PRACTICAL

ELECTRONICS

MARCH 1974

25p

RHYTHM GENERATOR

Also...

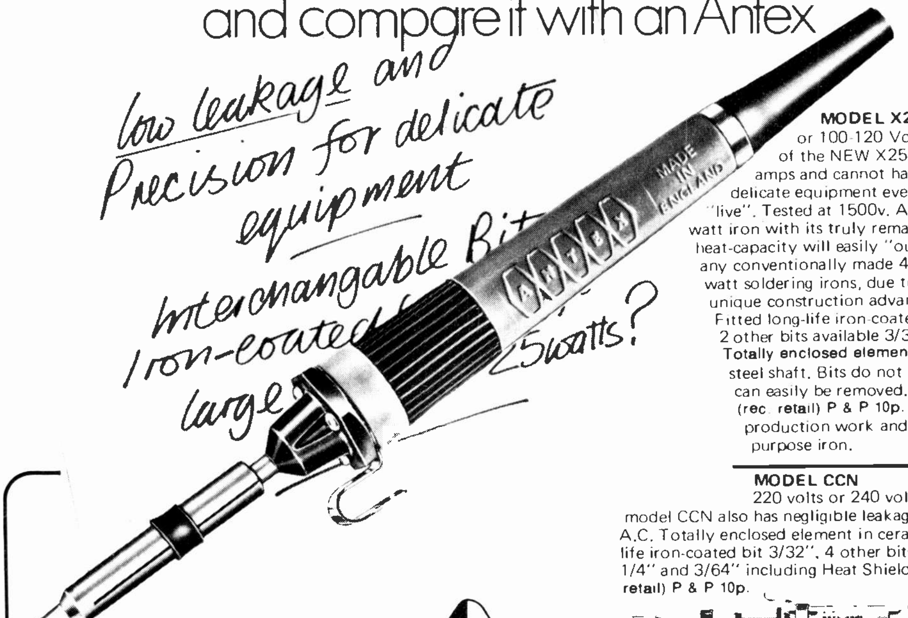
FREE! IN THIS ISSUE...

Our **BLUEPRINT** *for combating the* **FUEL/POWER CRISIS**

- SCORPIO Mk2 CAR IGNITION SYSTEM
- FLUORESCENT LAMP INVERTER

Write the Specification of your perfect iron

and compare it with an Antex

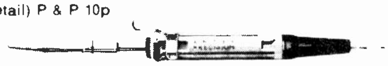


MODEL X25 Soldering Iron 220-240 or 100-120 Volts. The leakage current of the NEW X25 is only a few micro-amps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element. Ceramic and steel shaft. Bits do not "freeze" and can easily be removed. **PRICE £2·05** (rec. retail) P & P 10p. Suitable for production work and as a general purpose iron.

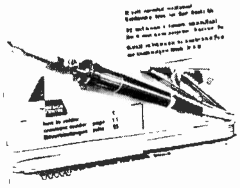
MODEL CCN
220 volts or 240 volts. The 15 watt miniature model CCN also has negligible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32", 4 other bits available 1/8", 3/16" 1/4" and 3/64" including Heat Shield. **PRICE £2·48** (rec. retail) P & P 10p.

as selected for the DESIGN CENTRE

MODEL C Miniature 15 watt soldering iron fitted 3/32" iron coated bit. Many other bits available from 3/64", to 3/16". Voltages 240, 220, 110, 50 or 24. **PRICE £2·05** (rec. retail) P & P 10p

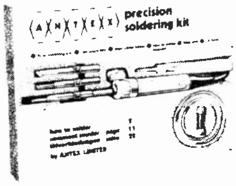


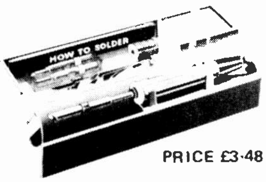
MODEL G 18 watt miniature iron, fitted with long-life iron-coated bit 3/32". Voltage 240, 220 or 110. **PRICE £2·26** (rec. retail) P & P 10p



MODEL MLX KIT
Battery operated 12v.
25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet and with booklet "How to Solder".
PRICE £2·54 (rec. retail)
P & P 12p.

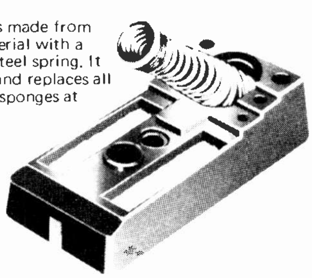
MODEL SK.2 KIT
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder and "How to Solder" booklet.
PRICE £3·25 (rec. retail)
P & P 10p.





MODEL SK.1 KIT
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.
PRICE £3·48 (rec. retail)
P & P 12p.

ST3 Stand – This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.
PRICE: £1·00 (rec. retail) P & P 10p.



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PE3

PRACTICAL ELECTRONICS

VOLUME 10 No. 3 MARCH 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

*SPECIAL FREE BLUEPRINT

FLUORESCENT LAMP INVERTER—P.E. SCORPIO Mk 2 IGNITION SYSTEM

Our April issue will be published on Friday, March 8, 1974

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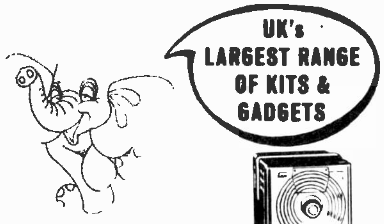


TEST EQUIPMENT

MULTIMETERS

(carr., etc. 30p)
M210 20k/V Slimline, £6·75
THL33D 2k/V Robust, £7·50
U437 10k/V Steel case. A.C. up to 40kHz, £4·95
U4324 20k/V with A.C. current ranges, £8·00
AF105 50k/V, £11·95
U4313 20k/V A.C. current. Steel case, £10·50
U4341 Plus built in transistor tester, £10·50
Model 500 30k/V, £9·95

OTHER EQUIPMENT

SE250B Pocket Signal Injector, £2·10. Carr. 15p
SE500 Pocket Signal Tracer, £1·70. Carr. 15p
TE15 Grid Dip Meter 440kHz—280MHz, £15·00. Carr. 30p
TE40 A.C. Millivoltmeter 1·2MHz, £18·95. Carr. 35p
TE65 28 Range Valve Voltmeter, £19·95. Carr. 40p
TE20D 120kHz—500MHz RF Generator, £17·95. Carr. 40p
TE22D 20Hz—200kHz Audio Generator, £18·95. Carr. 40p
SE350A Deluxe Signal Tracer, £12·50. Carr. 20p
SE400 Volts/ohms/R-C sub./RF field/RF gen., £14·75. Carr. 20p

New Revolutionary Supertester 680R

680R Multi-tester, £18·50

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

A SELECTION OF INTERESTING ITEMS

C3025 Compact transistor tester, £6·30. P. & P. 15p
E1300 Mono mag cart preamp, £2·75. P. & P. 15p
E1310 Stereo mag cart preamp, £4·62. P. & P. 25p
Easiphone telephone amplifier, £7·95. P. & P. 25p
D1203 Teleamp with PU coil, £4·40. P. & P. 20p
LL1 Door Intercomm. and chime, £7·95. P. & P. 25p
Chattalite (lights as you talk), £13·90. P. & P. 20p
1kW Dimmer/controller, £3·00. P. & P. 10p
9in Twin spring unit, for Reverbs, £3·30. P. & P. 15p
16in Twin spring unit, for Reverbs, £6·85. P. & P. 25p
Car Tachometer Electronic, £8·95. P. & P. 15p
VHF Aircraft band corrector, £4·50. P. & P. 15p
B2005 4 Ch. mic. mixer, £3·75. P. & P. 15p
B2004 2 Ch. stereo mixer, £5·95. P. & P. 15p
PK3 Kit. Etch your own printed circuits, £1·50. P. & P. 20p

EXCLUSIVE: SPECIAL OFFERS

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

8 TRACK CAR STEREO (— earth) with speakers, in pods and fixings. **£12·50** carr/packg. 40p.

Portable Battery Cassette tape player **£7·25**.

Car Lighter Plug and adaptor for all cassette and radio 6/7½/9 volt output (state width). **£1·95** each.

Rotel Stereophones
RH630 .. .. £4·50
RH700 .. .. £6·75
RH430 .. .. £3·30

Rotel RA310 15 + 15 watt Stereo Amplifier (List £52·00) **£34·52**.

Wein W500 Battery/Mains Cassette Recorder **£12·75**.

AKAI GXC40 stereo cassette recorder **£59·95** carr/packg. 50p.

Pair Akai ADM microphones. **£6·95** carr/packg. 20p.

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

HANIMAX BC808 POCKET CALCULATOR with % key. **£28·95**.

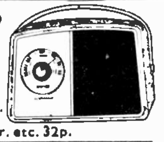
Hanimax BC811M Memory Version **£37·50**.

Mains Unit for BC808, BC811M **£2·85** (state model).

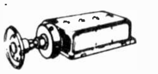
Hanimax H101 Stereo Compact Record Player 2 × 7w. Complete with speakers (List £54·50). Price **£39·95**. Plus free pair of stereo phones.

BUILD THIS RADIO

PORTABLE MW/LW RADIO KIT using Mullard RF/IF module. Features MW—bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts **£7·98** (battery 22p). Carr. etc. 32p.



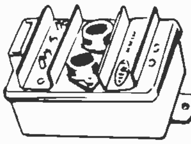
SPECIAL PURCHASES



UFH TV TUNERS CHANNELS 21 to 64. Brand new transistorised geared tuners for 625 Line Receiver IF output. **£2·50**. Post 20p.

EASY TO BUILD KITS BY AMTRON—EVERYTHING SUPPLIED

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



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation, subject to change without notice.

BUILD THIS TUNER

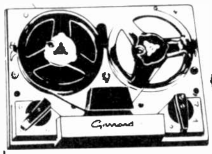
MW/LW Radio tuner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built-in battery. Excellent results. Size: 7in × 2¾in × 3¾in. All parts £4·85. Carr. 15p.

MULTI-USE AND RADIONIC KITS

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

ALL TRANSISTOR CIRCUITS WITH HANDBOOKS

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



GARRARD BATTERY TAPE DECK

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

TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity).
Singles Log and Lin 5kΩ, 10kΩ, 22kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1 Meg. **45p each.**
Ganged Log and Lin 10kΩ, 22kΩ, 50kΩ, 100kΩ, 250kΩ. **65p each.** (Quantity discounts available). Complete with knobs.

MARRIOT TAPE HEADS

4 TRACK MONO or 2 TRACK STEREO '17' High Impedance, **£2·00**; '18' Med. Impedance, **£2·00**. Erase Heads for '17' and '18', **75p**; '63' 2 track mono-Hi imp., **£1·75**; '43' Erase Head for '63', **75p**. (Post, etc. 15p any quantity).

R730/E73 2 Track Mono Record Erase Low Imp., **75p** pair.

Sinclair, Miniature Amplifiers & Tuner/Decoder

AMPLIFIERS (Carr. etc. 20p).

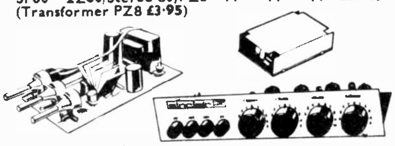
		£
4–300	0·3 watt 9 volt	1·75
104	1 watt 9 volt	2·80
304	3 watt 9 volt	2·95
555	3 watt 12 volt	3·10
E1208	5 watt 12 volt	5·10
608	10 watt 24 volt	4·10
410	10 watt 28 volt	4·95
E1206	30 watt 45 volt	9·95
E1210	2½ + 2½ watts 12 volt	6·25
RE500	5 watt IC mains operated Amplifier with controls	6·30
SAC14	7 + 7 watt Stereo with controls	8·70
SAC30	15 + 15 watt Stereo with controls	11·75

SINCLAIR PROJECT 60 (Carr. 20p)

	£
Z30 3·57 Z50	4·37
Stereo 60 Preamplifier	7·97
PZ5	3·97
PZ6	8·37
PZ8 (for Z50)	4·77
TRANS.	3·95
AFU	4·45

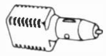
NEW SINCLAIR PROJECT 80

	£
Stereo Preamplifier	11·95
Audio Filter Unit	6·95
Z40 15 Watt Amplifier	5·45
Z60 25 Watt Amplifier	6·95
PZ5 Model for 1 on 2 Z40	4·98
PZ6 Model (S. Tab.) 1 on 2 Z40	7·98
PZ8 Model (S. Tab.) 1 on 2 Z60	7·98
TRANSFORMER FOR PZ8	2·95
Project 605 Kit	19·95
Project 805	£26·95
SP40-5 2Z40/Stereo 80/PZ5	£25·00
SP40-6 2Z40/Stereo 80/PZ6	£27·75
SP60 2Z60/Stereo 80/PZ8 (Transformer PZ8 £3·95)	£30·45



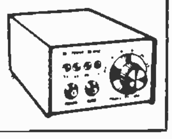
POWER SUPPLIES FOR EVERY PURPOSE

(All cased unless stated chassis)
470C 6/7½/9V 300mA, (Includes Multi-Adaptor for Tape Recorders, etc.), **£2·15**. Post 20p
Car Lighter Voltage Adaptors 300mA (State Voltage 6V, 7½V, 9V), **£1·95** each. Post 25p
SC202 3/6/7½/9V 400mA, **£3·35**. Carr. 30p
HC244R Stabilised version, **£4·35**. Carr. 30p
P500 9V 500mA, **£2·90**. Post 20p
P11 24V 500mA (chassis), **£2·90**. Post 20p
P15 26/28V 1 amp (chassis), **£2·90**. Post 20p
P1080 12V 1 amp (chassis), **£4·25**. Post 20p
P1081 45V 0·9 amp (chassis), **£7·50**. Post 20p
P12 4½—12V 0·4—1 amp, **£7·15**. Post 30p
SE101A 3/6/9/12V 1 amp (Stab.), **£10·30**. Post 25p
RP164 6/7½/9/12 1 amp (Stab.), **£10·20**. Post 30p



FIBRE OPTICS

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



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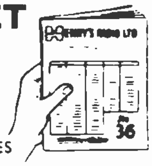

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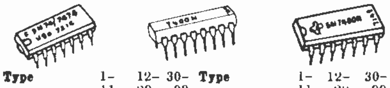

Type	1–11 £p	12–29 £p	30–99 £p	Type	1–11 £p	12–29 £p	30–99 £p
SN7400N	20	18	16	SN7446N	2·16	2·16	1·89
SN7401N	20	18	16	SN7447AN	1·80	1·80	1·57
SN7401AN	38	38	33	SN7448N	1·50	1·27	1·13
SN7402N	20	18	16	SN7450N	20	18	16
SN7403N	20	18	16	SN7451N	20	18	16
SN7403AN	38	38	33	SN7453N	20	18	16
SN7404N	24	21	18	SN7454N	20	18	16
SN7405N	20	18	16	SN7460N	20	18	16
SN7405AN	44	44	38	SN7470N	33	30	27
SN7406N	40	38	35	SN7472N	38	38	34
SN7407N	40	38	35	SN7473N	44	41	37
SN7408N	25	22	19	SN7474N	48	48	42
SN7409N	33	33	28	SN7475N	59	55	51
SN7409AN	44	44	38	SN7476N	45	36	32
SN7410N	20	18	16	SN7480N	80	70	50
SN7411N	25	23	21	SN7481N	1·25	1·10	95
SN7412N	28	28	25	SN7482N	87	80	72
SN7412AN	38	38	33	SN7483N	1·20	1·10	1·00
SN7413N	30	27	25	SN7485N	1·87	1·87	1·63
SN7414N	72	72	63	SN7486N	50	50	44
SN7416N	30	27	25	SN7489N	4·32	4·32	3·78
SN7417N	30	27	25	SN7490N	75	70	63
SN7420N	20	18	16	SN7491AN	1·10	1·00	90
SN7422N	28	28	25	SN7492N	75	70	63
SN7422AN	38	38	33	SN7493N	75	70	63
SN7423N	37	34	32	SN7494N	85	80	75
SN7425N	37	37	32	SN7495N	85	80	75
SN7427N	37	37	32	SN7496N	1·00	90	83
SN7428N	43	43	37	SN74100N	2·16	1·89	1·89
SN7430N	20	18	16	SN74104N	60	53	45
SN7432N	37	37	32	SN74105N	60	53	45
SN7433N	43	43	38	SN74107N	51	51	45
SN7433AN	57	57	50	SN74110N	57	57	50
SN7437N	43	43	37	SN74111N	86	86	75
SN7438N	43	43	37	SN74116N	2·16	2·16	1·89
SN7438AN	57	57	50	SN74118N	1·00	90	83
SN7440N	20	18	16	SN74119N	1·92	1·92	1·68
SN7441AN	85	79	73	SN74120N	1·05	1·05	92
SN7442N	85	79	73	SN74121N	57	57	50
SN7443N	1·50	1·27	1·13	SN74122N	80	80	70
SN7444N	1·50	1·27	1·13	SN74123N	1·44	1·44	1·26
SN7445N	2·16	2·16	1·89	SN74125N	69	69	60

Type	1–11 £p	12–29 £p	30–99 £p
SN74126N	69	69	60
SN74132N	72	72	63
SN74136N	63	63	55
SN74141N	1·00	90	80
SN74142N	2·88	2·88	2·52
SN74145N	1·44	1·44	1·26
SN74147N	2·30	2·30	1·83
SN74148N	2·01	2·01	1·63
SN74150N	2·30	2·30	2·01
SN74151N	1·15	1·15	1·00
SN74153N	1·09	1·09	95
SN74154N	2·30	2·30	2·01
SN74155N	1·55	1·55	1·00
SN74156N	1·09	1·09	1·00
SN74157N	1·09	1·09	95
SN74159N	2·44	2·44	2·14
SN74160N	1·58	1·58	1·38
SN74161N	1·58	1·58	1·38
SN74162N	1·58	1·58	1·38
SN74163N	1·58	1·58	1·38
SN74164N	2·01	2·01	1·76
SN74165N	2·01	2·01	1·76
SN74166N	2·16	2·16	1·89
SN74167N	4·10	4·10	3·59
SN74170N	2·88	2·88	2·52
SN74172N	5·76	5·76	5·04
SN74173N	1·66	1·66	1·45
SN74174N	1·80	1·80	1·57
SN74175N	1·29	1·29	1·13
SN74176N	1·44	1·44	1·26
SN74177N	1·44	1·44	1·26
SN74180N	1·44	1·44	1·26
SN74181N	5·18	5·18	4·53
SN74182N	1·44	1·44	1·26
SN74184N	2·16	2·16	1·89
SN74185AN	2·16	2·16	1·89
SN74188N	6·48	6·48	5·67
SN74190N	2·30	2·30	2·01
SN74191N	2·30	2·30	2·01
SN74192N	2·30	2 30	2·01
SN74193N	2·30	2·30	2·01
SN74194N	1·72	1·72	1·51
SN74195N	1·44	1·44	1·26
SN74196N	1·58	1·58	1·38
SN74197N	1·58	1·58	1·38
SN74198N	3·16	3·16	2·77
SN74199N	2·88	2·88	2·52

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SN74 (HIGH POWER), SN74 (LOW POWER) series in stock. Send for List 36 free on request. Low Profile Sockets, 14 pin, **15p**, 16 pin, **17p**, 8 pin, **14p**.

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AC128	20	BCY32	85	BYZ13	35	OC45	18	ZTX300	14	2N3714	1·60
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ACY39	65	BCY70	15	GET115	75	OC77	55	2G301	40	2N3790	2·25
AD149	50	BCY71	20	GET880	55	OC81	28	2N697	15	2N3819	35
AD161	39	BCY72	13	LM309K	1·87	OC83	25	2N706	10	2N3866	75
AD162	39	BD124	80	MAT121	25	OC140	65	2N930	20	2N3903	15
AF117	20	BD131	45	MJE340	50	OC170	25	2N987	45	2N4062	14
AF118	50	BF115	22	MJE520	65	OC200	55	2N1132	25	2N4126	15
AF139	33	BF180	33	MJE305S	75	OC202	90	2N1304	22	2N4871	35
AF186	40	BF194	13	MPF105	46	OCP71	1·00	2N1613	20	2N5457	36
AF239	44	BFX13	25	NKT217	45	ORP12	55	2N1671	1·00	2S001	3·00
ASY27	30	BFX34	55	NKT404	60	ORP60	45	2N2147	75	2S026	8·90
BA115	10	BFX88	22	OA5	60	P346A	20	2N2160	69	2S303	70
BAX13	5	BFY50	20	OA81	10	TIL209	25	2N2926	10	40250	45
BC107	15	BFY51	20	OA200	8	TIP29A	49	2N3053	20	40361	45
BC108	15	BFY64	45	OA202	10	TIP30A	58	2N3054	45	40362	40
BC109	15	BFY90	75	OC16	85	TIP31A	61	2N3055	45	40408	50
BC109C	14	BLY36	6·25	OC20	1·25	TIP41A	74	2N3440	50	40486	75
BC113	16	BSX20	15	OC28	65	TIP42A	90	2N3442	1·10	40636	1·00
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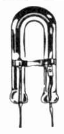

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¼ × ¼ × ⅛in dia.

½ AMP 1–11

Type	P.I.V.	Price ea.
B05/05	50V	20p
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B05/60	600V	27p

¼H × ¼L × 3/16in. dia.

1 AMP

B1/05	50V	25p
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B1/60	600V	30p

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B2/05	50V	35p
B2/10	100V	40p
B2/20	200V	45p
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B6/20	200V	80p
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B6/60	600V	£1·00

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Type	P.I.V.	1–11
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CRS 1/05AF	50V	30p
CRS 1/10AF	100V	30p
CRS 1/20AF	200V	35p
CRS 1/40AF	400V	45p
CRS 1/60AF	600V	55p
3 AMP (TO48)		
CRS 3/05AF	50V	40p
CRS 3/10AF	100V	40p
CRS 3/20AF	200V	45p
CRS 3/40AF	400V	55p
CRS 3/60AF	600V	65p
5 AMP	400V	60p
CRS	5/400V	60p
7 AMP (TO48)		
CRS 7/100	100V	60p
CRS 7/200	200V	67p
CRS 7/400	400V	85p
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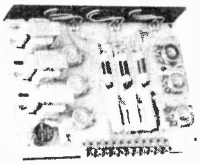
Mk III Sound to Light Unit Chassis Version



The audio drive voltage is derived directly from the amplifier output or across the speaker load. The unit converts the audio-frequency signals into a three-coloured light display when used with coloured flood lamps or similar; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.
Max. power 1·5kW per channel at 240V a.c.
Complete assembly built and tested. Size: 9in × 7in × 3in. Price **£27·50.**

MN3 3 Channel I.C. Mixer Kit

Three channel I.C. audio mixer kit MN3 is specially designed for the home constructor or educational project. Suitable for use in domestic audio, discotheque and simple p.a. applications. The MN3 mixer kit has the following features: Advanced design using 5 ICs; Slider fader level controls mounted directly to p.c. board; Full range Bass and Treble controls; Uses top grade components with fibreglass ready-drilled and tinned printed circuit board and the unit may be operated from twin 9V batteries (PP3) if required.

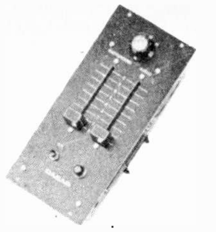
As optional extras, an attractive ready-punched facia panel and control knobs are available. The unit is available as a ready built mixer with facia.

Size: 9.5in × 4·8in × 1·5in (with facia).

Construction manual available separately at 25p.

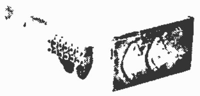
Kit Price **£11.**

STL/1 Single Channel Sound to Light Unit



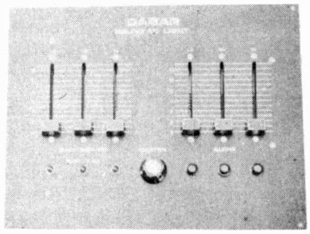
Single channel "Sound to Light" unit with 60mm slider fader controls for audio trigger level and background load dimmer.
This unit is switchable for response to High, Mid. and Low frequency audio signals, selected by facia control. A D.J. "pulse-flash" push button is fitted for manual flashing of the lamp load together with neon load indicator.
Maximum Load: 1kW at 240V a.c.
Size: 8in × 3·6in × 3in. Price **£14·30.**

Practical Electronics "Scorpio" Electronic Ignition System Kit



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc.
Case size: 7·25in × 4·5in × 2in approx.
Complete assembly and wiring manual **25p.**
Price **£12·10.**

STL/3 Sound to Light Unit



The performance of this unit is similar to the Mk III chassis version above, but is provided with an attractive black anodised facia panel and designed to mount directly into equipment desks or cabinets. High, Mid. and Low frequency channel sensitivity controls employ 60mm slider faders for present-day attractive appearance and ease of use. Size: 11in × 8·5in × 4in. Price **£42·35.**

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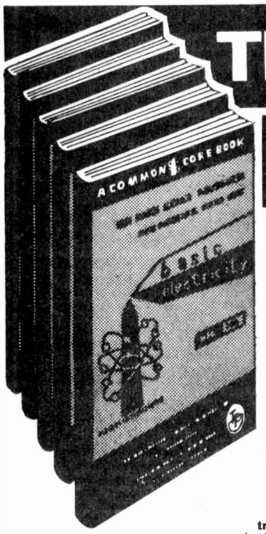

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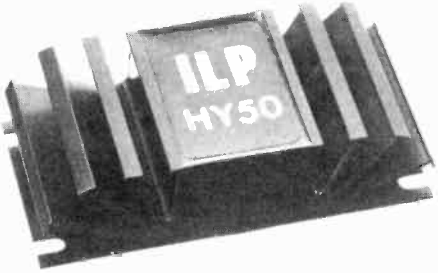

A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices.
We have now finally reduced the modular audio amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split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

SPEC.

OUTPUT POWER:	25W RMS, 50W peak music power.
LOAD IMPEDANCE:	4–16Ω into 8Ω
INPUT SENSITIVITY:	0dB (0·775V RMS).
INPUT IMPEDANCE:	47kΩ.
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25W typically 0·05.
SIGNAL/NOISE RATIO:	better than 75dB.
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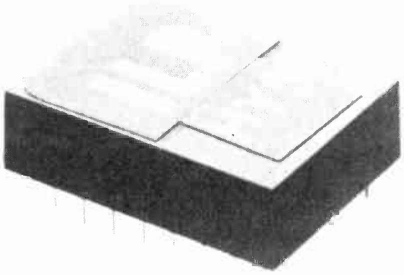
SUPPLY VOLTAGE:	±25V.
SIZE:	105 × 50 × 25mm.

Price £5·60 mono £11·60 stereo. Price inclusive of VAT & P. & P.

NEW HY5 PREAMPLIFIER

Unchallenged for two years, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.
Like the HY50, the new HY5 has no external components and has been redesigned to run off a split power line with improvements in signal/noise, overload capability and reduced distortion. The output has been increased to match the power module (0dB), and share the same power supply.
Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.
When combined with the HY50 and power supply only potentiometers are required to complete a simple mono amplifier with input and output facilities expected to be found on Hi-Fi amplifiers.
The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.



SPEC.

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

OUTPUTS
Tape 100mV.
Main output. 0dB (0·775V).

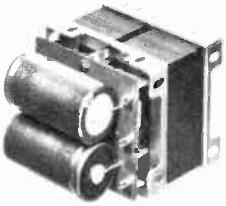
ACTIVE TONE CONTROLS
Treble ± 12dB at 10kHz
Bass ± 12dB at 100Hz

OVERLOAD CAPABILITY
(equalization stage) 40dB on most sensitive input.

OUTPUT NOISE LEVEL
(below 10mV magnetic input) 68dB.

DISTORTION 0·05% at 1kHz.
SUPPLY VOLTAGE ± 16–25V.
SUPPLY CURRENT 15mA.

Price £4·51 mono £9·02 stereo. Price inclusive of VAT & P. & P.



POWER SUPPLY PSU50

The new PSU50 has a low profile look being only 2½in high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25V.
INPUT VOLTAGE 210–240V.
SIZE: L. 70 D. 90 H. 60mm.
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47µF 6½p
100µF 6½p
200µF 6½p
320µF 6½p
1000µF 13p
4700µF 29p

6·3 VOLT
33µF 6½p
68µF 6½p
150µF 6½p
470µF 11p
680µF 13p
1500µF 18p
2200µF 18p
3300µF 26p

10 VOLT
22µF 6½p
47µF 6½p
100µF 6½p
220µF 8p
330µF 10p
470µF 10p
1000µF 11p
1500µF 20p
2200µF 24p

16 VOLT
15µF 6½p
33µF 6½p
150µF 6½p
150µF 8p
220µF 9p
680µF 17p
1000µF 17p
1500µF 25p
2000µF 43p

25 VOLT
10µF 6½p
22µF 6½p
47µF 6½p
100µF 8p
150µF 8p
220µF 10p
470µF 13p
680µF 20p
1000µF 22p
2200µF 39p
5000µF 68p

40 VOLT
6·8µF 6½p
15µF 6½p
33µF 6½p

40 VOLT
47µF 6½p
68µF 10p
100µF 9p
220µF 11p
470µF 19p
680µF 25p
1000µF 25p
2200µF 44p

63 VOLT
1µF 6½p
2·2µF 6½p
4·7µF 6½p
6·8µF 6½p
10µF 6½p
22µF 6½p
68µF 10p
100µF 11p
150µF 18p
220µF 19p
330µF 22p
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3 Amps			60p

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¼ watt 5% carbon	1p
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range 10 ohms to 4·7 megohms.	
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range 10 ohms to 1 megohms.	

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Primary 200-220-240V.

			£	P./P.
MT111	12V	0·5A	1·11	16p
MT111/3	24V	0·25A	1·35	20p
MT71	12V	2A	1·76	22p
MT71/B	24V	1A	1·76	22p
MT18	12V	4A	2·47	36p
MT18/8	24V	2A	2·47	36p

30V transformers

Prim. 200–220–240V. Secondary voltage, 12, 15, 20, 24, 30V or 12–0–12V or 15–0–15V.

		£	P./P.
MT112	0·5A	1·32	22p
MT79	1A	1·80	36p
MT3	2A	2·96	36p
MT20	3A	3·30	42p
MT51	5A	4·84	49p

50V transformers

Prim. 200–220–240V. Secondary voltage, 19, 25, 33, 40, 50V or 25–0–25V.

		£	P./P.
MT102	0·5A	1·76	30p
MT103	1A	2·58	38p
MT105	3A	4·84	52p
MT106	4A	6·02	22p

60V transformers

Prim. 200–220–240V. Secondary voltage, 24, 30, 40, 48, 60V or 24–0–24V or 30–0–30V.

		£	P./P.
MT124AT	0·5A	1·76	38p
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AD150 60p
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BC125 16p
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BC134 16p
BC135 16p
BC137 16p
BC138 36p
BC142 33p
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Prim. 120/240V. Sec 120/240V Centre Tapped and Screened

ALSO AVAILABLE WITH 115/120V SEC. WINDING

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·0 × 6·0 × 6·0	2·32	30
149	60	3	12	9·9 × 7·7 × 8·6	3·45	36
150	100	5	8	9·9 × 8·9 × 8·6	3·79	52
151	200	8	0	12·1 × 9·3 × 10·2	6·45	52
152	250	13	12	12·1 × 11·8 × 10·2	8·41	67
153	350	15	0	14·0 × 10·8 × 11·8	11·20	82
154	500	19	8	14·0 × 13·4 × 11·8	16·25	*
155	750	29	0	17·2 × 14·0 × 14·0	22·10	*
156	1000	38	0	17·2 × 16·6 × 14·0	29·87	*
158	2000	60	0	21·6 × 15·3 × 18·1	49·25	*

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20	1	0	5·8 × 5·1 × 4·5	0-115-210-240	1·22	22
64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·40	30
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	2·89	36
66	300	6	4	9·9 × 9·6 × 8·6	,, ,,	5·63	52
67	500	12	8	12·1 × 11·2 × 10·2	,, ,,	8·36	67
84	1000	19	8	14·0 × 13·4 × 14·3	,, ,,	15·19	82
93	1500	30	4	14·0 × 15·9 × 14·3	,, ,,	21·99	*
95	2000	32	0	17·2 × 16·6 × 14·0	,, ,,	28·70	*
73	3000	40	0	21·6 × 13·4 × 18·1	,, ,,	39·17	*

CASED AUTO TRANSFORMERS

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

LOW VOLTAGE SERIES (ISOLATED)

PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		8	4·8 × 2·9 × 3·5	0-12V at 0·25A × 2	1·22	22
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·44	22
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	1·90	22
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·68	36
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·20	42
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	3·60	52
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·25	52
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·10	52
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	6·56	52
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	8·36	67
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	15·40	82
226	60	30	32	0	17·2 × 15·3 × 14·0	0-12V at 30A × 2	28·44	*

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	1·42	22
79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	1·92	36
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	2·90	36
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	3·58	42
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·25	52
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	5·30	52
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	6·31	52
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	8·18	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	10·33	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	1·90	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	2·80	36
104	2·0	5	8	7·9 × 8·9 × 8·6	,, ,,	3·87	42
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·26	52
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	6·99	52
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	10·35	67
118	8·0	18	0	14·0 × 12·7 × 11·8	,, ,,	13·51	97
119	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	16·95	*

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	1·93	36
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	2·70	36
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·25	42
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	6·46	52
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	8·36	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	9·85	67
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	12·14	82
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	13·65	*
122	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	20·09	*
189	12·0	29	00	17·2 × 14·0 × 14·0	,, ,,	22·49	*

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	1·31	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·52	22
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·12	10
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·52	10
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	2·03	22
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	2·73	30
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·52	10
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·60	22
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	1·41	30
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·08	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	2·82	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	2·86	38

*Carriage via B.R.S.

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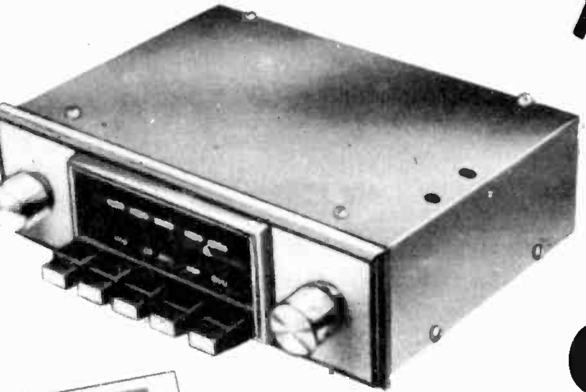

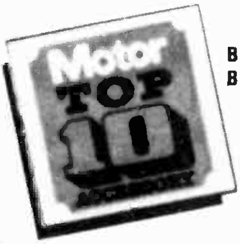

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Technical specification:

1.) **Output** 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
2.) **Integrated circuit** output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and 4 5/16 ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p.free with kit.

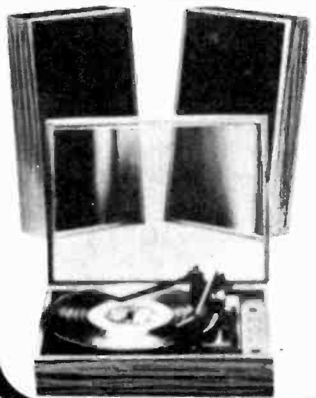
Car Radio Kit
£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
£1.65 + 23p. postage & packing.

Recommended **Car Aerial** - fully retractable and locking.
£1.35 post paid.

STEREO 21

QUALITY SOUND FOR LESS THAN £19·00



Stereo 21 easy to assemble audio system kit, - no soldering required Includes:—

BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.

Two 8″ 5″ speakers with cabinets.

Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

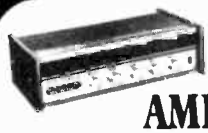
For the technically minded:—

Specifications:

Input sensitivity 600mV: Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs. **Overall Dimensions**. Speakers approx. 15½″ × 8″ × 4″. Complete deck and cover in closed position approx. 15½″ × 12″ × 6″. Complete only **£18·45 + 16p. p & p**

Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individua level controls and padded earpieces to give optimum performance. **£3.85.**

DISCO AMPLIFIER



Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) – all 250mV sensitivity.

Size approx. 12½ ins. × 6 ins. × 3½ ins.
£13.50 + 60p. postage & packing.

