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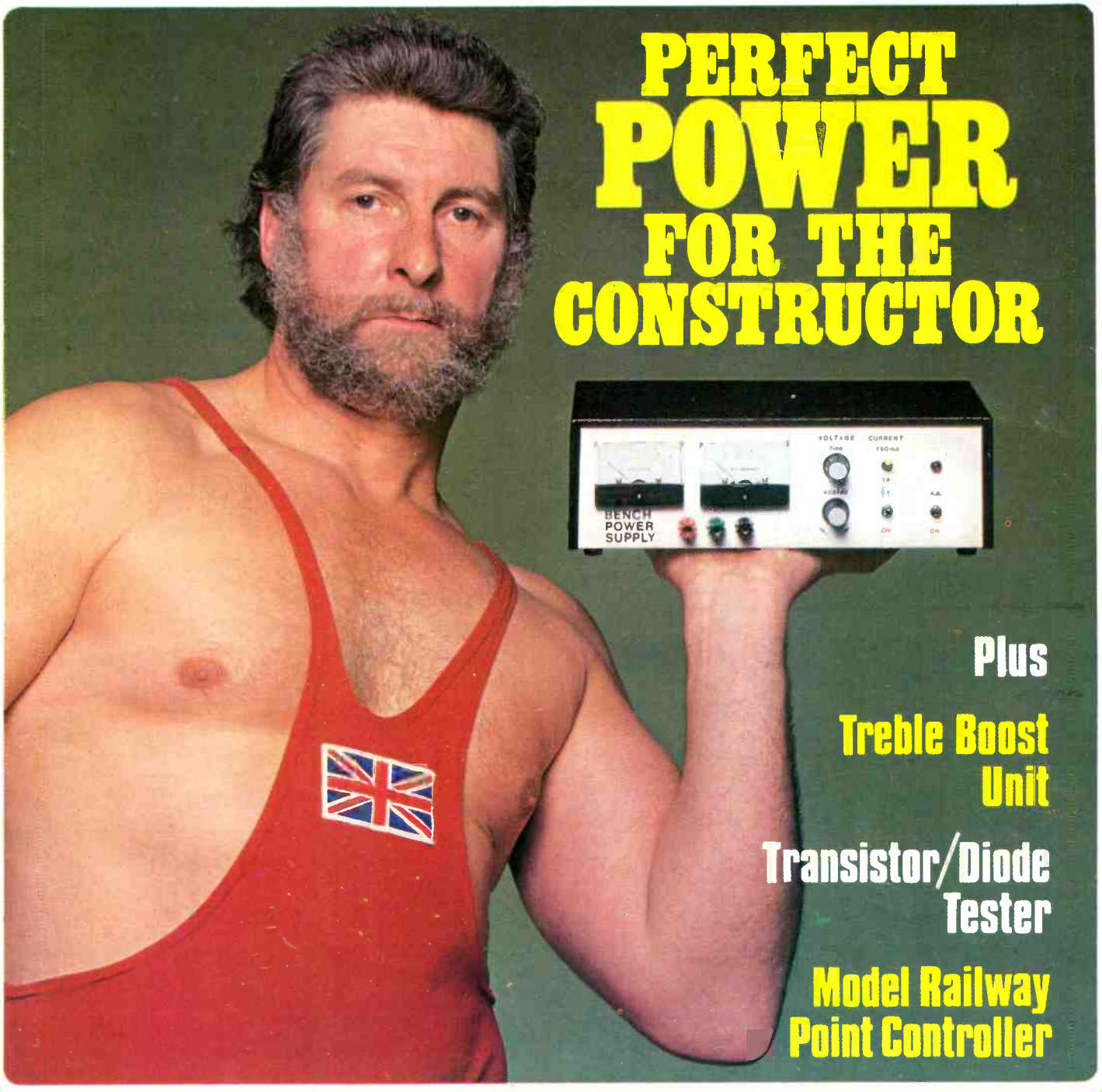
MARCH 81
60p



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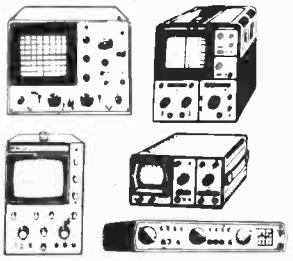

HAMEG ● TRIO ● LEADER ● SINCLAIR ● HITACHI

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Hm 307-3 10mHZ, 5mV, 6 × 7cm display plus component Test	£158·78
C01303D 5mHZ, 10mHZ, 7 × 7cm display	£109·25
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LB0512A 10mHZ, 10mV, 5" display	£195·50
CS1559A 10mHZ, 10mV, 5" display	£232·00
V151 15mHZ 1mV 5" display	£241·50

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CS1566A 20mHZ, 5mV, 5" display	£339·00
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Hm 412-4 20mHZ, 5mV, 8 × 10cm display plus Sweep Delay	£399·50
CS1577A 35mHZ, 2mV, 5" display	£478·00
CS1830 30mHZ, 2mV, 5" display plus Sweep Delay	£569·00
Hm 512-8 50mHZ, 5mV, 10 × 8cm display, Delay Sweep	£667·00
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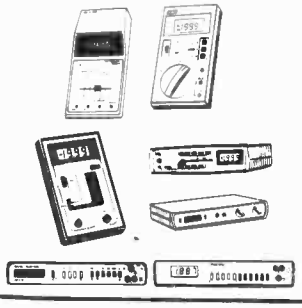

HAND HELD

(UK post etc 85p)

TM352 3½ Digit LCD plus 10ADC and Hfe checker	£54·95
PDM35 3½ Digit 16 range LED (no AC current)	£32·95
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LM2001 3½ Digit LCD 2 amp AC/DC 0·1%	£51·70
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6220 As 6200 plus 10A AC/DC	£49·95
6100 As 6200 plus Cont. test/ range hold	£59·95
6110 As 6100 plus 10A AC/DC	£74·95

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(UK c/p £1·00)

DM235 3½ Digit LED 21 ranges, 0·5% AC/DC 2A	£56·50
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TM353 3½ Digit LCD AC/DC 2 amp	£86·50
TM351 3½ Digit LCD AC/DC 10 amp	£107·95
LM100 3½ Digit LCD AC/DC 2 amp	£86·50
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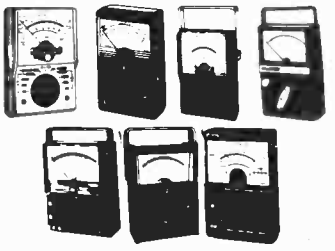
1503 4½ Digit LCD 28 ranges, AC/DC 10 amp include Mains adaptor	£159·85

(DM series options: Carry case £8·80, Nicads £7·95, Mains adaptor £4·00.)

MULTIMETERS

(UK post etc 75p)



KRT101 1K/Volt 10 range pocket	£4·50
ATM1/LTI 1K/Volt 12 range pocket	£5·95
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ATI 2K/Volt 12 range pocket de luxe	£7·95
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YN360TR 20K/Volt 19 range pocket plus hfe test	£13·95
AT1020 20K/Volt 19 range de luxe plus hfe test	£16·95
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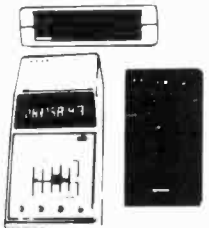

HAND HELD (UK post etc 85p)

PFM200 20HZ to 200mHZ 8 Digit LED	£54·50
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MAX550 30KHZ to 550mHZ 6 Digit LED	£106·00

BENCH PORTABLES

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SIGNAL TRACER. Feb. 81. £6·95. Less Probe.

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Ni-Cd BATTERY CHARGER. Feb. 81. £11·57.

UNIBOARD 3—POWER SUPPLY. Feb. 81. £15·20.

ULTRASONIC INTRUDER DETECTOR Jan. 81. £45.98. Less case & chassis.

AUTO SLIDE CHANGER. Jan. 81. £6·44.

PHASER SOUND EFFECTS. Jan. 81. £22·83.

ICE ALARM. Jan. 81. £6·71.

LOGIC PULSE GENERATOR. Jan. 81. £6·80.

2 NOTE DOOR CHIME Dec. 80. £8·78.

LIVE WIRE GAME. Dec. 80. £9·95.

SOUND TO LIGHT. Nov. 80. 3 channel, £18·95 inc. etched & drilled pcb. Less light display.

PRECISION TIMER. Nov. 80. £24·48.

GUITAR PRACTICE AMPLIFIER. Nov. 80. £10·96 less case. Standard case £3·50. High quality case £8·33.

SOIL MOISTURE MONITOR. Nov. 80. £4·94 inc. probes.

TRANSISTOR TESTER. Nov. 80. £9·89 inc. test leads.

AUDIO EFFECTS UNIT FOR WEIRD SOUNDS. Oct. 80. £10·75

PHONE CALL CHARGE JOGGER. Oct. 80. £6·19

BICYCLE ALARM. Oct. 80. £8·80 less mounting brackets.

IRON HEAT CONTROL. Oct. 80. £4·99.

DARKROOM CONTROLLER. Oct. 80. £21·65 case differs.

BEDSIDE RADIO. Sept. 80. £15·98.

TTL LOGIC PROBE. Sept. 80. £4·41.

TTL POWER SUPPLY UNIT. Sept. 80. £13·72.

ELECTRONIC TOUCH SWITCH. Jan. 78. £2·33 less case.

AUTOPHASE. June 80. £21·41. Rectangular Case.

COURTESY LIGHT DELAY. June 80. £6 09.

A.F. SIGNAL GENERATOR. June 80. £22·54.

AUTOWAA. June 80. £21·33. Rectangular Case.

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SIGNAL TRACER. June 80. £5·50.

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SPRING LINE REVERB. UNIT. Jan. 80. £21·05.

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CABLE & PIPE LOCATOR. Mar. 80 £3·40 less coil former.

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MICRO MUSIC BOX. Feb. 80 £13·82. Grey Case £3·63 extra.

SIMPLE SHORT WAVE RECEIVER. Feb. 80. £21·65, headphones £3·28.

SLIDE/TAPE SYNCHRONISER. Feb. 80. £10·46.

MORSE PRATICE OSCILLATOR. Feb 80. £3·93.

UNIBOARD BURGLAR ALARM. Dec. 79. £9·13.

BABY ALARM. Nov. 79 £8·20

OPTO ALARM. Nov. 79 £5·77 Inc. optional ports.

MW/LW RADIO TUNER. Nov. 79 £15·50 less dial.

ONE ARMED BANDIT. Oct 79. £16·30. case extra £3·98.

HIGH IMPEDANCE VOLTMETER. Oct. 79. £15·87.

CHASER LIGHTS. Sept. 79. £18·95.

VARICAP M.W. RADIO. Sept. 79. £8·98.

SIMPLE TRANSISTOR TESTER. Sept. 79. £6·26.

ELECTRONIC TUNING FORK Aug. 79 £9·15. Suitable microphone & plug £1·59 extra.

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DARKROOM TIMER. July 79. £2·47.

TREMOLO UNIT. June 79. £11·26.

ELECTRONIC CANARY. June 79. £4·99.

LOW COST METAL LOCATOR. June 79. £5·44.
Handle & coil former parts extra £5·55.

QUAD SIMULATOR. June 79. £6·25.

INTRUDER ALARM. May 1979. £18·71. Less Ext. Buzzer & Lamp and Loop Components.

THERMOSTAT. 'PHOTO' SOLUTIONS. May 79. £16·02. Less socket, tube and grease.

TRANSISTOR TESTER. April 79. £4·05.

TOUCH BLEEPER. April 79. £3·52.

ONE TRANSISTOR RADIO. Mar. 79. with Amplifier & Headset. Less case. £6·93.

AUDIO MODULATOR. Feb. 79. £1·56 less case and pins.

THYRISTOR TESTER. Feb. 79. £3·22.

ADJUSTABLE PSU. Feb. 79. £24·60. Case (horizontal layout) £5·21 extra.

FUZZ BOX. Dec. 78. £6·20.

VEHICLE IMMOBILISER. Inc. PCB. Dec. 78. £5·74.

AUDIO EFFECTS OSCILLATOR. Nov 78. £3·99 inc. board.

FUSE CHECKER. Oct. 78. £1·97.

TREASURE HUNTER. Oct. 78. £17·88 less handle & coil former.

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LOGIC PROBE. July 78. £2·53.

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WEIRD SOUND EFFECTS GENERATOR. Mar. 78. £4·80.

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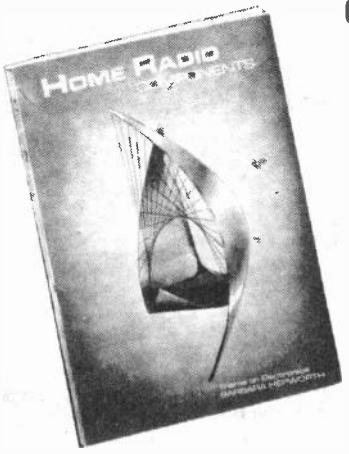

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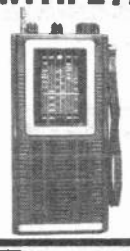

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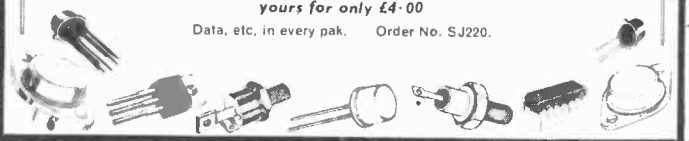

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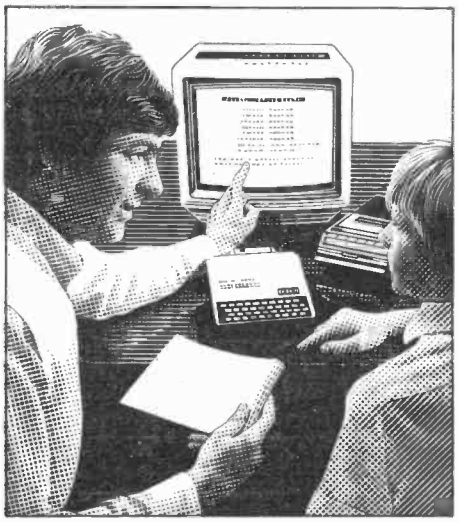

The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer.

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Kit or built – it's up to you

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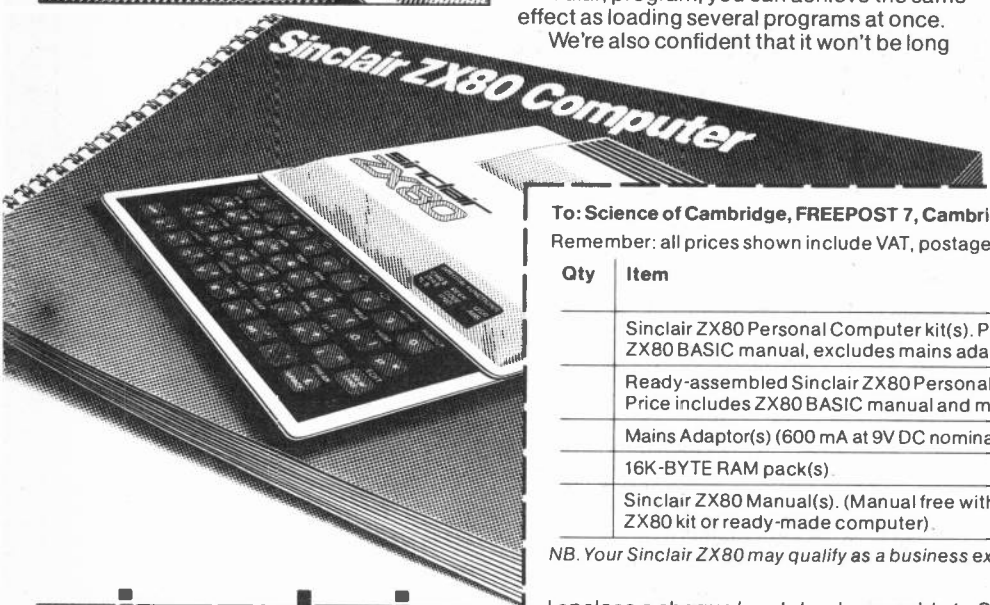

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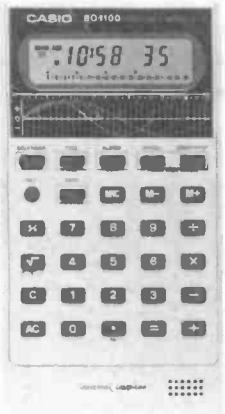

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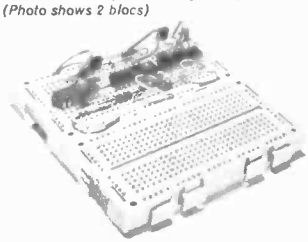
VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs and be joined together. Bus strips on X & X axis—total 360 connexion points for just £4·15.
(Photo shows 2 blocs)



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Z525 Contains 11 800mA 60V 2N5061 SCR's, 11 6V8 zeners, 11 1N4004 diodes + R's, C's etc. Only £1·00.
Z527 2 × 6V reed relays, 6 × 2S030 or 2S230 6 × 400V rects, + R's. Only 50p.

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Special purchase of 1A rects, Russian made. Packed in boxes of 300, £8·50 per box; 4 boxes £30·00; 10 boxes £75·00.

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0·05μF 12V 15mm dia. 100 £1·50; 1000 £12·00.

741 — 7 for £1
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Take advantage of this unbelievable offer!! Small signal NPN/PNP transistors in plastic package at an incredibly low, low price!! Almost all are marked with type number—almost all are full spec devices, some have bent leads. Over 30 different types have been found by us, including BC184/212/238/307/328; BF196/7; ZTX107/8/9/342/450/550 etc. Only available as a mixed pack at £3/100; £7/250; £25/1000.

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PL40CP—69 × 16 × 9mm, 40mm slide length. 220R, 2k2 or 10k lin only. Prices (any mix): 1-24 20p; 25-99 17p; 100+ 14p.

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K503 150 wirewound resistors, 1W-12W. Wide range of values. £2·00.
K511 200 small value poly, mica, ceramic caps for a few pF to 0·2μF £1·20.
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Each pack £1; any 25 packs £22

K101	16	BC239B transistors
K102	15	BC349A transistors
K103	10	BC546B transistors
K104	18	BC182B transistors
K105	50	1N4148 diodes
K106	18	BC184L transistors
K107	18	BC2131 transistors
K108	8	2N5060 thyristors, 30V 0·8A T092 case
K109	15	BC114 transistors
K110	4	BD131 transistors
K111	4	BD132 transistors
K112	12	3A 100V rects, wire ended
K113	30	DA002 rects 150V 0·5A
K114	15	XK6116 (BF241) transistors
K115	18	SP1218 (2N3702) transistors
K116	10	MPSL01 NPN 140V T092
K117	10	BF450 PNP TV IF amp transistor
K118	16	ME4101 NPN 60V AF low noise
K119	10	2N5401 NPN 160V T092
K120	6	prs 2SD96/2SB496 AF O/P sim to AC128/176
K121	20	7V5 400mW zeners
K122	10	VR525 5·25V 2·2W zener
K123	10	56V 1W zener
K124	50	·02μF disc ceramic
K125	200	1k 5% ¼W carbon film resistors
K126	100	3000pF 63V polystyrene preformed caps
K127	25	47μF 25V axial lead caps
K128	25	1μF 40V do
K129	8	AA113 diodes
K130	25	470R V 0·1W presets
K131	10	VA1086 thermistor
K132	12	4·7μF 50V bead tants
K133	20	3 way 5A term blocks
K134	50	unmarked untested OC71 type transistors
K135	30	4·7μF 10V radial elecs
K136	4	AC187k transistors
K137	5	18μF 100V non-polarised caps
K138	30	½" coil former with slug
K139	40	·025μF 50V mylar caps
K140	30	·05 do
K141	40	0·01μF 400V axial caps (C296)
K142	25	wire ended neons std size, 90V
K143	200	squares mica insulation 25mm sq.
K144	30	IR5 3W wirewound resistors
K145	10	1500μF 16V caps—radial PC mntg
K146	25	330μF 4V axial caps
K147	3	150μF 350V caps—radial PC mntg
K148	30	transformer former type X228
K149	12	Ferrite rod type X036
K150	10	switches type W430
K151	12	0·125" red LED's
K152	10	0·2" red LED's
K153	30	T05 heat sinks, same as G104
K154	15	5 pin 180° Din socket, clip fix
K155	100	metres thin flex (50×2m lengths)
K156	15	1¼" chassis mntg fuseholder
K157	12	16 pin QIL-QIL IC sockets
K158	6	SPCO centre off white rocker switches
K159	20	0·3W presets 500k V with knurled knob
K161	20	0·3W presets 2k5 V
K162	20	0·3W presets 2M5 V with knurled knob
K163	400	15R ¼W 5% preformed vert mntg resistors
K164	50	22pF 2% silver mica caps
K165	20	Sub-min reed switch, body 20mm long
K166	100	3300pF 630V polyester PC mntg caps
K167	30	10V 400mW zener, preformed for H mntg
K168	50	AA144 diode preformed as above
K169	30	8V2 400mW zener as K167
K171	25	11V do
K173	12	1·5μF 25V tant bead caps
K174	12	0·47μF 25V tant bead caps
K175	100	2000pF 2½% 125V p/s caps
K176	24	150R 0·1W vert presets
K177	24	470R 0·1W horiz presets
K178	24	470R 0·1W vert presets
K179	24	2k 0·1W horiz presets
K180	24	2k 0·1W vert presets
K181	24	2k2 0·1W horiz presets
K185	200	IR ¼W CF preformed R's for Horiz mntg, 15mm centres
K187	18	PE5030 NPN SI T092 transistors, Vce 35V, Hfe 75
K188	18	F544 PNP SI TO92 transistors Vce 20V, Hfe 300
K189	30	1N649 600V 0·4A diodes, preformed for H mntg.

ELECTRONICS

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BIG, WELL ILLUSTRATED BOOK ideal for beginners — gives lots of general information — explains how to build lots of projects : Intercom, Rain Alarm, Radios, Organ, Parking Light etc. All parts supplied and can be re-used on special deck provided, so NO SOLDERING is required. Just needs 4½V battery.

£17·50 inc. VAT & Post
Also
ADVENTURES WITH MICROELECTRONICS — Explore the world of silicon chips — All components & Deck, £27.95 inc VAT & Post.

NEW PRACTICAL ELECTRONICS PROJECT 125 WATT POWER AMP KIT

SPECIFICATIONS

Max. Output power	125 watt RMS
Operating voltage (DC)	50-80 Max.
Loads	4-16 ohms
Frequency response Measured at 100 watts	25Hz-20kHz
Sensitivity for 100 watts	400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load	0.1 %
Dimensions	205 x 90 and 190 x 36 mm

The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, the output stage uses four 115 watt transistors normally only two would be used, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chassis is preformed and ready to use. supplied with all parts and circuit diagrams.

125 watt power amp kit **£9.50** plus £1.00 p&p

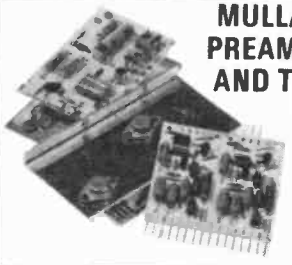
ACCESSORIES

Suitable L.S. coupling electrolytic **£1.00** plus 20p p&p

Suitable Mains Power Supply Unit sufficient for one power amp **£7.50** plus £2.75 p&p

AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES



MULLARD STEREO PREAMP MODULES AND TWO 12 WATT POWER AMP KITS.

In easy to build form P.C.B.s backprinted, etched and drilled ready to use.

BUILD A 12 WATTS PER CHANNEL STEREO AMPLIFIER ACCESSORIES AND L.S. KIT EXTRA *(not available separately)* £6.00

DIY PACK 1 2 x power amp kits LP1182/ preamp module, suitable for ceramic and auxiliary inputs. **£6.00** plus £1.10 p&p

DIY PACK 2 2 x power amp kits LP1184 preamp module suitable for magnetic ceramic and auxiliary inputs. **£8.50** plus £1.15 p&p

DIY SPEAKER KIT Two 8" x 5" approx. 4 ohm bass. **£3.50** plus £1.70 p&p

DIY ACCESSORIES Mains transformer smoothing capacitor rectifier 4 x slider controls, for base, treble and volume. **£3.00** plus £1.60 p&p

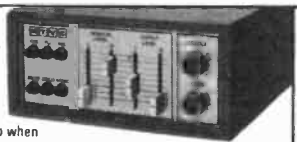
ACCESSORIES: Available only at time of purchase of Bargain Packs

12 + 12 WATT AMPLIFIER KIT

NOTE: for use with 4 to 8 ohms speakers.

With up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit. Size 9¼" x 8¾" x 4" approx.

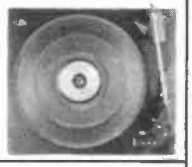
NOTE: for use with 4 to 8 ohms speakers. **£13.95** plus £2.55 p&p



BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge **£8.50** plus £2.75 p&p when purchased with amplifier. Available separately **£10.50** plus £2.75 p&p.

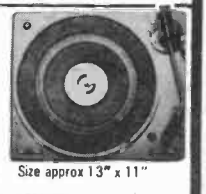
8" SPEAKER KIT. 2 Phillips 8" approx. speakers. **£4.75** per stereo-pair plus £1.50 p&p when purchased with amplifier. Available separately **£6.75** plus £1.50 p&p.

STEREO MAGNETIC PRE-AMP CONVERSION KIT all components including P.C.B. to convert your ceramic input on the 12 + 12 amp to magnetic. **£2.00** when purchased with kit featured above. **£4.00** separately inc p&p.



BSR Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.

£12.25 OUR PRICE plus £2.75 p&p



Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037

Size approx 15¼" x 12¼"

Hi Fi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge—*LIMITED STOCK.*

UNBEATABLE OFFER AT

£27.50 complete plus £2.75 p&p

OFFER! SAVE MONEY by purchasing 12 + 12 amp kit, BSR record deck and speaker kit together for only **£25.50** p&p £4.50.

PRACTICAL ELECTRONICS CAR RADIO KIT £10.50

(Constructors pack 7) plus £1.75 p&p

2 WAVE BAND MW LW
* Easy to build * 5 push button tuning
* Modern styling design * All new unused components
* 6 watt output * Ready etched & punched P.C.B.
* Incorporates suppression circuits * Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia. The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards. Complete with instructions.

CONSTRUCTORS PACK 7A

Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack, p&p £1.00

Pack 7A may only be purchased at the same time as Pack 7.

NOTE: Constructor's pack 7A sold complete with radio kit **£15.20** including p&p.

FEATURED PROJECT IN PRACTICAL ELECTRONICS.

30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. OIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14¾" x 10" approx.

READY TO PLAY £32.90 plus £3.30 p&p

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21A HIGH STREET, ACTON W3 6NG

ACTON: Mail Order only. No callers

ALL PRICES INCLUDE VAT AT 15%

All items subject to availability. Price correct at 1/1/81 and subject to change without notice.

For further information send for instructions 20p plus stamped addressed envelope.

NOTE: Persons under 16 years not served without parent's authorisation.

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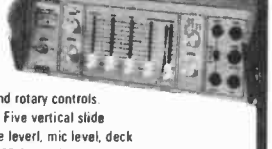
ARISTON PICK UP

Ariston pick-up arm manufactured in Japan. Complete with headshell. Listed price over £30.00

OUR PRICE **£11.95** plus £2.50 p&p

100 WATT MONO DISCO AMPLIFIER



Brushed aluminium fascia and rotary controls. Size approx 14" x 4" x 10¼. Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

£76.00 plus £4.00 p&p

50 WATT MONO DISCO AMPLIFIER

Size appox 13⅜" x 5¼" x 6¾". 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

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Projects... Theory... and Popular Features...

THE WAY AHEAD

Many traditional industries are under threat of extinction. Those that do pull through the present recession will have a reasonable fighting chance in the future only if they adopt new methods of production and administration. Essentially this implies computer controlled robots in the workshop areas, and computers and word processors in the offices. Likewise, small businesses of all kinds will be under increasing pressure to equip themselves with minicomputers. If they don't, they must lose out eventually to their more foresighted competitors.

Thus, the message comes over loud and clear. Brutal, but undoubtedly true.

There is, thankfully, some encouraging news. First, the setting up of a Small Systems Centre by the National Computing Centre. The purpose is to create greater awareness of modern developments and to help and guide businessmen and other individuals in their choice of suitable computing equipment.

It was at the launch of the Small Systems Centre in January that the recently appointed Minister for Information Technology Mr Kenneth Baker had some words to say about the vital importance of teaching young people the use of computers. Stating that only about one-quarter of our secondary schools have computer facilities on which to train the citizens of tomorrow, the Minister made clear his intentions to encourage and promote a much wider appreciation of computers in the schools.

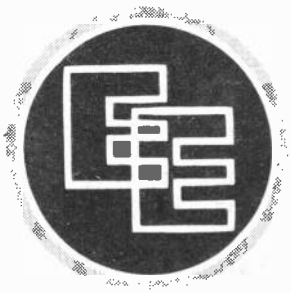
Exactly what tangible form this support will take, the Minister was not then prepared to say. We can, however, be reasonably optimistic that, despite the paralysing influence of ideological monetarists within the Cabinet, the public purse strings will be released for this investment in the future. For did not Kenneth Baker go on record, a few weeks before his appointment to the Government, with his view that the Department of Education's £9 million five-year programme for software and teacher-training was inadequate?

The wider application of computerised equipment means more job opportunities in the companies that design, manufacture and install computers and associated telecommunications equipment. Young people who have no particular leaning towards computer operation and programming but who do have an interest in the technical (hardware) side are well advised to "get into electronics".

A number of one-time stable industries are crumbling around us. But electronics *must* have a great future. So much depends upon it.

Fred Bennett

Our April issue will be published on Friday, March 20. See page 179 for details.



Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday
ELECTRONICS

VOL. 10 NO. 3 MARCH 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Back Issues
Certain back issues* of EVERYDAY ELECTRONICS are available worldwide price 80p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.
* *Not available:* October 1978 to May 1979.

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Binders to hold one volume (12 issues) are available from the above address for £4·40 (home and overseas) inclusive of postage and packing. Please state which Volume.

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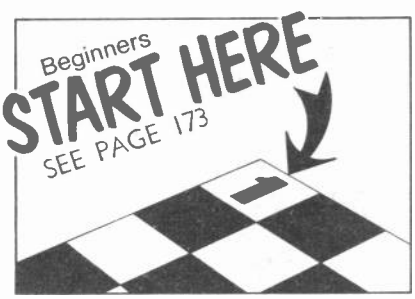


L.E.D. DICE

BY A. P. DONLEAVY

So you want to play Monopoly but the dice have gone walkies and you don't know where. This electronic dice provides a useful alternative and gives completely random "throws".

CIRCUIT

The full circuit of the electronic dice is shown in Fig. 1. This consists of two parts; IC1, which forms an oscillator and IC2 which consists of six flip-flops with a common clock input. These drive five of the six display l.e.d.s, D2 to D6 (see later).

Each of the flip-flops has two terminals, a data terminal, *D*, and an output terminal, *Q*. When a positive clock pulse is applied to pin 9, the output will assume the same state as its *D* terminal.

The flip-flops are arranged so that the output of one is connected to the *D* terminal of the next. When the first clock pulse arrives at pin 9 (all the flip-flop outputs being off), only the output of the first flip-flop goes high (pin 15) since all the rest of the *D* outputs are held low by the output of the preceding flip-flop.

The *D* input of the first flip-flop is held at nine volts. The *D* input of the second flip-flop will now be held high by the output of the first flip-flop so that at the next clock pulse, the output of the second flip-flop will then go high.

The subsequent clocking pulses will sequentially cause the outputs of the other flip-flops to go high. The output of the sixth flip-flop (pin 2) is connected via a gate (IC1d) to pin 1 to reset all the outputs to 0 on the sixth pulse.

