14⅞" × 1⁄16" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for details. Only £6·60 each. P. & P. 60p.
NOW ALSO AVAILABLE 8in. 10W rms 20W peak 40Hz—20,000Hz. Overall depth 1in. Ideal for Hi-Fi or for use in cars. £4·32. P. & P. 40p.

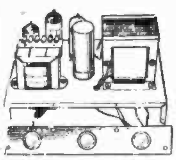
SPECIAL BARGAIN OFFER: Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge. **Brand new. ONLY £8·00 + p. & p. 60p.**

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ± 3dB 12–15,000 Hz. Bass, boost approx. to ± 12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2½"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

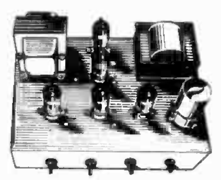
AMPLIFIER KIT	£12·96	P. & P. 50p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·32	P. & P. 55p
CABINET	£4·32	P. & P. 55p

(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £28·08. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4½"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £6·50. P. & P. 70p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £5·50. P. & P. 70p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £10·25. P. & P. £1·00. Also available ready built and tested £14·00. P. & P. £1·00.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8–16 ohms. Easily converted for Mono. PRICE £3·50. P. & P. 25p.

PRICES INCLUDE VAT

Open 9.30-5.30 Monday to Friday. 9.30-5 Saturday Closed Wednesday.
Prices and specifications correct at time of press. Subject to alteration without notice

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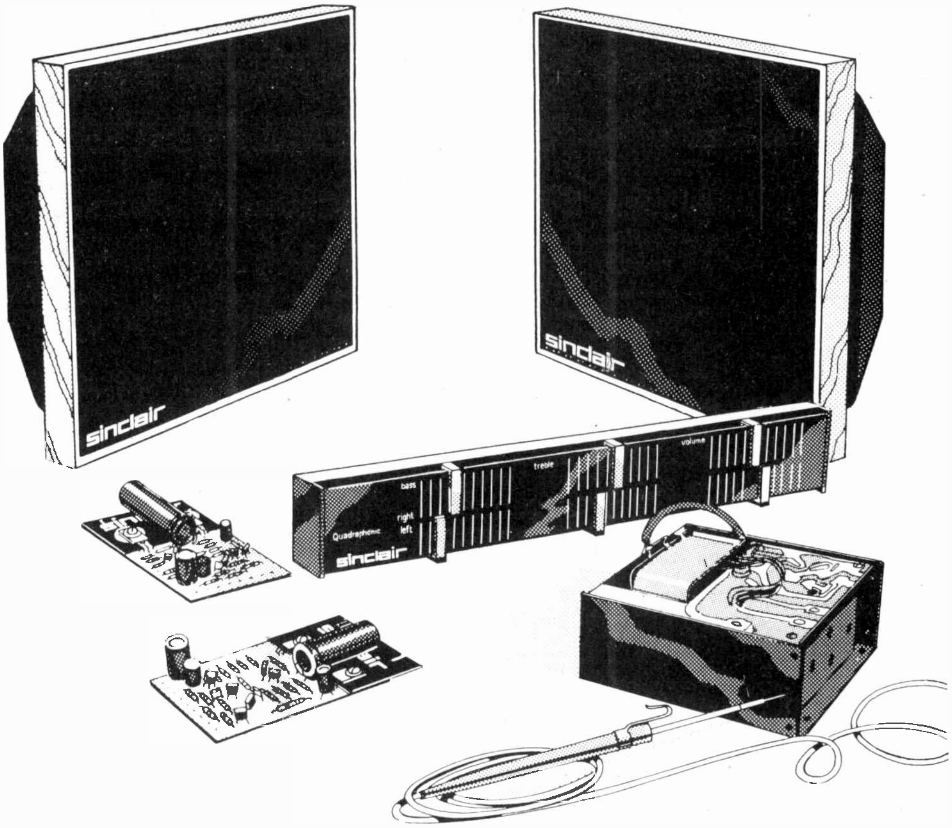
(Please write clearly)
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

Go quad for around £50

(including the speakers!)



Sinclair Project 80 hi-fi modules

If you've thought of switching to quad, you've probably found it an expensive process Do you part with your existing stereo amp – which probably cost you a lot in the first place – and replace it with an even more costly quad amp? Or do you buy an expensive add-on kit – often costing as much as £90 even *without* the extra speakers?

With Sinclair Project 80 hi-fi modules, you can keep your existing amplifier ... add a quad decoder, two power amps and a power supply unit ... a couple of Sinclair Q16 speakers and you've got a high-quality, true quad system which will have cost you only £50 or so to convert!

How does Sinclair Project 80 work?

Project 80 is a comprehensive set of hi-fi modules or sub-assemblies. Amps ... pre-amps ... FM tuner ... quad decoder ... control units ... everything you need to assemble hi-fi units. They're all designed to look alike and are all completely compatible with each other. Simply decide on the specification of the unit (stereo or quad) you want to build ... buy the necessary modules ... connect them up and house them.

You can even build a quad amp entirely from Project 80 modules. Two power amplifiers, a control unit and a power supply give you a stereo amp for as little as £31.80 plus VAT. The necessary add-on quad modules cost only £36.80 + VAT. Together, they make up a true hi-fi quad amp for only £68.60 + VAT!

And whenever you choose, you can add extra Project 80 refinements. An FM tuner ... a scratch/rumble filter ... higher-output power amps – Project 80 is an enjoyable way to develop your own hi-fi system!

Is it difficult to build?

Not at all. All Project 80 module circuitry is complete in itself – all you have to do is connect the external wiring to numbered solder points.

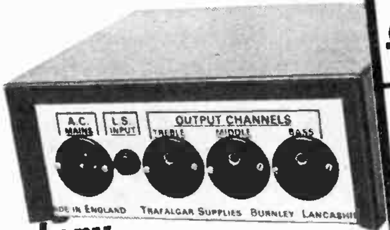
And if you're not so hot with a soldering iron? Use Project 805 kits. Project 805 uses Project 80 modules, but provides special clip-on tagged-wire connections – positively no soldering! There are two Project 805 kits – the basic 805 stereo amplifier kit, and the 805Q quad conversion kit.

805Q can be used to convert a Project 80 or 805 stereo system, or your existing stereo system.

You'll find more details and some system suggestions opposite.

Sound to Light Master Unit

▲Front



▲Rear

600 watts per channel

Connects to your loudspeaker or loud-speaker socket. The unit can be connected to your existing spotlight fittings or to our type A or B fittings.

Special Introductory Price Including channel output plugs and mains input socket.

Only £29.95 incl VAT plus p&p £1.00

Type B 3 BANK UNIT

B.C. fitting (less lamp)

£6.50 incl VAT plus p&p 40p each

Type A

B.C. fitting

(less lamp)

£1.60 incl VAT plus p&p 25p each.

100 WATT SPOT LAMPS Red, pink, yellow, green, blue, clear. Only £1.00 each

Minimum 3 lamps £3.00 plus p&p 25p.

B.C. fitting

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Interested in seeing the world and earning a good salary at the same time? There are excellent career prospects as a Marine Radio Officer and in the Civil Service. Full-time Courses in Radiocommunications, Radar and Marine Electronics start in September and January of each year.

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Full-time Courses start in September of each year for prospective Licensed Aircraft Maintenance Engineers in either the Radio Category or in Airframes and Engines. The Courses are fully approved by the CAA and include practical work on College Aeroplanes.

Course Entry Requirements

Prospective entrants should have obtained or be studying for CSE or GCE Ordinary level passes in Mathematics, English and a Science subject, or have appropriate experience. All applicants will be interviewed before acceptance.

For further details of the above and of Courses for experienced Marine and Aeronautical personnel please contact:
Mr. F. E. Barltrop, Head of Department of Marine and Aero Electronics, Brunel Technical College, Ashley Down, Bristol BS7 9BU. Tel. (0272) 41241

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TV PLUGS, metal type, 6 for 50p.
TV SOCKETS, metal type, 5 for 50p.
TV LINE CONNECTORS (back to back socket), 5 for 50p.
SOLDER (multicore) approx. 9yds., 25p.
OA81 DIODES, 15 for 25p.
OC200 TRANSISTORS, 6 for 50p.
BSY95A TRANSISTORS, 6 for 50p.
PL259 PLUGS, 50p each, or 5 for £2·25.
REDUCERS (for small co-ax) to fit above, 15p each.
SO239 SOCKETS (to fit PL259 plugs), 50p each, or 5 for £2·25.
TELEPHONE-TYPE EARPIECE INSERTS, 50p.
REEDS (for reed relays, single pole make), 5 for 30p.
MULLARD CERAMIC TUBULAR TRIMMERS, 1–18pF, 6 for 50p.
I.C.s (some coded, some unmarked), 14-DIL types, mixed, untested, 20 for 25p.
SMALL NEONS, 6 for 25p.
24V, 2·8W LAMPS, MES type, 6 for 20p.
MINIATURE SLIDER SWITCHES, 2 pole, 2 way, 5 for 50p.
PNP SILICON AUDIO-TYPE TRANSISTORS, TO5 type, untested, 12 for 25p.
PLESSEY ELECTROLYTICS, 10,000mF at 63V, 75p each.
ITT ELECTROLYTICS, high grade, screw terminals, 6,800mF at 25V, complete with mounting clip, 50p each.
HIGH QUALITY SPEAKERS, 8½ × 6in elliptical, only 2in deep, inverse magnet, 4 ohms, rated up to 10W, £1·50 each, or 2 for £2·75 (qty. discount available).
TWIN HEAVY DUTY CABLE, PVC covered, 50/0·25mm. 15p per metre, or £10·20 per 100m reel.
MIXED WASHERS, 15p per pack.
5A MAINS CIRCUIT BREAKERS, 75p each.
MINIATURE EARPHONES with min. Jack plug, 2 for 50p.
3 PIN MIN. MAINS PLUG AND SOCKET, 40p set.
LF CHOKES on ¼" × 2" cores, 5 for 20p.
I.C. AUDIO AMPS, TBA800, rated 5W (sorry, no data), £1 each.
MAGNETIC DEVICES PROGRAMMERS, contain 9 microswitches, with 9 adjustable drums for period switching (needs slow motion motor to drive drum, not supplied), many switching applications, £1 each.
CURLY LEADS, 4 core telephone type, 2 for 20p.
TRANSISTOR HEATSINKS, to take 2 × TO18 transistors, screw in clamps, block size 1 × ½ × ½in, with holes for mounting, 3 for 50p.
VARIABLE STABILISED PSU, solid-state, 240V a.c. input, output 0–24V d.c. at 500mA, + 32V d.c. at approx. 50mA. Voltage controlled by external 5kΩ pot. Size 7½ × 4 × 2½in (less 5kΩ pot). £5 each.
THREE-TURN WIRE-WOUND POTS, 5kΩ, for above, 75p each.
LARGE DIE CAST BOXES (brand new ITT) 10½ × 6½ × 2½in, £2 each.
25-way **ISEP PLUGS AND SOCKETS**, 40p set (1 plug + 1 skt.).
DIN SPEAKER SOCKETS (2-pin) 4 for 30p.
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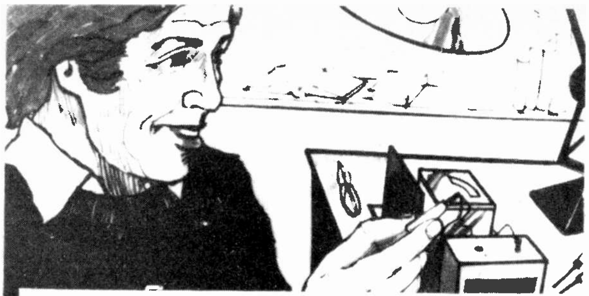

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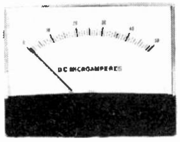

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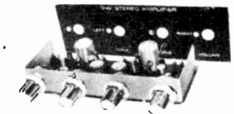

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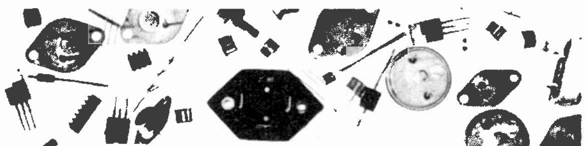

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AC141	20
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AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	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	28
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39
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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	9
BC108	9
BC109	9
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
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
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
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BD185	72
BD186	72
BD187	77
BD188	77
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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
BF176	39
BF177	39
BF148	33
BF179	33

BF180	33
BF181	33
BF182	44
BF183	44
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BF194	13
BF195	13
BF196	16
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BF259	94
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BF273	39
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BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
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BFY52	22
BFY53	19
BSX19	17
BSX20	17
BSY25	17
BSY26	17
BSY27	17
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MAT100	21
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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
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OC81D	17
OC82	17
OC82D	17
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OC171	28
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OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
OC309	44
OCP71	48
ORP12	48
ORP60	44
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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
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2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
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2N706A	10
2N708	13
2N711	33
2N717	39
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2N718A	55
2N726	31
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2N1711	22
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2N2147	79
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2N2714	23
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2N2923	16
2N2924	16
2N2925	16
2N2926G	14
2N2926Y	12
2N2926O	11
2N2926R	11

2N2926B	11
2N3010	77
2N3011	16
2N3053	19
2N3054	51
2N3055	45
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2N3393	16
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2N3403	23
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2N3525	83
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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
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40361	44
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AAY30	10	BY128	17	OA5 short leads	23
AAZ13	11	BY130	18	OA10	15
BA100	11	BY133	23	OA47	8
BA116	23	BY164	55	OA70	8
BA126	24	BYX38/30	46	OA79	8
BA148	16	BYZ10	39	OA81	8
BA154	13	BYZ11	33	OA85	10
BA155	16	BYZ12	33	OA90	7
BA156	15	BYZ13	28	OA91	7
BA173	16	BYZ16	44	OA95	8
BY100	17	BYZ17	39		
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72741	0·30	0·29	0·28
72741C	0·28	0·27	0·26
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BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
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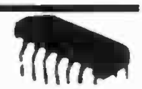

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7401	0·15	0·14	0·13	7450	0·15	0·14	0·13	74123	0·75	0·73	0·70
7402	0·15	0·14	0·13	7451	0·15	0·14	0·13	74141	0·85	0·82	0·79
7403	0·15	0·14	0·13	7453	0·15	0·14	0·13	74145	£1·30	£1·25	£1·20
7404	0·15	0·14	0·13	7454	0·15	0·14	0·13	74150	£1·50	£1·40	£1·30
7405	0·15	0·14	0·13	7460	0·15	0·14	0·13	74151	£1·10	£1·05	£1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	£1·00	0·95	0·90
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	£1·70	£1·65	£1·60
7408	0·25	0·24	0·23	7473	0·41	0·39	0·35	74155	£1·20	£1·15	£1·10
7409	0·25	0·24	0·23	7474	0·41	0·39	0·35	74156	£1·20	£1·15	£1·10
7410	0·15	0·14	0·13	7475	0·60	0·58	0·56	74157	£1·00	0·95	0·90
7411	0·25	0·24	0·23	7476	0·44	0·43	0·42	74160	£1·40	£1·35	£1·30
7412	0·28	0·27	0·26	7480	0·60	0·58	0·55	74161	£1·40	£1·35	£1·30
7413	0·32	0·31	0·30	7481	£1·10	£1·05	£1·00	74162	£1·40	£1·35	£1·30
7416	0·30	0·29	0·28	7482	0·90	0·85	0·80	74163	£1·40	£1·35	£1·30
7417	0·30	0·29	0·28	7483	£1·20	£1·15	£1·05	74164	£1·80	£1·75	£1·70
7420	0·15	0·14	0·13	7484	£1·00	0·97	0·95	74165	£1·80	£1·75	£1·70
7422	0·30	0·29	0·28	7485	£1·60	£1·55	£1·50	74166	£1·60	£1·55	£1·55
7423	0·40	0·39	0·38	7486	0·35	0·34	0·33	74174	£1·60	£1·55	£1·50
7425	0·40	0·39	0·38	7489	£4·00	£3·75	£3·50	74175	£1·10	£1·05	£1·00
7426	0·40	0·38	0·36	7490	0·65	0·63	0·60	74176	£1·25	£1·20	£1·15
7427	0·40	0·38	0·36	7491	£1·10	£1·05	£1·00	74177	£1·25	£1·20	£1·15
7428	0·45	0·42	0·40	7492	0·74	0·71	0·64	74180	£1·25	£1·20	£1·15
7430	0·15	0·14	0·13	7493	0·74	0·71	0·64	74181	£3·95	£3·85	£3·75
7432	0·40	0·38	0·36	7494	0·85	0·82	0·75	74182	£1·25	£1·20	£1·15
7433	0·42	0·40	0·38	7495	0·85	0·82	0·75	74184	£1·80	£1·75	£1·70
7437	0·35	0·32	0·30	7496	0·96	0·93	0·86	74190	£1·95	£1·90	£1·85
7438	0·35	0·32	0·30	74100	£1·50	£1·45	£1·40	74191	£1·95	£1·90	£1·85
7440	0·15	0·14	0·13	74104	0·60	0·58	0·55	74192	£1·95	£1·90	£1·85
7441	0·74	0·71	0·64	74105	0·60	0·58	0·55	74193	£1·95	£1·90	£1·85
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	£1·30	£1·25	£1·20
7443	£1·20	£1·15	£1·10	74110	0·60	0·55	0·50	74195	£1·10	£1·05	£1·00
7444	£1·20	£1·15	£1·10	74111	0·90	0·88	0·85	74196	£1·20	£1·15	£1·10
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7446	£1·20	£1·15	£1·10	74119	£1·50	£1·40	£1·30	74198	£2·75	£2·70	£2·65
7447	£1·10	£1·07	£1·05	74121	0·50	0·48	0·45	74199	£2·50	£2·40	£2·30

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Q30	7	Silicon switch transistors 2N706 *npn*	0·54
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Q33	3	Silicon *npn* transistors 2N1711	0·54
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Q35	3	Silicon *pnp* TO-5. 2 × 2N2904 & 1 × 2N2905	0·54
Q36	7	2N3646 TO-18 plastic 300MHz *npn*	0·54
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U45	7	3A SCR. TO66 up to 600PIV	1·08
U46	20	Unijunction transistors similar to TIS43	0·54
U47	10	TO220AB plastic triacs 50V 6A	1·08
U48	9	NPN Sil. power transistors like 2N3055	1·08
U49	12	NPN Sil. plastic power trans. 60W like 2N5294/5296	1·08

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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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
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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.

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UIC00	12×7400	0·54	UIC46	5×7446	0·54	UIC86	5×7486	0·54
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UIC02	12×7402	0·54	UIC50	12×7450	0·54	UIC91	5×7491	0·54
UIC03	12×7403	0·54	UIC51	12×7451	0·54	UIC92	5×7492	0·54
UIC04	12×7404	0·54	UIC53	12×7453	0·54	UIC93	5×7493	0·54
UIC05	12×7405	0·54	UIC54	12×7454	0·54	UIC94	5×7494	0·54
UIC06	8×7406	0·54	UIC60	12×7460	0·54	UIC95	5×7495	0·54
UIC07	8×7407	0·54	UIC70	8×7470	0·54	UIC96	5×7496	0·54
UIC10	12×7410	0·54	UIC72	8×7472	0·54	UIC100	5×74100	0·54
UIC20	12×7420	0·54	UIC73	8×7473	0·54	UIC121	5×74121	0·54
UIC30	12×7430	0·54	UIC74	8×7474	0·54	UIC141	5×74141	0·54
UIC40	12×7440	0·54	UIC76	8×7476	0·54	UIC151	5×74151	0·54
UIC41	5×7441	0·54	UIC80	5×7480	0·54	UIC154	5×74154	0·54
UIC42	5×7442	0·54	UIC81	5×7481	0·54	UIC193	5×74193	0·54
UIC43	5×7443	0·54	UIC82	5×7482	0·54	UIC199	5×74199	0·54
UIC44	5×7444	0·54	UIC83	5×7483	0·54	UICX1	25 Assorted 74's	1·65
UIC45	5×7445	0·54						

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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
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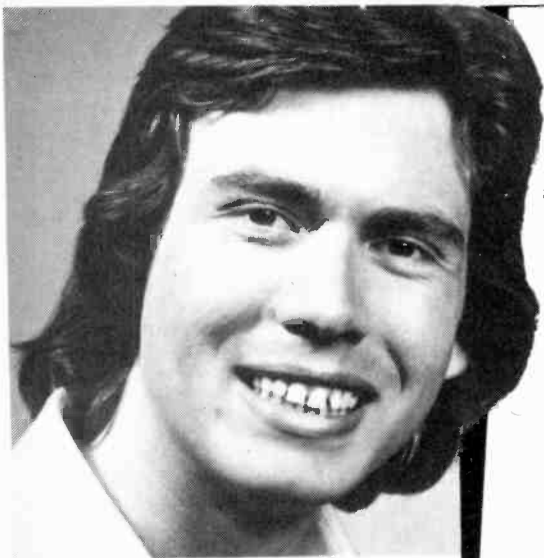

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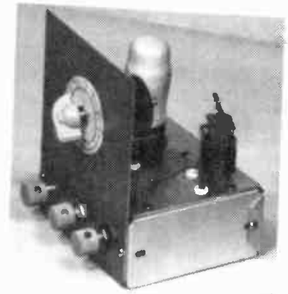

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(6) Instructions (4 Pages).

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ETCHING MATERIALS LISTED ON PAGE 95

Recently I've been telling you just why I've been a customer of Home Radio Components for so long. I've given special emphasis to their superb catalogue, and now it's time to show you a typical page. The problem is—which one? There are 240 to choose from—for example, 17 pages of capacitors, 6 of resistors, 10 of switches and 8 of stylii. These are run-of-the-mill things, but here's a page that's specially interesting—page 94, showing a Short Wave Kit and an Etching Kit.

The managing director of Home Radio Components tells me there's quite a story behind these items. Briefly, Home Radio Components always listed a S.W. Kit, but eventually the firm making them ceased trading so H.R.C. decided to produce their own. When they looked around for an Etching Kit they were unable to find any at a sensible price, so again they said, "Right, we'll make our own!" Sounds simple, but the managing director told me that if you produce any kit within 12 months of deciding to go ahead you're doing very well. "As for the problems of producing an Etching Kit," he said, "I could write a book about it!"

Incidentally, if you want to order either of these kits the prices are:

KT4B. S.W. Kit—£4·75 plus VAT, plus 35p for P & P.
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A GOOD REFERENCE

ASSIDUOUS researchers and impatient instant-information seekers alike will all agree that any large work of reference is but "as good as its index". A quick and reliable assessment of a book's real worth usually can be made by examining and testing those final pages. There the reader should get the full measure of the subjects covered, with helpful cross-referencing to save him much time and trouble.

Periodicals, as opposed to books, may have but an ephemeral existence or, on the other hand, they may have staying power so that their useful life is extended far beyond their nominal period of public exposure. Publications in the latter class are of course often accumulated by their owners, and steadily build up into the proportions of a huge work of reference. In such cases an index does then become most essential if the stored material is to be fully utilised.

This undoubtedly is true in the case of PRACTICAL ELECTRONICS. We will therefore in future incorporate an index in every December issue, as a fitting completion of that volume. Because of this new policy separate indexes will not be offered for sale as hitherto. Therefore, in order to satisfy the present outstanding requirement, the index for Volume 10 has been included in this present issue.

Apart from its permanent reference value, an immediate perusal of this index should prove an interesting exercise. No doubt many things can be deduced from a sampling of 12 months' constructional projects. For instance, some readers might feel that the motorist is getting rather more than his fair share. Nine projects as opposed to three for the photographer. What does this indicate—deep and significant social changes? Or is it simply that camera manufacturers have been able to pack a lot of electronic gadgetry into their products whereas the motor car still remains a very accommodating vehicle for private constructors' ancillary units?

Audio retains a respectable portion of the cake, though the nine projects listed include but two solely for reproduction of music; it seems the truly adventurous are busy creating—not just *recreating*—sounds these days!

Intrumentation is a convenient term which can embrace a wide range of fascinating devices and systems. A total of seven such projects are listed, some still quite novel—like liquid crystal displays and gas detectors. Though technically important and exciting, many measuring and controlling instruments often take on an unglamorous role in real life. But in performing routine tasks, thermometer/controllers and their like are without doubt contributing to the current Save Energy Campaign.

And what of games? There are but two. So much for those complaints heard from time to time that electronics is used too flippantly.

But we are all entitled to our own prejudices and can analyse the listed items and draw what conclusions we wish!

More seriously, it is hoped this month's special inclusion will help our regular followers to extract the maximum usefulness from their stored issues with the least difficulty, whether now or sometime in the future. Casual readers should also benefit from this perspective of the immediate past. We hope it will help them to get the true measure of d.i.y. electronics.

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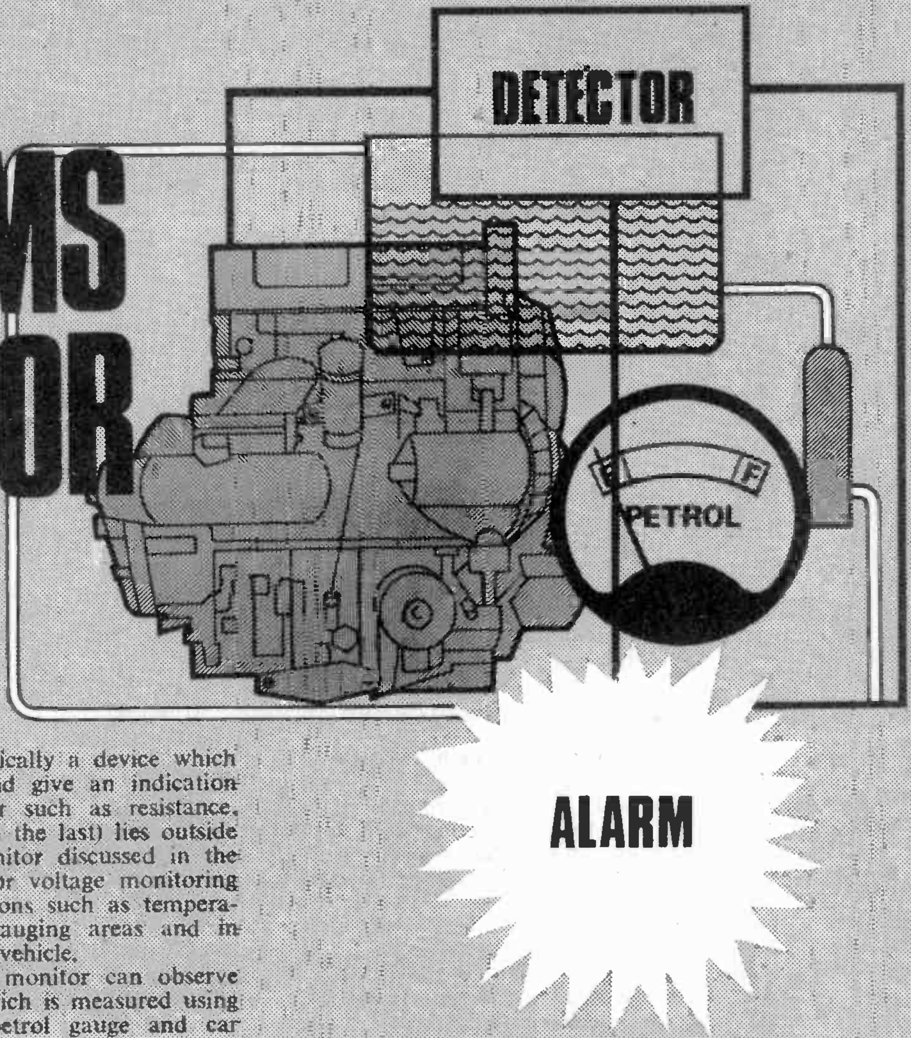
ADAPTABLE SYSTEMS MONITOR

By L.J. BELL

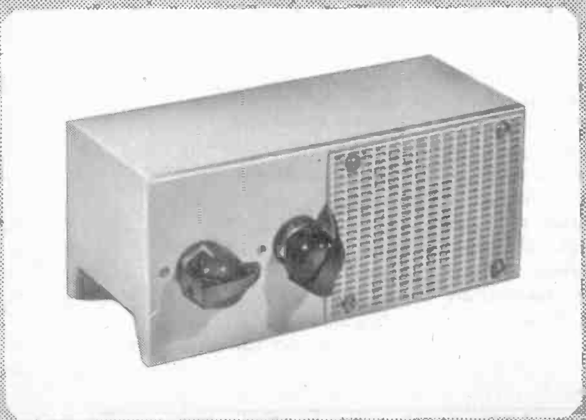


THE systems monitor is basically a device which will monitor a circuit and give an indication when an important parameter such as resistance, current or voltage (more often the last) lies outside a given value zone. The monitor discussed in the present article can be used for voltage monitoring in a wide variety of applications such as temperature, light level and other gauging areas and in security systems and the motor vehicle.

In the latter application a monitor can observe the state of any parameter which is measured using voltage, as in the normal petrol gauge and car thermometer.