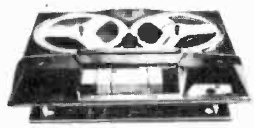
8 TRACK CARTRIDGE PLAYER

Elegant self selector push button player for use with your own stereo system. Compatible with Viscount III system, the Stereo 21 and the Unisound module.
Technical specification.
Mains input. 240V. Output sensitivity 125mV
Comparable unit sold elsewhere at £24·00 approx.
Yours for only £10·60 + 90p. p & p

BUILD YOUR OWN STEREO AMPLIFIER

For the man who wants to design his own stereo —here's your chance to start, with Unisound— pre-amp. power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
£7·64 + 55p. p & p

P.E. TAPE LINK CONSTRUCTORS



A suitable 3 speed tape deck, less heads. Caters up to 5¾ ins. spools. 240V AC mains. Unused but store soiled hence no warranty. **£4.00 + £1.00 p & p**

Marshall's

A. Marshall & Son (London) Limited
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& 65 Bath Street Glasgow G2 2BX, Telephone 041-332 4133

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Our price £29·00 excluding VAT
Recommended price £42·50. P&P 30 pence UK

Transistors

2G301	0·15	2N3392	0·13	3N187	1·55	ASY29	0·36	BCY72	0·13	BFY11	0·45
2G302	0·15	2N3393	0·13	3N200	2·49	ASY50	0·20	BCY87	3·54	BFY17	0·90
2G303	0·25	2N3394	0·13	3N201	1·12	ASY55	0·15	BCY88	2·42	BFY18	0·35
2G306	0·30	2N3402	0·18	40050	0·78	BC107	0·16	BCY89	0·97	BFY19	0·35
2G309	0·30	2N3403	0·19	40251	0·81	BC108	0·15	BCZ10	0·35	BFY20	0·50
2G345B	0·25	2N3404	0·24	40309	0·30	BC109	0·19	BCZ11	0·50	BFY29	0·40
2G371	0·15	2N3405	0·27	40310	0·50	BC113	0·13	BD115	0·75	BFY37	0·20
2G374	0·15	2N3414	0·10	40313	0·92	BC114	0·12	BD116	0·75	BFY41	0·43
2N174	1·40	2N3415	0·10	40316	0·50	BC115	0·15	BD121	0·75	BFY43	0·65
2N404	0·43	2N3416	0·15	40318	0·92	BC116	0·15	BD123	0·82	BFY50	0·22½
2N456	0·75	2N3417	0·21	40360	0·46	BC116A	0·18	BD124	0·67	BFY51	0·18½
2N456A	0·75	2N3570	1·25	40361	0·48	BC117	0·21	BD131	0·40	BFY52	0·20½
2N457A	0·80	2N3571	1·12½	40362	0·50	BC118	0·11	BD132	0·50	BFY53	0·16
2N491	3·58	2N3572	0·97	40363	0·61	BC119	0·29	BD135	0·43	BFY56	0·34
2N696	0·15	2N3702	0·11	40389	0·46	BC121	0·23	BD136	0·49	BFY64	0·41½
2N697	0·15	2N3703	0·12	40394	0·56	BC125	0·15	BD137	0·55	BFY75	0·40
2N698	0·25	2N3704	0·14	40395	0·65	BC126	0·20	BD138	0·63	BFY76	0·22
2N699	0·29	2N3705	0·12	40406	0·44	BC132	0·30	BD139	0·71	BFY77	0·24
2N706	0·16	2N3706	0·09	40407	0·33	BC134	0·11	BD140	0·87	BFY78	0·36
2N706A	0·18	2N3707	0·13	40408	0·50	BC135	0·11	BDY10	1·25	BFY90	0·60
2N708	0·14½	2N3708	0·70	40409	0·52	BC136	0·15	BDY11	1·50	BRY39	0·28
2N709	0·38	2N3709	0·11	40410	0·52	BC137	0·15	BDY17	1·50	BSX19	0·13
2N711	0·30	2N3710	0·12	40411	2·25	BC138	0·24	BDY18	1·75	BSX20	0·20½
2N718	0·21	2N3711	0·11	40414	3·55	BC140	0·34	BDY19	1·87	BSX21	0·20½
2N718A	0·49	2N3712	0·96	40467	0·69	BC141	0·29	BDY20	1·05	BSX26	0·49
2N720	0·50	2N3713	1·20	40468A	0·44	BC142	0·23½	BDY38	0·65	BSX27	0·34
2N721	0·55	2N3714	1·38	40600	0·69	BC143	0·21	BDY60	0·85	BSX28	0·25
2N914	0·22	2N3715	1·50	40601	0·67	BC144	0·24	BDY61	1·25	BSX29	0·47
2N916	0·41	2N3716	1·80	40602	0·46	BC145	0·21	BDY62	1·00	BSX60	0·54
2N918	0·47	2N3773	2·65	40603	0·58	BC147	0·12	BF115	0·25	BSX61	0·42
2N929	0·30	2N3779	3·15	40604	0·56	BC148	0·13	BF116	0·23	BSX76	0·15
2N930	0·48	2N3790	2·40	40636	1·10	BC149	0·12	BF117	0·43	BSX77	0·20
2N1090	0·30	2N3791	2·35	40673	0·70	BC153	0·18	BF119	0·58	BSX78	0·25
2N1091	0·32	2N3792	2·69	AC107	0·25	BC154	0·18	BF121	0·25	BSW70	0·28
2N1132	0·54	2N3794	0·10	AC113	0·16	BC157	0·14	BF123	0·27	BSY24	0·20
2N1302	0·18½	2N3819	0·37	AC117	0·20	BC158	0·13	BF125	0·25	BSY25	0·20
2N1303	0·18½	2N3820	0·38	AC121	0·13	BC159	0·14	BF152	0·20	BSY26	0·20
2N1304	0·24	2N3823	1·42	AC126	0·25	BC160	0·37	BF153	0·21	BSY27	0·15
2N1305	0·24	2N3824	1·33	AC127	0·25	BC167B	0·13	BF154	0·16	BSY28	0·15
2N1306	0·31	2N3826	0·23	AC128	0·25	BC168B	0·13	BF158	0·23	BSY38	0·19½
2N1307	0·22	2N3854	0·18	AC141K	0·30	BC168C	0·11	BF159	0·27	BSY39	0·19½
2N1308	0·25	2N3854A	0·16	AC142K	0·25	BC169B	0·13	BF160	0·23	BSY51	0·25
2N1309	0·35½	2N3855	0·19	AC151V	0·14	BC169C	0·13	BF161	0·41½	BSY52	0·25
2N1483	0·90	2N3855A	0·20	AC152V	0·17	BC170	0·11	BF163	0·31½	BSY53	0·25
2N1507	0·30	2N3856	0·19	AC153	0·25	BC171	0·13	BF166	0·31½	BSY54	0·30
2N1613	0·33	2N3856A	0·20	AC153K	0·25	BC172	0·11	BF167	0·21	BSY56	0·79
2N1631	0·38	2N3858	0·16	AC154	0·20	BC182	0·12	BF173	0·24	BSY65	0·15
2N1637	0·36	2N3858A	0·19	AC176	0·18	BC182L	0·12	BF177	0·29	BSY78	0·40
2N1638	0·32	2N3859	0·14	AC176K	0·25	BC183	0·09	BF178	0·35	BSY79	0·40
2N1701	1·19	2N3859A	0·19	AC187K	0·28	BC183L	0·09	BF179	0·43	BSY790	0·45
2N1702	2·15	2N3860	0·19	AC188K	0·34	BC184	0·11	BF180	0·35	BSY95A	0·10½
2N1711	0·45	2N3866	1·09	ACY17	0·35½	BC184L	0·11	BF181	0·34	BU104	1·42
2N1893	0·81	2N3877	0·25	ACY18	0·24	BC186	0·25	BF182	0·40	BU105	2·25
2N2102	0·30	2N3877A	0·26	ACY19	0·27	BC187	0·27½	BF183	0·40	C111	0·53
2N2147	0·70	2N3900	0·21	ACY20	0·22	BC207	0·12	BF184	0·17	D40N3	0·55
2N2148	0·94	2N3900A	0·21	ACY21	0·26	BC208	0·11	BF185	0·17	GET111	0·45
2N2192	0·40	2N3901	0·32	ACY22	0·17	BC212K	0·10	BF194	0·16	GET113	0·25
2N2192A	0·40	2N3903	0·24	ACY28	0·20	BC212L	0·16	BF195	0·17	GET114	0·20
2N2913	0·40	2N3904	0·27	ACY30	0·42	BC214L	0·21	BF196	0·15	GET115	0·50
2N2193A	0·61	2N3905	0·24	ACY39	0·65½	BC237	0·09	BF197	0·15	GET119	0·35
2N2194	0·73	2N3906	0·27	ACY40	0·17	BC238	0·09	BF198	0·18	GET120	0·40
2N2194A	0·30	2N4036	0·62½	ACY41	0·17	BC239	0·09	BF199	0·18	GET535	0·20
2N2218A	0·86	2N4037	0·42	ACY44	0·31	BC251	0·20	BF200	0·40	GET536	0·20
2N2219	0·57	2N4058	0·16	AD136V	0·96	BC252	0·18	BF224J	0·14	GET538	0·20
2N2219A	0·86	2N4059	0·09	AD142	0·50	BC253	0·23	BF225J	0·19	GET873	0·12
2N2220	0·45	2N4060	0·11	AD143	0·45	BC257	0·09	BF237	0·22	GET875	0·15
2N2221	0·41	2N4061	0·11	AD149V	0·66	BC258	0·09	BF238	0·22	GET880	0·35
2N2221A	0·83	2N4062	0·11	AD150	0·63	BC259	0·13	BF244	0·16	GET883	0·20
2N2222	0·60	2N4302	0·25	AD161	0·45	BC261	0·20	BF245	0·33	GET887	0·20
2N2222A	0·91	2N4303	0·47	AD162	0·45	BC262	0·18	BF246	0·43	GET890	0·25
2N2368	0·31	2N4916	0·11	AD161	Pr.	BC263	0·23	BF247	0·49	GET895	0·25
2N2369	0·37	2N4917	0·17	AD162	1·05	BC300	2·12	BF254	0·16	TIP29A	0·49
2N2369A	0·41	2N4918	0·73	AF109R	0·40	BC301	0·34	BF255	0·17	TIP30A	0·58
2N2646	0·77	2N4919	0·84	AF114	0·25	BC302	0·29	BF257	0·47	TIP31A	0·62
2N2647	1·12	2N4920	0·99	AF115	0·24	BC303	0·54	BF258	0·59	TIP32A	0·74
2N2711	0·13	2N4921	0·73	AF116	0·25	BC307	0·10	BF259	0·55	TIP33A	1·01
2N2712	0·12	2N4922	0·84	AF117	0·20	BC307A	0·10	BF270	0·21	TIP34A	1·51
2N2713	0·17	2N4923	0·83	AF118	0·50	BC308	0·09	BF272	0·53	TIP35A	2·90
2N2714	0·18	2N5172	0·12	AF121	0·22	BC308A	0·12	BF273	0·15	TIP36A	3·70
2N2904	0·55	2N5174	0·22	AF124	0·24	BC308B	0·09	BF274	0·17	TIP41A	0·79
2N2904A	0·70	2N5175	0·26	AF125	0·20	BC309	0·10	BF457	0·53	TIP42A	0·90
2N2905	0·71	2N5176	0·32	AF126	0·19	BC309A	0·10	BF458	0·65	TIP2955	0·98
2N2905A	0·88	2N5190	0·92	AF127	0·20	BC309B	0·10	BFS21A	2·30	TIP3055	0·60
2N2906	0·65	2N5191	0·95	AF139	0·38	BC327	0·21	BFS28	0·92	ME0401	0·18
2N2906A	0·70	2N5192	1·24	AF170	0·25	BC328	0·19	BFS61	0·27	ME0402	0·20
2N2907	0·38	2N5195	1·46	AF172	0·25	BC337	0·19	BFS98	0·20	ME0404	0·13
2N2907A	0·41	2N5245	0·43	AF178	0·55	BC338	0·19	BFW11	0·61	ME0411	0·17
2N2923	0·12	2N5457	0·49	AF179	0·65	BCY30	0·43	BFX13	0·23	ME0412	0·18
2N2924	0·14	2N5458	0·45	AF180	0·50	BCY31	0·51½	BFX29	0·30	ME0413	0·14
2N2925	0·17	2N5459	0·49	AF186	0·40	BCY32	1·15	BFX30	0·25	ME1120	0·25
2N2926		3N128	0·73	AF200	0·35	BCY33	0·34	BFX37	0·33	ME4001	0·09
Green	0·12	3N138	1·65	AF239	0·51	BCY34	0·36½	BFX44	0·33	ME4002	0·11
Yellow	0·11	3N139	1·42	AF240	0·72	BCY38	0·52½	BFX63	2·48	ME4003	0·14
Orange		3N140	0·92	AF279	0·54	BCY39	1·05	BFX68	0·30	ME6101	0·10
	0·11	3N141	0·81	AF280	0·54	BCY40	0·87	BFX84	0·24	ME4102	0·11
2N3053	0·32	3N142	0·58	AFY42	0·74	BCY42	0·15	BFX85	0·30	ME4103	0·10
2N3054	0·86	3N143	0·75	AL102	0·75	BCY43	0·15	BFX86	0·25½	ME4104	0·11
2N3055	0·75	3N152	0·92	AL103	0·70	BCY58	0·21	BFX87	0·28	ME4101	0·14
2N3390	0·26	3N153	0·81	ASY26	0·30	BCY59	0·22	BFX88	0·25	ME6102	0·16
2N3391	0·28	3N154	0·84	ASY27	0·36	BCY70	0·17	BFX89	0·45	ME8002	0·17
2N3391A	0·29	3N159	1·17	ASY28	0·28	BCY71	0·22	BFY10	0·35	ME8003	0·16

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RL54	13p
RL55	42p
RL209	33p
RL4484	31p
RL4850	31p
DL707 (Alphanumeric)	2.35

Litronix LED's
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Full range of Cosmos Capacitors - Siemens Nitsuko Ducati

Zener Diodes Sescocem and Mullard

400mw	11p
1w	17p
1½w	25p
10w	40p
20w	52p

Components supplied for most projects in this magazine

Our full range is in our catalogue available now - price 20pence

Post and Packing 13p per order. Europe 25p. Commonwealth (Air) 65p (MIN). Matching charge (audio transistors only) 15p extra per pair. Prices subject to stock availability.

Kellner Construction Kits

We are the sole distributors in U.K.

ES3 3 watt Mono Transistor Amplifier Kit .. .. £4·08
ES15 15 watt Hi-Fi Transistor Amplifier Kit [two for stereo] with Tone Control and Pre-Amp .. .. £13·20
ES30 30 watt Mono Hi-Fi Power Amplifier .. .. £9·20
ES50 50 watt Mono Hi-Fi Power Amplifier .. .. £10·53
EV3 Distortion Compensated Pre-Amplifier .. .. £4·00
AV7 Aerial Amplifier. LW, SW, MW, VHF, T/V Channels 2–12 .. .. £2·04
UH870 FM Transmitter Kit. 65mHz–145mHz. A GPO Licence is required .. .. £2·79
MUE7 Short Wave and VHF Receiver Kit. Companion to UH870 25mHz–150mHz .. .. £3·22
EW18 Electronic Dice Kit .. .. £6·53
EW20 Electronic Dice with Sensor Button .. .. £7·79
ST800 Strobe Light Kit, 120W/S .. .. £7·86
LO1000 Psychedelic Light Control, single channel .. £7·00
LO350 Psychedelic Light Control, three channel .. £13·50
NT15 Power Supply—4 to 30V, 1·5W .. .. £7·46
NT85 Professional Stabilized Power Supply, 5 to 70V, 2A .. .. £12·53
D800 800W Light Dimmer Speed Control .. .. £2·98
WT7 Aircraft Communications Tuner 110–130mHz. Built and aligned .. .. £15·46
WT9 Transmitter VFO for 2 meters [144mHz–146mHz]. Built and aligned .. .. £15·46

All prices plus 10% VAT and plus 15p post and packing. All kits with easy to follow instructions and covered by a full guarantee.

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	Plastic				Metal—Professional quality			
	£	£	£	£	£	£	£	£
	1A	2A	4A	6A	5	15	25	50A
50	0·24	0·32	0·60	0·62	2·22	2·64	3·36	12·30
100	0·36	0·37	0·70	0·75	2·24	3·00	3·60	12·36
200	0·30	0·41	0·75	0·80	2·82	3·78	4·32	14·40
400	0·36	0·45	0·85	1·10	3·72	4·20	5·40	16·38
600	0·40	0·52	0·95	1·25				

AB Potentiometers—carbon

Rotary type 45: Singles (Log and linear) 15p. Single switched (Log and linear) 21p. Doubles (Log and linear) 38p.
Slider type 58: Singles (Log and linear) 30p. Doubles (Log and linear) 50p.
Presets: 0·1 watt 6p, 0·2 watt 6p, 0·3 watt 7½p. Please specify vertical or horizontal.

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PIV	50	100	200	400	600	800	1000
1·5	8p	9p	10p	11p	12p	15p	20p
3	15p	17p	20p	22p	25p	27p	30p
10	—	35p	40p	47p	56p	—	—
35	84p	92p	£1·18	£2·15	£2·52	£3·65	£4·20

Cathode Stud Only
IN3766 (35A 800pv) £3·65 | IN3786 (35A 1000pv) £4·20

IN34A	10p	BA141	17p	BY237	12½p	OA79	7p
IN914	7p	BA142	17p	BYZ10	35p	OA81	8p
IN916	7p	BA144	12p	BYZ11	32p	OA85	10p
AA119	7p	BA145	17p	BYZ12	30p	OA90	7p
AA129	15p	BA154	12p	OA9	10p	OA91	7p
BA100	15p	BY100	15p	OA10	20p	OA95	7p
BA102	25p	BY126	15p	OA47	7½p	OA200	7p
BA110	25p	BY127	17½p	OA70	7½p	OA202	10p
BA115	7p	BY140	£1	OA73	10p	OA210	27p

Integrated Circuits

Each month we will show a different range of i.c.'s which are kept in stock.

CA3000	2·28	CA3028b	1·17	CA3054	1·19	CD4010ae	1·07
CA3001	3·38	CA3029	0·52	CA3055	1·44	CD4011ae	0·51
CA3002	2·26	CA3029a	0·63	CA3059	1·84	CD4012ae	0·51
CA3004	2·26	CA3030	1·08	CA3060	4·91	CD4013ae	0·99
CA3005	1·50	CA3030a	1·64	CA3062	2·97	CD4014ae	2·66
CA3006	3·47	CA3033	2·92	CA3064	1·42	CD4015ae	2·66
CA3007	3·28	CA3033a	4·93	CA3065	1·42	CD4016ae	1·02
CA3008	1·98	CA3034	1·65	CA3066	2·61	CD4017ae	2·66
CA3008a	3·24	CA3035	1·52	CA3067	2·72	CD4018ae	2·66
CA3010	0·56	CA3036	0·90	CA3068	3·01	CD4019ae	1·23
CA3010a	0·69	CA3037a	2·60	CA3070	2·15	CD4020ae	2·96
CA3011	0·92	CA3038	2·60	CA3071	2·01	CD4021ae	2·70
CA3012	1·11	CA3038a	3·40	CA3072	2·07	CD4022ae	2·58
CA3013	1·30	CA3039	1·00	CA3075	1·46	CD4023ae	0·51
CA3014	1·52	CA3040	2·95	CA3076	1·67	CD4024ae	4·95
CA3015	1·40	CA3041	1·30	CA3078	3·19	CD4025ae	0·51
CA3015a	1·82	CA3042	1·30	CA3080	0·58	CD4027ae	1·58
CA3016	2·61	CA3043	1·73	CA3080a	1·90	CD4028ae	2·34
CA3016a	3·90	CA3044	1·42	CA3086	0·46	CD4029ae	3·79
CA3018	0·88	CA3045	1·50	CA3088e	1·38	CD4037ae	1·93
CA3018a	1·19	CA3046	0·86	CA3089e	2·18	CD4042ae	2·11
CA3019	0·94	CA3047	1·59	CA3090q	4·70	CD4043ae	2·11
CA3020	1·55	CA3047a	2·92	CD4000ae	0·51	CD4044ae	2·11
CA3020a	2·01	CA3048	2·34	CD4001ae	0·51	CD4045ae	2·65
CA3021	1·90	CA3049	1·96	CD4002ae	0·51	CD4046ae	2·84
CA3022	1·61	CA3050	2·28	CD4006ae	2·45	CD4047ae	1·65
CA3023	1·55	CA3051	1·73	CD4007ae	0·51	CD4049ae	0·90
CA3026	1·25	CA3052	1·80	CD4008ae	2·53		
CA3028a	0·88	CA3053	0·52	CD4009ae	1·07		

PE

INSPIRING TIMES

If necessity be the mother of invention, we are now surely entering upon a period of prolificity in circuit creation and adaptation.

It is the amateur designer and experimenter who so often has the knack of hitting upon the right kind of solution to a sudden problem affecting everyday life. And problems there certainly are at this present time when restrictions in the use of electricity, if not complete cuts in the supply, affect all households; and soaring prices, if no actual shortage of petrol, make every motorist that more efficiency conscious.

This month's *Ingenuity Unlimited* includes a novel circuit devised by one of our readers and it is likely to be of interest to those with electrically controlled gas fired heating systems. A fore-runner, no doubt, of other crisis inspired ideas. We shall be happy, indeed consider it to be our duty, to publish other circuit ideas which may help overcome hardships or inconvenience experienced at home or on the road.

There already exist, of course, many circuits and systems that have relevance in the present difficult times. As a service to our readers we have prepared a special Blueprint for inclusion in this issue. It gives details for constructing two extremely useful and topical projects.

One side of this Blueprint carries details of the *P.E. Scorpio Mk 2 Ignition System.* The great success of the first Scorpio ignition system coupled with a continuing demand for copies of the original article made it quite clear that publication of an up-dated version would be highly welcomed; and in actual fact, could be a genuine service to the car owning public. The merits of the capacitor discharge ignition system are now well established, but they are, in any case, summarised in the article which complements the information given on the Blueprint.

The other side of the Blueprint is devoted to a design for a lamp inverter. Such devices are not by any means novel, but since design information may not be immediately to hand at the crucial moment, we expect a number of readers will appreciate the appearance of this useful design.

NEW PRICE

We ourselves, alas, are not immune from the effects of rising prices and shortages of raw materials, and we regret having to end this month with the following domestic note.

An apology is due to our readers for the lack of advance warning with regard to an increase in price of PRACTICAL ELECTRONICS. This increase to 25p takes effect as from this (March) issue. Unfortunately it was not possible to make an earlier announcement in this respect.

We trust all our readers will understand that the current high cost of materials, especially paper, makes this new price for P.E. unavoidable.

F.E.B.

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PROBABLY the simplest rhythm generator is the old fashioned metronome. This device maintains the player's tempo but it cannot emphasise the down beat or create any special effects.

Down beat enhancement can be achieved electronically but for more entertaining rhythm accompaniment it is more satisfying to tie the output of an electronic metronome to electronic percussion generators in a selected sequence or rhythm pattern such as Waltz, Cha-cha, etc.

All commercially available switched rhythm generators have fixed rhythms which cannot be changed except by rewiring the switches. The generator to be described has no such limitations, it can produce any rhythm pattern of 16 pulses, for a total of 64,000 patterns, to be used to drive any one of eight percussion generators. Details for setting up the common rhythm patterns will be given.

Four time signature switches select 4/4, 3/4, 6/8 or 9/8 time for the 16 available pulses and when programming a rhythm pattern the pulse order can be monitored using a Minitron indicator. Because circuit layout is not particularly critical detailed constructional information has been omitted and instead use has been made of photographs annotated where necessary, to provide rudimentary guidelines for assembly.

BLOCK DIAGRAM

Fig. 1 shows the block diagram for the Rhythm Generator. The tempo generator is an assymetrical astable multivibrator. It will start when power is applied and run at all times from that point on. The frequency is controlled by the tempo control VR1.

The output of this generator is fed to a divide by four circuit. This expedient was used to keep the size of the tempo generator components to reasonable levels and insure more reliable operation of that part of the circuit. The tempo generator runs then at an effective 64 beats per measure.

The four bit binary counter is used to generate 16 binary numbers which are decoded for the address information (storage address) and applied to IC6 for decoding and application to the Minitron indicator. IC5 decoding chip is used to supply reset pulses to the counter for 9 and 12 counts giving 9/8 time and 3/4 or 6/8 time respectively.

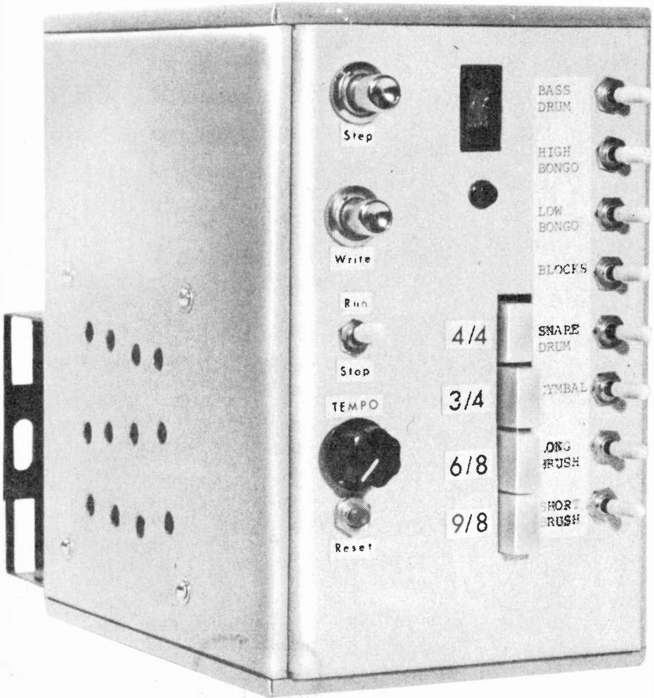
The step generator is switched to the input of the counter when the "Stop/Run" switch is placed in the "Stop" position. The divide by four output is removed at that time and the counter can be manually stepped from 0 through 15.

MEMORY CHIPS

The storage section for the programmed rhythms is made up of two SN7489, 64 bit bipolar memory chips (IC7/IC8). Each of these contains 64 flip-flops capable of storing a binary 0 or 1 (0 volts or 4 volts respectively). The particular group of four flip-flops selected per chip (eight for both chips) is controlled by the address lines which get their information from the counter. Thus 16 registers of eight bits each are available.

Each of these 16 registers is operated or selected in turn when the counter is running or being manually stepped and the contents of each can be controlled by the input switches to store either a binary 0 or 1. The actual output of each bit is inverted and is reoriented by the output gates, IC9/IC10.

Besides the address lines, input lines and output lines, there is a "chip select" and a "write" line.



RHYTHM GENERATOR

BY BRICE WARD

Cover photograph by courte... SPECTRUM COLOUR LIBRARY

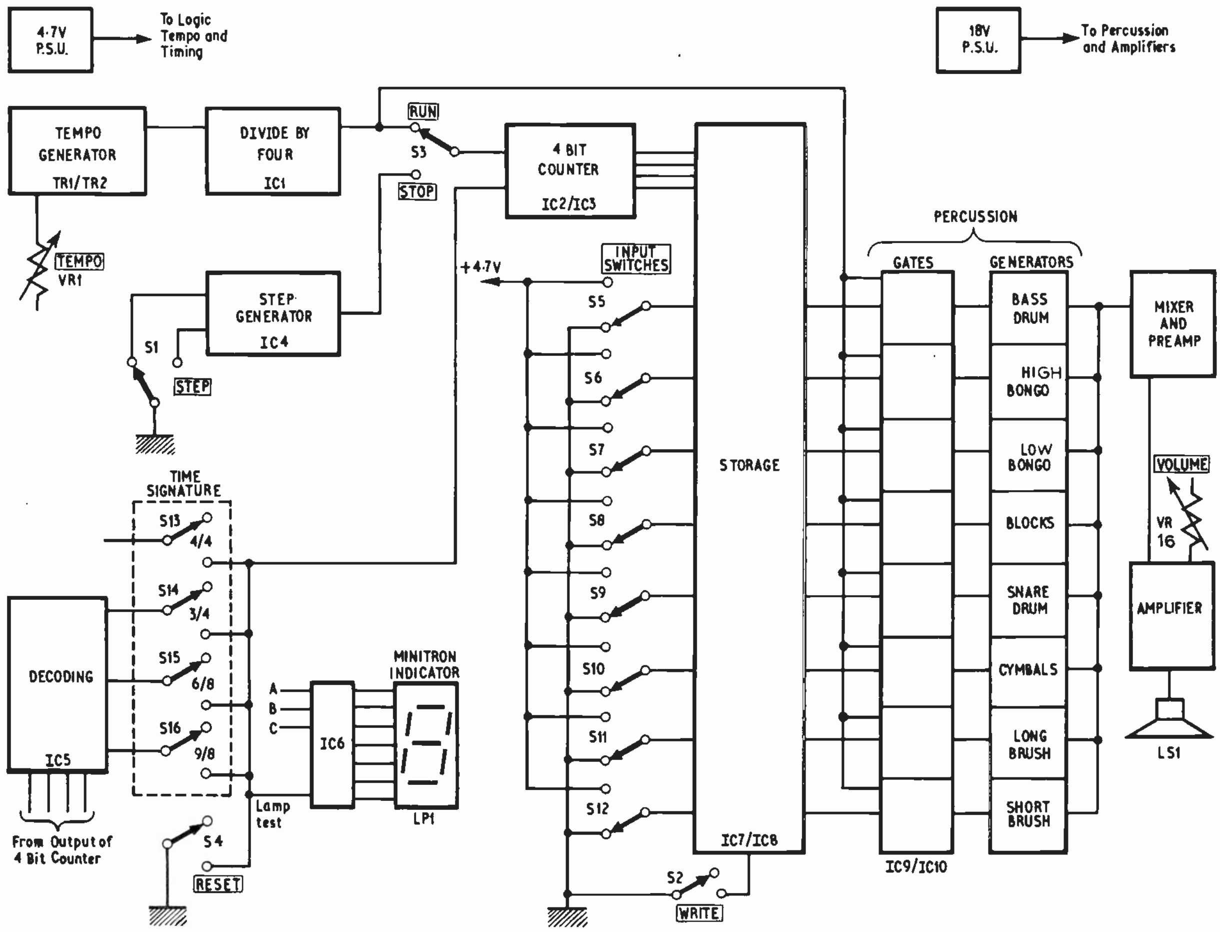


Fig. 1. Block diagram of rhythm generator

The chip select line is permanently grounded in this application because it simply makes the output available. The "write" line is used to write new information into storage when programming the rhythm generator. Setting the input switches as desired (S5 through 12) and pressing the "Write" switch will cause the new information to be stored, otherwise, the input does not effect the condition of the storage locations.

The output of the instrument gates is controlled by the output of the storage section and the divide by four counter. The result is a positive pulse of voltage initiated when the counter changes state if, in the new count position, a "1" has been stored for that instrument.

- ***Rhythms can be programmed by the user***
- ***Eight percussion generators***
- ***Can produce any 16 pulse rhythms up to 64,000***
- ***Four time signature switches for 4/4, 3/4, 6/8 or 9/8 measures***
- ***Pulse order can be observed using a Minitron Indicator***

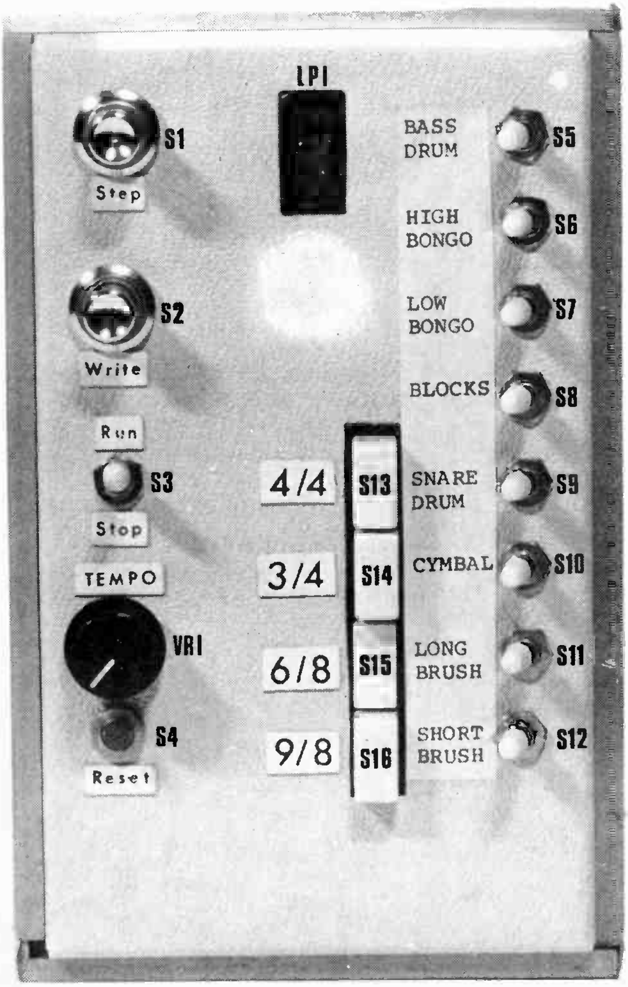
PERCUSSION GENERATORS

The percussion generators make use of various circuits to generate the sounds of drums, bongos and so forth.

The bass drum generator, for example, contains an input amplifier which converts the 5 volt input pulse to 18 volts, shapes it and applies it to a twin-T ringing oscillator. The circuitry for the bongos and blocks is similar.

The snare drum, cymbal and brushes make use of a noise diode the output of which is shaped and filtered, mixed with some basic frequency and applied to the mixer. The first four instruments are applied to a single f.e.t. stage. The final four are applied to individual f.e.t. stages and the output of these five f.e.t.s is applied to a source follower as an output stage to the amplifier.

The output of the 18 volt power supply is regulated to reduce hum and noise while the 4·7V supply is held reasonably level with a Zener diode. The volume control, VR16, is located on the back panel of the complete instrument.



COMPONENTS . . .

TEMPO, TIMING AND LOGIC

Resistors
R1 1kΩ
R2 22kΩ
R3 15kΩ
R4 1kΩ
All 10% ½ watt carbon

Capacitors
C1 0·01μF ceramic 100V
C2 10μF elect. 25V
C3–C6 0·01μF polyester (4 off)

Integrated Circuits
IC1–IC3 SN7473 (3 off)
IC4 SN7400
IC5 SN7420
IC6 SN7447
IC7–IC8 SN7489 (2 off)
IC9–IC10 SN7402 (2 off)

Transistors
TR1–TR2 BC108

Switches
S1–S2 Single pole change over, break before make push-button.
S3 Single pole change over miniature toggle
S4 Single pole change over, break before make push-button
S5–S12 Single pole change over miniature toggle (8 off)
S13–S16 Bank of four, four pole change over switches
All switches available from Home Radio

Potentiometer
VR1 250kΩ carbon lin.