The sequence then repeats itself. The outputs of each individual flip-flop are connected to an l.e.d. which illuminates when the output is high. The reset pulse will extinguish all the l.e.d.s which are driven by the flip-flops leaving only one l.e.d., D7 alight. This is always alight when S1 is depressed and is driven by IC1d, a gate with its inputs permanently connected to ground. Thus the reset pulse (that is the sixth pulse) actually represents a one on the dice, first pulse a two and so on.

OSCILLATOR

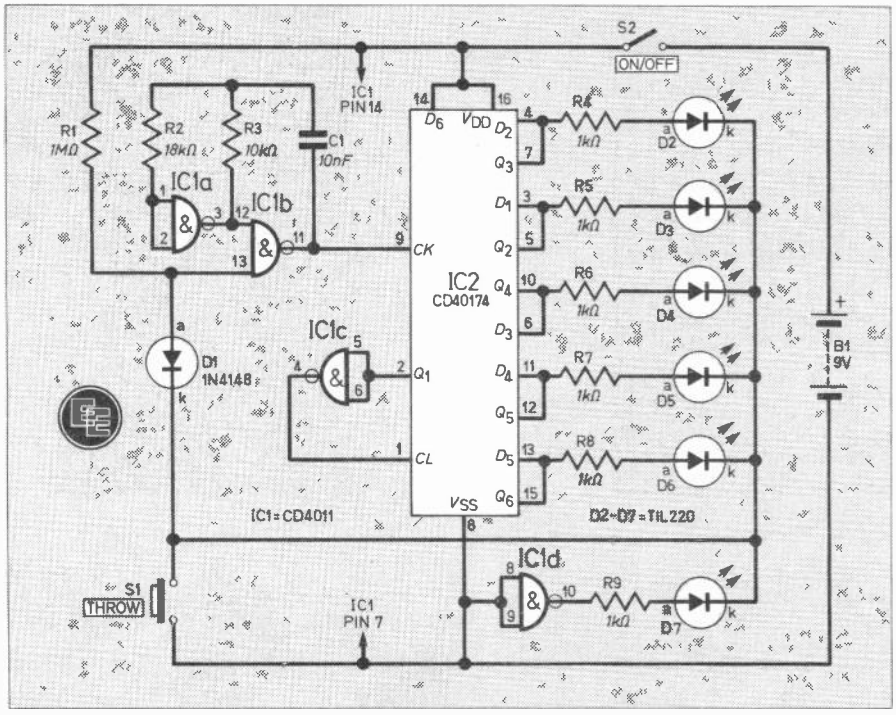
Clocking pulses are provided by IC1a and IC1b. These are connected as an oscillator and operate at a frequency of about 4·5kHz. When S1 is pressed pin 13 of IC1 is grounded and the oscillator is stopped. The number of l.e.d.s alight will depend on the part of the sequence at which the oscillator is stopped.

The cathodes of the l.e.d.s are also connected to S1 so that the display only illuminates when S1 is depressed. This is a current saving device to prolong the life of the battery. The unit consumes about 800μA without any l.e.d.s illuminated and 25mA with all l.e.d.s on.

L.E.D.S

The colour of these components can be varied according to the constructor's taste although we have specified the red type. Similarly the values of the resistors R4 to R9 can be decreased if a brighter display is wanted although the minimum value should be about 470 ohms.

Fig. 1. Complete circuit diagram of the L.E.D. Dice.



COMPONENTS

See Shop Talk page 159

Resistors
- R1 1MΩ
- R2 18kΩ
- R3 10kΩ
- R4-R9 1kΩ (6 off)
- All ¼W carbon ± 5%

Capacitor
- C1 10nF polyester C280 type

Semiconductors
- IC1 CD4011 CMOS quad 2-input NAND date
- IC2 CD40174 CMOS hex D-type flip-flop
- D1 1N4148 small signal silicon
- D2-D7 TIL220 5mm red l.e.d. (6 off)

Miscellaneous
- S1 push-to-make, release-to-break switch
- S2 s.p.s.t. toggle
- B1 9V, PP3 type

Plastics case, 120 × 65 × 40mm, Verobox 202-21029J, or similar; Stripboard, 0·1 inch matrix, size 28 strips by 20 holes; battery clip; thin interconnecting wire; nuts, bolts and spacers to secure circuit board.

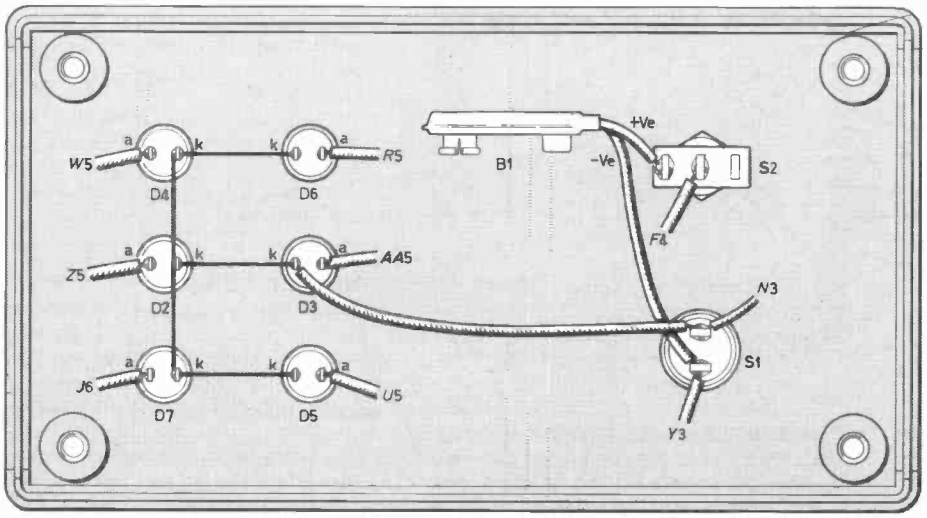
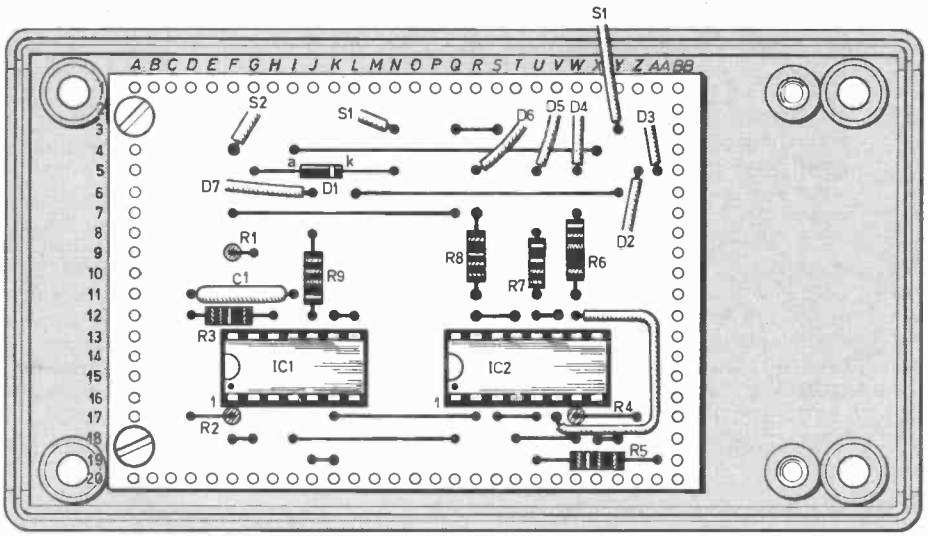
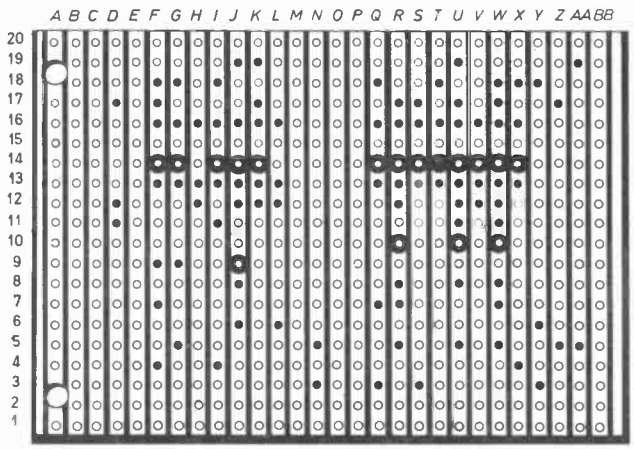


Photo above shows outside view of completed unit.



COMPONENTS approximate cost £7·50



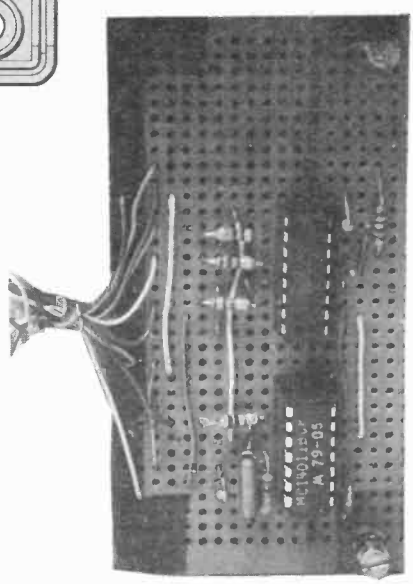


Fig. 2. Circuit board layout and interconnections between board and front panel. Note that the copper strips run from top to bottom of the board. Photo bottom right shows top view of prototype board. Layout has been slightly re-arranged for ease of construction.

Obviously the brighter the l.e.d.s the higher the current consumption and although the unit was designed to run from a 9 volt PP3 battery, the unit will work on any supply from 4 to 15 volts.

CONSTRUCTION starts here

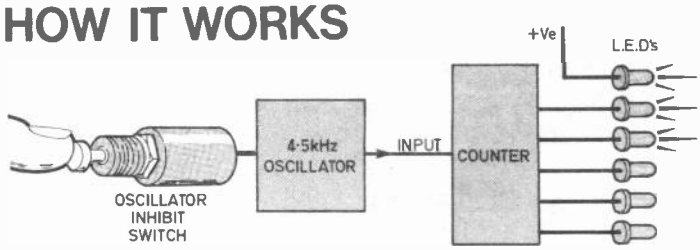
STRIPBOARD

The complete unit is built on a piece of 0·1 inch matrix stripboard, 20 holes by 28 strips. As both i.c.s are CMOS types they should be mounted in sockets, and only inserted when all assembly work has been completed. The stripboard layout is shown clearly in Fig. 2.

The completed unit is housed in a plastics box size 120 x 65 x 40mm, (Verobox type 202-21029J or similar), and the top of the box should be drilled to take the six l.e.d.s and the two switches. All the rest of the components, apart from the battery, are mounted on the circuit board. The electronic dice is completed by finishing the interwiring between the board and front panel. Keep the leads sufficiently long to allow easy access inside the box when the unit has been assembled.

The battery is secured in place using sticky backed, double sided mounting tabs, and the front panel may be finished off with dry transfer lettering protected by a coat of clear varnish.

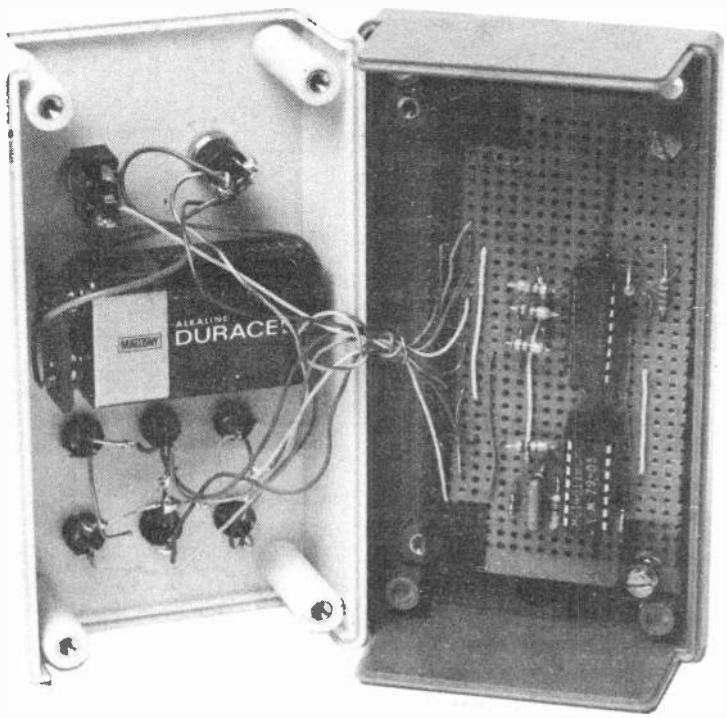
HOW IT WORKS



Pulses from a high frequency oscillator are fed into a set of six cascaded flip-flops. An l.e.d. is connected to the output of each flip-flop but cannot turn on as the cathode is not grounded.

The pulses turn on each flip-flop in turn until the sixth is reached whereupon the whole system is reset and the cycle is repeated. When the oscillator inhibit or "throw" button is pressed, it stops the oscillator and grounds the cathodes of the l.e.d.s.

This lights up the l.e.d.s connected to flip-flops which have turned on. Because of the high oscillator frequency it is virtually impossible to stop the oscillator at any given point and so number selection is practically random.



Inside view of completed unit. Circuit board is on the right and inside front panel on the left.

TROUBLE SHOOTING

In the unhappy event that the instrument does not work properly when first switched on, the following procedure may be of help.

Disconnect the cathodes of the l.e.d.s from S1 and connect them directly to ground. All the l.e.d.s should then light up although they are in fact switching on and off in a very fast sequence. You, of course, cannot see this, as the frequency is too great.

If only some of the l.e.ds light, check the polarity of the unlit diodes.

The cathode is the lead by the flat on the body of the device. Check also that the breaks in the copper tracks are complete and that there is no swarf or solder shorting across adjacent tracks.

NO LIGHTS

If none of the l.e.d.s light up, check the voltage at pin 1 of IC2. This should be about eight volts. If it is near zero then the reset is being held at zero and is therefore on when it should be off, and this can be investigated.

Measure the voltage at pin 9 of IC2. If this is about half the supply voltage then this is an indication that the oscillator section, IC1a and IC1b is working properly. If the voltage is near ground or supply voltage then something is amiss and this can be investigated.

For a really stubborn fault, connect a 4·7μF capacitor across C1. This will slow down the oscillations sufficiently to enable one to measure the input and output level voltages of the various stages of IC2 as the counting cycle proceeds and pinpoint the faulty section. ⌑

By Dave Barrington

Making Printed Circuit Boards

As a follow-up to our recent article on making printed circuit boards readers may like to investigate the possibilities of Fotoboards from Marshall's and a new Drillmaster Junior Kit from Microflame (UK) Ltd.

The Fotoboards are pre-sensitised printed circuit boards that are protected by a peel-off plastic sheet. Ideal for one-off and small batches, the boards are "developed" by exposing in ultra violet light for approximately 10 minutes or alternatively left in the sunshine for a day.

Available in single or double-sided versions the boards will accept standard transfers and track tape. The boards are developed using a Photo Board Developer which, due to its constituents, is only available through Marshall's shops and NOT through the postal service. Also available are Ultra Violet light boxes and kits.

The Drillmaster Junior Kit consists of a low voltage mini-drill and a range of accessories for drilling, grinding, polishing, cutting and deburring.

The drill is fitted with a "flexicord" lead and is suitable for battery or transformer operation. A feature of the drill is a detachable chuck finger shield. A chuck with 4 precision cut steel collets is fitted as standard, whilst an automatic 3-jaw chuck may be purchased as an optional extra.

Also available as optional extras are a drill stand with a magnifying glass attachment, a variable speed transformer/rectifier and a flexible drive shaft attachment.

For addresses of nearest stockists and price lists readers should write to Microflame (UK) Ltd., Dept EE, Vinces Road, Diss, Norfolk IP22 3HQ.

New Publications

With UK sales of video recorders forecast to pass the 300,000 mark by the end of the year, Sony has produced a 48-page full-colour handbook containing details not only of the best ways to exploit all the facilities of video recorders, but also how to make home video movies, the use of sound and lighting and even the creation of professional style, special effects and titling.

Well illustrated and using simple non-technical language *How to Video* is currently on sale at Sony London Showroom, Dept EE, 134 Regent Street, London W1, price 60 pence. It is also available by post from the Showroom for an *extra* 30p.

The completely revised third edition of the PIL catalogue has just been released and is available from Precision Instrument Laboratories.

Giving specifications for over 400 different instruments, the catalogue is subdivided into 55 different product groups ranging from multimeters to recorders and oscilloscopes to breadboards.

Copies of the PIL catalogue can be obtained from Precision Instrument Laboratories Limited, Dept EE, 727 Old Kent Road, London SE15.

Containing 120 full-colour pages, with photographs, the latest 1981 Catalogue from Toolrange must surely list the largest single source of tools in the UK. From a screwdriver to soldering stations and components cabinets to complete tool kits, you name it and you'll probably find it in the catalogue.

For copies apply to Toolrange Limited, Dept EE, Upton Road, Reading, Berks RG3 4JA.

A new 6-page colour short-form catalogue featuring a fairly comprehensive range of instruments has been produced by Salford Electrical Instruments Limited.

Products covered include multimeters, ammeters, wattmeters, photometers and test sets. One section of the catalogue is devoted to the new SEI range of digital panel meters.

Copies of the short-form catalogue can be obtained from Salford Electrical Instruments Limited, Dept EE, Barton Lane, Eccles, Manchester M30 0HL.

PIL Catalogue

The Drillmaster Junior Kit from Microflame

CONSTRUCTIONAL PROJECTS

This month there should be very few component purchasing problems as most projects use standard off-the-shelf items.

Bench Power Supply

Only a couple of parts could cause readers sourcing problems for the *Bench Power Supply*, this month's major project.

The mains transformer used in the prototype was a Douglas MT79AT. This seems to be only listed in the Home Radio catalogue. Another suitable type is listed in the advertisement from the transformer specialists Baydis, under the 30V section. The optional mains suppressor is available from Maplin.

Although the 1A moving coil meter seems to be generally available, rather surprisingly the 25V d.c. meter would appear to be only listed by Watford Electronics under their type A range.

Treble Boost Unit

The successional action or push-on push-off footswitch is the only item that we could possibly label as a "special" for the *Treble Boost Unit*. This switch is designed to stand up to the rigorous treatment it receives in use and are stocked by Maplin, Watford and Magenta Electronics.

Make sure you are given a logarithmic (log.) potentiometer when ordering VR1, as some suppliers have been known to pass over a linear pot as a matter of course.

Modulated Tone Doorbell

The dual timer i.c. type 556 called for in the *Modulated Tone Doorbell* is now a commonly stocked device and should be available from most suppliers for a very reasonable sum.

The doorbell switch should be available from any of the large electrical or general stores, such as Woolworths.

Mini Siren

All of the components required for this month's *I.C. Uniboard—Mini Siren* project are standard parts stocked by advertisers.

The rotary switch SI will have to be a 4-pole 3-way type and only one half used. The only other alternative switch is one of the more expensive types with adjustable stops. An investigation of catalogues shows that a 2-pole 3-way rotary switch is unobtainable.

Simple Transistor/Diode Testers

When ordering, components for the *Simple Transistor/Diode Testers* make sure to specify a push-to-make release-to-break switch for S1.

L.E.D. Dice

If any readers experience difficulties in locating the CMOS integrated circuit type CD40174 for the *L.E.D. Dice*, these are stocked by Watford and Maplin Electronics. Apart from the i.c. the rest of the components should not present any difficulties.

Most of the components for the *L.E.D. Flasher* and the *Model Railway Points Controller* should be available from readers existing "parts boxes". Practically any general purpose transistors could be used in the L.E.D. Flasher.

TREBLE BOOST

BY E.M.TERRELL

MANY lead guitarists and vocalists in "pop groups" have an insatiable desire for "top" or what is technically called treble boost. This is due to the fact that when they are playing to crowded audiences, the high frequency content of the sound is readily absorbed by the crowd and any soft furnishings that may be present, resulting in a general dulling of the sound and loss of penetration.

Also, the guitarist may wish to add a significant amount of top for a short time, when playing a solo for example. This needs to be instantly switchable in and out, ruling out in most cases resetting of the tone controls on the amplifier and/or guitar.

The Treble Boost to be described here provides these facilities and allows the boosted loudness to be set by the inclusion of a built-in gain control. The unit is powered by a single PP3 battery with current consumption less than 1mA.

CIRCUIT DESCRIPTION

The circuit diagram of the Treble Boost is shown in Fig. 1. The battery is connected to the circuit when the input jack is plugged into the stereo input jack socket. The circuit is made by the shank of the jack plug shorting the rear two contacts of the socket.

A high pass filter is formed by C1 and R2. By the a.c. potential divider effect of C1 and R2 the incoming signal is transmitted with an attenuation inversly proportional to the frequency of the input signal. That is, higher frequencies are attenuated less. These are then amplified by TR1, a simple common emitter amplifier; R1 and R2 are the potential divider bias resistors and C2 increases the a.c. gain.

The amplified signal at the collector is passed to the volume control via d.c. blocking capacitor C3. The required amount of gain is tapped from the wiper of VR1 and available at the output through S1. With S1 in its other position the input signal is fed directly to the output socket and is therefore unmodified.

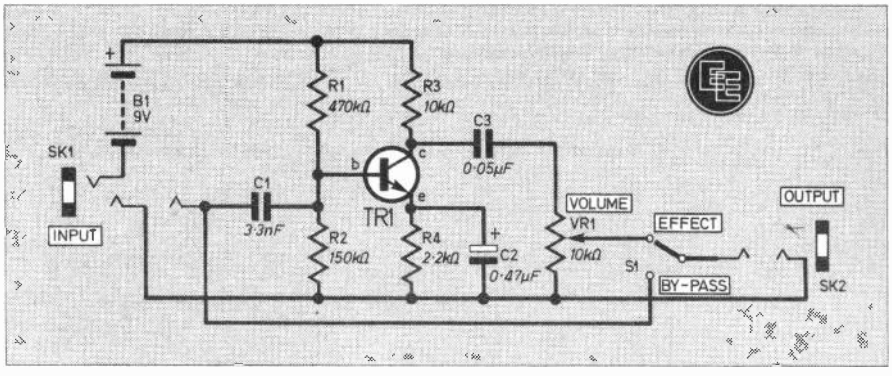


Fig. 1. The complete circuit diagram for the Treble Boost.

CONSTRUCTION starts here

ASSEMBLY

As the unit is to be floor mounted and operated by foot, a rugged case is called for. A Bimbox type 5003/13 is ideal for this application and can be obtained in a stove finished enamel as was used in the prototype.

The components are mounted on a small piece of 0·1 inch matrix stripboard size 22 strips x 9 holes as shown in Fig. 2. Not all the strips are used but this size board is necessary if it is to be mounted by means of the guides in the Bimbox.

A hole or cutaway is required as shown at each top corner to allow wires to feed from one end of the case to the other and the lid to seat properly. Only two breaks are required on the underside of the board at locations *L5* and *K3*. Mount the components in any order and attach the flying leads to reach the case mounted components.

The case should be drilled next and the components fitted and wired up as shown in Fig. 3. A small piece of card placed beneath the component board will prevent the possibility of the strips shorting against the case; similarly above the board before the lid is screwed down. A piece of foam sponge placed on top of the battery will prevent it from moving when in use.

The switch used in the prototype is a changeover type and modified with a diagonal link to make it into a s.p.d.t. switch as required, see Fig. 3.

IN USE

The unit is intended to be interposed between the musical instrument and the amplifier. Although intended for electric guitar, there is no reason why any other instrument or microphone shouldn't be used. In one position of S1, the signal will be unaffected in sound or volume. In the other, the input signal will have the higher frequency content boosted, the level of boost being controlled by VR1.

The Treble Boost can be made to look "professional" by fixing a label and lettering the controls and sockets with Letraset for example. A coating of clear lacquer or polyurethane should be applied to protect this. Self-adhesive rubber feet can be fitted that will prevent the unit from moving when operated, as well as enhance its appearance. ☐

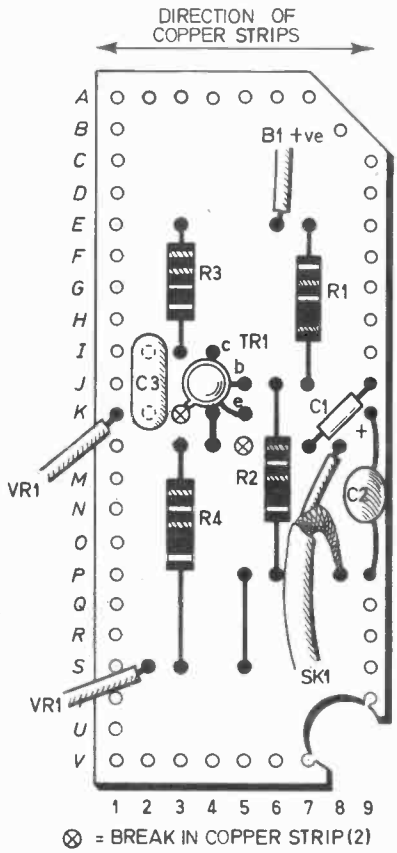


Fig. 2. The component layout on the circuit board shaped to suit the slotted case.

COMPONENTS

See Shop Talk page 159

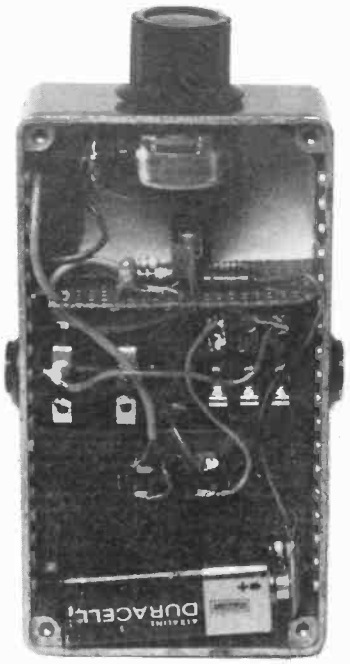
Resistors
R1 470kΩ
R2 150kΩ
R3 10kΩ
R4 2·2kΩ
All carbon ¼W carbon ± 5%

Capacitors
C1 3·3nF ceramic plate
C2 0·47μF 10V tantalum (for size only)
C3 0·05μF plastic or ceramic

Semiconductor
TR1 BC109 *npn* silicon or other low noise type

Miscellaneous
VR1 10kΩ carbon log. Jaw shafted type
S1 single-pole changeover successional action foot-switch (see text)
SK1 standard stereo jack
SK2 standard mono jack
B1 9V type PP3
Stripboard: 0·1 inch matrix size 22 strips × 9 holes; battery connector for B1; case, Bimbox 5003/13 enamelled diecast box; control knob; screened cable.

COMPONENTS approximate cost £3·50



View inside the prototype with base (lid) removed. You can see the card beneath the circuit board which prevents shorting of the board against the case.

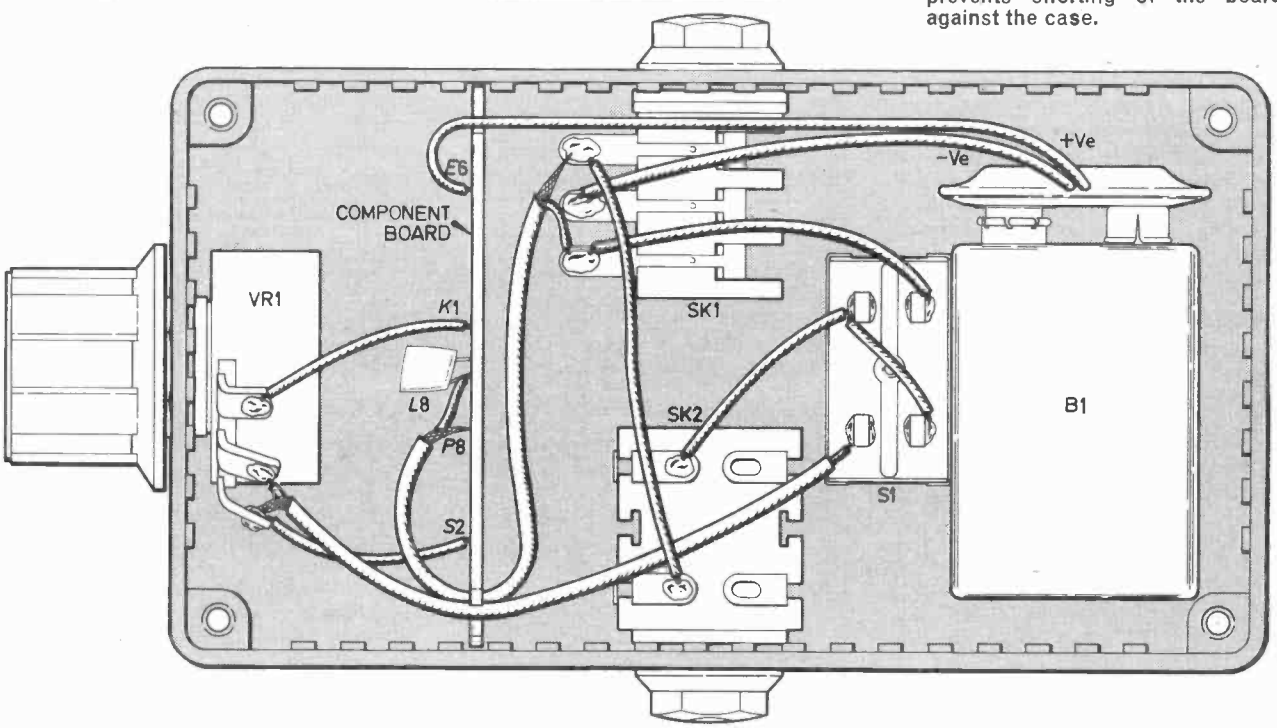


Fig. 3. The positioning of the components within the case and interwiring details.

MODEL RAILWAY POINTS CONTROLLER

BY S. J. SPREADBOROUGH

WHEN points in a model railway are remote from the operating position, it becomes necessary to use a "point motor," usually consisting of two solenoids pulling a bar backwards and forwards to move the track. In a simple system, 16V a.c. is applied momentarily across the coils to operate the motor. These coils, however, have a very low resistance and virtually short circuit the transformer. If operated for a long time possible damage to the motor and/or transformer could result.

Capacitive discharge systems, such as that to be described in this article, provide a large pulse of current to activate the motor, reducing to virtually zero after the initial discharge. This current limit feature results in no risk of damage to the motor. Commercial units are available which will charge up a capacitor, but not all incorporate the current limit facility included in the design here.

CIRCUIT DESCRIPTION

The circuit diagram of the controller is shown in Fig. 1. Transistor TR3 charges up the capacitor, C1, at a constant current of about 1 ampere. The base current is supplied by R2 and TR2. When the output is connected to a point motor there is a very large initial burst of current as C1 discharges through the motor. TR3 will then attempt to recharge the capacitor, but while the points button is pressed, all the charging current flows through D1 and D2 which develops a voltage of about 1·4 volts across the pair. This is sufficient to switch on TR1 which cuts the base current to TR2 and thus TR3. The short circuit is therefore limited to that value which will develop enough voltage across D1 and D2 to switch on TR1. In the prototype this was about 10mA.

On release of the button, no voltage is developed across D1 and D2, TR2 is turned on and so the full charging current flows and charges up the capacitor.

The charging current is determined by R1 and R2 and the gain of TR1. To increase the current, reduce R2. The limiting current is determined mostly by D1 and D2 but also to a certain extent by R3. Reducing R3 reduces the limiting current.

POWER SUPPLY

The unit should be supplied from a smooth d.c. supply in the range 16 to 20V. The 12V d.c. "uncontrolled" output from many train controllers is suitable but will require smoothing. A suitable circuit for this is shown in Fig. 2. If such an output is not available in the system, then a mains derived supply will need to be made. A suitable circuit for doing this is seen in Fig. 3. See the Component List for full specification for these components.

CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

The unit circuitry is constructed on a small piece of fibreglass printed circuit board. The full-size pattern for this is shown in Fig. 4. The black

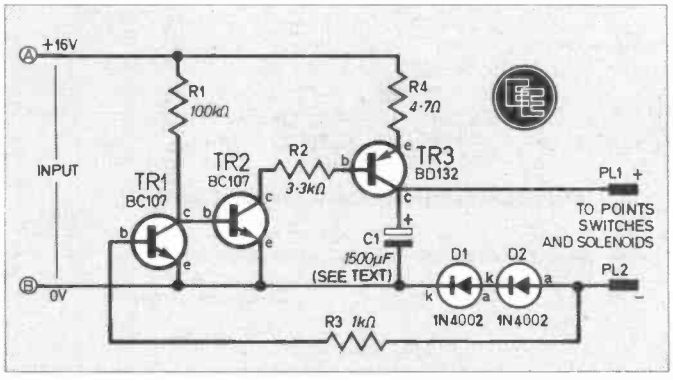


Fig. 1. The circuit diagram of the Points Controller.

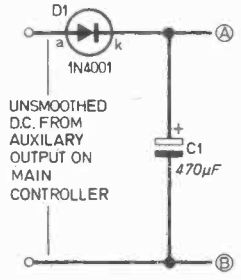


Fig. 2. A suitable smoothing circuit for use with an "uncontrolled" controller output.

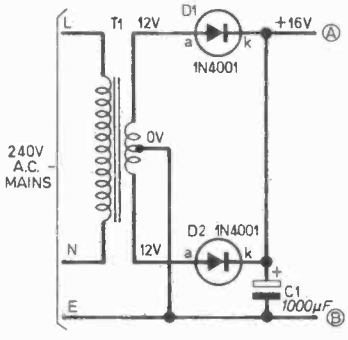


Fig. 3. A self-contained mains derived d.c. supply.

areas are the regions of copper to remain after etching.

The layout of the components on the topside of the board is shown in Fig. 5. Care should be taken when positioning and soldering D1 and D2 as these components form the protection circuitry input.

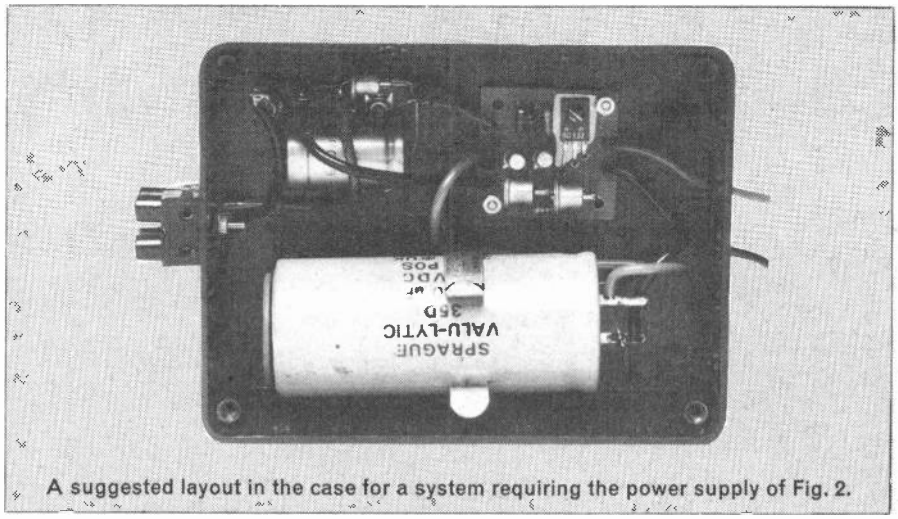
In the prototype, observant readers will see in the photograph that a double-sided p.c.b. was used, the area remaining on the topside providing a heatsink for TR3. If it is expected that the unit will be charged and discharged at a high rate, then a heatsink should be fitted. A small piece of 1 or 2mm thick drilled aluminium can be fitted behind the transistor casing.

No provision has been made for mounting the capacitor on the board as this is a very large component compared with the other components and their board area.

ASSEMBLY

The wires for connecting the capacitor to the board should be heavy gauge (flexible 2-core mains cable is suitable) and kept as short as possible. The output wires should be of similar thickness. Good soldering is required here, as any resistance in these leads will derate the performance of the unit.

The basic unit is small enough to be incorporated in most layout control panels, or alternatively could be fitted in its own case as seen in the photograph. Here the "uncontrolled" controller output is assumed to be employed and so the circuit of Fig. 2 is seen wired on a short length of tagstrip. The size of the case will largely be dependent on the capacitor used.



A suggested layout in the case for a system requiring the power supply of Fig. 2.

COMPONENTS

See Shop Talk page 159

COMPONENTS approximate cost £2·50 excluding supply and case

Resistors

R1	4·7Ω	R3	1kΩ
R2	3·3kΩ	R4	100kΩ

All ¼W carbon ±5%

Semiconductors

D1, D2	1N4002 1A 100V silicon (2 off)
TR1	BC107 *npn* silicon
TR2	BC107 *npn* silicon
TR3	BD132 *pnp* silicon

Miscellaneous

C1 1500μF 20V elect. tag end (see text)
PL1, 2 4mm banana plugs (1 red, 1 black) (optional)
Printed circuit board, fibreglass size 35 × 35mm; Terry clip for C1; screw terminal block; heavy duty insulated wiring; 6BA fixings.

D.C. Supply

(Fig. 2)		(Fig. 3)	
C1	470μF 20V elect.	C1	1000μF 20V elect.
D1	1N4001 1A 50V silicon	D1, D2	1N4001 1A 50V silicon
		T1	mains primary/12-0-12V 0·5A secondary

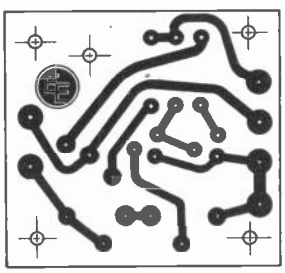
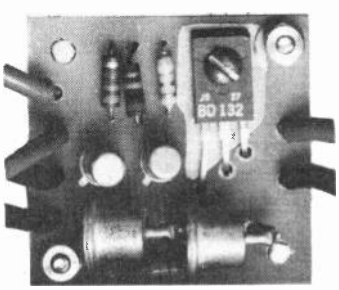


Fig. 4. Full size master of the prototype p.c.b.



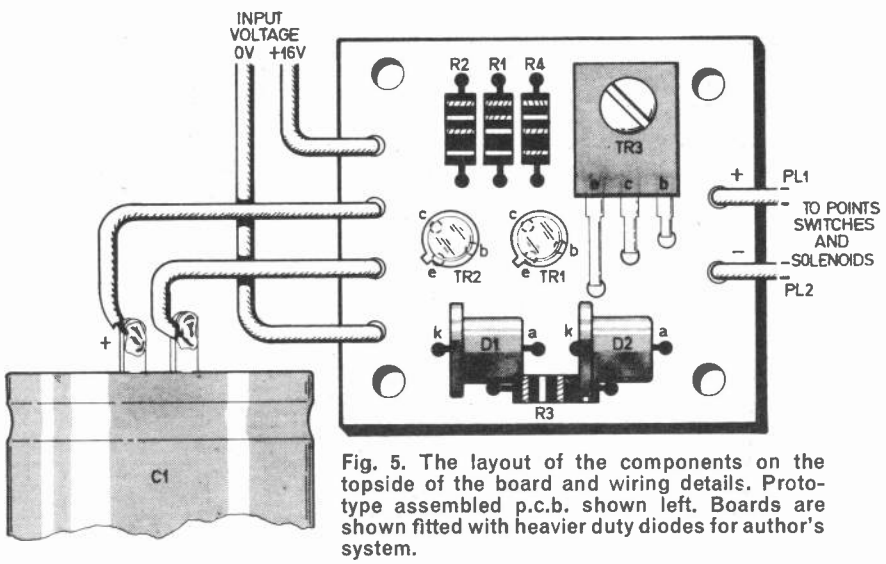


Fig. 5. The layout of the components on the topside of the board and wiring details. Prototype assembled p.c.b. shown left. Boards are shown fitted with heavier duty diodes for author's system.

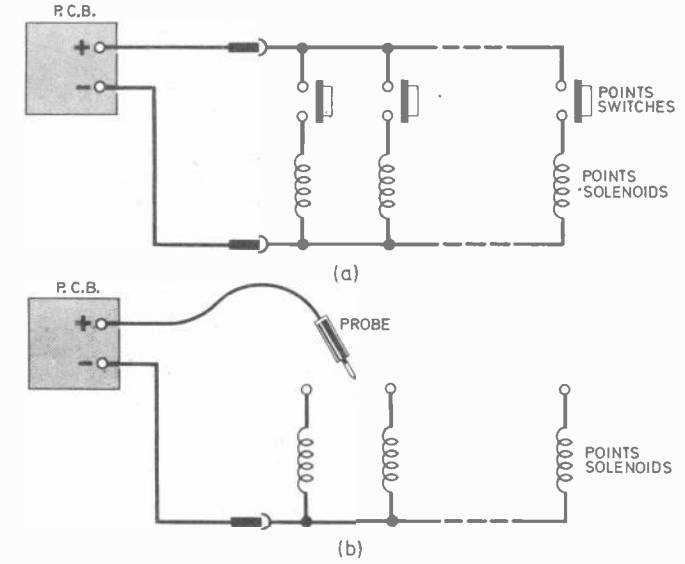


Fig. 6. Showing two methods of using the unit to operate more than one set of points. (a) via a bank of momentary action push button switches and (b) a probe system. The probe contacts or switches could be positioned on a map of the track system for obvious practical purposes.

CONNECTION TO POINTS

The output −ve (PL2) is taken to a common connection of all the point motors, the output +ve (PL1) goes to a probe or a set of push buttons (see Figs. 6a and b).

This unit is ideal for use with diode matrices to operate several points simultaneously. The capacitor value should be increased according to the number of points operated. "Peco" point motors require about 1500μF each, "H & M" motors require rather more.

When using push buttons, the button should be pushed firmly to avoid excessive sparking which can drastically reduce switch life.

If a very much larger capacitor is used, it is suggested that D1 and D2 be replaced by types 1N5402.

CONCLUSION

The prototype has been operating well for about two years charging up a 30,000μF capacitor which operates up to seven points simultaneously through a diode matrix. Charging time is about 0·5 second which is fast enough to be unnoticeable. ☐

Bright Ideas

"February Fill Dyke". An old country saw! Yes I am aware this is the March issue, but you will all be reading this in February. Anyway, the meaning is fairly clear; it means it rains in February fairly hard.

I expect the Magazines will produce their usual crop of rain warning devices. Last year I adapted one of these to tell me if my storage water tank was overflowing.

As to weather, well I always use a "Donkey Barometer" myself. This consists of a small china donkey with a string tail. It works like this: If the tail is wet, it's raining. If it moves, it's windy. If it is solid, it's freezing. If you can't see it, it's foggy. If it falls out, it's an Earthquake!

I am all for simplicity in design, whether it is mechanical or electronic, but not so the back room boys, bless their hearts. They are not happy unless they can put in a collection of i.c. triacs, flip-flops etc. Take a simple thing like a fuse tester. To my way of thinking all you need is a pair of leads, an l.e.d., a suitable resistor and a battery. If the l.e.d. lights up the fuse is O.K., if it doesn't, it's dud.

Give it to the Boffins and when they have made it to their liking you finish up with a gadget with flashing red and green lights indicating good or bad, plus an array of buttons and switches. However, we would be lost without them (the technical chaps, not the buttons and switches). Long may they continue to flourish.

Design Register

In a recent article I advised you against going to the expense of taking out a Patent on any idea you had developed. I suggested instead, that you registered the design.

One reader wrote to ask me how you register a design and asked why I didn't write an article on the subject? Well the answer is, this ground has already been well covered by the Patent Office itself.

If you require information on this subject write to: Designs Registry, The Patent Office. 25 Southampton Buildings, London, WC2A 1AY. They will send you free of charge, a booklet called *Protection of Industrial Designs*, plus an application form.

Hot Stuff

I read with great interest the splendidly illustrated article *Making Printed Circuit Boards* by Mr. Dollin (January issue). If I could add my two bits worth. We put an etching kit on the market a few years ago but before we released it we experimented with Ferric Chloride in various forms. To elaborate, it is available in at least three forms.

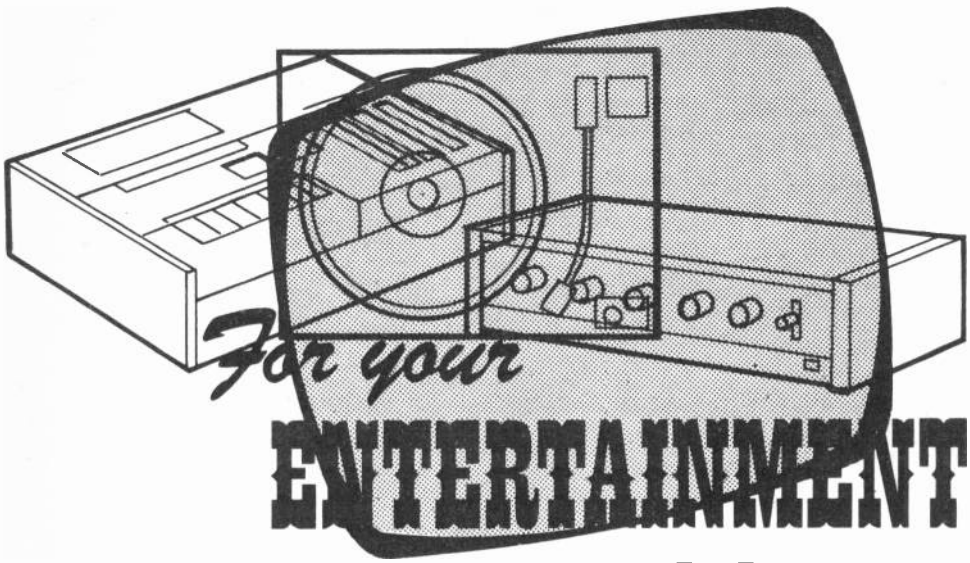
The commercial grade which is like pale yellow rock candy, is very hard and very slow to dissolve.

In liquid form sold in bottles at about two pounds (£2) a bottle: very convenient and each bottle will etch about two dozen boards.

Pure Anhydrous Ferric Chloride sold in 1lb bags and double-packed in sealed plastic bags: the pure form and probably the most dangerous, because apart from being toxic and poisonous it produces tremendous heat on contact with water. If you use this, you must always add the crystals to the water, a *fraction* at a time. It is even possible to make the solution too strong, which prevents any etching taking place.

I vividly remember having a pile of this substance in a plastic dish on my desk and without thinking added a dessert spoonful of water. Within seconds the mixture became so hot, it melted the dish and poured on to my desk, completely destroying a pile of unpaid bills.

I was naturally delighted but if you do use this type be *extra* careful and store it in an airtight jar.



By BARRY FOX

The Spoilers

Here's an opportunity for readers to exercise their brains. Record companies around the world have always clung to the notion that, given enough time and money for research, scientists will eventually come up with an electronic answer to home taping.

The record companies' idea of Heaven is a so-called "spoiler" signal which is recorded on a disc or tape or is broadcast along with the music. This spoiler is inaudible during normal listening but somehow, magically, confuses a tape recorder when an attempt is made to make a copy. Let's look first at what is already well known to be possible but impractical.

The spoiler signal must obviously be too high pitched or too low pitched or of too low a sound level to be heard during normal listening. If a very high pitched signal is recorded on top of the music, then it will be inaudible to most humans and may under certain circumstances beat with a tape recorder bias signal (which is usually at between 80 and 100kHz) to produce a lower pitched and thus audible whistle on tape.

You can make such a system work in a laboratory but not in practice. For example you can't normally transmit ultrasonic signals by radio; the transmitted audio bandwidth is too narrow and the spoiler interferes with the stereo pilot tone. You can't record ultrasonic signals on a Musicassette tape for the simple reason that high speed duplicated Musicassettes seldom offer even a full audio bandwidth, let alone extend to ultrasonics (above 20kHz).

It *is* possible to cut ultrasonic signals onto an ordinary disc record and this was the basis of at least two of the old quadraphonic "discrete" systems. But cutting ultrasonic signals on to a disc is very difficult because the cutter heads have a nasty habit of burning out under the strain of high energy high frequencies.

When ultrasonic signals are reproduced on domestic systems they can burn out the loudspeaker tweeters and they can also disturb pets and some young people—especially women—whose hearing extends above the normal aural range. More to the point most domestic gramophone pick-ups will not track an ultrasonic signal or it will be filtered off to the connecting leads.

And talking of filtering, it's all too easy to filter off an ultrasonic signal deliberately and so defeat the spoiler system.

Filters

The same proviso extends to low frequency spoilers. The aim here is to saturate the tape with an inaudibly low frequency signal or confuse any automatic gain control by producing a slowly fluctuating low frequency signal.

This can be achieved by cutting a low frequency tone into the disc groove or burying a small permanent magnet under the record label so that as it rotates it produces a pulsed field in a magnetic pick-up. But low frequency signals can easily be filtered off with a simple high pass filter. It's really all only common sense. If a signal is too high or too low to be heard, then it can be filtered out without any audible effect on the music.

If the spoiler signal is in the audible range, e.g. between 30Hz and around 16kHz it will have to be of very low level to remain inaudible. It thus remains impotent as a spoiler and risks being lost in electronic noise created by the reproduction chain. It can also be removed by a noise gate or notch filter without adversely effecting normal reproduction.

The issue of normal reproduction is crucial. It's perfectly possible to issue records which can't easily be copied onto tape.

If a very wide dynamic range of music is recorded, with unlimited peaks, it can be virtually impossible to copy the recording onto a domestic cassette recorder with any degree of fidelity. Quiet passages will recede into ground noise and the unlimited peaks will saturate the tape, causing overload distortion.

However, such records will be unsuitable for most normal domestic use. The low passages will recede into room and system noise and the unlimited peaks will overload the amplifier and loudspeakers causing clipping distortion and bringing complaints from the neighbours.

Distorted Interview

It is sometimes possible to prevent a tape recorder from working properly. Several years ago a BBC reporter went to the Chinese Embassy with a recorder hidden under his coat. When he returned to the BBC newsroom proudly carrying a candid taped interview he found that although the machine was working perfectly before and after entering the building, the clandestine recording made inside the Embassy was badly distorted.

The mystery was never solved, because you can hardly ask someone to explain how they prevented you making an unauthorised recording. But it's likely that the Embassy rooms are saturated with a heavy magnetic field which in some way upset the bias circuits of the recorder. Alternatively the rooms could have been drenched in very low frequency soundwaves.

Something similar has been proposed to prevent unauthorised concert recording and an optical version is used by some Japanese factories to prevent unauthorised photography. In addition to ordinary illumination there is hidden, invisible, ultraviolet light which fogs every shot taken with a normal camera.

Digital Spoilers

The record industry is staffed by some of the world's best electronic engineers and is wholly dependent on high technology for its daily bread; the gramophone record is arguably the most precision item ever mass produced from plastic. But industry executives seem oblivious of the kind of simple factual breakdown given above. They still talk vaguely about a spoiler signal one day becoming a practical proposition. There is now even talk of digital spoilers.

Naively, record companies believe that digital records will be uncopyable. This may be so; it may prove impractical for the public to copy digital recordings in the digital mode. But because we all hear through ears which operate in analogue fashion, every digital reproduction chain will have to have a digital-to-analogue converter at some stage, probably in the amplifier. It's here, where the signal comes back to analogue, that copying must take place.

Research Guide

Every few months now it seems the record industry talks again of spoilers and the uncritical music press reports such talk enthusiastically. All round the world enthusiastic engineers are unwittingly re-researching the same old spoiler ideas that others already found to be a dead duck.

At the first hint of success they secure some publicity. But when they finally realise that their system is impractical there is no publicity. So someone, somewhere is soon re-researching the whole idea again.

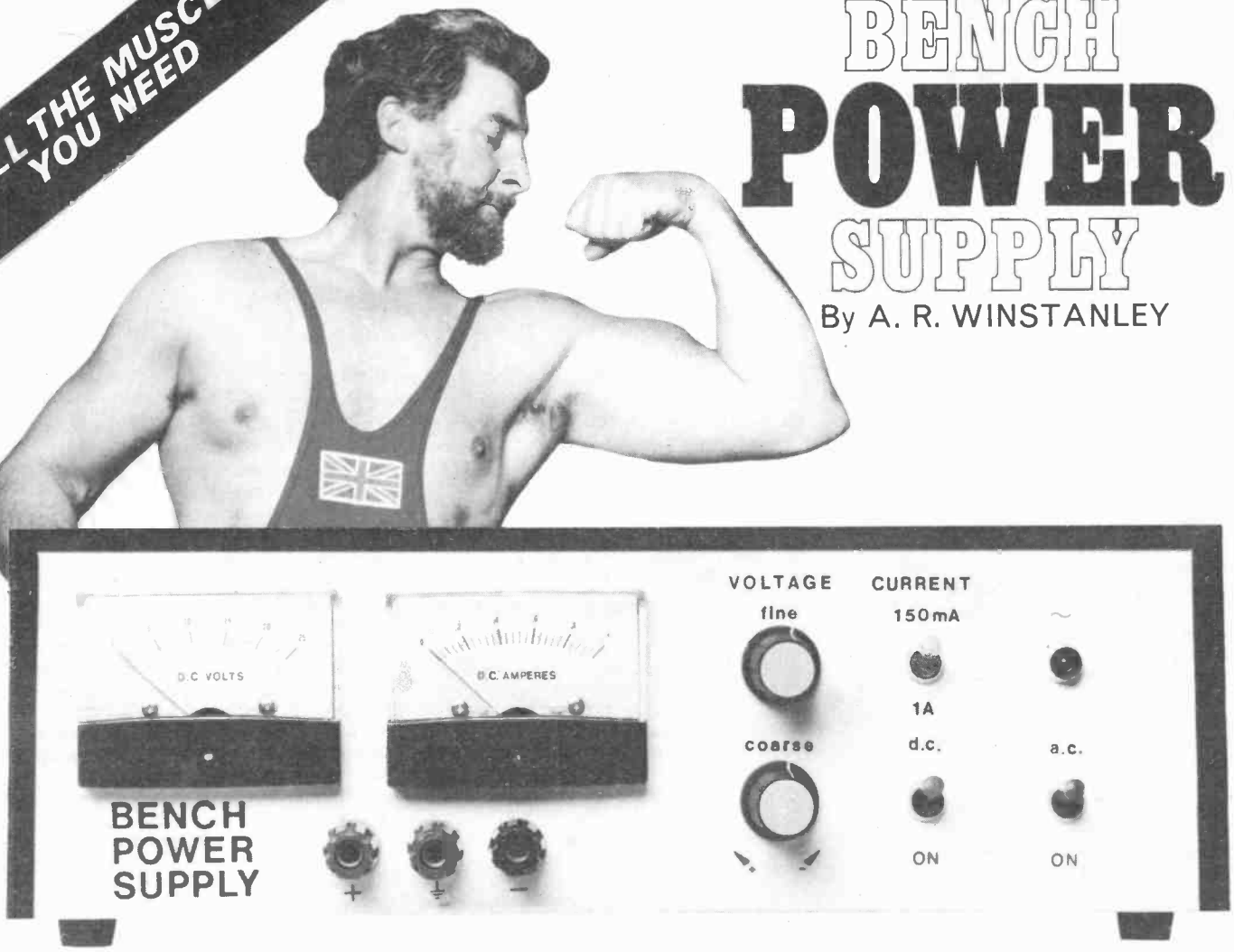
Several years ago the British Phonographic Industry, the trade body which represents the British record companies, commissioned a £10,000 report on spoilers by the Wolfson Unit of Southampton University. Predictably and understandably Wolfson came up with no practical spoiler system. But less understandably the BPI steadfastly refuses to release the report and so steer researchers away from the blind alleys investigated by Wolfson.

It seems that if electronics engineers around the world are to avoid further wasted research they will have to organise their own pool of dead ends.

ALL THE MUSCLE YOU NEED

BENCH POWER SUPPLY

By A. R. WINSTANLEY



ANY CONSTRUCTOR who intends taking more than a casual interest in electronics will wish to amass a useful selection of test equipment. Certainly a major requirement for any serious enthusiast is a variable power supply.

This would facilitate the operation of projects and circuits under testing from a highly stable mains-powered source, eliminating problems normally associated with the use of dry batteries in such a role.

The Bench Power Supply unit described here should meet the needs of the majority of enthusiasts.

The electronics behind this project is greatly simplified by the utilisation of two modern integrated circuit regulators, type LM317. Construction therefore is quite straightforward and is suitable for the less experienced enthusiast who possibly wishes to build their first item of test gear.

SPECIFICATION

D.C. Range: 1·25 to 25V variable
A.C. Range: six fixed outlets giving 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 or 30V.
Current limit: 1A or 150mA switched.
Regulation: ± 3% on prototype.
Ripple: 4mV peak to peak at full load.

REGULATOR I.C.

The integrated circuits are variable voltage regulator/current limiter i.c.s which are extremely easy to use. They are capable of supplying 1·5 amps over a voltage range of 1·2 to 37 volts. Within the device there is all the usual overload protection which is only available in i.c.s, including in-built current limiting and thermal overload shutdown.

The device is shown in Fig. 1 in its basic voltage regulator mode. It can be seen that there are only three terminals, namely input, output and "adjustment".

A 240 ohm resistor is usually placed between the output and adjustment pins, and a highly stable 1·2V reference voltage is present across this resistor. The output voltage is determined by the resistance of R_x and the value of this component is given by:

$$R_x = \frac{(V_o \times R1)}{1{\cdot}2} - R1 \text{ ohms}$$

or with R1 equal to 240 ohms,

$$R_x = 200V_o - 240 \text{ ohms}$$

In practice it is wise to substitute a preset for R_x so that exact trimming of the output voltage can be achieved.

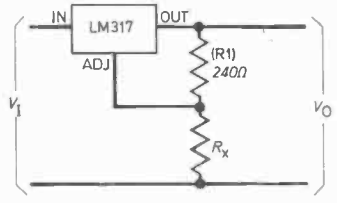


Fig. 1. Voltage regulator circuit.

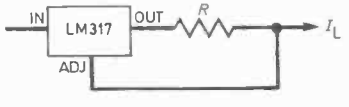


Fig. 2. Current regulator circuit.

Virtually the only way to destroy the device is to exceed the maximum input-output differential voltage of 40V. Power dissipation however is internally limited by the protection circuitry. Otherwise the i.c. is nearly indestructible.

The LM317 already has a built-in current limiting circuit. This limit level depends mainly on the temperature of the chip and also the input-output differential voltage. A typical value for the LM317K (TO-3 package) is 1·5 to 2·2 amps.

The i.c. can also however be utilised as a precision current-limiting circuit, see Fig. 2. Here the precision reference voltage is placed across a series power resistor, and by altering the value of R, various current-limit values can be obtained. If I_L is the desired limit level, the value of R will equal $1·2/I_L$.

Due consideration must be paid to the power dissipated in this resistor (equal to $1·44/R$). Also, R must not be less than 0·8 ohms or in excess of 120 ohms. Note that the current-limit level does not vary in a linear fashion, and the use of a power potentiometer does not give very good results.

Finally, the i.c. is generally available in three packages. The TO-3 version should be used in this design.

CIRCUIT DESCRIPTION

A block diagram of the Bench Power Supply can be seen in Fig. 3 and the complete circuit diagram appears in Fig. 4.

Mains voltage is applied to the primary of T1, a multi-tapped transformer, via the mains on-off switch S3. The neon indicator LP1 illuminates when the mains is switched on and RV1 is a mains transient suppressor. This is optional and can be omitted if required.

The secondary of T1 has six tappings: 0, 12, 15, 20, 24 and 30V a.c. These are extended to the back panel of the cabinet using SK1-6 as connectors to exterior equipment.

By connecting between different sockets, it is possible to extract all of the fixed a.c. voltages mentioned in the specification. This a.c. facility has proved to be quite useful, but if readers do not consider it necessary to their requirements, then T1 can be substituted by a transformer having simply a 30V a.c. one amp secondary.

The 30V a.c. tapping also provides the main supply rail for the power supply unit proper. This voltage is rectified by D1-4 and smoothed by C4 to give a rough unregulated d.c. voltage of 42V no load, 35V full load.

Transistors TR1 and TR2 form an emitter follower pair of reasonably high gain. Diodes D5 and D6 are Zener diodes which clamp the base of TR1 to about 32V (plus or minus the tolerance on the Zener diodes) and R1 limits the current through the Zeners.

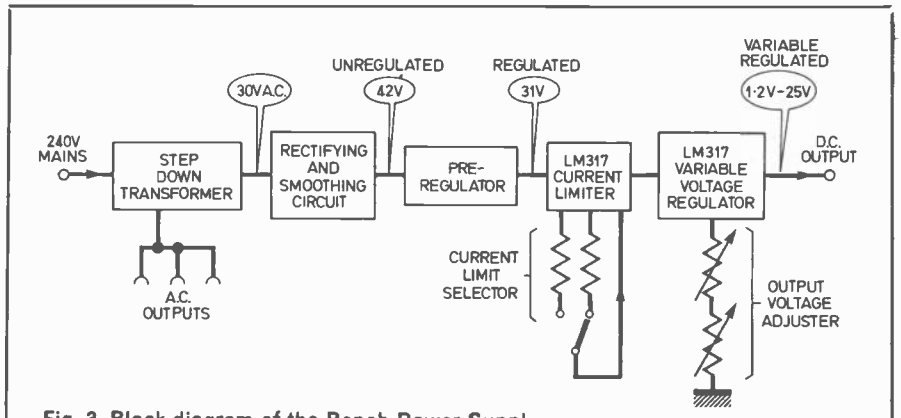


Fig. 3. Block diagram of the Bench Power Supply.

Now, the emitter of TR1 will be 0·6V less than its base, that is about 31·4V. Similarly the emitter of TR2 is 0·6V less than its base, roughly 31V. Capacitor C6 provides local smoothing and reduces any noise across the two Zener diodes.

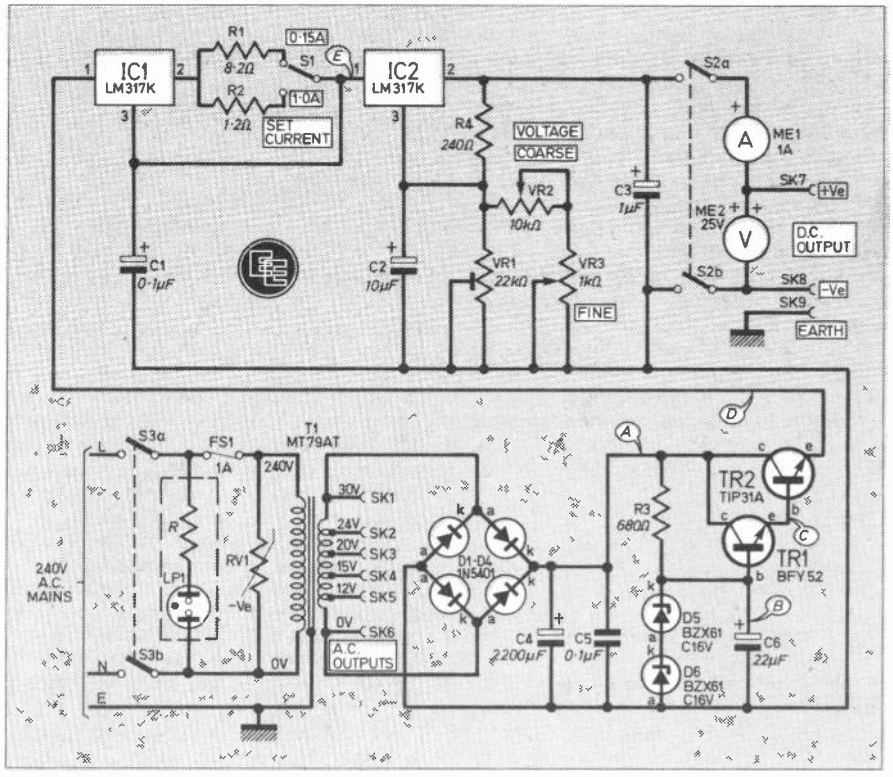
PRE-REGULATOR

Initial prototypes did not employ this two-transistor circuit but the effects of using a "pre-regulator" are several. For example, nearly all of the ripple present on the supply line is filtered out by the Zener diodes and suppressed at the emitter of TR2. The supply rail is pre-regulated to 31V, no matter what the emitter current of TR2, and after allowing for the tolerances of the Zeners a very stable rail is achieved. The smoothing effect of C6 is amplified by the combined gain of the two transistors, its effect being equivalent to using a large smoothing capacitor on the supply line, and, most importantly the maximum input-output differential voltage of the i.c.s will not be exceeded.