BASIC CONCEPT

The present monitor is built around a Motorola comparator chip, the MC3302P, which contains four comparators. Selection of this device is based on its ability to operate from a single source, avoiding double power supplies, and its high input impedance which suits it to a very wide range of applications as it does not unduly load an observed circuit.



The MC3302P is a single chip i.c. and will in fact work with power potentials of from 2 to 28V. Thus the devices discussed may be powered from between 9 and 18V sources, suiting them to car applications amongst others.

The outputs from the MC3302P are so-called "open collector" so they should be connected to the positive supply via current limiting resistors which will hold the current to below 20mA.

COMPARATOR OPERATION

Whenever the voltage at the non-inverting input, the +ve input, is higher than that at the inverting or −ve input then the voltage at the output "goes high" as the output transistor in the comparator turns off and the full supply potential can be detected at the output.

Reverse the situation so that the voltage at the −ve input is higher than that at the +ve input and the reverse happens, the output "goes low" as the output transistor turns on and forms a low resistance path to earth.

One point of caution worth mentioning. The input potentials should not be allowed to either rise above the positive rail potential or drop to a negative value below zero volts.

FAMILIARISATION

To get the feel of a comparator it is a simple matter to wire one up on something like μ–DeC according to the circuit of Fig. 1. IC1a is one of the four comparators in the i.c., the pin connections for which are also shown. In fact it does not matter particularly which of the four is chosen, but for those who might wish to make a car systems monitor described later, the author's selection was based on being able to use some of the experimental circuit made up on Veroboard for a working model later.

If any form of experimental circuit is made up, it is suggested that an i.c. holder is used for the fairly obvious reasons that the chip is not damaged by soldering heat and is readily available for use elsewhere.

Assuming that the potentiometers are reasonably similar, one will be able to see clearly the way in which the output to the meter ME1 changes as the relationship of the voltages on the input pins changes.

Whenever the potential at the +ve input is higher than that at the −ve, the output will remain at nearly 9V but if the situation is reversed then the voltage drops to 0V. As a matter of interest an l.e.d. may be substituted for the meter if desired.

AUDIO OUTPUT

It is not difficult to convert a comparator into an oscillator or square wave generator by feeding the output back to the −ve input via a resistor as has been done in Fig. 2. The frequency of the output is governed by the *RC* combination C1, R4 and in fact the oscillator will not function unless the potential at pin 5 is about midway between +ve rail and 0V. R2 and R3 both act as base bias resistors for TR1 and provide the correct potential at pin 5.

Again one can try the circuit out on μ-DeC or other experimental layout or mount it on Veroboard.

SIMPLE MONITOR

Combining the circuits of Fig. 1 and Fig. 2 can create a simple monitor capable of giving audible indication of an increase in one voltage or decrease in another.

If this is done using the components of Fig. 1 and Fig. 2 in combination, then R1 of Fig. 1 and R2 of Fig. 2 become the same component and one of the potentiometers VR1 and VR2 is deleted. The comparator input which was connected to the deleted potentiometer becomes the input for the voltage to be sensed.

The circuit thus constructed will serve as quite a good voltage monitor capable of responding immediately to voltages which go outside the limits set by VR1. In fact in this circuit almost any potentiometer value from 1kΩ to 1MΩ may be used for VR1.

If accuracy of measurement is an important factor, then it is suggested that the circuit be modified in order to include some form of voltage stabilisation. A suggested circuit is shown in Fig. 3 where a Zener diode D1 is used to provide a stabilised voltage to one input of each of two comparators on the i.c.. The Zener voltage can be up to three-quarters of the supply voltage.

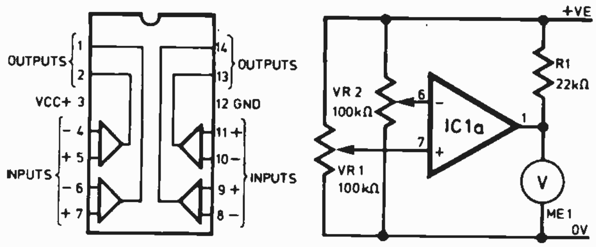


Fig. 1. The pin connections for the MC3302P i.c. and a basic circuit for familiarising oneself with the action of a comparator

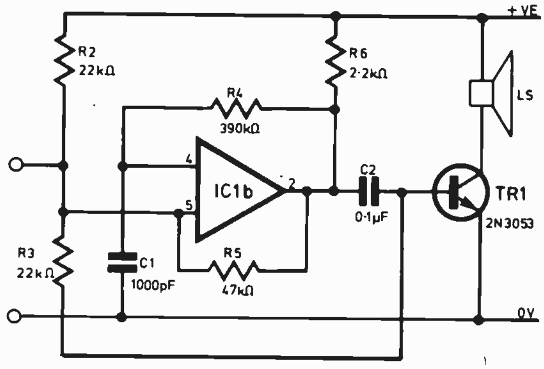


Fig. 2. Using a comparator to make up an audio oscillator

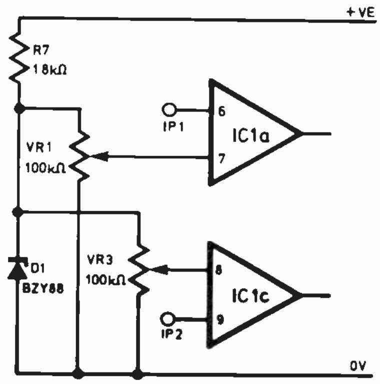


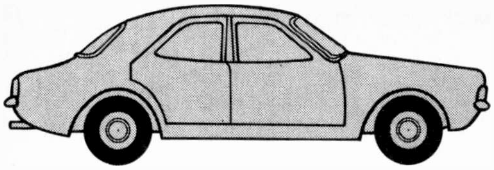
Fig. 3. Using a Zener diode to provide a stabilised reference voltage against which input voltages can be detected. Here two comparators are used to accept two separate and, if required, different inputs

APPLICATIONS

For the person who wants to monitor a simple voltage the foregoing will suffice. Indeed, the circuit can be used as a substitute for an oscilloscope for some purposes. If both inputs are joined together and set to react at very close or identical voltages, any alteration in input condition from the selected voltage will cause an output. Thus a varying input will cause an output.

As will be appreciated, the use of two input comparators in Fig. 3 presupposes the associated use of two audio oscillators and it is a simple matter to select the tone-deciding components so that two different tones are generated, one for a falling voltage and one for a rising voltage.

Thus the device could be used perhaps as a voltmeter for a blind person or where dark operation is required.

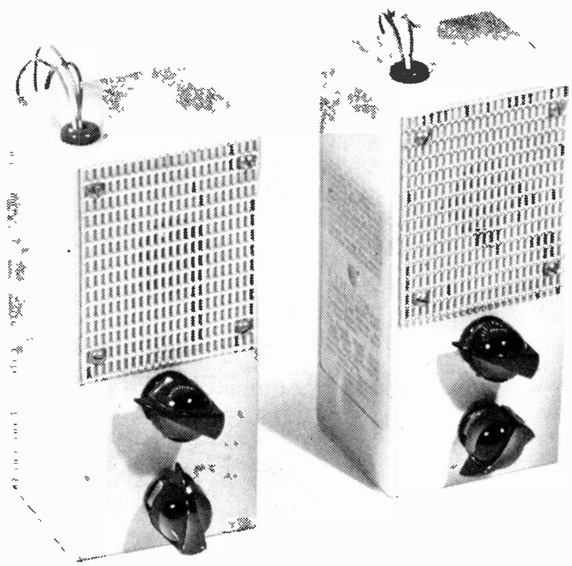


CAR SYSTEMS MONITOR

As mentioned earlier, one possible application of the monitor is in the automobile area where the system can be used to "observe" the state of, for example, the petrol gauge and the water temperature gauge.

Most vehicles have some form of automatic voltage control and the instruments in this case do not respond immediately to any change in parameter indicated. In fact, variations in battery voltage are compensated for by interrupting the supply voltage intermittently using a hot-wire thermostatic switch which operates at a few cycles per second.

The monitor in its simpler form would respond immediately to the variations caused by these interruptions and thus the circuit requires some modification. A suitable circuit is shown in Fig. 4 and here a degree of hysteresis is introduced by including resistors and capacitors on each input line. Using this arrangement the monitor only sounds the alarm if one of the observed voltages goes out of limit for more than a second.



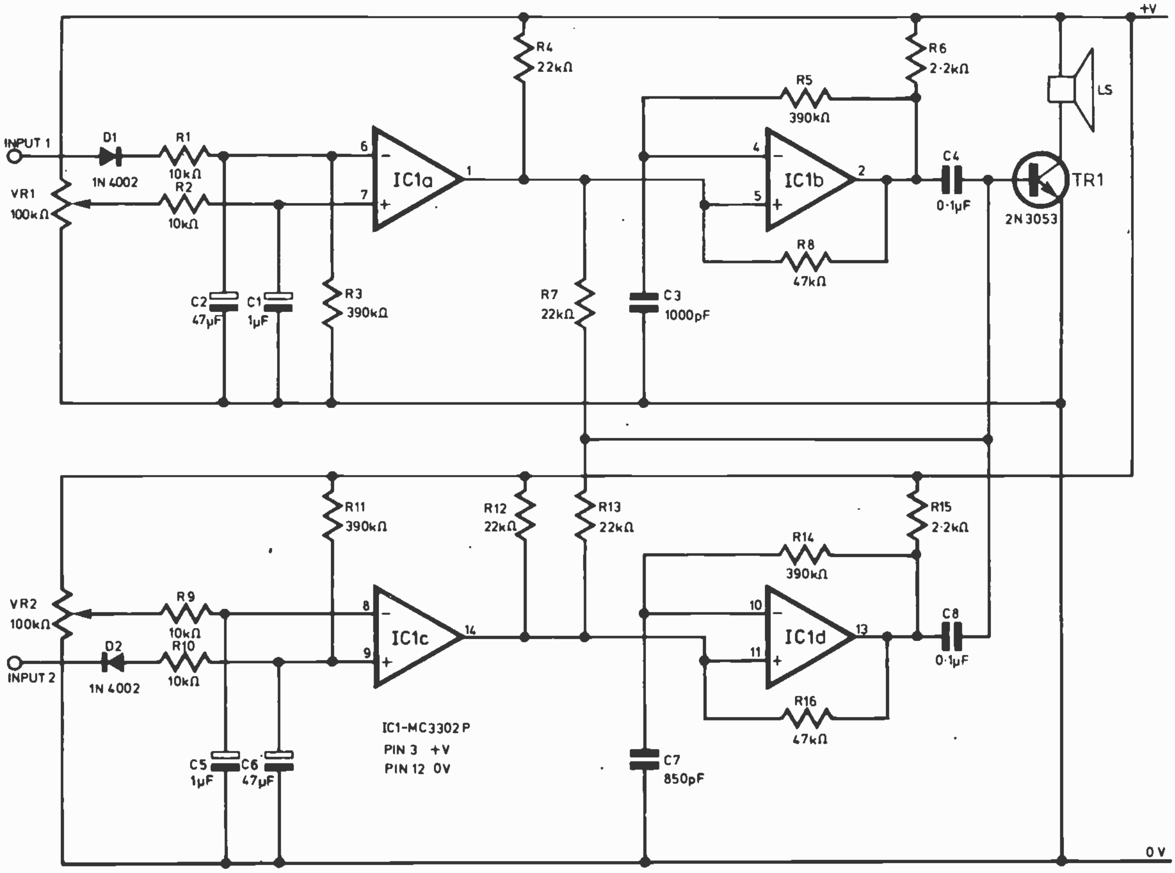


Fig. 4. Circuit diagram of a car systems monitor using the comparator i.c. For use on positive and negative earth vehicles see notes in the text

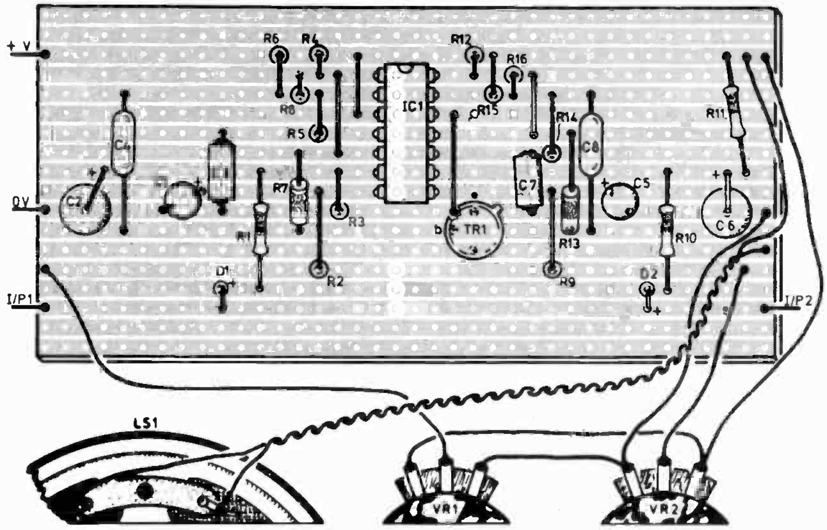


Fig. 5. Veroboard layout and cutting details for the car systems monitor of Fig. 4

COMPONENTS . . .

CAR SYSTEMS MONITOR

Resistors

R1	10kΩ
R2	10kΩ
R3	390kΩ
R4	22kΩ
R5	390kΩ
R6	2·2kΩ
R7	22kΩ
R8	47kΩ
R9	10kΩ
R10	10kΩ
R11	390kΩ
R12	22kΩ
R13	22kΩ
R14	390kΩ
R15	2·2kΩ
R16	47kΩ

All 5%, $\frac{1}{4}$W

Potentiometers

VR1 100kΩ lin (see text)
VR2 100kΩ lin (see text)

Semiconductors

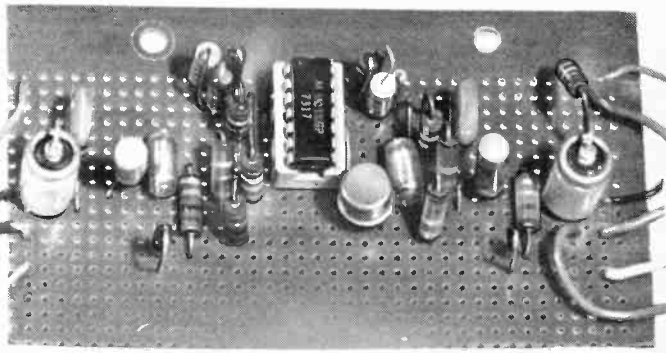
IC1	Quad comparator MC3302P
TR1	2N3053 or similar n.p.n.
D1 and 2	1N4002

Capacitors

C1	1μF
C2	47μF
C3	1,000pF
C4	0·1μF
C5	1μF
C6	47μF
C7	850pF
C8	0·1μF

Miscellaneous

Veroboard; case, preferably plastic; wire; solder etc.



Providing that the unit is constructed in an insulated container with only power supply leads and alarm inputs, then there is no real problem over negative or positive earth vehicles. The polarity of the power supplies remains the same for each case and the input protection diodes are the only components to be altered.

For negative earth vehicles, orient both D1 and D2 as D1 and for positive earth orient as D2.

As can be seen from Fig. 4, only one loudspeaker is required and by selecting different values for C3 and C7 two tones are produced thus identifying which input has altered.

The loudspeaker can be mounted in the box with the circuit board shown in Fig. 5 but care should be taken to ensure that there is no risk that holding bolts for the Veroboard contact both tracks on the board and parts of the chassis of the carrying vehicle.

The two monitors illustrated in the accompanying photographs are a car systems monitor and a simple monitor. Both are housed in small plastic cases together with their asociated loudspeakers. ★

THIS month, the Power Supply, Tone Generator and Top C Envelope circuitry are described.

POWER SUPPLY

The circuit of the power supplies is shown in Fig. 2.1 and is basically a simple unregulated system apart from the 5V logic supply which is provided by a three terminal integrated regulator.

Transformer T1 is rated at 17V, 2A, with a 9V tapping. Other suitable alternatives would be 9-0-9V or 10-0-10V, but in the latter case it would be necessary to increase the value of supply line resistors to compensate for the higher voltage. The potted bridge rectifier D1–D4 should have a p.i.v. rating of greater than 50V and a 2A capacity. Using the Norman CT2 transformer the input voltage to the 5V regulator is approximately 9V on load. The value at the high level output is 19V, with a 2V drop across R1 which is linked to the touch resistors on the key switch assembly.

The negative supply is obtained from a voltage doubler. The requirement here is for less than 50mA so that the current rating of diodes D5 and D6 can be very low, with a p.i.v. of greater than 70V. A number of manufacturers can supply miniature transformers suitable for T2; on the prototype an Eagle version was used which gave −22·5V on load.

SOCKET PANEL

All sockets for the Piano are integrated into the Power Supply chassis (see photograph) providing a convenient mounting point for the mains input, pedal input, external amplifier output, and headphone output sockets, and the mains input fuse.

COMPONENTS . . .

POWER SUPPLY UNIT

Resistor
R1 3·9Ω 2W

Capacitors
C1 1,000μF elect. 16V
C2 1,000μF elect. 16V
C3 4,700μF elect. 16V
C4 4,700μF elect. 25V

Diodes
D1–D4 C1406 bridge rectifier (Electrovalue)
D5–6 ZS171

Integrated Circuit
IC1 MC7805CP (Motorola)

Transformers
T1 Mains transformer—Norman CT2 (Electrovalue) (see text)
T2 Mains transformer—12V 100mA

Miscellaneous
FS1 200mA fuse, FS2 1 amp fuse, LP1 mains neon, S1 mains switch on level potentiometer, Aluminium sheet 10¾in × 9½in, 8-way standard group board, tag strip, SK1 3 pin miniature mains socket, SK2 Standard ¼in jack socket mono, SK3–SK4 Standard ¼in jack socket stereo.

PE JOANNA PART 2

By A.J. BOOTHMAN B.Sc.

The zero level output of the Power Supply is used for connections to the other units in the Piano as will be shown later, but the earth input from the mains lead is connected to the output jack socket of the instrument, to avoid hum due to earth loops.

POWER SUPPLY ASSEMBLY

The plan/photograph view indicates the positions of all the major components in the Power Supply Unit. A piece of aluminium sheet 10¾in × 9½in is required to make the chassis which should be cut into the L-shape shown in Fig. 2.2. ⅛in holes should be drilled on the centres indicated, and air vent holes made in the bottom of the base plate with a ⅛in drill. The positions of the air vent holes are not critical but it is essential that matching holes are drilled in the bottom of the cabinet to give a continuous air flow. When all holes have been drilled

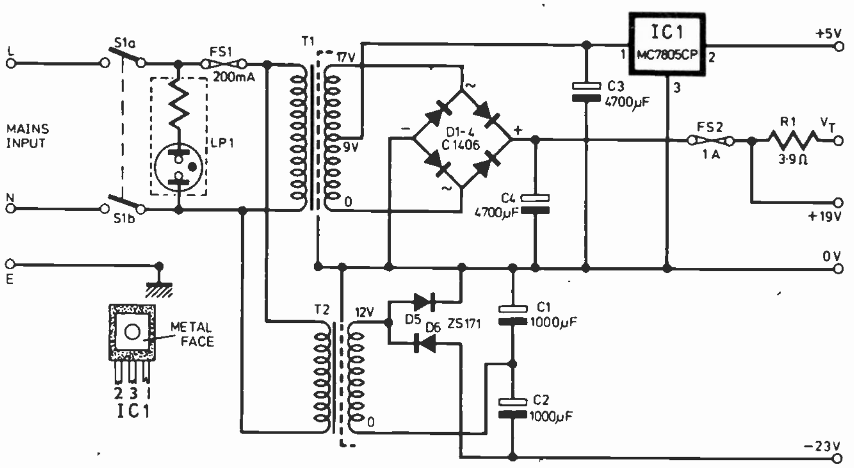


Fig. 2.1. Circuit of power supplies

in the aluminium sheet a paper pattern of the power supply base should be made. This will indicate the positions of all the holes such that when the cabinet is made the air vent positions can be transferred onto the woodwork, and in addition the positions of all screws (6BA) can be marked which allows the constructor to drill shallow holes in the cabinet to accommodate any form of protruding screw head used in the chassis assembly.

When the pattern is complete the chassis should be folded along the dotted lines shown in Fig. 2.2, folding upwards from the page. It is not necessary to fix the floating side of the chassis to the base since holes are provided for wood screws to fix into both the rear and the base of the cabinet when placed in position.

GROUP BOARD

The rectifiers and negative supply smoothing capacitors are mounted on a 16 terminal group board, the layout of which is shown in Fig. 2.3. The board is fixed to the chassis on pillars, consisting of threaded spacers 1½in long, in an inverted position. C1, C2 and D1–4 are soldered to the lugs whilst D5, D6 and FS2 are fixed to the back of the group board.

POWER SUPPLY CONNECTIONS AND FUNCTIONAL CHECK

In order to make the Power Supply a self-contained unit, all terminations are brought out to a tag strip running the full length of the supply. When all

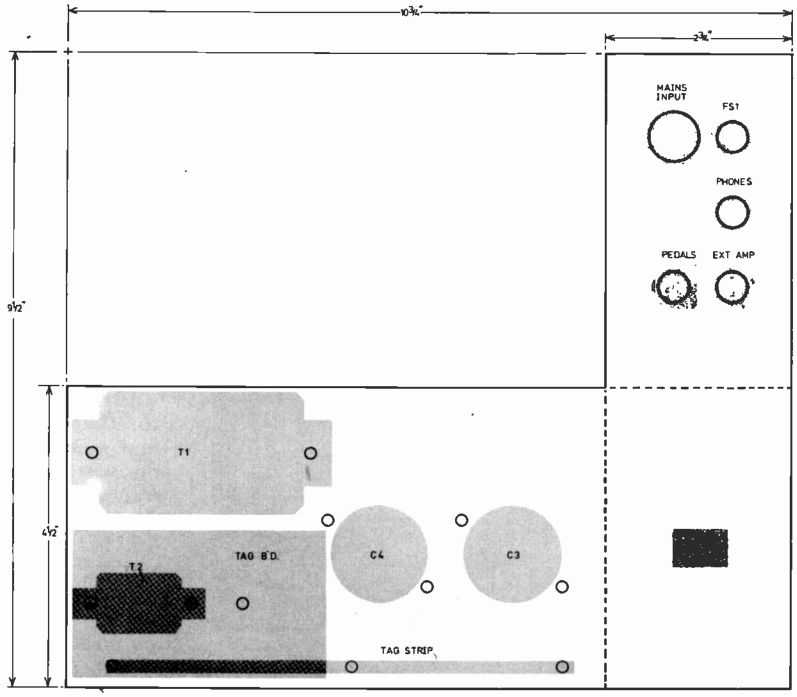
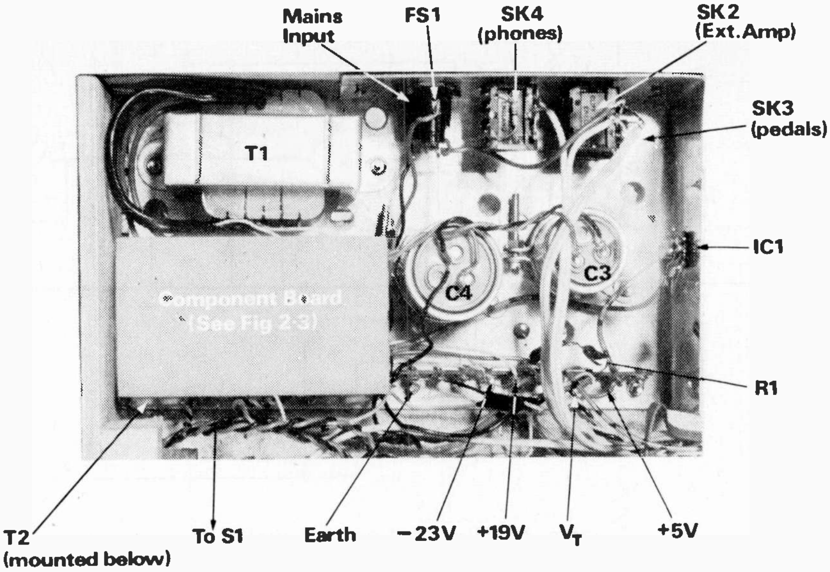


Fig. 2.2. Chassis drilling and bending detail for p.s.u.



Position of major components in Power Supply unit

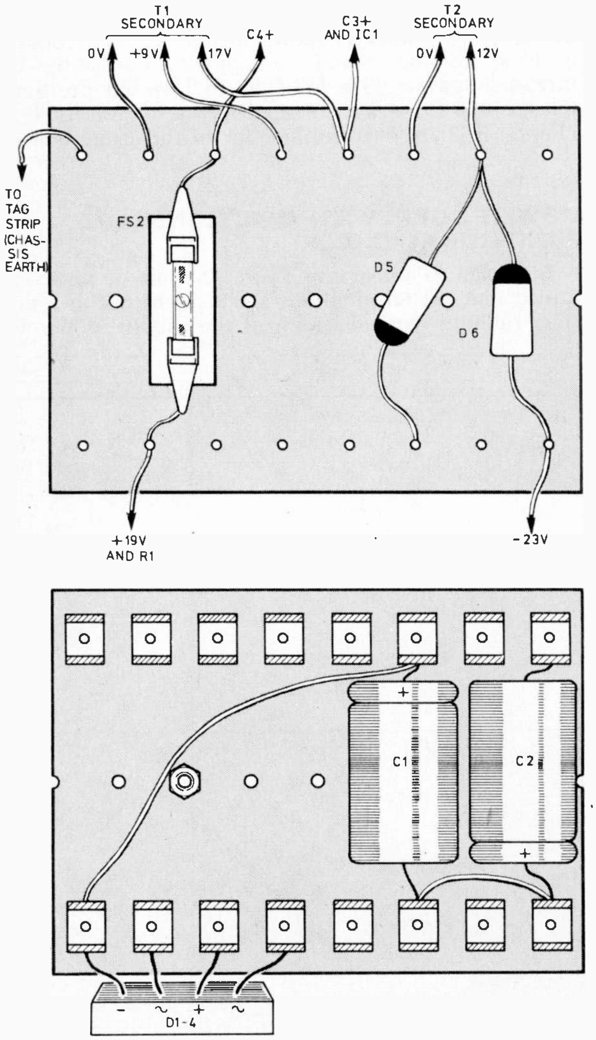


Fig. 2.3. Top and bottom views of group board

the interwiring has been completed the unit can be tested. Since both the internal resistance and the open circuit voltages of apparently similar transformers vary by a surprisingly high degree the unregulated voltage may have a fairly wide range.

The input to the 5V regulator should be in the region of 9–12V on a 600mA load but is not critical from the point of view of the regulator if it is in the range 8V to 15V. However, if for instance a 10-0-10V transformer is used, care should be taken not to exceed the voltage rating of C3. The +19V and −23V are on load measurements and are likely to be exceeded by at least 20 per cent when measured under open circuit conditions. Again if a transformer other than the Norman CT2 is used it would be advisable to use a higher voltage capacitor for C4. Open circuit voltages measured on the prototype were +24V, −30V, and +12V at the input to the 5V regulator.

TONE GENERATOR

Frequency generation in the Piano is dependent on the use of the General Instrument Microelectronics Master Tone Generator type AY-1-0212. This unit leads to the realisation of very accurate relative tuning across the keyboard, which is also extremely easy to adjust.

TUNING ACCURACY

Comparison of the top octave frequency values for the equal tempered scale and the chip indicate that maximum deviations occur in D, Eb, F and G, the worst representing 0·113 per cent of the absolute frequency. Experiments have been reported to have shown that the average person can distinguish an 0·7 per cent deviation if two tones are sounded simultaneously with this error, and that an excellent musician might approach 0·03 per cent (probably by luck). These tests were of course carried out under an unreal situation in that such a rigid comparison is not relevant to the intervals on a single piano keyboard. The author is convinced that the AY-1-0212 accuracy is irreproachable for this application,

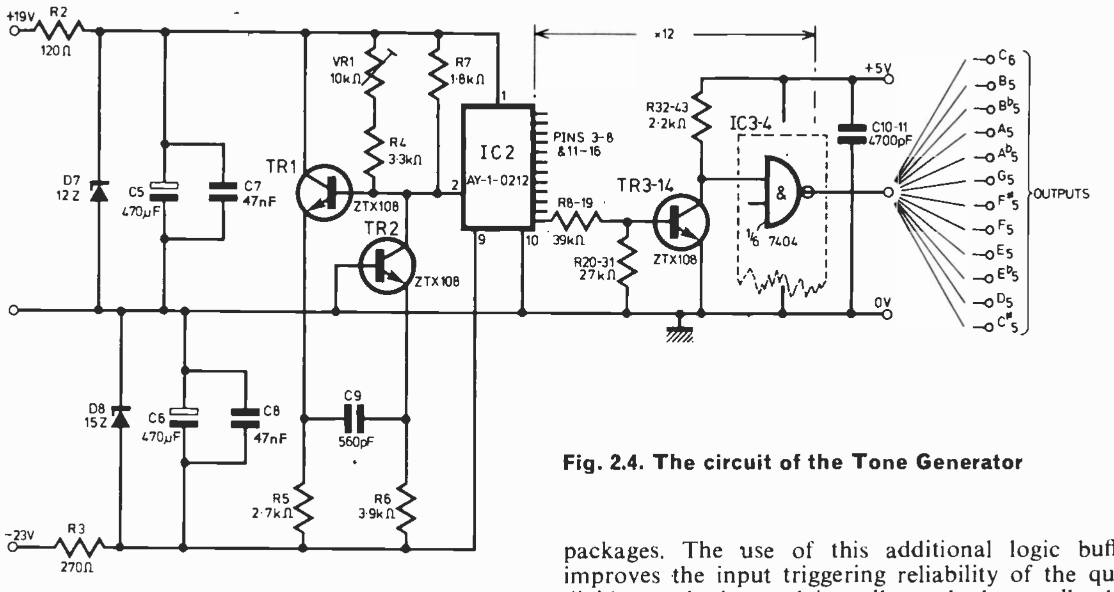


Fig. 2.4. The circuit of the Tone Generator

and the resulting chordal sounds from the keyboard are highly acceptable.