Lamp
LP1 Minitron 3015F 7 segment indicator

Miscellaneous
Contil Mod 2B case (West Hyde Developments)
2 plug in Veroboards 5·1in×3·744in, 0·1in matrix to suit 32 contact edge connectors, type B

POWER SUPPLY UNIT

Resistors
R5 7Ω 2W
R6 270Ω ½W

Capacitors
C7 2,000μF elect. 25V
C8 1,000μF elect. 15V

Transistors
TR3 2N3054

Diodes
D1 ZL4·7 4·7V Zener 1W
D2 ZL18 18V Zener 500mW

Bridge Rectifiers
D3–D6 MDA 942A1 Motorola
D7–D10 MDA 942A1 Motorola

Transformer
T1 Pri-240V, Sec. 1 18V, 0·35A; Sec. 2 6·3V 0·7A (Henry's Radio)

Miscellaneous
FS1—200mA cartridge fuse S17–Double pole main toggle switch

BASS DRUM

Resistors

R7	4·7k Ω	R13–R14	56k Ω (2 off)
R8	1M Ω	R15	1·2M Ω
R9	2·7k Ω	R16	100 Ω
R10	82k Ω	R17	68k Ω
R11	2·2k Ω	R18	10k Ω
R12	2·7k Ω		

All 10% ½W carbon

Capacitors

C9 0·1μF
C10 0·02μF
C11–C15 0·1μF (5 off)

Potentiometers

VR3 5k Ω miniature preset
VR4 50k Ω miniature preset

Transistors

TR4–TR5 BC109

HIGH AND LOW BONGOS

Resistors

R19–R20 4·7k Ω (2 off)
R21–R22 2·7k Ω (2 off)
R23–R24 1M Ω (2 off)
R25–R26 27k Ω (2 off)
R27–R28 2·2k Ω (2 off)
R29–R30 6·8k Ω (2 off)
R31–R34 56k Ω (4 off)
R35–R36 1·2M Ω (2 off)
R37–R38 68k Ω (2 off)
R39–R40 100 Ω (2 off)
R41–R44 82k Ω (4 off)
All ½W 10% carbon

Capacitors

C16–C17 0·01μF (2 off)
C18–C23 0·015μF (6 off)
C24* 0·033μF (High bongo only)
C25* 0·1μF (Low bongo only)
C26–C27 0·05μF (2 off)
C28–C29 0·01μF (2 off)

Transistors

TR6–TR9 BC109 (4 off)

Potentiometers

VR5–VR6 5k Ω miniature preset (2 off)
VR7–VR8 50k Ω miniature preset (2 off)

BLOCKS

Resistors

R45	4·7k Ω	R50	68k Ω
R46–R47	27k Ω (2 off)	R51–R52	22k Ω
R48	150k Ω	R53	15k Ω
R49	390k Ω	R54	2·7k Ω

All 10% ½ watt carbon

Capacitors

C30 0·1μF
C31–C33 0·002μF (3 off)
C34 0·1μF
C35 500pF

Potentiometers

VR9 50k Ω miniature preset

Transistors

TR10–TR12 BC109 (3 off)

SNARE DRUM

Resistors

R55–R56	4·7k Ω	R61	12k Ω
R57	3·3k Ω	R62	120k Ω
R58	1k Ω	R63	2·2k Ω
R59	120k Ω	R64	3·9k Ω
R60	100k Ω	R65	15k Ω

All ½ watt 10% carbon

Capacitors

C36 1μF elect. 15V
C37 10μF elect. 15V
C38 0·1μF
C39 0·0022μF
C40 0·022μF
C41 220pF
C42 1·5μF elect. 15V
C43 500pF

Potentiometer

VR10 100k Ω miniature preset

Transistors

TR13–TR14 BC109 (2 off)

Diodes

D11 1N914
D12 Z1J (Semitron)

Inductor

L1 OL130 transformer (Henry's Radio)

CYMBAL

Resistors

R66	3·3k Ω	R73	120k Ω
R67	10k Ω	R74	100k Ω
R68	470kΩ	R75	120k Ω
R69	47k Ω	R76–R77	10k Ω
R70	10k Ω	R78	2·2k Ω
R71	1·5M Ω	R79	1M Ω
R72	680 Ω	R80	10k Ω

All ½ watt 10% carbon

Capacitors

C44	2μF elect. 15V	C47	0·05μF
C45	8μF elect. 15V	C48	1μF elect. 15V
C46	0·1μF	C49	0·05μF

Transistors

TR15–TR17 BC109 (3 off)

Diodes

D13–D14 1N914 (2 off)
D15 Z1J (Semitron)

Inductor

L2 OL130 transformer

LONG BRUSH

Resistors

R81	4·7k Ω	R88	100k Ω
R82–R83	22k Ω	R89–R90	10k Ω
R84	1·2M Ω	R91	2·2k Ω
R85	390 Ω	R92	150k Ω
R86	100k Ω	R93	82k Ω
R87	68k Ω		

All ½ watt 10% carbon

Capacitors

C50	4μF elect. 15V	C53	0·01μF
C51	0·1μF	C54	2·5μF elect. 15V
C52	0·02μF	C55	0·22μF

Transistors

TR18–TR20 BC109 (3 off)

Diodes

D16 1N914 D17 Z1J (Semitron)

SHORT BRUSH

Resistors

R94 4·7k Ω
R95–R96 22k Ω (2 off)
R97 1·2M Ω
R98 390 Ω
R99 100k Ω
R100 68k Ω
R101 100k Ω
R102–R103 10k Ω (2 off)
R104 2·2k Ω
R105 150k Ω
R106 82k Ω
All ½ watt 10% carbon

Capacitors

C56 1μF elect. 15V
C57 0·1μF
C58 0·02μF
C59 0·01μF
C60 2·5μF elect. 15v
C61 0·22μF

Transistors

TR21–TR23 BC109 (3 off)

Diodes

D16 1N914
D17 Z1J (Semitron)

MIXER AND PRE-AMPLIFIERS

Resistors

R107 4·7k Ω
R108–R112 2·2k Ω (5 off)
R113 10k Ω
R114 2M Ω
R115 10k Ω
R116 2·2k Ω
All ½ watt 10% carbon

Capacitors

C62–C66 0·01μF (5 off)
C67 0·05μF

Potentiometers

VR11–VR15 2·5M Ω miniature preset (5 off)

Transistors

TR24–TR29 2N3819 (6 off)

AMPLIFIER

Resistors

R117	330k Ω	R121	39k Ω
R118	39k Ω	R122	3·3k Ω
R119	18k Ω	R123	22 Ω
R120	150k Ω	R124	1k Ω

All ½ watt 10% carbon

Capacitors

C68	0·1μF	C71	0·1μF
C69	0·002μF	C72	50μF elect. 15V
C70	500μF elect. 15V		

Potentiometer

VR16 25k Ω

Integrated Circuit

IC1 PA263 (Jermyn)

Loudspeaker

LS1 8 Ω, 5 watt 4in loudspeaker

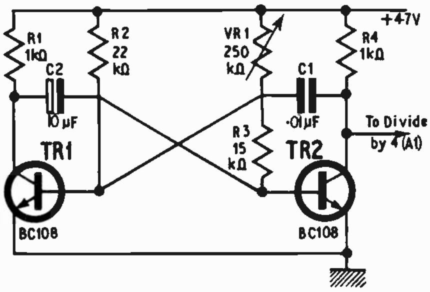


Fig. 2. Circuit of tempo generator

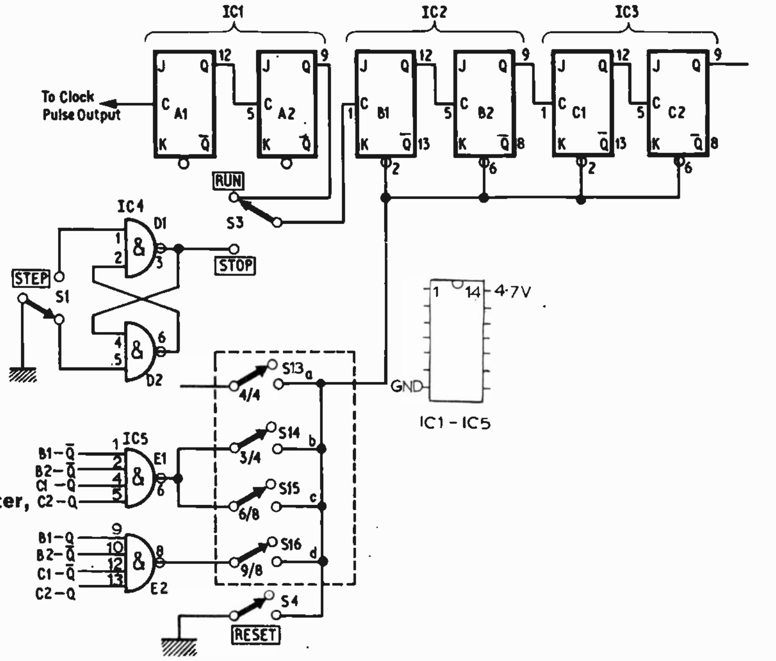


Fig. 3. Circuit of divide by four, four bit counter, time signature decoder and step generator

TEMPO GENERATOR

The circuit for the tempo generator is shown in Fig. 2. If the multivibrator capacitors were of equal value, the output would be a symmetrical square wave but C1 is 1/1000 the value of C2 creating a pulse of very short duration at a repetition rate determined largely by the value of C2. The output period is made variable by VR1 and gives a sufficient range of tempo to cover most requirements.

The output feeds a divide by four counter stage (IC1) composed of flip-flops A1 and A2 as shown in Fig. 3. The output of this counter is a symmetrical square wave with a period variable from 2 seconds to 25 milliseconds. This output is the basic timing waveform for the entire system.

FOUR BIT COUNTER

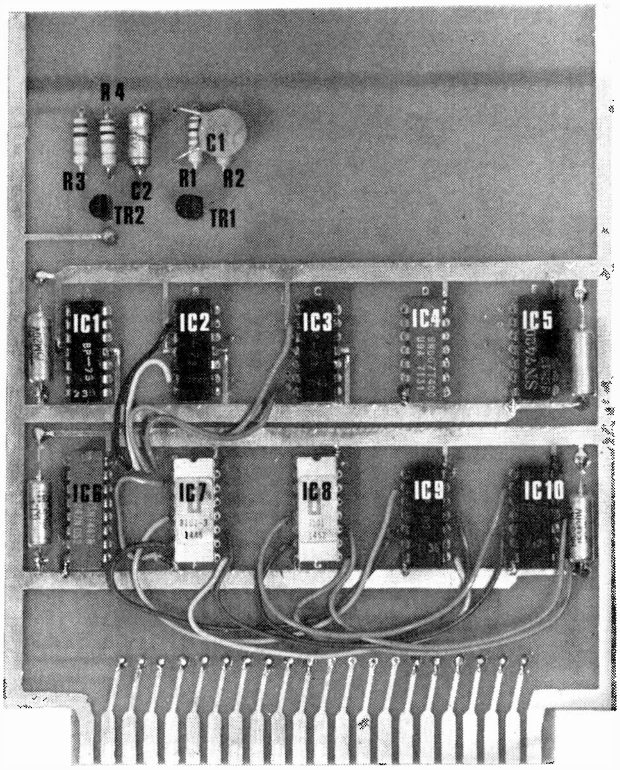
The four flip-flops labelled B1, B2, C1 and C2 (IC2, IC3) make up a four bit binary counter. Drive for this counter is obtained either from the output of the divider in the "Run" position of S3, the "Stop/Run" switch, or from the bistable latch (D1 and D2) in the "Stop" position. This allows the counter to be stepped through the count sequence manually with S1, the "Step" switch.

All four flip-flops can be reset by grounding the reset pins (2 and 6 of each chip). To reset the counter in the "Stop" position, the "Reset" switch S4 is pressed. This forces the counter to binary 0000.

In the 4/4 position of the "Time Signature" switch S13, the counter will count through 16 counts and automatically return to 0000. In the 3/4 and 6/8 positions, the counter must be forced back to 0000 after 12 counts.

This is done by applying the $\bar{Q}$ outputs of B1 and B2 and the Q outputs of C1 and C2 to the input of NAND gate E1 (IC5). When this count is reached, the output of that gate will go immediately to 0 and the counter will be reset.

For 9/8 time, only 9 counts are allowed and the counter is then reset with NAND gate E2.



Prototype p.c.b. including tempo, timing and logic assembly. Four 0·01µF capacitors must be included for decoupling the chip supply lines

STORAGE, OUTPUT AND INDICATOR

Fig. 4 shows the logic diagram for the storage, indicator and output gates. The four counter Q outputs from IC2/IC3 are applied to the A, B, C and D inputs of each of the memory chip address select lines.

S5 through S12 are the instrument input switches and S2 is the "Write" switch. The chip select inputs (pins 2) on both IC7 and IC8 are permanently grounded which simply means that the output will always be available.

The output of these storage or memory chips is applied to the inputs of eight NOR gates (IC9/IC10) and gated with the output of the divider IC1 to give a positive pulse out for each position and time segment that an instrument is to sound.

IC6 uses outputs A, B and C of the counter to decode the correct sequence of grounds to be applied to the Minitron indicator.

LOGIC ASSEMBLY

Although the prototype used plug-in printed circuit boards, 0·1in plug-in Veroboards can be successfully substituted for the logic and percussion circuitry.

While no constructional details are included sufficient information for this should be gleaned from the photograph of the prototype logic card showing the disposition of the tempo generator and logic chips. Note carefully the use of four 0·01μF capacitors connected between the supply and ground lines. These should be added to prevent spurious triggering.

Point to point wiring on the board should be carried out according to the circuit diagrams given. It really boils down to wiring between the i.c. pin numbers shown and taking off external wiring, such as to control switches and percussion generators, to those copper strips which will mate with the Veroboard's edge connector.

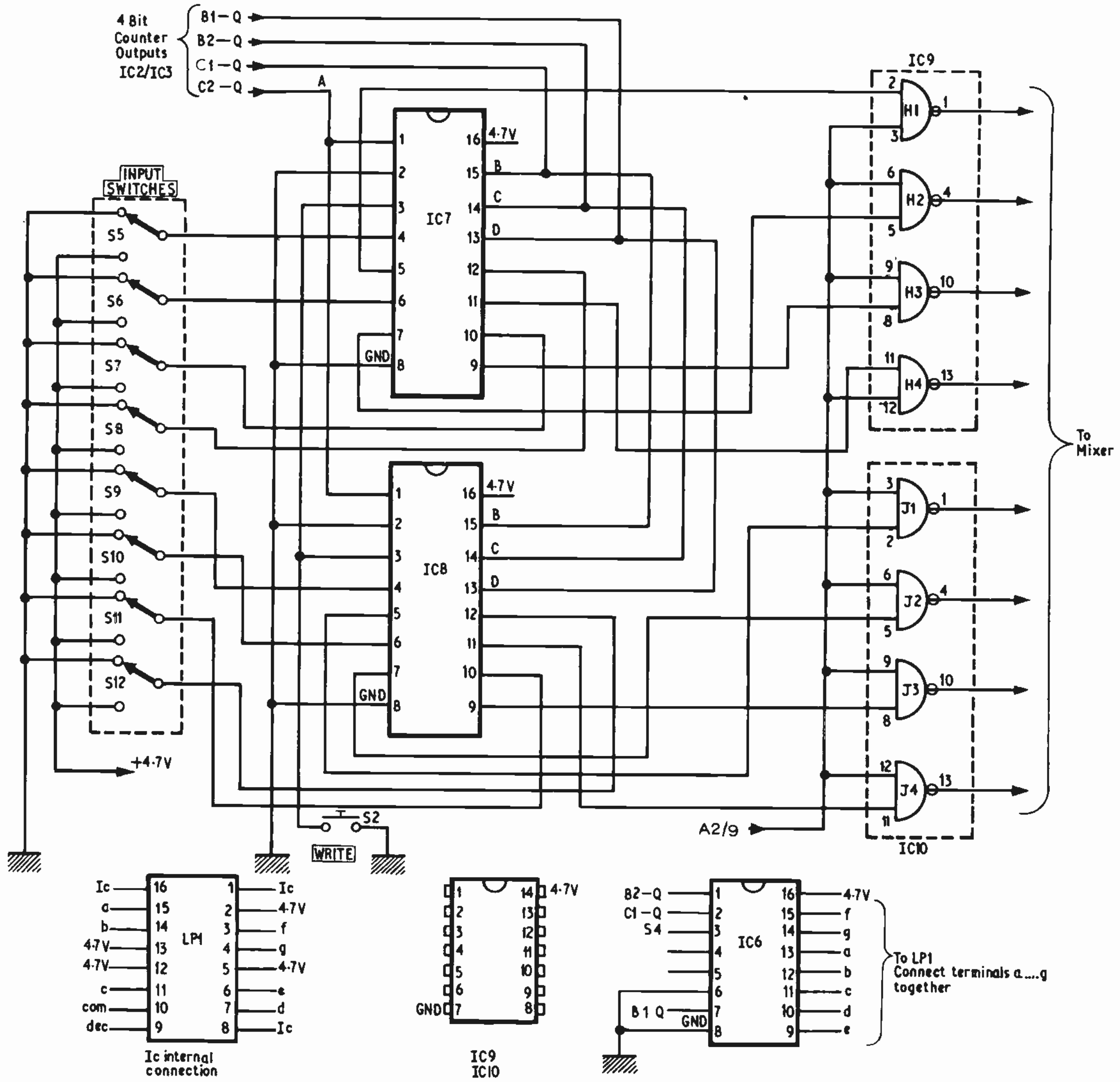


Fig. 4. Circuit for storage, lamp driver and percussion gates

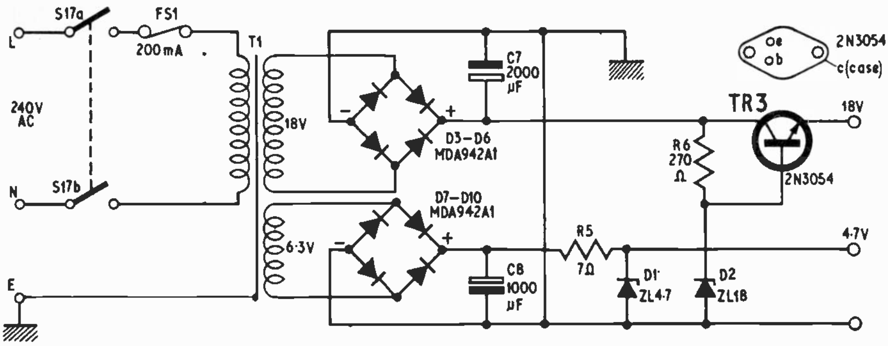
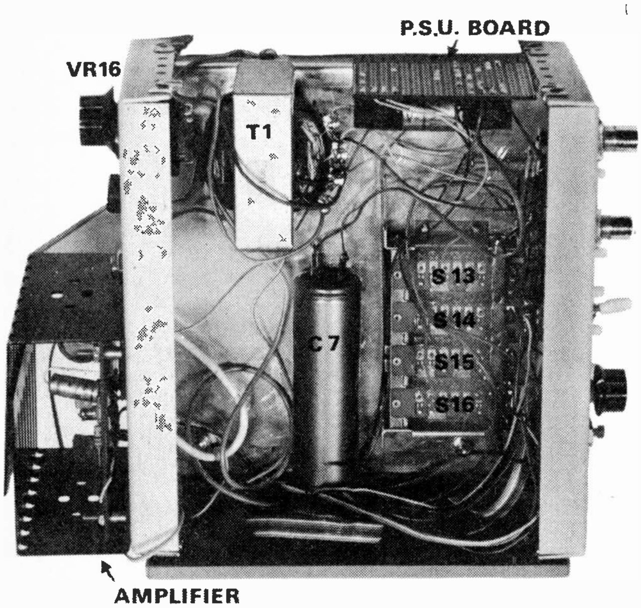


Fig. 5. Circuit of power unit



Part of the component assembly within the case. The amplifier is outboard mounted and the speaker connected to the removed plate

Once connections have been made and verified breaks in the copper should be made where appropriate. Finally check all wiring according to the circuits and make sure that there are no solder bridges or loose bits of wire around to cause future trouble.

POWER SUPPLY

The power supply is made up on a $2\frac{1}{2}$in × $2\frac{1}{2}$in, 0·15in matrix Veroboard. With the transformer and large electrolytic C7 these are all finally mounted on the Contil case chassis plate. With the wiring completed for this connect to the mains and ensure that the line output voltages are correct.

At this point it is a good idea to cut and drill those holes for the control panel switches and indicator. The locations for these are indicated in the photograph.

The 4·7V power lines can now be connected to the logic board edge connector and the appropriate connections to the control panel switches made. A number of tests can now be made.

First plug in the board and switch on. In the "Stop" position of S3, press the "Reset" button. The Minitron indicator should show a figure eight. This is a lamp test feature and assures that all seven segments of the indicator work correctly. With the switch released the indicator should read 0. With S3 now in the "Run" position the Minitron indicator should go through 0 to 7 repetitively. The "Tempo" control can slow this process right down so that single digit changes can be easily observed.

If these tests are satisfactory, the unit is sound to this point. There are other tests that could be made but they would require additional instruments and are not really worth including.

Next month details for the percussion generators, mixer and amplifier will be given.

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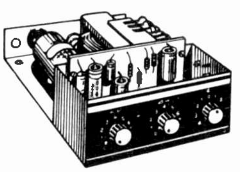

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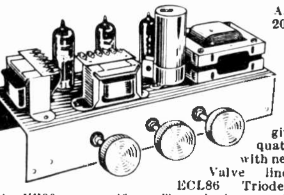
DE LUXE STEREO AMPLIFIER



A.c. mains 200–240 volts. 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 11in. w × 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £9·90.** P. & P. 50p.

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200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp on load.
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" × 3¾" × 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2⅝in × 3in approx. **28p** pair. P. & P. 6p.

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 full wave. Size 3inL × 3½inW × 3inD. Price **£2·31**, P.&P. 40p

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V Sec. 9-0-9 at 500mA. **£1·10** P. & P. 25p. Pri. 200/240V Sec. 12-0-12 at 1 amp. **£1·21** P. & P. 26p. Pri. 200/240V Sec. 10-0-10 at 2 amp. **£1·82** P. & P. 35p.

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OUR ROCK BOTTOM BARGAIN PRICE £3·30 P. & P. 40p

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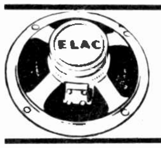
5in 3 ohm **£1·25**, P. & P. 15p. 7 × 4in 3 ohm **£1·40**, P. & P. 20p. 10 × 6in 3 or 15 ohm **£2·10**, P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet **£1·70**, P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm **£3·50.** P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network **£4·65**, P. & P. 30p.
EMI CERAMIC MAGNET HEAVY DUTY TWEETER. approx. 3¼in. Av. 3 or 8 or 15 ohms. **£1·25** plus 20p p. & p.
BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£7·50.** Guitar models: 25w **£7·50.** 35w **£9·35.** P. & P. 45p each.



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LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance.

£3·70. P. & P. 35p.

Also available specification as above but size 10" × 6" **£2·70** and size 8" round **£2·60** P. & P. 35p.
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10 watts peak handling. 3, 8 or 15 ohm. **£2·45.** P. & P. 36p.
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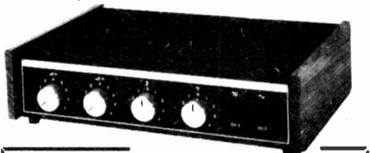
HAVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



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Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES	AMPLIFIER KIT,	£11·55	P. & P. 25p.
	(Magnetic input components 33p extra)		
	POWER PACK KIT,	£3.30	P. & P. 35p.
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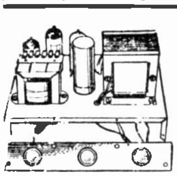
(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£23·10.** Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

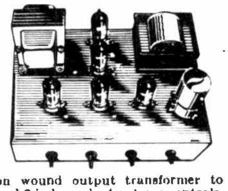
3-VALVE AUDIO AMP. HA34 MK II



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. × 4in. d. × 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£5·50.** P. & P. 45p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£4·50.** P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **15p** plus S.A.E. (Free with parts). **All parts sold separately.** ONLY **£8·80.** P. & P. 60p. Also available ready built and tested **£12·10.** P. & P. 70p.

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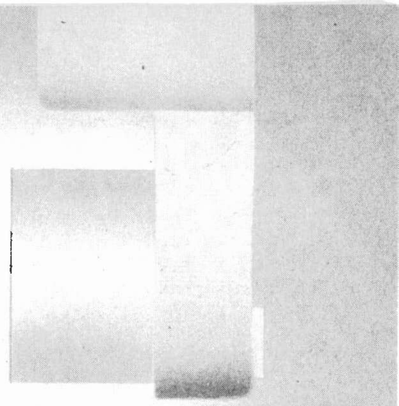
FLUORESCENT LAMP INVERTER



By C. J. MILLS

High efficiency light source from a 12V d.c. supply

With power cuts an annual recurrence the construction of an inverter to drive a fluorescent lamp from a 12V d.c. supply, such as a car battery, is a worthwhile investment.

Although one basic circuit is described, with minor component changes the inverter is capable of driving either an 8W, 13W or 20W lamp.

HIGH FREQUENCY OPERATION

The choice of an operating frequency above 20kHz for the inverter means a reduction in transformer size, increased lamp efficiency and the elimination of audible whistles.

The unit incorporates transistor protection against lamp removal by automatically stopping the oscillator. Diode protection against supply polarity reversal is also included.

CIRCUIT DESCRIPTION

The circuit shown in Fig. 1 is developed from the well-known Hartley oscillator. The primary winding of the pot core transformer T1 is in the emitter circuit so that the collector of the transistor TR1 can be earthed. This arrangement means that the feedback winding must give a greater voltage than the primary winding and therefore has more turns.

The feedback winding provides the drive to the transistor base via a limiting resistor R1, one of the lamp heaters and C3.

The voltage across the secondary winding is sufficient to strike the tube and the leakage inductance in conjunction with the base resistor limits the tube running current. This is necessary because the fluorescent tube tends to maintain a constant voltage.

Heater current for the tube is provided at one end by the drive current and at the other by a few extra turns on the secondary winding. The bypass capacitor across the transistor limits the peak collector emitter voltage to a safe value. This is not normally required in the 8W version.

POSITIVE AND NEGATIVE EARTH

If the circuit is being constructed in a separate metal case and used with a positive earthed supply system the transistor can be mounted directly on to the case. If the supply is negative earthed a mica washer and plastic bushes should be used to insulate the transistor which should be protected from possible shorts to earth by a plastic cover.

The circuit board should now be cut and drilled to fit the case and the components mounted as shown. The transformer leads can be connected to the printed circuit via pins and further pins can

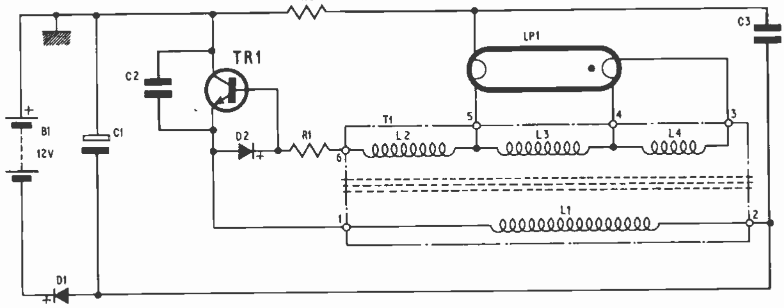


Fig. 1. Circuit diagram of fluorescent lamp inverter

A P.E. BLUEPRINT FEATURE

be used for connecting leads to the transistor and the fluorescent lamp.

When the wiring-up is completed the circuit should be carefully checked before it is connected to the voltage supply to ensure that both diodes and the transistor are connected the right way round and that copper breaks in the Veroboard have been cleanly cut and that there are no shorts between strips due to surplus solder.

TESTING

Testing should start with a low voltage battery or a gradually increasing voltage supply with a series ammeter to check that the current consumption is not excessive and that the transistor is not overheating.

The fluorescent tube must be connected to complete the bias circuit and if the circuit is oscillating a glow will be seen from the heaters at the ends of the tube. When the full voltage is applied the lamp should strike and light up but during preliminary testing the lamp will strike easier if a fine wire is stretched between the metal end caps and connected to one of the heater pins.

If the circuit does not oscillate L1 may be reversed or there may be some shorted turns in the transformer. When operating normally with a 13 watt tube this inverter consumes about 1·4 amps at 12 volts. This current and the light output can be varied slightly by small adjustments to R1 and/or C3.

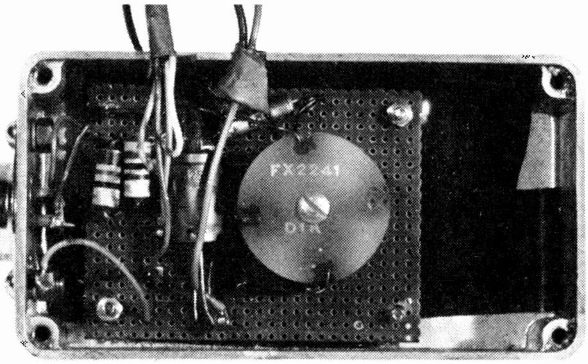
PRECAUTIONS

All metal parts, including the metal end caps on the tube, should be earthed and the fine wire connected to the heater pin during tests should be removed. The voltage across the tube is high enough to provide a nasty shock and should be treated with respect.

TRANSFORMER WINDING

The winding order is identical for the 8 watt, 13 watt or 20 watt versions of the inverter. Start by winding the primary L1 on the bobbin according to the relevant data given in the Components List. Lead ends on each coil should be colour coded for later identification.

Insulate with plastic adhesive tape and then add L2 again insulating the winding with tape. Finally add L3 and L4. The direction of winding for all coils is the same.



Interior assembly of 13W inverter

Before bolting the two halves of the Ferroxcube pot core together onto the Veroboard, two paper spacing washers should be cut and fitted between them.

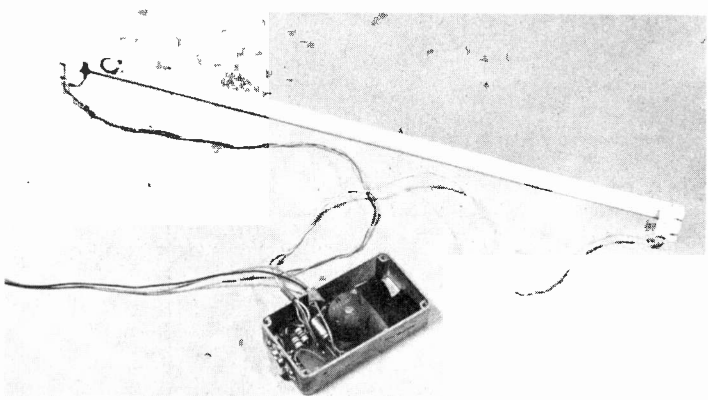
CONSTRUCTION

The Ferroxcube transformer and majority of circuit components are mounted on a 2in × 2½in, 0·1in matrix Veroboard with the transistor connected to case.

The mounting of the fluorescent lamp will depend on the application and to a certain extent on the constructor's preferences. For example an 8 watt tube can be used in a caravan mounted flush with the roof and components separate or on a channel support with the components mounted in the channel.

Alternatively an attractive table or hanging lamp can be constructed with the fluorescent lamp in a vertical Perspex tube with the components in a suitable case at one end of the tube.

Another idea is to construct a portable lamp using two 6V lantern batteries in a suitable case with the lamp and reflector mounted on the outside. Leads can then be connected via a plug and socket for external battery supplies such as a car battery. This makes an ideal camping light but the lantern batteries should be isolated from the car battery by diodes or a switch. ★



The 13W inverter with output leads terminated with clips and lamp

VARIABLE VOLTAGE TRANSFORMERS

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

SHROUDED TYPE

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4 KVA (20 amp) £72·50
37·5 amp £102·50

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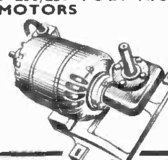
2	30, 40, 50V at 5A	£6·90	+60p
3	10, 17, 18V at 10A	£5·00	+50p
4	6, 12V at 20A	£6·50	+60p
5	17, 18, 20V at 20A	£7·30	+60p
6	6, 12, 20V at 20A	£6·90	+60p
7	24A at 10A	£5·30	+50p
8	4, 6, 24, 32V at 12A	£7·20	+60p
9	6 and 12V at 10A	£3·80	+40p

VOLTAGE CHANGING TRANSFORMER

M.f.g. to highest W.D. spec. Auto wound, and tapped 0–130–160–200–250 at least 2kVA. Can also be used as 230–240V input, 115V out for U.S.A. equipment, or reverse to obtain 240V from 115V. The ideal transformer for making up solid state constant voltage unit, by use of taps the following voltages may be obtained 30–40–50–70–90V at 10 amps. Weight 40lb, length, 260mm, height 190mm, width 230mm. In original maker's wooden case, £8. Carr. £1.

PARVALUX TYPE SD19 230/250 VOLT A.C. REVERSIBLE GEARED MOTORS

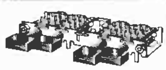


30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of makers' price. £7·48.

AEI A.C. MOTOR

Smooth running, powerful, continuously rated, reversible motor. 230/250V a.c., 50 cycle 1/50 H.P., 0·25A. £3·50 post 30p.

4 BANK 3c/o PUSH BUTTON ASSEMBLY



Black rectangular buttons. 5 units (min. order) 85p. Post 15p.

600 WATT DIMMER SWITCH

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

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For Power tools. Heating, Sewing Machines, Lighting, etc £8·00. Post 27p.

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200/250 Volt 2-ON/2-OFF every 24 hours at any manually pre-set time. 20 amp contacts. Fitted diecast case. Tested and in perfect condition £4·75. Post 25p.

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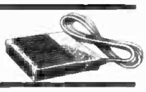

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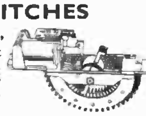
UNISELECTOR SWITCHES



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GENERAL ELECTRIC POWER-GLAS TRIACS

10 amp. Glass passivated plastic triac. Latest device from U.S.A. Long term reliability. Type SC146D 10 amp, 400 PIV, £1. Post 5p. Type SC146E 10 amp, 500 PIV, £1·30. Post 5p. (Inclusive of data and application sheet.) Suitable Diac **18p.**

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EXPERIMENTERS' ECONOMY KIT

Speed adjustable 1 to 30 flash per sec. All electronic components including Xenon Tube and instructions **£6·30.** Post 30p.

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Ideally suitable for schools, laboratories, etc. Speed adjustable 1-80 f.p.s. Approx. ¼ output of Hy-Lyght. Price **£12·00.** Post 50p.

HY-LYGHT STROBE MK III

For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. **£12.** Post 50p.

THE 'SUPER' HY-LYGHT KIT

Approx. four times the light output of our well proven Hy-Lyght strobe.

- Variable speed from 1-13 flash per sec.
- Reactor control circuit producing an intense white light. ONLY **£20.** Post 75p.

ROBUST, FULLY VENTILATED METAL CASE. For Hy-Lyght Kit including reflector **£4·75.** Post 25p.
Super Hy-Lyght Kit including reflector **£7.** Post 60p.

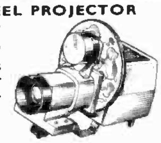
7-inch POLISHED REFLECTOR

Ideally suited for above Strobe kits. Price **55p.** Post 15p.

RAINBOW STROBE FOUR LIGHT CONTROL MODULE

Will operate four of our Hy-Lyght or Super Hy-Lyght Strobes in either 1, 2, 3, 4 sequence; 2 + 2; or all together. Thoroughly tested and reliable. Complete with full connection instructions. Price: **£18.** Post 50p. Send S.A.E. for details.

COLOUR WHEEL PROJECTOR

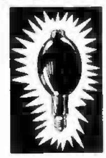


Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50.** Post 50p.

6 INCH COLOUR WHEEL

As used for Disco lighting effects, etc. Price **£4.** Post 30p.

BIG BLACK LIGHT



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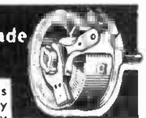

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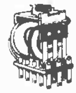

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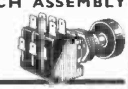

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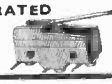

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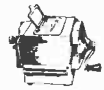

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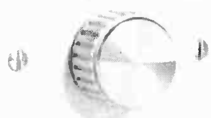

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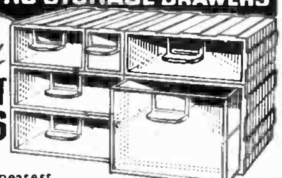

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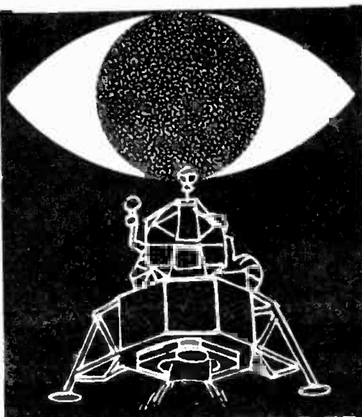


SPACEWATCH

BY FRANK W. HYDE

SKYLAB—LAST MISSION

As this is being written the last *Skylab* mission planned before the Soviet–American rendezvous in space, is not quite half way through. The longest single mission of three astronauts will bring to an end the triple series of scientific programmes.

By whatever standards these experiments may be judged they represent one of the major events in the history of the solar system. Some may regard the *Skylab* project as more important than the *Apollo* programme. Certainly, a very comprehensive coverage of observation (and running repairs) will add much to the data so far amassed. It must not, however, be forgotten that side by side with the success story go some rather disquieting happenings.

It is intended that the return of the team will be in early February. However, at the time of writing, there are possibilities that there could be an earlier termination because of certain disciplinary reactions. Perhaps it is to be a blessing, if seen in the broad context of advanced technology.

The problems that have arisen are twofold. There have been technical difficulties and some personnel problems. None of the present crew have flown in space before and this could to some extent explain the behavioural problems.

CREW CONCERN

Mission Control have been concerned about the crew in that they suffered from motion sickness for several days and attempted to conceal this from the physicians monitoring the flight. Perhaps this is understandable since they would be worried about being recalled. On the other hand there were other signs such as proneness to error and poor disposition.

Their sleep sessions have tended to be longer than was thought to be required, compared with the previous crews. They have been moody and temperamental when in contact with control and have complained somewhat bitterly about their workload. Refusal to come in from extra vehicular activities has seemed to show a somewhat antagonistic attitude towards instructions.

The consequences on their work has been very noticeable. The most serious error has been in relation to the operation of the cameras during observation passes of the Earth. The proper filters to six cameras were forgotten. Much of the film will be useless though some may be recoverable using certain special techniques when they are returned to base.

The medical unit in charge at control will be seeking an answer to these rather irrational episodes. Despite this however, it cannot detract from the remarkable *Skylab* project.

Some of the technical problems have been concerned with the gyroscopes. One of these has been out of use since the end of November. The other has tended to show a slowing down. Normally it would have a revolution of 8,200 per minute. It slowed by 14 revolutions and then by a further 10 per minute. This is quite serious and should it continue to fall then the mission could well be curtailed.