The pre-stabilised 31V rail is passed to IC1 which is connected as a current-limiter circuit. The in-built two-amp current-limit level of the i.c.s, was regarded as being too high for Bench Power Supply use and a level of one amp was thought to be satisfactory. Furthermore a glance through some catalogues showed that 2 amp transformers can be very expensive!

The resistor determining the current-limit value is selected by S1.

Fig. 4. Complete circuit diagram of the Bench Power Supply.



Resistor R1 when selected, limits the current to about 150mA by virtue of IC1. When the switch is in this position, should a fault occur in the load under test, the unit will limit the current through the load to a safe value (that is 150mA) thereby protecting most of the components in the test circuit. When R2 is selected by S2, then the maximum current available is one amp.

FINAL STAGE

After the current limiter comes the regulator itself, IC2 and associated circuitry. Resistor R4 is the standard 240 ohm reference component and VR2 and VR3 are panel-mounted potentiometers which provide coarse and fine adjustment of the output voltage.

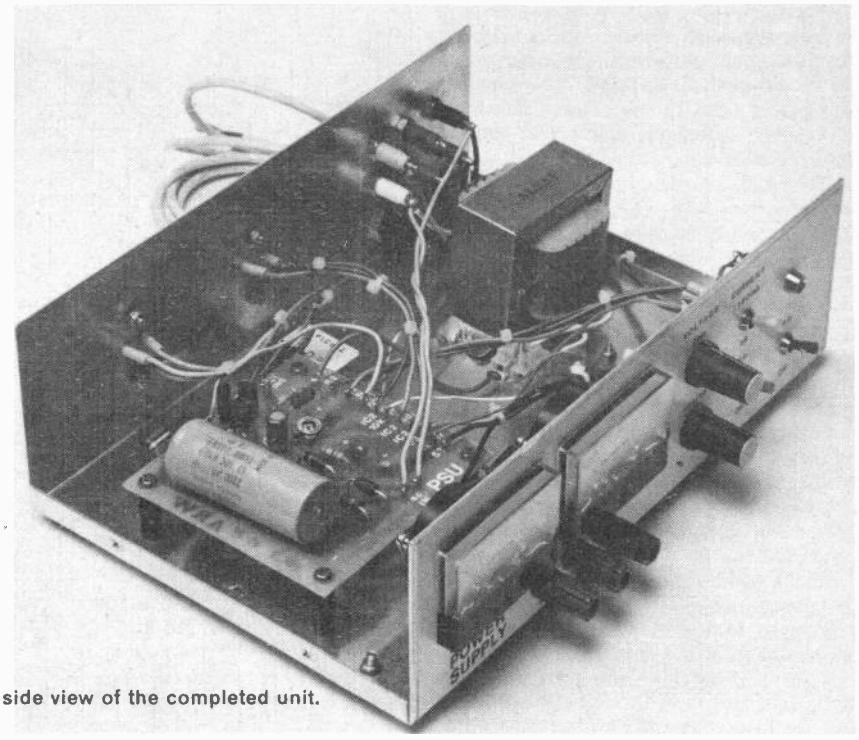
The final control has most effect at the lower end of the output range, and as 25V is approached, it begins to have a decreasing effect.

The maximum output voltage is controlled by VR1. This is the voltage that is available when the two potentiometers are set for a full deflection of the voltmeter (ME2). Preset VR1 enables an exact 25V maximum output to be trimmed, so that the voltmeter is not overdriven.

Capacitors C1, C2 and C3 are additional components which decouple the supply rails and also increase the ripple rejection of IC2 to about 80dB.

Direct current switching is provided by S2. This enables the user to immediately isolate the load undergoing testing and is considerably quicker than using S3 as the on-off switch, because C4 and C3 would tend to retain their charge for many seconds after the unit had been switched "off". Switch S2 compensates for this effect.

Finally, the output current and voltage are together monitored by ME1 and ME2 respectively. The output is connected to SK7 (positive) and SK8 (0V), which are two 4mm binding posts, and also SK9 is a separate earth terminal which enables either the positive or negative line to be earthed if required.


Inside view of the completed unit.

COMPONENTS

COMPONENTS approximate cost £48 complete

Resistors

R1	8·2Ω	R3	680Ω
R2	1·2Ω 3W wire-wound	R4	240Ω

All ¼W carbon ± 5% except R2

Potentiometers

VR1 22kΩ lin. miniature horizontal preset
VR2 10kΩ lin. carbon
VR3 1kΩ lin. carbon

Capacitors

C1	0·1μF 35V tantalum bead	C4	2200μF 63V elect.
C2	10μF 35V tantalum bead	C5	0·1μF polyester C280
C3	1μF 35V tantalum bead	C6	22μF 50V elect. p.c.b. mounting

Semiconductors

IC1, 2 LM317K positive variable voltage regulator, TO-3 can (2 off).
TR1 BFY52 *npn* silicon
TR2 TIP31A *npn* silicon
DI-D4 1N5401 100V, 3A silicon rectifier diode (4 off)
D5, 6 BZX61C16V 1·3W, 16V Zener diode (2 off)

Miscellaneous

S1 s.p.d.t. miniature toggle
S2, 3 d.p.d.t. miniature toggle (2 off)
T1 mains primary/12, 15, 20, 24, 30V secondary at 1A, Douglas type MT79AT
RV1 mains transient suppressor (see text)
ME1 1A f.s.d. moving coil meter
ME2 25V d.c. f.s.d. moving coil meter
SK1-SK6 4mm sockets, assorted colours (6 off)
SK7-SK9 4mm screw terminals (1 red, 1 black and 1 green)
FS1 20mm 1A fuse and panel mounting holder
LP1 mains panel neon indicator with integral resistor

Printed circuit board, 100 × 100mm; metal case, 280 × 190 × 90mm, Norman type WB5; finned TO-3 heatsink (2 off); finned TO-5 type heatsink; TO-3 type mounting kit (2 off); TO-66 type mounting kit; two knobs; p.c.b. mounting pillars; 3A cable for interior interwiring; 2-way connector block; veropins; nuts and bolts for heatsink and p.c.b. mounting; cabinet feet (4 off).

See Shop Talk page 159

CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

With the exception of TR2, IC1 and IC2, the circuit is built onto a glass-fibre printed circuit board measuring 100 × 100mm, see Fig. 5.

In designing the p.c.b., due consideration has been given to the current-carrying capabilities of the copper track. Also an adequate air space must be left around most of the components to enable them to dissipate heat efficiently.

Commence construction of the p.c.b. by soldering in the four rectifiers.

These have thick leads which must not be bent close to the rectifier bodies. Furthermore do not mount the rectifiers close to the board but stand them off slightly.

Proceed with the soldering of the Zener diodes. Mount these vertically, observing correct polarity, and again take care when bending the leads.

Transistor TR1 is fitted with a push-on TO-5 heatsink, but this heatsink is not entirely necessary and it has been suggested merely as a precaution. If used, the radiator must be fitted to the transistor can before the transistor is soldered into place.

POWER RESISTOR

The power resistor, R2, is soldered proud of the p.c.b. surface so that it receives adequate ventilation. During maximum output conditions it will get quite warm in operation, assuming of course that the 1A range is in use.

Everything else on the p.c.b. is straightforward. However make quite certain that the electrolytic and tantalum bead capacitors are soldered in correctly.

Finally, Veropins can be used for connecting flying leads to the p.c.b., and although they were not used on the prototype, in retrospect it would be most wise to utilise them. Check the p.c.b. most carefully and then proceed to the casework.

CASE

The case eventually selected for the finalised model was the "Norman" cabinet, type WB5. This measured 280 × 190 × 90mm and comprised a p.v.c.-covered steel cover and folded aluminium chassis.

It is very important that an *aluminium* chassis is used. If a steel chassis is used, then this can seriously affect the accuracy of the panel-mounting voltmeter. Even the relatively expensive Japanese type used in the prototype was found to be misreading when used in a steel chassis on an earlier model.

Furthermore there is quite extensive metalworking to be performed, and an aluminium chassis will make this very much easier.

General points regarding metalworking are given below, but no details regarding dimensions are given. This will of course mainly depend on the case employed by the individual and also the components and parts used in each instance.

FRONT PANEL

This needs to be prepared to take the following: voltmeter and ammeter, three toggle switches, two potentiometers, pilot lamp and three output terminals.

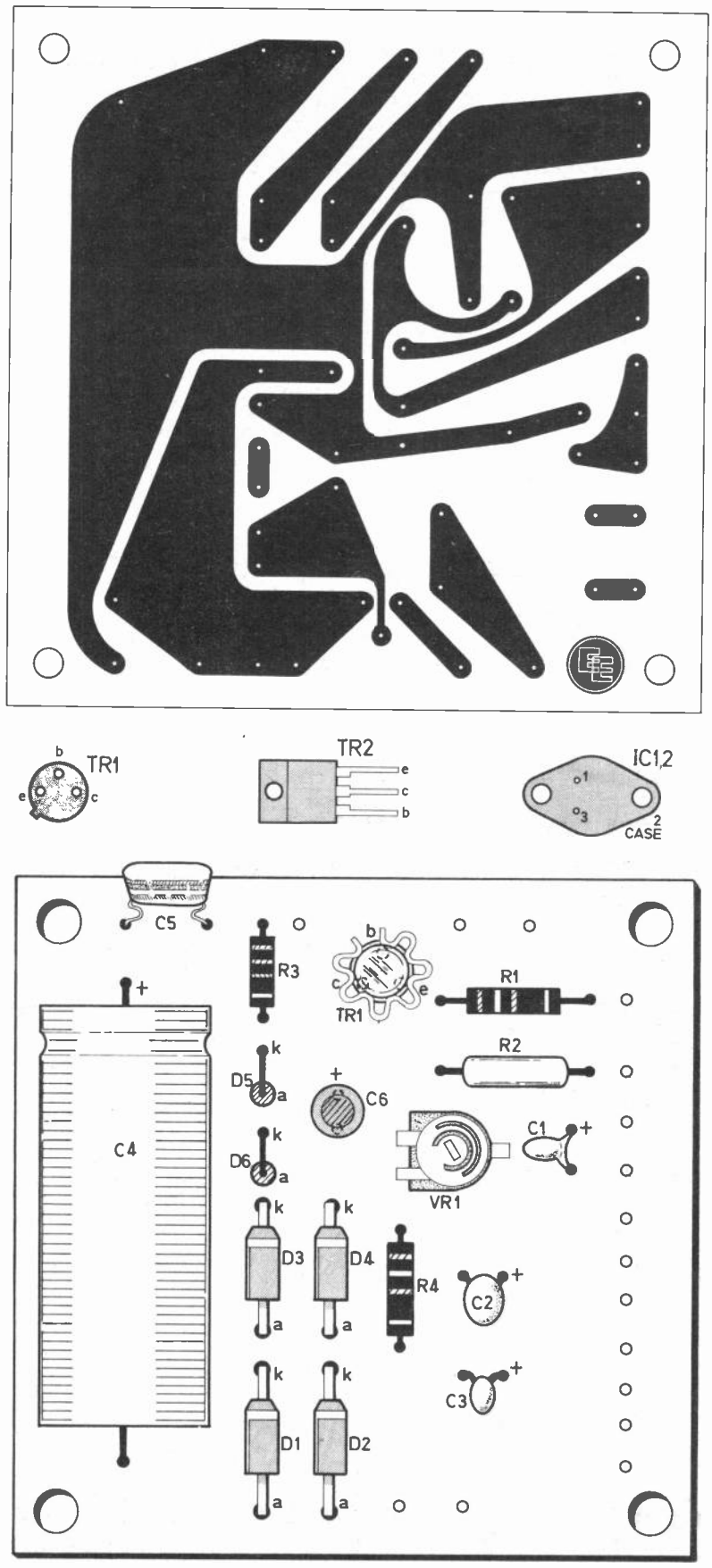
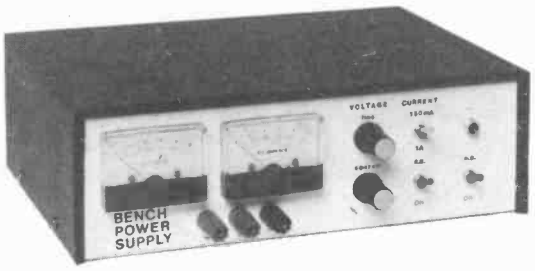
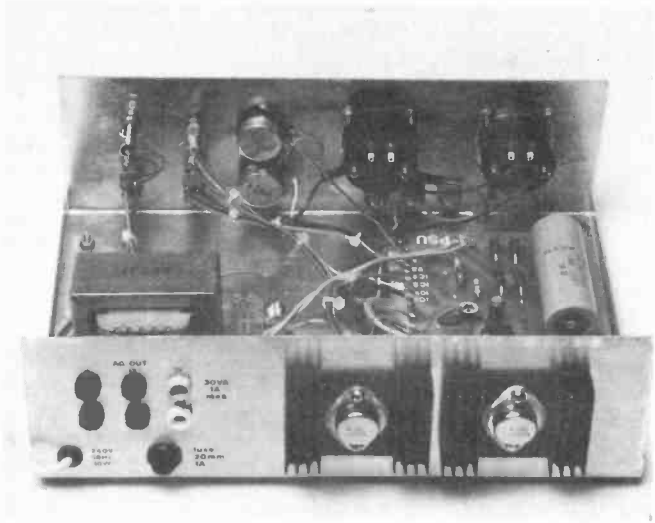


Fig. 5. Foil pattern for the p.c.b. shown actual size. Below this is the component layout and transistor and i.c. outlines. Note that the rectifier diodes D1 to D4 should be mounted clear of the board as should R2.

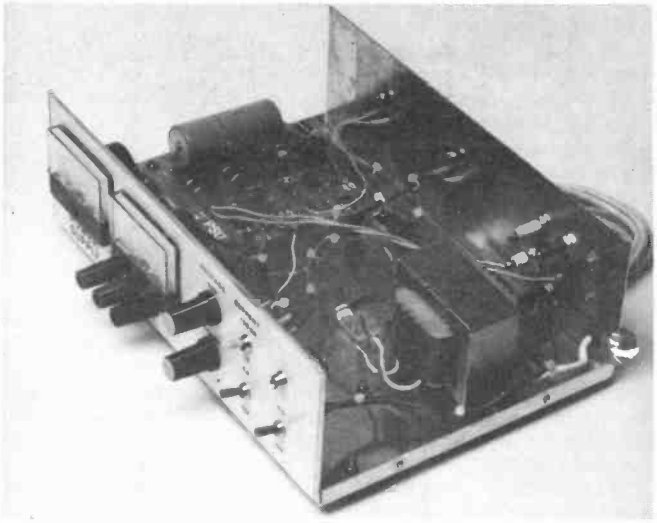


BENCH POWER SUPPLY

Fig. 6. Wiring diagram of the complete unit. The front and rear panels have been folded down for clarity. The regulator i.c.s, IC1 and IC2, must be mounted on heatsinks using insulating mica washers and plastic bushes.



View from rear showing heatsinks for IC1 and IC2 and rear of front panel.



View from side. Note the output sockets for the a.c. voltage tappings.

The large cutouts required for the meters can be punched by using a tank cutter or hole saw. Both devices must be fitted to drills running at a slow speed. Alternatively, a ring of small holes could be drilled, the centre punched out and then the edges filed until smooth, but this can be hard work!

The three terminals require a "key-hole" shaped cutout to take the insulating bushes.

CHASSIS

The bottom of the case carries the p.c.b. mounting pillars (four off), the mains transformer, two-way terminal block and also the power transistor, TR2. The transistor can be fixed down with a 6BA bolt and so requires a 6BA clearance hole in the chassis.

The positioning of the transformer is quite important. It should be placed in one corner, away from the output terminals. If it is too close to the output sockets, then there is the possibility that mains hum could be induced on the output. Also it has been known for the magnetic field of the transformer to have an adverse effect on the voltmeter readings.

REAR PANEL

The two TO-3 i.c.s are mounted, with finned heatsinks, on the rear panel next to each other. Each i.c. will require a mica washer for mounting, and this can be used as a marking-out guide prior to drilling. The devices are mounted using two 4BA bolts each.

Note that the holes which are drilled to take the integrated circuits must be filed quite smooth. There must be no burrs on the edges.

A small hole is needed to take the mains cable inlet. This hole must have a rubber grommet and cable clamp fitted, in order to avoid fracturing or wearing away of the cable insulation on the metal edges.

Six holes may be required for the 4mm sockets if a.c. outlets are incorporated. One final cutout of appropriate diameter carries the chassis-mounting fuseholder.

TOP COVER

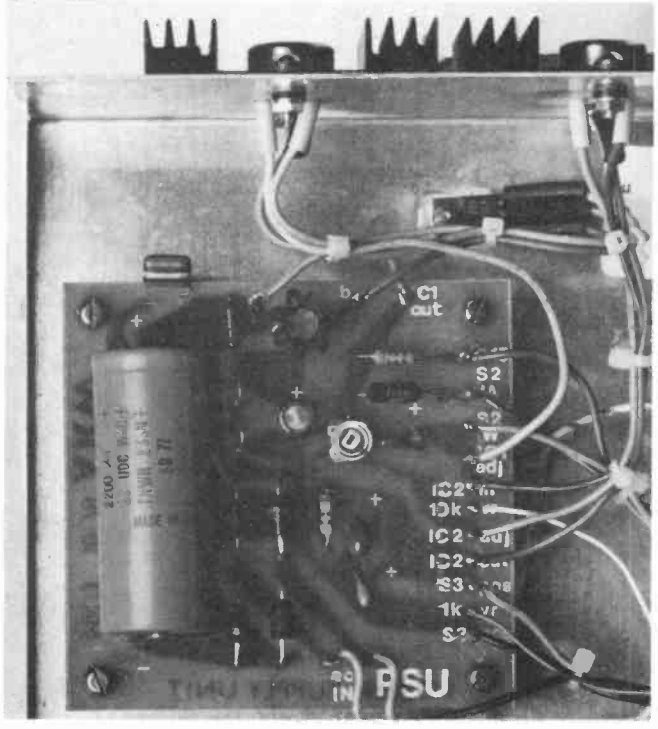
If not already ventilated, then several holes should be made, using preferably a metal punch, in order to allow a throughflow of air.

With drilling completed, all necessary lettering should be carried out at this stage. Use proprietary rub-down lettering and then give the lettered panels several light coats of clear lacquer.

The final part of construction is the interwiring. It is best to start at the mains input and work logically through the circuit. The complete interwiring diagram is shown in Fig. 6.

The earth input is soldered to a tinned tag which is placed under one of the transformer mounting bolts. The mains transient suppressor, if fitted, is connected to the two-way terminal block as shown.

Throughout ensure that interconnecting wire of adequate electrical specification is used. Low tension



Close up view of circuit board. The voltage regulators mounted on finned heatsinks can also be seen and TR2 is shown mounted on the bottom of the case. This must also be insulated from the metal case by using a mica washer and insulating bush. A small amount of silicon grease is smeared between these three items and the metal to aid heat transfer and sleeving is placed over the soldered connections to avoid short circuits.

wires should be rated at least one amp, preferably two to three amps.

Wiring should be completed in accordance with Fig. 6 and then the wires can be arranged into small looms using nylon tying-clips. Note that all looms should be as short as possible and also they should be kept away from the mains transformer and mains interwiring.

Finish off the cabinet with four self-adhesive feet on the bottom of the chassis.

FINAL CHECKS

When construction is complete, check all wiring most carefully. Check the p.c.b. once more and also re-check the connections to the power transistor and two i.c.s.

A resistance check between the earth pin of the mains plug and metal chassis should indicate a short circuit (that is, a good earth connection). Similarly check both the resistance between the tab of TR2 and chassis, and also the cases of the two i.c.s and the chassis.

In both instances the resistances should be infinite, indicating that all three devices are correctly isolated from the chassis. Do not proceed until this aspect is finalised.

If everything appears in order, set VR1 to minimum resistance, and rotate VR2 and VR3 fully clockwise to give maximum voltage output. Switch both S2 and S3 to on. The voltmeter should read approximately 1·2V. Now adjust VR1 to give a maximum reading on the voltmeter of 25V.

Table 1: Test readings for the Bench P.S.U

Location	No load voltage	Full load (*25V at 1A*)
A	42V	35V
B	33V	32·5V
C	32·4V	31·9V
D	31·8V	31·3V
E	30V	27·5V
F	1·2V	1·2V

Check that rotation of the two potentiometers now give both fine and coarse adjustment of the output.

CURRENT LIMITING

Testing the current-limiting circuit depends on what equipment is available, but could consist of placing dummy wirewound resistors across the output and checking that the current-limit switch is performing correctly. If the one-amp current limit circuit appears to operate prematurely, then this could be due to the tolerance on R2.

The effect is that the power supply limits the maximum output current to less than one amp. The remedy is to replace R2 with a similar resistor until a one-amp output is achieved.

Table 1 gives voltage readings taken on the prototype, and can be used if any faults appear to exist in readers' prototypes. Readings for both no-load and full-load conditions are given. ⌑

SQUARE one FOR BEGINNERS

THE CIRCUIT DIAGRAM

ALL electronic circuits, from the simplest to the highly complex, use the same standard or conventional symbols to represent components and to indicate certain kinds of wiring and interconnections.

There is international agreement on most of these symbols, but some alternatives exist. For example the long established zig-zag for a resistor is nowadays often replaced by a non-descript rectangle.

EVERYDAY ELECTRONICS continues to use the zig-zag. It is quicker to draw and represents graphically precisely just what a resistor does: it introduces an obstacle to the easy flow of current. All ordinary straight lines on diagrams joining two or more components represent wire (or some other connecting medium) of zero or very low resistance.

LEFT TO RIGHT

Circuit diagrams are intended to be read "left to right". This is borne out by the numbering of components. The input signal is applied at the left, and the signal progresses through the circuit, being modified or otherwise affected as required, according to the design. Sometimes two or more signals are involved and they may interact upon one another in the process of passing through the circuit.

The final required result appears at the right hand of the diagram as the "output". This output may be directly coupled to say a loudspeaker, or it may terminate at output sockets or terminals on the diagram.

TOP TO BOTTOM

There is however another dimension to a circuit diagram. What has just been described is the *signal path* of a circuit diagram. In addition there must be a source of electric power to operate the circuit. In its simplest form this can be a dry battery. The battery is usually drawn at the far right of the diagram and its positive side is connected to the top horizontal "h.t." or "+Ve" line. The negative side goes to the bottom horizontal line, which is sometimes earthed.

From this it will be gathered that electronic circuits are drawn with the highest positive voltage points at the top of the diagram.

Any component or combination of components connected between the upper and lower horizontal lines will have developed across it the full voltage of the battery. In the case of two or more components in series, the total voltage is distributed across the individual components in proportion to their ohmic values. All points connected to the bottom "0V" or "earth" line are at this same zero potential or voltage.

A PRACTICAL EXAMPLE

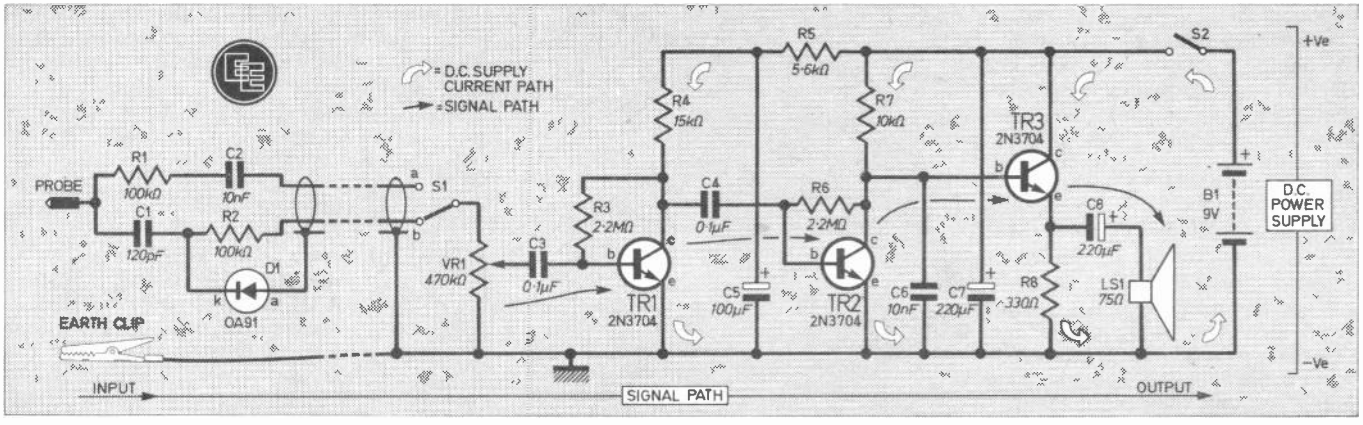
A circuit diagram of a Signal Tracer (February issue) is reproduced here in Fig. 1 as an example. Study this carefully, noting particularly the symbols used to represent different components, and the "circuit references" given to those components.

POLARISED CAPACITORS

Capacitors C5, C7 and C8 are electrolytic capacitors and are "polarised". The symbol shows one of the plates in outline and this is further identified by a "+" sign, whilst the other plate is blacked in. On the actual component one of the tags, leads or terminals will be marked "+" (positive). This side of an electrolytic capacitor must always be connected in accordance with the circuit diagram.

Other (non-polarised) capacitors are represented by two solid black plates, and may be connected into the circuit either way round—like resistors.

Fig. 1. Circuit diagram for a Signal Tracer *(from February issue of EE)*, This is a good example to study, the design is simple and it uses commonplace components. These are resistors (including a variable potentiometer), capacitors (polarised, electrolytic and non-polarised types), two switches, a loudspeaker, and four semiconductor devices: a diode and three transistors. The diagram is drawn in the conventional manner and it will be seen that it has "two dimensions":
(1.) The Signal Path: The signal (high frequency a.c.) proceeds from left to right across the diagram.
(2.) The D.C. Power Supply Circuits: Power to produce the required amplification is supplied by a 9V dry battery. This supplies direct current to each of the three transistors, positive side to the collectors. The supply circuits are completed via the emitters back to the negative side of the battery.



I.C.s EXPLAINED PART 6

by O.N. BISHOP

LAST MONTH we discussed several types of logic gate, the basic units from which the greater part of all other logic circuits are constructed. Gates have the simplest type of behaviour in that, if we know what their input is now, we can say exactly what their output should be.

The circuits described in this month's article have an additional feature: their output now may depend not only on what their inputs are now but also on what they were in the past. These are sequential circuits that go through a series of states one after another.

There are several kinds of sequential circuit. Those we are dealing with here all have two distinct states. It is possible for the circuit to change or be forced to change from one state to another. We can think of the circuits as changing or vibrating from one state to the other, over and over again—hence their name, *multivibrators*.

BISTABLE MULTIVIBRATORS

The simplest of all multivibrator circuits illustrates the points mentioned above. It can be constructed from just two logic gates. Fig. 6.1 shows two NAND gates connected to form a *bistable* (to save space we will leave out that long word "multivibrator" from now on).

The circuit has two inputs, Set (S) and Reset (R). It has two outputs, Q and $\overline{Q}$, of which $\overline{Q}$ is normally the inverse of Q. Fig. 6.2 shows how the circuit works. Normally, both inputs are high (or 1), as at (a). The circuit is stable in this state, as you can check by comparing the inputs and output of each gate with the truth table.

What happens if the Set input is made low? In (b) we see one possible result: Q goes high, so both Q and $\overline{Q}$ are high for an instant, but the circuit

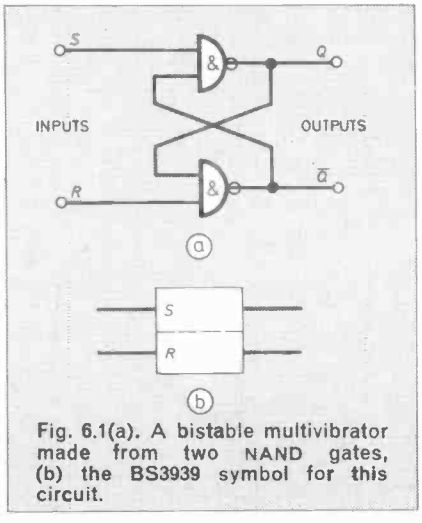


Fig. 6.1(a). A bistable multivibrator made from two NAND gates, (b) the BS3939 symbol for this circuit.

immediately goes on to stage (c). This is its other stable state. It remains in this state whether S stays low as in (c) or reverts to high as in (d). The name *bi*stable derives from the *two* stable states.

What happens now if S is made low as in (e)? The answer to that question is *nothing!* We can see how the response of the circuit depends on what the inputs were in the past.

Once the circuit has been set, by making S low, further setting has no effect. To reset the circuit to its original state, we must make input R low. We can think of the circuit as having a memory—it remembers which of its inputs was the last one to be made low. This bistable circuit was used last month on the *Who-was-first* monitor. Being a sequential circuit, it told us in which order the two buttons had been pressed.

Building bistables from pairs of gates is easy, but bistables are required so frequently that they are available ready-made in integrated form. In these articles we are considering only CMOS i.c.s, though similar devices are available in TTL.

In CMOS, the 4044 contains four identical and independent circuits each consisting of cross-coupled NAND gates as in the circuit of Fig. 6.1 and performs the same function. They have the additional facility of tri-state outputs, the nature of which

was described in last month's article. Such i.c.s are useful in holding (or "memorising") a four-bit binary number, for example, and transferring it to a data bus when the outputs are enabled.

This circuit is often called a *flip-flop*, for it *flips* to one state when set and then *flops* back again when reset. The 4043 i.c. is similar to the 4044, but its flip-flops are built from NOR gates. Their *S* and *R* inputs are normally held low and made high to set or reset the circuit.

D-TYPE FLIP-FLOPS

If we can isolate a flip-flop from its inputs at will, we can "freeze" the output at any instant and hold it unchanged for as long as we wish. This is the function of the *D*-type flip-flop, or *latch*.

The "*D*" stands for *D*ata, indicating that we consider the input to be data (1 or 0) which may be changing rapidly, and we wish to be able to hold it or latch it for long enough to look at it, or to do something else with it. *D*-type flip-flops can be based on simple NAND or NOR gates, as is the rule with TTL, but CMOS circuits generally make use of a different principle.

In Fig. 6.3 a latch is built from four NOT gates and two transmission gates. We will consider the latter in more detail in Part 8 of this series. For the moment, think of the transmission gate (TG) as a switch that can be turned on or off according to the state of a control voltage.

Here the control voltage is applied to the *clock* input. When the clock input is high, TG1 is closed and TG2 is open, as shown in Fig. 6.3. In this state, output Q is the same as input D, since it is D, twice inverted. Output $\bar{Q}$ is D inverted three times, so is the invert of D. Thus the circuit of Fig. 6.3 has a similar action to the more conventional flip-flop of Fig. 6.4, though it operates in a rather different way.

The effect (though not the action) of the clock input is the same in both. When Clock is low, the D input becomes isolated from the output side of the circuit. In the CMOS circuit (Fig. 6.3) TG1 opens and TG2 closes. The outputs remain latched in the state they were at the instant the clock input was made low. In Fig. 6.4, the low clock input to each NAND gate, ensures that their output remains high whatever the state of D. This being so, the flip-flop can no longer be made to change state.