TONE GENERATOR CIRCUIT

The circuit of the Tone Generators is shown in Fig. 2.4. The raw supplies of 19V and −23V are regulated by Zener diodes to +12V and −15V respectively and supply a Bowes astable multivibrator driving the AY-1-0212. The Bowes astable is a non-saturating circuit easily capable of oscillating at the required frequency. The frequency of operation is determined by C9 and the combination of R7, VR1 and R4. For stability C9 should be mica or polystyrene, whilst R4 and R7 could be metal film.

The collector of TR2 swings between approximately 1V and 11V, which is the required input for the Master Tone Generator. The outputs of the AY-1-0212 are equivalent to a 3·5 kilohm resistor connected to a source alternately swinging between zero and 12V, and since the "Joanna" uses TTL dividers for economy it is necessary to have a buffer amplifier for each semitone of the top octave. TR3–TR14 perform this function, and each transistor is followed by a TTL gate in the hex inverter (7404) packages. The use of this additional logic buffer improves the input triggering reliability of the quad divider packages, and is well worth the small additional cost of the two i.c.s.

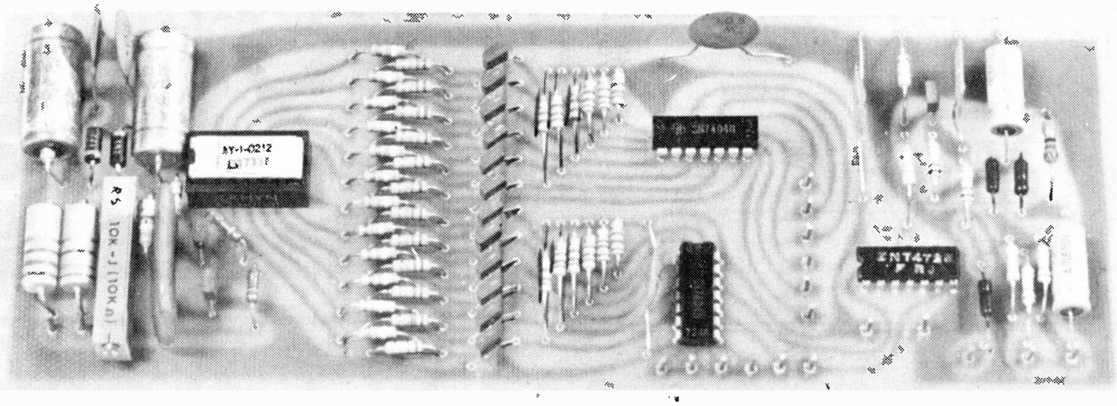
TOP C ENVELOPE CIRCUIT

For layout convenience the Tone Generator Board also contains the Envelope Shaper Circuit for top C. The circuit is shown in Fig. 2.6, with the single divider (7472) which provides pitch C5. The detailed operation of the Envelope circuit will be described next month, and is not identical for all notes.

TONE GENERATOR BOARD ASSEMBLY

The Tone Generator and top C Envelope circuitry are combined on a single printed circuit board, the etching and drilling details of which are given in Fig. 2.5 with the component assembly details below.

To assemble the board, the terminal pins should be fitted, followed by resistors, capacitors, diodes and transistors. VR1 should be a linear track potentiometer with rotary drive. The printed circuit board has been planned to accept two popular versions of this component. IC3, 4 and 5, should be soldered into the board, and it is recommended that a socket be used in the IC2 position, ready to accept the Master Tone Generator. If metal can transistors



Photograph for M.T.G. and Top C Board

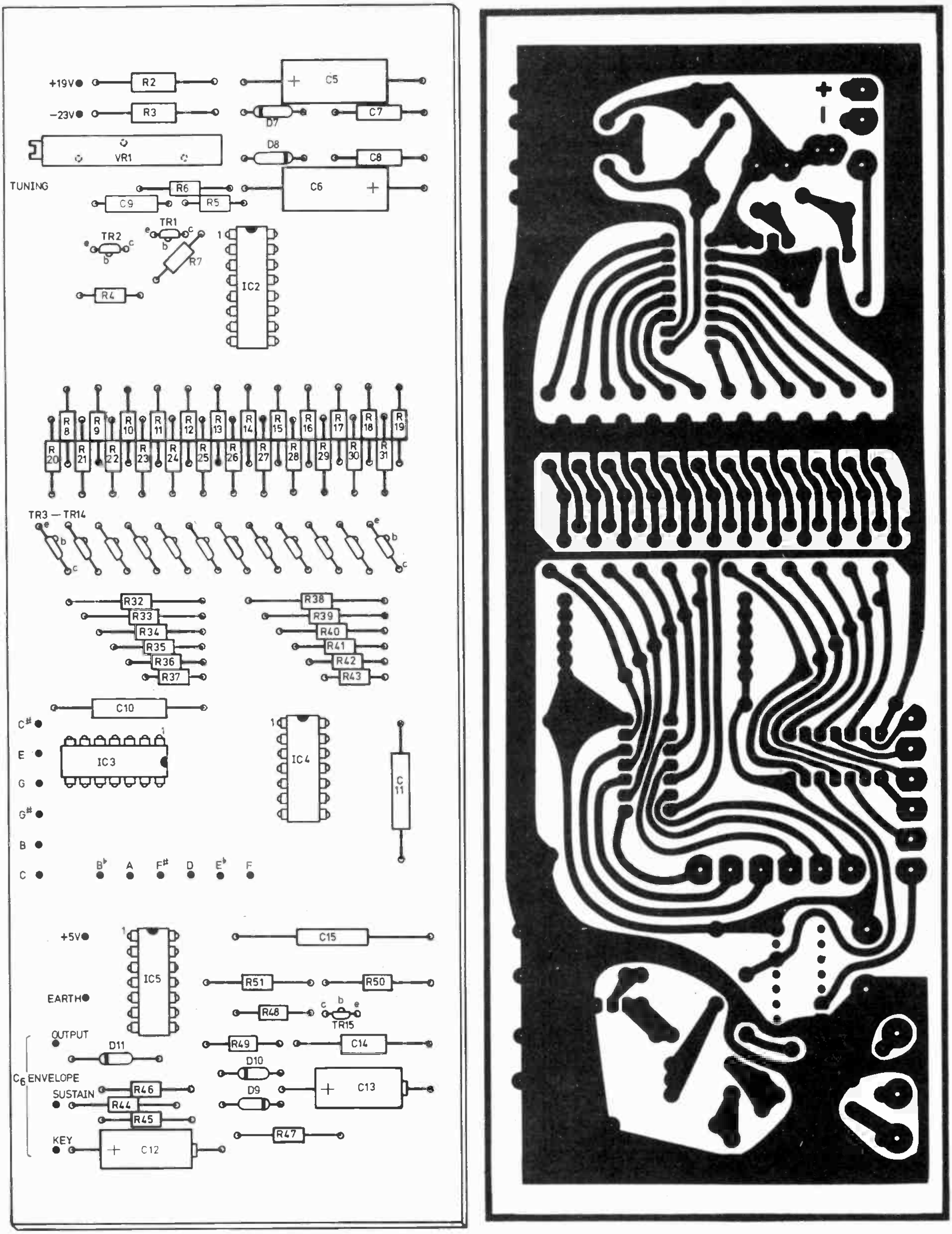


Fig. 2.5. Etching details and component layout for Master Tone Generator and Top C Board

are used instead of the ZTX 108, great care should be taken to ensure that the cans do not touch each other.

PRECAUTIONS WITH THE M.T.G.

The AY-1-0212 is an integrated circuit using MTOS (metal-thick-oxide-silicon) p-channel enhancement mode field effect transistors. Whilst General Instruments have designed protection circuits into the device it is wise to take a number of precautions in its use.

The devices are normally supplied packed in a conductive foam, and should not be removed from this until the constructor is ready to insert the unit into the socket. Handle the device carefully, having previously touched an earth lead, and if it is decided to risk avoiding the use of a socket then soldering should be carried out with a well earthed soldering iron.

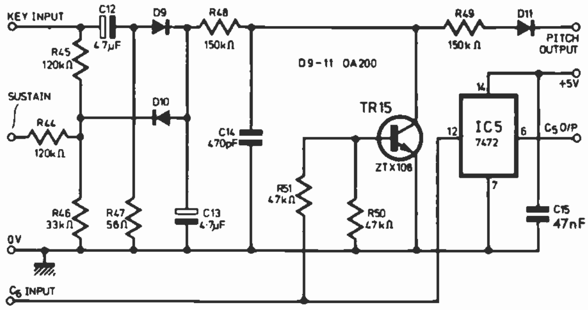


Fig. 2.6. Top C Envelope shaper

COMPONENTS . . .

TONE GENERATOR BOARD

Resistors

R2	120Ω 1 watt	R32–43	2·2kΩ
R3	270Ω 1 watt	R44–45	120kΩ
R4	3·3kΩ metal film	R46	33kΩ
R5	2·7kΩ	R47	56Ω
R6	3·9kΩ	R48	150kΩ
R7	1·8kΩ metal film	R49	150kΩ
R8–19	39kΩ	R50–51	47kΩ
R20–31	27kΩ		

All ⅓ watt, 5%, except where stated otherwise

Capacitors

C5–6	470μF elect. 16V	C12	4·7μF elect. 25V
C7–8	47nF ceramic	C13	4·7μF elect. 16V
C9	560pF mica	C14	470pF
C10–11	47nF ceramic	C15	47nF

Potentiometer

VR1 10kΩ multi-turn linear preset

Diodes

D7 12 volt Zener diode 1 watt
D8 15 volt Zener diode 1 watt
D9 11 Silicon diodes

Transistors

TR1–14 ZTX108 TR15 ZTX108

Integrated Circuits

IC2 AY-1-0212 G.I.M. IC5 ZN7472
IC3–4 ZN7404

EXPERIMENTING WITH THE TONE GENERATOR BOARD

The units built so far allow a test to be carried out, using the experimental keys and jig described last month. A test arranement is shown in Fig. 2.7 in which one of the five experimental keyswitches is used to trigger the C6 envelope, and the resultant output can be checked using an external amplifier as described last month. The 12 semitones can also be checked and should give continuous square wave outputs.

When performing this experiment the power supply should first be loaded and the outputs measured to ensure that the voltages applied to the Tone Generator Board are correct, or damage to components on the board could result. For the touch mechanism to work correctly the four unused keyswitches must be in the grounded position, and the 39 ohm resistor used to give the correct touch voltage.

The 100 kilohm resistor soldered to the +19V terminal on the Tone Generator Board provides the correct level to check the Sustain pedal action on the single envelope. This part is only a crude test, and connection of the leads may introduce hum which should be ignored.

Next Month : The complete envelope generation system

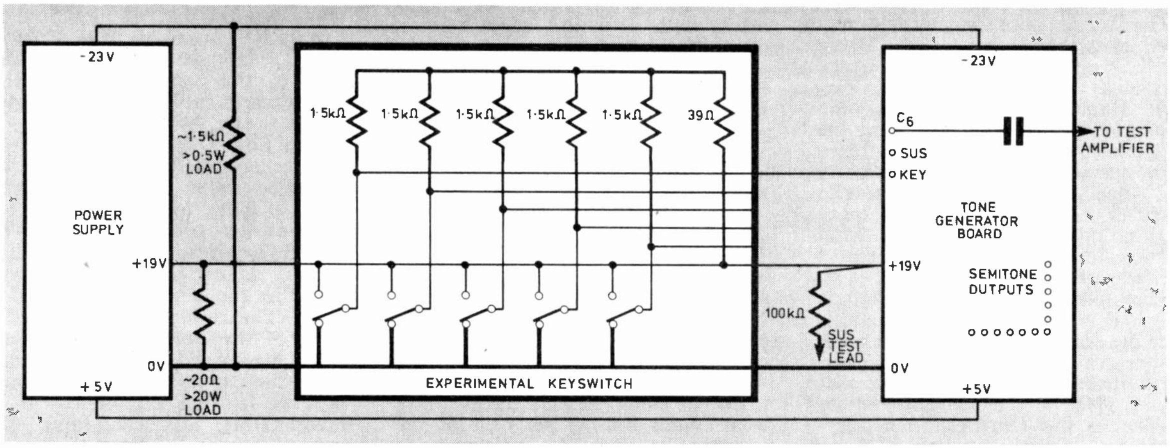


Fig. 2.7. Test set-up for the Tone Generator Board

SPACEWATCH

BY FRANK W. HYDE

Our Space Commentator has just returned from a visit to the USSR. The Soviet Permanent Space Exhibition, Moscow was naturally one of the main items on his itinerary.

SOVIET ACTIVITIES

In December 1974 the *Salyut 4* orbital station was launched. This spacecraft has had a successful and profitable life so far. By March the station had made more than a thousand revolutions round the Earth.

The year 1974 was a very active one for Soviet space research. Academician Keldysh, President of the USSR Academy of Sciences, speaking at the general meeting, made special mention of the *Soyus 16* satellite. This vehicle piloted by Anatoly Filipchenko and Nikolai Rukavishnikov, was launched to check the new systems and equipment to ensure the success of the *Soyus-Apollo* mission.

The Intercosmos programme was also extended during 1974. Using satellites and meteorological rockets, specialists in the Soviet countries have studied the radiation of the Sun, ionospheric conditions and the magnetosphere. In addition there were special studies of the density and energies of micro-meteorite particles. A number of joint space exploration projects involving France, India and Sweden were also carried out during 1974.

The long term orbital stations *Salyut 3* and *Salyut 4*, had made it possible for a wider and more comprehensive exploration of the near-earth space as well as the processes taking place in the Sun and remote objects in the Universe. In near-earth activities the photography for oil prospecting, gas exploration, the search for water resources and minerals was also a major part of the programme.

During 1974 it had been established, by automatic stations set up for the purpose, that there were no differences in the composition of the rocks found on Earth and the rocks found on Mars. It was also established that the magnetic field on Mars was more than a thousand times less than that on Earth. It had been noted that the Martian climate was continually changing. From the data received it was clear that at one time there must have been a very considerable amount of water on the planet.

MAN AND THE BIOSPHERE

At the time of writing there is another conference "Man and the Biosphere" taking place at Zvenigorod near Moscow. Among the items being discussed are the problems of the study of the Earth from space.

The Director of the USSR Space Research Institute, Academician Roald Sagdeyev, stressed that the main task of the conference was to work out unified systems for the study of Earth resources and the control of the environment by satellites. It was necessary to maintain a global watch in all areas of scientific activities.

He also said that it was important that not only was it necessary for all branches of science to co-operate, but also to consider international boundaries as less important. Pollution could spread over these boundaries and it was necessary therefore to consider close international co-operation to tackle such problems.

NEW LAUNCHINGS

In the first quarter of 1975 already there has been intense activity over a wide field. In February a single rocket launched eight satellites of the *Cosmos* series. They are all travelling in their calculated orbits with a period of revolution of 115·5 minutes.

The *Cosmos 719* was launched in March for studies of outer space. It has an extended orbit with a perigee of 182km and an apogee of 329km. The orbital period of revolution was initially 89·3 minutes. The angle of the orbit is 65°.

METEORITES IN THE USSR

A meteorite which weighed 2,276 grammes was found in Chukotka, North East Siberia. It was discovered when a brook was being cleared by a team from the Academy of Sciences.

Cobalt and nickel traces have been found but 90 per cent of the meteorite is iron. Behind the oxide layers it is possible to discern inergrown laminæ and crystals which are between 2 and 3cm in size.

The second meteorite find is perhaps the most significant so far as scientific history is concerned. It relates to the Tungus meteorite which fell to Earth in 1908 causing great damage over an enormous area. Trees were flattened over a very wide area, some completely charred. It was seen from many places in Asia and Europe.

A BLACK HOLE?

No pieces of the object were found in spite of many searches. The area was swampy and it was concluded that it probably vaporised or at least disintegrated into very small particles.

Recently there was a suggestion that it was not a meteorite but a small black hole which passed through the Earth. Support for this was claimed because there was an intense blue shaft of light seen at the time. This was not accepted generally as sufficient evidence.

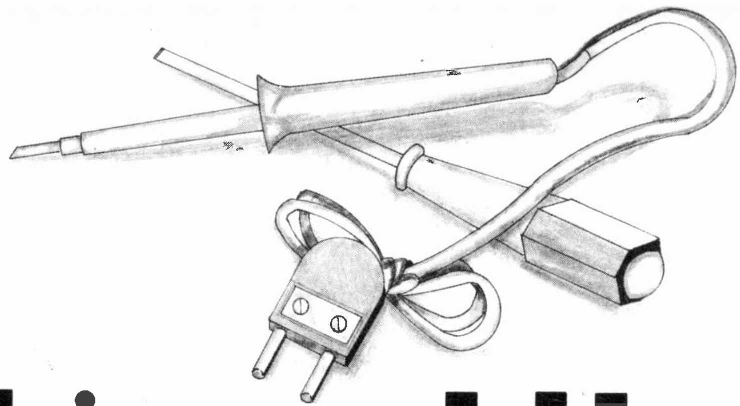
However, the mystery has now at least been modified for it is now confirmed that the meteorite was in fact the nucleus of a small comet. Final confirmation of this will help to evolve a theory of destruction of the nuclei in planetary atmospheres.

In a peat bog, near the centre of the disaster area, a profusion of molten glass spheres with bubbles of gas inside were found at a depth of 25·4cm. The composition of the particles is unusual. The silicates included in them have a high content of silicon and alkaline metals. The bubbles of some of the spheres are filled with carbon dioxide or hydrogen sulphide.

THE CONTINUING SEARCH

The comet hypothesis is supported by the fact that a glow in the sky persisted for several days and was seen as far off as Southern France. This could have been the comet's tail scattered by the pressure of the Sun's rays and which was caused to deviate to the west of the site of the fall.

The Soviet scientists believe that a considerable part of the comet exploded as it entered the atmosphere. The matter would have liquified or even vaporised. This would result in an aerosol cloud which stratospheric winds would carry in the direction of the north west. The result would be that the bulk of the debris would fall at a point a hundred kilometres or more from the centre of the explosion. It is now in that direction that the investigators are continuing their search.



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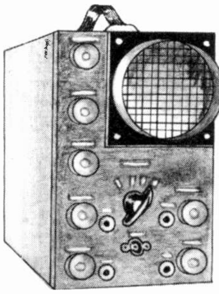

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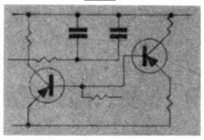

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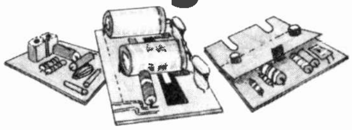

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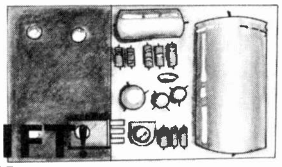

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4·7μF 63V	7p	150μF 16V	7p
6·8μF 63V	7p	150μF 63V	17p
8·0μF 40V	7p	220μF 6·4V	7p
10μF 16V	7p	220μF 10V	7p
10μF 25V	7p	220μF 16V	8p
10μF 63V	7p	220μF 63V	21p
15μF 16V	7p	330μF 16V	8p
15μF 63V	7p	330μF 63V	25p
16μF 40V	7p	470μF 6·4	14p
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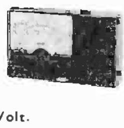
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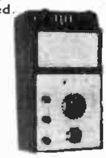
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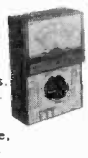
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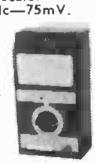
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TRANSDUCERS

PART 3 Inductive Devices & Physical Parameters

By P. R. ALLCOCK*

INDUCTIVE transducers make use of the properties of magnetic systems involving magnetic materials, coils and air gaps, and they may be either passive or self generating. The self generating type relies on the principle of relative motion between a conductor and a magnetic field inducing a voltage in a conductor. In self generating transducers this relative motion is provided by changes in the measurand and consequently only dynamic measurements are possible with this device.

Self generating transducers can be conveniently grouped into four categories based on the way in which the output signal is generated by the magnetic system in response to the input measurand.

MOVING COIL SYSTEMS

All transducers that employ the principle of a coil moving in a magnetic field can be called moving coil transducers, the motion employed to cause coil movement depending on the details of the application. Thus the motion might be linear as in a moving coil microphone, or angular as in the simple generator or a.c. tachometer.

These two cases are illustrated in Fig. 3.1 and Fig. 3.2 respectively. In Fig. 3.1 the measurand is sound pressure on the diaphragm and changes in this pressure cause linear displacements of the moving coil along the axis indicated. The concentric pole pieces of the permanent magnet system ensure a reasonably uniform radial flux in the air gap and only when the coil moves will there be a voltage induced in it.

Fig. 3.2 illustrates the principles of a coil that rotates in a fixed magnetic field and in this case two slip rings are required to make connection to the moving coil. The common moving-coil meter has a similar construction but is used to transform an electrical input into the angular displacement of a needle. Similarly, the moving coil loudspeaker uses

* North Staffordshire Polytechnic

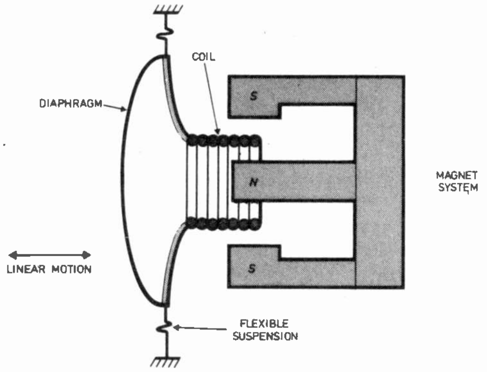

Fig. 3.1. The moving coil microphone

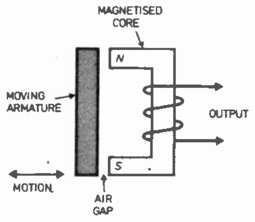

Fig. 3.3. The variable reluctance transducer

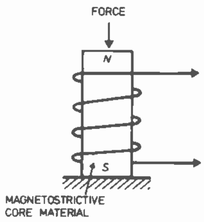

Fig. 3.4. The magnetostrictive transducer

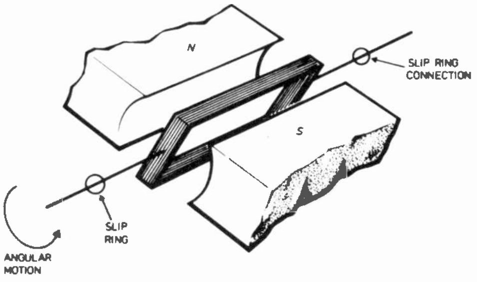

Fig. 3.2. The simplest form of a.c. tachometer using a moving coil

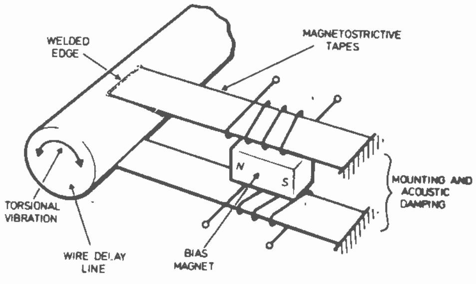

Fig. 3.5. The Scarrot-Naylor tortional transducer which makes use of magnetostrictive effects

the principle of Fig. 3.1 but the input is again the electrical signal and the audio output results from the displacement of air by the cone.

In all the moving coil transducer systems, the amplitude of the output signal will depend on the rate of change of the flux-linkage and so will be proportional to the linear or angular velocity. The linear moving coil system can indicate the sense or direction of movement as well as the velocity since the output polarity depends on the direction of movement of the coil.

The angular transducer on the other hand produces an alternating output which ever way the coil revolves. In some devices the coil is stationary and a moving magnet is used to give a velocity dependent voltage output, thus simplifying the problem of coil connections.

VARIABLE RELUCTANCE TRANSDUCERS

Transducers in this group utilise variation in the reluctance of the magnetic flux path and the principle is illustrated in Fig. 3.3. The armature moves through changes in the measurand, thus varying the lengths of the air gaps which form a significant part of the magnetic circuit. As the air gap increases the flux in the coil changes and a voltage is induced in the coil.

The output voltage can be calibrated in terms of changes in the measurand but since the flux variation with armature position is approximately an inverse law the output is only roughly proportional to armature velocity for small armature displacements. The armature is attracted to the magnet and must therefore be restrained by some flexible support system so that an air gap exists even with zero input.

The reluctance of the magnetic path is normally dominated by the reluctance of the two air gaps and under this condition the reluctance is approximately proportional to air-gap length.

MAGNETOSTRICTIVE TRANSDUCERS

Some ferromagnetic materials exhibit changes in their permeability when subject to mechanical stress. Consequently a coil wound on a core of such material will experience changes in its flux pattern when under stress. The voltage induced will depend on both the magnitude and the rate of change of the applied stress and the principle is shown in Fig. 3.4. Typical magnetostrictive materials include permalloys, nickel, cobalt and certain ferrites. The main areas of use are those in which high power levels are encountered, ultrasonic applications such as thickness gauging and underwater sonar detection systems.

The magnetostrictive behaviour of these materials is reversible in that suitable magnetic excitation will produce dimensional changes in the material. These effects have been used in some computer delay lines and one such application is illustrated in Fig. 3.5. The delay is produced by the propagation time of torsional waves transmitted down the nickel wire. The waves are initiated by causing the wire to twist as the two magnetostrictive tapes expand and contract due to the applied magnetisation. The magnet provides a permanent flux to which is added the flux due to the signal in the coils. The magnetisation is so arranged that one tape expands whilst the other shrinks giving a kind of push-pull drive to the delay wire. The receiving transducer is basically similar to the transmitter.

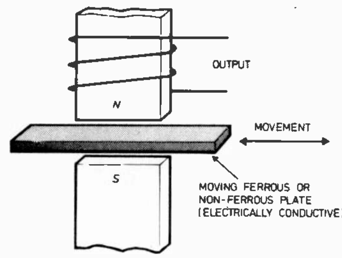

Fig. 3.6. Principle of operation of the eddy current transducer

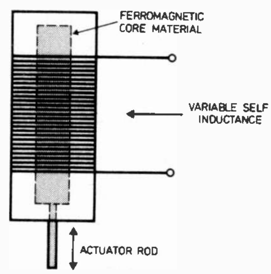

Fig. 3.7. Self-inductive version of the passive inductive transducer

EDDY CURRENT TRANSDUCERS

Referring to Fig. 3.6, if the plate is moved in the direction shown, eddy currents are set up within the plate in proportion to the plate velocity. These currents create their own magnetic field which tends to oppose the main field of the magnet system but as long as the velocity is constant there is no output signal. However, a changing velocity will cause changes in the magnetic flux which gives rise to an output which is roughly proportional to the acceleration of the plate.

PASSIVE INDUCTIVE TRANSDUCERS

Passive inductive transducers require power from some external source and the transducer is normally used to modulate, say, the current flow in the excitation circuit. Both static and time varying measurands can be handled and converted to quantitative output signals, the normal unmodulated excitation level acting as the zero reference. As with the self generating types, four main categories can be identified.

VARIABLE INDUCTANCE

The self or mutual inductance of a coil system can be made dependent on the position of a core of ferromagnetic material as illustrated in Fig. 3.7 and Fig. 3.8. In Fig. 3.7 the self inductance of the coil increases as the core enters the coil, reaching a maximum value when the core is in the central position.