PIONEER 10 AND JUPITER

Some of the vital statistics so far recorded during *Pioneer*'s mission to Jupiter have confirmed previous thinking. The magnetic field for example is recorded at 4 gauss. In a recent "SPACEWATCH" mention was made that Dr C. H. Barrow had used a figure of 9 to 10 gauss. Re-examination of his previous papers can now lead to some constructive theories.

The off-set magnetic field confirms Warwick's claim made several years ago. The higher level of the radiation belts has also been confirmed. It is also confirmed that Io has an ionosphere. This supports the earlier data that Io has an influence on the decametre radiation from Jupiter.

It will be some time yet before the accumulated data is to hand for distribution.

Perhaps another important point that might be made is the fact that so far the 8W transmitter has fulfilled its task admirably. It remains to be seen (heard?) how far out it will continue to supply data.

One further important development is that it is now quite definitely confirmed that there are hazards to control, in the magnetosphere of Jupiter. There is the possibility of random effects giving the same sort of command signal to the vehicle.

The case of far out probes such as *Pioneer 10*, introduces the long time period of signal travel. That is 45 minutes out and 45 minutes back. This could be much too long to counteract false signals. To overcome this a method of repeating commands every 30 minutes is being used. By this means the risks are minimised.

MOON AS A STANDARD LAMP

Dr J. Linsky of Boulder, Colorado, has made use of data obtained from the *Apollo* missions and the study of the lunar soil, to set the moon as a standard of comparison for infra-red and microwaves.

The average values have been studied and Linsky's results have shown an accuracy of 4 per cent for wavelengths between 10 micrometres and 1 metre. By averaging the radiation between successive new moons he arrived at a figure for radiation over a lunar day for the central part of the moon's disc. It is possible to use this standard to calibrate the sun and parts of the galaxy.

Linsky is able to fix the brightness at an order of magnitude better than with other methods. Possibilities of a better study of the chromosphere are therefore indicated and perhaps a better view of how the heat transfer shock waves operate.

QUASARS

The see-saw of opinion continues to operate in the controversial field of quasars. In spite of this there is growing confirmation of the claims of the radio astronomers that these are far distant rapidly receding objects.

Recent new work has offered a new dilemma for theorists since in one particular case the observers are faced with deciding as to whether, in certain cases, the quasar is in fact way beyond its apparent position relative to a galaxy or whether Hubbles law is in doubt in such cases.

It still leaves the position largely as before, that of all the new discoveries of other sources such as pulsars, black holes, X-ray stars, etc., the quasar remains the most mysterious. Near or far as to position still remains in doubt when looking at the overall picture.

One advantage of inserting a resistor in series with the source is that the slope resistance of the device is increased. This is because a change in channel current causes a change in the voltage across the resistor which alters the reverse bias on the gate. Obviously, for a given change in current, the voltage change is proportional to the resistance in series with the source.

HIGH SLOPE RESISTANCE

In applications where a very high slope resistance is required, the circuit shown in Fig. 7 can be used. In this circuit, the source resistor is replaced by an f.e.t. current generator which provides a high slope resistance in series with the source of TR1.

For proper operation, the cut-off voltage V_p of TR1 should be greater than that of TR2. The slope resistance can be increased by one or two orders of magnitude using this technique.

The temperature coefficient of drain current depends on the value of drain current, being negative at high currents and positive at low currents. At an intermediate value of drain current $I_{D(0)}$, the two effects causing these changes cancel and the temperature coefficient is approximately zero. The current at which this occurs is given approximately by:

$$I_{D(0)} = \frac{0{\cdot}4}{V_p^2} \times I_{DSS}$$

y AND *h* PARAMETERS

It is often convenient to refer to the characteristics of transistors by means of *y* or *h* parameters. There are four *h* and four *y* parameters for each of the three basic transistor connections.

The four *y* parameters describing a transistor operating in the common emitter configuration are: y_{ie}, y_{fe}, y_{re} and y_{oe}. The second subscript letter "e" refers to the fact that the transistor is in the common emitter connection. Similarly, "b" denotes common base, "s" denotes common source, etc. The first subscript letters refer to input, forward transfer, reverse transfer and output parameters respectively.

Each "y" parameter is the ratio of a current to a voltage. Thus:

y_{ie} is the input admittance (the ratio of input current to input voltage);

y_{fe} is the forward transfer admittance (the ratio of output current to input voltage);

y_{re} is the reverse transfer admittance (the ratio of input current to output voltage);

y_{oe} is the output admittance (the ratio of output current to output voltage).

Whereas *y* parameters are all ratios of currents to voltages, different *h* parameters represent ratios of different quantities. Thus:

h_{ie} is the input impedance (the ratio of input voltage to input current);

h_{fe} is the forward current transfer ratio (the ratio of output current to input current);

h_{re} is the reverse voltage transfer ratio (the ratio of input voltage to output voltage);

h_{oe} is the output admittance.

Although common emitter parameters have been quoted, the definitions are also valid for other connections.

Of the six possible sets of parameters, only *h* and *y* parameters are widely used in transistor circuit analysis. If one set of parameters is known, any other set can be calculated quite easily. This means that the choice of parameters for a given application is largely a matter of convenience.

The characteristics of bipolar transistors are usually described by *h* parameters and those of field effect transistors by *y* parameters.

BIPOLAR TRANSISTORS

A bipolar transistor in either the common base or common emitter configuration can also be used as a constant current source as shown in Fig. 8. Since the collector-base junction is a reverse biased diode, the current through it is only slightly affected by the voltage across it.

The slope resistance in the common base connection is (h_{fe} + 1) times larger than the slope resistance in the common emitter connection. The difference between common base and common emitter circuits lies in the resistances in series with the base and emitter leads.

The circuit in Fig. 9 is a generalised common base or common emitter circuit. If $R_B = 0$ and $R_E = \infty$ the slope resistance is equal to the reciprocal of the low frequency common base output admittance h_{ob}. In practice, provided that R_E is more than a few kilohms, the slope resistance is not appreciably less than this value. If $R_B = \infty$ and $R_E = 0$, the slope resistance equals $1/h_{oe}$. Then h_{oe} and h_{rb} are related by the equation:

$$h_{oe} = h_{ob} \times (h_{fe} + 1).$$

With intermediate values of R_B and R_E the slope resistance lies between these two values. For a BC108, $h_{ob} = 10^{-7}\mu S$ and $h_{oe} = 3 \times 10^{-5}\mu S$.

The circuit of a simple transistor constant current generator is given in Fig. 10. The base voltage is set to 4V by the potential divider across the supply.

Since the BC184 is a silicon transistor, the emitter voltage is about 3·4V. Thus the emitter current is $3{\cdot}4V/6{\cdot}8k\Omega = 500\mu A$ and since $\alpha \simeq 1$, the collector

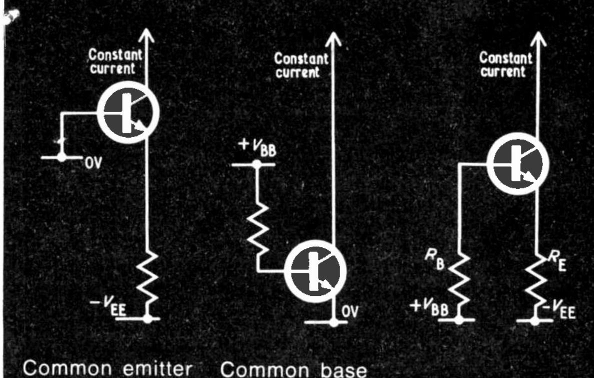


Fig. 8. Transistor constant current generators

Fig. 9. Generalised common base, common emitter circuit

current is also about 500μA. Because the emitter resistance is 6·8kΩ, the slope resistance of this current source is very high. The knee voltage is about 4V.

The major disadvantage of the circuit in Fig. 10 is that the current is approximately proportional to the supply voltage. To produce a more stable current source, R2 is often replaced by a Zener diode so that the base voltage, and hence the emitter voltage, is less affected by supply voltage variations.

The temperature coefficient of this source depends on the temperature coefficients of the Zener diode and the base-emitter junction. If a Zener of about 4V is used, the temperature coefficients will cancel.

IN INTEGRATED CIRCUITS

Fig. 11 shows the circuit of an interesting transistor current source which is often used in integrated circuits. In this circuit, the base current for the transistor is supplied by part of the current through the resistor. The remainder of the current from the resistor flows through the diode.

In an integrated circuit, since all the transistors and diodes are produced simultaneously on the same chip of silicon, the diode can be made identical to the base-emitter junction of the transistor. Because the diode and the base-emitter diode are connected in parallel, the voltages across the two are equal. Since the two diodes have the same characteristics, the currents through them (I_D and I_E) are also equal.

The current through the diode comes entirely from the resistor but the emitter current in the transistor is provided partly by the resistor and partly by the collector circuit. In other words,

$$I_D = I_E$$
$$= I_C + I_B$$

The base current of the transistor is about one per cent of the emitter current and can be neglected. With this assumption, it can be seen that the collector current of the transistor is equal to the current flowing through the diode. Because the base current is small, almost all of the current flowing through the resistor flows into the diode so that the collector current of the transistor is approximately equal to the current in the resistor.

Circuits of this type have very low knee voltages, typically less than 0·5V. This circuit also has a very low temperature coefficient because the diode and transistor have equal temperature coefficients of voltage which cancel each other.

The breakdown voltage of a transistor current generator can be anything from 15 to 500V depending on the transistor employed.

SOPHISTICATED CIRCUITS

There are several more complex constant current circuits available which are used where high stability is required. The ring-of-two circuit shown in Fig. 12 is often used as a precision current generator. It is a two-terminal current source because, unlike the transistor circuits described above, no extra supply voltage is necessary.

The operation can be understood if it is considered as two constant current sources, the first consisting of D1, R1 and TR1 and the second containing D2, R2 and TR2. These sources are connected so that each one supplies a constant current to the Zener diode of the other. The knee voltage of the ring-of-two is rather high, and is equal to the sum of the Zener voltages of D1 and D2.

Just as it is possible to construct regulated voltage power supplies, so regulated current supplies can be made.

The current is usually measured by passing it through a resistor and comparing the voltage thus produced with a reference voltage to derive a control signal. This signal is then applied to a bipolar transistor or an f.e.t. which controls the current. A block diagram for such a scheme is shown in Fig. 13. ★

In the concluding part of this article next month, practical applications of constant current sources will be described.

Fig. 10. Simple transistor constant current source

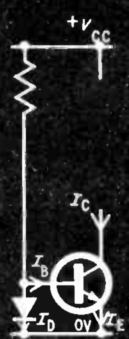


Fig. 11. Matched diode transistor constant current source

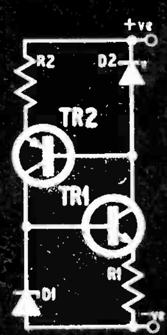


Fig. 12. Ring-of-two constant current generator

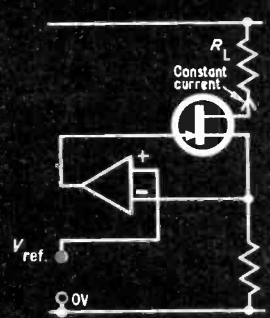


Fig. 13. Stabilised current power supply

ELECTRONIC SNAP

By C. J. ALLEN

THERE are many games in which contestants' reaction times play a vital part; "snap" is an obvious example and a guessing game where the first contestant to press a button is allowed to answer is another. This simple unit has two push buttons and gives a positive indication (by lighting a lamp) of the button which is pressed first.

CIRCUIT DESCRIPTION

The circuit of the Electronic Snap is shown in Fig. 1. It makes use of a single digital integrated circuit type SN7400 which is available for less than 20p. The indicators used are light emitting diodes which are simply diodes which emit light when forward biased.

The SN7400 contains four NAND gates. A NAND gate is one whose output will only go to logic 0 if *both* inputs are logic 1. They are cross-coupled in the circuit so as to form two bistables, circuits which

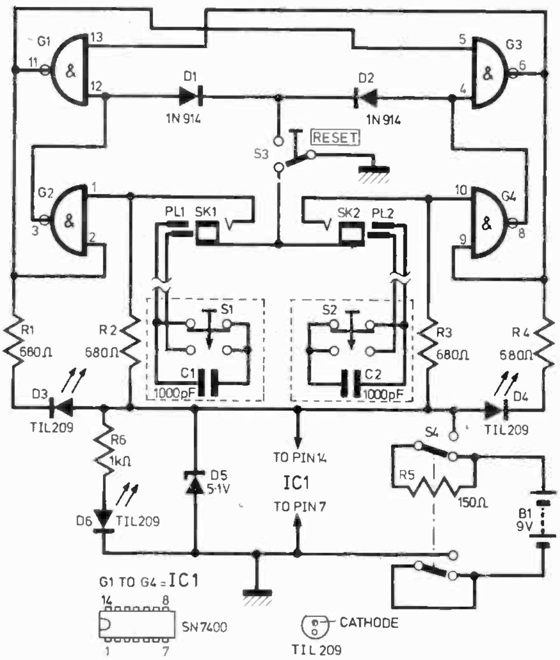


Fig. 1. Circuit diagram of the Electronic Snap

COMPONENTS . . .

Resistors
- R1-R4 680 Ω (4 off)
- R5 150 Ω
- R6 1k Ω
- All ±10% ¼W carbon

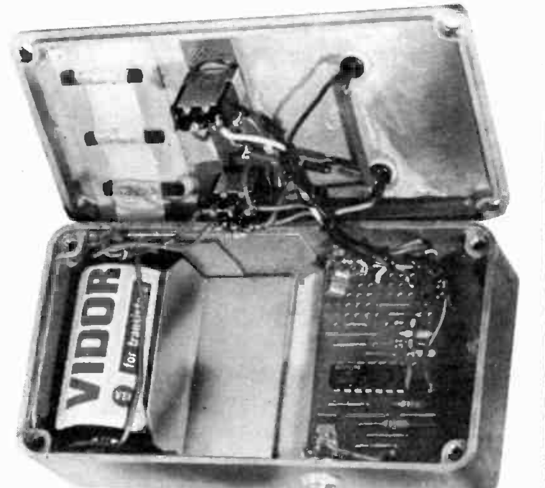
Capacitors
- C1, C2 1,000pF polystyrene (2 off)

Diodes
- D1, D2 1N914 or any general purpose silicon diode (2 off)
- D3, D4, D6 TIL209 or similar light emitting diode (3 off)
- D5 5·1V 400mW Zener diode

Integrated Circuit
- IC1 SN7400N Quad 2-input NAND gate

Switches
- S1, S2 Push to changeover (1 pair normally closed, 1 pair normally open) (2 off)
- S3 Push to changeover
- S4 Miniature d.p.d.t. toggle

Miscellaneous
- B1 9V PP4 battery
- 0·1in matrix Veroboard 2in × 1½in
- Diecast box 4¼in × 2¼in × 1in
- 35mm film cases (2 off)
- 3·5mm jack plug and socket (2 off)



are stable in either of two states. When the reset button is pressed inputs to gates G1 and G3 are taken to logic 0 (less than 0·8V) through diodes D1 and D2. The outputs of G1 and G3 must go to logic 1 regardless of the state of pins 13 and 5.

Switches S1 and S2 are open so the inputs on pin 1 of G2 and pin 10 of G4 are logic 1. Because the outputs of G1 and G3 are logic 1 it follows that all inputs to gates G2 and G4 are logic 1 so their outputs go to logic 0. The circuit will stay in this state even when S3 is released.

Assume S1 is now pressed. One input to G2 goes to logic 0, the output goes to logic 1 causing the output of G1 to go to logic 0 which, in turn, causes l.e.d. D3 to conduct and light up. Pin 5 of G3 is now held at logic 0 so even if S2 is pressed causing the output of G4 to go to logic 1 the output of G3 will stay at logic 1 keeping l.e.d. D4 off.

POWER SUPPLY

Power for the circuit is provided by a nine volt battery which is dropped down to the five volts required by the integrated circuit by the 150Ω resistor R5 and Zener diode D5.

One point that may be noticed is the connection of switches S1 and S2. These are not connected so as just to ground the inputs to G2 and G4 but to provide a very short pulse which is enough to take the inputs to logic 0 but will not drain the battery if the switches are held down.

The switches are connected as changeovers and the very short interval during which the capacitor charges is enough to momentarily take the output to ground.

CONSTRUCTION

The bulk of the circuit is built on a small piece of Veroboard as shown in Fig. 2. Jack plugs are used to connect the switches to the main unit. The switches are mounted in 35mm film cases and the capacitors C1 and C2 are mounted on the switch contacts. ★

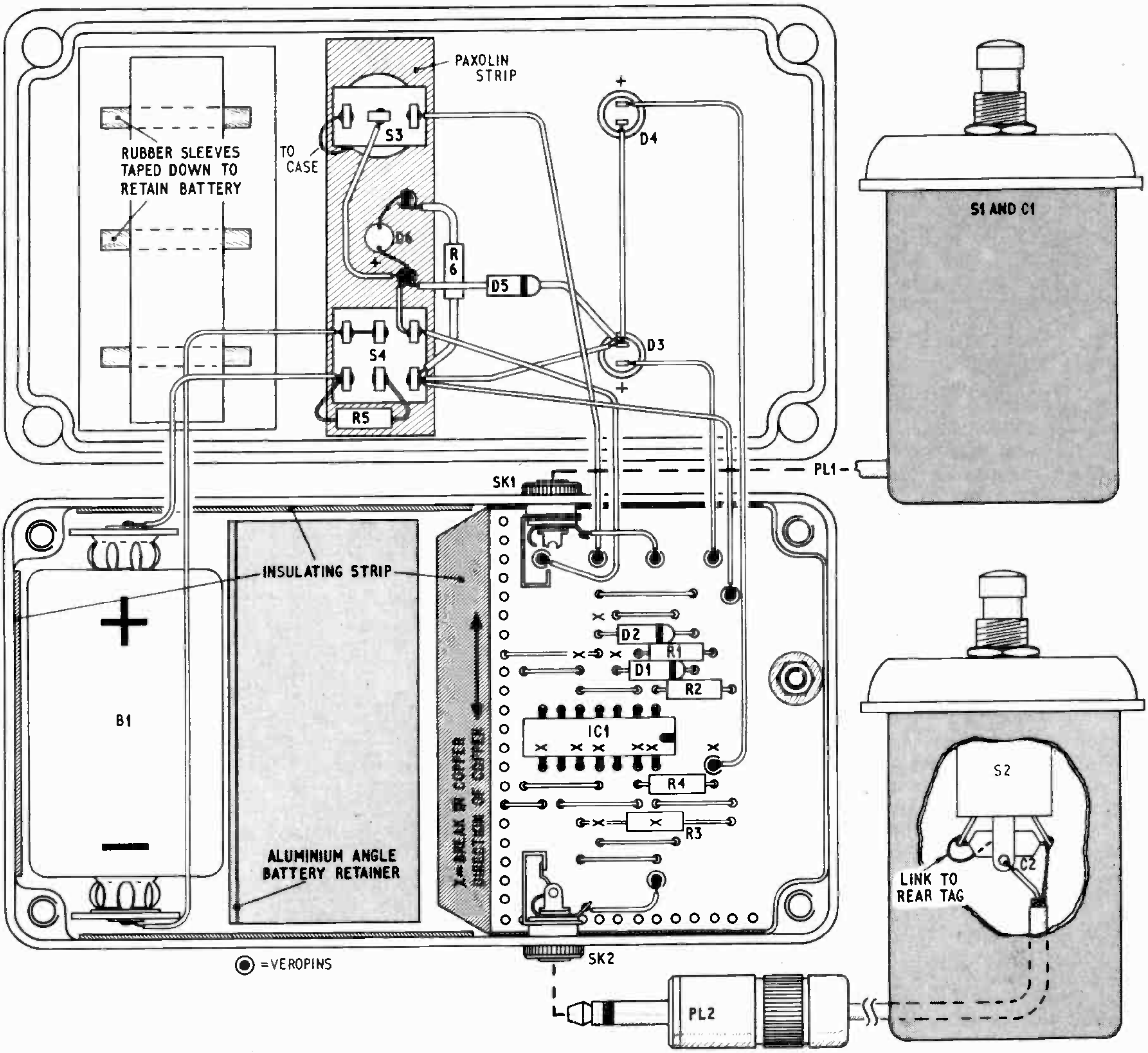
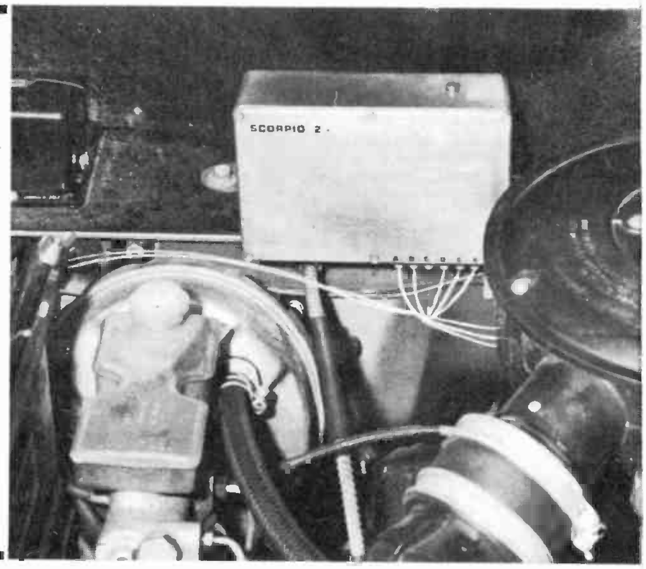


Fig. 2. Layout of the components on the Veroboard and front panel, and interwiring details

SCORPIO Mk.2 IGNITION SYSTEM

By D.S.GIBBS & I.M.SHAW



SINCE publication of the original *Scorpio* ignition system, about two and a half years ago, many requests have been received for a six volt version for use on cars and motor cycles with six volt electrical systems.

It is, unfortunately, impractical to build a unit to operate on both 6V and 12V, so two units have been designed with differing component values, and a number of improvements have been made to reduce radio interference and improve tachometer triggering. Both units give substantially the same performance and can be used on either positive or negative earth cars by altering a few connections.

PERFORMANCE

There has been a tremendous rise in interest in capacitor discharge ignition systems over the past few years and their advantages are now widely recognised. The main features are:

(a) Easier starting from cold. The higher spark voltage and faster rise time enables it to fire wet or oiled up plugs. The electronic system can deliver twice the spark voltage of the conventional system into a load of 470kΩ and 40pF—simulating a badly fouled plug.

(b) Smoother running at high speeds. Fig. 6 shows how the electronic system maintains an almost constant spark voltage up to 12,000 r.p.m. for a four cylinder engine (8,000 r.p.m. for six cylinder). This promotes better combustion at high speeds, eliminating misfiring and reducing the level of pollutants in the exhaust.

(c) As a result of the improved combustion there is a small improvement in power and fuel economy.

(d) The contact breaker will remain correctly adjusted for up to 20,000 miles. This keeps the car electrically "in tune", with a consequent improvement in fuel economy.

(e) Spark plug wear is reduced. In the conventional system the spark current is unidirectional and causes deposition of metal from one electrode to the other. In the electronic system the spark current is bidirectional and of much shorter duration. This increases spark plug life and reduces the need for adjustment.

CIRCUIT DESCRIPTION

The circuit of both 12V and 6V versions is the same and is shown in Fig. 1. Transistor TR1 is not required for positive earth operation but it can be left in circuit if desired. This will enable the unit to be used on either positive or negative earth cars merely by changing a few connections.

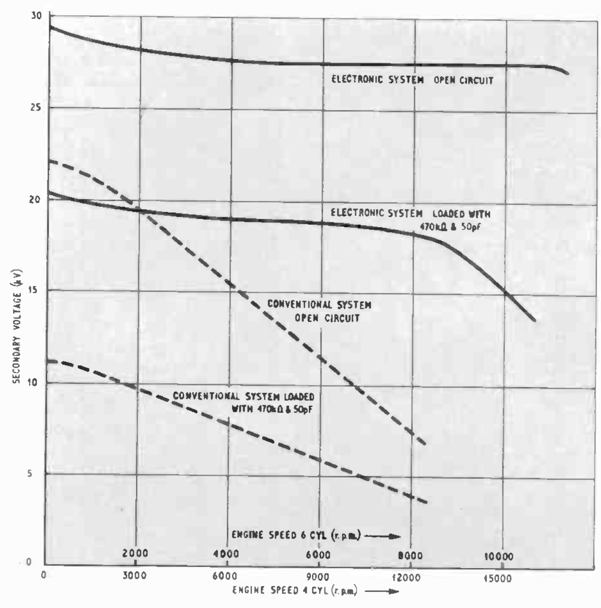


Fig. 6. Graph showing the variation of output voltage with engine speed for conventional and capacitor discharge systems

A P.E. BLUEPRINT FEATURE

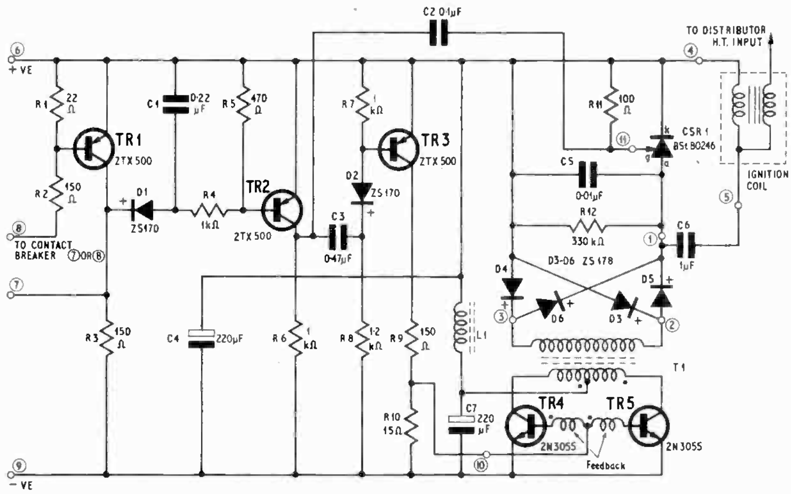


Fig. 1. Circuit diagram of the 12V version of the Scorpio Mk 2 capacitor discharge ignition system.

Refer to blueprint for full constructional details

Please note: R12 should be 1W (both versions).
TR3 (6V) should be BFS97 or ZTX550.

The circuit operates as follows (assuming negative earth operation with tag 9 earthed and the contact breaker connected to tag 8):

With the contact breaker closed TR1 is saturated and its collector voltage is close to the positive rail. When the contact breaker opens TR1 turns off and C1 is rapidly charged by R3 and diode D1. This brings TR2 hard on, its collector voltage rises to the positive rail and this positive pulse fires the thyristor CSR1. At the same time TR3 is reverse biased by C3 and remains cut off for about 0·3 milliseconds. This removes the bias from the inverter and prevents the thyristor from latching on.

When the contact breaker points close again TR1 turns hard on, but TR2 remains on for about 0·3 milliseconds—until C1 has discharged through R4 and R5. This effectively prevents contact bounce from retriggering the thyristor at the wrong time. Further noise immunity is provided by C2 and C3, which take about one millisecond to recharge fully after TR2 turns off.

Transistors TR4 and TR5, with the ferrite cored transformer T1, form a very efficient push pull inverter oscillating at about 2kHz. The 400 volt a.c. output is rectified by diodes D3 to D6 and charges up the energy storage capacitor C6 in about 1·5 milliseconds. When the thyristor fires this charged capacitor is thrown directly across the primary of the ignition coil. The primary voltage immediately rises to 400V and this is stepped up to 20 to 30kV at the secondary, forming an arc between the plug electrodes.

CONSTRUCTION

The unit is constructed in a 7¼in × 4½in × 2in diecast box, which acts as a heatsink for TR4, TR5, and the thyristor. Most of the other components are mounted on the printed circuit board shown in Figs. 2 and 3.

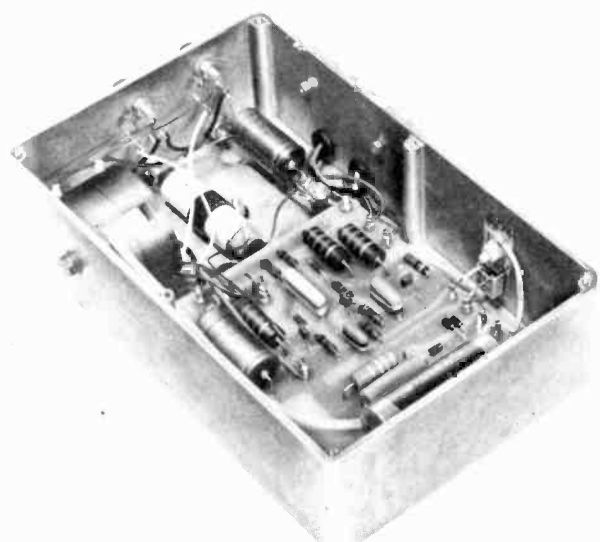
Connections to the board are made via turret tags, or the wires can be soldered direct to the board. If turret tags are used they should be expanded with a centre punch after insertion, to lock them in place, and then soldered.

COMPONENTS

The diodes, transistors and resistors are all readily available. Capacitors C1 to C3 are not critical but Mullard type C280 miniature foil types are used in the prototype. The 1μF 440V a.c. rated capacitor (C6) is available from many of the advertisers in P.E. The Siemens thyristor is available from A. M. Marshall and Electrovalue who also supply the Siemens pot core. The address of a supplier for the printed circuit board is shown in the components list. The total cost of the unit is around £8·50.

TRANSFORMER CONSTRUCTION

Details of suitable cores and bobbins are given in the parts list and winding details in Fig. 4. Both types are very similar and give substantially the same perormance.



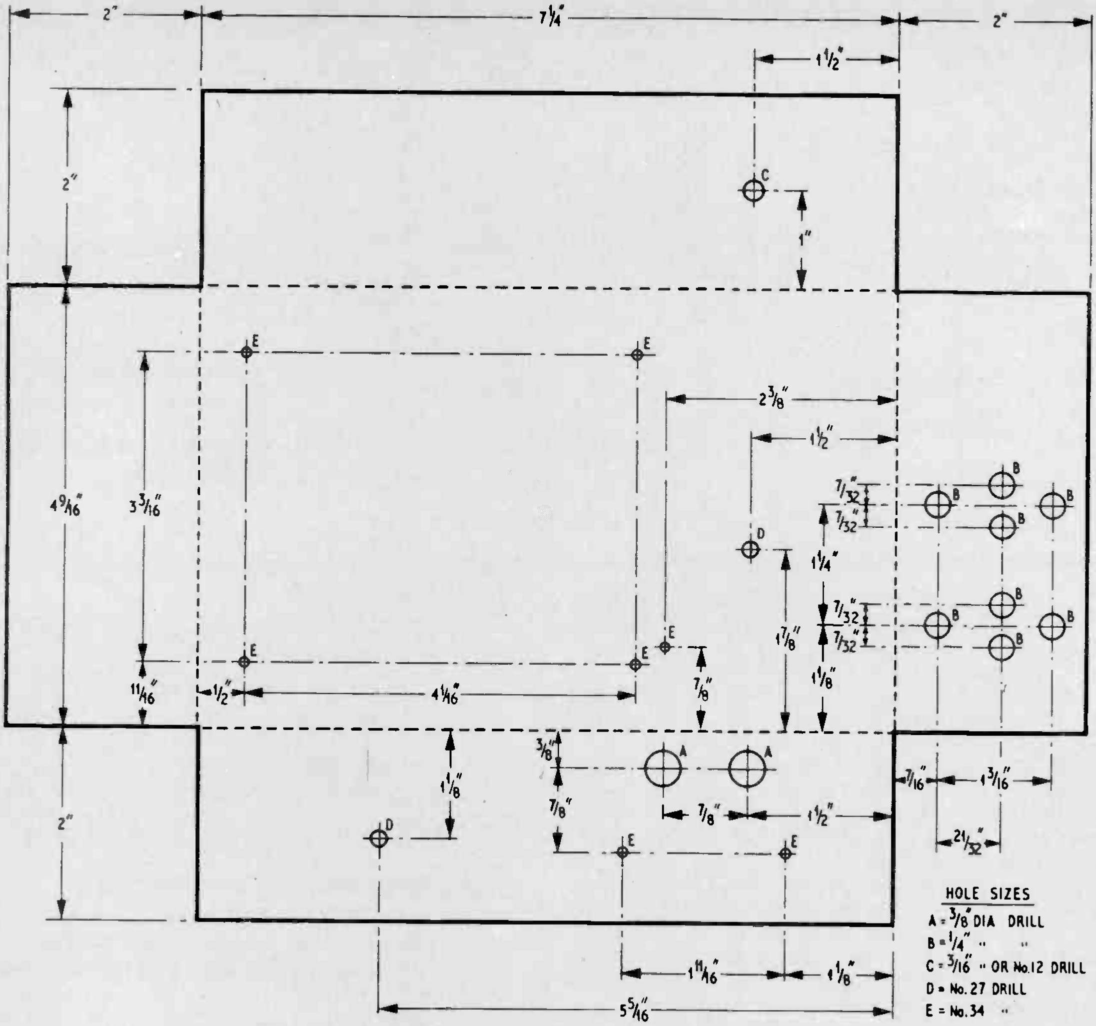


Fig. 7. Drilling details for the diecast box

12V version

First wind on 400 turns of 34 s.w.g. enamelled wire in eight neat layers—taking care not to cross adjacent turns. Insulate the lead out wires with thin sleeving and insulate the whole winding with four turns of thin insulating tape. Then wind on 12 + 12 turns of 20 s.w.g. bifilar (i.e. two wires wound together), and lastly 3 + 3 turns of 30 s.w.g. bifilar. Put coloured sleeving on the wires for identification and to protect them from abrasion against the core and insulate the whole coil with several more turns of insulating tape.

It is a good idea to join the two ferrite cups with a very thin smear of Araldite to prevent the core from making an objectionable whine, but test the transformer before doing this as it will be impossible to separate the core afterwards.

6V version

As above, but with a secondary of 300 turns of 34 s.w.g., a primary of 6 + 6 turns of 18 s.w.g. and a feedback winding of 3 + 3 turns of 30 s.w.g.

ASSEMBLY

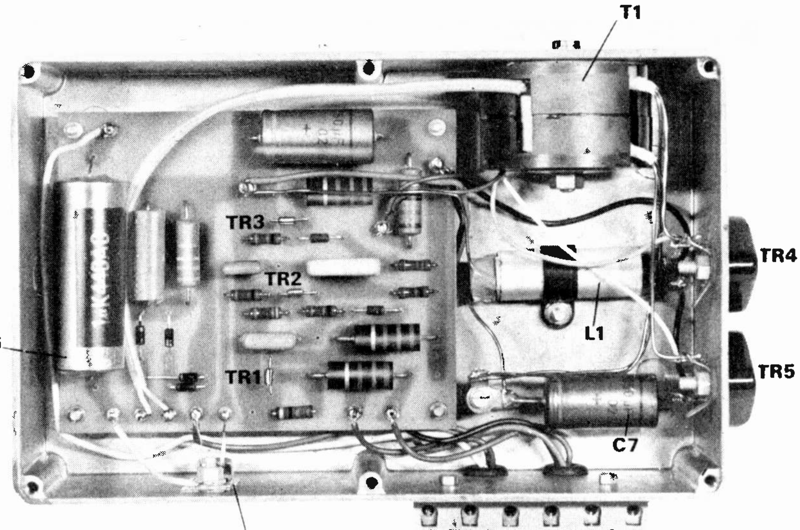
Drill the box as shown in Fig. 7, taking special care to deburr the holes for TR4, TR5, and the thyristor. Mount TR4 and TR5 with mica washers and insulators as shown in Fig. 5 and the transformer T1 with a 2BA bolt and spring washer. The stand-off insulator, and capacitor C7 can now be fixed in place and most of the inverter circuit wired up. Filter L1 is fixed with a ½in "p-clip" bolted to the case.

Assemble the printed circuit board and mount with 6BA bolts and ⅛in spacers. Then mount the thyristor with a mica washer and a 4BA nylon bolt. It should be possible to solder the gate and cathode leads of the thyristor directly to tags 11 and 4 respectively on the printed circuit board.

It is advisable to fix down the large capacitor C6 either by tying or by gluing as the considerable vibration puts a great strain on the capacitor leads.

Wire up the circuit as shown in Fig. 5 with 14/0076 connecting wire and mount a six-way 5 amp connector block on the outside of the box for the external connections. Fit two plastic covers to the power transistors to prevent accidental short circuits.

Photograph showing the completed Scorpio Mk 2 ignition system



TESTING

Before the unit is installed in the car a few simple tests should be performed to ensure that it is operating correctly.

Temporarily disconnect the anode of the thyristor and connect the car battery to terminals E and F on the connector block, via a 2 amp fuse. The unit should be heard to "sing" immediately and 400V d.c. should appear between tags 1 and 4 on the p.c.b. (6 volt system—300V).

If the inverter has been wired incorrectly it will probably fail to oscillate at all, but if one base winding has been connected the wrong way round the inverter can oscillate on one transistor only. Under these conditions high voltage spikes are produced and up to 800V may appear across tags 1 and 4.