The 4042 i.c. contains four *D*-type latches of the kind shown in Fig. 6.3. It also has a "polarity" input which causes the signal at the clock input to be inverted before it goes to the transmission gates. If "polarity" is 0 (low), latching occurs when the clock input is made high. If it is 1 (high) latching occurs when the clock input is made low.

Another i.c., the 4099, has eight latches with Q outputs available, Fig. 6.5. Data input is sent to a selected *one* of the latches by setting the three address inputs to form a binary number. For example, with A_0 and A_2 high and A_1 low we get the number "101" (decimal 5) so latch 5 takes whatever value is on line D at that time.

D-type latches are used in many data-manipulating circuits, especially in shift registers (see later).

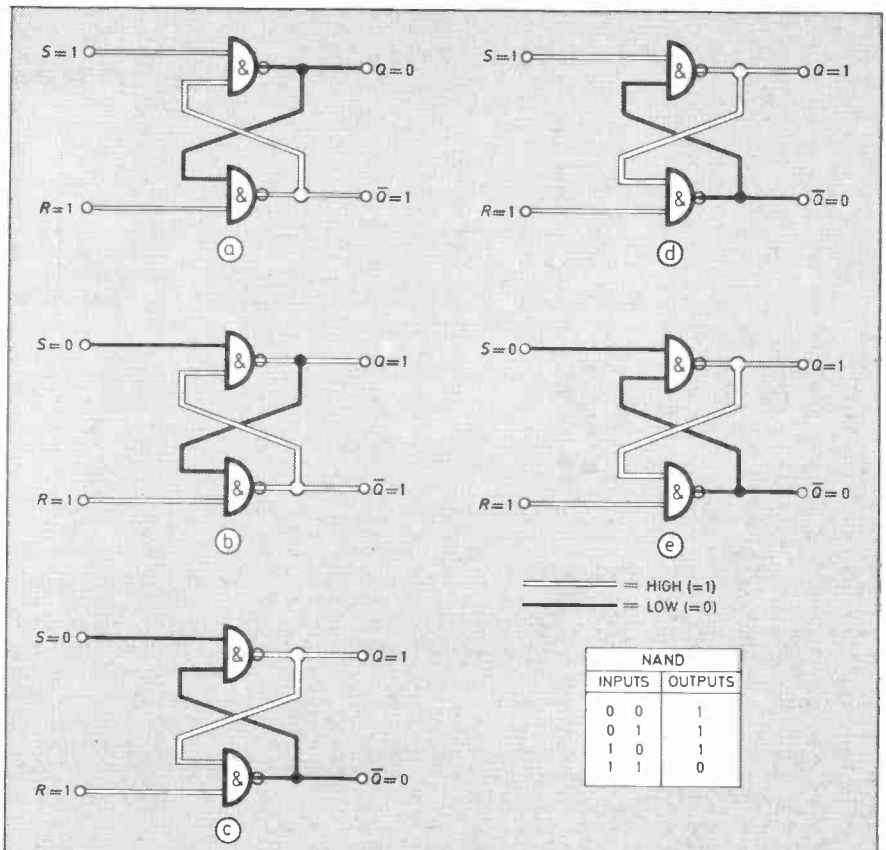


Fig. 6.2. Action of a bistable multivibrator in various stages of its operation (see text) and the Truth Table for a NAND gate.

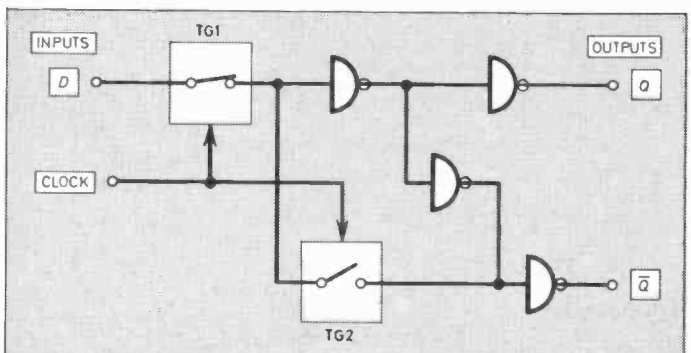


Fig. 6.3. *D*-type latch in CMOS. TG represents a transmission gate (see text).

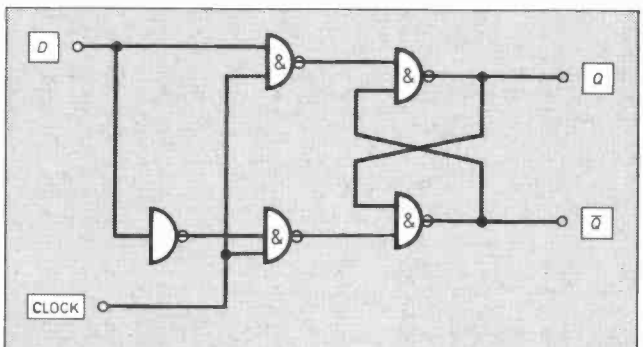


Fig. 6.4. *D*-type latch built from logic gates.

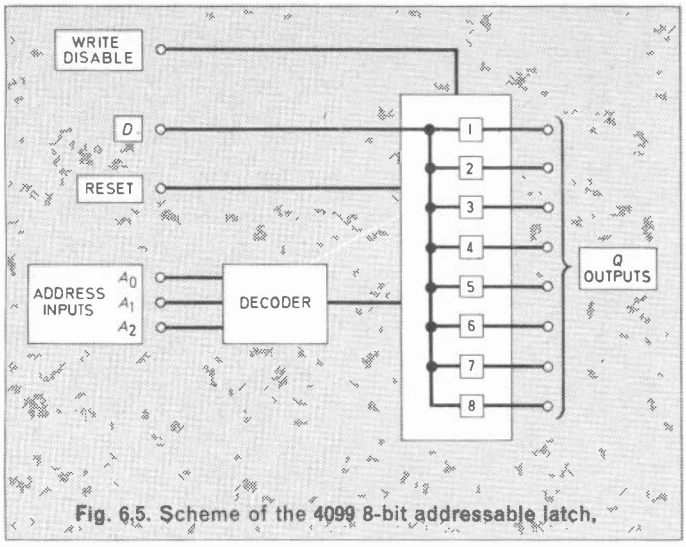


Fig. 6.5. Scheme of the 4099 8-bit addressable latch.

EDGE-TRIGGERED CIRCUITS

A latch such as that described above has many uses but some disadvantages. The chief of these is that its latching action is controlled by the *level* of its clock input. This may be no problem if we have only one latch in use but, if we have several operating at high speed, it can lead to complications. The clocking gates do not operate at exactly the same rate and this means that some latches and parts of latches become latched or unlatched before others.

When latches are being used to send data on to other latches, the situation becomes even more alarming. The solution is to use pairs of flip-flops so arranged that only one of each pair can change at one time, and both flip-flops are under the control of the same clock. This puts the system under much tighter control.

A *D*-type latch that has this arrangement is shown in Fig. 6.6. The two flip-flops are known as the *master* and *slave*. With clock input low, TG3 is open and the slave is isolated from the master. The slave then acts as an ordinary cross-coupled flip-flop, just like that in Fig. 6.1 except that it is built from NOR gates. The set and reset inputs are normally held low; a high pulse on one or the other input will make the slave change state, independently of the state of the clock.

The master flip-flop receives data *D* via TG1 and its output is the inverse $\overline{D}$. When the clock starts to go high the transmission gates are switched over. As soon as the change *begins*, *D* can no longer have any effect on the master. With TG2 closed, the master becomes an ordinary cross-coupled flip-flop with its output in state $\overline{D}$. As TG3 closes, the data from the master is transferred to the slave. The slave changes state (if necessary) so that its output at *Q* is the inverse of $\overline{D}$, i.e. is the same as *D* was when the clock began to change state. No further changes can occur because *D* is disconnected from the system and the master is in a stable state. These changes occurred at clock changed from low to high—at the *rising edge* of a high pulse.

When clock changes back (from high to low), the master once more begins to follow the data input. But this has no effect on the slave, because TG3 is open again. Output *Q* remains latched in the former state *D* until the next rising edge of the clock.

Several flip-flops of this kind are available in CMOS. The 4013 contains two such circuits. The 40175 has four of them, all sharing a common clock input, allowing the four digits of a binary number (four bits) to be latched simultaneously. The flip-flops also have a common reset line (or "clear"), but no "set" inputs are provided.

The 40174 has as many as six flip-flops, all in a 16-pin package. As might be expected, the limit in the number of pins means that only the *Q* outputs are provided. The 4077 has four flip-flops with tri-state output, so is useful for holding data ready for transfer to a data bus.

J-K FLIP-FLOP

The *J-K* flip-flop is another circuit which comprises master and slave flip-flops. The master is controlled by two inputs, known as *J* and *K*. At the rising edge of the clock input, the state of the output of the master is transferred to the slave and appears at *Q*. The inverse appears at $\overline{Q}$.

The logic circuits produce the following results at the rising clock edge:

(a) If *J* and *K* are both low; *Q* and $\overline{Q}$ show no change.
(b) If *J* is high and *K* low; *Q* goes high, $\overline{Q}$ goes low.
(c) If *J* is low and *K* is high; *Q* goes low and $\overline{Q}$ goes high.
(d) If *J* and *K* are both high; *Q* and $\overline{Q}$ both change state.

Here we have a device that responds to clocking by "no change", "high", "low", or "change" depending on the *J* and *K* inputs. The circuit is also under the control of the Set and Reset inputs, which operate independently of the clock. As will be explained in Part 7, *J-K* flip-flops are especially useful in building up counters.

The 4027 and 4095 i.c.s both contain two *J-K* flip-flops. The 4027 has inputs as shown in Fig. 6.7.

The 4095 has three *J* inputs, which first go to an AND gate. Thus all three *J* inputs must be high to act as an high *J* input to the flip-flop. Similarly, there are three ANDed *K* inputs.

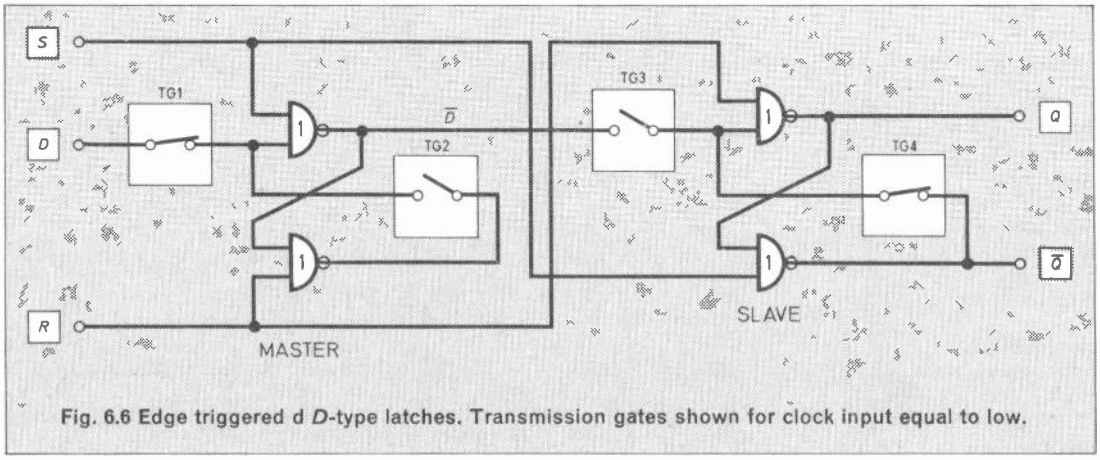


Fig. 6.6 Edge triggered d *D*-type latches. Transmission gates shown for clock input equal to low.

BINARY LOGIC

The greater part of this article has been concerned with bistable multi-vibrators and their close relatives, the latches. This is understandable because such devices play a large part in logic circuits, including computers. The fact that their outputs have two clearly defined states and that they can be switched from one

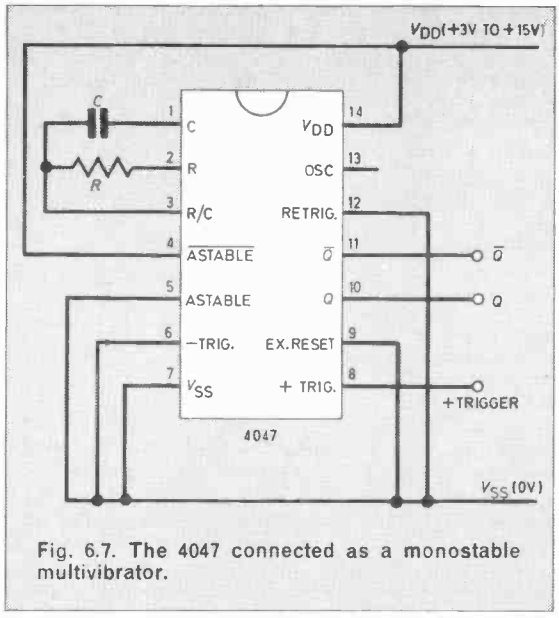


Fig. 6.7. The 4047 connected as a monostable multivibrator.

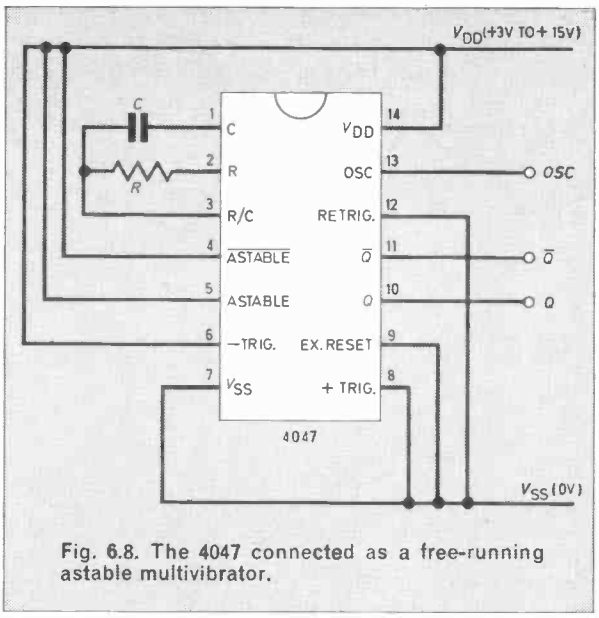


Fig. 6.8. The 4047 connected as a free-running astable multivibrator.

to another by a variety of control inputs means that they are ideal for storing and processing binary data.

Now we move on for a brief look at other types of multivibrator i.c.

MONOSTABLE MULTIVIBRATORS

Like the bistables, monostable multivibrators have two states and change rapidly from one state to another. The difference is that they are stable in only one of these states. When the monostable is put into its unstable state, it remains in that state for a while but invariably it returns to its stable state.

555 TIMER I.C.

An example of a monostable is the 555 timer i.c. described in Part 4 of this series. The time that the circuit spends in its unstable state is determined by the value of the timing capacitor and resistor. Its output is high for the duration of this period. If the timing capacitor and resistor have high values, the circuit remains in the unstable state with high output for periods of several minutes of even hours. This gives it many applications as a process timer.

With smaller values the circuit generates a "high" pulse of precisely fixed length but perhaps only a few milliseconds or microseconds long.

A CMOS version of the 555 is available, generally known as the ICM 7555. It can usually be used as a direct replacement for the 555 and has the advantage of much lower power consumption.

In the CMOS 4000 range there is the 4047 multivibrator i.c. As connected in Fig. 6.7, it is triggered by a rising (positive-going) edge. For negative-edge triggering the trigger pulse is applied to pin 6 (no longer grounded) with pin 8 connected to V_{DD}. The i.c. requires two external components, the timing resistor and capacitor.

The duration of the output pulse is equal to $2{\cdot}48\times RC$. Thus if $R=1M\Omega$ (the maximum recommended value) and $C=4700\mu F$, the length of the pulse is $2{\cdot}48\times1\times10^{6}\times4700\times10^{-6}=$ 11 656 seconds or a little over 3 hours. The only reservation is that leakage through the capacitor may prevent it ever charging fully.

At the other extreme if $R=10k\Omega$ (minimum recommended value) and $C=1000pF$ (minimum recommended value) the pulse length is $2{\cdot}48\times10\times10^{3}\times1000\times10^{-12}=24{\cdot}8$ microseconds.

Another CMOS monostable it is the 4098, which contains two monostables in one package, see Fig. 6.9.

ASTABLE MULTIVIBRATORS

Finally there is the type of multivibrator that is not stable in either state. It changes back and forth between one state and the other indefinitely. Since it is completely unstable (or astable), it can be used as an oscillator. Its frequency depends on the value of the timing capacitor and resistor. The 555 can be connected as an astable, as described in Part 4.

The 4047 is also designed to be used in this way, as Fig. 6.8 shows. The output period is $4{\cdot}40\times RC$. In addition, there is another output, from pin 13, running with half this period. The applications for the 4047 as an astable include clocks for driving logic and counting circuits and tone generators in many kinds of circuit.

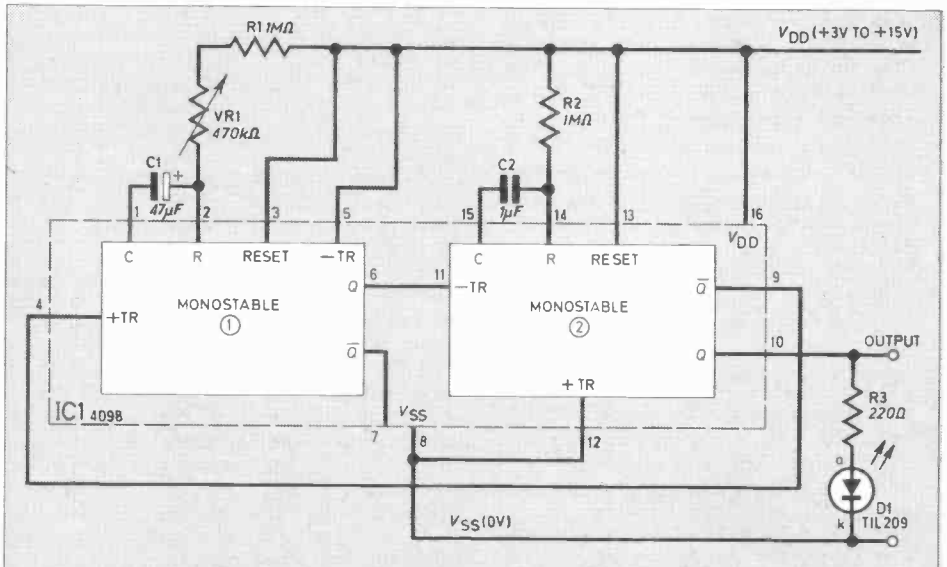


Fig. 6.9. The circuit for a variable period lamp flasher using the 4098.

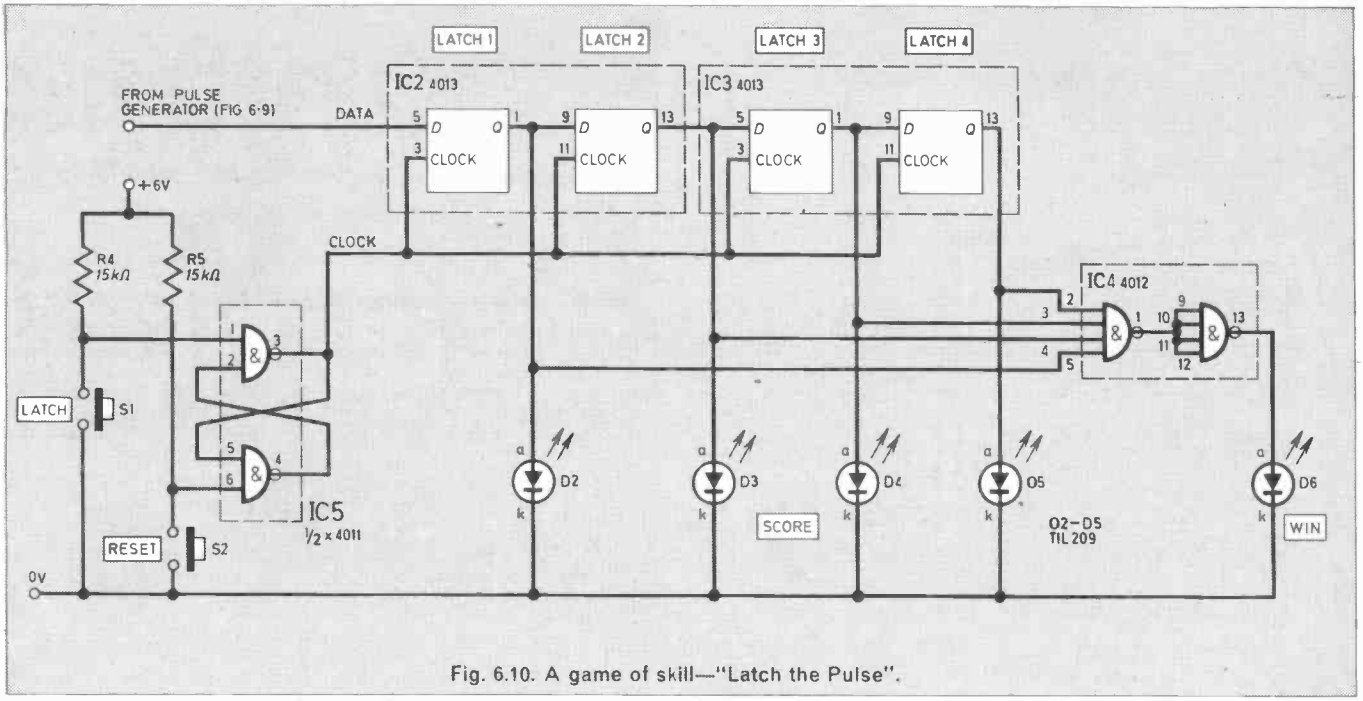


Fig. 6.10. A game of skill—"Latch the Pulse".

The two monostables of the 4098 cannot be used individually as astables since they lack the retriggering inputs required. However, it is possible to connect the two together so that each in turn triggers the other. This requires a capacitor and resistor for each monostable. For many applications the 4047 does the job better and with fewer components.

If an asymmetrical waveform is required (for example 1 second high pulses at intervals of 1 minute) the 4098 is ideal. Fig. 6.9 shows monostable 2 providing the short high pulse. The falling edge of this pulse triggers monostable 1 which, after 1 minute, triggers monostable 2 again, and so the cycle is repeated.

Note the coupling used between the two monostables. Monostable 1 triggers monostable 2 at the end of its long high pulse; as the output at Q falls, the *falling* edge triggers the TR(−) input of monostable 2. The Q output of monostable 2 then rises to give the 1 second pulse, and its $\overline{Q}$ output falls. At the end of the period, the Q output rises; its *rising* edge triggers the TR(+) input of monostable 1.

These monostables also have reset inputs (pins 3 and 13) but these are not used in this application.

TWO TO TRY

The astable based on the 4098 (Fig. 6.9) makes a useful process timer. With the values indicated, the l.e.d. flashes briefly once a minute, which is handy for timing moves in games such as chess. If C1 is reduced to 10μF and R1 to 820kΩ, the l.e.d. flashes every 10 seconds; this could be useful as a darkroom process timer.

In either case, C1 must be a tantalum capacitor, not an aluminium electrolytic type. If the circuit is operated from a 6 volt battery or power-pack or has a supply of lower voltage, R3 may be omitted.

LATCH THE PULSE GAME

The second project (Fig. 6.10) brings together many of the devices mentioned in this article and in the previous article. One second pulses are generated every 10 seconds from the 4098 astable described above. These pulses become the data of a chain of *D*-type latches.

When the clock input rises, latch 1 registers the state of the astable output. At the same time the data previously held by latch 1 is passed on to latch 2. The data at latch 2 passes on to latch 3 and that at latch 3 passes to latch 4. The data at latch 4 is lost. This array of latches illustrates how a shift-register is built up. It is a most useful device for manipulating binary data.

A 4-stage shift-register such as this can be obtained as a single i.c., the 4015, and several other versions are available.

The aim of the game is to clock the latches at exactly the right instant so as to latch on to the short high pulses from IC1. If four successive attempts are successful, all four l.e.d.s (D2 to D5) will be lit. This event will be detected by the NAND gate of IC4, making its output go low. This output is inverted by the second gate to light the "Win" l.e.d., D6 (or you could make it sound a buzzer).

It is essential to eliminate multiple clocking for, if we use a simple push-button, contact bounce causes the data to be shifted several steps on each occasion. Bounce-free switching is provided by the bistable flip-flop (IC5). Press S1 to latch a pulse, then press S2 to reset the flip-flop in readiness for the next attempt. ☐

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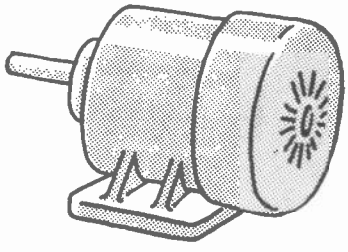

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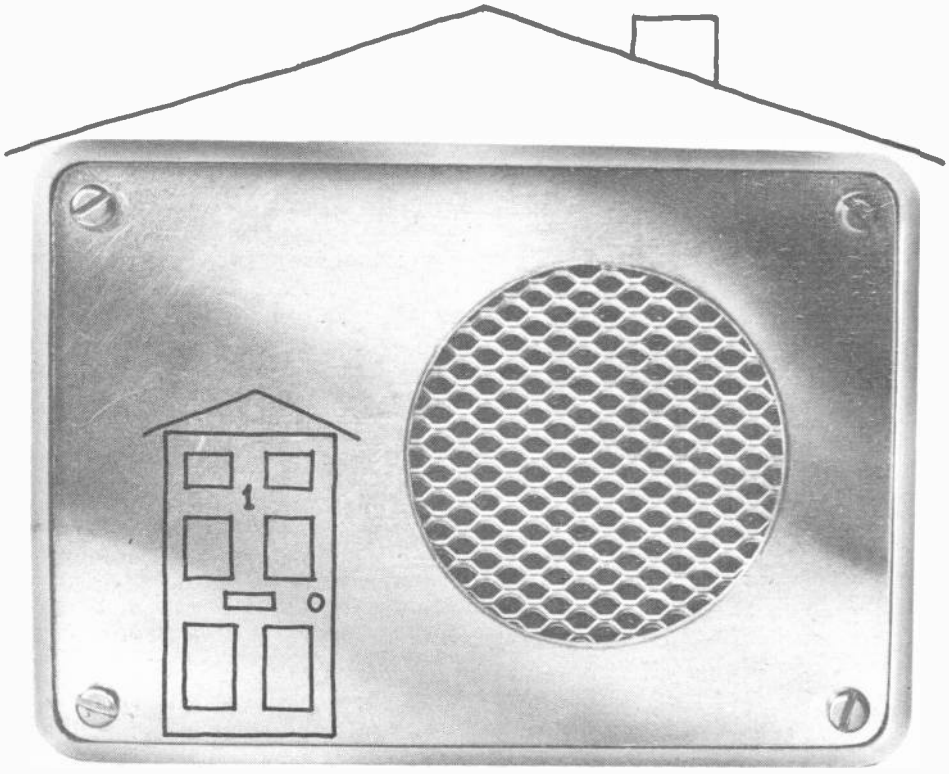


MODULATED TONE DOORBELL

R.A.PENFOLD

THIS ELECTRONIC doorbell design is simple and inexpensive to construct. It has the advantage over most doorbuzzers and bells of very high reliability and, being an electronic device, it is largely unaffected by dust and other environmental conditions.

The only moving part apart from the pushbutton is a loudspeaker, so there is nothing which is likely to wear out. The unit is certainly far more reliable than the unit it has been used to replace.

FREQUENCY MODULATION

It is not advisable to use a straight forward tone generator as a doorbuzzer because a single tone is easily masked by other sounds and is thus easily missed. Using a very high volume would overcome this to a large extent, but would make the unit highly objectionable to anyone who happened to be close to it when it sounded.

Better alternatives are to use either a pulsed tone (rapid on and off switching of the signal), or frequency modulation (rapid up and down variations in the pitch of the tone). In either case the varying nature of the signal plus the fact that a fairly wide range of frequencies are generated results in it being very noticeable and not easily masked by other sounds.

CIRCUIT

The unit described here has a frequency modulated tone and the circuit diagram appears in Fig. 1. This is based on an NE556 dual timer i.c. which is capable of producing a very wide range of pulse and frequency modulated signals. Incidentally, the NE556 i.c. contains two circuits of the type that are used in the popular NE555 single timer i.c.

One section of the 556, IC1b is used to provide the basic audio tone, and this section of the i.c. is wired in the astable or freely oscillating mode. In this configuration C4 will charge up via R4 and R5 until two thirds of the supply rail potential is developed across C4.

The circuit is then triggered into an alternative state where C4 is discharged into pin 13 of the i.c. by way of R5 until one third of the supply voltage is produced across C4.

The circuit then reverts to its original state with C4 charging up to two thirds of the supply voltage once again. The circuit is then triggered once more to its alternative state, and it continuously oscillates in this manner.

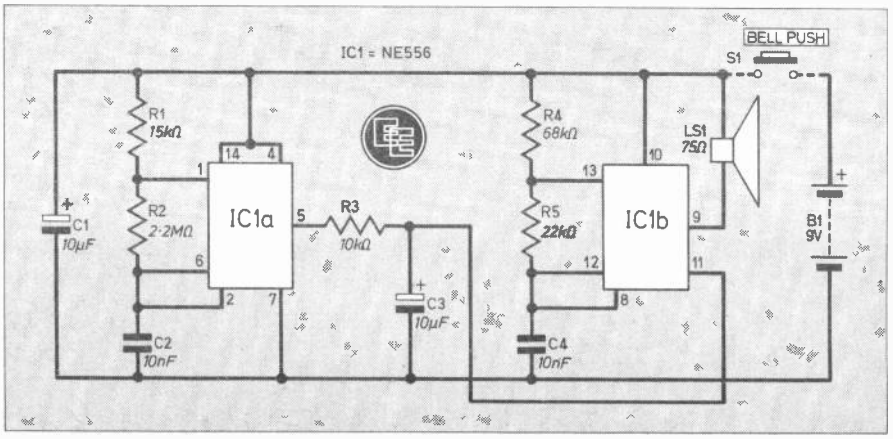
LOUDSPEAKER

A loudspeaker is connected between the output of IC1b (pin 9) and the positive supply rail. Normally the output is at virtually the full positive supply rail voltage with little current being supplied to the speaker in consequence, but during the discharge period of C4 the output goes to a very low voltage and current is fed to the speaker.

It obviously takes C4 longer to charge up through R4 and R5 than it takes to discharge through R5 alone, particularly in view of the fact that R5 has a much lower value than R4.

The time during which the output of the i.c. goes to a low voltage is therefore comparatively short; the

Fig. 1. Full circuit diagram of the Modulated Tone Doorbell.



high to low ratio (termed the mark/space ratio) being about four to one. The waveform across the speaker is therefore a series of fairly short pulses, and this type of waveform produces a quite piercing sound from a comparatively low average output power.

THRESHOLD VOLTAGE

The component values have been chosen to provide a nominal operating frequency of 1·4kHz, but this is modulated of course. The obvious way of frequency modulating the oscillator is to vary the threshold voltage at which C4 starts to discharge.

Raising this level would increase both the charge and discharge times of C4 and would reduce the operating frequency. Lowering this voltage would produce an increase in frequency by reducing these times.

This can in fact be achieved as the relevant reference voltage is available at pin 11 of the i.c. and is easily modulated as it is at a fairly high impedance.

The modulating signal is obtained from a second astable circuit which utilises IC1a and is basically the same as the tone generator. However, R1 has been given a value which is very much lower than that of R2 so that the mark space ratio of the output waveform is almost one to one.

The component values have been chosen to produce a comparatively low operating frequency, the actual figure being approximately 27Hz.

If the output at pin 5 of IC1a was to be directly coupled to pin 11 of IC1b this would result in the tone oscillator being rapidly switched between two frequencies. A pleasant and equally effective sound can be produced by a smoother transition between the upper and lower frequency limits of the tone generator.