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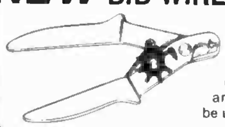

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AF180	45
AF181	45
AF239	40
AF240	60
BC107	11
BC108	10
BC109	14
BC109C	14
BC113	13
BC116A	19
BC117	14
BC125B	15
BC132	25
BC135	15
BC137	19
BC138	26
BC142	23
BC143	25
BC147	11
BC147A	11
BC148	10
BC149	10
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BC154	15
BC157	14
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BF195	8
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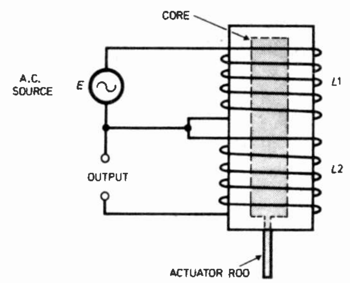


Fig. 3.8. Mutual inductance version of the passive inductive transducer

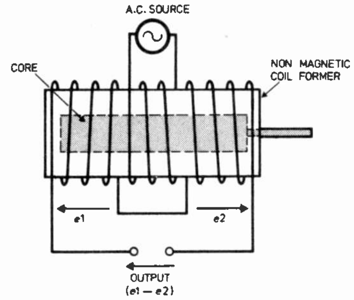


Fig. 3.10. The linear variable differential transformer (LVDT) in which displacement of the core to one or other side of a centre position gives a negative or a positive output

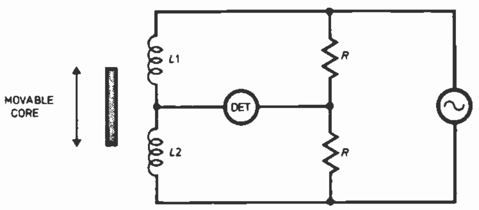


Fig. 3.9. A two-coil variable inductance transducer

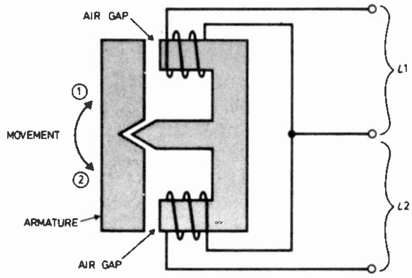


Fig. 3.11. A passive variable reluctance transducer in which armature movement will be caused by small angular or linear displacement

In Fig. 3.8 the mutual inductance coupling between the two coils $L1$ and $L2$ depends on the core position and hence the output voltage across $L2$ can be calibrated, in terms of position, providing the excitation E is held constant. An alternative arrangement, Fig. 3.9, uses a coil system similar to Fig. 3.8 but with $L1$ and $L2$ connected as two ratio arms of an a.c. bridge.

As the core moves from the central position the effective inductance of, say, $L1$ increases whilst that of $L2$ decreases, thus causing an unbalance of the bridge and consequently the output detector can be calibrated as before. Since the changes in $L1$ and $L2$ act together to unbalance the bridge the sensitivity is effectively doubled.

Directional information can be determined from all of these arrangements although the method shown in Fig. 3.8 would require a phase-sensitive detector system since a simple a.c. detector would respond only to the degree of unbalance between $L1$ and $L2$ and would not indicate the sense of core displacement from the central position.

DIFFERENTIAL TRANSFORMER

The so-called linear variable differential transformer or LVDT is shown in Fig. 3.10. The device consists of three coils wound on a common former. The centre coil is connected to an alternating voltage source whilst the two outer coils are connected so that their induced voltages are in phase opposition.

When the core is central the induced voltages are equal and the output is zero. Any displacement of the core from the central position gives rise to a difference between the two voltages and an output signal is then produced. The relative phase of the output voltage depends on the direction of displacement.

A core displacement to the right of centre is considered positive and the magnitude of the output is zero when the core is central. The change in phase either side of the zero position can be detected and used to indicate the sense of core movement.

The LVDT can be used with d.c. excitation in which case it becomes a dynamic transducer since no output occurs except when the core is in motion. The output amplitude is now proportional to the rate of change of the core displacement with time and thus gives a velocity-proportional signal. Rotary differential transformers are also available but the variation of output signal usually follows a sinusoidal variation. The output amplitude is approximately a linear function of angular displacement over a range of $\pm 30°$.

VARIABLE RELUCTANCE (PASSIVE)

This class of devices relies on the change of inductance by virtue of a change of reluctance. Unlike the self generating system the core is not normally magnetised by the inclusion of a permanent magnet but relies on the external excitation. A double coil system for use in an a.c. bridge would be similar to Fig. 3.9 except that the changes in $L1$ and $L2$ would be the result of changes in reluctance due to, say, a changing air gap as shown in Fig. 3.11. Movement in the direction (1) increases $L1$ and decreases $L2$.

Next Month: Synchro Transformers

SYMBIOSIS...

A composition for the PE MINISONIC

By M. POINTON B.Mus.

NOT so very many years ago the electronics engineer and the musician seemed poles apart. A quick passing of the time of day as the serviceman finished his mammoth task of tracking down an intermittent crackle in the radio set was the sum total of their contact. Today that contact is more intimate, although it is often the electronics enthusiast who shows a greater interest in electronically produced music than the average musician. I find this sad. However through my contact with PRACTICAL ELECTRONICS I have discovered that there is a large body of people which believes, as I do, that a very big slice of our musical future will reflect, in some form or another, advances in electronic technology.

Many of these people will no doubt be the first to admit that their interest was really awakened by the appearance of the do-it-yourself synthesisers. The steady trickle of interested parties which followed the publication of the PE Sound Synthesiser details in 1973–4 is threatening to become a flood as the Minisonic makes its impact. There is no doubt at all that the low cost of this latest arrival is a significant factor in its popularity, and this can only be for the good. The more people can begin to appreciate the satisfaction of producing their own music the better.

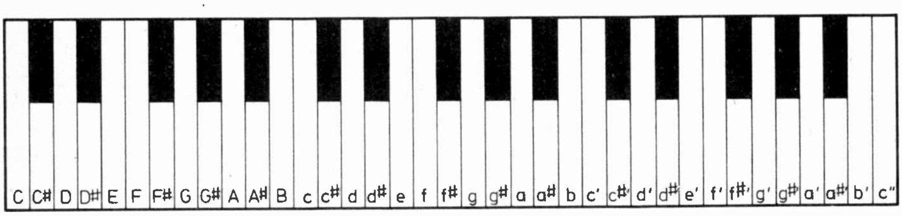


Fig. 1. The keyboard showing the letter names of the notes

MAKING MUSIC

With traditional acoustic musical instruments the way to expertise is a hard one; difficult techniques have to be learnt. Rapid and precise finger movement, subtle muscular control and, if you play with others, an almost telepathic rapport take years to achieve and a lifetime to perfect. Most of us do not have the time to devote to these necessary skills and we give up almost before we've started and resort to the secondhand—records, cassettes and radio.

The electronic sound synthesiser fulfils the amateur musician's needs admirably. In his hands lies the means to a musical creation which is his alone and demands little more than a superficial knowledge of how voltages can be made to interact, a reasonable pair of ears and an enthusiasm to do something new. And the sonic result of his efforts is not just a one-finger-dabble but an arrangement of sound events which, in sheer complexity and wealth of colour, can outshine the most virtuoso symphonic work in the repertoire.

SCORING FOR MINISONIC

This project makes use of some of the many effects to be found in the Minisonic, and although it is basically a re-creative exercise in that it centres on my composition "Symbiosis" there is plenty of leeway built into the score to allow for individual interpretation. To some extent this element of chance in what appears to be a rigid format was dictated by the synthesiser itself. It is extremely difficult to pinpoint precisely the many control settings without recourse to sophisticated external measuring equipment. In my own version of the work no measuring device was necessary so I consciously allowed for individual "error" in subsequent realisations.

The equipment required for a performance of "Symbiosis" is not esoteric, comprising the Minisonic, a stereo tape machine with separate record and playback heads, another tape machine, a simple stereo mixer with at least five inputs, three outputs and channel switching facility, and a mono or stereo amplifier and speaker(s) for monitoring purposes. The Minisonic is the only sound source used. Although the stylus keyboard is not ideal from a performance point of view I have avoided the temptation to patch in a standard keyboard and this has meant that the kind of material used in the piece is relatively simple. Paradoxically the very limitations imposed by the stylus have resulted in several accidental discoveries!

The sound patterns in the work have been kept fairly straightforward in the sense that I have tried not to overtax the resources of the performer by writing extended passages which require a considerable amount of dexterity both in stylus manipulation and rapid knob control. A diagram of the keyboard is given (Fig. 1) together with the letter names of the notes, as they are referred to in the text.

LAYOUT FOR PATCHING

In order to simplify the description of patching arrangements the original front panel lay-out of the Minisonic has been reorganised so that a matrix of input and output sockets could emerge. (Fig. 2) Thoughout the text reference will be made exclusively to this diagram.

sound events in sequence. Each sub-section of the piece is marked off by vertical lines with a timing in seconds given at the top. The boxed upper-case letters, A to S, are for reference purposes only as the performer works through the data. Most of the events themselves are not meticulously annotated in order to allow for individual variation although their visual appearance often gives some clue to the kind of sound that is expected. The strict measurements of time are not meant to be adhered to rigidly—they merely give a sense of scale. An error of plus or minus ten seconds in sixty will not upset the piece unduly. The total duration of the work should be around seven minutes.

Before getting down to the work make sure that you have brand-new batteries in the Minisonic; although, as was mentioned in the constructional articles, most of the units will function down to ±7·8V.

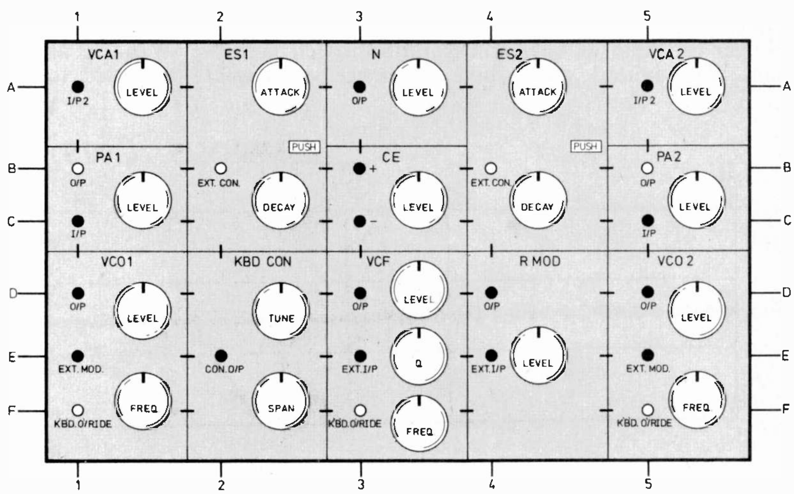


Fig. 2. Reorganised panel layout to simplify control references

The units themselves are abbreviated as follows:

VCO1, VCO2	:	Voltage Controlled Oscillators
VCA1, VCA2	:	Voltage Controlled Amplifiers
ES1, ES2	:	Envelope Shapers
PA1, PA2	:	Power Amplifiers
VCF	:	Voltage Controlled Filter
RMOD	:	Ring Modulator
KBD	:	Keyboard
KBD CON	:	Keyboard Control
CE	:	Control Envelope
N	:	Noise Generator

The control settings for the Re-an skirted knobs used on the prototype (measured 1 to 12 over almost 360 degrees) are included too. With the potentiometers used the settings range from 1 (minimum) to 11 (maximum). It must be borne in mind that the settings given in this text may not accurately match those on any other machine. Where a particular configuration is critical hints will be given on achieving it.

THE SCORE FOR SYMBIOSIS

The musical score of "Symbiosis" (Fig. 3) is laid out pretty imprecisely as regards virtually every parameter and is simply a graphic representation of the

SEQUENCE A TO D

The v.c.o.s have first to be tuned, in the first instance to only one note. Unfortunately the v.c.o.s in the Minisonic are prone to frequency drift and the way to stabilise them is to patch in to the keyboard hold circuit. This is achieved quite simply by taking a lead with a miniature crocodile clip at each end and attaching the stylus tip to the bottom resistor on the keyboard chain. Normally one could hold the stylus on the keyboard but for this particular section of the piece both hands will be needed at the controls. The control settings are as follows:

RMOD	—	Level 11
KBD CON	—	Tune 3·8; Span 5
VCF	—	Level 11; Q 1; Freq 5
VCO1	—	Level 11; Freq 7
VCO2	—	Level 11; Freq 7

With these settings you should be very close to requirements. The only additional adjustment is to KBD CON; rotate the knob until VCO2 gives out a middle C (check this with a piano or any other fixed-pitch instrument or tune to about 262Hz).

Patch-cords: 3E to 4D; 3D to 1C; 5D to 4E. With this set-up you should hear nothing. Advance VCF frequency to about 8 and both v.c.o.s will be heard out of tune. Adjust VCO1 frequency very slowly until a steady single pitch is heard. Next move the control very slowly indeed until a beat frequency of about 2Hz is heard. You are now ready to start recording the first section of the piece. Return VCF frequency to 5 or less.

Letter A in the score is silence; from A to B very gradually increase VCF frequency until the 2Hz beat is heard softly but comfortably. At letter B rotate VCO1 frequency clockwise very slowly until the beat frequency becomes, at C, a rasping noise. Immediately after C the effect of ring modulation appears as you continue, at an even, infinitesimally slow, rate, to rotate the knob. Continue this slow progress until about a minute has elapsed. The final eight seconds before D show that you have arrived at a distinguishable beat frequency of about 2Hz. (You will have passed several of these on your way up, shown by an inclined dotted line.) If you happen to like certain modulation effects, do not be afraid to linger on them or back-track and approach them again. Throughout the whole sequence increase VCF frequency very slowly so that it reaches a peak in the middle of the eight-second "throb" at the end of the top line of music.

This done, cut the tape just before the last dying strain.

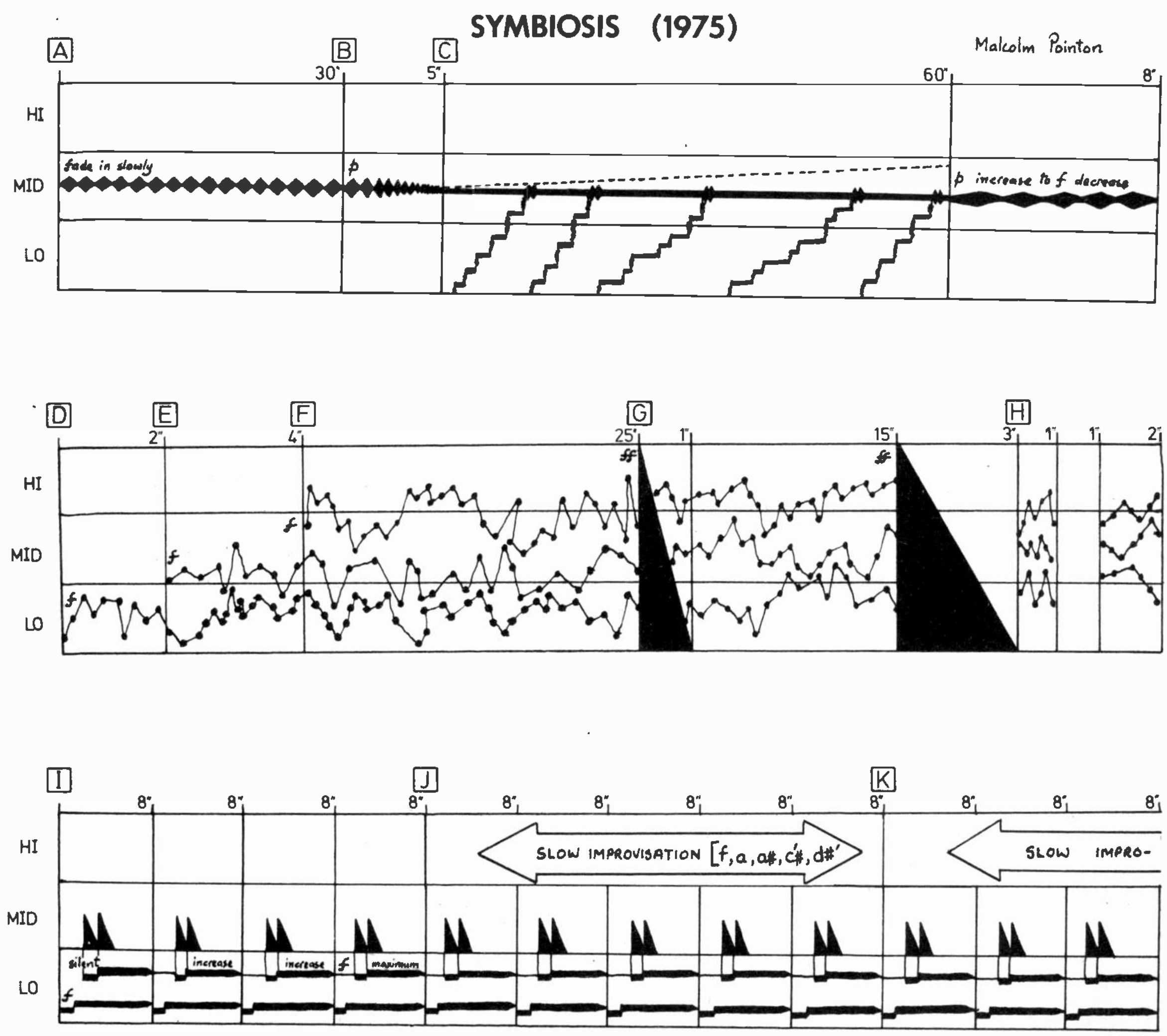
SEQUENCE D TO I

The setting-up procedure here is quite straightforward. No patch-cords are required since the relevant links are made internally. The only possible problem may be the tuning of the two v.c.o.s an octave apart. Initially set up as follows:

VCO1 and 2	—	Level 11, Freq 6
ES1 and 2	—	Attack 1, Decay 1
VCA1 and 2	—	Level 7
KBD CON	—	Tune 5; Span 5

Tune the two v.c.o.s to the same pitch, then decrease VCO1 frequency to approximately 5·6 until they sound in tune.

Since this sequence is interrupted by two bouts of noise and a silence, sufficient material must be recorded to cover about 55 seconds. I suggest you



make 90 seconds' worth so that you can hack out the bits you like for the two interpolations after H.

On track one of your stereo machine record the bottom line of linked black dots. This should sound as it looks—pretty random in pitch and rhythm. Using the stylus dodge around the whole range of the keyboard as you like but without playing any long-held notes. The effect must be of short, rapid stabs.

Having recorded this, play back track one as you record the same kind of thing again on to track two. This time advance KBD CON tuning to 6, thus increasing the overall frequency by about an octave.

Play back both tracks through the mixer into your second tape machine whilst you play a third "random" sequence on the keyboard, this time with the KBD CON tuning set at 7·2, another approximate octave higher. The result is a piece of three-part counterpoint moving rapidly and nervously.

The noise at letter G is added, when all the foregoing has been completed, by playing the sequence back on to the first tape machine, your finger being poised above the push button on ES1. The setting-up procedure for this noise is as follows:

VCO1 and 2	—	Level 1
ES1	—	Attack 1; Decay 4
VCF	—	Level 11; Q 11; Freq 7
CE	—	Maximum clockwise
N	—	Level 11

Patch-cords: 3F to 3C; 3A to 3E; 3D to 1C

This should give a one second decay time; if not, adjust ES1 decay accordingly.

This second splash of noise is recorded on to virgin tape and spliced on to the end of the contrapuntal sequence. For this noise the ES1 decay is advanced to give a three second envelope. On to this is spliced a one second cutting from the excess counterpoint, followed by a one second piece of clean tape and a two second stretch of counterpoint. The whole sequence can now be added to the end of sequence A to D.

Next Month: Symbiosis is concluded

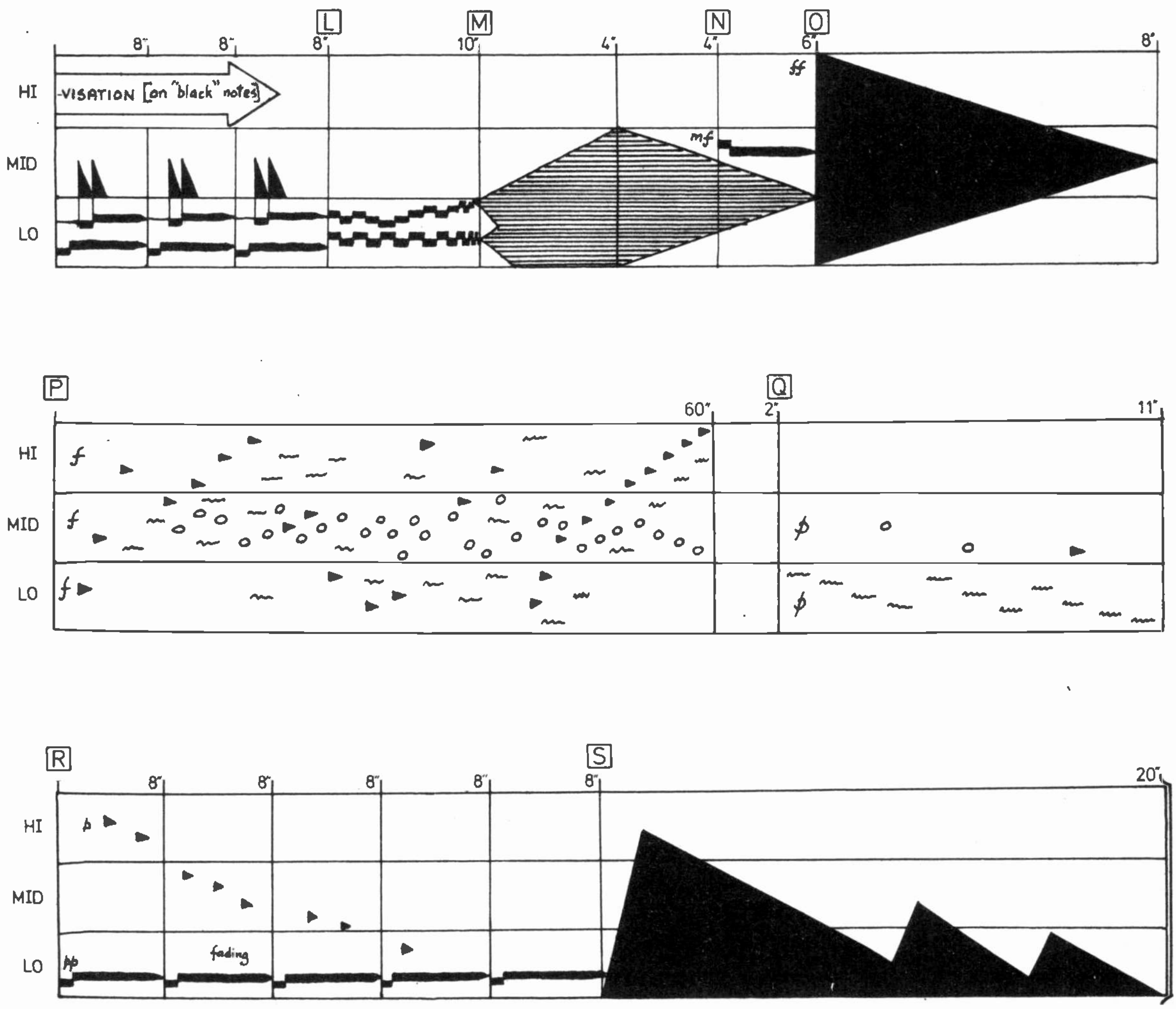
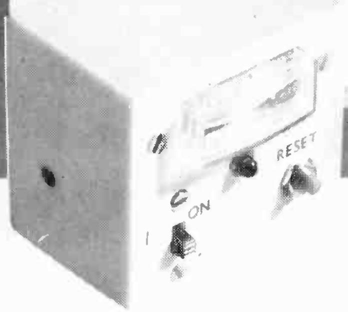


Fig. 3. Musical score of "Symbiosis"

REACTION TIMER

By C. R. MASSON



REACTION time is an aspect of human performance which is important in many situations. This article describes a pocket-sized device which measures the speed of reaction to a visual stimulus. It is possible to use the timer to find, for instance, the effect of alcohol on reaction time, and so should prove a fund of amusement around the local in one of its applications. However, whether lighthearted or more serious the uses are manifold.

THE UNIT IN USE

The person whose reactions are being tested presses a button which resets the previous reading and initiates the operation. After a delay of up to 10 seconds, a light appears and the subject has to release the button as quickly as possible. The time interval between the appearance of the light and the release of the button is measured and displayed on a moving-coil meter. The meter reading remains steady until the next time the button is pressed.

If the delay between the pressing of the button and the appearance of the light is constant, the subject will soon learn when to expect the light. To prevent this, the delay varies unpredictably between 0 and 10 seconds.

Most people's reaction times are about 150ms and nobody reacts faster than 100ms. Because readings on a linear time scale would be rather cramped, the reaction timer has a suppressed zero scale with the meter zero corresponding to about 100ms and mid scale to 150ms.

CIRCUIT DIAGRAM

The circuit diagram is given in Fig. 1 and a timing diagram illustrating one complete cycle of operation is shown in Fig. 2. Until the button S2 is pressed, the oscillator TR1, TR2 runs continuously, producing a short pulse every 10 seconds. The oscillator output is shown in waveform (a) and the press button voltage is shown in waveform (b). On the first pulse after the button has been pressed, the bistable is set. Waveform (c) shows the state of the bistable which controls the l.e.d. and the timing circuit. Waveform (d) is the voltage across the timing capacitor C3. When the button is released, the bistable is immediately reset, turning off the light and stopping the timing circuit.

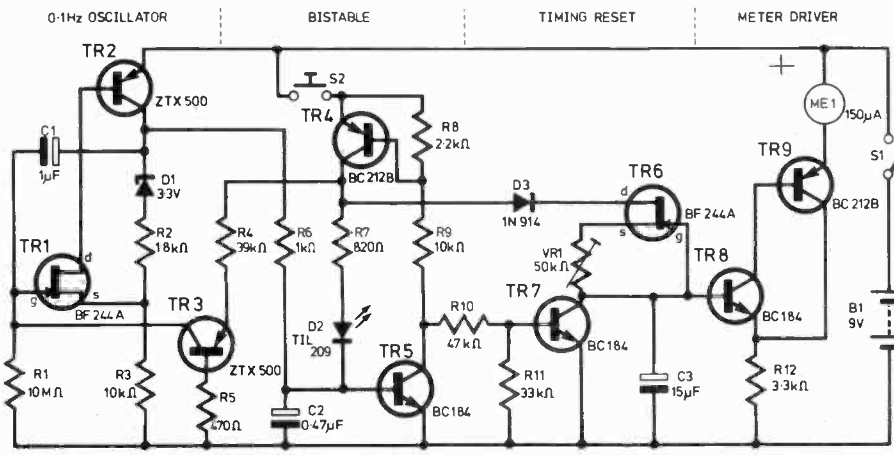


Fig. 1. Circuit diagram of Reaction Timer

Since the delay time between the pressing of the button and the appearance of the light is dependent on the phase of the 0·1Hz oscillator which is unknown to the user, it is not predictable and will vary randomly in the range 0 to 10 seconds. However, the phase of the oscillator at the point where the bistable is turned on is known precisely and does not vary from one cycle of operation to the next. If no precautions were taken, the delay time for any test would be a simple function of the time interval since the end of the previous one. To avoid this, the phase of the oscillator must be altered by an unknown amount after the bistable has been triggered. During the time that the bistable is set, the oscillator frequency is increased to approximately 100Hz. This suffices to produce delay times which are, in practice, completely unpredictable.

The charge on the timing capacitor will decay because of leakage and the current taken by the meter. To minimise the rate at which the charge is lost, a unity gain amplifier with a high input impedance is interposed between the capacitor and the meter. In the prototype, the decay time constant is 1,500s which is more than adequate.

The timing capacitor is discharged when the button is first pressed but, of course, the discharge must be inhibited while the timing of the reaction is taking place.

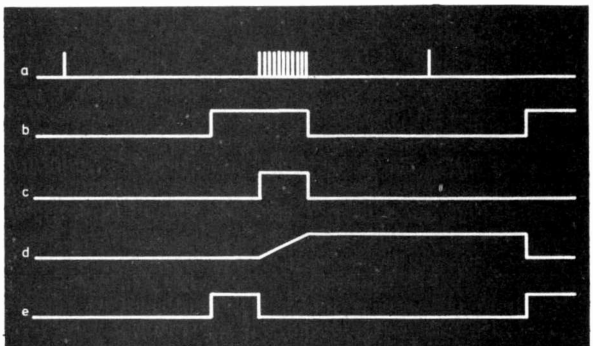


Fig. 2. Timing figure showing one cycle of operation

OSCILLATOR

The 0·1Hz oscillator is an unusual circuit employing an *n*-channel f.e.t. and a *pnp* transistor in a complementary arrangement. This produces pulses whose period is determined by the time constant R1/C1.

The duty cycle of the oscillator can be altered by making the charge and discharge paths of C1 different. In the Reaction Timer, R1 is 10 megohms and on positive half cycles it is shunted by the series combination of R5 and the forward-biased collector base junction of TR3.

The duty cycle given by this arrangement is about 0·005 per cent, with the transistors conducting for only 500μs in every 10s. With such a low duty cycle the current drain is negligible since the average current is only a few microamps.

BISTABLE

A complementary circuit is also used for the bistable, again to reduce power consumption. The necessary control of the bistable by the press switch is obtained by switching the supply to the bistable.

COMPONENTS . . .