INSTALLATION

Positive earth

The wire or wires connected to the SW or "−" terminal of the ignition coil should be connected to terminal F on the unit instead, and the SW terminal of the coil connected to terminal A. Connect the CB or "+" terminal of the ignition coil to B, the contact breaker to C, and a good earth from the car body or the positive battery terminal to E.

Negative earth

Disconnect the wire or wires to the "+" terminal of the ignition coil and connect them instead to E on the unit. Connect the "+" terminal of the coil to B and the "−" terminal of the coil to A. Connect the contact breaker to D and a good earth to F.

Cold start coils

Some cars are fitted with a cold start coil, consisting of a low voltage coil with a series ballast resistor. The ballast resistor is usually connected to one of the terminals of the coil, but may take the form of a resistance cable. It does not make any significant difference to the spark produced by the unit if the resistor is left in series with the coil, but ensure that the supply current for the unit does not flow through the resistor as there will then be a considerable loss of voltage. In all cases the connection between the starter solenoid and the coil *must* be removed.

SEALING

When the unit is completed and tested and operation is satisfactory the box should be waterproofed to prevent any dampness getting into the electronics. This can be done either using ignition system waterproofing aerosol available under names such as W.D. 40 or "Coldstart", or bath caulking compound. Make sure the grommet holes are sealed as well.

PRECAUTIONS

Because of the very high open circuit voltage produced by this unit *never* attempt to remove the spark plugs whilst the engine is running, since not only is there a danger of breaking down the insulation of the coil, but the experimenter stands a good chance of getting a nasty shock.

In addition the thyristor can be exposed to transient voltages of up to 1,000V under these conditions, and may be destroyed.

TACHOMETERS

There are a large variety of tachometers in use, all differing in their exact requirements, so some experimental work may be necessary to obtain the best results.

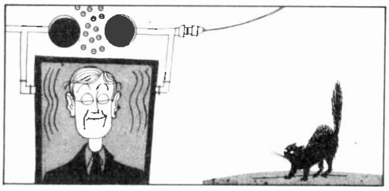
There are two possible connection points for current operated tachos (the most common type). The lead from the ignition coil to terminal A on the unit carries a 10 amp short duration pulse and the lead to terminal E (negative earth) or terminal F (positive earth) carries a wider pulse of 4 amps amplitude. In both cases try coupling the wire through the tacho pickup both ways as the polarity of the pulse may be important.

Regarding voltage operated tachos, the high voltage type should operate if connected to terminal B on the unit whilst a low voltage type can be left connected to the contact breaker. If in doubt, try both positions. ★

. . . . *never attempt to remove spark plug leads while engine is running*

Gerry Brown . . .

ON THE FRINGE



NEGATIVE IONS AGAIN

It seems only recently that we were chatting about the effects that charged atoms and molecules appear to have on us, other animals, and plant life. Since then I have read a number of quite serious reports about these "ionic beasties" and, indeed, discovered in addition that the people at the University of California actually have a faculty there which deals with the subject!

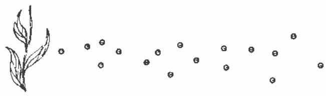
To refresh your memory about ions; generation of airborne ions all begins when sufficient energy is transferred to a gaseous molecule causing it to release an electron. This electron then "climbs aboard" any nearby molecule causing it. in turn, to become charged and in all likelihood convert to a negative ion (by virtue of the charge carried by the electron). The first molecule, however, has, in the process, turned into a positive ion. Umpteen of these molecular collisions occur, with the result that whole layers of species exist having either an overall positive or negative charge.

That, though, is by no means, the end of the story. Water molecules, too, get in on the act and jostle for position around individual ions, so forming somewhat larger ions.

According to Profesor A. Krueger of the University, mentioned earlier, these slightly larger (albeit, still tiny) molecules are of four types, namely $H^+(H_2O)_n$, $(H_3O)^+(H_2O)_n$, $O_2^-(H_2O)_n$, and one with a hydroxyl group attached having the formula $OH^-(H_2O)_n$. The $_n$ in the formulae has quite a small value.

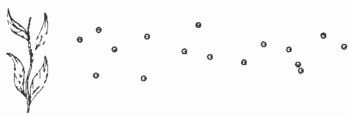
Apparently, negative ions are the more mobile, when compared with the positive variety, and, since the Earth itself carries a negative charge, the former are repelled from the surface of the ground.

According to the experts, negative ions are decidedly the "good guys", which bears out our earlier thoughts on the subject. Unfortunately, the positive ("bad guys") are in the majority by something like a factor of 1·2 to 1. Pollution, additionally, helps to keep this



ratio looking nasty, because, as you will recall, atmospheric dust has the habit of discharging any negative ions with which it comes in contact.

At the present time we can only produce (and successfully maintain) relatively small quantities of the beneficial ions; i.e., in buildings, or in cubicals where the size of the generator/transmission network can be kept within reasonable bounds. However, there ought



to be sufficient encouragement for contemplating some really big set-ups. For example, plant growth has been caused to increase by as much as 50 per cent as a result of moderate exposure to air ions. Silkworms, too, hatched out earlier and larval growth was also accelerated. On the other hand, positive ions have been shown to increase the death rate among mice suffering from influenza!

In the final shakedown, it is worthy of mention that negative ions are suspected of lowering the blood serotonin (5-hydroxy tryptamine, 5HT) level, and since this is a hormone which, among other things, appears to be connected with the facilitation of neural signals across the synaptic junctions between nerves, it is not surprising to learn that high negative ion counts can result in profound mental effects. These may range from clearer headedness to a kind of tranquillity.

No amount of persuasion has yet encouraged my editor to change his mind about putting a taboo on a special high-voltage negative ion generator I intended to include. It could no doubt, be lethal in the wrong hands, so I guess his decision is the right one!

MAGNETO-CHEMISTRY

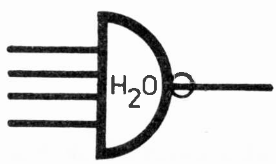
Still on the subject of chemy's, I notice that R. Skorsky of the Alabama University has discovered an interesting effect in ferric oxide, Fe_2O_3. Haematite, for that's it's other name, can, according to him, be reduced at much lower temperatures than previously achieved by simply surrounding the sample in an a.c. field of a few hundred gauss.

Skorsky has a theory that the cause of this effect is due to the increased pressure of hydrogen at the surface of the material resulting from its attraction to the magnetised iron (due to initial reduction of some of the ferric oxide at the beginning of the reaction).

Interestingly enough, C. Peters, over here, at the University of Surrey seems to think that the effect can be expected. His proposal amounts to the fact that since there is a considerable difference in the magnetic properties of the non-reduced material and final product, and because the reaction is going in a "direction" which favours a ferromagnetic substance as an end result, anyway, the outcome will be an *increased* tendency towards production of a magnetic material when a field of sufficient intensity is available. Sounds reasonable!

TAILPIECE

Washington, you'd think, had received its share of trouble. But it would seem the wags haven't finished with 'em yet. Only yesterday I came across this odd bit of logic.



A.C. DETECTOR PROBE

By B. BOWLES

IT IS often necessary, particularly in radio circuits, to check for the presence of high frequency oscillations but most amateurs do not possess test equipment capable of responding to frequencies greater than a few megahertz. The probe described here will respond to frequencies between 200Hz and 30MHz, allowing use in general a.c. signal tracing. Any a.c. of a few millivolts or more will light a small light emitting diode (l.e.d.). The whole instrument can be held in one hand.

CIRCUIT DESCRIPTION

The complete circuit is shown in Fig. 1. Transistors TR1 and TR2 form a high gain a.c. amplifier which also rectifies the signal to drive the l.e.d. (D2). The configuration is known as a d.c. feedback pair. TR1 is biased just into conduction by feedback from the emitter of TR2. The preset potentiometer VR1 is used to set the d.c. conditions for the circuit. Components R5 and C2 and C3 form a filter which reduces the a.c. feedback so that the a.c. gain of the circuit is not reduced.

The input impedance is roughly equal to the value of R2 since C2 and C3 form a low impedance path for a.c. C3 is used to compensate for the inductive effect of C2 at high frequency. Diode D1 protects the input from negative voltage swings.

RECTIFICATION

The diodes in the emitter of TR2 serve to rectify the signal in the following manner. When the input swings positive TR1 will conduct tending to lower the voltage at TR2 base and by emitter follower action at TR2 emitter as well. The diodes cease to conduct and the voltage at TR2 emitter drops causing the current fed back to TR1 to drop, counteracting the effect of the positive input. If, however, the input goes negative, TR1 will conduct less causing TR2 base to rise. The diodes will, however, maintain the voltage at TR2 emitter almost constant so there will be no negative feedback to the base of TR1.

The circuit thus has high gain when the input goes negative but low gain when it goes positive. Thus an a.c. input will cause TR2 to conduct and hence pass more current through the l.e.d. The resistor in parallel with the l.e.d. allows enough current to pass through the transistor to keep the diodes conducting and the resistor in series limits the maximum l.e.d. current to less than 10mA.

The circuit is so stable that the battery voltage can fall to 7V without affecting performance.

COMPONENTS . . .

R1 4·7kΩ
R2 4·7kΩ
R3 120Ω
R4 1·2kΩ
R5 4·7kΩ
All ±5% ⅛W carbon

Potentiometer
VR1 5kΩ linear sub-miniature skeleton horizontal mounting

Capacitors
C1 0·22μF
C2 10μF 6·3V tantalum bead
C3 1,000pF ceramic
C4 47μF 10V elect.

Diodes
D1 1N4148
D2 TIL209 light emitting diode
D3 OA91
D4 1N4148

Transistors
TR1, TR2 BC107 *or* BFY90 (2 off)

Miscellaneous
S1 Push-to-make, release-to-break push-button
B1 9V PP3 battery
Veroboard 0·1in matrix 2in × 0·9in
Veropins, 6BA and 8BA nuts and bolts and washers, wire, suitable case (see text)

A.C. DETECTOR PROBE

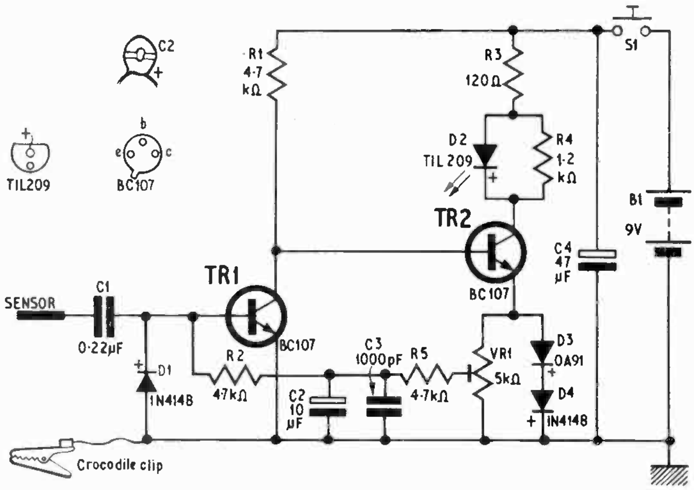
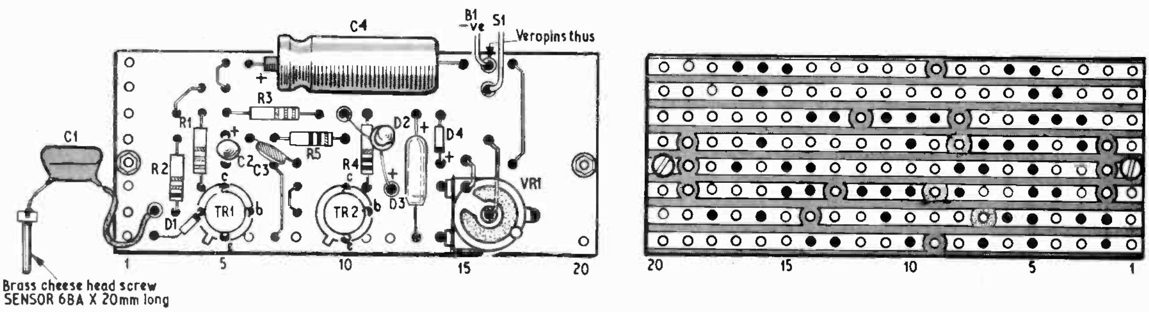


Fig. 1. Circuit diagram of the A.C. Detector Probe



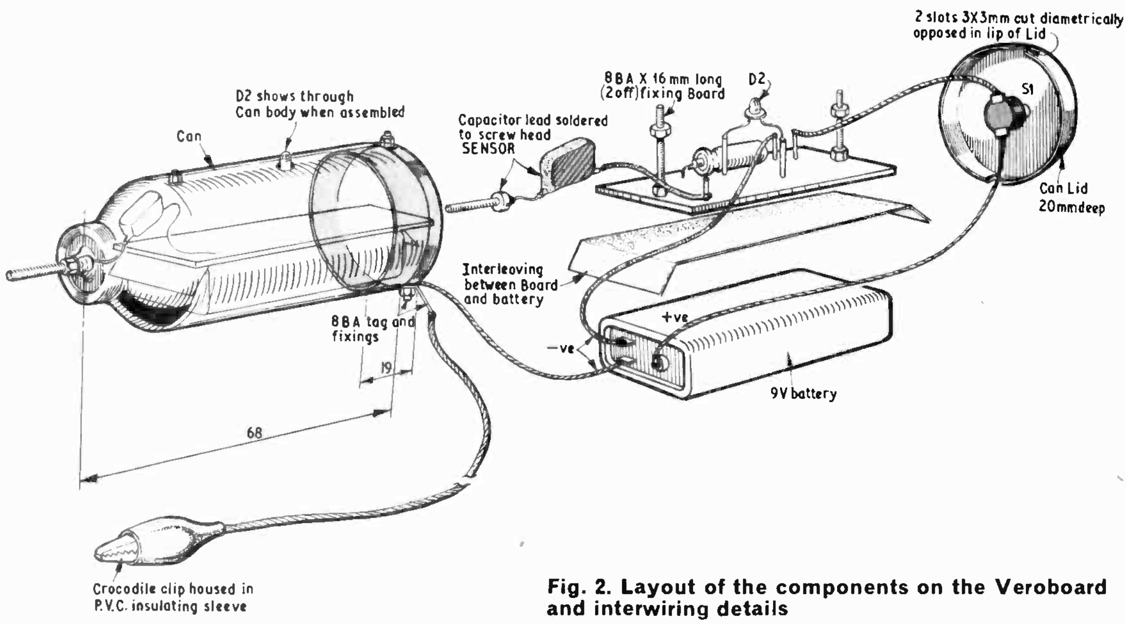
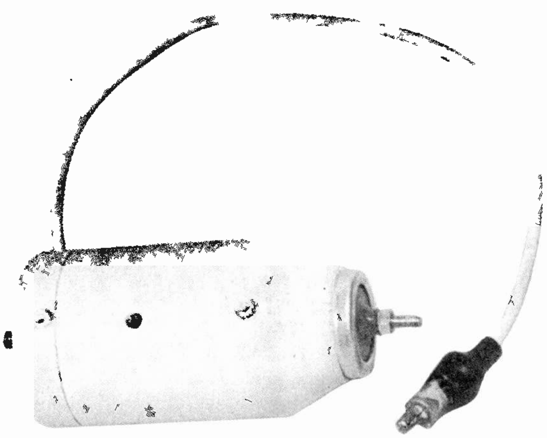


Fig. 2. Layout of the components on the Veroboard and interwiring details



Photograph showing the completed A.C. Detector Probe

CONSTRUCTION

The circuit for the A.C. Detector Probe can be made very compact so that the whole unit can be held in the hand, making it convenient for testing equipment. All the components except the capacitor C1 are mounted on a small piece of Veroboard as shown in Fig. 2. Veropins are used for wire connections to the board. The l.e.d. is mounted on two pins higher than the rest of the board so that it shows through the side of the probe case. Take care not to overheat the l.e.d. when soldering.

Only one end of C1 is connected to the board.

SETTING UP

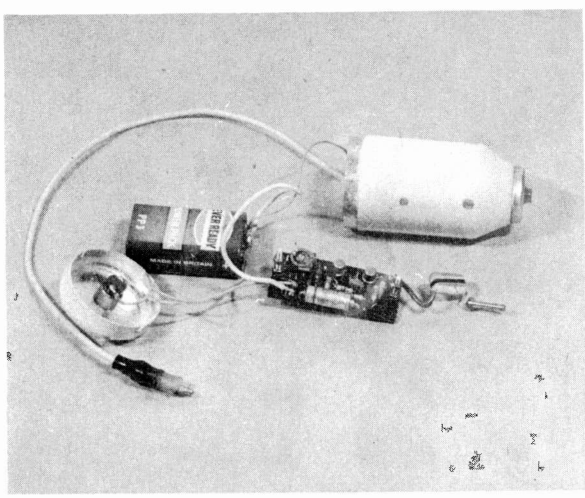
Before mounting in the case VR1 must be set up.

Connect the battery to the board. The l.e.d. should light with VR1 at one end of the track and extinguish at the other end. If the l.e.d. dims but does not go out, TR1 has low gain and should be replaced.

VR1 should be adjusted so that with no input D2 is just faintly lit. Any a.c. input with a frequency of 200Hz to 10MHz should now cause the l.e.d. to light.

The l.e.d. should flash each time the power is applied, this being due to the charging of C2.

Photograph showing the construction of the A.C. Detector Probe before assembly



CASE CONSTRUCTION

The prototype case was made from an empty butane lighter fuel container of medium size but any aluminium tube will do. Great care should be taken that there is no gas left in the container.

First pierce the container about five inches from the tip or nozzle. This should be done well away from naked lights, preferably outdoors. Then cut the case into three parts as shown in Fig. 2.

Do not drill the holes yet. After the cutting and any necessary smoothing of the edges, the body of the probe, the end cap and a 19mm ring remain. This ring should be cut with scissors, its ends overlapped and then pushed into the probe body. Mark the overlap, remove the ring and cut off the overlap so that when re-inserted into the tube it fits with the ends butted together. The ring can now be glued into the body leaving about 6mm protruding from the body.

END CAP

This now makes a push-fit seating for the end cap, and provided the cuts have been made square gives the probe a good appearance.

The end cap should now be pushed on and held with adhesive tape and the holes drilled.

The holes in the end cap should now be enlarged into slots so that the end cap can slide over the two bolts which secure it. A hole is also drilled in the end cap to take the push button switch.

The plastic insert in the front of the tube should also be enlarged to 3mm.

FINAL ASSEMBLY

The free end of C1 is soldered to the head of a 12mm 6BA bolt. The solder tag on the mounting bolt should be soldered to the negative line on the board. The battery is then connected up. Some insulating tape is stuck inside the tube in case the circuit should touch, and the board pushed in making sure that the bolt on C1 goes through the end of the tube. The battery is then pushed in with a piece of card between it and the board to stop the metal case shorting the board.

The end cap is now fitted and nuts fitted to the bolts holding the end cap and the probe bolt. Attachment of the earth lead and crocodile clip completes the unit.

USE AND APPLICATIONS

The A.C. Detector Probe is very sensitive and its frequency response extends up to several megahertz. If high voltages are to be measured a resistor can be connected to the probe bolt to act as an attenuator.

Bandwidth can be extended by eliminating D1 and replacing TR1 and TR2 with BFY90 transistors which give high sensitivity up to about 70MHz. Above this frequency the l.e.d. may actually dim when connected to a.c. this being due to phase shift causing the normal rectifying action to be reversed. This is just as valid an indication of the presence of a.c. ★

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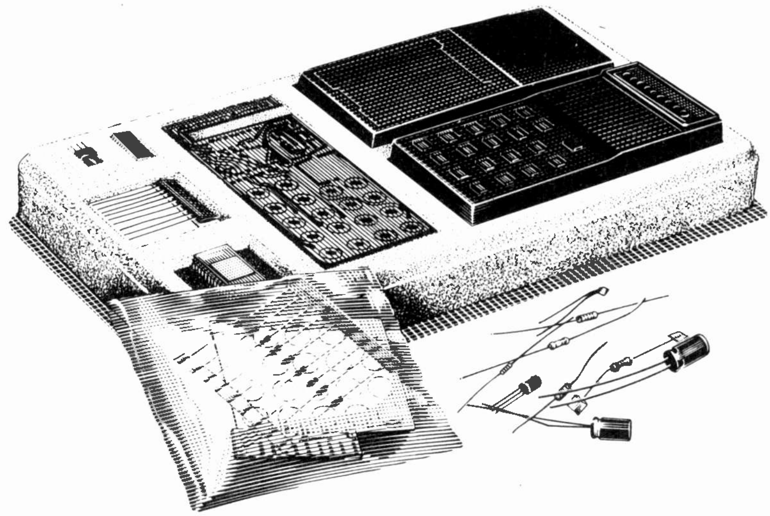
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



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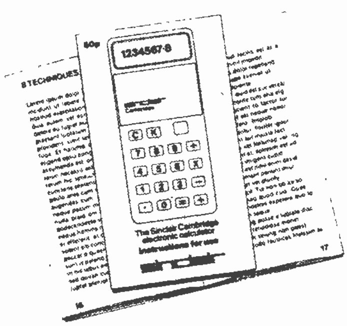

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PLEASE PRINT

CRYSTAL CALIBRATION OSCILLATOR

by R. A. Penfold

THE PURPOSE of a crystal calibrator is to provide signals at standard frequencies over the medium and short wavebands, in order to allow accurate calibration of a radio receiver dial.

Providing the output from the calibrator is nearly a square wave it will be rich in harmonics (i.e. multiples of the fundamental frequency). A good calibration oscillator of fundamental frequency 200kHz will have harmonics which are reasonably strong right up to the upper limit of the short wave band (30MHz).

Using a crystal means that the fundamental frequency is predetermined, and extremely stable with respect to time and temperature.

In order to allow the signal to be easily identified on a receiver an audio oscillator has been included to modulate the r.f. signal.

CIRCUIT DESCRIPTION

The full circuit diagram is shown in Fig. 1 and can be seen to be divided into two sections, the audio oscillator and the crystal controlled r.f. oscillator. The active elements used in the unit are contained in two integrated circuits type μL914 whose internal circuits are shown in Fig. 2.

The μL914 is intended for use in logic systems and is one of the family of Resistor Transistor Logic (RTL) circuits. It can be adapted for use as an amplifier by inserting a biasing resistor between the collector and the existing base resistor of one of each pair of transistors and ignoring the other, thus forming two, one-transistor amplifiers from each i.c.

CRYSTAL OSCILLATOR

A crystal has the property that at one particular frequency (known as the series resonant frequency) its impedance (resistance to current flow) becomes very low while at all other frequencies its impedance is high.

In the oscillator circuit used in the calibrator the two, one-transistor amplifiers in the μL914 are connected in series *via* the crystal and the capacitor C6.

At the series resonant frequency the impedance of the crystal is sufficiently low for the positive feedback between the two stages to maintain oscillation. Because of the large positive feedback the switching between the two states (transistor on and transistor off) is rapid so that the output is almost square producing the large number of harmonics required. The 200kHz crystal used in the prototype gave enough harmonics to cover the long and medium bands.

AUDIO OSCILLATOR

The other i.c. and its associated components form an audio frequency oscillator with a frequency of about 2kHz. When applied to the crystal oscillator

COMPONENTS . . .

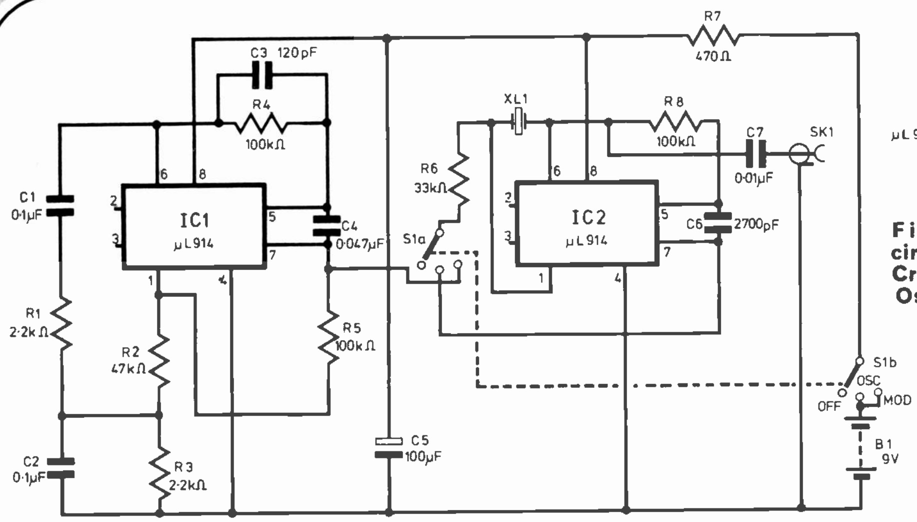
Resistors
R1 2·2kΩ
R2 47kΩ
R3 2·2kΩ
R4 100kΩ
R5 100kΩ
R6 33kΩ
R7 470Ω
R8 100kΩ
All ±10% ¼ watt

Capacitors
C1 0·1μF } ceramic
C2 0·1μF }
C3 120pF
C4 0·047μF ceramic
C5 100μF 10V elect.
C6 2,700pF
C7 0·01μF

Integrated Circuits
IC1, IC2 μL914 or equivalent (2 off)

Crystal
XL1 200kHz crystal with holder (Henry's Radio type FT241A)

Miscellaneous
S1 4-pole 3-way rotary
B1 9V battery type PP4 with clips
SK1 Coaxial panel mounting socket
2·8in × 1·4in Veroboard 0·1in matrix
Aluminium case approx. 4in × 3½in × 2in



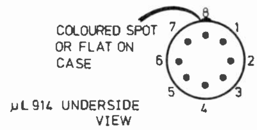


Fig. 1. Complete circuit diagram of the Crystal Calibration Oscillator

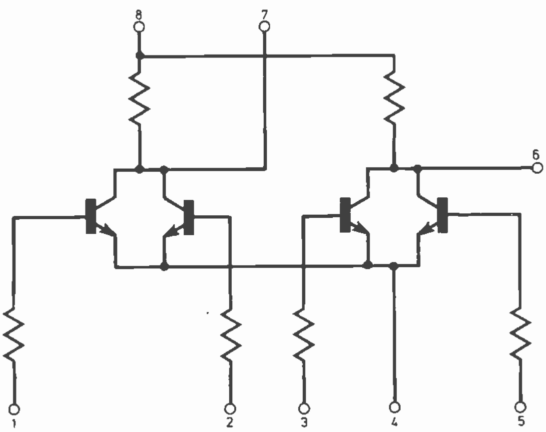
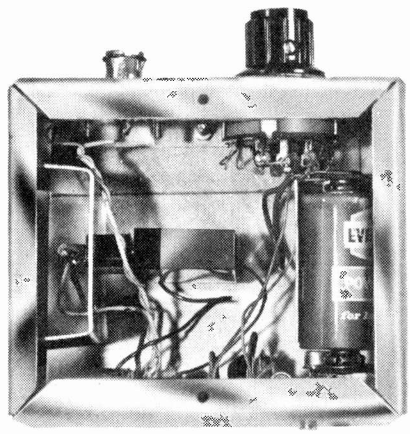


Fig. 2. Circuit diagram showing the internal circuit of the µL914 integrated circuit



Photograph showing the arrangement of the components in the small aluminium case with the crystal mounted on its bracket

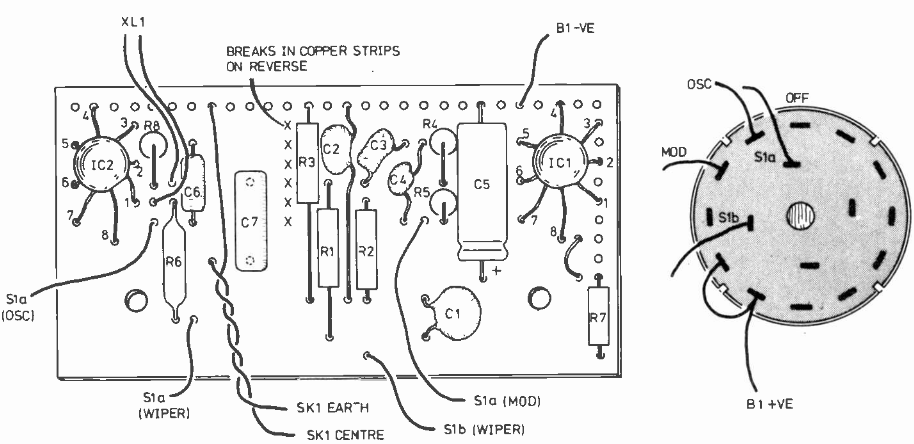
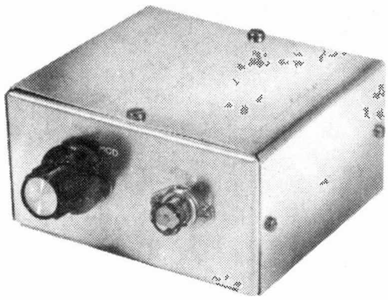


Fig. 3. Constructional details of the Crystal Calibration Oscillator



via R6 it varies the amplitude of the r.f. signal so that an audio signal of 2kHz will be heard when the receiver is tuned correctly.

The two amplifiers in the i.c. are connected in series to form an amplifier whose output is in phase with its input. The components C1, R1 and C2, R3 form what is known as a Wien Bridge, and it is these components that determine the frequency.

The switch therefore has three positions, OFF, OSC which gives the unmodulated crystal frequency and MOD which gives this frequency modulated by the oscillator.

Resistor R7 and capacitor C5 are included to reduce the supply voltage down to the 5V required by the i.c.s.

CONSTRUCTION

Construction is simple, all the components except the crystal, switch and output socket being mounted on a piece of Veroboard as shown in Fig. 3.

Any small aluminium case will do providing it is of sufficient size to accommodate all the components. It is wise to obtain a socket with the crystal as soldering to it directly could cause damage. A small bracket to hold the crystal can be mounted on the side of the box as can be seen in the photograph.

The switch used in the prototype is a four-pole three-way type with only two poles used.

USING THE CALIBRATOR

Once the unit has been completed, and all wiring checked for mistakes, a length of lead should be connected to the output socket and the unit turned on.

If the lead is now placed near a medium wave radio receiver, and the receiver is tuned over the band, strong signals from the calibrator should be received at intervals across the dial. Switching on the modulation should produce an audible note on these signals.

Using a 200kHz crystal, harmonics will be generated at 600kHz, 800kHz, 1MHz, 1·2MHz, and 1·6MHz. To find out which is which the receiver should be tuned to a known frequency (say Radio 1 on 1·214MHz) then the dial turned until the nearest signal from the calibrator is received (in the case above this will obviously then be 1·2MHz). Other frequencies can then be ascertained by counting the number of harmonics above or below the known frequency, as each corresponds to a difference of 200kHz.

This method of identification can be used on any band where the exact frequency of a station is known. ★

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.
This is YOUR page and any idea published will be awarded payment according to its merits.

OPTICAL COMMUNICATION SYSTEM

THE circuit described here is for a novel communication system using light beams to carry audio signals. Light emitting diodes (l.e.d.s) are particularly suitable for producing modulated light beams as they produce an intense concentrated spot

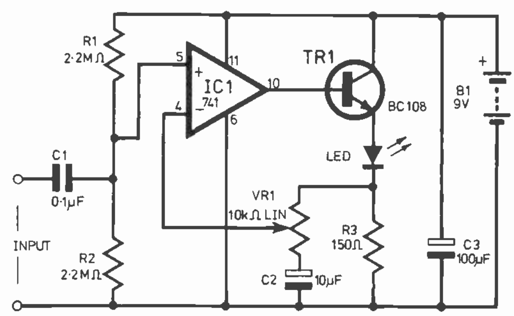


Fig. 1. Transmitter circuit diagram

BOILER GAS VALVE OPERATION AT LOW D.C.

PERHAPS the enclosed circuit idea would be of interest to your readers in view of impeding power cuts this winter. It allows a gas boiler mains operated gas valve, to be operated from a low voltage d.c. supply. The circuit has low battery consumption and low break current to minimise thermostat contact erosion.

I hesitate to recommend exact component values as the circuit was developed hurriedly to be ready for power cuts. In addition it was intended to run from a car battery so I did not bother to optimise the oscillator circuit or the capacitor and charge resistor values for minimum consumption.

I used an available Ferroxcube in the oscillator circuit and I do not know the exact turns ratios. I do not know how much variation exists between individual gas valves so that some experimentation by readers will therefore be required in both these areas.

Fig. 1 shows the circuit where R1 and C1 are included to prevent possible radio interference.

In operation, S1 is first closed charging C5 to about 120V. After a minute or so S2 is operated. The charge on C5 operates the gas valve, the voltage of which is prevented by D1 from falling much of light, have a linear current/light output relationship, and have a good high frequency response (the type of l.e.d. with a plastic diffusing dome is not suitable for use in this circuit).

The circuit shown in Fig. 1 will modulate the light from the l.e.d. using a cystal microphone or a loudspeaker output. IC1 acts as an a.c. amplifier with an input impedance of about 1MΩ. R1 and R2 are biasing resistors and together with IC1 and TR1 they produce a d.c. of 30mA in the l.e.d. VR1 and C2 control the a.c. feedback causing the input signal to be amplified and superimposed upon the bias.

To obtain the maximum range from the transmitter the optical system must be efficient. Either a convex lens or a concave mirror as shown in Fig. 2 can be used to convert the l.e.d. output into a parallel beam.

For efficient reception the light collecting area must be large; the author used a large concave make-up mirror costing 40p, but better quality mirrors will give better results.

The received light is concentrated onto a sensitive photo-Darlington transistor as shown in Fig. 3. Because the transistor is so sensitive the load resistor must be low to prevent saturation in daylight conditions.

At short range the signal across the load resistor is adequate to drive a crystal earpiece, though for longer range an a.c. amplifier and a loudspeaker are needed. The phototransistor output impedance is 1kΩ and most commercially available audio amplifiers are suitable.

The overall distortion is quite low, speech being excellent and music quite acceptable. The main cause of interference is mains lighting but this can be minimised by careful design of the optical system.

Transmitter and receiver must be accurately aligned and the transmitter gain should be carefully adjusted by means of VR1 to give maximum modulation without clipping. Clipping causes obvious distortion and is easily recognised.

J. N. Jones,
Cheshire.

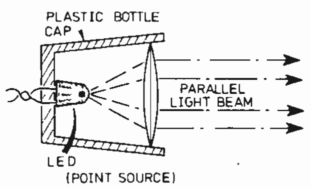


Fig. 2. Typical optical system for the transmitter

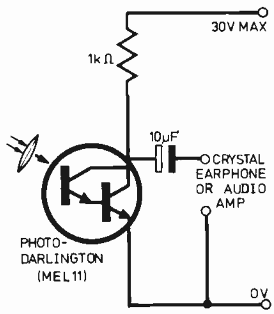


Fig. 3. Receiver circuit diagram

below the battery voltage. When the thermostat cuts out C5 recharges ready for the next operation.

C4 was included to adjust the charge rate of C5; it obviously affects the oscillator also and should not be needed in a fully developed design. D1 and D2 should have a minimum p.i.v. of say 200V and 400V respectively. D3 and D4 can be any silicon diodes.

I found that my Potterton boiler gas valve included a rectifier and that it closed at about 70V d.c. and held in at voltages below 11V. The consumption was about 2mA at 12V d.c.

For better economy of operation, a switching circuit might perhaps be devised to switch off the oscillator when the gas valve is energised but I have not tried this.