Therefore, R3 and C3 are used to filter the squarewave modulating signal to produce a roughly triangular waveform which is coupled to pin 11 of IC1b.

The power supply is decoupled by C1, and S1 is the door push-switch which is simply connected to operate as an on/off switch. The current consumption of the unit is about 30mA or so and this is provided by a small (PP3) 9 volt battery which will have virtually its shelf life under normal circumstances.

CONSTRUCTION starts here

STRIPBOARD

Details of the 0·1 inch pitch stripboard layout and wiring of the unit are illustrated in Fig. 2. Start construction by cutting out a board having 17 holes by 17 strips and then make the necessary breaks in the copper strips.

Next drill the two 3·2mm diameter mounting holes and then solder the

COMPONENTS

See Shop Talk page 159

Resistors
- R1 15kΩ
- R2 2·2MΩ
- R3 10kΩ
- R4 68kΩ
- R5 22kΩ

All ¼W carbon ± 5%

Capacitors
- C1 10μF 10V elect.
- C2 10nF polyester type C280
- C3 10μF 10V elect.
- C4 10nF polyester type C280

Semiconductors
- IC1 NE556 dual timer i.c.

Miscellaneous
- S1 push-to-make, release-to-break door bell push
- LS1 miniature loudspeaker 50 to 80 ohms impedance.
- B1 9V battery, PP3 type

Plastics case, size 110 × 70 × 45mm, Bimbox type BIM4004 or similar; stripboard, 0·1 inch matrix, size 17 holes by 17 strips; battery clip; speaker cloth; bell wire; interconnecting wire; 6BA hardware to mount circuit board.

COMPONENTS approximate cost £8 excluding case

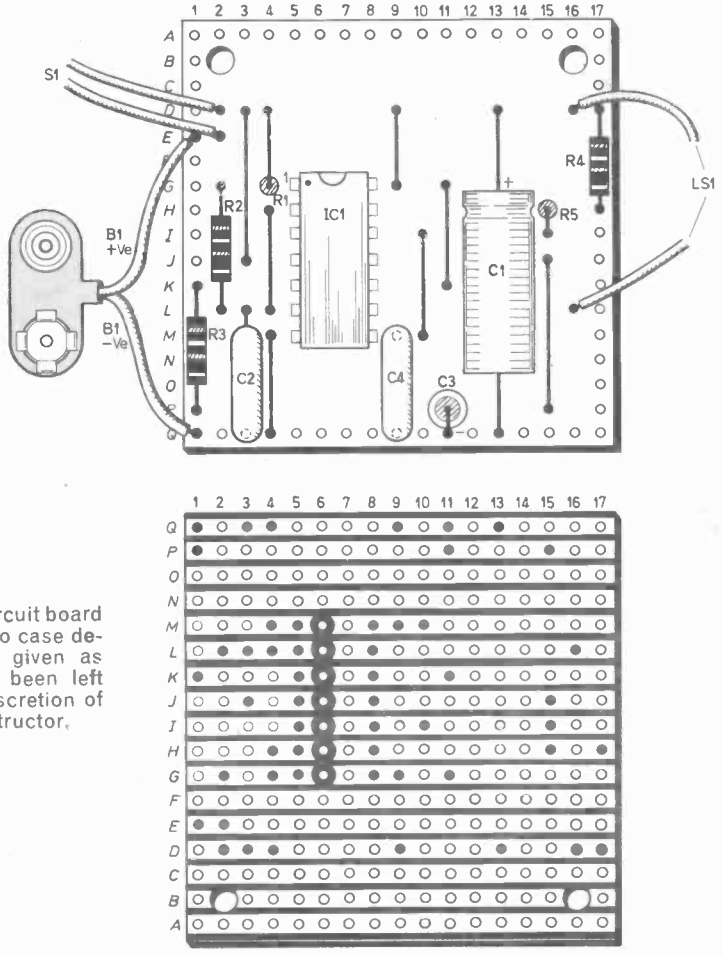
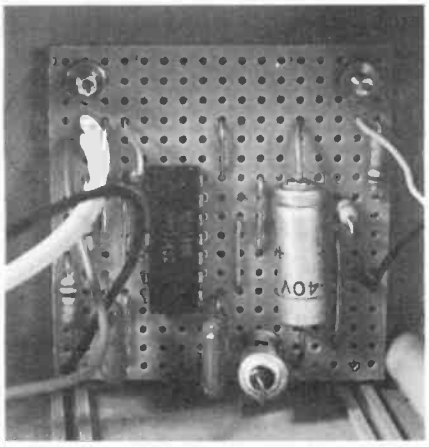


Fig. 2. Circuit board layout. No case details are given as this has been left to the discretion of the constructor.



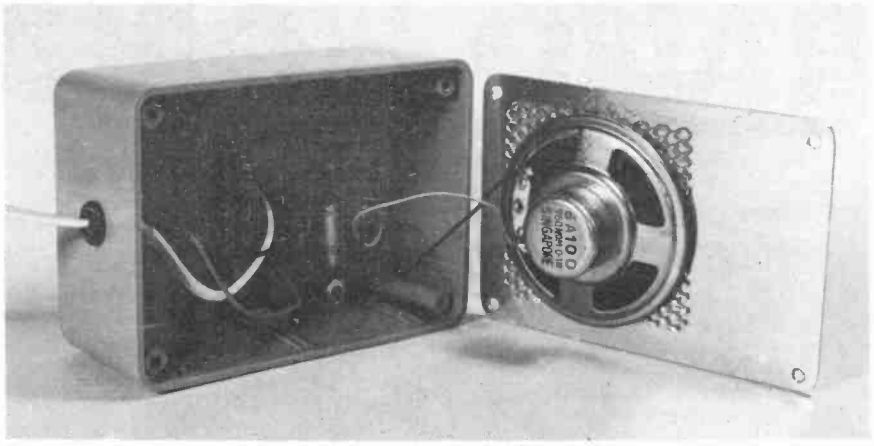


Photo left shows a close-up view of the circuit board. Photograph on the right shows the interior of the case showing the loudspeaker in position on the lid and the circuit board fixed to the base. Note that the lead from the bell-push is hard wired straight to the board.

components and link wires into position. Also connect the battery clip, ensuring that the polarity is correct.

The unit can be housed in any small plastics box of adequate proportions to accommodate all the parts. The prototype is built into a Bimbox type BIM 4004 which has an aluminium front panel and dimensions of about 110 × 70 × 45mm.

LOUDSPEAKER

The loudspeaker is mounted towards the right hand side of the front panel and a circular cutout of slightly smaller diameter than the cone must be made here. This can be made by drilling a series of small holes (about 3 to 4mm in diameter) around the inside of the periphery of the required cutout.

Provided the holes are very closely spaced it will then be possible to push out the material inside the holes. The rough edges of the cutout can then be filed smooth using a large round file.

A piece of speaker cloth or fret is glued in place behind the cutout using a good quality general purpose adhesive. The speaker is then glued in place onto this, but only apply a small amount of adhesive to the very rim of the speaker. When the glue has set, the speaker is wired to the component panel using insulated leads about 100mm long.

BELL PUSH

A hole for the bell-wire must be made in the left hand side of the case. The bell-wire is then threaded through this and connected to the component panel. It is quite acceptable to use a very long length of bell-wire if this should be necessary.

The component panel is bolted to the rear of the case using short M3 or 6BA bolts which should preferably be countersunk types. It is advisable to use an extra nut over each mounting bolt, between the case and the component panel, as otherwise the panel will probably buckle when the mounting nuts are tightened.

If the unit is to be mounted on a wall this can be accomplished using a couple of screws through the rear of the case, and is done after the component panel has been mounted.

If the unit is working correctly a trill-like sound somewhat like that of a Trimphone should be produced when the bell-push is operated. ☐

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in My Class

by
T.R.de Vaux-Balbirnie

THE class were trying their hands at soldering for the first time. When I toured around to see how they were managing I was horrified—had they learned nothing from the theory lesson?

I had to tell John that it was no good applying solder to his soldering iron then chattering for five minutes before making the joint. The blue smoke was all the flux burning off. As the purpose of flux is to clean and prepare the surfaces to "take" the solder, its purpose was lost. Solder and iron should be applied to the joint *together*, I told him.

Gerald was next. He was "buttering" the joint with solder, scraping the iron until he had built up a thick layer. This is a sure way to make a bad joint, the solder should melt in one operation. Stephen was caught wiggling the wires around to find out when the solder had hardened. This causes "dry joints", everything should be kept still until the solder has hardened.

Several members of the class were blowing on their joints to cool them. By doing this, the outer skin of solder contracts before the inside causing internal stresses and cracks. This joint is likely to fail sooner or later.

When they had had their fun, I spent half an hour running through the theory again. I told them that although it was easy to make a soldered joint, a *good* job was a work of art demanding a good deal of care.

A very common fault is that the solder does not "take" properly to the surfaces and the joint only conducts because of the physical contact between the metals. This will be very unreliable and is likely to alter its resistance with movement.

A good joint will be shiny in appearance, a greyish or cracked joint is always suspect. It is always a good plan to give wires a gentle pull to test the joint, after the solder has hardened.

My final point was that they should not expect the flux to do all the work. Gentle scraping of dirty surfaces with a penknife blade helps.

RADIO WORLD

By Pat Hawker, G3VA

Travel by radio

In some Eastern European countries, amateur radio is officially recognised as a competitive, sporting activity (in Russia a particularly active amateur can become a Master of Sport). In most parts of the world there are now a plethora of "contests", operating awards and certificates . . . too many, some of us feel at times. However they are mostly good fun, at least when they do not bring out an excess of zeal to work rare or new countries by putting out the loudest signal on the band or by butting into other people's contacts.

Fortunately for the hobby, there are many others who succeeded by careful listening rather than brute force. Indeed quite a few British amateurs have made contact with well over 300 different countries, as carefully defined by the American Radio Relay League.

Although at one time quite a keen "DX chaser" I must admit that I largely opted out of this time-consuming race many years ago and my own total is not much over 200. Nevertheless, I still keep a tally and reckon to work between 70 to 100 different countries each year without intensive country chasing.

There are all sorts of ways in which one can enliven such activity. For instance with the coming of 1981, I set myself a small task: to see how many different countries I could work in successive contacts without duplication.

Since there are vastly more active amateurs in some countries than in others, the temptation to work more than one station in a single country soon becomes very powerful. But I was pleasantly surprised to find in the first days of January, with relatively few hours on the air, that 36 solid and pleasant contacts on all bands from 1·8 to 28MHz, yielded a score of 36 countries in 4 continents. Starting off in Italy my journey finished up in French Guiana, South America.

Even using only a simple "long-wire" aerial, it is certainly possible to tour the world rapidly and in comfort on the amateur h.f. bands. Others, such as those who took part in "Operation Drake" still prefer to travel slowly, in person . . .

Travel with radio

The arrival back in the Pool of London of the 150-ton brigantine *Eye of the Wind*—at the conclusion of "Operation Drake" which enabled 404 "Young Explorers" from 27 countries (picked from over 60,000 applications) to take part in some phase of this two-year scientific expedition around the world—gave its leader, Lt-Col J. N. Blashford-Snell, the opportunity to explain how successful and helpful he had found modern single-sideband h.f. radio communication.

The expedition spent a lot of its time away from the ship (which carried standard marine radio equipment supplemented by what proved to be a very successful amateur-type h.f. transceiver by the American firm appropriately called Drake) and during these periods often relied on a communications link with the Royal Signals at Blandford, Dorset using a Plessey "Clansman" UK/PRC320 h.f. manpack military transceiver. This all-solid-state, frequency-synthesised, compact equipment provides some 30 watts peak envelope power output and can be used with whip, dipole or long-wire aerials.

Although intended primarily for tactical medium-distance voice communication, the pack sets repeatedly showed that they could be relied upon to provide voice links with England at distances up to 11,000 miles. On several occasions they were used under emergency conditions, once to effect a dramatic helicopter rescue of three casualties. On another occasion, when a light aircraft had damaged their aerials in a volcanic crater near Nairobi, East Africa, they were able to warn the airfield that the plane itself had suffered damage, and also to report the incident to Blandford using only make-shift aerials.

Lt-Col Blashford-Snell spoke enthusiastically of the effectiveness of these voice links, when compared with the need on earlier expeditions to depend upon Morse for long-distances, pointing out that single-sideband communication proved possible even under poor propagation conditions—though privately he admitted to me that he had at first been rather dismayed to find very few of his volunteers had any knowledge of Morse, and so was extremely relieved to find the little pack-set performing so well even when using batteries and a hand-generator.

Radio Spectrum Pollution

Viewers and listeners in the UK are fortunate in being able to call upon the free assistance of skilled Post Office engineers in tracing, and often curing, persistent interference from domestic and industrial equipment and the like. This is done by obtaining and filling in a form "Good Radio and Television Reception" available from Post Offices.

However, it should be noted that this free service applies only to interference that affects the reception of broadcast transmissions for that locality. It is also sensible first to try to make sure that the problem really is electrical interference and not due to a faulty receiver or inadequate aerial or from equipment in your own home, and is of a persistent nature. Not even the Post Office teams can be expected to overcome the occasional click.

Twenty years ago or so, the number of people who appealed to the Post Office for help each year was over 100,000. A recent Home Office report shows that in 1979 the number was 35,500. The steady improvement over the past two decades can be ascribed partly to the results of the legislation that regulated the amount of interference from car ignition, electric motors and refrigerators and partly to the effects of moving television from the v.h.f. bands up to u.h.f.

But unfortunately I suspect that it does not mean that we can claim to have overcome the problem. The amount of spectrum pollution all the way from low frequencies to v.h.f. continues to be very severe, particularly in urban and suburban environments.

This can be shown by the fact that although complaints about TV interference have fallen steadily, radio listeners are reporting more and more interference. In 1971 only about 6500 radio complaints were made; by 1979 the figure had risen to 23,782 (16,568 i.f./m.f., 7214 v.h.f./f.m.) including a staggering 25 per cent increase over the 1978 tally.

Part of this large increase reflects the many complaints about the reception of Droitwich on 200kHz following the reallocation of this frequency to Radio 4 in November 1978. But another major factor has been the increasing problem, throughout the 1970s, of interference due to defective "contact devices" including faulty switches and especially the thermostats used in hot water and central heating systems. In 1979, some 28 per cent of all complaints (68 per cent of complaints later ascribed to specified sources) were due to contact devices.

As usual, many complaints were found by the Post Office to be due to "conditions at the receiving site" by which is meant inadequate aerials, faulty of maladjusted receivers, or receivers having insufficient "immunity" to strong local signals. This category accounted for 36 per cent of all complaints, with 56 per cent of these due to aerials or feeders and 31 per cent due to receiver design characteristics.

The Post Office do not advise in cases of interference to distant stations, and most radio amateurs could testify to the increasing extent of man-made spectrum pollution on the m.f. and h.f. bands from such causes as the unwelcome timebase and switched-mode power supplies of many colour TV sets. Very few viewers recognise that they themselves are putting out a series of nasty noises every 15kHz or so at frequencies up to about 15MHz or higher.

Here and there

A "télétheque" a museum dedicated to television is to be opened soon at the French television centre at the Palais de Chaillot, Paris. It will include a viewing room where selections of French programmes screened during the past 30 years will be shown daily.

Incidentally, the fascinating IBA's "Broadcasting Gallery" at 70 Brompton Road, London SW3 (opposite Harrods) although not primarily a "museum" does provide an excellent idea of how radio and TV broadcasting has developed and how it is run. There are four free guided tours from Mondays to Fridays, each lasting about 90 minutes. Advance booking is required and there is a minimum stipulated age of 16 years. Phone 01-584 7011 and ask for the Broadcasting Gallery to book a place on a tour.

An American made film *The World of Amateur Radio* has won a gold medal at a National Film and Television Festival in New York. It was judged the best industrial film in a "hobbies and recreational" category.

Everyday News

CREDIT CARD CALLS

Public payphones, using plastic cards instead of coins, will be tried out this year by British Telecom, the telecommunications part of the Post Office.

About 200 of these push-button Cardphones will go on trial in London, Birmingham and Manchester, in busy places like airports and main line railway stations. In addition to making inland calls, it will be possible to use the cards for overseas calls to all 101 countries on direct dialling from the UK.

To use the new phones, customers will need to buy special cards which will be the same size and shape as credit cards. These cards contain telephone credit units which are erased by a thermal process when the card is inserted into the cardphone to pay for calls.

The units are priced at 5p and there will be two values of card on sale, one of 40 units costing £2, and a 200 unit card at £10, which is double sided.

The trial cardphones are to be supplied by Landis and Gyr Group. These will use the Sodeco debit card, incorporating holographic technology, based on special patterns of light, to provide a high level of security against fraud or forgery.

Prototype Card Phone made by Landis and Gyr

LICENCE EXEMPTION

Users of model control equipment and metal detectors no longer need official licences to operate their equipment under the Wireless Telegraphy Act 1948.

Announcing this recently the Home Secretary emphasised that exemption of metal detectors would not absolve users in anyway from the need to obtain permission to enter, search and dig land and to keep off protected archaeological and other sites.

At the same time is was announced that an additional frequency band of 35·005MHz to 35·205MHz is to be made available for model aircraft control.

Although metal detectors and model control equipment are exempted from licensing they should conform to the following simple technical conditions in order to avoid interference with other radio users.

Metal Detectors

A metal detector shall be used only with emissions at a fundamental frequency within the frequency band 0Hz to 148·5kHz.

The strength of the electric field of the emissions shall not exceed 3,000 micro volts per metre measured at a distance of 6 metres.

The strength of the electric field of the spurious emissions produced by a metal detector shall not, insofar as those emissions are within the frequency band 148·5kHz to 6·5kHz exceed 100 micro volts per metre when measured at a distance of 6 metres.

The use of a metal detector shall not cause undue interference with any wireless telegraphy.

Model Control Equipment

Model control equipment shall be used only with emissions which are within the 26·96MHz to 27·28MHz band or the 458·5MHz to 459·5MHz band.

With a maximum mean power not exceeding 1·5 watts in the 26·96MHz to 27·28MHz band and 0·5 watts in the 458·5MHz to 459·5MHz band.

Notwithstanding these provisions model control equipment designed solely for the purpose of controlling the movement of a model aircraft may be used with emissions which are within the frequency band 35·005MHz to 35·205MHz and with a maximum mean power of 1·5 watts. This is an additional band not previously available.

The use of model control equipment shall not cause undue interference with any wireless telegraphy.

The use of model control equipment shall be subject to the condition that it is made available for inspection if so required by any person authorised for the purpose by the Secretary of State.

An adaptor costing under £200 that will turn an ordinary TV set into a Prestel terminal is being marketed by Zycor Ltd. To be known as the Teledek 2000, it uses a hand-held infra red keypad for "page" selection with a range of up to 9 metres (30 feet).

Fluked Again

A major coup is being claimed by Fluke (GB) Ltd with the winning of a large order for handheld digital multimeters from British Telecom, the Post Office telecommunications operation.

The order, which is believed to be one of the largest ever placed for DMMs in the UK, is for nearly 3,000 of Fluke's low cost $3\frac{1}{2}$ digit 8022A handheld models.

Spy-in-the-Sky

Marconi Avionics Heli-Tele helicopter-borne colour TV system has been re-ordered by the Metropolitan Police for a second Bell 222 helicopter.

The airborne camera is in a stabilised mount to eliminate helicopter vibration and includes powerful zoom facilities to read number plates and identify people from the air. The TV pictures are relayed to a ground control post by radio link.

In the Chair

Plessey is sponsoring an industrial professorship at Trent Polytechnic, Nottingham furthering the close links which already exist between the Company and Trent, one of the country's leading institutions of higher education.

Called the *Plessey Chair in Computing*, support for the professorship reflects the Company's move into computer and software applications as it changes from electro-mechanical to digital, computer controlled products.

. . . from the World of Electronics

ANALYSIS

BREAKTHROUGH

The history of electronics can be compartmented into major advances in technology, each of which crashed through a barrier leading to even greater advance. Examples of such breakthroughs in the first half of the century were Fleming's diode which was the world's first thermionic valve patented in 1904, and de Forest's triode valve patented three years later. These were the great fundamental inventions which were the foundations of all later developments.

In the second half of the century the greatest leap forward was solid state technology, a development even more significant than the thermionic valve and which opened the door to electronics as we know it today. The vintage years were the 1950s and 1960s when breakthroughs of various types were so numerous that the very word became devalued to the extent that today it is almost out of fashion.

The development of microelectronics and its phenomenal success in so many applications has deadened our sense of wonder. Magnificent colour photographs of Saturn, transmitted electronically 900 million miles through space, created less popular interest than the blurred photograph of a footballer transferred for a high fee. The miracle of a home computer cheap enough to be within the reach of all passes almost without comment.

Are we so saturated with technological advance that the idea of a breakthrough has gone forever? Would it be a breakthrough if, for example, we were able to take a very large commercial mainframe computer and shrink it in size to that of a biscuit tin while, at the same time, improve its operating speed by a factor of 20 and reduce its power consumption to a few watts?

Well, scientists are working diligently on superconducting junctions operating at very low temperatures based on a phenomenon discovered by Brian Josephson at Cambridge in 1962. They expect to achieve an entirely new generation of computers which will have the features described above. Where very large memories are needed, typically 10^9 bits upwards. the overall technological and economic advantages of a Josephson computer would easily outweigh the additional cost of the cryogenic cooling equipment.

At least four companies, two in the United States, two in Japan, are known to be active in this exciting new technology and it seems likely that the first Josephson computer will appear towards the middle of this decade.

It should merit the description of breakthrough. It will probably be dismissed as nothing very remarkable.

Brian G. Peck

Leading the Way

The United Kingdom leads Europe in data communications with 117,000 data connections in use, compared with 61,700 in Germany and 54,000 in France.

VIDEO AT HOME

Video at Home is the name of a new company set up within Thorn TV Rentals to supply the group's rental outlets with software for VHS video cassette recorders.

Buying British

Belgium is the sixth country to buy Prestel technology from British Telecom. They are also buying the GEC 4085 computer on which the system is based.

In the UK, Prestel now has 6,700 users of the 170,000 pages of information currently available.

COURSES FOR THE UNION

The electronics union, EEPTU, has set up courses to train members in the new electronics technology which they are now having to face.

The basic courses are of five weeks duration tailored to individual needs from semiconductor theory through to use of MPUs.

More than 1,500 microcomputers are now in use in UK secondary schools in familiarisation programmes in computing techniques.

Protecting War Relics

Nearly 500 electronic sensors are used in a new fire warning system at the Imperial War Museum.

The system, supplied by AFA-Minerva (EMI), is unique in that automatic extinguishing systems using water or gas cannot be used because of the fragility of many of the exhibits. Instead the fire early-warning system uses a variety of sensors which includes photo-electric smoke detectors, infra-red detectors, fixed temperature and rate-of-rise-of-heat detectors, and flame detectors.

The control system indicates the exact location of any "alarm" condition enabling instant action to be taken.

Business Comsat

A European communications satellite network for business use is planned to be operational in 1983. Companies and organisations will have their own small earth terminals with 4m dishes on or near their premises.

Initial testing will be through the European Space Agency's Orbital Test Satellite (OTS) and the service will use the European Communications Satellite (ECS), which will be modified to include the business service, and the French Telecom 1 system.

Training a PET

Continuing the successful and well-attended series of PET Seminars and Programming Courses, Commodore Business Machines have announced details of their 1981 seminar programme.

Organised and presented by Commodore's own training team, these courses provide participants with theoretical and practical programming and operating experience.

Restricted to small tutorial groups, allocating one Pet computer to every two students, each course contains a high proportion of exercises which participants carry out themselves.

The World Sea Angling Championship staged in Britain was the first angling event, it is claimed, to use a computer and electronic display to provide a running record of catches and competitor placings in all categories during the contest.

Space-Age Armour

The problem of damage to space satellites from high energy electron bombardment is claimed to have been solved by British Aerospace with the development of a new composite sandwich material which dissipates surface charges as soon as they are encountered.

Bookmark

The electrical and electronics library of the IEE has just celebrated its centenary. It was opened 100 years ago with a foundation of 12,000 books on electricity and magnetism from the collection of Sir Francis Ronalds. Today it has 40,000 books, increasing by 2,000 books every year.

Everyday News

AIR SAFETY

One of the hazards of flying is unexpected windshear such as down-draughts which cause an aircraft to sink rapidly, particularly dangerous during take-off and landing. A new laser system, now being test flown, can detect the wind-speed well ahead of the aircraft and warn the pilot of impending windshear.

The system known as LATAS (LAser True Airspeed System) has been developed by the Royal Aircraft Establishment in collaboration with the Royal Signals and Radar Establishment.

EURO-DEBUT

The first European demonstration of RCA's CED Video Disc system has taken place in Cannes. The Capacitance Electronic Disc (CED) is due for launch in the United States in March.

The US market is expected to attract sales of 200,000 players in the first year plus two million SelectorVision discs. Players are expected to cost under $500 and the discs at between $15 and $25 each.

A date for European marketing has not yet been announced.

Multi-Part Standards

Three parts of a new British Standard of particular interest to manufacturers and users of visual aids and television for educational, training and similar applications, have recently been published. The BS 5817 *Audio-visual, Video and Television Equipment Systems* is being planned in 12 parts, and is designed as a framework into which further items can be fitted with the advent of new technologies in this field.

The systems covered in the standard range from very simple general purpose devices to highly professional equipment used, for example, for audio-visual distribution systems.

Records and Musicassettes, the way they reach the customer, their future with a view to video—these and other topics will be dealt with at the first "International Music Market Seminar" in Berlin on April 29 and 30, 1981.

Represented will be the music industry as well as experts from the media and the discotheque scene.

Wired City

Milton Keynes has been selected as the first British town to have an experimental fibre-optic communications system, paving the way to the "wired city" of the future.

Twenty houses are to be served with radio and TV through the fibre-optic links. The real-life field trials are the logical next step following work on such systems by British Telecom engineers at the Martlesham Research Laboratories.

SAVINGS IN SPACE

As part of its continuing drive to improve communications, British Telecom has signed an agreement with four Nordic countries to provide mutual access to *Inmarsat* ship-to-shore communication satellites.

The deal will enable British telephone and telex users to link up with the *Inmarsat* Indian Ocean satellite through a new ground aerial at Eik, Norway. At the same time, Scandinavians will have access to the Atlantic Ocean maritime satellite through Telecom's earth station on Goonhilly Downs, Cornwall.

In this way, British Telecom and its counterparts in Denmark, Finland, Norway and Sweden can provide service covering the two ocean regions by constructing only *one* aerial each, representing a substantial saving in capital and operating costs.

Marconi Space and Defence Systems has signed its largest single export order, worth £50 million, with the Swiss Government via British Aerospace.

The MSDS contract is for the Blindfire tracking radar of the Rapier anti-aircraft missile system which gives Rapier 24-hour all-visibility all-weather operation.

The British Computing Society is holding an international symposium entitled "Computing for National Development" at the University of London Institute of Education on March 23 to 27.

Devoted to the use and application of computers in engineering, the second international conference and exhibition "Engineering Software" is being held at the Imperial College of Science and Technology from March 24 to 26.

Scotland's first Business to Business Exhibition, which will come under the banner of "The Scotsman" newspaper, will be held at the Royal Highland Exhibition Hall, Ingliston, near Edinburgh from April 27 to 30, 1981.

Bear Mauls Logger

An unattended automatic data-logger recording meteorological and geological data in the Arctic Circle for a Swedish university scientific project has been attacked by a polar bear. The bear destroyed the tent and the fibre-glass protective case of the logger leaving the equipment exposed and some ten feet from its original position.

The logger, built in the UK by Microdata, was found by the Swedish scientists in perfect mechanical order and still collecting data.

Electronics for Teachers

The Department of Electrical Engineering Science at Essex University will be holding its annual *Electronic Systems Summer Schools for Teachers* during the week commencing July 5, 1981.

This year two newly structured courses are to be run simultaneously, "Feedback and Communications Systems" and "Digital and Computer Systems". The two courses have been designed primarily to complement the "A" level in Electronic Systems. However, the courses should also be of interest to teachers wishing to further their knowledge in the field of electronics.

The Feedback and Communication course covers topics on transistor circuits, operational amplifiers, an audio systems case study, comunications and television systems. The Digital and Computer Systems course examines transistor switching circuits, combinational and sequential logic design, introduction to microprocessors and the use of microcomputers in schools.

Each course is supported by formal lectures and an extensive laboratory programme, together with optional evening seminars. Teachers wishing to obtain further details of these courses should contact Mrs J. Mead, Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

MICRO-ELECTRONICS COME HOME . . .

. . . A PIPE DREAM?

Some of the latest microelectronic products for use in and around the home are available for all to see at the "Micro-Electronics Come Home" exhibition now running at the London Design Centre until March 7, 1981. It will be repeated at the Glasgow Design Centre between March 30 and May 30, 1981.

Syntar guitar without strings, designed by Mark Morrison, North Staffordshire Poly.

Women's World

Women will be particularly interested to see the sleek and modern lines of some easy to operate and labour saving devices for use in their homes. For instance, the electronic controlled oven, washing machine, tumble dryer, central heating controllers with digital kitchen clock incorporated and other more personal modern timepieces to be worn.

Sure to be a favourite with many is the "Mole". This is a vacuum cleaner that remembers where you have taken it. Next time its use is required, merely press a button and it does it for you . . . by itself. These have been designed by students at North Staffordshire Polytechnic.

Youngsters (and others) will be entertained by the T.V. Games Centre, the microprocessor controlled model railway system and computer chess.

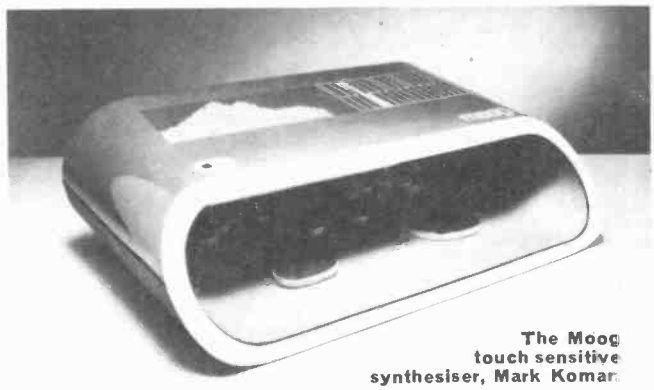
Two synthesisers, one without a keyboard, and a guitar with not a single string, are the most futuristic looking devices on show. The guitar resembles a painted plastic drainpipe and the synthesiser looks a bit like a hot-air hand-drier. Disappointingly though, they are to be seen and not heard. All are touch sensitive devices (!).

Man's World

For the man-about-the-house (and out-of-doors types) there is a Navigational Computer, Radio Compass, a Micro Micrometer, an Advanced Car Computer and a ZX80 computer being demonstrated. Perhaps he can use this to work out the best way of paying for all these items. And to protect all your "electronic furniture" there is a Burglar Alarm System.

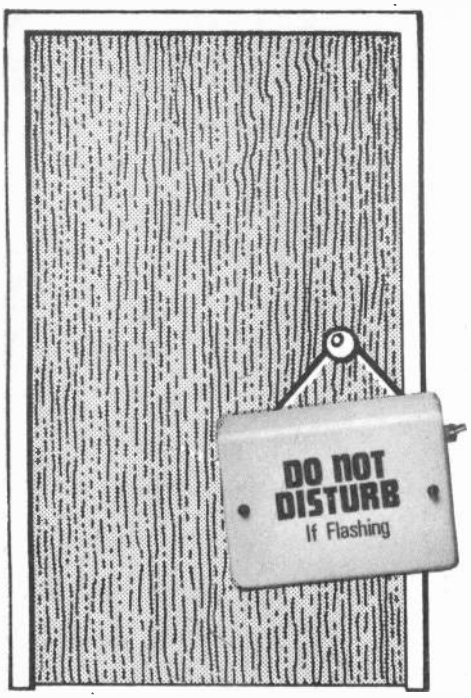
Business World

Other items on display include a Prestel Business Terminal, Telephone Answering Machine, a Bet Settling Computer (to make life easier for the bookmaker) and various TV sets.