Resistors

R1	10MΩ	R7	820Ω
R2	1·8kΩ	R8	2·2kΩ
R3	10kΩ	R9	10kΩ
R4	39kΩ	R10	47kΩ
R5	470Ω	R11	33kΩ
R6	1kΩ	R12	3·3kΩ

Capacitors

C1 1μF 35V tantalum bead
C2 0·47μF 35V tantalum bead
C3 15μF 20V tantalum

Transistors

TR1 BF244A
TR2–3 ZTX500
TR4 BC212B
TR5 BC184
TR6 BF244A
TR7–8 BC184
TR9 BC212B

Switches

S1 Miniature d.p.d.t. slide
S2 Press-to-make

Potentiometer

VR1 50kΩ linear preset

Diodes

D1 BZX61 3·3V 400mW Zener
D2 TIL209 or equivalent
D3 1N914

Miscellaneous

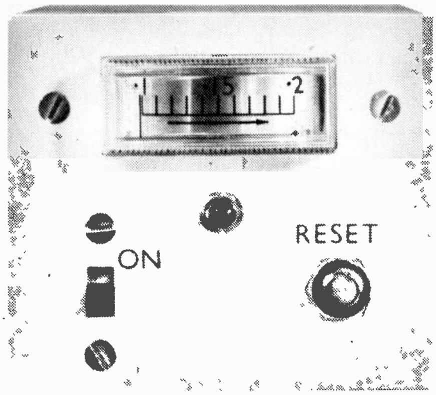
B1 9V PP3 battery
M1 150μA meter (see text)
Box, printed circuit, hardware

This means that the bistable will turn off as soon as the switch is released. The bistable is coupled to the 0·1Hz oscillator by R6.

The light is produced by an l.e.d., D2, which is driven directly by the bistable to save components. An l.e.d. is used because it is small and provides adequate light output from a current of less than 10mA whereas a filament bulb would probably require several times this current.

While the bistable is set, TR4 connects the top end of R4 to the positive supply to produce an emitter current of 200μA in TR3. On positive half cycles, the collector-base junction is forward biased as before and the current from R4 flows through the base lead of TR3. On negative half cycles, TR3 operates as a common base amplifier and its emitter current flows through the collector lead, increasing the rate of charge of C1 and hence raising the oscillator frequency.

C3 is the timing capacitor which is supplied with a constant charging current by TR6 while the bistable is set. Since the current is constant, the voltage across the capacitor is a linear function of time. A tantalum capacitor is used in this position because it has a low leakage current and a tolerance of 10 per cent. A tantalum bead could be used but the tolerance is worse. The total discharge current must be kept as low as possible so that the meter reading remains steady. Leakage through TR6 is prevented



by D3. The presence of R11 reduces the leakage through TR7. The maximum value of I_{CBO} for this type of transistor is low enough to be ignored. The buffer amplifier, which has a current gain greater than 10,000, takes only about 10nA at f.s.d.

RESET DRIVE

The base drive for the reset transistor, TR7, comes from the press switch via R8, R9 and R10 until it is shunted through TR5 when the bistable turns on. C2 was found to be necessary to prevent contact bounce from affecting the operation. If this component is omitted, the contact bounce will cause the reading to be set to zero as the switch is released and there may also be a tendency for the bistable to turn on as the switch is pressed.

METER SCALING

In the prototype, the meter reads from 100-200ms. The suppressed zero is obtained by virtue of the fact that the base-emitter voltage of TR8 must reach 0·5V before it conducts. The base-emitter voltage of TR8 is about 500mV so the resistor R12 is chosen to drop 500mV at f.s.d.; i.e. the value is given by:

$$R12 = \frac{0{\cdot}5}{\text{full scale current}}$$

A 150μA meter was used in the prototype but any other may be used if R12 is changed to the appropriate value.

Since the author did not have access to a timer during development, an indirect method was used to calibrate the meter. After 150ms, the voltage across C3 should be 750mV and the meter should read midscale. After a time t, the voltage E across C3 is:

$$E = \frac{It}{C3}$$

where I is the current provided by TR6 in microamps.

If a resistor is placed in parallel with C3 and the current is applied for a sufficient time, the voltage will be:

$$E = IR$$

where R is the value of the resistor.

By comparing the two equations above, it can be seen that the voltage when a 10 kilohm resistor is present is the same as that after 150ms when the resistor is not present. To calibrate the meter, a 10 kilohm resistor is temporarily connected in parallel with C3 and the press switch is held down until the l.e.d. turns on. VR1 is then adjusted until the meter reads mid-scale. The resistor is then removed. The accuracy of calibration obtained with

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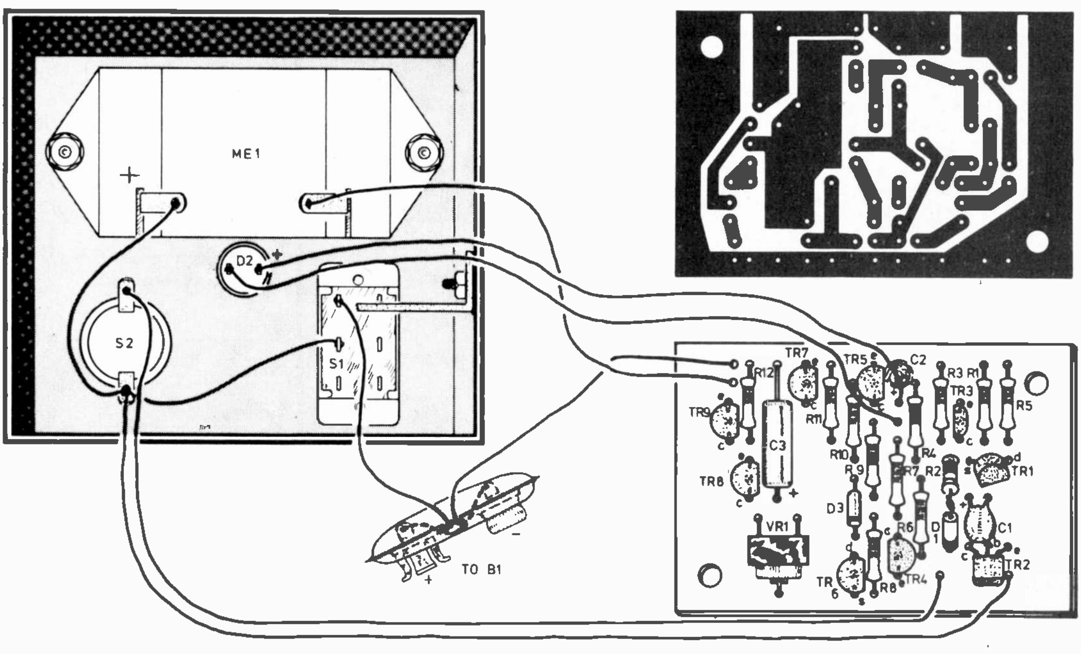
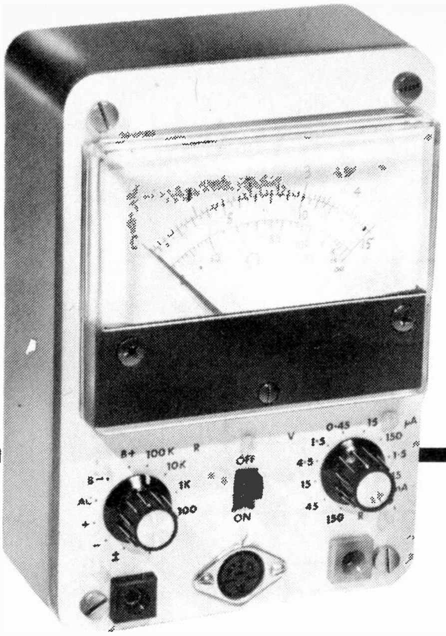


Fig. 3. Assembly details for Reaction Timer



ELECTRONIC MULTIMETER

By D. E. CROCKER

MODERN semiconductors are often operated at very low current levels so that the connection of a voltmeter drawing about 50μA may significantly change the potential which the user attempts to measure. Hence the need for an electronic multimeter in which the current for the meter movement is not taken from the circuit under test.

The multimeter to be described has an input resistance of 8MΩ on all voltage ranges and thus draws negligible current. Unlike a conventional multimeter, it is suitable for the measurement of small alternating voltages since the effect of voltage drop and non-linearity in the rectifier diodes is eliminated while an amplifying probe further extends the sensitivity.

AMPLIFIER CONFIGURATIONS

Each of the circuit configurations shown in Fig. 1 can be used to increase meter sensitivity. Fig. 1a gives a current amplification of $1 + R2/R3$, $R1$ acting as a multiplier as in a conventional voltmeter. This requires very high values of $R1$ on the higher voltage ranges if switching between ranges is to be kept simple.

The arrangement of Fig. 1b is better in this respect, since ranges are altered using a potentiometer, VR1, giving constant input resistance. Furthermore, frequency compensation is easier since the loop gain is constant and phase shift in the feedback loop is smaller; this allows a wider bandwidth to be obtained. However, the operational amplifier must have a very low input current, otherwise this will flow through the potentiometer giving rise to a range-dependent zero error.

Since the feedback essentially controls the current through the meter movement, the inclusion of a bridge rectifier as in Fig. 1c will not significantly

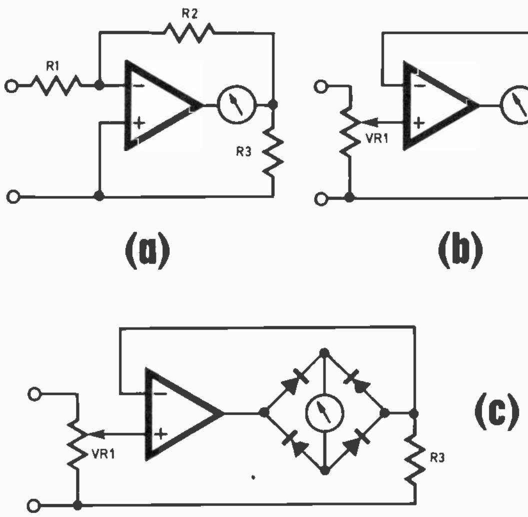


Fig. 1. Various methods of increasing meter sensitivity

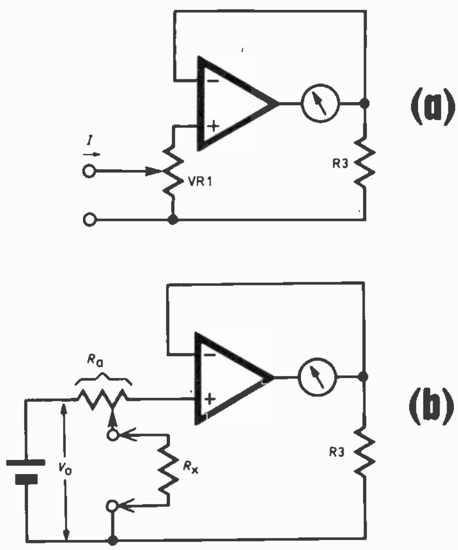


Fig. 2. Current and resistance measurement with an operational amplifier

MULTIMETER CIRCUIT DETAILS

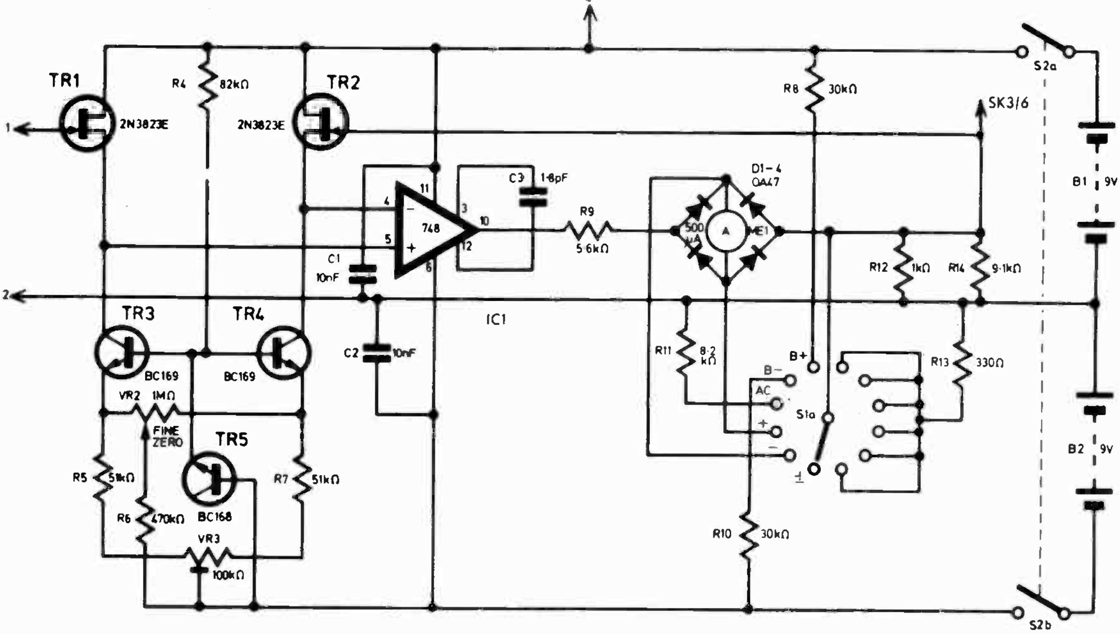


Fig. 3. Circuit diagram of a complete multimeter using f.e.t.s and an operational amplifier to give a high input impedance

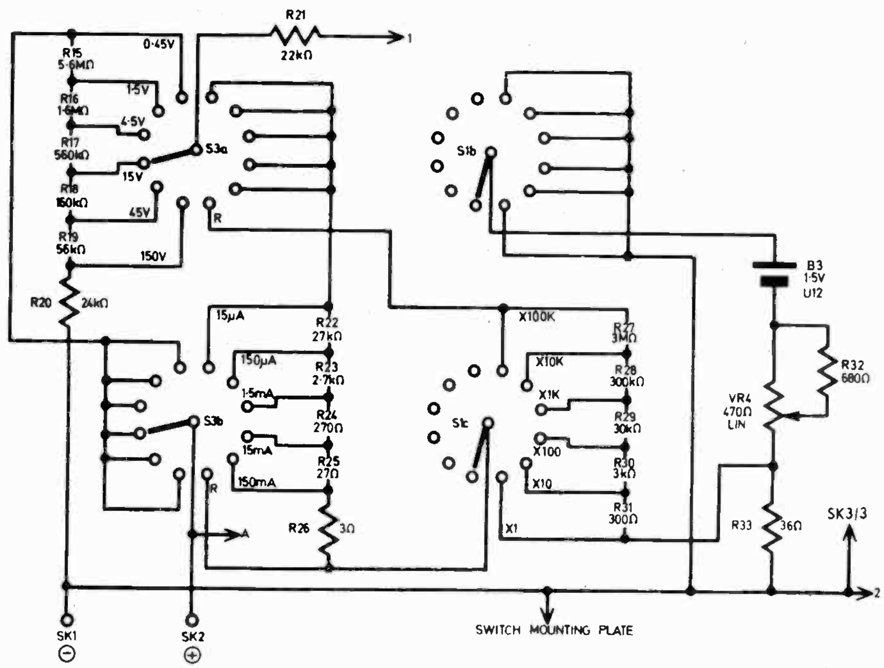


Fig. 4. Switching details for the circuit of Fig. 3

SPECIFICATION . . .

Voltage Ranges
0·45/1·5/4·5/15/45/150V a.c./d.c. f.s.d.

Input Resistance
8M Ω

Current Ranges
15/150μA/1·5/15/150mA a.c./d.c. f.s.d. Voltage drop 0·45V at f.s.d.

Bandwidth
Reading 2% down at 200kHz.

Resistance Ranges
6 forward reading ranges giving scale calibrations from 1 Ω to 100M Ω

Facilities
Can be set to respond to either polarity of input or both polarities. Internal batteries can be checked.

Accessories
÷10 a.c. range multiplier
Diode probe can be used for r.f. measurement.

alter the linearity of the circuit. This allows the meter to be used on a.c. as well as d.c. and protects the movement from incorrect input polarity.

Current ranges can be provided by measuring the voltage drop across a resistance through which the current flows; this is the lower half of the potentiometer VR1 in Fig. 2a.

The resistance ranges can use the resistance to be measured in a potential divider fed with a constant voltage V_0; the voltage across the unknown resistance R_X is given by $V = V_0 \cdot R_X/(R_A + R_X)$—see Fig. 2b, where R_A is that section of the potentiometer inserted between V_0 and R_X. This gives a non linear scale which is, however, forward reading.

THE AMPLIFIER

Using a basic circuit sensitivity of 450mV in the circuit of Fig. 3, a difference between the amplifier input terminals of 4·5mV would give a 1 per cent error. Since the output voltage for f.s.d. is about 4V (due to the inclusion of a series resistance R9 for overload protection) the amplifier open loop gain must be at least 1,000 for an error of less than 1 per cent.

The 748 amplifier used has a gain in excess of 10,000 so that the sensitivity could be increased to 45mV if required. A low input current is obtained by adding source followers TR1 and TR2, the source currents being stabilised by TR3, TR4 and TR5 used as a low current Zener diode, in order to eliminate drift with changing battery voltage.

S1 provides battery check facilities using R8/R10. In the a.c. position the sensitivity is increased to give an r.m.s. reading on sinusoidal a.c. By shorting out one of the diodes, the meter can be made to respond to one polarity of input only, hence the + and − positions. On resistance ranges the sensitivity is increased to reduce the current taken from the battery B3.

Fig. 4 shows the complete range switching circuitry. The number of ranges provided has been limited so that only two 12-way switches are required (S1 and S3).

COMPONENTS

The meter movement chosen for the prototype was an SW100 type as this is a convenient size. Unfortunately only the tip of the needle is knife-edged, but this covers the two principal scales.

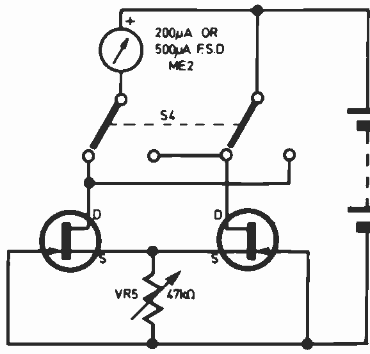


Fig. 5. F.e.f. matching circuit

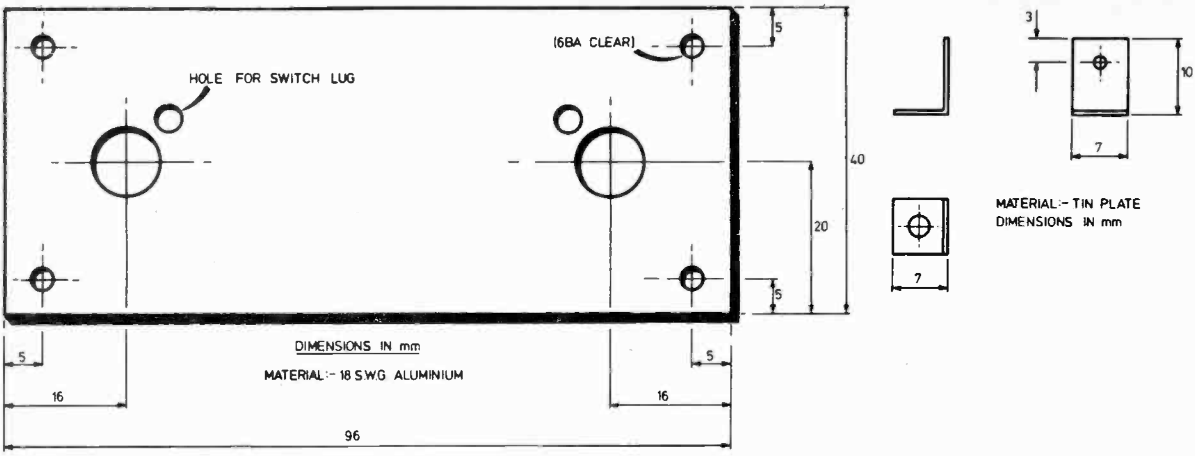
The only critical components are the field effect transistors TR1 and TR2 as it is essential that these have low gate leakage. 2N3819 types were found unsatisfactory in this respect, but the 2N3823E type specified was found to have typically less than 50pA leakage. A matched pair of transistors is needed, ideally matched for drain currents differing by less than 50μA when the gate-source voltages are equal and the average drain current is 200μA, although a pair matched for similar gate-source voltages proved satisfactory in the prototype.

In the prototype the f.e.t.s were matched by Electrovalue Ltd. for similar gate-source voltages at a specified drain current. The matching can be carried out using the circuit of Fig. 5 and here, to determine if a pair of devices shown are reasonably matched the meter is switched to read the drain currents alternately.

The 46kΩ potentiometer is slowly reduced until the sum of the two readings is 200μA. If the difference between the pair is less than 50μA they are suitable.

The range selection resistors are specified as 1 per cent tolerance although a fair accuracy is obtained with 2 per cent types. The 5·6MΩ and 1·6MΩ resistors may have to be selected from 5 per cent components using a bridge.

VR2 and VR4 were miniature potentiometers with a screwdriver slot on the rear; type P20 is suitable. Larger types will not fit the circuit board shown.



Details of switch mounting plate and battery brackets

The on/off switch employed was a slider type; this takes up less space than a rotary type but has only two poles so the cell used on resistance ranges is switched by S1 instead.

CONSTRUCTION

The multimeter should be housed in a well insulated case, and in the present instance a 160 × 105 × 55mm p.v.c. box was used. The amplifier, and the cell used for resistance ranges, are mounted on a Veroboard panel fixed on the meter movement. The Vero and component layout is shown in Fig. 6. R14 and C3 are mounted above the board on Vero-pins for easy adjustment.

Range selection resistors are mounted on the associated switch wafers and the switches are fixed to an aluminium panel which provides a degree of screening. The batteries are fitted on the same panel, between the switches and the panel is fixed to the front of the p.v.c. box using ½in. 6BA tapped pillars.

S2 and SK3 are fitted under the aluminium panel and this requires the tags to be cut short due to the small clearance involved. The accompanying photographs show the layout in the p.v.c. box. Nylon bolts are used for fixings to the front panel for safety.

COMPONENTS . . .

Resistors

R1, 2, 3	See text		R21	22k Ω	
R4	82k Ω		R22	27k Ω	
R5	51k Ω		R23	2·7k Ω	1%
R6	470k Ω		R24	270 Ω	
R7	51k Ω		R25	27 Ω	
R8	30k Ω 2%		R26	3 Ω	
R9	5·6k Ω		R27	3M Ω	
R10	30k Ω 2%		R28	300k Ω	
R11	8·2k Ω		R29	30k Ω	2%
R12	1k Ω (see text)		R30	3k Ω	
R13	330 Ω		R31	300 Ω	
R14	9·1k Ω (see text)		R32	680 Ω	
R15	5·6M Ω		R33	36 Ω 2%	
R16	1·6M Ω		R34	22k Ω	
R17	560k Ω	1%	R35	10M Ω	
R18	160k Ω		R36	18k Ω	
R19	56k Ω		R37	47k Ω	
R20	24k Ω		R38	4·7k Ω	
			R39	47k Ω	
			R40	100 Ω	
			R41	100k Ω	

All ⅛W, 5% carbon film unless otherwise stated

Potentiometers

VR1 See text
VR2 1M Ω Lin. Miniature (see text)
VR3 100k Ω Subminiature horizontal preset
VR4 470 Ω Lin. Miniature (see text)
VR5 47k Ω

Capacitors

C1, 2 0·01μF disc ceramic
C3 1·8pF ceramic (see text)
C4, 5 0·068μF polyester or polycarbonate
C6 10μF elect.
C7 1,000pF ceramic

Integrated Circuit

IC1 748 d.i.l. operational amplifier

Transistors

TR1, 2 2N3823E matched pair of f.e.t.s (see text)
TR3, 4 BC169 (2 off)
TR5 BC168
TR6 2N3823E
TR7 BC258B

Diodes

D1–4 OA47 (4 off)
D5 OA79

Switches

S1 3-pole, 12 way rotary (Doram, Maka)
S2 2-pole slider
S3 2-pole, 12 way rotary (Doram, Maka)
S4 2-pole change-over

Miscellaneous

ME1 500μA f.s.d. meter (SW100, Laskey)
ME2 200μA or 500μA, see text
SK1, 2 4mm black and red sockets
SK3 6-pole DIN socket
PL3a, c, d 5-pole DIN plugs
PL3b 6-pole DIN plug
B1, 2 9V, PP3
B3 1·5V U12
Case, 160 × 105 × 55mm p.v.c.; Veroboard, 0·1in matrix 95 × 95mm; 18 s.w.g. aluminium sheet, 106 × 40mm; PP3 battery clips; 6BA pillars, wire etc.

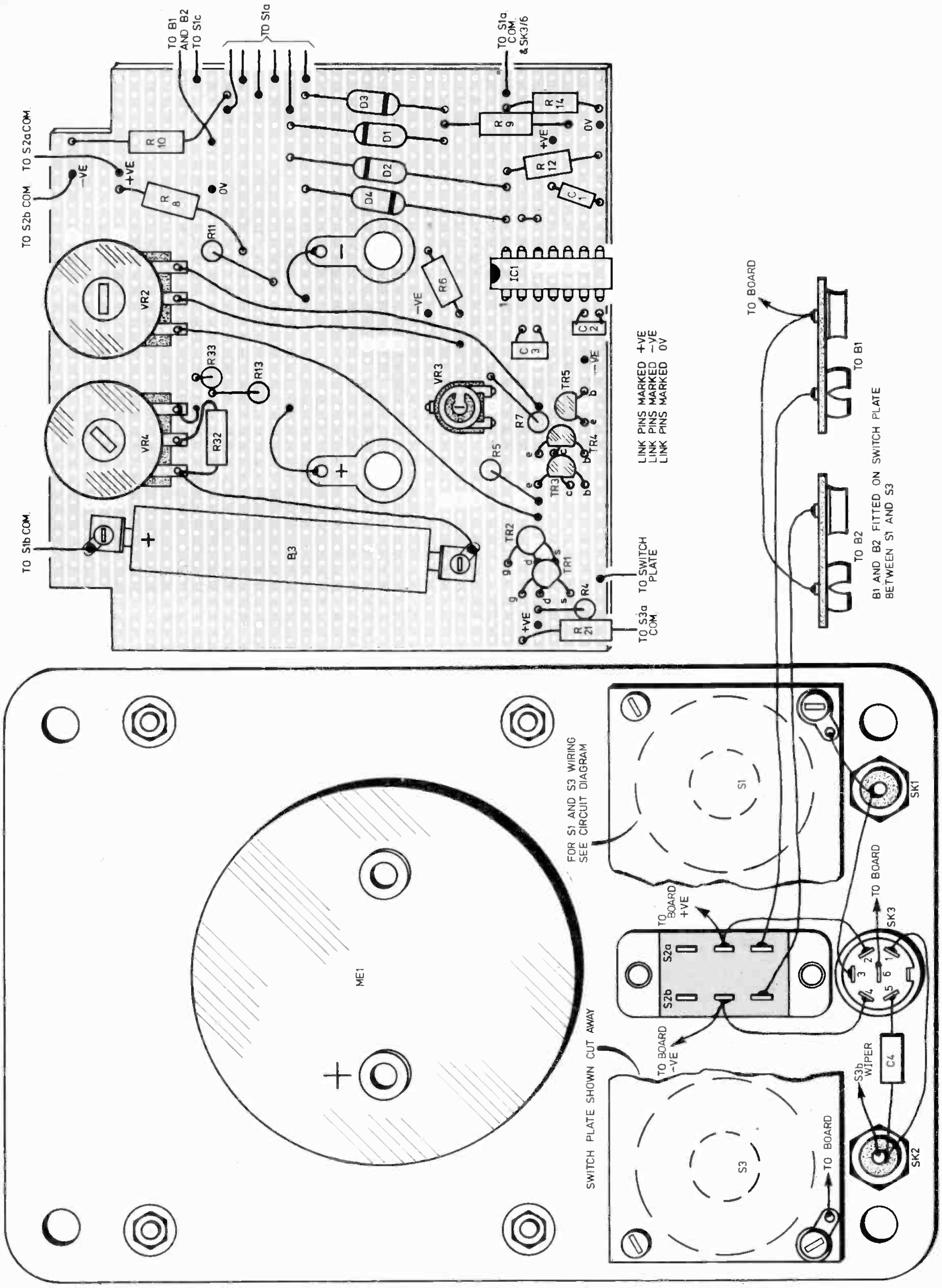
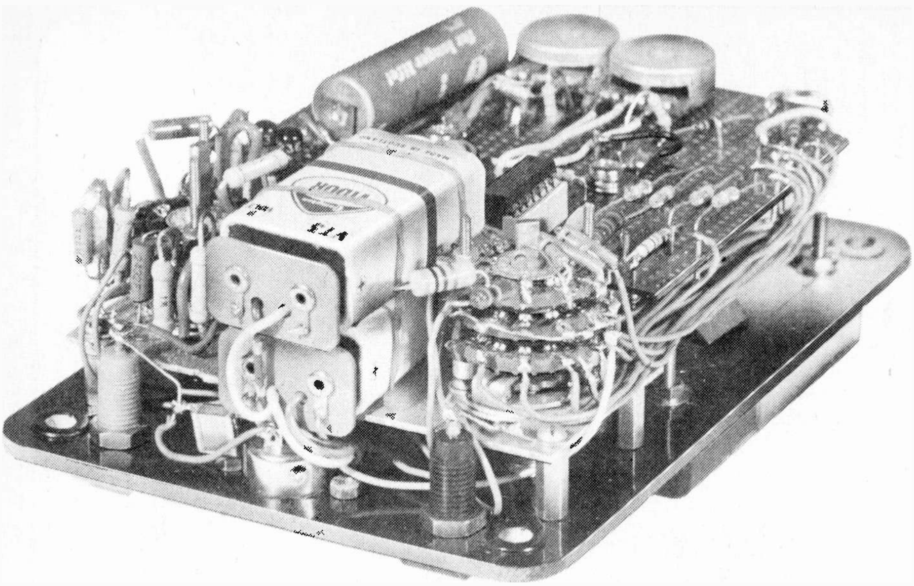


Fig. 6. Component layout and Veroboard cutting details



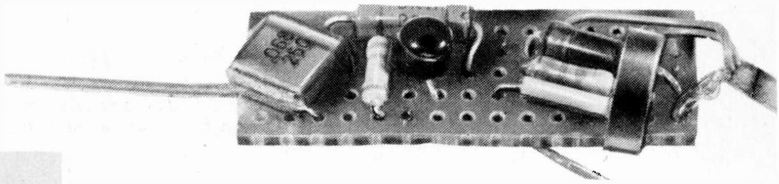


Table 1

Scale marking	Degrees	Scale marking	Degrees
0	0	40	49·1
1	2·6	45	51·7
2	5·1	50	54·0
3	7·4	60	57·9
4	9·6	70	61·0
5	11·7	80	63·5
6	13·7	90	65·7
7	15·6	100	67·5
8	17·4	150	73·6
9	19·1	200	77·1
10	20·8	300	81·0
15	27·9	400	83·1
20	33·75	500	84·4
25	38·6	1k	87·1
30	42·6	Infinity	90·0
35	46·1		

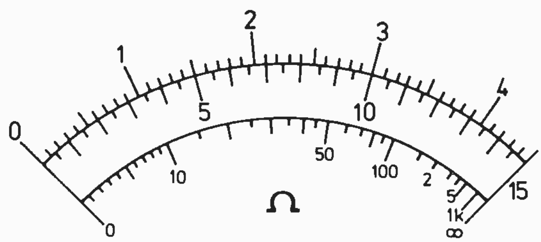


Fig. 7. Scales used on the prototype instrument

SCALING THE METER

The choice of ranges in multiples of 4·5 and 15 makes scaling easy since using a movement having a 90° full scale deflection (such as the SW100), increments of 0·1 on the 0 to 4·5 scale occur at intervals of 2° while increments of 0·5 on the 0 to 15 scale are at intervals of 3°. These scales are thus easily marked off using a protractor.