C. J. Collins,
Letchworth.

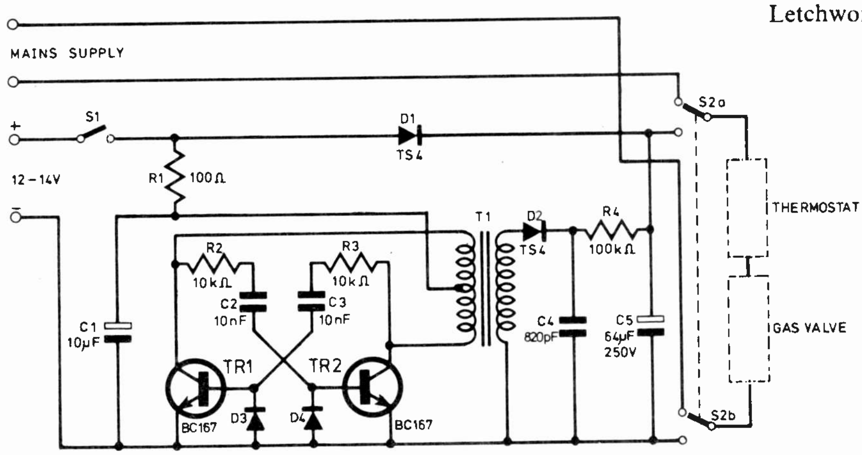


Fig. 1. Circuit for operating gas valve from low voltage d.c. supply

SLOW TIMEBASE OSCILLATOR

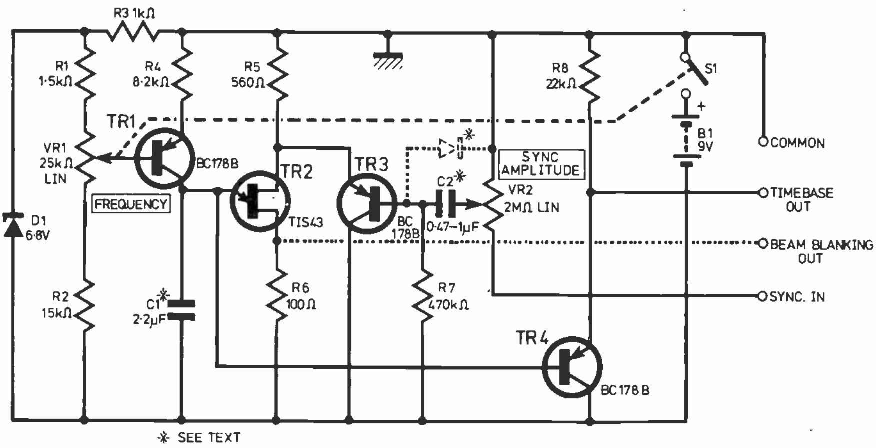


Fig. 1. Circuit diagram of the slow timebase oscillator

The sawtooth generator shown in the circuit diagram Fig. 1 was designed to extend the timebase range of a general purpose oscilloscope down to 1Hz. As well as the linear sawtooth with fast flyback, there is provision for an external synchronising signal and flyback blanking output.

The timing capacitor C1 of the relaxation oscillator, TR2, is charged by a constant current source from TR1. The base potential of TR1, controlling the constant current, is derived from the divider network R1, VR1 and R2. The Zener diode across the divider keeps the voltage at a constant level.

Since the sawtooth output at the emitter of the unijunction is at high impedance, the output is fed to an emitter follower to buffer the output against possible low impedance loads. The output should, however, not be taken to loads of less than 20kΩ impedance.

The synchronising input has a constant input resistance of 2MΩ and a portion of the signal is taken to an emitter follower via VR2 and C2. The effect of the emitter follower output is to modulate the supply voltage to the unijunction in step with the sync signal so that the sawtooth tends to be locked in frequency to the sync signal or a multiple thereof.

For adequate synchronisation even at the lowest frequencies, the input impedance of the emitter follower must be greater than the reactance of the capacitor at the lowest frequency.

The voltage rating of C2 should be sufficient to block the highest d.c. voltages likely to be encountered.

Adequate sync is available with a 0·3 to 1V r.m.s. input, but if higher voltages are used a diode should be wired as shown dotted, see Fig. 1, to prevent transistor emitter/base breakdown.

The frequency range of the oscillator is 1 to 60Hz, but could be extended up to 20kHz by varying the value of the timing capacitor C1. Capacitor C1 should be a low leakage type to ensure good linearity at low frequencies.

One of the many applications would be to use the oscillator for monitoring heart pulses in conjunction with the "Biological Amplifier" published in the January and February '73 issues (no back issues available). Care should be taken to ensure that the output from the Bio-amplifier is a.c. coupled to the vertical input of the monitoring 'scope.

M. H. George,
Upminster,
Essex.

AN IMPROVISED TAPE GUIDE

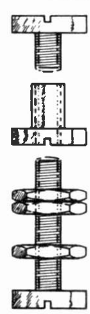
The drawing in Fig. 1 shows an improvised tape guide with height adjustment.

The guide itself is a ¼in brass binding post and is of the type which is threaded right through. These are obtainable from most well-stocked stationers.

The guide is simply fixed and adjusted by a BA bolt and three nuts.

Paul A. Koh,
Sunbury-on-Thames.

Fig. 1. Construction of the improvised tape guide



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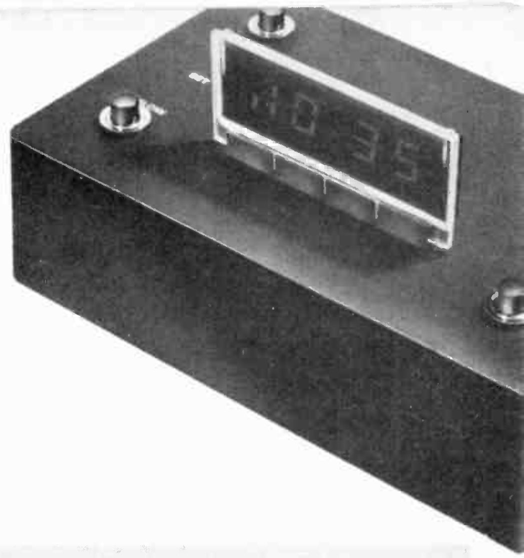

LIQUID CRYSTAL CLOCK

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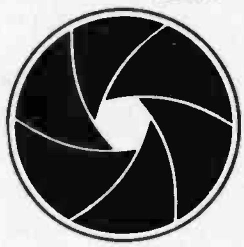

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PRACTICAL ELECTRONICS

APRIL ISSUE ON SALE MARCH 8, 1974

Subject to the current National industrial situation at the time of going to press

Boolean Algebra—1

By B. J. Wood

A two part article providing an introduction to switching theory and concluding with a practical design of a simple adder/subtractor

George Boole published a treatise "An Investigation of the Laws of Thought" discussing the system now called Boolean Algebra over a century ago in 1861. The basis of his concept is that a statement in words may be represented in the first place by a letter of the alphabet.

Thus we can say that the letter A represents the statement "It is Sunday" and the letter B "It is sunny." These are positive statements and Boole assigned them a value 1.

Using his system it is very simple to identify the opposite statements "It is NOT Sunday" and "It is NOT sunny" by simply putting a bar over the chosen letter thus $\overline{A}$ or $\overline{B}$. This time Boole assigns the value 0 to these negative statements.

To test the system let us assume that we ask the question "Can I mow the lawn?", having set the conditions that one can, but only if it is sunny and also a Sunday.

Thus for a sunny Sunday we have both A and B, or shown mathematically, A.B, where both A and B are 1. Clearly the answer is 1, or positive. If either of the conditions is a negative then the answer will be negative. Thus $\overline{A}.B = 0$ and $A.\overline{B} = 0$ and it is not suitable to mow the lawn.

This type of decision making is called an AND function in which the factors have been multiplied together.

The condition could be "It is Sunday" or "It is sunny" in which case an addition of the two values would be required. If either had a value of 1 the result would be 1. This is called an OR function and in the case of the OR when both are 1 the rather odd result of $1 + 1 = 1$ arises but here the AND and OR are interchangeable.

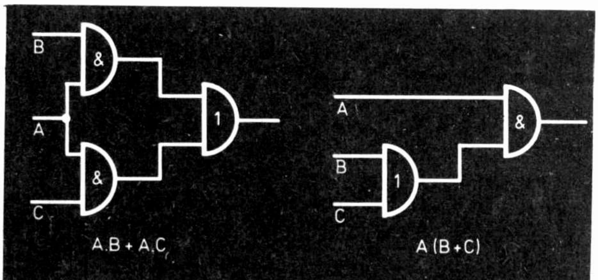

Fig. 1. Two logic diagrams which both represent the same overall function. Note the simpler form of the right-hand version

If the condition "Sunday and dry" is just as suitable for mowing the lawn as "Sunday and sunny" the decision to mow the lawn or not may be stated as A.B + A.C where C means "It is dry". Boolean algebra may be manipulated like any other algebra so that A.(B + C) means the same as A.B + A.C, giving the same arithmetic result.

If there are many conditions and alternatives the algebra can become quite involved. Generally, it is enough to work out one or two decisions at a time and build up the logic gradually.

LOGIC DIAGRAMS

In logic of the electronic kind, diagrams are useful to describe the flow of information. In the initial stages such diagrams contain only simple elements whilst later a whole group of elements may be put into one box and given a label in the same way that a collection of components may be labelled "amplifier". Fig. 1 shows the two ways of connecting AND and OR boxes which will give the same decision, to mow or not to mow the lawn.

The symbols used are fairly simple, being in the form of "D" shapes with inputs to the left and output to the right, a figure in the symbol denotes the number of inputs which must assume a logic 1 state for the output to be logic 1. An & sign in the symbol denotes an AND element.

Thus the operation to decide to mow the lawn under the Sunday and sunny or Sunday and dry conditions can be determined from these diagrams. Notice that the simplification of A.B + A.C to A.(B + C) also simplifies the diagram.

LOGIC ELEMENTS

Logic integrated circuits are available in many forms, simple and complex. They are very convenient packages, reducing external wiring to a minimum. Their low cost allows the constructor to build equipment which, a few years ago, would have been too expensive in terms of time and money. For the moment, however, elements built from discrete components will be discussed and related to the i.c.s as convenient. It does not matter that these devices are not identical as long as they react in the same way.

AND, OR, NOT ELEMENTS

These are the basic devices. More complex devices may be built from them. The AND may be made from diodes and a resistor as in Fig. 2a.

If either of the switches is closed representing an input of a 0 function then the whole of the voltage available from the supply is dropped across R1 and the output is at earth potential. Obviously, closing both switches has the same effect. It is only when both switches are open that a voltage is available at the output terminal.

The presence of this voltage is called logic 1. In its absence the state is logic 0. Why "logic"? Normally, the switches in the diagram are replaced by the outputs of other elements.

In practice absolute voltage levels are not possible at reasonable cost and so the design must allow for fluctuation. Thus logic 0 may be 0·5V or less and logic 1 anything over 2V.

To following elements these values are taken to represent 0 or 1. There is an electrical no-man's-land in between the two values which is avoided by the design and proper use of the devices involved.

AND

To return to the AND element, there is a table at 2a in which the states of A and B are given together with the resultant output for the four possible states of input. Called a truth table, this device shows that for a 1 output all inputs must be at logic 1. For any other combination the output is at logic 0. This applies for two, three or twenty inputs. Note that, to an AND input, an open circuit is a logic 1.

NOT

The NOT is shown at Fig. 2b It is simply an inverter in which, if a logic 1 voltage is applied at the base of the transistor it is switched hard on, the collector bottoms and the output goes to logic 0. If the base is at logic 0 the output is up near the rail voltage.

The second diagram at Fig. 2b is much more like an i.c. inverter in that the transistor is held on with a logic 0 output, unless presented with a logic 0 input. Like the AND, an open circuit input is treated as logic 1.

SYMBOLS

There are conventional symbols used to denote the various elements we have discussed so far as well as others to follow. They are used to avoid the need for either discussing or indeed even showing the actual components used in a particular element such as the diodes or transistors already noted.

Thus the elements AND and NOT, shown in detail at Figs. 2a and 2b may be shown as the two separate 'D' shapes joined together in Fig. 2c. Here the AND element is that with the ampersand (&) inscribed. This is intended to show that the element has inputs which have to be at logic 1 for the output to go to logic 1.

The second element with the small circle on the output line is the NOT element of Fig. 2c. Here the small circle denotes the logic 0 output obtained if the input goes to a logic 1.

NAND

The two elements at Fig. 2c denote NOT AND which is normally known as NAND. In fact this has a new symbol of its own as shown to the right in Fig. 2c, the small circle denoting the NOT output and the ampersand the requirement for logic 1 inputs for this. The truth table shows the outputs obtained for various inputs and it can be seen that only when all inputs are logic 1 will the output be logic 0. Of course, as before the logic 1 input includes an open circuit.

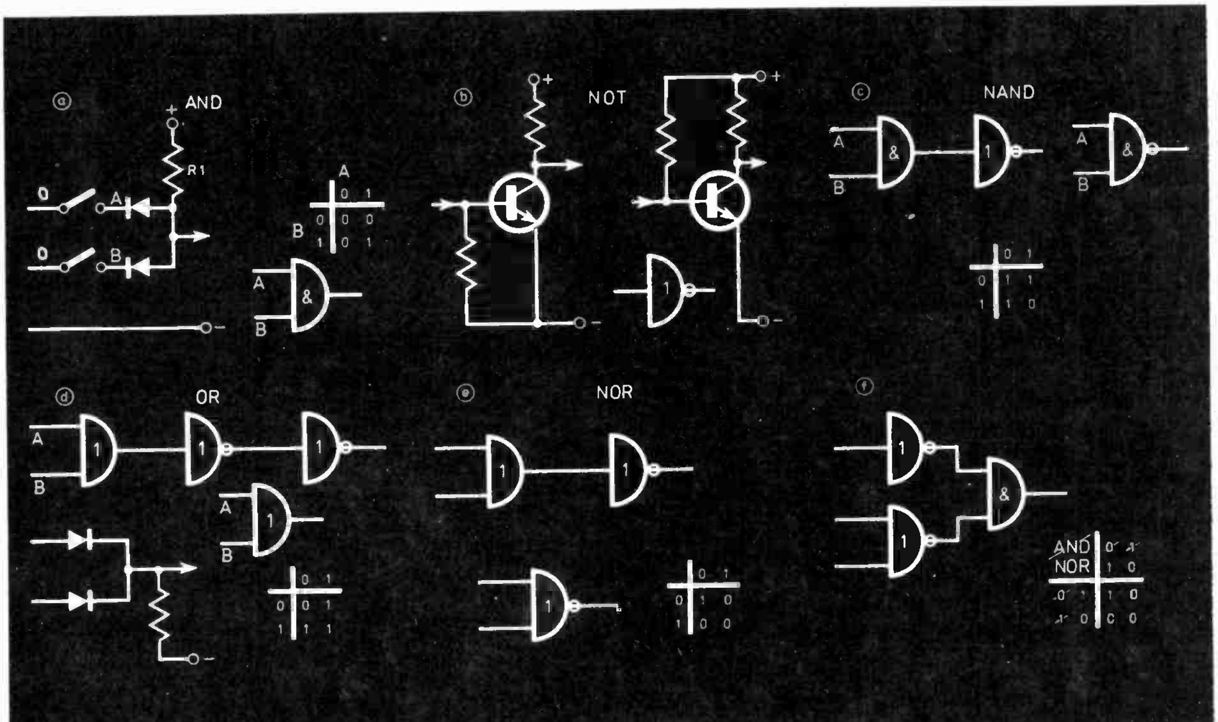

Fig. 2. Various forms of the logic element, associated circuitry and truth tables

OR

In its simplest form the OR element is made from diodes as shown at Fig. 2d. As can be seen these point in the opposite direction from those in the AND element. If a logic 1 appears at any input it becomes available at the output. The OR treats an open circuit as logic 0. In diode form the resistance of the load must be small enough to look like a logic 0 to the following element but large enough to demand only a reasonable current from the input source. The second diagram of Fig. 2d overcomes this difficulty by the introduction of two NOTs.

In this case the first element is a basic threshold element and the number inside denotes the number of inputs which must be at logic 1 for the output to be at logic 1. This element is followed by the two NOT elements and the whole may be shown as below.

NOR

A NOR element is an OR followed by one inverter element as shown at Fig. 2e. Only when all the inputs are at logic 0 is the output at logic 1. Under any other condition, as can be seen from the truth table the output is at logic 0.

INVERTED INPUTS AND OUTPUTS

Suppose that an AND is used with an inverter in each input so that 0 becomes 1 and vice versa. Fig. 2f truth table shows that it becomes a NOR. If, additionally, the output is inverted it then becomes OR. The reader should treat all the other truth tables in a similar fashion. It will be seen that any element may be made to exhibit the characteristics of the other three.

For what follows in this text the important point is that a NAND with inverted inputs becomes an OR. In general the devices to be used will be NANDs with diodes as ANDs when convenient plus NOTs. In the beginning it will be, perhaps, easier to recognise that an OR is required and then use a NAND with inverters in the inputs.

BINARY NUMBERS AND ARITHMETIC

In the kind of logic under discussion there are only the two states 1 and 0. Any process to be handled by the logic must therefore be described in these terms. In everyday arithmetic the radix of 10 is used with ten possible digits of 0 to 9. But if, as with Boolean logic, 2 is used as the radix, only the digits 0 and 1 are possible.

In the scale of 10 the number 286 can be written $(2 \times 10^2) + (8 \times 10^1) + (6 \times 10^0) = 200 + 80 + 6 = 286$.

In the scale of 2 the number 1101 means $(1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) = 8 + 4 + 0 + 1$. (A number to the power of 1 is itself. Any number to the power of 0 is 1).

As a point of interest, decimal-to-binary conversion can be achieved as follows.

CONVERSION

Convert 83 to binary. This may be done mechanically by dividing the number 83 continuously by 2 ignoring remainders until the answer of 1 is reached. Write (—) against odd answers and (0) against even answers. The result looks like this.

83	—
41	—
20	0
10	0
5	—
2	0
1	—

If now the paper is turned so that the (—) against the final answer of 1 is at the left then this is the result in binary:—

1	2	5	10	20	41	83
1	0	1	0	0	1	1

where $1010011 = 64 + 16 + 2 + 1 = 83$.

Conversely, to convert binary notation to its decimal counterpart simply multiply the left-most digit by two and add the following binary digit. Multiply the result by two adding the next binary digit and so on until the end is reached as below.

1	1	0	1	0	1
	3	6	13	26	53

The final figure, in this case 53, is the correct answer.

ADDING BINARY NUMBERS

The rules for adition of two binary digits (bits) are $0 + 0 = 0$; $0 + 1 = 1$; $1 + 1 = 0$ and carry 1. Where there is a carry from the previous position it requires the following rules, $0 + 0 + 1 = 1$; $0 + 1 + 1 = 0$ and carry 1; $1 + 1 + 1 = 1$ and carry 1.

Using the rules to add 6 to 7 —

Binary		Decimal
111	=	7
110	=	6
1101	=	13

SUBTRACTION

The rules for subtraction of two binary digits (bits) are $0 - 0 = 0$; $1 - 1 = 0$; $0 - 1 = 1$ and borrow 1, $1 - 0 = 1$. Where there is a borrow the following applies, $0 - 0 - 0 = 0$; $1 - 0 - 0 = 1$; $0 - 1 - 0 = 1$ and borrow 1; $1 - 1 - 0 = 0$; $1 - 1 - 1 = 1$ and borrow 1, etc.

Thus if we subtract 3 from 5:

Binary		Decimal
101	=	5
011	=	3
010	=	2

Of course, problems arise when larger numbers have to be subtracted from smaller numbers. Using decimal notation, the human animal in fact reverses the process, subtracts the smaller from the larger and then calls the result a "negative."

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AC127	15p	AF180	40p	BF179	32p	OC71	12p	2N3819	32p
AC128	15p	AF181	40p	BF180	32p	OC72	12p	2N4062	12p
AC131	12p	BC107	12p	BF181	32p	OC81	12p	2N4286	20p
AC132	12p	BC108	12p	BF194	14p	OC82D	12p	2N4289	20p
AC176	15p	BC109	12p	BF195	14p	2N2646	60p	40360	35p
AC187	22p	BC147	12p	BF197	15p	2N2904	20p	40361	35p
AC188	22p	BC148	12p	BF200	32p	2N2926	10p	40362	40p
AD140	50p	BC149	12p	BFY50	20p	2N3054	58p	40408	40p
AD149	45p	BC157	14p	BFY51	20p	2N3055	60p	ZTX108	15p
AD161	33p	BC158	14p	BFY52	20p	2N3702	13p	ZTX300	15p
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AF115	20p	BD131	75p	OC26	45p	2N3705	12p	ZTX503	20p
AF116	20p	BD132	75p	OC28	50p	2N3706	11p		
AF117	20p	BD133	75p	OC35	50p	2N3707	12p		
AF118	38p	BF115	25p	OC42	12p	2N3708	10p		
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160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p**. 0·1μF **3½p**. 0·15μF **4½p**. 0·22μF, **5p**. 0·33μF, **6p**. 0·47μF, **7½p**. 0·68μF, **11p**. 1·0μF, **13p**.

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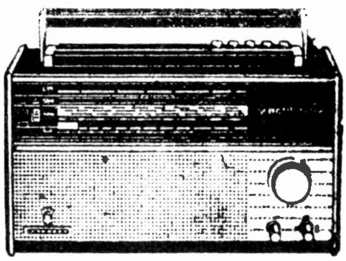

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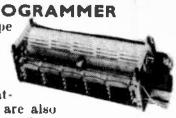
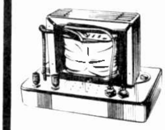


This is a drum type timing device, the drum being calibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price **£6·33** plus 25p post and insurance. Don't miss this terrific bargain.



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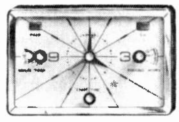

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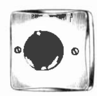

For any lamp up to 1kw. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2·95**, plus 20p post and insurance. Industrial model 5A **£3·30**. Not on plate.

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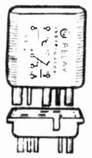

American made. Our Ref.: REL A1. Measures only ⅞in wide × ⅜in thick and ⅞in high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price **28p** including base.

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Please add 10% V.A.T.

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(Dept. P.E.), 7 PARK STREET, CROYDON CRO 1YD
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Whilst a machine can be made to do this it is not part of the present discussion as it is complex and requires very lengthy explanation.

Take the case of subtracting 7 from 3. In decimal the answer is obvious, it is minus 4 (−4). Equally, if you take 5 from 2 the answer is −3. In binary terms using the methods so far discussed this is not so. Thus in the case of 3 − 7:

$$\begin{array}{r} 011 \\ 111 \\ \hline (1)\ 100 \end{array}$$

And in the case of 2 − 5:

$$\begin{array}{r} 010 \\ 101 \\ \hline (1)\ 101 \end{array}$$

In both cases there is a borrow 1 with nothing to subtract it from and in fact even if there were more positions to the left the resultant row would be filled with figure 1's with an unsatisfied borrow 1 emerging at the far left.

The same thing happens in decimal notation if one persists in trying to subtract using this type of approach. Thus in decimal the results could be shown as (1)6 and (1)7, the figure in the bracket being the unsatisfied borrow.

In fact the two answers 6 and 7 are the tens complements of the correct answers, subtract the 6 and the 7 from 10 and you have, in positive form, the correct answer.

Similarly, with the binary computation the results must be subtracted from 8 which, in binary is 1000 There are two snags to this situation. First the operator needs to know before the event that a negative result will arise and re-arrange the inputs.

COMPLEMENT

The word complement was mentioned. This is the key to the answer. In the 1 and 0 binary system the 1s complement of 1 is 0 and vice versa.

Ignoring the unsatisfied borrow in the two binary answers, if 1 is changed to 0 and vice versa 100 becomes 011 and 101 becomes 010 or 3 and 2 in decimal, both wrong by being 1 too few. What is really needed is the complement of 7 which can be arranged by subtracting 1 before the complement is taken. To do this the unsatisfied borrow from the left is carried round to the right to form part of the subtraction. Using the examples again—

$$\begin{array}{rrl} 011 & 010 & \\ 111 & 101 & \text{Subtract} \\ \hline (1)\ 100 & (1)\ 101 & \\ \hookrightarrow 1 & \hookrightarrow 1 & \text{Subtract} \\ \hline 011 & 100 & \text{Answers} \\ 100 & 011 & \text{Complements, both in fact negative.} \end{array}$$

The complements give the answer in positive form but it is known that the answer is negative because the mode of operation is subtract and there is the borrow 1.

The following table gives all the possible results for the system. The reader is advised to work out columns b, c and d to gain an understanding.

Decimal	a positive	b negative	c neg − 1	d complement of c
0	0000			
1	0001	1111	1110	0001
2	0010	1110	1101	0010
3	0011	1101	1100	0011
4	0100	1100	1011	0100
5	0101	1011	1010	0101
6	0110	1010	1001	0110
7	0111	1001	1000	0111
8	1000			
9	1001			
10	1010			
11	1011			
12	1100			
13	1101			
14	1110			

Next month: Constructional details of a simple adder/subtractor will be given

BOOK REVIEWS

IMPROVING YOUR HI-FI

By John Earl
Published by Fountain Press
203 pages, 8¾in × 5½in. Price £3·00

THE title of this book is slightly misleading as the theme is not really improving hi-fi systems but getting the best out of them. Written in a non-technical style, it appears to be directed towards the people who are not satisfied with low-fi but are not *au fait* with all the technicalities and jargon of high-fi and are perhaps not getting all they could from their set-up.

This is strictly a practical book dealing with things like the importance of correct earthing, the need to maintain correct dynamic ranges throughout the system, and the meaning of specifications.

For the non-technical enthusiast this book would be essential reading before he considers buying expensive hi-fi equipment S.R.L.

FET APPLICATIONS HANDBOOK

Edited by Jerome Eimbinder
Published by Foulsham-Tab
350 pages, 8½in × 5½in. Price £1·85

THIS book is a collection of applications data from a wide number of manufacturers and provides an excellent reference work for anyone who is involved in the use of field effect transistors (f.e.t.s).

All types of f.e.t.s are described from the simple junction types to the complementary M.O.S. systems used in the pocket calculators of recent years. Many applications of f.e.t.s are described ranging from voltage controlled resistors to amplifiers, switches and digital circuits. S.R.L.

ESP etc

By Brian Baily...

" . . . more things in heaven and earth . . . "

The first reaction of many readers when they read the above title was probably to ask "What's a subject like this doing in P.E.?" You may well ask. Others may have taken the view that our friend Ed is off his rocker and yet others may take the opposite view, and exclaim "At last Ed has come to his (extra) senses, and allowed publication of this previously 'tabooed' subject." |

The fact is, this article was written long before Uri Geller's impressive fork—(if not mind)—bending demonstration on BBC television, but friend Ed was a little sceptical I think before that night when I talked him into viewing it! We must all be grateful for his open-minded approach in allowing this article to appear.

Naturally, there will be those for and those against, but whether you are a sheep or a goat (these are the two rather inappropriate terms that sceptics use to describe the believers and non-believers, respectively) there is always a good reason to give the whole matter another look. Remember, times change, and so do peoples' ideas, evidence, equipment, and even phenomena.

First, let us get quite clear what is meant by extra-sensory perception (E.S.P.). Take the words literally, and you will get the best definition possible. They mean perception of events (etc.) by some means not obviously connected with any of the five normal senses.

Let me hasten at this point to make a quick distinction or two. Unfortunately, the Press, Radio, and TV media often treat all subjects which cannot be explained by presently-accepted terms of analysis—witchcraft, black magic, ghosts . . . what-have-you—as E.S.P. This is a great pity, because there are quite different forms of unexplained phenomena, and the only true umbrella titles which could be fairly used to embrace the lot, would be "the occult" (unknown), or "paraphysics."

However, when writing a subject which must be sensational, so-called evidence is often dragged in from as many different fields as possible to try and get the reader all excited and on the edge of his chair. In fact, the opposite often happens, and many are left believing less one way or the other than when they first started reading!

So, though other subjects come under the above general headings, they are not all E.S.P. Such subjects will be described in this series as the etceteras.

Reasonable Approach

It must always be remembered that there is no commonplace thing of today that, at some time past, was not considered impossible. We are all still learning, and humility is, to the truly rationally-minded, something which can only increase, not decrease, with increased knowledge. Just because humans have relied on speech, sight, etc., for communication and direct physical intervention for getting things done, is not to say that there is no need of a set of equally valid alternatives in his make-up, which needs only to be developed, once discovered—always given he adopts a reasonable approach.

E.S.P. is nothing new. One can go back to the New Testament, if this is considered far enough, and find references to "gifts of the spirit". I will not digress further, other than to say that evidence of the possibility of E.S.P. has cropped up probably as long as man has inhabited the earth, and in other forms, before.

E.S.P. rarely occurs under controlled laboratory conditions. Read a person's thoughts say, once, and then try to continue the pattern under strict control, and the chances are that you will not succeed again even once. This is the very thing the sceptic looks for, and when it occurs he jumps in with both feet and says "Pooh what did I tell

you?" Ok, ok, I say, I am as aware as you that the effect is not repeated under these conditions, but might this not be a point worthy of investigation? "Why?" he would say, and then would come my first analogy, speaking as an electronics bod.

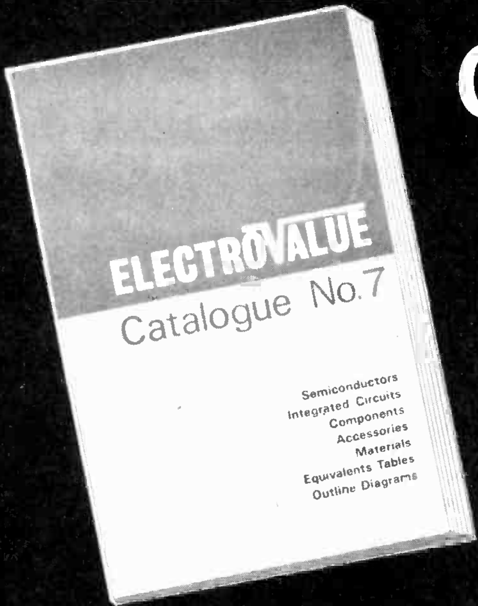
Take out your comb and comb your hair, or if this is greasy, rub it on your Harris Tweed jacket. The comb is now charged, and you can prove this by picking up small bits of tissue paper from the table. What voltage? Would you believe there's probably more than 5kV on it? There probably is!

Now ask the sceptic to get his voltmeter and place one lead on the gas or water pipe (earth) and the other on the comb and see what he gets. Tell him the meter is at least 20 kilohms per volt. Naturally, he gets no reading. Why, you were on the 250V scale and the needle didn't even flick. Reason is that the meter requires current to flow to operate its needle, and the amount of current required for this is in excess of what the comb could supply despite over 5kV on it, at the point of contact with the meter lead.

Could E.S.P. be elusive for some similar reason? By this I mean, by trying to "tap" its power to prove an experiment, could we require too much "current" for the source to supply and operate our "meter"? Perhaps the tension caused by the anticipation of all spectators present draws off the very power we are trying to use!

Next month: The Scientists Investigate.

ELECTROVALUE



CATALOGUE 7

An A to Z guide to component buying

On the index page of Catalogue 7, between "Aluminium Boxes" and "Zener Diodes" are over 200 references to contents amounting in all to thousands of items, classified, described, often illustrated, and priced. There is a wealth of technical diagrams and data. At 25p, Catalogue 7 is excellent value by any standard. With the 25p Refund Voucher it costs you virtually nothing when you order £5-worth or more.

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

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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	0·22–3·9	7	7	8	
WW	3	1–10K	7	7	8	
WW	7	1–10K	9	9	8	

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

Values: All E12 except C⅛W, C½W and MO½W at E.12.
E12, 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82.
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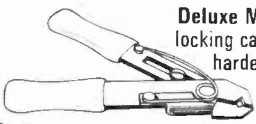

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INDUSTRY NOTEBOOK

By Nexus

BEATING THE CLOCK

Coming into service in a few weeks is Cantat 2, the 2,805-mile long transatlantic cable costing £30 million and capable of handling 1,840 telephone conversations simultaneously.

Laying of the cable had its share of drama. The mini-submarine *Pisces 3* sank while burying part of the cable on the UK continental shelf. The two-man crew were rescued, happily, after three days of being trapped on the sea-bed. The craft was also recovered and will be in service again soon.

The cable-laying ship *Mercury* was also damaged in a storm of force 11, forcing her to operate for a time on emergency power. But despite all the upsets, the cable-laying was completed six days ahead of schedule which makes quite a change in a world of go-slow or stop.

The other heartening news out of the *Cantat 2* saga is that because of the vastly increased number of channels available, the new cable is 20 times cheaper per circuit than the transatlantic cable laid between the UK and USA in 1956. But don't expect the cost of a call to go down.

HI-FI HIT

Hi-Fi, like the motor car, has become the index of a nation's prosperity. But what was astonishing in the good old days of 1973 was the number of equipments advertised to the general public—not the addict—at prices of £200 up, and reportedly selling well. Top weight equipment for the real enthusiast was typically Trio's Package 10 quadraphonic package listed by Lasky's at £460 cash or £577·48 on HP. At the bottom of the pack were plenty of modest units around £30.

A survey of the audio market "Finresearch Audio Industry Service" published by Ovum Ltd. at £30 lists 380 companies active in the audio business which has trebled in size in three years. Such was the boom, according to editor Tony Beaumont, that three new companies have been entering the field every week for the past two years.

First "audio separates" I recall was back in 1937 when I was enchanted with the reproduction of 78 r.p.m. discs on the famous corner horn loudspeaker developed by P. A. H. G. Voigt. But I see Ferguson claiming they "invented" what they call Unit Audio just 30 years later in 1967. Claims and counter-claims in the colour ads are numerous and often funny.

This clearly will not be a good year for the audio business. HP restrictions and a general tightening of belts will see to that. But the audio scene will not collapse. It'll still be comparatively big-biz as well as show-biz.

MAINTENANCE PROBLEM

Try to imagine 15,000 fixed transmitter/receivers of powers from five to 300W and 25,000 mobile vehicle-mounted transmitter/receivers. Tack on 30,000 personal portable transmitter/receivers and 200,000 nickel/cadmium batteries to power them. And just add to that little lot 15,000 pocket alarm receivers and all their batteries.

In round figures, this is the size of the maintenance problem of the Home Office Directorate of Telecommunications which looks after the procurement and servicing of Britain's police and firefighting networks as well as a few others.

The problem was discussed in some detail by A. N. Holdstock in a paper given at "Automatic Testing 73", the first full-scale exhibition and conference to be held on the subject. The magnitude of the Home Office's task was such that automatic testing was seen as a solution as early as 1967. Holdstock reports several equipments now in full service but reports that no radio equipment manufacturers are yet designing sets with in-field maintenance by ATE as a prime consideration. Consequently, there are always snags in having to build special jigs and adaptors before ATE can be successfully used in the field.

The next big job is provision of ATE for 1,000 alpha-numeric video-display terminals now being fitted in police stations throughout the country. Each of them has six large PCBs and 530 TTL integrated circuits.

A new and profitable outlet for ATE on production lines is in the automotive industry. No less than six papers were read on the subject including one on the experience of Ford in checking out car electrical systems. Ford will, in fact, move 100 per cent to ATE for this purpose in the UK during this year.

So successful was "Automatic Testing 73" that organiser John Shearsmith has already announced November 5, 1974, as opening day for the next show. The first exhibition attracted 50 companies and 4,000 visitors. Seven hundred delegates attended the technical conference.

INNOVATION

I have to confess that I was one of the sceptics when Advance Electronics went into the calculator business in mid-1972. Like many others I had underrated their ingenuity.

Advance didn't take the easy path by buying off-the-shelf LSI devices. They designed their own in conjunction with General Instrument Microelectronics and did it in such a way that they could be used in many other applications. So watch out for some competitive lines from Advance in business machines.

MINICOMPUTER LEAGUE

A league table of minicomputer manufacturers prepared by Modern Data in the USA shows Digital Equipment Corporation still way ahead with 16,473 units shipped in 1973. Runner up is Data General with 4,230 and Hewlett Packard in third spot has a score of 2,855, marginally ahead of Varian with 2,337. Honeywell ranks only No. 8 with 1,564 while Texas Instruments, mighty in other fields, is bottom and unlucky thirteenth with 452.

Computer Automation, who came to the market with the concept of the Naked Mini, ranks fifth with 1,915 units shipped in the year. Stripped of all frills, the Naked Mini was offered at a rock-bottom price. Since then CA has offered the "Computer-on-a-card" with the whole package on a single printed circuit board, an even lower priced unit for people who want to build a computer into their own equipment.

Digital Equipment still has the stranglehold in minis that IBM has in the larger machine market. But watch out for increased competition and a re-shuffling of positions lower down the table.

PATENTS REVIEW...

AUTOMATIC COMMENTARIES

The Secretary of State for Defence has a new British patent (BP 1 325 161) which concerns automatic machines for playing commentaries to accompany exhibits in museums or exhibitions.

The object of the invention is to provide a replay device which works on the closed loop principle and will always be at the correct start point when brought into action by a new listener. This is relatively easy to achieve if the loop is only to play once, but much more difficult to achieve if the listener is to be afforded the opportunity of listening to the loop more than once.

The tape replay device works with an endless loop of magnetic tape and its audio output passes through the pre-amplifier to two amplifiers, see Fig. 1. The output from amplifier 2 is fed to a simple rectifier circuit, D1 and C1, and passed via R1 to a Schmitt trigger circuit, TR1, TR2. The Schmitt trigger is connected to the power supply and controls operation of the tape replay motor.

The switch S1 is mounted as part of a telephone handset and closes when the earpiece is lifted off its rest. The switch is open while the earpiece is on its rest. Amplifier 1 is coupled to the headset earpiece through transformer T1.