The Moog touch sensitive synthesiser, Mark Komar.

Canon Couture De-Luxe gas oven uses microelectronic control.
Zero 1 model railway control console from Hornby Railways.
Microprocessor controlled Creda washing machine, claimed to be the world's most sophisticated.



L.E.D FLASHER

BY K. B. CROFT

A LARGE part of the author's electronic interest lies in various applications to audio; "Jingle" cassettes for disco operators, silly (but incredibly complicated) tapes to friends and relatives abroad, dubbing sound tracks on home movies, effects for theatre productions, and of course good music anywhere in the house at the flick of a switch.

RECORDING HAZARDS

Serious attempts at recording are likely to involve the use of microphones, and here silence is of the essence. Even where mics. are not "open" a great amount of concentration is often needed, especially where dubbing or putting together a composite tape (one film dubbing session involved five cassette recorders, two disc players and two electronic effects!). At times like these, Murphy's law demands that, on the ninth and apparently successful attempt, mum waltzes in with a tray of mugs of tea, trips over a cable and skids across the floor. Even if you have no mics. open and can manage to keep concentrating on the job in hand, the sight of the book shelves toppling over on to the pre-faded playout disc can be distracting, and ruin a good "take".

Locking the door is really no answer, as the average person seems to try the "Sweeny" approach before accepting that the door cannot be opened, then of course he or she will knock on the door, calling out at the same time.

Some sort of warning, outside the door, could stop such catastrophes and save the tea getting spilt. Such a simple unit is the subject of this article.

CIRCUIT

The circuit diagram of the L.E.D. Flasher is shown in Fig. 1 and is seen to be a basic astable multivibrator using transistors. This circuit may be thought by some to be "old fashioned" in this era of i.c.s but has the advantage that virtually any transistor can be used.

In this application, component values are not critical allowing the circuit to be constructed from components at hand in the "spares" box as was the case with the prototype. With this cross-coupled arrangement of the transistors, an oscillator is produced where TR1 and TR2 alternate with each other to be on and off.

COMPONENTS

Resistors
R1 100Ω
R2 3·3kΩ
R3 3·3kΩ
R4 100Ω
All ¼W carbon ± 5%

See Shop Talk page 159

Capacitors
C1, C2 100μF 3V elect. (2 off) (see text)

Semiconductors
TR1, 2 BFY51 or any general purpose silicon *npn* type with I_c = 100mA or more
D1, D2 TIL209 light emitting diode (2 off)

Miscellaneous
S1 miniature s.p. on/off toggle.
B1, B2 1·5V size AA cell (2 off).
Stripboard, 0·1 inch matrix, size 11 strips × 28 holes; battery holder for two AA batteries; case, Vero type 202-21025K (2 off) or similar; battery clip.

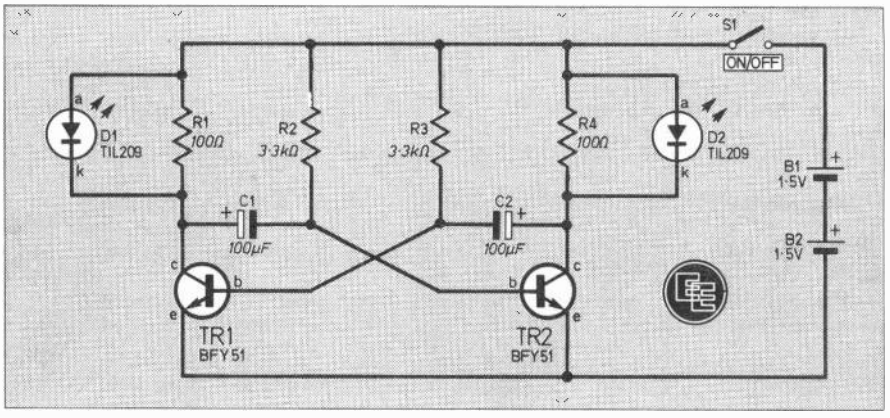


Fig. 1. The full circuit diagram for the L.E.D. Flasher.

As a result, one of the l.e.d.s will be on, the other off, at any one time. With the values of R2 and R3 as shown, the l.e.d.s will each flash for about one-third of a second. Decreasing the resistance of R2 and R3 to about 2 kilohms will give a rapid flash. Increasing the resistor values to about 4·7 kilohms will slow the flash cycle to about 1Hz, that is to say each l.e.d. will glow for about half a second.

Capacitors C1 and C2 could be anything from about 50μF upwards, although 100, 125 or 150μF are the values most likely to be found in the "spares box", all of which would work.

If the resistor of one of the timing circuits, R2 or R3, is of a different value, then the flash rate will be uneven, in other words, one l.e.d. will light for longer than the other.

CONSTRUCTION starts here

ASSEMBLY

The prototype circuit board layout is shown in Fig. 2. There are no breaks to be made on the underside. Points to watch for when assembling the components are capacitor and l.e.d. polarities. The latter have their cathode (k) marked with a flat on the body, or in some cases a notch.

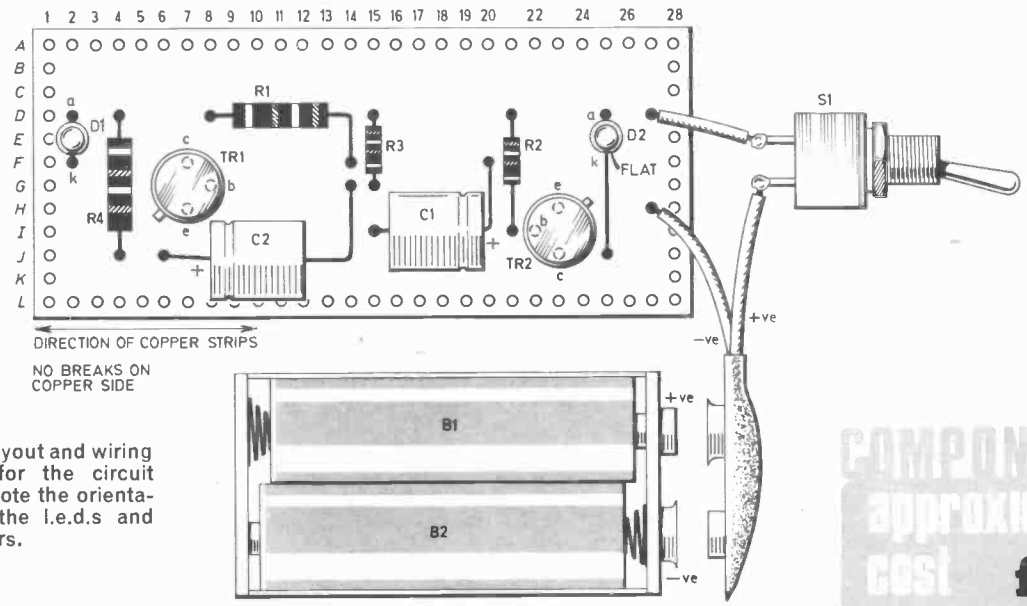
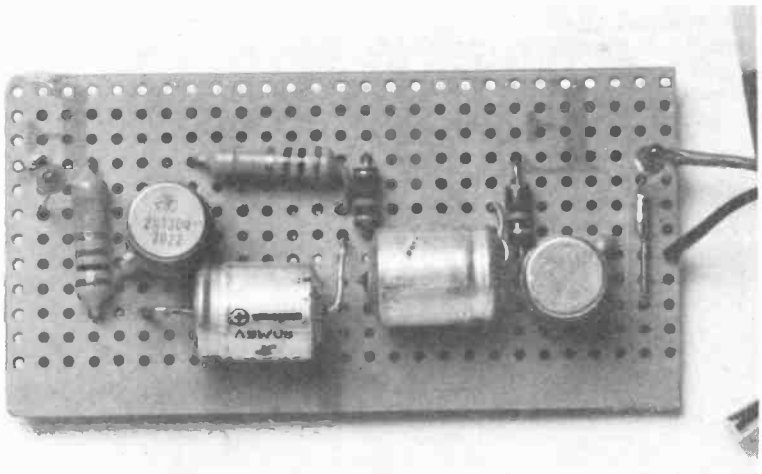


Fig. 2. Layout and wiring details for the circuit board. Note the orientation of the l.e.d.s and capacitors.

COMPONENTS approximate cost £3

The case used and seen in the photograph was two major sections from the Vero General Purpose range. The two sections are held together by nails. The correct size nail produces a very secure connection. The on/off switch and battery holder reside in the case lower section; the battery holder is fixed with self adhesive foam.

The circuit board is tailored to be a close fit lengthwise into the upper case half, and holes are drilled in the case to allow the l.e.d.s on the board to protrude. Blu-Tak satisfactorily held the board in its place. A piece of paper or foam sponge can be sandwiched between the two case sections to eliminate the possibility of shorting the underside of the board with the batteries.

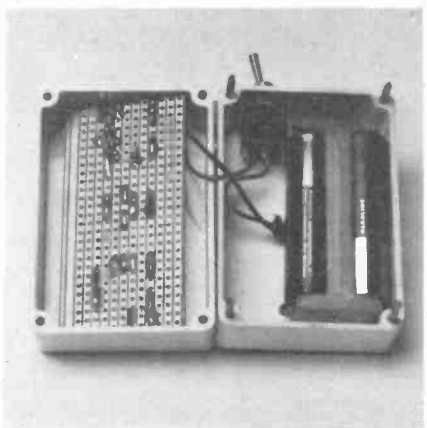


Close up view of the completed circuit board.

IN USE

Letraset was used to label the unit front panel which will be in accordance with its application at the time, RECORDING, MEETING IN PROGRESS, or just, DO NOT DISTURB. Countless other uses will come to mind no doubt. The unit is light enough to be attached to the door or whatever using Blu-Tak or Buddies.

The overall size of the sign and flashing l.e.d.s will be 70×50×40mm and is thus unlikely to annoy the owner of the house. The very fact that the l.e.d.s flash will make even such a small notice catch the attention of a would-be intruder. Whether they act accordingly depends on the people concerned. The important thing is of course to not use the sign too often, or people will learn to ignore the warning! ⌑

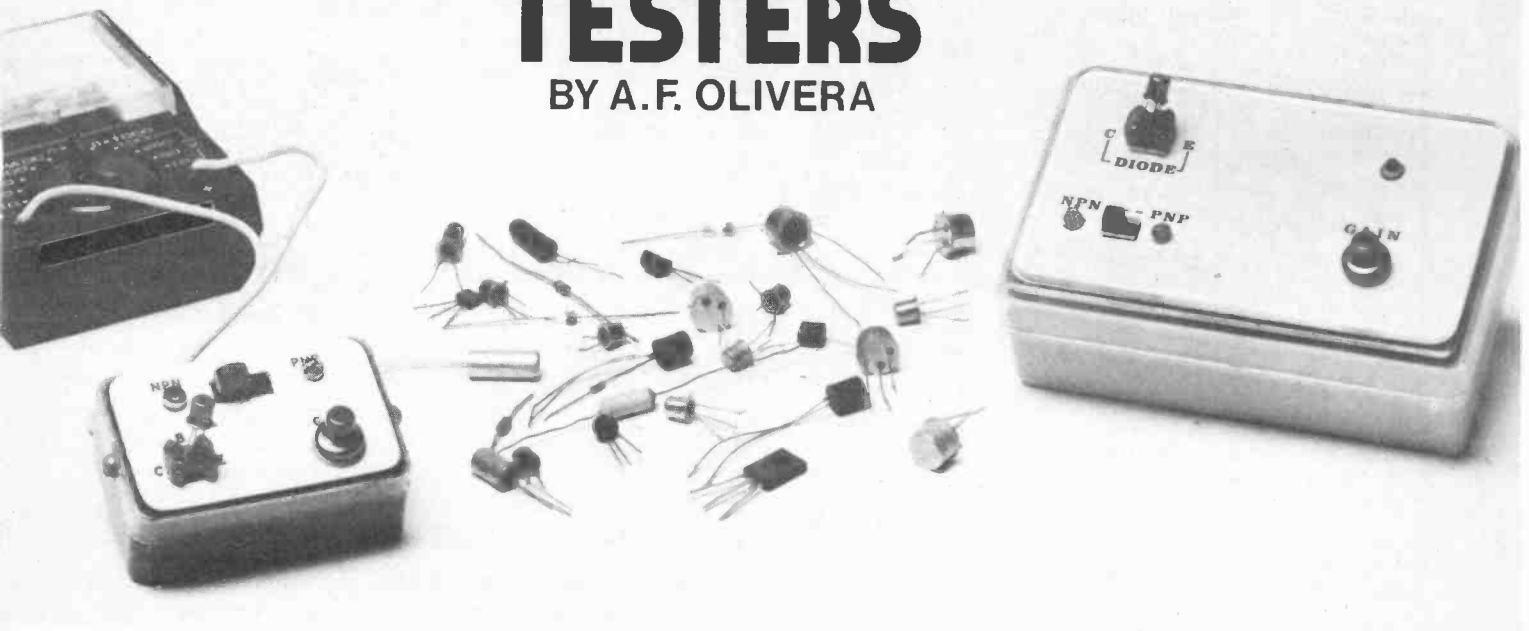


Shows the position of the board, switch and battery holder in the case.

The completed and fully assembled prototype with Letraset varnish protected labels

SIMPLE TRANSISTOR/DIODE TESTERS

BY A.F. OLIVERA



THIS article describes two very simple transistor testers, which can also be used to test diodes and identify their leads. They are of the go/no-go type, but should still prove very useful. Each uses only a handful of components and are thus very simple and inexpensive to build.

OPERATING PRINCIPLE

The testers work by detecting whether or not transistor action takes place. Fig. 1 shows the basic circuit with a *pnp* transistor. With *S1* open no current should flow between point *A* and point *B*. The transistor collector/emitter leakage current is normally so slight that it can be ignored. On closing *S1*, *R1* supplies bias current to the base of the transistor and turns it on if it is a functioning device, thus allowing a relatively large current to flow from *A* to *B*.

If the transistor is faulty, closing *S1* will make no difference to the current flow measured. It is in the manner that this increase in current is indicated that the two testers described here differ, one using an ohmmeter an dthe other an l.e.d.

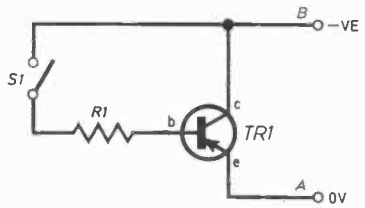


Fig. 1. The basic circuit.

OHMMETER VERSION

The ohmmeter version is marginally more efficient than the other, in that with practice one can "guesstimate" excessive leakage and the approximate gain of the transistor. It can thus be useful in selecting matched pairs. The full circuit diagram is shown in Fig. 2a.

When S1, the TEST switch is closed, base bias is applied to the transistor under test via R1. S2 can reverse the supply polarity to allow the testing of both *pnp* and *npn* transistors.

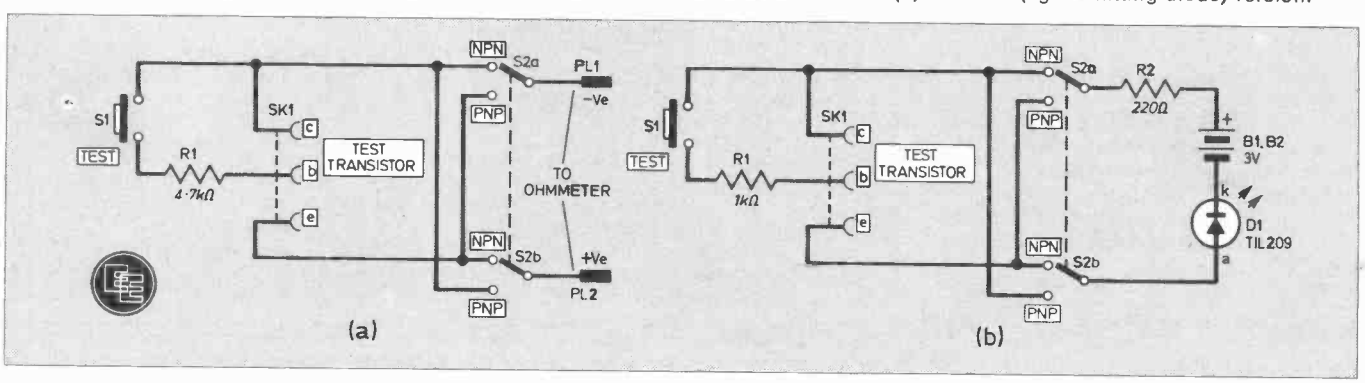
This tester has been designed to be used in conjunction with a multimeter, which in addition to lending its meter also provides power for the tester.

Multimeter resistance ranges are generally connected internally in such a way that the black (negative) socket is at a positive potential relative to the red socket, and the tester leads must therefore be connected to the plugs as shown in Fig. 2a, i.e. PL1 black, PL2 red.

USING OHMMETER VERSION

The red and black plugs are connected to the corresponding sockets on the multimeter, which must be set to a resistance range. The NPN/PNP switch (S2) is set as required by

Fig. 2. Circuit diagrams for the Transistor/Diode Testers (a) Ohmmeter version and (b) the l.e.d. (light emitting diode) version.



the transistor under test and the transistor inserted in the holder. At this stage the meter will indicate the transistor collector/emitter leakage, which in most cases will be negligible for a "good" device.

The TEST switch (S1) is then pressed and if the transistor is serviceable the meter pointer will be deflected appreciably—the bigger the deflection, the higher the gain of the transistor.

L.E.D. VERSION

The l.e.d. version should be of greater interest to readers who do not own a multimeter, since it is fully self-contained with its own power supply. The circuit diagram is shown in Fig. 2b. A battery and an l.e.d. replace the multimeter in the first version; R2 is a current limiting resistor. The rest of the components perform the same functions as in the first version.

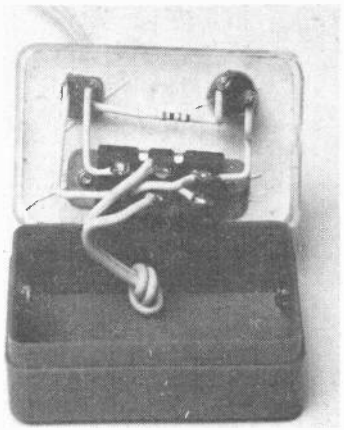
USING THE L.E.D. TESTER

The transistor to be tested is inserted in the holder, and the NPN/PNP switch is set as necessary. If the l.e.d. lights up at this stage, the transistor probably has a collector to emitter short and is unserviceable. It should be noted, however, that germanium power transistors normally have very high leakage current—enough for an appreciable glow to be seen in the l.e.d. The TEST switch (S1) is then pressed, and if the transistor is serviceable the l.e.d. lights up.

TESTING DIODES

The diode-testing procedure is the same for both versions. The diode to be tested is connected between "c" and "e" of the transistor holder, and the NPN/PNP switch is changed over. If the diode is serviceable the meter pointer or l.e.d., as the case may be, will react in only one of the switch positions.

The position of the switch at which the reaction is seen indicates the polarity of the diode: if the reaction takes place when the switch is moved to the PNP position the anode terminal of the diode is that connected to "e" of the holder. If, however, the reaction takes place when the switch is set to the NPN position, then the anode terminal is that connected to "c".

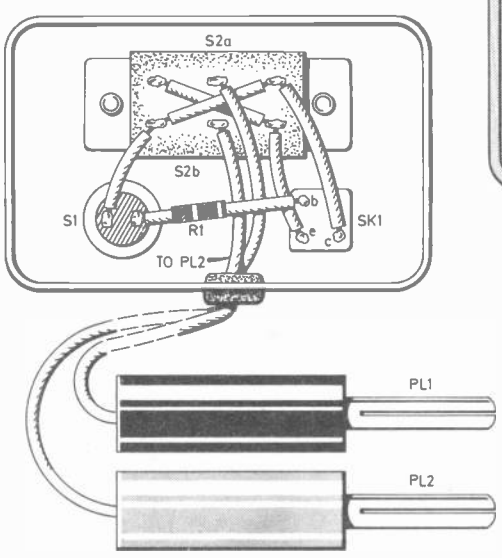


The finished ohmmeter version.

ASSEMBLY

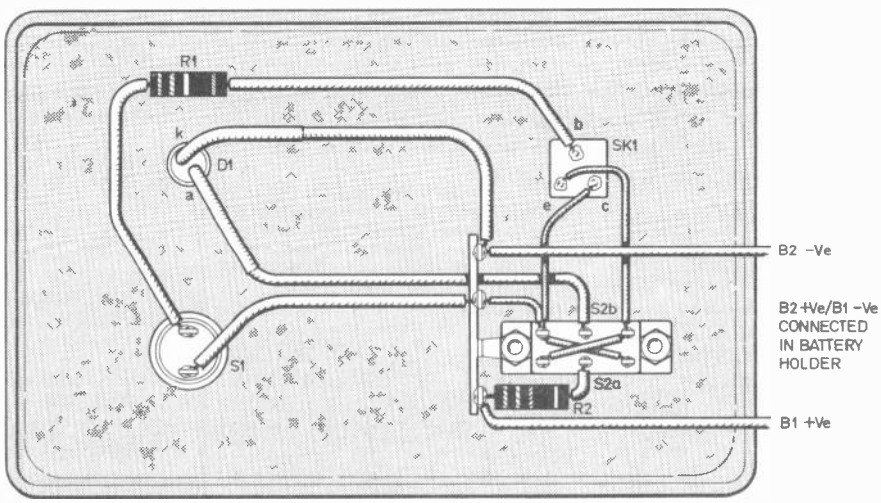
Assembly details for both units are shown in Fig. 3. The layouts are not critical in any way and may therefore be changed to suit requirements.

COMPONENTS approximate cost £2·00 each



(a)

Fig. 3.(a) Component layout and wiring for the ohmmeter version.



(b)

Fig. 3. (b) Layout of components and interwiring for the l.e.d. version. The tag strip is mounted under one of the polarity switch fixing screws.

COMPONENTS

OHMMETER VERSION

R1 4·7kΩ ¼W carbon ± 5%
S1 Miniature push-to-make, release-to-break switch
S2 Miniature d.p.d.t. slide switch
SK1 Transistor holder
PL1 4mm banana plug (red)
PL2 4mm banana plug (black)
Plastic case (see text); rubber grommet; connecting wire—extra-flexible type preferred.

L.E.D. VERSION

R1 1kΩ } both ¼W carbon ± 5%
R2 220Ω }
D1 TIL209 light emitting diode
S1 miniature push-to-make, release-to-break switch
S2 miniature d.p.d.t. slide switch
SK1 transistor holder
B1, B2 1·5volt cells size AA (2 off)
Battery holder; tag-strip, 4-way with mounting foot; plastic case (see text).

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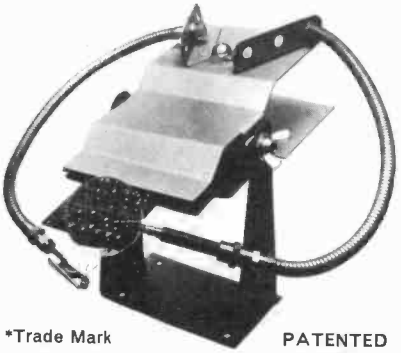

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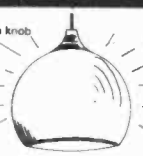
As with all our kits, these units come complete with all components, including RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal pads to touch, ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.



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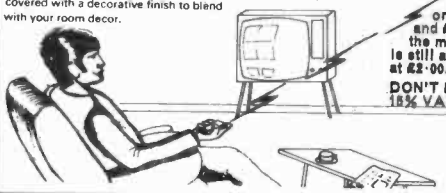
In two years' time everyone will be selling remote control dimmers but you can have your TDRK300K kit NOW for only £14·30 for the dimmer unit and £4·20 for the transmitter. For the more athletic of you, the TD300K is still available at £8·50 and the TDE/K at £2·00.

DON'T FORGET to add 40p P&P and 15% VAT to your total purchase.



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Optional Opto Input
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LEDs

0·1" Red or 0·2"	9p
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0·2" Yellow	12p
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4007	·17	4026	1·30	4077	·26
4011	·19	4027	·40	4081	·20
4012	·17	4028	·50	4093	·54
4013	·38	4040	·80	4501	·24
4015	·75	4049	·38	4511	·90
4016	·35	4050	·40	4514	1·80
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TBA800 5W Audio Amp.	68p
TBA810AS 7W Audio Amp.	£1·00
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TDA2020 20W Audio Amp.	£2·85
ZN1034E Timer	£1·80

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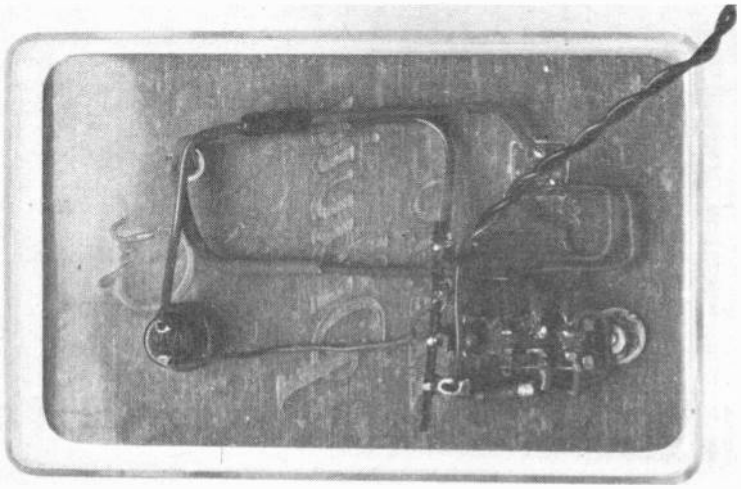
3A	49p		
8A	58p	16A	95p
12A	85p		
6A with trigger			80p
8A Isolated tab			65p
Diac			18p

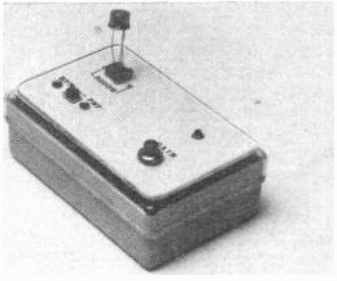


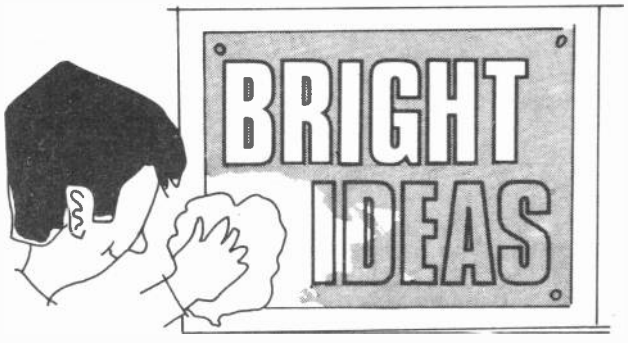
The completed l.e.d. version. The leads from the tagstrip "running off" the photograph at the top right go to the battery holders.

In the prototype ohmmeter version, a plastic box which originally contained a spare set of contact points for the car was used with the components mounted on the lid underside. The measurements were 55×35×20 mm.

A plastic soap dish measuring 95×60×30mm was found to be a suitable container in which to house the l.e.d. version. All the components except the battery were mounted on the lid. The tag strip was fitted to one of the screws holding the polarity switch to facilitate wiring. A small piece of self adhesive plastic foam will hold the battery container firmly in place on the case lower section.

Construction is straightforward, the only points to watch for being orientation of the l.e.d. and the labelling of the finished units. The transistor sockets are glued in place. Letraset on card fitted beneath thin Perspex for protection, produces a neat and durable finish. This method was used with the l.e.d. version. Alternatively a piece of white laminated with Letraset protected by varnish could be used as was on the other prototype. In both instances, the panels were held to the case rails through the polarity switch fixings. ⌑





Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

FUSE WIRE BIT

I have devised a way of making very fine soldered joints without having to pay a considerable amount of money for a fine soldering iron bit. I use a short piece of 13A or 15A fuse wire. This is cleaned using emery paper. The bit of the iron is also scraped clean to make a good heat-transference interface. The wire is then bound to the bit using Constantan wire. The fuse wire is then cut at a slant at the tip and is about 8mm long.

Kanak Patel,
Fosse Estate, Leicester

PAPER CLIP BIT

When drilling a home-made p.c.b., a straight section cut from a paper clip could be used as a drill bit. The piece is cut and filed to a point. When the bit becomes bent or blunt it can easily be replaced with another inexpensive "bit."

Kevin Lawe (aged 13 years),
Dublin, Eire

NEEDLE DRILLS

Having got rather tired of breaking and buying very small drills which are rather expensive I decided on an alternative. I obtained several darning needles of various sizes, nipped off the tip and the eyes (be careful of these pieces). I then filed the end of the needle four sided as square as I could; these act as the cutting edges, tapering to a point at the tip but not too fine a point

I use a lot of Formica for my projects and these "drills" go through this quite easily, and even 18 s.w.g. aluminium. They are also useful for making pilot holes for larger drills.

E. Vaughan,
High Wycombe, Bucks

MAGNETS IN THE WORKSHOP

I am always losing small nuts, bolts and screws. Putting them in a box helps but this is sometimes knocked over, and I spend a long time looking for them. Placing a magnet in the box keeps all the nuts, bolts and screws together, even if knocked over.

I also keep my small screwdrivers magnetised with magnets from loudspeakers as well because when I had to screw in a screw in a restricted area I could not hold the screw in position. The magnetised screwdriver does this without difficulty.

T. Lee,
Queensborough, Isle of Sheppey

DOUBLE-SIDED FEET

I have found that double-sided self-adhesive foam strips e.g. Sellotape sticky fixers, make good self-adhesive feet for boxes. If one pad is cut in half and the backing of one side is removed then it can be pressed firmly onto a rubber sheet. For this I used an old inner tube. You can carefully cut around the pad with scissors, remove the protective backing of the other side and press firmly onto the case. These have been found to work as well as shop-bought sticky feet.

D. Cockburn,
Middleton, Manchester

I.C. UNIBOARDS

SIMPLE INTEGRATED CIRCUIT DESIGNS

MINI SIREN

No. 4

BY A. R. WINSTANLEY

THIS MONTH'S Uniboard project is a Mini Siren which can produce three distinctive sounds—twin tone, U.S. police-car style siren and a "bleep" alarm signal. The unit makes a good alarm tone generator and perhaps could form a novel toy for a youngster with plenty of imagination.

An integrated circuit type NE556 is used. This i.c. consists of two individual timers similar to the NE555 used in the Uniboard No-Entry Indicator project. In fact the electrical characteristics and method of operation of each timer in the NE556 are identical to those of a normal NE555.

CIRCUIT

The circuit diagram of the Mini Siren is shown in Fig. 1. Integrated circuit IC1 is the NE556 timer chip and this has been shown in the circuit diagram as IC1a and IC1b. Each half of the i.c. can be considered to be just like a standard 555 timer.

One half of the i.c., IC1b, is wired as a slow-running astable multivibrator. It oscillates at approximately 3Hz, and the square wave output from this is obtained at pin 9. More detailed information regarding the function of the astable is given in the "No Entry Indicator", project No.1.

The other half of the i.c., IC1a, is another astable, this time running at about 220Hz, in fact at an audio frequency. This frequency can naturally be changed as required by altering the timing components R1, R2 and/or C1.

CONTROL VOLTAGE

An electronic alternative to this is to impose a voltage at pin 3 of IC1a. This pin is the control voltage input and provides a means of altering the frequency of operation without having to physically change the value of a timing component.

The slow square wave from IC1b is coupled to the control voltage pin of IC1a through S1a, a rotary switch which selects the function of the Mini Siren: bleep, twin-tone or U.S. siren.

EFFECTS

If S1a is set to "twin-tone", the output from IC1b is fed straight through to the control voltage terminal on IC1a. This results in a rapid decrease and then increase in the frequency of oscillation of IC1a. Hence a two-tone effect is created.