The non-linear resistance scale may be produced from Table 1. The scales are marked out on white paper which can be glued to the existing aluminium scale. The arrangement of the scales can be seen from Fig. 7.

SETTING UP

Select the 150V range and switch on. The meter should be zeroed by adjustment of the preset VR3, using VR2 as a fine adjustment. If this is impossible, the amplifier may be unstable (increase C3) or TR1 and TR2 may be mismatched.

Once zeroed, sensitivity can be adjusted by variation of R14 using a standard cell or other standard voltage. If no standard is available, R12 may be 1kΩ 1 per cent and R14 may be 9·1kΩ 5 per cent; this will give reasonable accuracy. If a signal generator is available, C3 may be optimised. With C3 too low the meter will oscillate or show a peak in sensitivity at about 500kHz, while increasing C3 too far reduces the bandwidth.

USING THE MULTIMETER

For voltage or current measurement select the range on S3 and set S1 to AC, +, − or ± as appropriate. If one side of the input is "earthy" this should be connected to SK1 (black socket).

MULTIMETER PROBE DETAILS

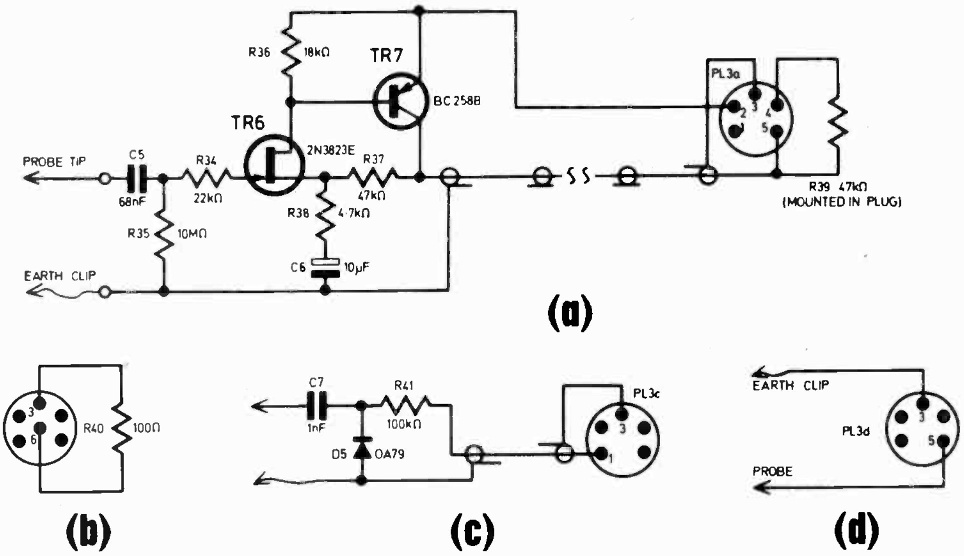
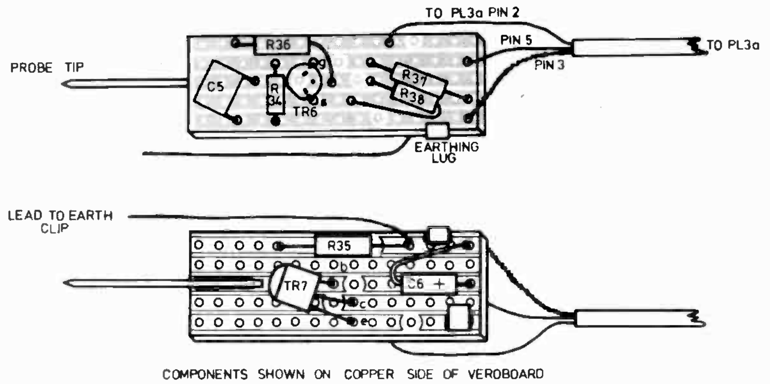
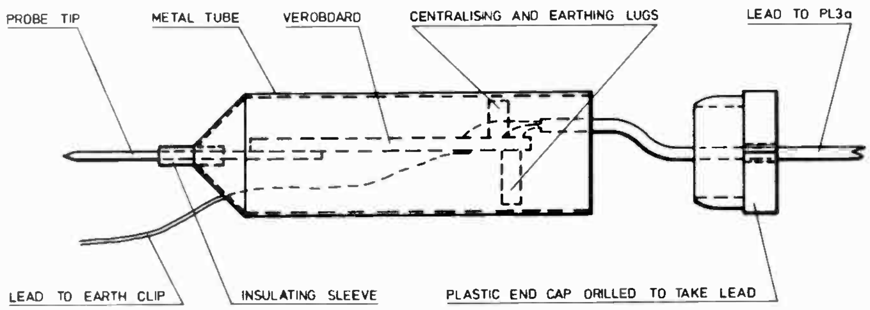


Fig. 8. Various probe and extender circuits for use with the multimeter. The plug numbering is as viewed from the rear (wire side) of the plugs

A



A.c. probe wiring and layout



A.c. probe case details

For measuring resistance, set S3 to R and select the range of multiplier on S1. Accuracy is greatest about one third way up the scale. Note that current is drawn from B2 whenever S1 is set to a resistance range, even with the meter switched off, so S1 should not be left in this position. Unlike a conventional ohm meter, the resistance range is "zeroed" by adjusting VR4 to set the reading to infinity with the leads open circuit. VR4 is accessed through a hole in the back of the case as there is insufficient room on the front panel; however, adjustment is needed only to compensate for battery ageing and not between ranges.

The batteries may be checked by selecting B+ or B− on S1 (preferably with the test leads unplugged), reading the battery voltage directly from the 0 to 15 scale. B1 and B2 should always be replaced together.

RANGE EXTENSION

The sensitivity of the voltage and current ranges may be extended by inserting into SK3 a 6 pole DIN plug with a 100Ω resistor wired between pins 3 and 6 (Fig. 8b). On current ranges this has the advantage of reducing the maximum voltage drop across the multimeter from 450mV to 45mV. However, accuracy and bandwidth are both reduced.

For a.c. measurements an amplifying probe is preferred. The design of Fig. 8a has a gain of ten times and can be made conveniently small.

R.F. measurements can be made using a diode probe, such as the one in Fig. 8c.

When measuring a.c. voltages where a d.c. potential is present, the blocking capacitor C4 may be employed by using the probe of Fig. 8d. ★

REACTION TIMER *continued from page 496*

this method depends on the accuracy of the 10 kilohm resistor and the $15\mu F$ capacitor C3. A more precise calibration may be achieved by applying a pulse of known duration to the drain of TR6.

CONSTRUCTION

The prototype was built into a small plastic box as shown in the photograph. Exact measurements are not given because the size of box used will depend on the sizes of the components chosen by the constructor. Most of the components are mounted on a small printed circuit board (Fig. 3).

COMPONENTS

The bipolar transistors may be replaced by any reasonably high gain alternatives such as BC108, BC178, etc. The f.e.t. TR1 may be replaced by any *n*-channel f.e.t. with V_p less than 2·5V if C1 is altered to compensate for any change in frequency of the oscillator. If TR6 is replaced by a different f.e.t., it may be necessary to use a different value of resistance for VR1.

The meter used in the prototype was a cheap, rather non-linear tuning meter. If an accurate reading of time is desired, a better meter and a linear buffer amplifier should be used. ★

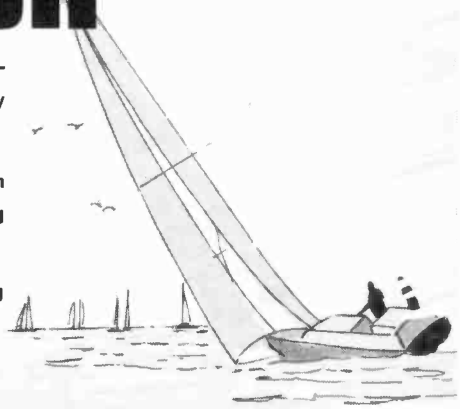
...with outdoor leisure activities in mind we present the

PE Portable GAS IGNITOR

The first D.I.Y. design for a portable electronic gas ignitor powered from a 1·5V dry cell.

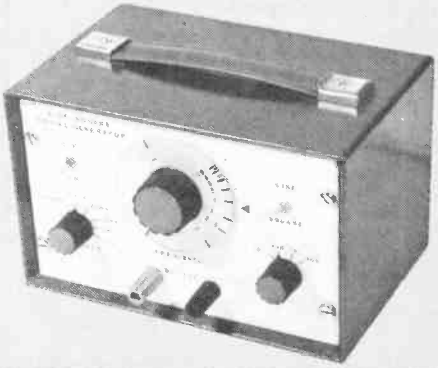
The ignitor produces a continuous stream of high voltage sparks capable of lighting natural, town and bottled gases.

Ideal for camping, boating and caravanning as well as for use in the kitchen.



Also... SINE/SQUARE WAVE SIGNAL GENERATOR

Output frequency is variable from 10Hz to 100kHz in four switched ranges. The output signal, which is 10V peak, can be attenuated down to 1mV. The output signal will drive loads down to 600 Ω on the 1 to 10mV ranges and 100k Ω above 20mV.
The square wave facility is very useful for testing audio amplifiers. Some of the principles behind square wave testing techniques as particularly applicable to the hi-fi field will be given.



GUITAR EFFECTS PEDAL

Add eight—yes eight!—different sounds to your guitar by building this special effects pedal. Using an oscillator, a voltage controlled filter and a voltage controlled amplifier this pedal gives eight basic effects, all of which can be varied.

PRACTICAL ELECTRONICS

JULY 1975 ISSUE ON SALE JUNE 13, 1975—PRICE 30p

PLACE A FIRM ORDER WITH YOUR NEWSAGENT TO AVOID DISAPPOINTMENT

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.

NEW CALCULATORS

In a bid to win a larger share (if that's possible) of the lucrative European calculator market, Sinclair Radionics have just announced the first models of a new range of calculators called the Oxford.

The three models, which are mains/battery portables, are the Sinclair Oxford 100, 200 and the 300 Scientific. The recommended retail prices are £13·98, £21·55 and £32·35 respectively.

The new Oxfords are designed as mains operated desk units, but with the facility for operating for several weeks from an internal 9V battery. All models include excellent large press keys and an angled red display for easy viewing.

The Oxford 200 has the addition of a memory and an automatic percentage key.

The optional mains adaptor unit for use with each of the Oxford calculators has a recommended retail price of £3·19.

Full details and addresses of nearest stockists of Sinclair calculators can be obtained from **Sinclair Radionics Ltd., London Road, St Ives, Huntingdon.**

THEATRE MIXERS

A range of high quality, transportable stereo sound mixing desks, specifically developed for theatre use, is announced by Cambridge Electronic Workshop.

The standard desk has 10 channels and contains cue lights, show relay/intercom systems, a monitoring system, loudspeaker switching and tape remote controls, all mounted on the front panel for ease of operation during performances.

The desks are capable of absorbing up to 30dB of overload at 0·1 per cent, enabling a good mix using the channel faders. The equalisation frequencies have been chosen for theatre use, bass tip-up filters are included and the presence frequency is continuously variable. Noise is claimed to be better than 126·5dB.

Further technical details and prices are available from **Cambridge Electronic Workshop, 4 Water Lane, Oakington, Cambridge, CB4 5AL.**

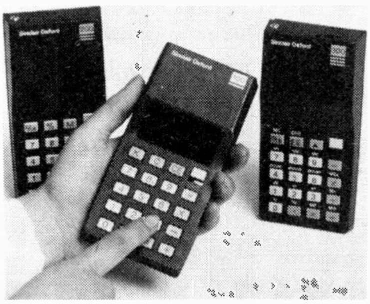
PRINTED CIRCUIT KIT

A new printed circuit kit containing all the necessary materials for producing "one off" boards is available from Home Radio (Components) Ltd.

By using one of the now familiar "special" marking pens, it is claimed that with a little care and by following instructions even the inexperienced can produce acceptable fairly complex printed circuit boards.

The kit contains two pieces of copper clad board, ferric chloride, etch resist pen, plastics etchant trough, tweezers, spoon and a laminate cutter. Also included in the kit is a booklet of instructions which readers are advised to read before handling the ferric chloride etchant.

The price of kit is £3·50 plus VAT and is available from **Home Radio (Components) Ltd., 234–240 London Road, Mitcham, Surrey, CR4 3HD.**



Oxford range of calculators from Sinclair Radionics

LIVE RHYTHMS

Probably the severest criticism of electronic rhythm generators is the monotony of the single bar sequences produced. Any owner of an electronic organ soon becomes very sparing in its use for this reason. A new development from Scotland claimed as the world's first fully synchronised continuous "live" rhythm unit departs entirely from the standard version.

Called the "Powerhouse", it uses ¼in multi-track continuous loop tape in eight cassettes. In all, 32 live rhythms have been recorded and each rhythm may be played in three different fashions: basic rhythm, more complex rhythm and a combination of both in synchronisation.

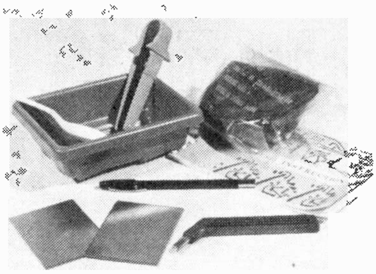
A mix control has been incorporated into the machine to facilitate the adjustment of the two volume levels in relation to each other.

When a musician wishes to change rhythms he can do so either by using a button on the front of the Powerhouse, or by using the special rhythm control foot pedal. A mute mechanism is another of the Powerhouse's features; once again it can be operated from the main control panel or by the special foot pedal.

A sophisticated electronic speed governor allows the musician to vary the tempo over a very wide range to coincide with his own requirements. Once set, the speed is electronically locked until the tempo control is reactivated.

The Powerhouse will produce sounds in mono or stereo, depending on the amplifier used. Coupled to a conventional hi-fi stereo amplifier, it will double as a superb quality 8-track stereo cartridge player.

Retailing at approximately £140, the unit will be available from distributors as specified by **Bandmast Limited** of **Gloucester Street, Glasgow.**



Home Radio Printed Circuit Kit

IMPORTANT NOTICE
BUDGET, APRIL 1975

Prices quoted in this issue may be subject to alterations arising from the new Budget proposals

The Bandmaster Powerhouse Rhythm Unit

CHROMASONIC electronics

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

RESISTORS

The standard ranges of Resistors stocked are either E12 or E24 and the values are all in multiples of ten times the decade shown below. The E12 items are only those in bold type. The E24 items are both those in bold and light type.

10	**18**	**33**	56
11	20	36	62
12	**22**	**39**	**68**
13	24	43	75
15	**27**	**47**	**82**
16	30	51	91

CARBON FILM 1/4 watt ± 5% tol. 2p ea.
E12 Series 10 to 330K

CARBON FILM 1/2 watt ± 5% tol. 1½p ea.
E24 Series 10 to 10M

'CERMET' THICK FILM 1/2 watt ± 2% tol. 8p ea.
E12 series 56 to 150K

METAL OXIDE FILM 1/2 watt ± 2% tol. 4½p ea.
E12 series 10 to 1M

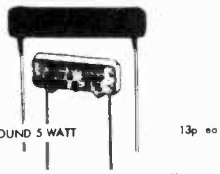
CARBON COMPOSITION 1/2 watt 4½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON COMPOSITION 1 watt 5½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON FILM 1 watt ± 5% tol. 3½p ea.
E12 series 10 to 10M

CARBON FILM 2 watt ± 5% tol. 6½p ea.
E12 series 10 to 10M

WIREWOUND 2½ watt ± 5% tol 0.22 to 0.47 15½p
E12 series ± 10% tol 1 to 270Ω 13p



WIRE WOUND 5 WATT 13p ea.

½	**25**	**250**	**1.5K**
1	30	270	1.8K
1.8	39	**300**	2K
2.2	**50**	330	2.2K
2.7	60	350	**2.5K**
3.3	**68**	400	2.7K
3.9	75	470	3K
4.7	82	**500**	3.3K
5	**100**	560	**3.5K**
5.6	125	600	3.9K
6.8	133	**680**	4.7K
8.2	**150**	**750**	**5K**
10	180	820	5.6K
15	**200**	**1K**	**6.8K**
21	220	1.2K	8.2K

WIRE WOUND 10 watt 14p ea.
All the values shown in bold in the 5 watt range

WIRE WOUND 10 watt ± 5% tol. 20p ea.
10K ; 15K ; 20K ; 25K

WIRE WOUND 15 watt 13½p ea.
All the values from 10 upward shown in bold in the 5 watt range.

POTENTIOMETERS

5K	250K	Log or Lin Less Switch (and 1K Lin)	14p
10K	500K	Log or Lin with Switch	26p
25K	1 Meg	Dual Less Switch	46p
50K	2 Meg	1 Meg Log only	57p
100K		10K Log + 10K Antilog Less Switch	46p

Sliders

10K, 25K, 50K, 100K — Single 33p; DUAL 55p

Presets

Vertical or Horizontal
.1 Watt 5½p .25 Watt 7p

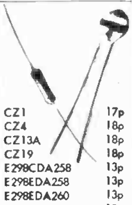
100	1K	10K	100K	1Meg
250	2.5	25K	250K	2.5 Meg
500	5K	50K	500K	5Meg

Cermets

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

40p

VDR's & Thermistors



CZ1	17p
CZ4	18p
CZ13A	18p
CZ19	18p
E298CDA258	13p
E298EDA258	13p
E298EDA260	13p
E298EDA262	13p
E298EDA265	13p
E298EDP268	13p
E298ZZ05	13p
E298ZZ06	13p
E299DDP336	14p
E299DDP338	14p
E299DDP342	14p
E299DDP348	14p
GL16	£1.21
GL23	£1.21
R53	£1.49
R54	£1.61
VA1005	16p
VA1026	16p
VA1033	16p
VA1034	16p
VA1039	16p
VA1040	16p
VA1053	16p
VA1055S	16p
VA1056S	16p
VA1066S	17p
VA1067S	19p
VA1077	19p
VA1098	21p
VA1104	31p
VA1107	29p

CAPACITORS

Ceramic Plate

Mullard C333 Series 63 Volts Wkg.
all at 5½p each

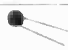
1.8pF ± 0.2pF	12pF ± 2%	68pF ± 2%
2.2pF	15pF	82pF
3.3pF	18pF	100pF
3.9pF	22pF	120pF
4.7pF	27pF	150pF
5.6pF	33pF	180pF
6.8pF	39pF	220pF
8.2pF	47pF	270pF
10 pF	56pF	330pF

Mullard 630 series 40 volts ± 10% tol
* 629 series 100 volts
all at 5½p each

390 pf	1000 pf	3300 pf
470 pf	1200 pf	3900 pf
560 pf	1500 pf	4700 pf
680 pf	1800 pf	* 10 nf
820 pf	2200 pf	* 22 nf
	2700 pf	

Erie Monolithic Ceramic 30 Volts Wkg.

27 nf 11p; 47 nf 13p; 100 nf 17p



Low Voltage Disc Ceramics
all at 5½p each

0.01 uF	18v	0.1 uF	30v
0.022 uF	18v	0.22 uF	6v
0.047 uF	18v	0.47 uF	3v

Mylar Film 100 Volts Wkg.

1000 pf	2½p	0.05 uF	3½p
2000 pf	2½p	0.068uF	5p
5000 pf	2½p	0.1 uF	5p
0.01 uF	3½p	0.2 uF	6½p
0.02 uF	3½p	0.47 uF	7p
0.04 uF	3½p		

Polystyrene

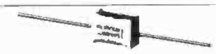
MULLARD C295 Series 63 volts
Tolerance ± 1% Polystyrene

6.800pF (6.8nF)	C295 AH/D6K8	11p
8.200pF (8.2nF)	C295 AH/D8K2	11p
13.000pF (13nF)	C295 AH D13K	15p
18.000pF (18nF)	C295 AH D18K	15p
20nF (0.02μF)	C295 AH/D20K	15p
30nF (0.03μF)	C295 AH/D30K	18p
39nF (0.039μF)	C295 AH/D39K	18p
51nF (0.051μF)	C295 AH/D51K	25p

Polystyrene 160 volts Wkg.
Tolerance ± pF up to 33pF ± 5% 47pF up
10 pf to 10,000 pf (0.01 uF) in multiples of:
10 ; 15 ; 22 ; 33 ; 47 ; 68.
all 5p each
Nimarks 0.22μF ± 5% 1000 11p
Wima MKS 0.22μF
± 5% 100V 11p

Mullard C280 Series. 250 Volts Wkg.
Metallised Polyester Film

0.01 uF	3½p	0.22 uF	5½p
0.015 uF	3½p	0.33 uF	7p
0.022 uF	3½p	0.47 uF	9p
0.033 uF	3½p	0.68 uF	12p
0.047 uF	3½p	1.0 uF	14½p
0.068 uF	4 p	1.5 uF	22p
0.1 uF	4½p	2.2 uF	26½p
0.15 uF	4½p		



Mullard C281 series 400 volts Wkg
Metallised Polycarbonate Film 10%

0.01 uF	5p	0.1 uF	8p
0.015 uF	5p	0.15 uF	9p
0.022 uF	5p	0.22 uF	11p
0.033 uF	6p	0.33 uF	15½p
0.047 uF	6½p	0.47 uF	16½p
0.068 uF	6½p		

CAPACITORS

Silvered Mica 350V.
Tol.± 0.5pf 11p each

2.2 pf	18pf	30pf
3.3 pf	20pf	33pf
5 pf	22pf	39pf
10 pf	25pf	47pf

Tol.± 1% 11p each

50pf		150pf
56pf	82pf	180pf
68pf	100pf	200pf
75pf	120pf	220pf

12p each

250pf	330pf	560pf
270pf	390pf	680pf
300pf	470pf	820pf
	500pf	

17p each

1000 pf	1500pf	220pf
	1800pf	

26p each

2700pf	3600pf	5000pf
	4700pf	

33p each

6800pf	8200pf	10000pf

Mixed Dielectric 600 Volts Wkg.

0.01 uF	8p	0.1 uF	9 p
0.022 uF	8p	0.22 uF	17½p
0.033 uF	8p	0.47 uF	26½p
0.047 uF	8p	1 uF	36½p
0.068 uF	9p		

Mixed Dielectric 1000 Volts Wkg.

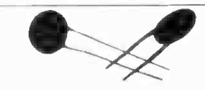
1000 pf	6½p	0.022uF	11p
2200 pf	6½p	0.047uF	13p
3300 pf	7p	0.1 uF	13p
4700 pf	7p	0.22 uF	24½p
0.01 uF	10p	0.47	33p

Solid Tantalum Beads
all at 16½p

0.1 uF	35v	10 uF	6.3v
0.22 uF	35v	10 uF	16v
0.47 uF	35v	10 uF	25v
1.0 uF	35v	22 uF	16v
2.2 uF	35v	47 uF	6.3v
4.7 uF	35v	100 uF	3v

Feed-through Ceramics

1000 pf 350v 6p



Disc Ceramics 750 Volt Wkg.
all at 5½p each

470 pf; 1000 pf; 5000 pf; 0.01 uF

Tubular HI-K Ceramics 750 Volts Wkg.

1000 pf	5½p	3000 pf	5½p
1500 pf	5½p	5000 pf	5½p
2000 pf	5½p	0.01 uF	5½p

Pulse Ceramics all at 10p each

12 kv D.C. Wkg		8kv D.C.
10pf	120pf	200pf
22pf	140pf	220pf
68pf	150pf	250pf
82pf	180pf	270pf
100pf	200pf	300pf

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INGENUITY UNLIMITED

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

CUTTING LOUDSPEAKER BAFFLES

THE chances are that when you come to construct a loudspeaker cabinet using only a modest supply of tools you will drill a ring of holes using a power or hand drill and then cut between the holes with a padsaw for the loudspeaker baffle board holes.

This is a laborious and rarely attractive method which can be avoided quite simply by using a home-made trepanning tool.

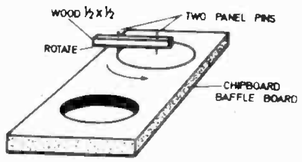


Fig. 1

As can be seen in Fig. 1, a bit of scrap wood about ½in. square with a couple of panel pins hammered through does the job. One of the nails is hammered through close to one end of the wood arm whilst the second is hammered through at a distance equal to the radius of the required hole from the first.

The first pin can now be hammered into the board at the centre of the required hole and the timber arm used as a lever to draw the other round the board to cut a path through the board.

It will be necessary to progress the cut from both sides of the board so as to avoid breaking of the hole edges when the cut is being finished.

This method was developed to cut holes in chipboard, always a difficult material to cut cleanly, and can no doubt be used on other materials with a little experiment. It could for example be improved by sharpening the tip of the cutting nail to an edge and by perhaps using heavier nails.

Using the original suggestion it takes about 10 minutes to cut a normal hole in chipboard and it should be remembered that the method can equally well be used in conjunction with a suitably sharp chisel to cut the recesses required for some loudspeakers such as the KEF T27.

K. J. Honour.
Kent.

RANDOM FLASHING DISPLAY

BASIS of operation of the flashing light display unit shown in Fig. 1 is fairly simple. TR1, TR2 form an astable multivibrator (they can be any general purpose switching transistors), TR2 is in the on state for about 0·01s which brings the collector voltage close to ground potential, logic 0.

This output is inverted by the first NAND gate in IC1 to make the output compatible with TTL. Thus one input of the second NAND gate in IC1 is at logic 1. Under these circumstances the three loop-connected gates in IC1 will now oscillate and in the prototype this was found to occur at about 24MHz.

During oscillation the four bistables in IC2 and IC3 will count something like 240k pulses, a number which will vary by about 1 per cent by virtue of the variation in oscillation frequency. In this way the count will be randomised.

The outputs of the bistables are monitored by transistors TR3 to TR6. If a bistable output is at logic 1 the associated transistor will be on and the series-connected relay switched. In the prototype the relays were used to switch coloured lights at 60W.

If a linear potentiometer is used for VR1 the time interval between light changes will be found to be directly proportional to the angle of rotation of the pot. Indeed, with careful timing the equipment can be made to appear music-controlled when used with sound equipment.

The J, K and Clear inputs of the two SN7473's must be at logic 1 so they should be connected together and then to the +5V rail via a 1kΩ resistor.