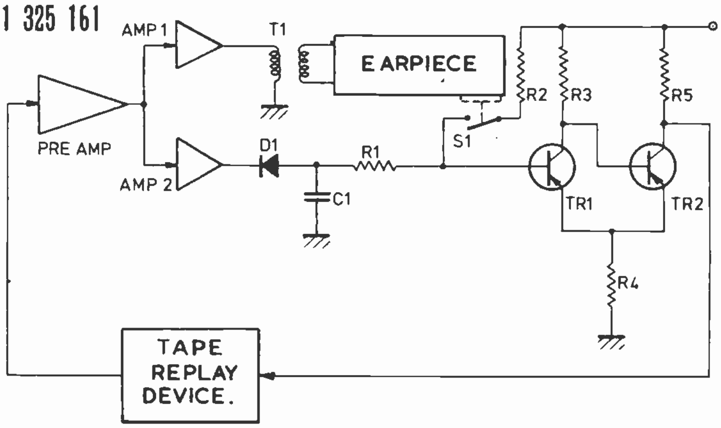
When a would-be listener picks up the earpiece S1 closes and the Schmitt trigger changes state to start the tape transport motor. The audio frequencies from the tape are reproduced through the earpiece and used, after rectification, to hold the Schmitt in its active state. This holding action will continue even when the earpiece is returned to its rest.

However, when the audio signals cease, the voltage across C1 dies away and the Schmitt trigger reverts to its former state and the tape motor stops. Thus the loop stops at its start position. The decay time constant of the voltage across C1 must, of course, be long enough to tide over natural pauses in the commentary.

If the listener wishes to hear the commentary through again, then he keeps the earpiece off its rest; the switch S1 holds the trigger circuit active and the loop is replayed.

The patent specification also details a twin channel system which can be used to control visual displays.

BP 1 325 161



SCORING FOR BOXING AND OTHER SPORTS BP 1 325 644

Although BP 1 325 644 from E. J. Sweeny of Ohio, USA, is intended primarily for the scoring of boxing matches by judges, its technology will find wider uses.

The specific intention is to enable three judges to score independently with the sum of their points displayed on a common board.

A master console and three identical scoring booths are spaced round a boxing ring with a visual score board mounted above. A single point will be recorded on the score board only after the master console has received a multiple number of point pulses from the individual scoring booths, e.g. three point pulses must be accumulated from one or more booths before a single point is recorded on the board.

The controls within the booths are duplicated for the two fighters.

VEHICLE GUIDANCE BP 1 320 314

Interest appears to be growing in the technology of automatic vehicle guidance. In BP 1 320 314 Autotrack Systems Ltd., and P.C.D. Ltd., jointly describe the automatic remote control of a tractor ploughing a field. The principle of the invention, however, is much more widely applicable, e.g. garden lawn mowing to model car control.

Guide wires are buried half a metre deep and six metres apart along the routes which the vehicle should take. These guides carry a continuous tone current of 2kHz and the a.c. field that this produces is detected by a detector head on the vehicle.

The detector head has a vertical pick-up coil and a horizontal pick-up coil. With the head exactly above the guide wire there is no phase difference between the outputs of the two coils, but if the head is moved to one side a phase difference appears in the appropriate sense and of magnitude proportional to the distance moved.

The two coils in the patented circuit control solenoids for left and right turn and operate pneumatic, hydraulic or electrical steering gear on board the tractor.

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

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HANDBOOK 10p

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UA041 5W Amplifier Module. £3·75

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CATALOGUE AND LISTS
Send S.A.E. and 10p.

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BA4	5¼"	×	4"	×	1½"	47p
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De Luxe Groov-Kleen
Model 42 £1·84
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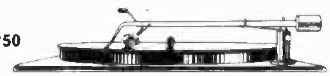

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Ref. 31. Cassette Head Cleaner 54p
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22SWG Tube 22p

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1100 For model CCN240 ³⁄₃₂"
1101 For model CCN240 ⅛"
1102 For model CCN240 ¼"
1020 For model G240 ³⁄₃₂"
1021 For model G240 ⅛"
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ALL 38p each

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Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0·55
C2	200	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 0·1%, 0·01% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	7	Pack Wire 50 metres assorted colours	0·55
C8	10	Reed Switches	0·55
C9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	4	Mains Slide Switches	0·55
C16	20	Assorted Tag Strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	Sheets Copper Laminate approx. 10" × 7"	0·55

PLUGS AND SOCKETS
SOCKETS

PS 35 DIN	2 Pin (Speaker)		0·06
PS 36 DIN	3 Pin		0·10
PS 37 DIN	5 Pin 180°		0·10
PS 38 DIN	5 Pin 240°		0·10
PS 39	Jack 2·5mm Switched		0·09
PS 40	Jack 3·5mm Switched		0·10
PS 41	Jack ¼" Switched		0·17
PS 42	Jack Stereo Switched		0·26
PS 43	Phono Single		0·06
PS 44	Phono Double		0·10
PS 45	Car Aerial		0·09
PS 46	Co-Axial Surface		0·09
PS 47	Co-Axial Flush		0·14

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·13
PS 22	D.I.N. 3 Pin	0·17
PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼" Plastic	0·24
PS 28	Jack ¼" Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	D.I.N. 7 Pin	0·15
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼" Plastic	0·13
PS 12	Jack ¼" Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·06
PS 15	Car Aerial	0·15
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CABLES

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CP 2	Twin Common Screen	0·08
CP 3	Stereo Screened	0·08
CP 4	Four Core Common Screen	0·23
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CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·07
CP 8	Twin Oval Mains Cable	0·06
CP 9	Speaker Cable	0·04
CP 10	Low Loss Co-Axial	0·10

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

VC 1	Single Less Switch	0·14
VC 2	Single D.P. Switch	0·26
VC 3	Tandem Less Switch	0·44
VC 4	1K Lin Less Switch	0·14
VC 5	100K Log anti-Log	0·44

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

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2 Transistor Equivalent Books
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BP4	International Handbook of the World's Short Wave, Medium and Long Wave Radio Stations and FM/TV Listings	35p
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ACOS GP93-1. 280mV at 1cm/sec	£1·65
ACOS GP96-1. 100mV at 1cm/sec	£2·65
TTC J-2005. Crystal/Hi Output	95p
TTC J-20 10C Crystal/Hi Output Compatible	£1·10
TTC J-200 CS Stereo/Hi Output	£1·60
TTC J-2105 Ceramic/Med. Output	£1·64

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

R1	50 Mixed 100 ohms-820 ohms	40p
R2	50 Mixed 1K ohms-8·2K ohms	40p
R3	50 Mixed 10K ohms-82K ohms	40p
R4	50 Mixed 100K ohms-1 Meg. ohms	40p

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

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C60, 32p; C90, 41p; C120, 52p

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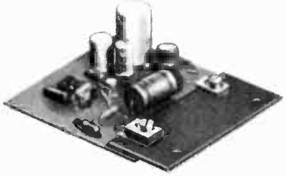
-the lowest prices!

BI-PAK *QUALITY* COMES TO AUDIO!

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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

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

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

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

AUDIO AMPLIFIER MODULES

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

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS PA 12 with Knobs £1·00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL50) £13·15

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

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

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

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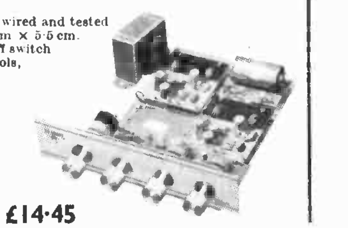
ALL PRICES INCLUDE VAT

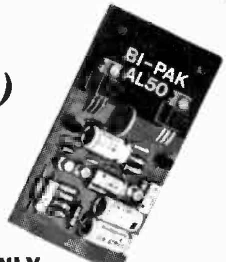
The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.



£14·45

50W pk 25w (RMS)



0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

THE AL50

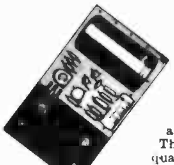
★ Frequency Response 15Hz to 100,000—1dB.
★ Load—3, 4, 8 or 16 ohms.
★ Distortion—better than ·1% at 1KHz.
★ Signal to noise ratio 80dB.

ONLY £3·58 each

★ Supply voltage 10-35 Volts.
★ Overall size 63mm 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

STABILISED POWER MODULE SPM80

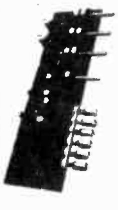


AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.



SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than −65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £13·15

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25·30 FREE p. & p.

Giro No. 388-7006

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NOW! A FAST *EASY* WAY TO LEARN BASIC RADIO & ELECTRONICS

Build as you learn with the exciting new TECHNATRON Outfit! No mathematics. No soldering—you learn the *practical* way.

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. . . and what's more, you will **understand exactly what you are doing.** The TECHNATRON Outfit contains everything you need, from tools to transistors—even a versatile Multimeter which we teach you to use. All you need give is a little of your spare time and the surprisingly low fee, payable monthly if you wish. And the equipment remains yours, so you can use it again and again.

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Among many other interesting experiments, the Radio set you build—and it's a good one—is really a bonus. This is first and last a teaching course, but the training is as fascinating as any hobby and it could be the spring-board for a career in Radio and Electronics.

A 14-year-old could understand and benefit from this course—but it teaches the real thing. The easy to understand, practical projects—from a burglar-alarm to a sophisticated Radio set—help you master basic Radio and Electronics—even if you are a "non-technical" type. And, if you want to make it a career, B.I.E.T. has a fine range of courses up to City and Guilds standards.

Specialist Booklet

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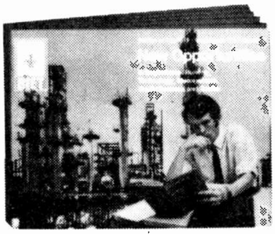

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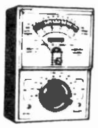
Top value 10,000 opv pocket multimeter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance 0/150k ohms. Decibels –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
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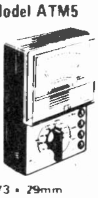
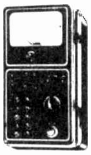
AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv), 0-6/30/300/600V DC, (5000 opv), 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 • 29mm
OUR PRICE £3.50 P&P 15p

MODEL TE200

20,000opv. Mirror scale, overload protection. 0/5/25/125/1000V DC. 0/10/50/250/1000V AC. 0/50uA/250mA. 0/60k/6 Meg ohms. –20 to +62dB.
OUR PRICE £4.95 P&P 15p

MODEL U437 MULTIMETER

10,000opv. A first class, instrument manufactured in USSR to the highest standards. Ranges 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistence 300 ohms/3/30/300k/3 Meg. ohms. Complete with batteries test leads, instructions and a sturdy steel carrying case.
OUR PRICE £4.95 P&P 25p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.
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HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.
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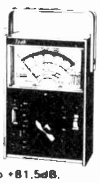
TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.
OUR PRICE £8.50 P&P 17p

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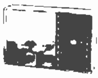
U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.00 P&P 20p

MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. –20 to +63dB.
OUR PRICE £7.50 P&P 15p

U4324 MULTIMETER

High sensitivity, overload protected. 20,000opv. Ranges. 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £8.00 P&P 20p

U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 20p

U4312 MULTIMETER

extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £9.75 P&P 25p

U91 Clamp VOLT AMMETER

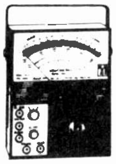
For measuring AC voltage and current without breaking circuit. Ranges 300/600V AC. Current 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £10.50 P&P 20p

MODEL C7080EN

Giant 6" mirror scale. 20,000 opv. 0/0.25/1/2.5/10/50/250/1000/5000V DC. 0/2.5/10/50/250/1000/5000V AC. 0/50uA/1/10/100/500mA/10A DC. 0/2k/200k/20 Meg. –20 to +50dB.
OUR PRICE £13.95 P&P 35p

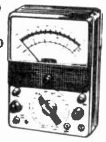
MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £10.95 Carr. paid
Leather case for above £1.75

KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
OUR PRICE £13.95 P&P 25p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC 2k/200k/2M/20MOhms –20 to +63dB.
OUR PRICE £14.95 P&P 20p

KAMODEN HM720B FET VOM

Input impedance 10 Megohms. Ranges. 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £14.95 P&P 30p

TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4¼" mirror scale. Size 149 x 117 x 60mm. 0.3–12000V DC. 3–300V RMS AC 8–800V P-P. DC current 0.12–12mA. Resistence up to 2000MOhms. Decibels –20 to +51dB. Supplied complete with leads and instructions.
OUR PRICE £17.50 P&P 20p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected Mirror scale. Ranges:–0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms
OUR PRICE £16.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.
OUR PRICE £17.50 P&P 25p

U4317 MULTIMETER

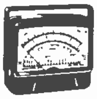
High sensitivity instrument for field and laboratory work Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £15.00 P&P 20p

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps–1.2MHz. –40 to +50dB supplied complete with leads and instructions.
OUR PRICE £17.50 P&P 25p

TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5–1500V. AC volts 1.5–1500V. Resistance up to 1000 Megohms, 200/240V AC operation. Complete with probe and instructions.
OUR PRICE £17.50 P&P 30p
Additional probes available RF £2.12. HV £2.50

TMK LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 25p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

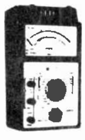
Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
OUR PRICE £49.00 P&P 50p

LB3 TRANSISTOR TESTER

Tests ICO and B. PNP/NPN. Operates from 9V battery. Complete with all instructions etc.
OUR PRICE £3.95 P&P 20p

LB4 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £10.50 P&P 20p

KAMODEN HM350 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
OUR PRICE £12.50 P&P 30p

S100TR MULTIMETER–TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA612A DC. 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £14.95 P&P 25p

Model 449A In Circuit TRANSISTOR TESTER

Checks true AC, Beta in/out. Checks ICO. Checks diodes in/out. Checks SCR etc. Beta HI 10–500 LO 2–50. ICO 0–500uA. 220/240V AC operation.
OUR PRICE £17.50 P&P 25p

KAMODEN HMG500 insulation resistance tester

Range 0–1,000 Megohms, 500V. Battery operated Wide range clear meter 4" x 4¾". Complete with deluxe carrying case, batteries and instructions
OUR PRICE £19.95 P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.
OUR PRICE £17.50 P&P 37p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine-wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £29.95 P&P 50p

LASKYS

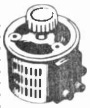
INCORPORATING LASKYS RADIO AND G. W. SMITH & CO. (RADIO).

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

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

MODEL S260 GENERAL PURPOSE BENCH MOUNTING

		P&P
1A	£8.75	30p
2.5A	£10.00	35p
5A	£14.70	37p
8A	£25.50	50p
10A	£28.10	75p
12A	£29.50	100p
20A	£72.50	125p
25A	£72.50	130p
40A	£103.10	150p



MODEL S260B Panel Mounting

1A	£8.75	30p
2.5A	£10.00	35p

AT201 Decade ATTENUATOR

Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.

OUR PRICE £12.50 P&P 37p

BELCO Sine Square Wave CR OSCILLATOR

Sine 18 x 200,000Hz Square 18 x 20,000 Hz. Maximum output +10dB (10k ohms) Operates from internal batteries. Attractive two tone case. Size: 196 x 127 x 50mm.

OUR PRICE £17.50 P&P 17p

CI5 PULSE OSCILLOSCOPE

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

OUR PRICE £39.00 Carr. paid

TO3 Portable OSCILLOSCOPE

3" tube. Y amp sensitivity 0.1Vp-p/CM. Bandwidth: 1.5Hz–1.5MHz. Input Impedence: 2 MOhms, 25pF. X amp. sensitivity: 0.9Vp-p/CM. Bandwidth 1.5Hz–800kHz. Input Impedence 2 Meg Ohms, 20pF. Time base, five ranges 10Hz to 300kHz. Synchronisation. Internal or external. Illuminated scale 140 x 215 x 330mm. Weight 15½lbs. 220/240V AC. Supplied brand new with handbook.

OUR PRICE £52.50 P&P 50p

RUSSIAN CI16 Double Beam OSCILLOSCOPE

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

OUR PRICE £87.00 Carr. paid

MCA220 Automatic Voltage Stabiliser

Input 88–125V AC or 176–250 V AC. Output 120V AC or 240V AC. 200V A rating.

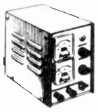
OUR PRICE £11.97 P&P 50p

PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.

OUR PRICE £11.97 P&P 25p

PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P25p

SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

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

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

CLEAR PLASTIC MODEL SD640

Size: 85 x 64mm

50uA	£3.35	20V DC	£3.20
100uA	£3.30	50V DC	£3.20
200uA	£3.30	300V DC	£3.20
500uA	£3.25	15V AC	£3.30
50-0-50uA	£3.35	300V AC	£3.30
100-0-100uA	£3.30	VU Meter	£3.45
1mA	£3.20		
5mA	£3.20		
10mA	£3.20		
50mA	£3.20		
100mA	£3.20		
500mA	£3.20		
1A DC	£3.20		
5A DC	£3.20		
10A DC	£3.20		
5V DC	£3.20		

CLEAR PLASTIC MODEL SW100

Size: 100 x 80mm

50uA	£4.55	300V AC	£4.00
100uA	£4.35	VU Meter	£4.75
500uA	£4.10		
50-0-50uA	£4.35		
100-0-100uA	£4.30		
1mA	£3.95		
1A DC	£3.95		
5A DC	£3.95		
20V DC	£3.95		
50V DC	£3.95		
300V DC	£3.95		

EDGWISE MODEL PE70

Size: 90 x 34mm

50uA	£4.15
100uA	£3.95
200uA	£3.75
500uA	£3.50
50-0-50uA	£3.95
100-0-100uA	£3.85
1mA	£3.50
300V AC	£3.50
VU Meter	£4.25

MODEL ED107 EDUCATIONAL METER

Size: 100 x 90 x 150mm including terminals

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

50uA	£7.60	300V DC	£6.55
100uA	£7.05	500mA/5A DC	£7.70
50-0-50uA	£7.05	5V/50V DC	£7.70
1A DC	£6.55	5V/15V DC	£7.70
5A DC	£6.55	1A/15A DC	£7.70
5V DC	£6.55		
10V DC	£6.55		
15V DC	£6.55		
20V DC	£6.55		
50V DC	£6.55		

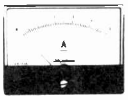
CLEAR PLASTIC MODEL 85P

Size: 120 x 110mm

50uA	£4.85	300V DC	£4.30
100uA	£4.70	15V AC	£4.35
200uA	£4.45	300V AC	£4.35
500uA	£4.30	S Meter 1mA	£4.30
50-0-50uA	£4.70	VU Meter	£5.00
100-0-100uA	£4.45	1A AC	* £4.30
500-0-500uA	£4.30	5A AC	* £4.30
1mA	£4.30	10A AC	* £4.30
1-0-1mA	£4.30	20A AC	* £4.30
5mA	£4.30	30A AC	* £4.30
10mA	£4.30		
50mA	£4.30		
100mA	£4.30		
500mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
15A DC	£4.30		
30A DC	£4.35		
10V DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
150V DC	£4.30		

CLEAR PLASTIC MODEL SD830

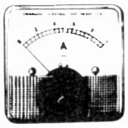
Size: 110 x 83mm



50uA	£3.75	10V DC	£3.40
100uA	£3.70	20V DC	£3.40
200uA	£3.65	50V DC	£3.40
500uA	£3.45	300V DC	£3.40
50-0-50uA	£3.75	15V AC	£3.65
100-0-100uA	£3.70	300V AC	£3.65
1mA	£3.40	VU Meter	£3.85
5mA	£3.40		
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10A DC	£3.40		
5V DC	£3.40		

CLEAR PLASTIC MODEL 45P

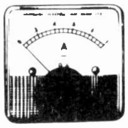
Size: 50 x 50mm



50uA	£3.00	300V AC	£2.70
100uA	£2.85	S Meter 1mA	£2.75
200uA	£2.75	VU Meter	£3.00
500uA	£2.70	1A AC	* £2.65
50-0-50uA	£2.90	5A AC	* £2.65
100-0-100uA	£2.75	10A AC	* £2.65
500-0-500uA	£2.65	20A AC	* £2.65
1mA	£2.65	30A AC	* £2.65
5mA	£2.65		
10mA	£2.65		
50mA	£2.65		
100mA	£2.65		
500mA	£2.65		
1A DC	£2.65		
5A DC	£2.65		
10V DC	£2.65		
20V DC	£2.65		
50V DC	£2.65		
300V DC	£2.65		
15V AC	£2.70		

CLEAR PLASTIC MODEL 38P

Size: 42 x 42mm



50uA	£2.80	15V DC	£2.50
100uA	£2.70	20V DC	£2.50
200uA	£2.65	50V DC	£2.50
500uA	£2.50	100V DC	£2.50
50-0-50uA	£2.75	150V DC	£2.50
100-0-100uA	£2.65	300V DC	£2.50
500-0-500uA	£2.50	500V DC	£2.50
1mA	£2.50	750V DC	£2.50
1-0-1mA	£2.50	15V AC	£2.55
2mA	£2.50	50V AC	£2.55
5mA	£2.50	150V AC	£2.55
10mA	£2.50	300V AC	£2.55
20mA	£2.50	500V AC	£2.55
50mA	£2.50	S Meter 1mA	£2.55
100mA	£2.50	VU Meter	£2.90
150mA	£2.50		
200mA	£2.50		
300mA	£2.50		
500mA	£2.50		
750mA	£2.50		
1A DC	£2.50		
2A DC	£2.50		
5A DC	£2.50		
10A DC	£2.50		
15A DC	£2.50		
20A DC	£2.50		
3V DC	£2.50		
10V DC	£2.50		

CLEAR PLASTIC MODEL SD460

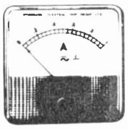
Size: 59 x 46mm

50uA	£3.10	10V DC	£2.85
100uA	£3.05	50V DC	£2.85
200uA	£3.00	300V DC	£2.85
500uA	£2.80	15V AC	£3.00
50-0-50uA	£3.10	300V AC	£3.00
100-0-100uA	£3.05	VU Meter	£3.20
1mA	£2.85		
5mA	£2.85		
10mA	£2.85		
50mA	£2.85		
100mA	£2.85		
500mA	£2.85		
1A DC	£2.85		
5A DC	£2.85		
10A DC	£2.85		
5V DC	£2.85		

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL 65P

Size: 86 x 78mm



50uA	£4.10	50V AC	£3.10
100uA	£3.45	150V AC	£3.10
200uA	£3.35	300V AC	£3.10
500uA	£3.05	500V AC	£3.10
50-0-50uA	£3.45	S Meter 1mA	£3.15
100-0-100uA	£3.40	VU Meter	£4.10
500-0-500uA	£2.85	1A AC	* £2.85
1mA	£2.85	5A AC	* £2.85
5mA	£2.85	10A AC	* £2.85
10mA	£2.85	20A AC	* £2.85
50mA	£2.85	30A AC	* £2.85
100mA	£2.85	50mA AC	* £2.85
500mA	£2.85	100mA AC	* £2.85
1A DC	£2.85	200mA AC	* £2.85
5A DC	£2.85	500mA AC	* £2.85
10A DC	£2.85		
15A DC	£2.85		
20A DC	£2.85		
30A DC	£3.10		
50A DC	£3.20		
5V DC	£2.85		
10V DC	£2.85		
20V DC	£2.85		
50V DC	£2.85		
150V DC	£2.85		
300V DC	£2.85		
15V AC	£3.10		

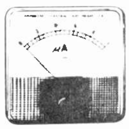
BAKELITE MODEL S80 Enlarged Window

Size: 80 x 80mm

50uA	£3.85
100uA	£3.75
500uA	£3.35
50-0-50uA	£3.75
100-0-100uA	£3.65
1mA	£3.00
1A DC	£3.30
5A DC	£3.30
20V DC	£3.30
50V DC	£3.30
300V DC	£3.30
300V AC	£3.30
VU Meter	£4.05

CLEAR PLASTIC MODEL 52P

Size: 60 x 60mm



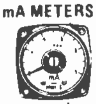
50uA	£3.85	S Meter 1mA	£2.85
100uA	£3.30	VU Meter	£3.95
500uA	£2.90	1A AC	* £2.75
50-0-50uA	£3.35	5A AC	* £2.75
100-0-100uA	£3.25	10A AC	* £2.75
1mA	£2.75	20A AC	* £2.75
5mA	£2.75	30A AC	* £2.75
10mA	£2.75		
50mA	£2.75		
100mA	£2.75		
500mA	£2.75		
1A DC	£2.75		
5A DC	£2.75		
10V DC	£2.75		
20V DC	£2.75		
50V DC	£2.75		
300V DC	£2.75		
15V AC	£2.85		
300V AC	£2.85		

BAKELITE MODEL 65 Size: 80 x 80mm

25uA	£5.05	30V AC	* £2.85
50uA	£3.90	50V AC	* £2.85
100uA	£3.30	150V AC	* £2.85
500uA	£3.00	300V AC	* £2.85
50-0-50uA	£3.35	500V AC	* £2.85
100-0-100uA	£3.30	VU Meter	£4.00
500-0-500uA	£2.85	1A AC	* £2.85
1mA	£2.85	5A AC	* £2.85
1-0-1mA	£2.85	10A AC	* £2.85
5mA	£2.85	20A AC	* £2.85
10mA	£2.85	30A AC	* £2.85
50mA	£2.85	50A AC	* £2.85
100mA	£2.85	500mA AC	£2.85
500mA	£2.85	50mV DC	£3.20
1A DC	£2.85	100mV DC	£3.20
2A DC	£2.85		
5A DC	£2.85		
15A DC	£2.85		
30A DC	£2.85		
50A DC	£2.85		
5V DC	£2.85		
10V DC	£2.85		
20V DC	£2.85		
50V DC	£2.85		
150V DC	£2.85		
300V DC	£2.85		

240° Wide Angle 1mA METERS

MW 1–6 60x60mm
£3.97 P&P 15p
MW 1–8 80x80mm
£4.97 P&P 15p



AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

80 WATT	£2.75	P&P 18p	1000 WATT	£9.50	P&P 38p
150 WATT	£3.50	P&P 18p	1500 WATT	£12.50	P&P 43p
300 WATT	£4.50	P&P 23p	2250 WATT	£20.95	P&P 50p
500 WATT	£6.95	P&P 33p	5000 WATT	£44.95	P&P £1

ALL PRICES EXCLUDE VAT

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10 wave-bands covering AM: 535–1605kHz. LW: 150–380 kHz. MB 1.6–4MHz. SW1: 4–8MHz. SW2: 8–1.6 MHz. SW3: 16–24MHz. PSB1: 30–50 MHz. PSB2: 148–174MHz. FM 88–108MHz. Air: 108–136MHz. Feature time zone map and timing dial. Large clear scale. Telescopic aerial and built in aerial. AFC on FM. 6"x4" speaker and personal earpiece. Battery/mains operation. Size: 345 x 133 x 305mm.
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Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size: 460 x 203 x 79mm AC 220/240V

PROCESS 4
For use with semi-professional tape recorders. Frequency response 30Hz –20kHz ± 2dB. S/N better than 70dB. Full source/tape monitoring. Switchable multiplex filter. Supplied with test tape.
OUR PRICE £50.00 P&P 50p

PROCESS 2
For use with cassette and tape recorders. Frequency response 30Hz–20kHz Switchable multiplex filter. 2 Dolby calibration meters. Off tape monitoring. S/N better than 70dB. Supplied complete with test tape or cassette.
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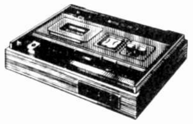
Instant recording and playing. Piano key controls. Automatic level control. Built-in speaker. Complete with remote control microphone, carrying case and shoulder strap.
OUR PRICE £8.50 P&P 50p

AUDIOTRONIC ACD660
Stereo Cassette Deck



A beautifully styled four track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter, normal/chrome tape selector, twin VU meter slider record/playback level controls, front panel headphone socket, recording indicator lamp, phono/Din line input sockets, 3.5mm microphone input sockets etc. etc. Frequency response: 40–12kHz (40–16kHz CrO2). S/N: –45dB. Crosstalk 45dB. Separation: –35dB. Noise limiter –6dB at 10kHz. Complete with connecting leads.
OUR PRICE £39.50 P&P 50p

AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1.37	£2.61	£6.16
C90	£1.95	£3.70	£8.71
C120	£2.38	£4.50	£10.65

AUDIOTRONIC CrO2 CASSETTES

TYPE	5	10	25
CR60	£3.41	£6.72	£16.63
CR90	£4.63	£9.19	£22.80

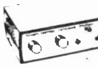
AUDIOTRONIC 8 TRACK CARTRIDGES

TYPE	Each	5	10
40M	75p	£3.50	£6.50
80M	99p	£4.70	£8.90

P&P Cassettes 3p. Cartridges 5p each OVER 10 of either POST FREE!

SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair
NB. Licence required for use in UK

1021 Stereo Listening Station



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on off slide switch, stereo headphone socket.
OUR PRICE £2.25 P&P 15p

AUDIOTRONIC STEREO HEADPHONES

LSH20 Individual volume controls. Stereo/mono switch. 8 ohms. 40–19,000Hz.
OUR PRICE £3.75 P&P 30p

LSH30 Open back type. Individual tone and volume controls. 8 ohms. 30–20,000Hz
OUR PRICE £5.95 P&P 30p

LSH40 Two way speaker system Individual volume controls. 8 ohms. 20–20,000Hz
OUR PRICE £7.50 P&P 30p

LSH60 3" speaker units. 8 ohms. Complete with zipped carrying case. 20–20,000Hz.
OUR PRICE £8.95 P&P 30p

LSH50 Electrostatic with self powered energiser, and control unit, with headphone speaker selector. 4–32 ohms 20–24,000Hz.
OUR PRICE £16.95 P&P 30p

LQH400 4 channel dynamic headphones. Each earpeice has four drive units. 4–32 ohms 20–20,000Hz
OUR PRICE £9.95 P&P 30p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc and output to your amplifier. Volume control and depth of reverberation control. Beau-walnut cabinet. 184 x 77 x 108mm.
OUR PRICE £7.50 P&P 20p

SPECIAL BARGAIN! FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems. 25 Watts. 4–8 ohms. 40Hz–18kHz. Size 560 x 340 x 255mm. approx. Wood grain finish with black fronts.
OUR PRICE £29.95 PR. P&P £1

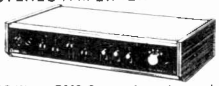
RECORD DECKS P&P 50p

BSR McDONALD	
C114 Mini	£3.95
C129 Mono	£5.50
C137	£7.00
510/TPD	£12.55
610	£11.30
610/TPD	£15.35
710	£23.10
810	£28.25
MP60	£8.85
MP60/ADC K8	£10.90
MP60/TPD	£14.15
HT70	£11.60
HT70/ADC K7E	£14.25
HT70/TPD	£16.55
CONNOISSEUR	
BD1 Kit	£10.20
BD1 Chassis	£12.50
BD2/SAU2/Chassis	£25.50
BD2/SAU2/Plinth/Cover	£32.25
GARRARD	
1025T Stereo	£4.95
2025TC Less Cartridge	£6.35
2025TC/KS40A	£6.95
SP25 Mk3	£9.25
SP25 Mk3/G800	£10.95
SP25 Mk4	£10.90
SP25 Mk4/M75-6	£13.90
86SB	£20.00
SL65B	£11.15
SL72B	£17.75
SL95B	£28.00
401	£28.60
ZERO 100	£34.10
ZERO 100S	£31.40
ZERO 100SB	£29.20
GOLDRING	
G101 Mk2/P/C	£22.50
GL72	£25.45
GL72P	£33.75
GL75	£32.20
GL75P	£41.65
GL78	£34.60
GL78/P/C	£56.25
GL85/P/C	£72.00

RECORD DECK PACKAGES

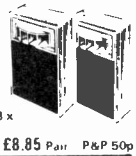
BSR McDONALD	**P&P 75p**
210/SC7M	£7.90
C129	£9.50
MP60/G800	£17.85
MP60/TPD/ADC K8	£16.97
MP60/M44-7	£17.50
HT70/TPD/ADC K7E	£19.20
610/TPD/ADC K8	£19.42
GARRARD	
2025TC/9TA-HC/D	£11.35
SP25 Mk3/G800	£18.15
SP25 Mk3/M44E	£18.25
SP25 Mk3/M44-7	£17.80
SP25 Mk3/M55E	£18.80
SP25 Mk3 Module/M75-6	£19.45
SP25 Mk4/G800	£19.95
SP25 Mk4/AMC 50E (M55E)	£21.30
AP76/G800	£26.75
AP76/G800E	£28.95
AP76/M44-7	£27.50
AP76/M44E	£28.00
AP76/M55E	£28.60
AP76/M75ED	£35.20
AP76/M75EJ	£31.20
GOLDRING	
GL72/G800	£35.65
GL75/G800	£40.90
GL75/G800E	£43.35
GL78/G800	£45.65
GL78/G800E	£48.15
G101/P/C/G800	£23.70
PHILIPS	
GA105/GP200	£12.40
GA205	£17.40
GA207	£20.90
RANK DOMUS	
BD2000	£43.60
BA4000	£53.95
BD6000	£67.50
WHARFEDALE	
Linton W30 Teak	£23.90
Linton W30 White	£25.10

LINEAR 202 STEREO AMPLIFIER



20 Watts RMS Stereo Amplifier with controls for volume, balance, bass and treble, Mono/Stereo switch, loudness and scratch filters. Uses 20 Silicon transistors. Inputs for magnetic and crystal cartridge, Aux. and tape.
OUR PRICE £22.50 P&P 50p

SPECIAL BARGAIN!! PHONIC 10 Two Way Speakers

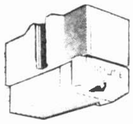


Matched pair of compact book-shelf speakers of unique design Incorporating a 2" high frequency unit & 6" woofer. 8 ohms impedence. Size: 348 x 228 x 110mm.
OUR PRICE £8.85 Pair P&P 50p

LEAK TRUSPEED Mk3 RECORD DECK PACKAGE

Incorporating low speed synchronous hysteresis motor giving constant turntable speed. 33 and 45 rpm Cast Alluminium turntable. Fitted Goldring L75 arm and G800 cartridge, complete in plinth with perspex cover. Size 321 x 400 x 191mm inc. cover. AC100-130 and 200-250V.
OUR PRICE £35.95 P&P 75p

AUDIOTRONIC AMC50E STEREO Magnetic CARTRIDGE



Made by SHURE the AMC50E offers professional performance at a budget price Frequency response 20Hz–20kHz Output voltage 6.6mV. Compliance 5 x 10–6 cm/dyne. Tracking force ¾ to 2 grammes. Stylus. Eliptical diamond .0007" x .0002".
OUR PRICE £4.50 P&P 12p

AD-76K STEREO MAGNETIC CARTRIDGE

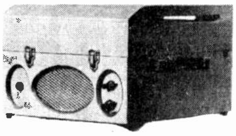
Frequency response 20Hz–20kHz. Output: 5mV (1kHz 5 cm/sec). 0.7 mil conical diamond stylus. Channel separation 20dB. Tracking weight 1½–2½ gms. Original price £3.50
OUR PRICE £1.95 P&P 12p

TELETON F2100 STEREO RECEIVER SYSTEM

6 watts per channel AM/FM Stereo tuner amplifier, Garrard 2025TC record deck with plinth, cover and stereo cartridge, and a pair of Keletron LS50 speakers. SUPER VALUE!
OUR PRICE £48.50 Carr. & Ins. £1.25

ALL PRICES EXCLUDE VAT

CASED AMPLIFIERS



Polished wooden cabinet 14 × 13 × 9in containing a sensitive (20μV) 4 valve amplifier with tone and volume controls. 3W output to 7 × 4in 3Ω speaker. Also included is a non-standard tape deck with solenoid operation. Supplied in good working condition complete with circuit diagram. Standard mains operation. Only **£3** (£1 up to 200 miles, £1·25 over). Suitable cassette **£1**. Spare head **30p**; Amplifier chassis only, complete and tested **£1·65** (40p). 7" × 4" speaker **40p** (12p).

7lb BARGAIN PARCELS

Hundreds of new components—resistors, capacitors, crystals, pots, switches, computer panels with transistors and loads of odds and ends. Still only **£1·65** (40p).

COMPUTER PANELS

3lb assorted panels **£1** (30p); 7lb **£2** (40p); 56lb **£13** (c/pd). 12 top quality panels containing power transistors, IC's, trimpots, etc. **£2** (30p); 100 boards **£12** (£1). Pack containing at least 500 components including at least 50 transistors **60p** (20p).

NEW COMPONENTS

SCR's: 200V 5A **40p**; 400V 5A **60p**; BYZ10 1200V 6A **40p**; OC16 **20p**; OC45 **8p**; OC71 **8p**; OC140 **25p**; OC170 **15p**; OC171 **15p**; BFY18 **12p**; BCY72 **8p**; 2N3055 **35p**; XC121 **5p**; BC107 **8p**; 2N3708 **8p**; 741C TO99 or 8 pin DIL **32p**; 100V 8A diodes **20p**; 3·9V or 27V 400mW zeners **7p**; 22V 1W **10p**.