P. Hobson.
Sheffield.

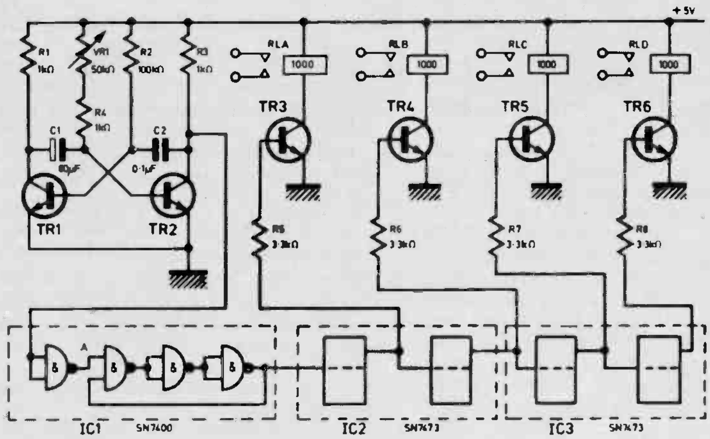


Fig. 1

INDUSTRY NOTEBOOK

By Nexus

GOOD AND BAD

First the bad news. Last month I reported that Transitron had pulled out of semiconductor production in Europe to concentrate on manufacture in the United States. Now I have to record that Microsystems International Ltd., the Canadian manufacturer, is closing down semiconductor manufacture altogether following heavy losses due, it is said, to an accelerated drop in demand and substantial price erosion in a softening market.

Microsystems International had made quite a splash in the industry since starting up in 1968. The company was regarded as something of a showpiece with a high level of technology, especially in MOS memories. The Canadian Government backed the venture with cash and sales were going well, running at 30 million dollars in 1974. But although this figure was nearly 9 million dollars up on 1973 so were the losses which increased to 12 million dollars.

However, Northern Electric, MIL's parent company, has been enjoying record profits and sales and it may yet turn out that MIL will have some role in the group though, apparently, not as a semiconductor manufacturer.

GOOD BAROMETER?

The ebb and flow of the fortunes of semiconductor manufacturers ought to be a good barometer for the international electronics industry as a whole. After all they are the people who make the fundamental building blocks of almost any modern equipment and, to a large extent, determine the trend of technology. But this particular barometer needs observing with a sceptical eye. It tends to overshoot and undershoot and is nearly always out of phase with what is actually happening.

In short, it is very tricky to make forecasts of future demand in what is always a volatile situation, and even more tricky to strike the right balance of production capacity which must be enough to satisfy demand in good times and not so much as to produce big losses when times are bad and the manufacturing capacity, installed at great expense, is under-utilised.

The manufacturers like to work along with the equipment builders to get some idea of future trend. They beg customers to let them know of future requirements. But if the equipment builders themselves don't know how much they are going to sell, say, over the next two years, this is hardly helpful.

So the semiconductor manufacturers are forced to base forecasts on the trend of current orders and they don't like what they see. They then cut labour capacity as a precautionary measure and also cut investment in modernisation of plant. It is thought that world wide, semiconductor manufacturing capacity is already 50 per cent down through outright closures and other cut-backs. When good times come back there will be severe shortages and these could start as early as next year.

BUT IN THE FUTURE

In 1976 or 1977 when the semiconductor manufacturers have more orders than they can cope with and quote six months or more delivery time, it is then that the equipment manufacturers start ordering far more than they need and on more than one manufacturer in the hope of meeting their requirements. Just like trade unions asking for a £40 rise in the expectation of settling for £10. Faced with a seemingly unprecedented demand, the semiconductor manufacturers expand and are once again faced with over capacity.

How this unhappy cycle of events can be overcome is completely unknown and presumably we shall have to live with it for as long as world trade remains cyclic.

Everything, however, is not all gloom and doom. The Microelectronics Division of the French company CIT-Alcatel is planning to double turnover by 1980. And the Spanish company Piher, currently only making discrete devices, is planning to expand into i.c.s. Plessey has just introduced a non-volatile MNOS memory, claimed to be a world first, and with many new applications.

The latest problem is armed invasion. Indians of the Navajo tribe recently occupied Fairchild's Shiprock, New Mexico, plant in protest against redundancies. What next?

BRITISH IS BEST

It's not often that the British sell automotive industry equipment to the big boys in Detroit. It was quite a triumph, then, for Herbert Controls and Instruments to supply an electronic gauging equipment for the manufacture of diesel engines.

Weighing 28 tons, it's the biggest piece of test gear I've ever seen and, at £150,000, the most expensive. An all singing, all dancing, gauging system, it measures 94 parameters on diesel engine cylinder blocks at the rate of 35 blocks an hour. Every block is compared with a master block, deviations are listed on a computer print-out and the HCIL equipment even stamps one of five coded categories on the block to instruct the next stage of manufacture which size cylinder liner to fit. The computer programme can be switched to read dimensions in metric if required. Accuracy is such that the block classification is in steps of 0·0005 inches.

This is mechanical automatic testing on the grand scale. A mass of performance statistics is available but a discreet silence is maintained on how many manual inspectors the machine will make redundant in the hard-pressed Detroit manufacturing complex. But it is doubtful whether any human inspector, using conventional gauges, could take so many measurements without mistake, and he would have no chance at all on a time scale of less than two minutes.

GREAT SCOT

Perhaps even more unforgivable than getting a person's name wrong is getting his nationality wrong. In reporting on ITT Components Group Europe in a recent issue I wrote with British pride that the 16,000-strong organisation was run by Doug Stevenson whom I described as "another Englishman". He is, in fact, a Scot, and I hasten to amend the record.

ITT Components Group is feeling the pinch on entertainment components but otherwise doing quite nicely. Plenty of new products are in the pipeline and, despite current uncertainties, high technology developments are being brought forward, an example being a plasma display panel suitable for a data terminal which could be in the market place by the end of the year.

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.

"Bow, bow, ye lower middle classes"

Sir,—I would like to congratulate Mr C. J. Allen, "Musical Doorbell", on a most amusing and enjoyable project.

May I add another specimen matrix, see Fig. 1, which plays a tune which will be recognised by devotees of Gilbert and Sullivan as accompanying the appropriate words:

"Bow, bow, ye lower middle classes."

This version is suitable for the back door; or can be sold to Rolls Royce drivers. I have further modified my version so as to make it a plug-in change between doorbell and car horn status; also, in the latter application, nickel cadmium batteries are trickle charged from the car's 12V system.

W. H. Jarvis,
Perthshire.

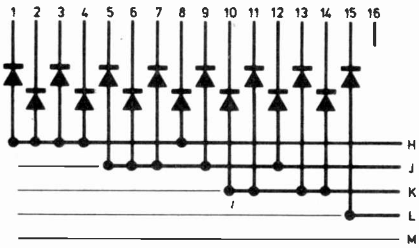


Fig. 1

Get With It!

Sir—With reference to the "Strictly Instrumental" article by Mr. K. Lenton-Smith in P.E. April 1975.

Mr. Lenton-Smith obviously has a good understanding of electronics. However, as for music, surely he has not done much research and is speaking purely and simply to provide a laugh for certain members of the older generation.

I refer specifically to the final paragraph in the article, in which he gives the impression that all pop groups sound alike, i.e.—rubbish. Obviously, he has got no further than watching "Top of The Pops".

For example, has he ever listened to the following:

Emerson, Lake and Palmer—"Trilogy".

Black Sabbath—"Sabbath Bloody Sabbath" (track "Who are You").

Also various tracks from early Elton John Albums.

Surely these must be rated amongst the highest in terms of best use of the synthesiser.

Yes, there are groups who abuse their instruments, but these are few and far between. Also, the few efforts at electronic classical music that I have heard have been O.K., but I would rather have had the original pieces and time.

Many of today's musicians have been using electronic instruments since they were first made available. Indeed, correct me if I am wrong, but did not E.L.P. (referred to earlier) develop the only synthetic drum device in current use?

It is far too easy to scoff at the work done by the younger generation, but could Mr. Lenton-Smith achieve the title of "Best Keyboards" (NME 1973, Rick Wakeman or was it Keith Emerson), both in the pop field?

Finally, thank you for an excellent magazine, which I have been reading since about 1968.

P. D. Scargill,
Northumberland.

Tell It To The Marines

Sir—In your April Editorial "Vital Links", you state, in reference to semiconductor devices "sensing" various stimuli, that "Only taste appears to be lacking at present".

Like smell, taste is a chemical sense, strictly speaking, sensitive only to sweet, bitter, sour and salty stimuli (possible alkaline or basic also).

Electrochemistry is older than semiconductors. For a long time pH meters have "sensed" or "tasted" acid and alkaline (H and OH) ions by means of glass and calomel electrodes among others. Mercury electrodes used with polarographs have sensed metallic ions at least, possibly others also. I am not sure if sweet and bitter tastes have been detected electrochemically, but some "tastes" at least have been so detected.

"Taste lacking . . .?" Tell that to the Marines—chemists won't believe it!

M. Knight,
Shooters Hill.

pH meters do not use semiconductor sensors. True these well known instruments detect "taste"—but in a very limited fashion. Sweet substances cannot be "tasted" by conventional pH electrodes, nor probably can many other distinctive tastes. Any analogy with the human taste buds is very tenuous.

The likelihood of a semiconductor device being produced that would respond to a wide range of tastes seems extremely doubtful, on theoretical grounds—but we remain inveterate optimists where electronics is concerned.—F.E.B.

Full Marks

Sir—I would like to refer to your December 1974 issue of P.E.

I have recently completed the Dwell Meter described in an article by a Mr. S. Jones. Not only did it work first time, but it required no calibration whatever. It is extremely accurate, having been checked and compared with a commercial meter.

With petrol at its present price, the dwell meter is not just another gadget, it is a very useful piece of equipment. I give Mr. Jones full marks for both the design of the meter and the excellent presentation of his article.

M. McDermott,
Crawley,
Sussex.

Motionless

Sir—I have read the letter from the Rev. Canon Guest, Readout May, and would comment on it as follows:

The circuit in my article, "Car Clock Repairs" (Feb. issue), was arrived at after considerable experimenting, initially with circuits of the type recommended by the Rev. Canon. In a new clock with unworn contacts, his circuit will be satisfactory, and eliminate arcing and consequent wear of contacts, but in an old clock with badly worn contacts the simple circuit does not provide a full solution. It is difficult to bend the contacts exactly back to the original position to give correct operation over a period of time and with pitted, dirty contacts there will be intermittent contact, which will not be cured by the single transistor circuit.

The circuit given in the article, while it is of the monostable type, acts in this case as a pulse stretcher,

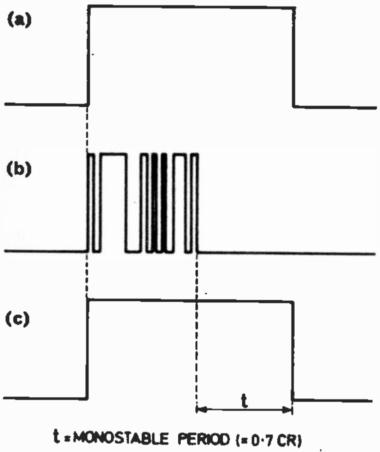


Fig. 1. Monostable pulse shapes from the circuit, all at the same arc of swing. (a) normal pulse (b) intermittent pulse due to worn contacts (c) pulse using monostable

giving a fixed delay *after* the contacts open. This compensates for both contact wear and intermittent contact in the manner shown, see Fig. 1.

The self-compensating action, mentioned by the Rev. Canon in his letter still occurs, as the period of the monostable starts from the *end* of the normal contact period.

In my circuit (including the supply decoupling), there are two diode forward voltage drops and one transistor V_{ce}, in series with the clock coil when current is flowing. This means that the clock is working on 10V normally, up to 12V or so when the engine is charging the battery. I found it would work down to below 8V, and there was no problem with "over banking" with the component values suggested.

I did not recommend oiling in my article, as any excess of oil (the correct quantity is minute) will have a detrimental effect, and may even stop the clock working at all. It is really necessary to dismantle the clock to oil it properly, and this is not recommended by the inexperienced.

While I agree that a stabilised power supply is beneficial, I found it unnecessary, as the simple diode/capacitor I suggested works well in practice. In any case, it is better to

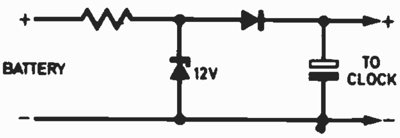


Fig. 2. Stabiliser circuit for car clocks

include the series diode, to guard against falling voltage while the starter, etc., are operated (see Fig. 2) and to increase the capacitor value as I recommended originally.

D. L. Cooper,
Dorset.

SORRY FOLKS

We would like to apologise to the two authors of Ingenuity Unlimited items published last month for omitting their names. The first item was the "Telephone Bell Synthesiser" by Mr M. Rudin, and the second was "Two-wire Signalling System" by Mr G. Rutter.

MILD & BITTER

CAN WE AFFORD TO BE EDUCATED By AP.S.

"ONE must never confuse education with training."—This profound statement was made by a prominent member of the teaching Establishment. The implication being that the one is noble and the other—well just useful.

From an electrical viewpoint, we might rephrase it to.

"One must never confuse the gold leaf electroscope with the multimeter". With the former, given a dry day and the wretched thing is not in "one of its turns", the students are rubbing shoulders with the aristocracy of the past, Coulomb, Volta and the Venerable Bede. Fascinating properties of the pith ball can be deduced from observation of the two little gold foils.

To bring an AVO into such a gathering would be as outrageous as introducing Bingo into the House of Lords. How could one possibly detect the voltaic twitching of a frog's leg with such a common and above all useful instrument?

It must be very puzzling for an A level physics student to be cast out into the sordid environment of the real world.

He may soon be wishing that his tutors had been a little more earthy, a little more concerned with circuitry, voltage drops, and simple filter action and a little less concerned with iron filings, magnetic lines, tangent galvanometers and the other relics of the traditional classroom. It is argued, and with justification, that students should be given a thorough grounding in the fundamentals of electrical science, particularly the historical background.

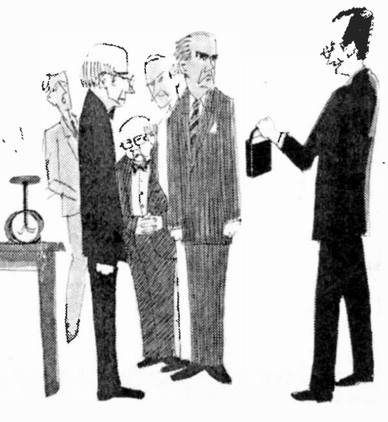
But must we go quite so far back? In these days of the computer, the integrated circuit, the phase-locked loop and quadraphonic sound does it really matter a damn if Newton, Leibnitz or Mick Jagger discovered the calculus? It would be wrong to throw out everything prior to 1940 but the Establishment might find it profitable to take a long hard look at the period prior to 1640—they may find that the lodestone could be discreetly laid to rest without causing serious discontinuity in the syllabus.

The pace of technology is frightening and is no longer subordinate to pure science. It is doubtful if we can really afford to waste so many teaching hours on the loftier aspects. Very, very few A-level students become involved in pure science so why not do a little more training and a little less educating. The after-dinner chit-chat may loose a few dBs of sparkle but the money saved on ruined test equipment would go some way towards solving the balance of payments problem.

It is not unusual for BSc (Honours) graduates to solve 3rd order partial differential equations in the morning and attempt to measure the source impedance of the live mains in the afternoons, using a multimeter on the "Ohms" range.

To criticise established teaching methods requires chrome vanadium nerve and the temperament of a bomb disposal expert.

The writer has none of these—he is simply aged, cynical and a resentful taxpayer who has very little left over from his salary as a *teacher*!



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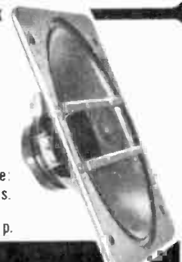

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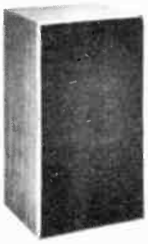

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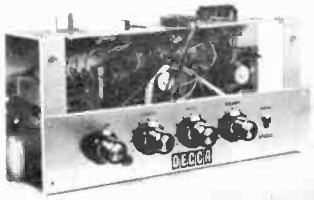

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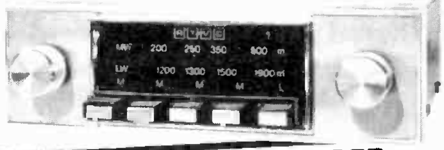

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Stereo sub-assembly PCB	86p

P.E. GEMINI 30W STEREO AMPLIFIER
An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements. While stocks last.

Main Amplifier:	
Set of resistors, capacitors and presets	£5·96
Stereo printed circuit board	£1·26
Pre-Amplifier	
Set of resistors, capacitors, potentiometers and switches—	
Standard tolerance set	£10·57
Superior tolerance set	£16·04
Stereo PCB (as published)	£2·20
Regulated Power Supply:	
Set of resistors, capacitors and preset	£4·58
Printed circuit board	72p

PROJECT Q4 (P.W. Oct. 73/Jan. 74)
Multi-system Ouadraphonic Decoder. While stocks last.

Decoder component set	£13·74
Power supply components	£3·22
Printed circuit board	£2·60

VOLTAGE CONTROLLED FILTER (P E Oct. 74)
An independently designed VCF that can be used with the P E Synthesiser

Component set	£3·41
Printed circuit board	£1·10

RHYTHM GENERATOR

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and cymbal), and with variable time signatures. Really fascinating and useful! (Published in P E. Mar./Apr. 1974).

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A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice operated fader, automatic fader and frequency-doubler.

Component set for above functions (excl. sw's)	£5·86
Printed circuit board	£1·44

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.

Component set (incl. PCB)	£2·10

PHASING UNIT (P.E. Sept. 73)
A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£2·20

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB)	£3·50

P.E. JOANNA

The new Electronic Piano published in P.E., series commencing May 1975. Send S.A.E. for our details.

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.

Component set incl. PCB	£2·40

OTHER PCBs (all "as published") While stocks last

Bench Power Supply (P.E. Sept. 74)	80p
Digital Power Supply (P.E. Aug. 72)	50p
Electronic Piano:	
Pre-amp PCB (P.E. Oct. 72)	95p
Pitch PCB (P.E. Nov./Dec. 72)	£1·50
Powert Supply PCB (P.E. Oct. 72)	65p
Gemini Stereo Tuner (P.E. June 72)	£1·50
Power Slaves (P.E. Aug. 74):	
Amplifier PCB	£1·05
Power Supply PCB	55p
Rondo:	
CBS SQ Decoder PCB (P.E. Sept. 73)	60p
Pre-amp PCB (P.E. Oct. 73)	60p
Tone, Balance and Vol-control PCB (Oct. 73)	£1·50
Triffid I.C. Radio (P.E. Feb. 73)	60p

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Multi-function circuits that with the use of other external equipment, can serve as lie detector alphaphone, cardiophone, etc

Pre-Amplifier Module	
Component set and PCB	£3·48
Basic Output Circuits	
Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp driver circuits	£4·96
Audio Amplifier Module	
Type PC7	£5·50

PHOTOPRINT PROCESS CONTROL
(P.E. Jan. Feb. 72)
For colour and B & W, an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage

Component set (excl meter)	£8·85
Printed circuit board	£1·60
Panel meter	£3·50

ENLARGER EXPOSURE METER AND THERMOMETER (P.E. Sept. 73)
Dual-purpose dark-room unit with good accuracy

Component set with PCB but excl meter	£4·00
Panel meter (100µA)	£3·50

P.E. MINISONIC

A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility.

Full details of component sets, printed circuit boards and discount facilities are in our list. Send S.A.E.

REVERBERATION UNIT (P.W. Nov./Dec. 72)
A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component set (excl. spring unit)	£6·82
Printed circuit board	£1·40
9 inch spring unit	£4·95
Panel meter (50µA) (optional)	£3·50

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(P.E. May 1972)
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SEMICONDUCTOR TESTER (P.E. Oct. 73)
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Semiconductors

		BFY50	22p	2N3703	12p
		BFY51	22p	2N3704	12p
		BFY52	24p	2N3819	35p
AC128	20p	BSY95A	22p	2N3823E	30p
AC176	20p	MJE2955	110p	2N4060	12p
BC107	13p	MJE3055	75p	2N4871	36p
BC108	13p	NKT0033	112p	2N5245	51p
BC109	13p	OC28	60p	2N5777	45p
BC147	12p	OC71	14p		
BC148	12p	OC72	14p	**Diodes**	
BC149	12p	OC84	25p		
BC157	13p	ORP12	60p	1N914	4p
BC158	13p	ZTX107	12p	1N4001	6p
BC159	13p	ZTX503	15p	1N4002	7p
BC182L	12p	ZTX531	23p	1N4004	8p
BC184	12p	2N706	13p	1N4005	8p
BC204	14p	2N914	22p	1N4007	10p
BC209C	14p	2N1304	22p	OA91	7p
BC212L	15p	2N2219	27p	OA200	8p
BC213	15p	2N2905	27p	OA202	8p
BC478	29p	2N2907	22p	1GP7	12p
BCY71	22p	2N3054	66p	1SJ50	11p
BF178	40p	2N3702	12p	ZIL (ZIJ)	75p

Integrated Circuits

709 8-pin DIL	40p
709 TO5	40p
723 TO5	95p
741 8-pin DIL	40p
747 14-pin DIL	115p
748 TO5	63p
748 8-pin DIL	63p
748 14-pin DIL	63p
7400	20p
7402	20p
7410	20p
7420	20p
7447	175p
7473	44p
7489	425p
µA7815 TO220	250p
CA3046	60p
MFC6040	95p
SG3402N	169p

Zeners

3 3V 400mW	12p
3 9V 400mW	15p
4 7V 1W	25p
5 1V 400mW	15p
5 6V 400mW	15p
5 6V 1·3W	20p
6 2V 400mW	15p
9 1V 400mW	15p
11V 1W	25p
12V 400mW	15p
12V 1 3W	30p
18V 400mW	15p
18V 1W	20p
20V 400mW	15p
20V 1 3W	23p
27V 400mW	15p

Thyristors

1A 400V	75p

Electrolytic Capacitors (µF/V)

0·47/63V	8p	47/63	7p	470/40	20p
1 0/63V	6p	100/4	6p	500/64	46p
1 5/63V	6p	100/10	6p	680/6 3	10p
2 2/63V	6p	100/25	6p	680/25	20p
4 7/63	6p	100/40	7p	680/40	25p
6 8/40	6p	100/63	13p	1000/10	14p
10/25	6p	150/16	6p	1000/16	25p
10/63	6p	150/63	13p	1000/25	30p
15/40	6p	220/10	6p	1000/40	54p
22/10	6p	220/16	7p	2200/25	45p
22/25	6p	220/25	11p	2200/40	71p
33/6 3	6p	220/40	14p	2800/100	390p
33/16	6p	220/63	21p	3300/63	133p
33/40	6p	330/10	8p	3300/100	390p
33/50	6p	470/6 3	6p	4700/16	60p
47/10	6p	470/10	12p	4700/25	75p
47/25	6p	470/25	18p	4700/40	93p
47/40	6p				

Polyester (µF)

0 01	3p
0 015	3p
0 022	3p
0 033	3½p
0 047	3½p
0 068	3½p
0 1	4p
0 15	5p
0 22	5½p
0 33	7p
0 47	9p
0 68	11p
1 0	14p
2 2	24p

Tantalum (µF/V)

0 1 35	12p
0 22 35	12p
0 47/35	12p
1 0/35	12p
1 5/35	16p
2 2 35	12p
4 7 35	12p
10/16	14p
10 25	16p
15 6 3	16p
22 16	16p
47 6 3	16p
47 16V	25p
100/3	16p

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2N456A	0·85	2N3053	0·25	2N5195	1·46	AF109R	0·40	BC184L	0·13	BF154	0·20	LM309K	1·88	OC42	0·50
2N457A	1·20	2N3054	0·60	2N5245	0·47	AF114	0·35	BC186	0·25	BF159	0·27	LM5TI	1·50	OC45	0·32
2N490	4·14	2N3055	0·75	2N5294	0·48	AF115	0·35	BC187	0·27	BF160	0·23	LM380	1·10	OC71	0·20
2N491	4·38	2N3390	0·45	2N5295	0·48	AF116	0·35	BC207	0·12	BF163	0·32	LM381	2·20	OC72	0·25
2N492	5·00	2N3391	0·28	2N5296	0·48	AF117	0·35	BC208	0·11	BF166	0·40	LM702C	0·75	OC81	0·25
2N493	5·20	2N3391A	0·29	2N5298	0·50	AF118	0·35	BC212K	0·16	BF167	0·25	LM709		OC83	0·24
2N696	0·22	2N3392	0·15	2N5457	0·49	AF124	0·30	BC212L	0·16	BF173	0·27	TO99	0·48	ORP12	0·55
2N697	0·16	2N3393	0·15	2N5458	0·46	AF125	0·30	BC214L	0·18	BF177	0·29	8DIL	0·38	R53	1·80
2N698	0·82	2N3394	0·15	2N5459	0·49	AF126	0·28	BC237	0·16	BF178	0·35	14DIL	0·40	SL414A	1·80
2N699	0·59	2N3402	0·18	2N5492	0·58	AF127	0·28	BC238	0·15	BF179	0·43	LM710	0·47	SL610C	1·70
2N706	0·14	2N3403	0·19	2N5494	0·58	AF139	0·65	BC239	0·15	BF180	0·35	LM723C	0·90	SL611C	1·70
2N706A	0·16	2N3440	0·59	2N5496	0·61	AF186	0·46	BC251	0·25	BF181	0·36	LM741		SL612C	1·70
2N708	0·17	2N3441	0·97	2N5777	0·45	AF200	0·65	BC253	0·25	BF182	0·35	TO99	0·40	SL620C	2·60
2N709	0·42	2N3442	1·40	2N6027	0·45	AF239	0·65	BC257	0·16	BF183	0·55	8DIL	0·40	SL621C	2·60
2N711	0·50	2N3414	0·20	3N128	0·73	AF240	0·90	BC258	0·16	BF184	0·30	14DIL	0·38	SL623	4·59
2N718	0·23	2N3415	0·21	3N139	1·42	AF279	0·70	BC259	0·17	BF185	0·30	LM747	1·00	SL640C	3·10
2N718A	0·28	2N3416	0·34	3N140	1·00	AF280	0·79	BC261	0·25	BF194	0·12	LM748		SL641C	3·10
2N720	0·57	2N3417	0·24	3N141	0·81	AL102	1·00	BC262	0·25	BF195	0·12	8DIL	0·60	SN76003N	2·92
2N914	0·39	2N3638	0·15	3N200	2·49	AL103	1·00	BC263	0·25	BF196	0·13	14DIL	0·73	SN76013N	1·95
2N916	0·28	2N3638A	0·15	40361	0·40	BC107	0·14	BC300	0·38	BF197	0·15	LM3900	0·70	SN76023N	1·60
2N918	0·32	2N3639	0·27	40362	0·45	BC108	0·14	BC301	0·34	BF198	0·18	LM7805	2·00	SN76033N	2·92
2N929	0·37	2N3641	0·17	40363	0·88	BC109	0·14	BC302	0·29	BF200	0·40	LM7812	2·50	ST2	0·20
2N930	0·22	2N3702	0·12	40389	0·46	BC113	0·15	BC303	0·54	BF225J	0·23	LM7815	2·50	TAA263	1·10
2N1302	0·19	2N3703	0·13	40394	0·56	BC115	0·17	BC307	0·17	BF244	0·21	LM7824	2·50	TAA300	1·80
2N1303	0·19	2N3704	0·15	40395	0·65	BC116	0·17	BC308A	0·15	BF245	0·45	MC1303	1·50	TAA350	2·10
2N1304	0·26	2N3705	0·15	40406	0·44	BC116A	0·18	BC309C	0·20	BF246	0·58	MC1310	2·92	TAA550	0·60
2N1305	0·24	2N3706	0·15	40407	0·35	BC117	0·21	BC237	3·27	BF247	0·65	MC1330P	0·90	TAA611C	2·18
2N1306	0·31	2N3707	0·18	40408	0·50	BC118	0·14	BC238	3·28	BF254	0·19	MC1351P	0·80	TAA621	2·03
2N1307	0·30	2N3708	0·14	40409	0·52	BC119	0·29	BC337	0·20	BF255	0·19	MC1352P	0·80	TAA661B	1·32
2N1308	0·47	2N3709	0·15	40410	0·52	BC121	0·35	BC338	0·20	BF257	0·47	MC1466	3·50	TBA641B	2·25
2N1309	0·47	2N3710	0·15	40411	2·00	BC125	0·16	BCY30	0·80	BF258	0·53	MC1469	2·75	TBA651	1·69
2N1671	1·54	2N3711	0·15	40594	0·74	BC126	0·23	BCY31	0·85	BF259	0·55	ME0402	0·20	TBA800	1·50
2N1671A	1·67	2N3712	1·20	40595	0·84	BC132	0·30	BCY32	1·15	BFR39	0·24	ME0404	0·13	TBA810	1·50
2N1671B	1·85	2N3713	1·20	40601	0·67	BC134	0·13	BCY33	0·85	BFR79	0·24	ME0412	0·18	TBA820	1·15
2N1711	0·45	2N3714	1·38	40602	0·61	BC135	0·13	BCY34	0·79	BFS21A	2·30	ME4102	0·11	TBA920	4·00
2N1907	5·50	2N3715	1·50	40603	0·58	BC136	0·17	BCY38	1·00	BFS28	0·92	ME4104	0·11	TIL209	0·30
2N2102	0·64	2N3716	1·80	40604	0·56	BC137	0·17	BCY39	1·50	BFS61	0·27	MJ480	0·95	TIP29A	0·49
2N2147	0·78	2N3771	2·20	40636	1·10	BC138	0·24	BCY40	0·47	BFS98	0·25	MJ481	1·20	TIP29C	0·80
2N2148	0·94	2N3772	1·80	40669	1·00	BC140	0·68	BCY42	0·28	BFX29	0·30	MJ490	1·05	TIP30A	0·58
2N2160	0·90	2N3773	2·65	40673	0·73	BC141	0·68	BCY58	0·30	BFX30	0·27	MJ491	1·45	TIP30C	0·85
2N2218A	0·22	2N3789	2·06	AC126	0·20	BC142	0·23	BCY59	0·32	BFX84	0·24	MJ2955	1·00	TIP31A	0·62
2N2219	0·24	2N3790	2·40	AC127	0·20	BC143	0·25	BCY70	0·17	BFX85	0·30	MJE340	0·48	TIP31C	1·00
2N2219A	0·26	2N3791	2·35	AC128	0·20	BC145	0·21	BCY71	0·22	BFX87	0·28	MJE2955	1·20	TIP32A	0·74
2N2220	0·25	2N3792	2·60	AC151V	0·27	BC147	0·14	BCY72	0·15	BFX88	0·25	MJE3055	0·75	TIP32C	1·25
2N2221	0·18	2N3794	0·24	AC152V	0·49	BC148	0·14	BD115	0·75	BFX89	0·90	MJE370	0·65	TIP33A	1·01
2N2221A	0·21	2N3819	0·37	AC153	0·35	BC149	0·15	BD116	0·75	BFY50	0·23	MJE371	0·75	TIP33C	1·45
2N2222	0·20	2N3820	0·64	AC153K	0·40	BC153	0·18	BD121	1·00	BFY51	0·23	MJE520	0·60	TIP34A	1·51
2N2222A	0·25	2N3823	0·78	AC154	0·25	BC154	0·18	BD123	0·82	BFY52	0·21	MJE521	0·70	TIP34C	2·60
2N2368	0·25	2N3904	0·27	AC176	0·30	BC157	0·16	BD124	0·67	BFY53	0·18	MP8111	0·32	TIP35A	2·90
2N2369	0·20	2N3906	0·27	AC176K	0·40	BC158	0·16	BD131	0·40	BFY90	0·75	MP8112	0·40	TIP36A	3·70
2N2369	0·20	2N4036	0·67	AC187K	0·35	BC160	0·60	BD132	0·50	BRY39	0·23	MP8113	0·47	TIP41A	0·79
2N2646	0·55	2N4037	0·42	AC188K	0·40	BC167B	0·15	BD135	0·43	BSX20	0·21	MPF102	0·39	TIP41C	1·40
2N2647	0·98	2N4058	0·18	ACY18	0·24	BC168B	0·15	BD136	0·49	BSX21	0·29	MPSA05	0·25	TIP42A	0·90
2N2904	0·22	2N4059	0·15	ACY19	0·27	BC168C	0·15	BD137	0·55	BU104	2·00	MPSA06	0·31	TIP42C	1·60
2N2904A	0·24	2N4060	0·15	ACY20	0·22	BC169B	0·15	BD138	0·63	BU105	2·25	MPSA12	0·35	TIP49C	0·70
2N2905	0·25	2N4061	0·15	ACY21	0·26	BC169C	0·15	BD139	0·71	C106D	0·65	MPSA55	0·26	TIP53	0·53
2N2905A	0·26	2N4062	0·15	ACY28	0·20	BC170A	0·15	BD140	0·87	CA3018A	0·85	MPSA56	0·31	TIP2955	0·98
2N2906	0·19	2N4126	0·21	ACY30	0·58	BC171	0·16	BD529	0·80	CA3020A	1·80	MPSU05	0·65	TIP3055	0·50
2N2906A	0·21	2N4289	0·34	AD142	0·57	BC172	0·17	BD530	0·80	CA3028A	0·79	MPSU06	0·58	TIS43	0·28
2N2907	0·22	2N4919	0·95	AD143	0·68	BC177	0·28	BDY20	1·05	CA3035	1·36	MPSU55	0·63	ZTX300	0·13
2N2907A	0·24	2N4920	1·10	AD149V	1·20	BC178	0·27	BF115	0·36	CA3046	0·70	MPSU56	0·80	ZTX301	0·13
2N2924	0·20	2N4921	1·83	AD150	1·15	BC179	0·30	BF117	0·55	CA3048	2·11	NE555V	0·70	ZTX302	0·20
2N2925	0·20	2N4922	1·00	AD161	0·50	BC182	0·12	BF121	0·35	CA3052	1·62	NE556	1·30	ZTX500	0·15
2N2926		2N4923	1·00	AD162	0·50	BY182L	0·12	BF123	0·35	CA3089E	1·96	NE560	4·48	ZTX501	0·13
Green	0·12	2N5190	0·92	AD161 }	PR	BC183	0·12	BF125	0·35	CA3090Q	4·23	NE561	4·80	ZTX502	0·18
Yellow	0·12	2N5191	0·96	AD162 }	1·15	BC183L	0·12	BF152	0·20	LM301A	0·48	NE565A	4·48	ZTX530	0·23
												OC23	1·35		
												OC28	0·76		

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CD4008	1·63	CD4021	1·72	CD4043	1·80
CD4009	1·18	CD4022	1·66	CD4044	1·80
CD4010	1·18	CD4023	0·36	CD4045	2·65
CD4011	0·36	CD4024	1·24	CD4046	2·84
CD4012	0·36	CD4025	0·32	CD4047	1·65
CD4013	0·66	CD4027	0·43	CD4049	0·81
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		SN7427	0·29			SN7475	0·50	SN7492	0·45	SN74123	0·60	SN74162	1·10	SN74196	1·60
												SN74163	1·10	SN74197	1·58
												SN74164	2·01	SN74198	2·25
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IN1184	0·92	IN1206	1·37	IN5406	0·25	BA102	0·25	BB104	0·45	OA70	0·07
IN1186	1·18	IN4001	0·06	IN5408	0·30	BA115	0·10	BY100	0·27	OA73	0·10
IN1190	2·52	IN4002	0·65	IS44	0·06	BA142	0·17	BY126	0·12	OA81	0·18
IN1191	0·59	IN4004	0·07	IS132	0·25	BA144	0·12	BY127	0·15	OA85	0·18
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IN1194	1·06	IN4007	0·10	IS920	0·07	BA148	0·20	BYZ10	0·60	OA91	0·06
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400	0·36	0·45	0·85	1·10
600	0·40	0·52	0·95	1·25
SCRs	100V	200V	400V	600V
½A TO18	0·43	0·44	—	—
1·2A plastic	0·45	0·50	0·69	0·85
3A plastic	0·55	0·63	0·70	1·05
4A plastic	0·50	0·55	0·65	—

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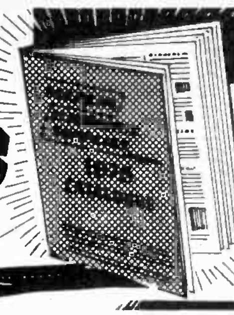

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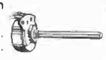
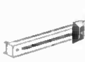


Rotary miniature carbon track ¼in spindle. Values available: 5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ. Log. Single-gang 17p. Lin. Single-gang (+1kΩ) 17p. Log. or Lin. Single-gang with switch 36p. Log. or Lin. Dual-gang without switch 54p.



Slider 60mm track. Metal-cased: overall length 86·15mm (knob 7p extra). Values available: 1k, 5k, 10k, 25k, 50k, 100k, 250k, 500k. Lin Single Gang 38p. Log Single Gang 42p. Lin or Log Dual Gang 49p.

Presets: 0·1W vert. or hor 100Ω, 220Ω, 470Ω, 1kΩ, 2.2kΩ, 4·7kΩ, 10kΩ, 22kΩ, 47kΩ, 100kΩ, 220kΩ, 470kΩ, 1MΩ 7p each.

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Sub-miniature
Axial lead electrolytic

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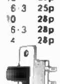
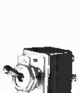
1·5	63	6p	68	6·3	6p	330	63	28p
2·2	63	6p	68	16	6p	470	6·3	6p
3·3	63	6p	68	63	14p	470	10	14p
4·7	63	6p	100	4	6p	470	25	16p
6·8	40	6p	100	10	6p	470	40	25p
6·8	63	6p	100	25	6p	680	6·3	14p
10	25	6p	100	40	6p	680	16	16p
10	63	6p	100	63	16p	680	25	25p
15	16	6p	150	6·3	6p	680	40	28p
15	40	6p	150	16	6p	1000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

● SWITCHES



Rotary adjustable stop. 1 pole, 2 to 12 way; 2 pole, 2 to 6 way; 3 pole, 2 to 4 way; 4 pole, 2 or 3 way 46p each. Slide Sub-min. DPDT 10½p. Slidemin. DPDT 14p. Push to make non-locking SPST 14p. Push-on, push-off locking DPST 250V 4A 36p. Rocker white DPST 250V 10A 42p. Rotary mains DPST 250V 2A 26p. Toggle with on/off plate DPDT 250V 1·5A 26p.



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AC128	18p	BY127	13p
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BA145	22p	OA91	6p
BC107	10p	OA200	7p
BC108	10p	OC71	20p
BC109	13p	SC146D	88p
BC109C	15p	T1S43	28p
BC142	23p	WOO5	30p
BC143	26p	WO4	33p
BC147	10p	1N914	4p
BC148	10p	1N4001	6p
BC149	12p	1N4002	6½p
BC168C	12p	1N4003	7p
BC169C	12p	1N4004	7½p
BC178	17p	1N4005	8p
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BC183L	12p	1N4007	9p
BC184L	12p	1N4148	4p
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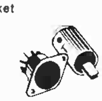

Din	Plug	Chassis Socket
2-pin	8p	7p
3-pin	9p	8p
4-pin	10p	8p
5-pin A (180°)	12p	8p
5-pin B (240°)	12p	8p
6-pin	12p	9p

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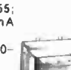

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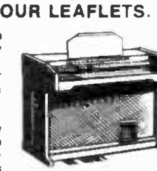

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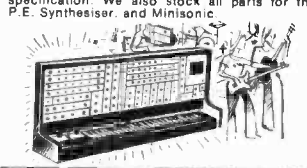

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40669	£1·10	BC167B	13p	MJE2955	£1·12
AC128	17p	BC168B	12p	MJE3055	68p
AC151R	38p	BC169B	12p	OA91	6p
AC153	27p	BC169C	13p	SD4	8p
AC153K	37p	BC179B	28p	TIP31A	70p
AC176	24p	BC182L	12p	TIP32A	80p
AC176K	38p	BC184L	10p	TIP41A	80p
AC187K	31p	BC212L	12p	TIP42A	£1·00
AC188K	29p	BC214L	14p	WO2	30p
AD133	£1·92	BC257A	14p	ZTX300	14p
AD136	£1·11	BC259B	14p	ZTX304	23p
AD149	52p	BCY58	30p	ZTX500	14p
AD161	42p	BD130	70p	ZTX504	45p
AD162	40p	BD131	48p		

ELECTROLYTIC CAPACITORS
Axial Lead

µF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	6p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	11p	—	—	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	—	—	26p	37p	41p	—	—
4,700	—	—	36p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

RESISTORS

Code	*Watts*	*Ohms*	*1 to 9*	*10 to 99*	*100 up* (see note below)
C	⅛	4·7–470K	1·3	1·1	0·9 nett
C	¼	4·7–10M	1·3	1·1	0·9 nett
C	½	4·7–10M	1·5	1·2	0·97 nett
C	1	4·7–10M	3·2	2·5	1·92 nett
MO	½	10–1M	4	3·3	2·3 nett
WW	1	0·22–0·47	18	14	11 nett
WW	1	0·56–3·9Ω	12	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 ⅛W, C ¼W 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 WW 10% ± 0·05Ω below 10Ω and ½W MO 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.

E.V. CATALOGUE 7 (Issue 3)

112 pages of up-dated information and prices. More valuable than ever now that our price stabilizing has been introduced. Includes a 25p refund voucher for spending on orders for £5 or more list value. So before you even look at a screwdriver, make sure you have your E.V. Catalogue No. 7 issue 3 to hand. Price, post paid 30p

PRICE STABILIZATION

Instead of changing prices from day to day with all the difficulties that brings, EV prices are now held for 3 monthly periods (as from April 1st) and then reviewed to see if changes are necessary for the next 3 months following.

★ So far this year we have held our prices without increase.

DISCOUNTS

apply on all items except the few where prices are shown NETT. **5% on orders from £5 to £14·99; 10% on orders value £15 or more.**

FREE POSTAGE AND PACKING

In U.K. for pre-paid mail orders over £2 (except Baxendall cabinets). If under £2, there is an additional handling charge of 10p.

QUALITY GUARANTEE

All goods are sold on the understanding that they conform to makers' specifications. No rejects, seconds or substandard merchandise.

VAT—add 25% to total value of order; excess will be refunded on request. Every effort is made to ensure correctness of information at time of preparing and putting this advertisement to press.

ANTEX Soldering Irons

C240	£2·25	Spare bits	32p
CCN240	£2·65	Spare bits	42p

WAVECHANGE SWITCHES
1 pole 12 way, 2 pole 6 way
3 pole 4 way; 4 pole 3 way — each 33p
TAG STRIP 28 way — 11p

NUTS, SCREWS, etc.
in lots of 100 each
4BA NUTS 34p; 6BA NUTS 28p; ¼" 4BA Screws 30p; ¼" 6BA Screws 24p; Threaded pillars 6BA, ¼" hexagonal £1·40; Plain spacers ¼" £1·32.

CAPACITORS
DALY ELECTROLYTIC *In cans, plastic sleeved*
1000mF/25V 34p — 2200/100 £1·91
1000/100 £1·00
5000/100 £3·56 — 1000/50 50p
5000/25V 75p — 2000/50 70p
2000/25V 45p — 5000/50 £1·44

10 x 0·047-38p
25 x 0·1 — £1
5 x 0·022-15p
10 x 0·01-3p
5 x 0·22-25p
£2

POLYESTER TYPE C.280. *Radial leads for P.C.B. mounting. Working voltage 250V d.c.*
0·01, 0·015, 0·022, 0·033, 0·047 — each 3p
0·068, 0·1, 0·15 — each 4p
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. Tolerance 1% or 0·5pF.*
Values in pFs—2·2 to 250 in 26 stages each 6p. 270–820 in 9 stages, each 7p.
1000, 1500, 1800 9p; 2200 10p; 2700, 3600, 4700, 5000 16p; 6800, 8200, 10,000 25p.

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0mF/35V, 1·5/20V — each 16p
2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V — each 16p
4·7/35V, 10/16V, 22/6·3V — each 21p
10/25V, 22/16V, 47/6·3V, 100/3V, 6·8/25V, 15/25V, — each 23p.

POLYCARBONATE
Type B42540 Working Voltage—250V. Values in mF:
0·0047, 0·0068, 0·01, 0·015, 0·022 — each 4p
0·018, 0·027, 0·033, 0·039, 0·047, 0·068, 0·082, 0·1 — each 5p
100 V. Values—0·1 5p; 0·12, 0·15 6p; 0·18, 0·22 7p; 0·27, 0·33 9p; 0·39, 0·47 11p; 0·56, 0·68 16p.

CERAMIC PLATE
Working voltage 50V d.c.
In 26 values from 22pF to 6800pF, each 2p.

POTENTIOMETERS
ROTARY, CARBON TRACK

Double wipers for good contact and long working life

P.20 SINGLE linear 100 ohms to 4·7 megohms. — each 14p
P.20 SINGLE log. 4·7 Kohms to 2·2 megohms. — each 14p
JP.20 DUAL GANG lin. 4·7 Kohms to 2·2 megohms — each 48p
JP.20 DUAL GANG log. 4·7 Kohms to 2·2 megohms. — each 48p
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only — each 48p
JP.20 DUAL GANG antilog 10K only — 48p
2A DP mains switch for any of above — 14p extra
Skeleton Carbon Presets, Decades of 10, 22 and 47 only available within limits in ranges above.
Type PR, horizontal or vertical 100Ω–10MΩ — each 6p

SLIDER
Linear or log mono 4·7K to 1 meg. In all popular values — each 30p
STEREO, matched tracks, lin. or log. in all popular values from 4·7K to 1 meg. — 60p
Escutcheon plates, mono, black or grey — each 10p
Control knobs, blk/wht/red/yel/grn/blue/dark grey, light grey — each 7p

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
Suitable BCD decoder driver 7447 — £1·15
3015G showing + or − & 1 & dec. pt. — £1·20
LEDS (Light Emitting Diodes) — 25p
Photo Cells cadmium sulphide, each — 40p

ELECTROVALUE LTD

All postal communications, mail orders etc. to Head Office at Egham marked, Section 4/6. S.A.E. with enquiries requiring answers, please.

28, ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY TW20 0HB
Telephone Egham 3603 Telex 264475 Shop hours 9–5.30 daily; Sat. 9–1 p.m.

NORTHERN BRANCH: 680, Burnage Lane, Burnage, Manchester M19 1NA
Telephone (061) 432 4945 Shop hours 9–1 p.m. 2–5.30 daily; Sat. 9–1 p.m.

U.S.A. CUSTOMERS are invited to contact ELECTROVALUE AMERICA, P.O. Box 27, Swarthmore PA 19081.

RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

Col. (1) Coil ohms
Col. (2) Working d.c. volts
Col. 3 Contacts
Col. (4) Price
HD = Heavy duty

1	2	3	4
52	4–8	2 c/o	70p*
58	5–9	6 c/o	80p
185	8–12	6M	60p*
230	9–18	2 c/o	70p*
430	15–24	4 c/o	80p*
700	12–24	2 c/o	60p*
700	16–24	4M 2B	60p*
700	16–24	4 c/o	80p*
1,250	18–36	2 c/o	60p*
2,500	31–43	2 c/o HD	60p*
2,500	36–45	6M	60p
9,000	40–70	2 c/o	60p*
15k	85–110	6M	60p*

*Incl. Base. All prices incl. P. & P.

OPEN TYPE RELAYS
6 VOLT D.C. 1 make contacts **35p.** Post 15p.
9 VOLT D.C. RELAY
3 c/o 5 amp contacts. 70 ohm coil. **75p.** Post 15p.
12 VOLT D.C. RELAY
3 c/o 5 amp contacts. 120 ohm coil. **75p.** Post 15p.
24 VOLT D.C. 3 c/o **75p.** Post 15p.
2 HD c/o 700 ohm coil. **75p.** Post 15p.
4 c/o 300 ohm coil. **85p.** Post 15p.
ENCLOSED TYPE RELAYS
24 VOLT A.C. Mfg. by ITT.3 h.d. c/o contacts. **55p.** Post 10p. Base **15p.**
55 VOLT A.C. RELAY
3 h.d. c/o contacts. Price **55p.** Post 10p. Base **15p.**
100 VOLT A.C. 2 c/o sealed type. **75p.** Post 10p. Base **15p.**
240 VOLT RELAY
3 h.d. c/o contacts. Price **75p.** Post 15p. Octal plug in base 15p extra.
230/240 VOLT A.C. RELAY. Mfg. by Arrow 2 h.d. 15 amp c/o contacts. Amp connectors. Price **£1.** Post 15p.
220/240 VOLT A.C. RELAY
3 c/o 5 amp contacts. Sealed. Mfg. ISKRA. **£1·25.** Post 15p. Base 15p extra.
CLARE-ELLIOTT TYPE RP7641 G8
Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. **70p** post paid.
110V. 2 c/o. 20 amp contacts. **£1·25.** Post 10p.
Many others from stock—phone for details.

VERY SPECIAL OFFER

Honeywell Type N100
10A changeover micro switch. 10 for **£2·50.** Post 25p.

PUSH BUTTON MICRO SWITCH. 5 amp. c/o contacts. NEW. 20 for **£2.** Post 15p. (Min. order 20). Ditto press to break, 20 for **£1·50.** Post 15p.

SUB-MINIATURE REED RELAY 3-9V d.c. 250 ohm Coil

Single make, size 1½ × ⅜ × ⅜in.
Outstanding Value only £1 for six, £1·50 for ten. Post 15p. (Min. order six.)

TRIAC

Raytheon Tag symmetrical Triac. Type TAG. 250/500V, 10 amp, 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long term reliability **£1·00.** Post 10p. (Inclusive of Data and application sheet.) Suitable Diac **18p.**

230/250 VOLT A.C. SOLENOID

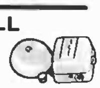
Approximately 1½lb pull. Size of feet 1⅜" × 1$\frac{3}{16}$". Price **£1·00.** Post 15p.

24 VOLT DC SOLENOIDS

UNIT containing 1 heavy-duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ½ inch travel. 6 × approx. 4oz. pull ½ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£2·50.** Post 75p. **ABSOLUTE BARGAIN.**

COIN MECHANISM (Ex London Transport)
Unit containing, selector mechanism for 1p, 2p and 5p coins. Micro switches, relays, solenoid operated hopper. 24 volt D.C. Precision built to high standard. Incredible VALUE at only **£2·50.** Post 70p.

'STC' 6" RED ALARM BELL



24/48 volt DC. **Brand New.**
Price **£4.** Post 50p.

'GENTS' 6" ALARM BELL

200/250V AC/DC. **Brand New.** Price **£5.** Post 60p.

CENTRIFUGAL BLOWER

Mfg. Airflow Developments Ltd. Precision continuously rated, smooth running. 230/240V a.c. motor 80 c.f.m. As illustration but with round aperture. **£6·50.** Post 50p.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0–260V All Types
SHROUDED TYPE

200 watt (1 amp) **£10·00**
0·5 KVA (2½ amp) (MAX) **£11·50**
1 KVA (5 amp) (MAX) **£16·50**
2 KVA (10 amp) (MAX) **£30·00**
3 KVA (15 amp) (MAX) **£33·00**
4 KVA (20 amp) (MAX) **£60·00**
37·5 amp (MAX) **£102·50**
CARRIAGE AND PACKING EXTRA
OPEN TYPE 1 amp (panel mount) **£10·00**

L.T. TRANSFORMERS

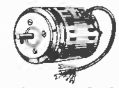
0, 6, 12 Volt at 10 amp.	**£5·60.**	Post 70p.
0, 10, 17, 18 Volt at 10 amp.	**£7·90.**	Post 70p.
0, 4, 6, 24, 32 Volt at 12 amp.	**£9·90.**	Post 70p.
0, 6, 12 Volt at 20 amp.	**£9.**	Post 70p.
0, 12, 24 Volt at 10 amp.	**£9·20.**	Post 70p.
0, 6, 12, 17, 18, 20 Volt at 20 amp.	**£10·40.**	Post 70p.

Other types to order at short notice—Phone your enquiries.

AUTO TRANSFORMERS

Step up step down
0–115/200/220/240 Volts. 75 watt **£2·64.** Post 40p. 150 watt **£3·50.** Post 50p. 300 watt **£6·20.** Post 60p. 500 watt **£9·20.** Post 75p. 1000 watt **£12·00.** Post 90p.

REVERSIBLE MOTOR



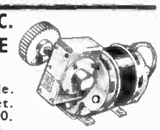
A.E.I. $\frac{1}{15}$ h.p. reversible motor 100/120 volt A.C. 50/60 cycle 1400/1680 r.p.m. Flange fixing. Dia. 4", length 6½", shaft 1" × $\frac{5}{16}$". Brand New. Price **£2·50.** Post 50p. Suitable 110/240v. 150 watt Auto Transformer **£3·50.** Post 50p. (Post for both items together 75p.)

230/240 VOLT A.C. MINIATURE MOTOR. 20 R.P.M. Price **£1.** Post 15p.

BODINE TYPE N.C.I. GEARED MOTOR

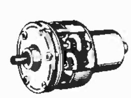
(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 0·38 amp. **(Type 2) 28 r.p.m. torque 20** lb. in **Reversible** 1/80th h.p. 50 cycle 0·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type **£6·25.** Post 65p or less transformer **£3·75.** Post 50p.

'FRACMO' 240 VOLT A.C. 50 cycle SINGLE PHASE GEARED MOTOR



33 r.p.m. 30 lb. ins. Reversible. Fitted with mounting feet. Brand New. **£14.** Post **£1·00.** (Total price incl. VAT **£16·20**).

9-12 VOLT D.C. GOVERNED REVERSIBLE MOTOR



Machine cut gear train, giving final speed of 2 r.p.m. with cam driving 3 sub-miniature micro-switches (removable). Spindle 12mm long 6mm dia. Built to PO spec., in heavy metal hinged case. **£3·75.** Post 40p.

POWER RHEOSTATS ! ! !

Superior Quality Precision Made NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k/2·5k ohm. **£1·70.** Post 15p.
50 WATT 1/5/10/25/50/100/250/500/1k ohm **£2·10.** Post 20p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£3·30.** Post 25p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

INSULATION TESTERS *NEW!*

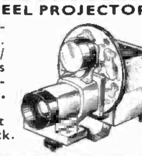
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. 500V, 500 megohms. **£30.** Post 80p.

All prices are subject to 8% VAT. (8p in the £)
To all orders add 8% VAT to total value of goods including carriage/packaging.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation. **RANGE OF FOUR STROBE KITS FROM STOCK. PRICES FROM £6·30 to £22.** S.A.E. for details.

COLOUR WHEEL PROJECTOR



Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£20·50.** Post 80p.
Extra colour effect wheels from stock. S.A.E. for details.

BIG BLACK LIGHT
400 Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. P.F. ballast is essential. Price of matched ballast and bulb **£18.** Post £1. Spare bulb **£8.** Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES
2ft 20 watt, £4·25. Post 40p. (For use in standard bi-pin. MINI. **12in 8 watt, £1·60.** Post 25p. **9in 6 watt, £1·30.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, **£1·70.** Post 25p. (9in and 12in measures approx.)

METERS NEW

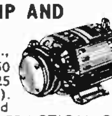
84mm diameter

M065/1, 1A d.c.; M065/15, 15A d.c.; S065/5, 5A a.c.; S065/10, 10A a.c.; S065/15, 15A a.c. **ALL AT £2·50. Post 20p.**

90mm diameter
65C5/2, 2A d.c. M/C; 65C5/5 5A d.c. M/C; 65C5/10, 10A d.c. M/C; 65C5/20, 20A d.c. M/C; 65C5/50, 50A d.c. M/C.
62T2/1, 1A a.c. M/I; 62T2/20, 20A a.c. M/I; 62T2/300, 300V a.c. M/I. **ALL AT £2·50. Post 20p.**
65L5/300, 300V a.c. R/M/C. **£2·75. Post 20p.**

64mm × 56mm RECTANGULAR METERS
85C1/5, 5A d.c. M/C; 85C1/20, 20A d.c. M/C; 85L1/5, 5A a.c. R/M/C; 85L1/10, 10A a.c. R/M/C; 85L1/300, 300V a.c. R/M/C. **ALL AT £3. Post 20p.**

ROTARY VACUUM AIR PUMP AND COMPRESSOR

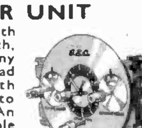


Carbon vane, oilless, 100/115V a.c., $\frac{1}{12}$h.p. motor, 50/60 cycle, 2875/3450 r.p.m., 20 in vacuum, comp. 1·25 c.f.m., 10 p.s.i. (approx. figures). New unused surplus stock. Supplied with electrical connection data. FRACTION OF MAKERS' PRICE **£12.** Post 50p. Suitable 110/240V, 150 watt auto transformer **£3·50.** Post 50p. (Both items together Post 75p.)

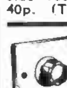
PROGRAMME TIMERS

230/240V a.c. 15 r.p.m. Motors Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays, etc. Ex equipment tested.
2 cam model. **£2·00** post 35p.
4 cam model. **£2·50** post 35p.
8 cam model. **£4·75** post 40p.
8 cam model, each cam fully adjustable. 6 r.p.m. Mfg. by Magnetic Devices. **£7·50.** Post 35p.

A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An addition. 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135mm × 130mm × 60mm. Price **£2.** Post 40p. (Total incl. VAT and Post £2·59).



600 WATT DIMMER SWITCH
Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.

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dia	0·125	0·2
RED	15p	19p
GREEN	27p	33p
YELLOW	27p	33p

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INFRA-RED LEDs with Data 550μW axial lead, 49p; 1·5 mW TO46, £1·10

OPTO-ISOLATORS with Data
IL74 1·5kV, 150kHz £1
4350 2·5kV, 5MHz £2·25

OP. AMPS
709 all 25p
741 8 pin 29p
748 D.I.L. 36p

THYRISTORS	50V	100V	400V
TO5 1A	25p	27p	46p
TO66 3A	27p	35p	50p

NE555V 60p
ZN414 £1·10
7400 16p
Dalo Pen 70p

Mica + bushes TO3 TO66 5p

AC127/8	15p	2N2926(R)	7p
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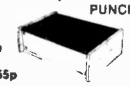

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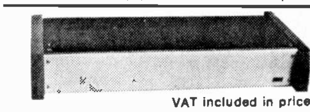

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