BULK COMPONENTS

500 assorted resistors **£1** (20p); 300 capacitors, all types **£1** (30p); 25 assorted 10X crystals **75p** (30p); 40 assorted pots **£1** (30p).

EX-COMPUTER EQUIPMENT

1200ft ¼in tape on 7in NAB spool **68p** (30p); 1800ft ¼in tape on 10½in NAB spool in case **68p** (40p); Screw top electrolytic capacitors: 20,000μF 50V **60p** (25p), 46,500μF 25V **60p** (25p); 35,000μF 15V **40p** (20p); 40,000μF 10V **40p** (20p); 20,000μF 30V **40p** (20p); 25,000μF 25V **40p** (20p).
Fans: 230V 50Hz 6½in dia. blades 2,800 r.p.m. complete with grill and mounting plate **£2·50** (40p). Heavy duty heat sinks 6 × 5 × 3in with 2 power transistors **80p** (30p).

POWER SUPPLY UNIT

Mains transformer, 2A thermal cut-out, bridge rect. gives 1·7–10·5V with 2 extra caps. Data sheet supplied **75p** (20p).

ODD UNITS

Useful module containing OC35, 2 × OC44, GET103, R's, C's, etc. **40p** (10p). Cat's whisker and crystal **15p**; Unit with 2 modern c/o lever switches, 3 trimpots, etc. **60p** (10p).

ADD 10% TO TOTAL FOR VAT
Carr. in brackets; small parts 5p

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24 Goodhart Way, West Wickham, Kent. SHOPS AT: 21 Deptford Broadway SE8. (Tel. 01-692 2009) and 38 Lower Addiscombe Road, Croydon.

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Designed for use when working or re-working P.C. Boards. Permits removal of molten solder from Multi-leg components, enabling easy extraction. The solder is 'sipped' through the nozzle, and automatically ejected when the instrument is next used.
A Swiss precision instrument manufactured to a high degree of accuracy.
The anti-corrosive outside casing has a knurled finish for more positive grip, and encases plated internal parts.
The Maxi-Super has been designed with a 3.5 kg. spring action recoilless plunger, whilst the Maxi-Mini with its conveniently shaped operating button, has a 2.5 kg. spring action plunger, protected by a channel guard.
Both models have been designed with an easy-to-replace 'dupont' teflon screw-in nozzle.

PLEASE FORWARD without obligation further details. ☐	PLEASE SUPPLY Maxi-Super HT 1810 at £6.60 ☐	PLEASE SUPPLY Maxi-Mini HT 1800 at £4.95 ☐

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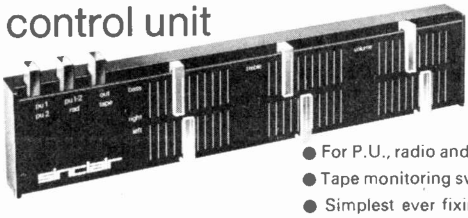
new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



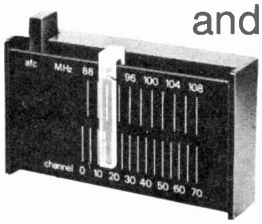
- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm ($10\frac{3}{4} \times 2 \times \frac{3}{4}$ins)
Finish – Black with white indicators and transparent Sliders
Inputs – Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV
Radio 300mV; Tape 30mV
Signal/noise ratio – 60dB
Frequency range – 20Hz to 15KHz ± 1dB. 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape radio and P.U. Sliders for volume, bass (+ 12dB to – 14dB at 100Hz) treble (+ 11dB to – 12dB at 10KHz)

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER
Size – 85 × 50 × 20mm ($3\frac{1}{2} \times 2 \times \frac{3}{4}$ins)
Tuning range – 87·5 to 108 MHz
Detector – I.C balanced coincidence for good A.M. rejection
One I.C. equal to 26 transistors
Distortion – 0·2% at 1KHz for 30% modulation
4 pole ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Output – 300 mV for 30% modulation
Power requirements – 23 to 33 volts

R.R.P. £11.95 +£1·19 V.A.T.

DECODER
Size – 47 × 50 × 20mm ($1\frac{7}{8} \times 2 \times \frac{3}{4}$ins)
One 19 transistor I.C.

R.R.P. £7.45 +0·74 V.A.T.

Guarantee

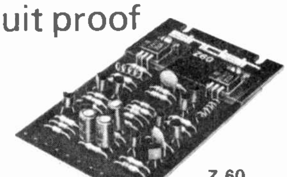
If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge. For damage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

sinclair

Sinclair Radionics Ltd. London Road, St. Ives, Huntingdon PE17 4HJ
Telephone St. Ives (0480) 64646

Z.40 & Z.60 power amplifiers
totally short-circuit proof

Z.40



Z.60

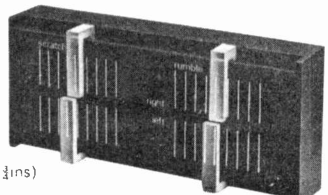
Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS
Size – 55 × 80 × 20mm ($2\frac{1}{4} \times 3\frac{1}{4} \times \frac{3}{4}$ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
Signal/noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0·1%
Power requirements – 12 to 35 volts

Z.60 TECHNICAL SPECIFICATIONS
Size – 55 × 98 × 15mm ($2\frac{1}{4} \times 3\frac{3}{4} \times \frac{3}{4}$ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal/noise ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min. max safe on open circuit

Z.40 R R P. **£5.45** + 0 54 V A T ; **Z.60** R R P. **£6.95** + 0·69p V.A.T.

Project 80 active filter unit



Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.

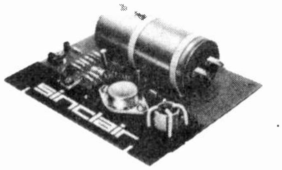
TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm ($4\frac{1}{4} \times 2 \times \frac{3}{4}$ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz controls minimum
Distortion – at 1KHz – 0·03% using 30V supply
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct slope

- For scratch and rumble control
- Transistorised active circuitry

R.R.P. £6.95 +0·69 V.A.T.

Power supply units

PZ.8



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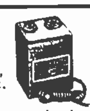

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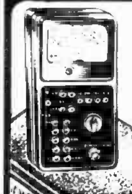

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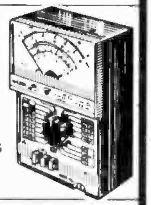

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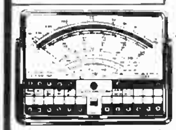

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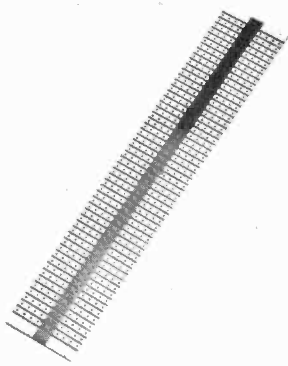

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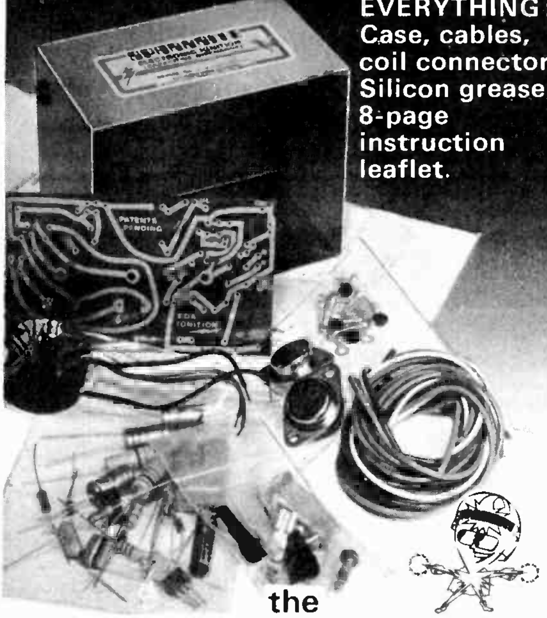

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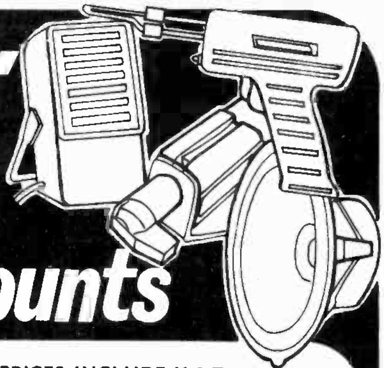

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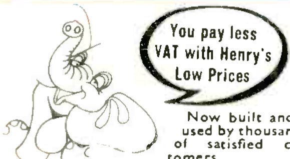

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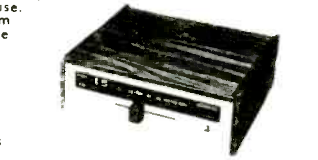

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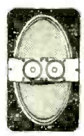

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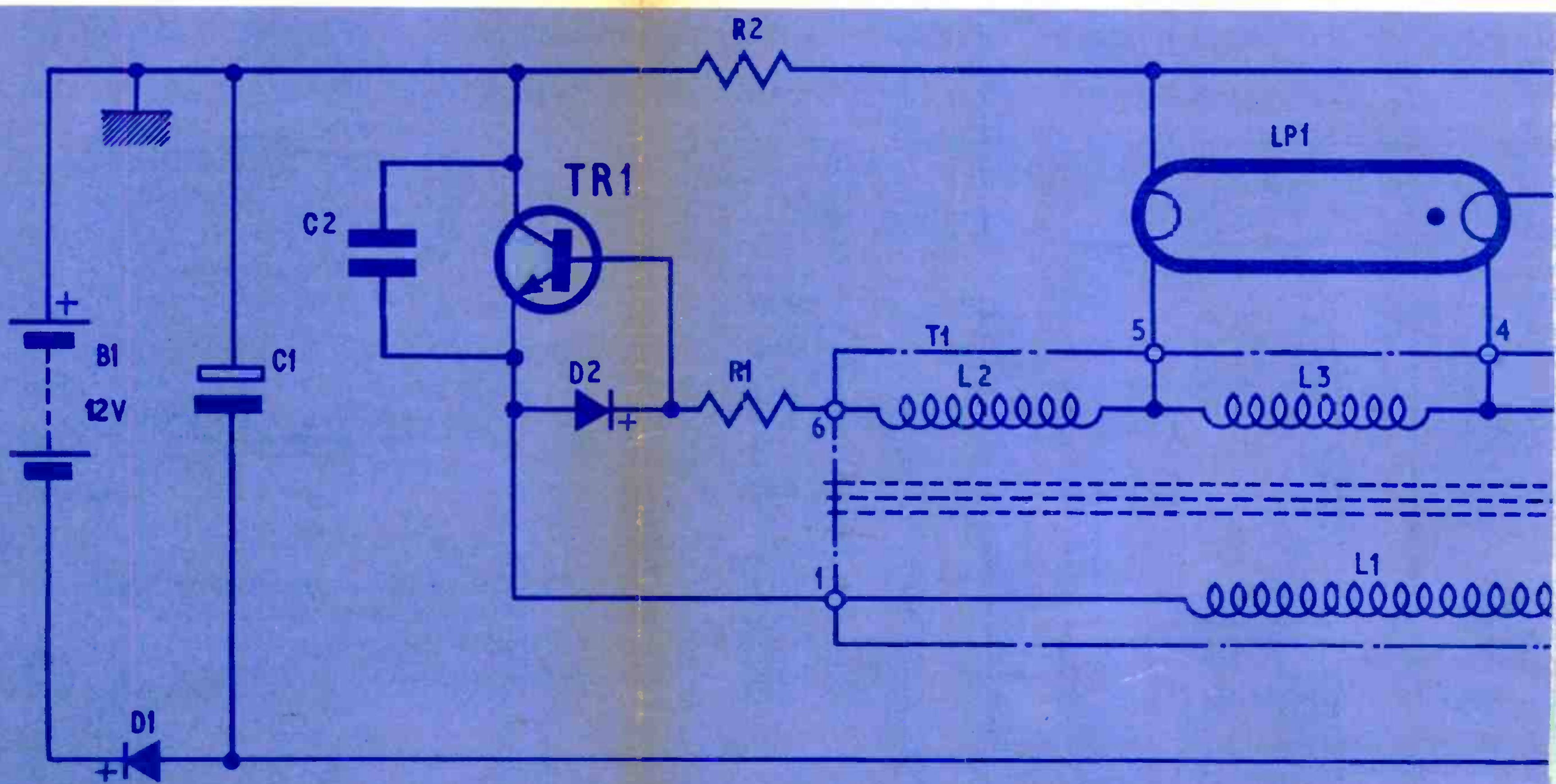
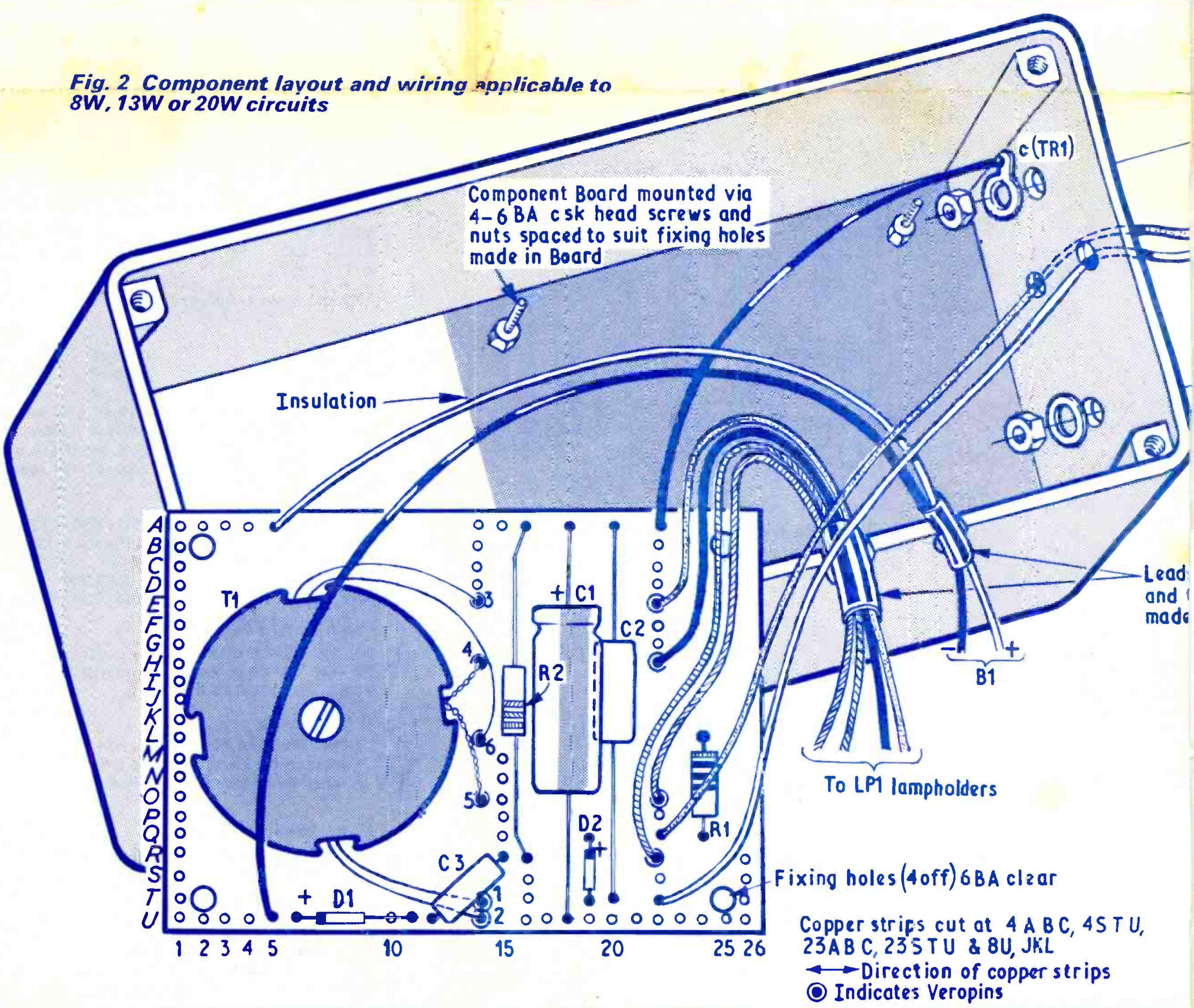


Fig. 1 Circuit diagram of lamp inverter. Component values applicable to 8W, 13W or 20W units are given in

Fig. 2 Component layout and wiring applicable to 8W, 13W or 20W circuits



R IGNITION SYSTEM

CAL ELECTRONICS MARCH 1974

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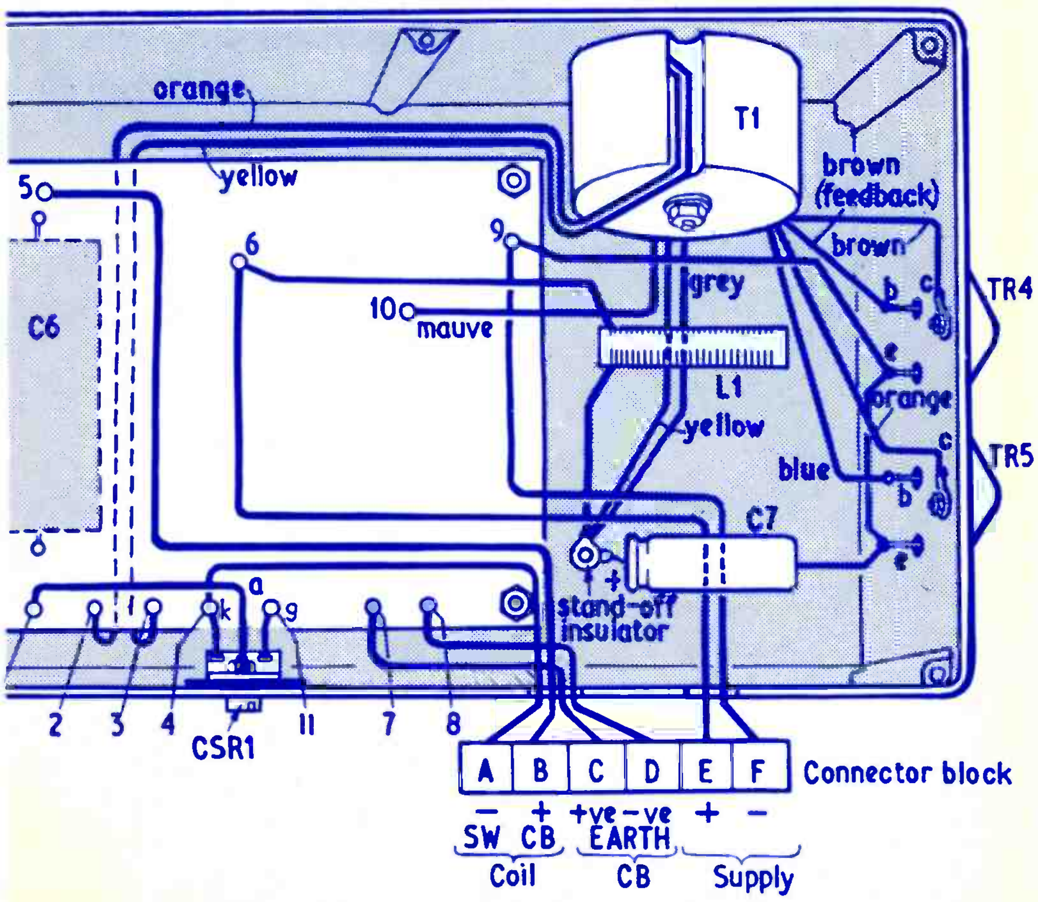
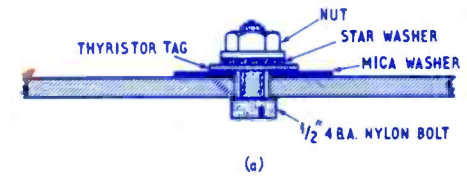
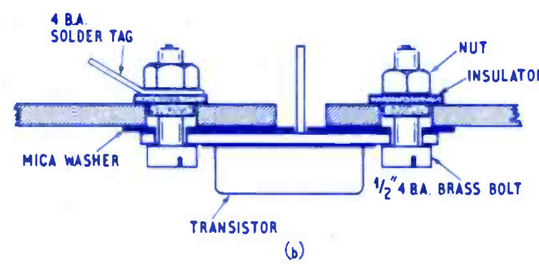


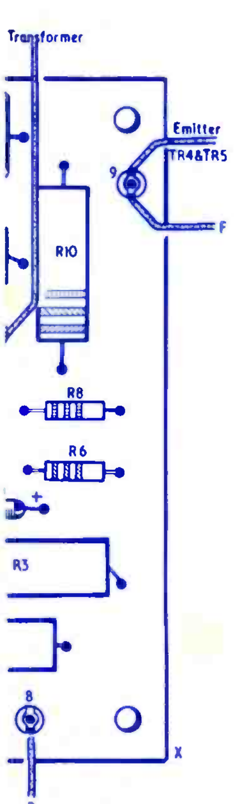
'nterwiring details of the ignition system. Also shown are ɔr and thyristor mounting details



Mounting details for thyristor



Mounting details for inverter transistors



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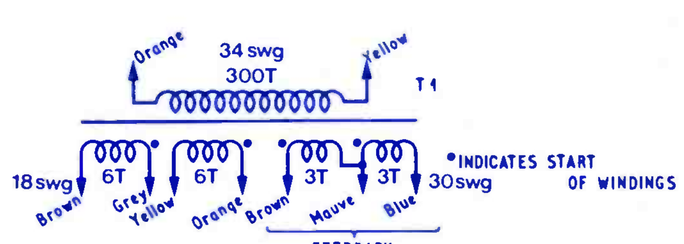

Fig. 4 Transformer winding details for the 6V version

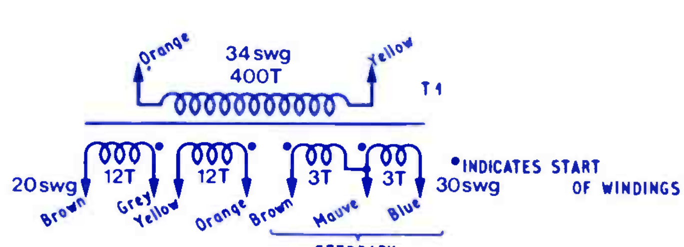

Fig. 4 Transformer winding details for the 12V version

COMPONENTS...

	12V VERSION	*6V VERSION*
Resistors		
R1	**22Ω**	**33Ω**
R2	**150Ω 2W**	**100Ω 1W**
R3	**150Ω 2W**	**100Ω 1W**
R4	**1kΩ**	**1kΩ**
R5	**470Ω**	**470Ω**
R6	**1kΩ**	**1kΩ**
R7	**1kΩ**	**10kΩ**
R8	**1·2kΩ**	**1kΩ**
R9	**150Ω 2W**	**33Ω 2W**
R10	**15Ω 1W**	**5Ω 2W**
R11	**100Ω**	**100Ω**
R12	**330kΩ**	**330kΩ**

All ±10% ½W carbon unless otherwise specified

Capacitors		
C1	**0·22µF**	**0·33µF**
C2	**0·1µF**	**0·22µF**
C3	**0·47µF**	**0·47µF**
C4	**220µF 40V elect.**	**220µF 40V elect.**
C5	**0·01µF 1000V**	**0·01µF 1000V**
C6	**1µF 440V a.c. rated**	**1µF 440V a.c. rated**
C7	**220µF 40V elect.**	**220µF 40V elect.**
Transistors		
TR1, TR2	**ZTX500 Ferranti (2 off)**	**ZTX500 Ferranti (2 off)**
TR3	**ZTX500 Ferranti**	**BFS97 *or* ZTX500**
TR4, TR5	**2N3055 (2 off)**	**2N3055 (2 off)**

Diodes and Thyristor

D1, D2 ZS170 *or* ZS270 Ferranti (2 off)
D3 - D6 ZS178 *or* ZS278 Ferranti (4 off)
CSR1 BStBO246 Siemens

Transformer

T1 Two Mullard FX2243 ferrite cups with DT2206 former *or* two Siemens B65631 - J0000 - R026 with B65632 - A0000 - P001 former

Miscellaneous

L1 Filter coil 60 turns 20 s.w.g. wound in two layers on 2in of ⅜in diameter ferrite rod
Eddystone diecast box 7¼in x 4½in x 2in
6-way 5 amp connector block, mica washers, screws, ⅜in spacers, turret tags, connecting wire, TO3 transistor covers
Printed circuit board (available from Davian Electronics, PO Box 38, Oldham, Lancs.)

LAMP INVERTER

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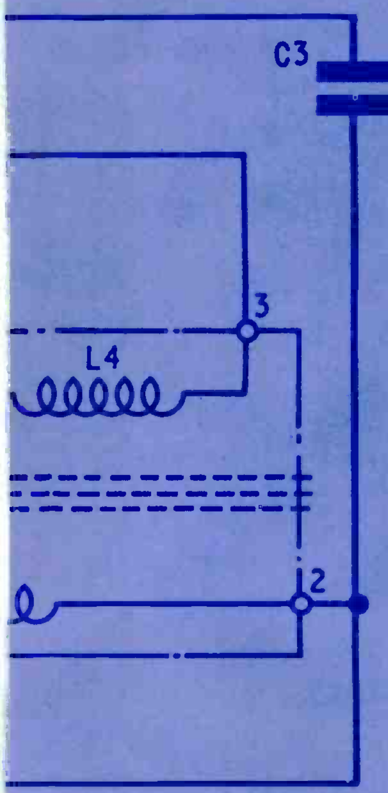
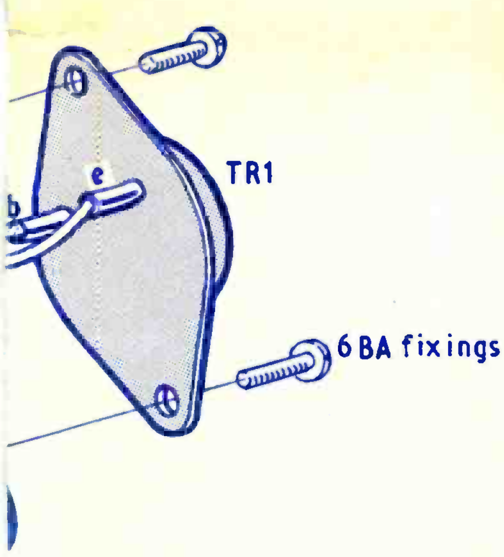


the Components List



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in lip of Box

- **Ideal Emergency Lighting**
- **Up to 20watts Output**
- **Automatic Circuit Protection**

COMPONENTS...

	8 WATT	13 WATT	20 WATT
Resistors			
R1	33Ω ½w	4·7Ω 1w	4·7Ω 2w
R2	10kΩ ½w	10kΩ ½w	10kΩ ½w
Capacitors			
C1	125μF/16v	125μF/16v	250μF/16v
C2	—	0·02μF/30v	0·05μF/30v
C3	0·04μF	1μF/10v	2μF/10v
Transistors			
TR1	MJE 520	BDY 62	BDY 62
Diodes			
D1	IN 4001	IN 5401	REC 31
D2	IN 4001	IN 4001	IN 4001
Transformer (T1)			
L1	10T/26 s.w.g.	10T/22 s.w.g.	10T/22 s.w.g.
L2	14T/30 s.w.g.	15T/26 s.w.g.	15T/26 s.w.g.
L3	105T/30 s.w.g.	55T/30 s.w.g.	55T/30 s.w.g.
L4	6T/30 s.w.g.	5T/30 s.w.g.	5T/30 s.w.g.
Ferroxcubes	FX2240	FX2241	FX2241

(both ferroxcube pot cores and bobbins to suit can be obtained from Gurneys Radio, 91 The Broadway, Southall, Middlesex).

Miscellaneous

Eddystone diecast box 4¼ in x 2¼ in x 1 in 2¾ in x 2 in, 0·1 in Veroboard, insulating washer, Veropins, 2-pin lampholders (2 off).

PE

SCORPIO MK2 CA

PRESENTED FREE WITH PRACTI

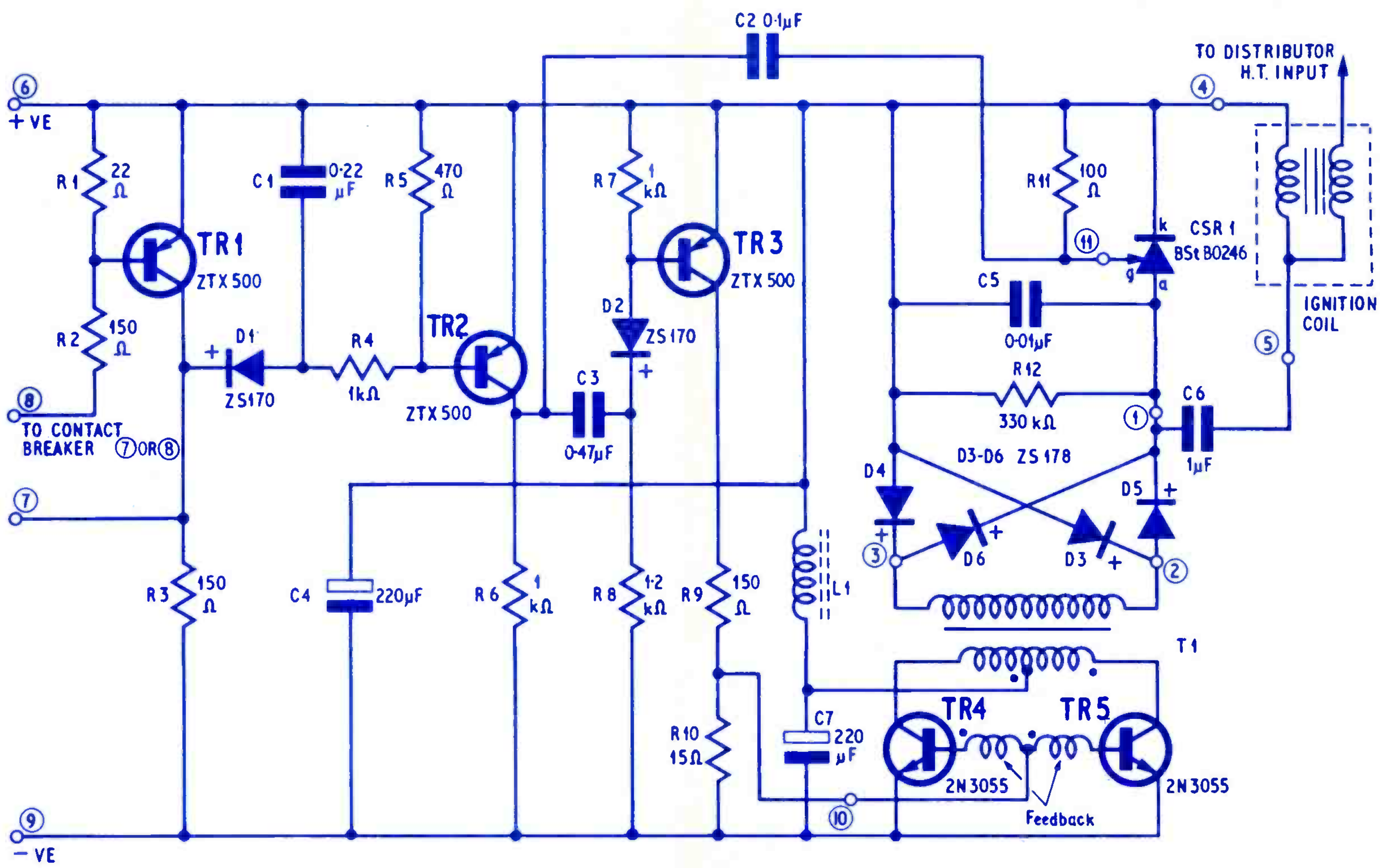
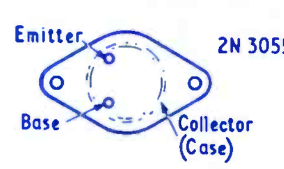
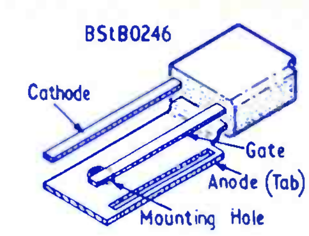


Fig. 1 Circuit diagram for the Scorpio Mark 2 ignition system. The component values shown are for the 12V version, for the 6V version see the accompanying component list





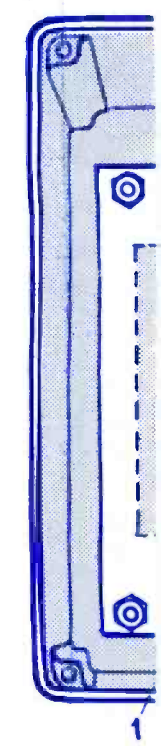


Fig. 5
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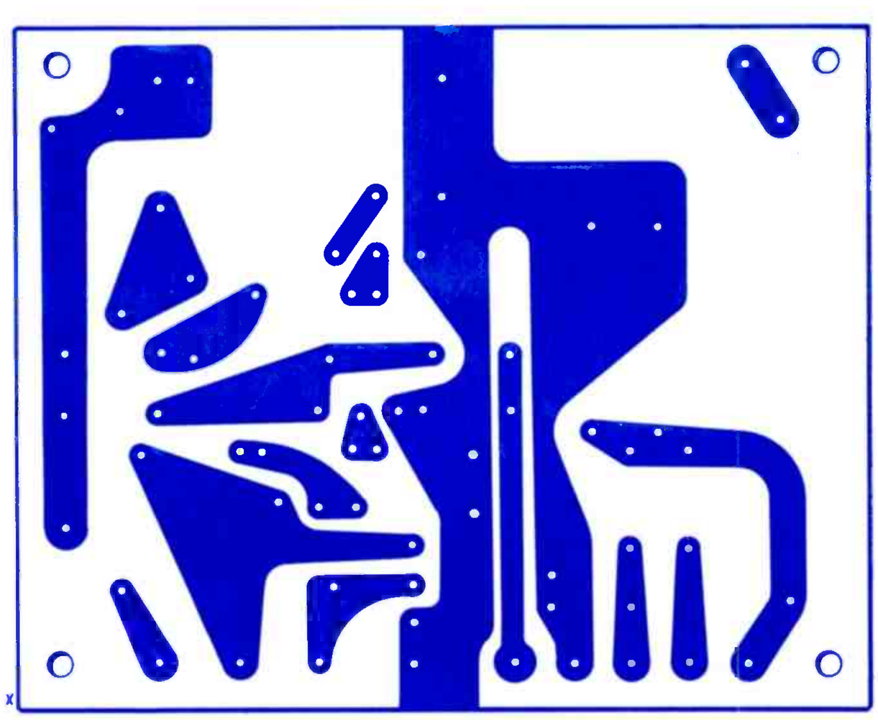

Fig. 2 Printed circuit board for the Scorpio Mark 2. The board is shown full size, the blue areas indicating copper

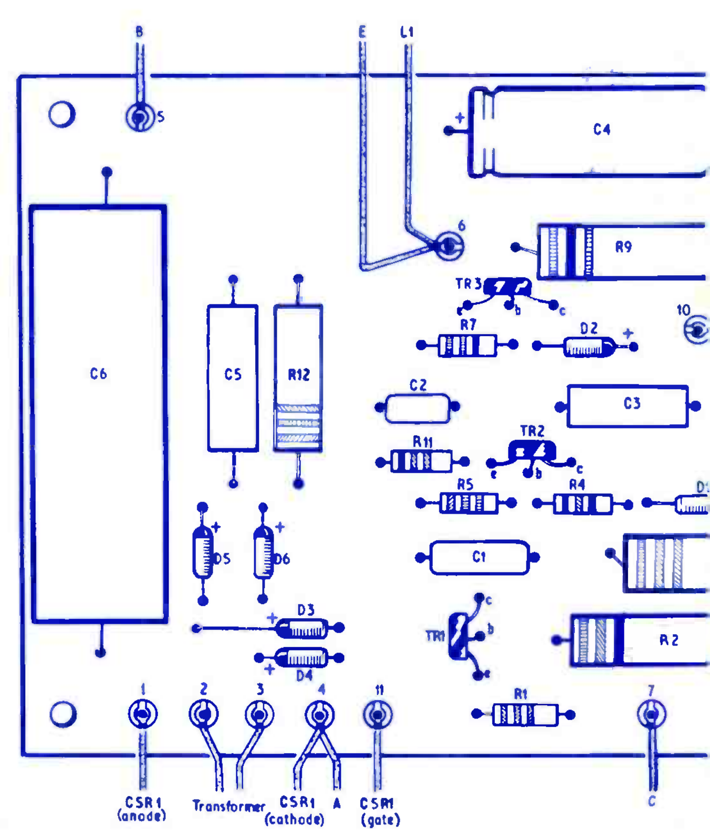

Fig. 3 Layout of the components on the pr circuit board