By moving the switch to the "U.S. siren" function capacitor C3 is brought into circuit by S1b. In effect this converts the output of IC1b from a square wave into an approximate sawtooth. The sawtooth then passes through to the control voltage terminal of IC1a.

The audio signal from IC1a is then modulated, or varied in sympathy with the sawtooth to produce a characteristic "whooping" tone similar to many American police-car sirens.

With S1 in the "bleep" position, IC1b imposes a 3Hz square wave on pin 4 of IC1a. This is the reset terminal of IC1a. (The reset pin of IC1b has been connected straight to the positive rail, incidentally, because it is not needed.)

By taking pin 4 down to 0V the i.c. is disabled. This means that the astable is prevented from oscillating. When the output from IC1b goes high again, the audio oscillator is enabled again. The overall result is that IC1a is repeatedly prevented from oscillating, producing a "bleeping" tone.

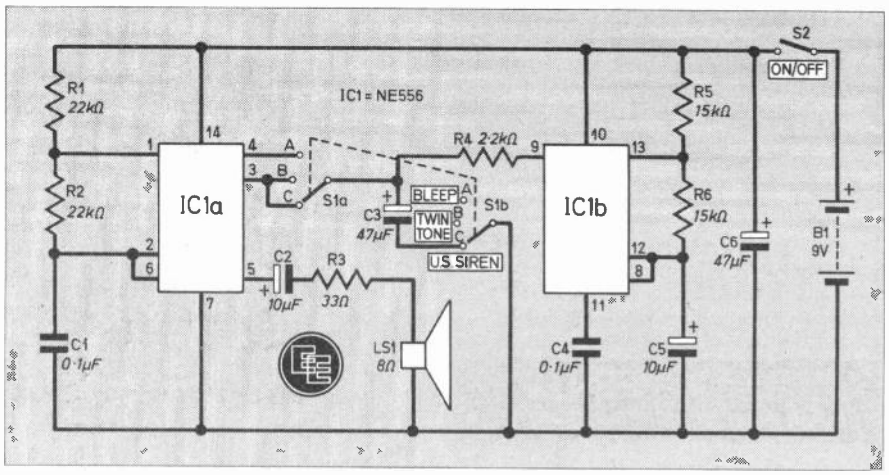
OUTPUT

The audio output from the whole circuit is taken from pin 5 on IC1a and this drives LS1 to generate an audible signal. The alarm tone is quite loud, suitable for burglar alarms and similar applications.

Measurements on the prototype showed that the siren draws about 40mA at 9V, and under 100mA when a 12V rail is used.

A 3·5mm jack socket can be used to connect up an external power supply. You may wish to use the Mini Siren in conjunction with another Uniboard project like the Burglar Alarm

Fig. 1. Complete circuit diagram of the Mini Siren.



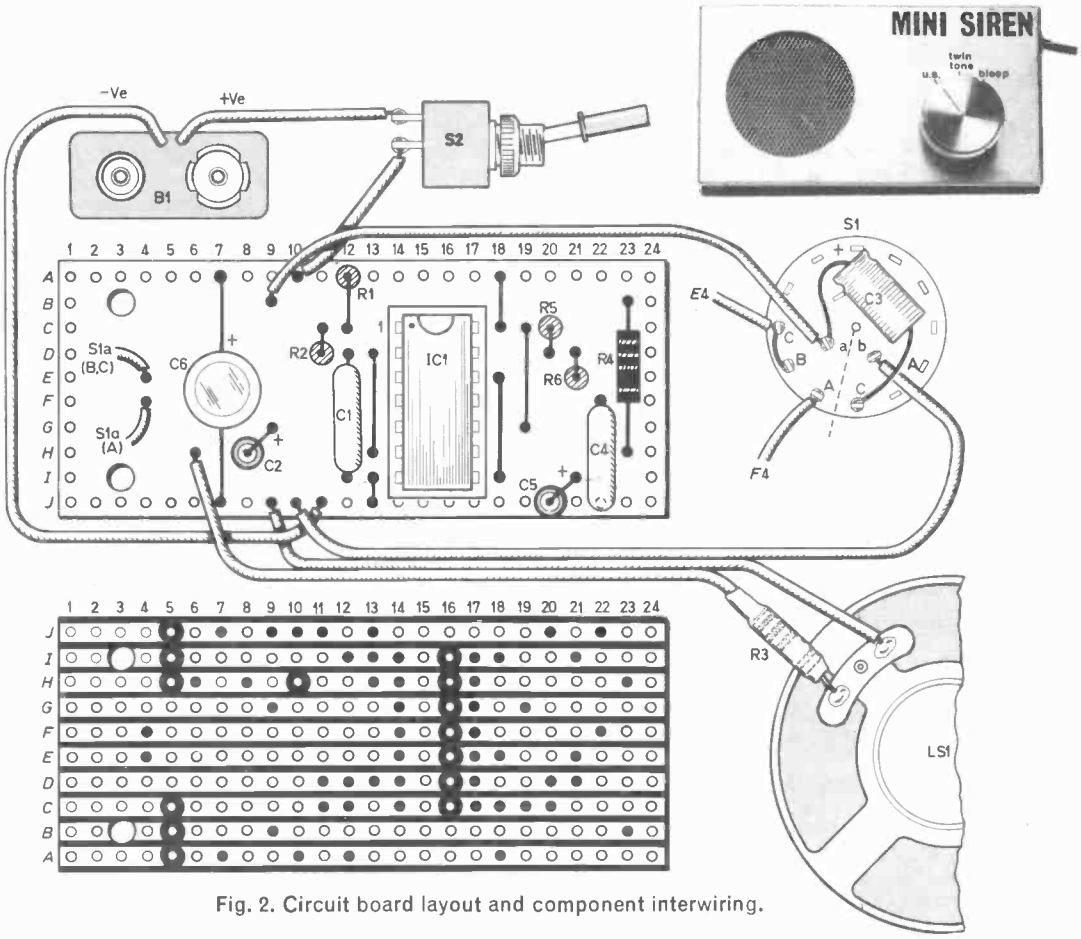


Fig. 2. Circuit board layout and component interwiring.

COMPONENTS

Resistors

R1	22kΩ	R4	2·2kΩ
R2	22kΩ	R5	15kΩ
R3	33Ω	R6	15kΩ

All ¼W carbon ±5%

Capacitors

C1 0·1μF C280 polyester
C2 10μF 25V elect.
C3 47μF 25V elect.
C4 0·1μF C280 polyester
C5 10μF 25V elect.
C6 47μF 25V elect.

Semiconductors

IC1 NE556 dual timer i.c.

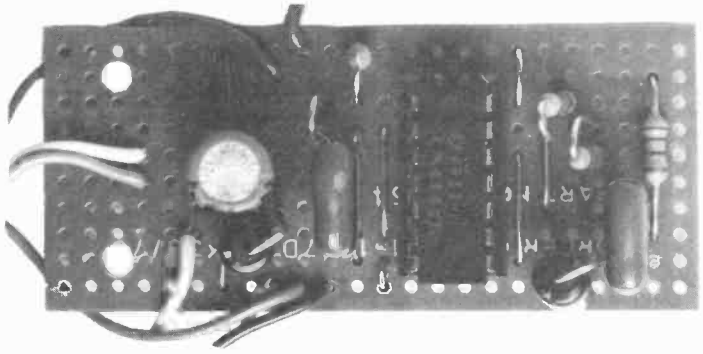
Miscellaneous

S1 2-pole, 3-way rotary
S2 s.p.s.t. toggle
LS1 8 ohm miniature loudspeaker
B1 9V battery, PP3 or PP9 size (see text)

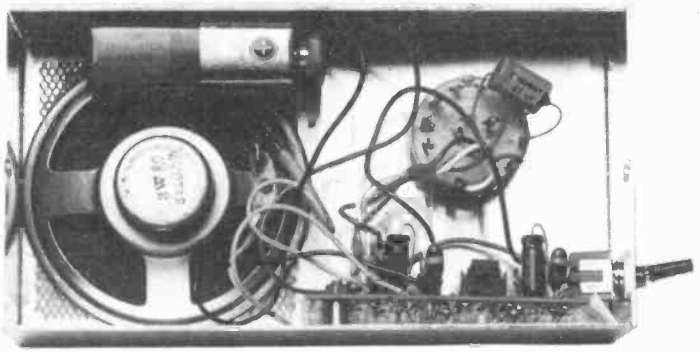
Aluminium case, 130 × 70 × 40mm; 0·1 inch matrix stripboard, 10 strips by 24 holes; 14 pin d.i.l. socket; battery clip; knob; speaker mesh; 6BA nuts, bolts and spacers (for mounting circuit board) (2 off each); connecting wire.

Guidance only
Approx cost
See page 159

£8·00
complete



Top view of circuit board.



Interior of completed unit.

or the Opto-Alarm. This is easily accomplished. Simply wire the Mini Siren in parallel with the audible warning devices (or in place of them) used in the projects.

Beware when using a battery. Because of the high current consumption a PP9 will probably give the most economical service, although the PP3 size is most compact. A battery clip of the appropriate size will of course be required.

CASE

The Mini Siren can be built into any type of case or box, whether metal, plastic or home-made. The prototype was contained within an aluminium box measuring 130×70 ×40mm and this was just wide enough to hold the loudspeaker.

The diagram in Fig. 2 illustrates how the various components are arranged on 0·1 inch matrix stripboard measuring 10 strips × 24 holes. It is best to use a 14-pin d.i.l. socket to carry IC1 and this should be soldered in after making the fourteen breaks in the copper strips.

The i.c. is not a CMOS type and no special handling precautions are needed. Insert the i.c. the right way round into its socket after soldering in all the link wires, resistors and capacitors.

You will see that C3 is mounted on the terminals of the rotary switch and also R3 is soldered onto one of the loudspeaker connectors.

Regarding the rotary switch, a 2-pole 3-way type is not generally available and therefore a 4-pole 3-way version must be used. Half of the switch is disregarded.

LOUDSPEAKER

The loudspeaker used in the author's prototype was an eight ohm 0·5 watt type measuring about 55mm diameter. In the case a large cut-out was made with a tank cutter, and then a piece of aluminium mesh was glued behind the resulting hole.

The speaker was then stuck down with a fairly generous application of glue around the rim. Try not to get any glue onto the loudspeaker cone itself.

If you do not have a tank cutter, you could drill a regular pattern of holes in the front panel. Alternatively, you can make a large cut-out by drilling a ring of holes and then punching out the middle.

The edge of the hole can then be filed with a half round file until a smooth finish is achieved. In practice it is not easy to achieve a presentable finish with this method.

FINISHING OFF

Dry transfer lettering can be applied as required to the front panel. The prototype was finished off by fixing a large aluminium knob onto the spindle of the rotary switch.

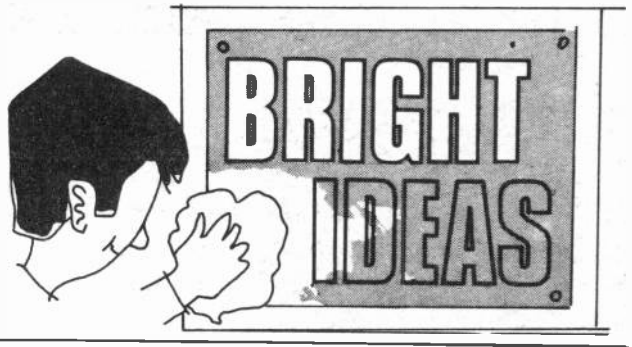
Once construction is finished check all wiring for errors or omissions. Take a look at the stripboard and check for dry joints or whiskers of solder bridging neighbouring strips.

USING THE SIREN

No setting up is needed so connect up a battery and switch on. It is important to wire up the power the right way round. This can come from a 9V Power Pack if a battery is not available.

Then you should hear the appropriate alarm tone depending on the positon of S1. If this is satisfactory, then construction is complete and the unit is ready to use.

Readers who like experimenting can try altering timing components R1, R2 or C1; R5, R6 or C5; R4 or C3 to see what effect this has on the sound produced. By doing this you can alter the tone of the alarm, the frequency of the bleeps and so on. ☐



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

PENCIL PROBE

I have discovered an inexpensive way of making probes for equipment. All that is needed to make one probe is a pencil (preferably the HB or B type). Just cut off the wood from the top with a blade or carving knife leaving the lead (graphite) and tie the wire around it. The wire can be secured to it by encapsulating in plastic resin or with a crocodile clip.

I have been using these probes for the *E.E. Continuity Tester* in the January '80 issue and on other pieces of equipment for many months and find its performance excellent! A series resistance of about 5 ohms is introduced with this probe which may need to be accounted for in some measurements.

Pankaj Sharma (aged 15 years),
Perivale,
Middlesex

BOOK REVIEWS

AMATEUR RADIO TECHNIQUES

Author	Pat Hawker G3VA
Price	£5·00 Paperback (£6·08 by post from RSGB worldwide)
Size	246 × 184 368 pages
Publisher	Radio Society of Great Britain
ISBN	0 900612 51 7

As the preface states, this is basically an ideas book and a source book and is intended to supplement standard handbooks. Some 50 new pages are included in this latest edition—the popularity of this publication is indicated by its reissue every two years since the second edition.

The material has largely been collected from the Technical Topics columns in *Radio Communication*, the Journal of the RSGB, and is arranged in nine chapters: Semiconductors, Components and Construction, Receiver Topics, Oscillator Topics, Transmitter Topics, Audio and Modulation, Power Supplies, Aerial Topics, and Fault-finding.

A number of "quick guides" have been incorporated in certain parts of the book to provide concise introductions to more recent devices and techniques. They cover (in Chapter One) topics such as Integrated Circuits, Digital Electronics, VMOS Power f.et.s, Microprocessors and (In the Audio and Modulation Chapter) Pulse Modulation, RTTY and SSTV.

There are over 800 diagrams, some 600 of these are circuits. The author's profound practical knowledge of the subject is obvious, and he has interlaced his text with comments on various amateurs' experiences and suggestions as well as references to published information in manufacturers' literature or in periodicals. F.E.B.

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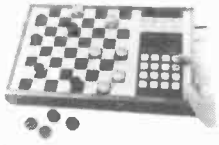

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BOOK REVIEWS

ROBOTS IN INDUSTRY

Author	G. L. Simons
Price	£10·00 Limp
Size	210 × 145mm 216 pages
Publisher	The National Computing Centre
ISBN	0 85012 236 8

THIS is a good up-to-date introduction to the subject for the general reader. The economic and social consequences of robot developments are discussed. We learn that most advances are being made in the US and Japan, the UK currently possessing 2 per cent of the world's robot population.

Other chapters describe the mechanical features of a robot; sensory systems; programming, software and control; applications and a brief look to the future. There are descriptions of many commercial robots and the kind of tasks they are intended to perform in industry, and problems still to be solved are discussed.

Quite "clever" robots can now be devised with advanced sensory systems, thanks to microprocessors and other electronic techniques. Video cameras provide visual facilities. The touch sense has been greatly improved of late; an interesting system described is a planar matrix artificial skin sensor consisting of a printed circuit on which a series of sensitive points have been isolated. The transversal impedance of a conductive coating on the structure varies according to the pressure exerted and so a variation in current or voltage is obtained.

An extensive bibliography is included and will be valuable for those wishing to pursue their studies of robots.

F.E.B.

THE ART OF ELECTRONICS

Authors	Paul Horowitz and Winfield Hill
Price	£35·00 Hardcover £12·50 Paperback
Size	250 × 175mm 716 pages
Publisher	Cambridge University Press
ISBN	0 521 23151 5 (Hardcover) 0 521 29837 7 (Paperback)

AS the title may suggest this is a textbook cum reference book with a difference. It is American, and has been compiled to meet the needs of a one-semester course in laboratory electronics at Harvard, where the enrolment was varied, ranging from undergraduates to post-graduate researchers, all with different skills but all requiring a comparatively simple way into electronics which they realised was an indispensable additional subject to aid their main discipline.

In the view of the authors, existing textbooks were inadequate for such a course, so they have produced this impressive and refreshingly different type of textbook which they suggest could be generally used for a full-year electronics circuit design course at the college level. It begins at a level suitable for those with no knowledge of electronics, but the mathematical level assumed includes some knowledge of trigonometry, exponential functions and differential calculus.

Semiconductors are treated as working devices without and preliminary discussions of solid state physics. (Perhaps the time is ripe for this to become general practice.)

A radical departure from conventional treatment of circuit design is the dismissal of the hybrid model (equivalent circuit) for a transistor as unsatisfactory, because of the wide variation (in practice) in h_{fe} between individual devices of the same type. Instead, emphasis is placed upon viewing the transistor as a transconductance device, and a modified model is used based on "the respected Ebers-Moll conventions". This, it is claimed, enables first-rate designs to be achieved without the need to do a lot of calculations.

This approach may not be universally applauded nor automatically adopted, but, in any event, teachers of electronics will find, in all, this an inspiring and mind-broadening volume. It is completely up to date, including digital techniques and microprocessors, measurements and signal processing in its formidable range of contents. A novel feature is the inclusion of selections of "Bad Circuits" which demonstrate how *not* to do things!

The second declared function of this volume is to serve as a reference book. The well sign-posted text and the wealth of tabulated data relating to contemporary semiconductors devices of all kinds make this a useful aid to have in the workshop. The price may be daunting, yet this large volume should prove a sound investment for the practising engineer and also for the amateur who has a serious interest in circuit design.

D.D.R.

NEWNES BOOK OF VIDEO

Editor	K. G. Jackson
Price	£5·95
Size	245 × 185mm 128 pages
Publisher	Newnes Technical Books
ISBN	0 408 00475 4

VIDEO is the new area in home entertainment and exciting things are going to happen. So a book that deals with the technicalities involved at a popular level is likely to be a success.

This book has 11 main articles, the work of established authors who are specialists in the areas they write about. The overall content is comprehensive, starting with a scene-setting piece The Video Centre which explains how the TV set is likely to become joined by a number of satellites such as tape and disc players, cameras, viewdata, computers and TV games. All these are discussed in following chapters. The history of development, present state of the art and possible future developments in each area are covered, with examples of typical equipment currently available.

The techniques involved are varied and in some instances, such as video recorders, the mechanics are as intriguing as the electronics. The text is well illustrated with diagrams and photographs of representative equipments.

Thankfully, not all video will be passive entertainment. The video camera opens up a new field for artistic creation by the individual and the making of programmes with a single camera forms the subject of one chapter.

Reading this book one realises how underworked our TV sets are at present. Clearly all this is about to change!

F.E.B.

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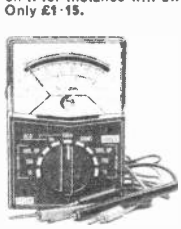
DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally. Price **£8·35.**

4-CORE FLEX CABLE
White pvc for telephone extensions, disco lights, etc. 10 metres **£2**, 100 metres **£15.** Other multicore cable in stock.

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. **£2·50** complete kit.

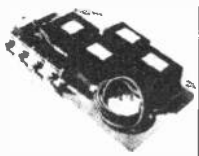
HUMIDITY SWITCH
American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Only **£1·15.**



MINI-MULTI TESTER
Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant range measure:
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges. Complete with Test Prods and Instruction book showing how to measure capacity and inductance as well.
Unbelievable value only **£6·75 + 50p** post and insurance.
FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini-tester and would like one, send **£2·50.**

VENNER TIME SWITCH mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2·95.** These are new but without case, but we can supply plastic cases (base and cover) **£1·75** or metal case with window **£2·95.** Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2·30.**

MULLARD UNILEX
A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16** including V.A.T. and postage.
FREE GIFT—Buy this month and you will receive a pair of **Goodman's** elliptical 8" × 5" speakers to match this amplifier.



SUPER HI-FI SPEAKER CABINETS. Made for an expensive Hi-fi outfit—will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price **£6·90** per pair (this is probably less than the original cost of one cabinet) carriage **£3** the pair.

FLUORESCENT TUBE INVERTER
For camping—car repairing—emergency lighting from a 12v battery you can't beat fluorescent lighting, it will offer plenty of well distributed light and is economical. We offer Phillips inverter for 12" 3 watt miniature tube for only **£5·25** with tube and tube holders as well.

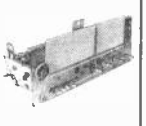
WALL MOUNTING THERMOSTAT. Danfoss, a handsome 2 tone, this is intended for living rooms but is just as efficient in a greenhouse or store. It is suitable for normal air temperature range 32F-80F—price **£4·60.**

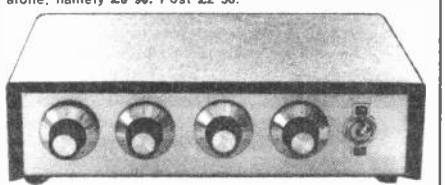
THIS MONTH'S SNIP

Vu METER Approximately 1⅞" square, suitable for use as a recording level meter, power output indicator or many similar applications. Full vision front cover easily removable if you wish to alter the scale. Special snip price **£1·00** or 10 for **£9·00,** post and VAT paid.

DRILL CONTROLLER
Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3·45**
Made up model **£1·00** extra.

CHASSIS BARGAIN
3 wave band radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which can only be described as superb. It is truly hi-fi. The chassis size is approximately 14". Push buttons select long, medium, short and gram. Control are balance, volume, treble and bass. Mains power supply. The output is 6 + 6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely **£8·90.** Post **£2·50.**





3-CHANNEL SOUND TO LIGHT KIT
Complete kit of parts for a three-channel sound to light unit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.
The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is **£14·95** in kit form or **£19·95** assembled and tested.

TERMS: Cash with order—but orders under **£10** must add 50p to offset packing, etc.
BULK ENQUIRIES INVITED. PHONE: 0444-54563.
ACCESS & BARCLAYCARD WELCOMED.

J. Bull [ELECTRICAL] Ltd.
(DEPT. EE1)
34-36 AMERICA LANE,
HAYWARDS HEATH SUSSEX.
RH16 3QU

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

BURGLAR ALARM CONTROL PANEL Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation, all you have to do is to take wires to pressure pads and to alarm bell. Price £6·90p. With complete diagram.

15-0-15v @ 2 AMP TRANSFORMER Mains transformer, upright mounting primary and secondary wound on separate bobbins with fixing lugs. Price **£3·45.** Post **£1·00.**

25-0-25v @ 750 mA MAINS TRANSFORMER Main transformer C core construction, heavily varnished for dead quiet operation. Upright mounting with fixing lugs. Price **£3·16.** Post **£1.**

25 WATT MID-RANGE SPEAKER 5¼" Made by Goodmans so there's none better. 4 ohm coil. Price **£3·95.** Post **£1·00.**

8 OHM TWEETER Made by Goodmans 3¼" square, 4" across fixings. Price **£1·72.** Post 30p.

TELEPHONE PICK-UP coil attaches by suction to phone body, enabling conversation to be recorded, put through amp or headphones. Price **£1·15.**

TELESCOPIC AERIAL 5 sections, 21" when extended, Nickel plated superior make, one nut fixing, folds over for FM. Price **£1·10.**

12v SUBMERSIBLE PUMP Our drill pump is useful, but this new one is even more so. Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming etc. and you get a very good head. Suitable for water, paraffin and any non-explosive, non-corrosive liquid. One use if you are a camper, make yourself a shower. Price **£6·90.** A free gift, first 100 purchasers will get tap with built in switch and length of plastic tubing.

E.H.T. MAINS TRANSFORMER with inductance control, normal primary, secondary output by our equipment, 3·5 kv 3 mA, E.H.T. voltage can be varied by applying a DC voltage to the lower normally unused bobbin. We are not sure how much the voltage may be increased or decreased but using a 9 volt battery we seem to get a rise or fall of about 50 volts. Ex unused P.S.U.'s. Price **£2·30.** Post **£1.**

RECHARGEABLE SOLID GEL BATTERY 12v 5 AH new and unused made by or for Elpower Corporation of California. Dimensions, 6" long, 3¼" high and 2¼" wide. Regular price of similar batteries. R.S Components is **£26·00.** Limited. quantity at **£15·80.**

EXTRACTOR FANS

Ex-Computer made by Woods of Colchester, ideal also as blower; central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" **£5·50,** 6" **£6·50;** post **£1** per fan.

LEDS are used increasingly and are now being recommended for nearly all indicators and for games and novelties. Due to a fortunate purchase, this month we are able to offer 10 red led's for **£1.** These are the small ones equivalent to the TIL 209. Bulk orice **£60·00** per 1,000 + V.A.T.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensers, multi turn pots, rectifiers, SCR etc. etc. for only **£8·50,** which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel, + **£1·27** VAT + **£2** post (it's a big parcel).

TIME SWITCH BARGAIN Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs **£2·50.**

TELEPHONE RINGING MAINS UNIT. Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25 Hz. this frequency gives correct ringing note for GPO bells. These units were made for the GPO so obviously are first class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price **£5·75.**

TELEPHONE EXTENSION BELLS in bakelite wall box, these will save you missing calls when you are out in the garden or shed, etc. Price **£4·75.**

CAR BATTERY POWER UNIT made for Rank Radio. This unit has been designed to operate 6v battery powered equipment from a 12v car battery, it provides a reliable source of stabilised voltage and gives protection to your equipment in case of accidental reversal of connections also against excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instrument being played is not connected to the car chassis. A real bargain at **£2·95.**

SLIDE SWITCH BARGAIN Double pole changeover standard size with good length of connecting wire soldered to each tag—10 for **£1·38.**

SIX DIGIT COUNTER Mains operated, 1 pulse moves counter through one digit, not resettable but all you have to do is to make a note of the numbers before the start of each count. Real bargain at **£1·15.**

CIRCUIT EXCHANGE

LOW VOLTAGE ZN414/ULN2283B RADIO

The low operating voltage of the ZN414 makes it ideal for portable use but careful choice of the audio amplifier stage is needed if the low voltage capability is to be exploited. I have designed and tested a circuit running off only 3 volts supply which I thought might interest you.

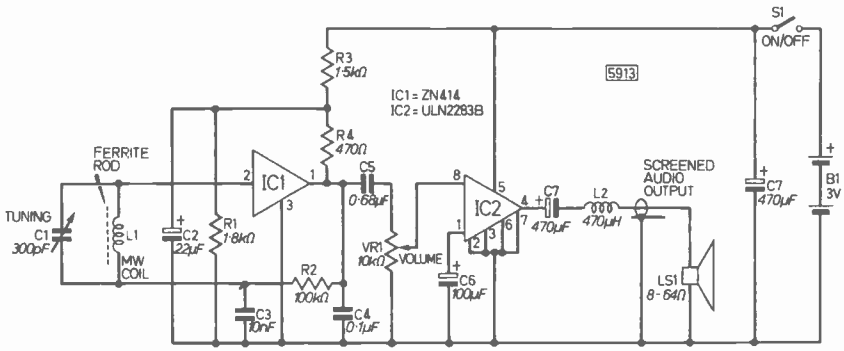
The circuitry around IC1 is conventional, R1 and R3 forming a potential divider to maintain a supply voltage to IC1 of 1·2 to 1·6 volts.

IC2 is a Sprague ULN2283B audio amplifier. Its high typical voltage gain of 43dB (about 140 times) means that the audio output of IC1 is sufficient to drive IC2 directly without the need for a transistor amplification stage. It can be operated from a supply voltage of 3 to 12·5 volts.

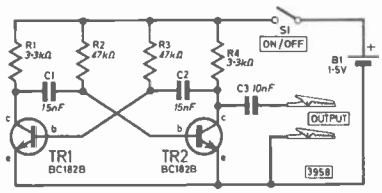
The 100μF capacitor on pin 1 of IC2 decouples an internal bias point and a 3 volt working capacitor can still be used if a higher supply voltage is applied.

To prevent r.f. oscillation of IC2 interferring with radio reception, especially with a low impedance loudspeaker, the output circuit shown should be used. The value of the series inductor is not critical and can be altered to suit what is available.

S. Niewiadomski,
Stapleford, Notts.



SIGNAL INJECTOR



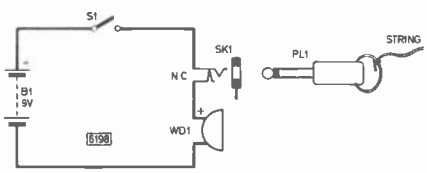
I have built this signal injector into a pocket flashlight, the circuit board occupying the space normally filled by one of the batteries. The values chosen for the timing capacitors and base resistors give a square wave output of approximately 1 kHz ($t = 0·7/CR$, where $C = C1 = C2$, $R = R2 = R3$) with equal work/space ratio.

D. J. Edwards,
St Ann's, Nottingham

BURGLAR ALARM HANDBAG PROTECTOR

This circuit would be a good thing for the beginner to make because of its simplicity. With a jack plug in the socket SK1 the alarm does not go off, but as soon as it is pulled out the two contacts in the socket join therefore setting off the alarm WD1. The device can be deactivated by S1 if needed. The battery used can be changed to suit the buzzer or vice-versa.

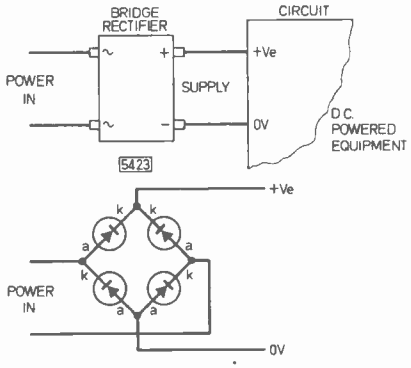
The circuit should be housed in a small case and carried in some secure part on the person. The free end of the string should be firmly attached to the handbag or other object it is intended to protect.



This circuit has many other uses, wherever a string-pulling alarm is needed, trip wires, doors etc.

M. Stevenson,
Craigavad,
Co. Down

REVERSED SUPPLY PROTECTION



This simple idea ensures that if battery or power supply leads to a d.c. powered circuit are reversed, no damage whatsoever will be entailed; in fact, it does not matter which way round the supply leads are—the circuit will work anyway.

The current and voltage specifications of the bridge rectifier must exceed the voltage and current used by the circuit powered. If a very low power circuit is to be protected, a very cheap bridge rectifier can be made up from small signal diodes, such as 1N4148 or 1N914, as shown below. Whichever way the power goes in, the voltage will always come out the same.

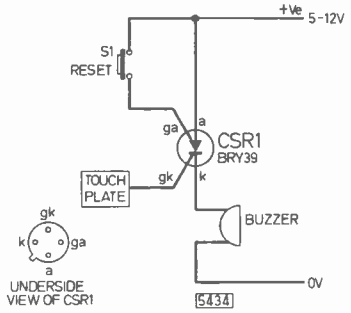
G. Durant,
Selby, North Yorkshire

TOUCH SWITCH

This is a simple one-contact touch switch (with reset), that can drive an l.e.d., solid state buzzer, low power relay and so on, that uses only one thyristor costing about 50p and one push-to-make reset button, and nothing else.

It could be put under the saddle of a bike, and many other places.

A. Trafford,
Milton Common, Oxford



CIRCUIT EXCHANGE

LETTERS

P.C.B. Solution

I have read your informative article on making p.c.b.s and would like to know (1) is there any means of telling when the ferric chloride is nearing the end of its useful life.

(2) When it comes to disposing of the ferric chloride solution is there a neutraliser which can be added first to prevent damage to pipes etc.

J. G. Burch
Southampton, Hants

The process of etching a p.c.b. is basically a chemical reaction in which the ferric chloride reacts with the exposed copper on the board to produce various chemical salts.

As more and more boards, and hence copper, are etched, the quantity of ferric chloride available in the solution to continue the process reduces. Also the quantity of chemical salts produced by the reaction increases and the result is that the etching process slows down,

Therefore the solution has reached the end of its useful life when the speed of etching is so slow as to be unacceptable. In practice you can expect 500ml of solution to etch about 2500cm² before it becomes exhausted.

When disposing of the solution, care must be taken as it is still a dangerous and unpleasant material. Unfortunately there is no commercial neutraliser available on the market so the best way of dealing with the problem is to start by pouring the used solution carefully into a plastic bucket which has been filled with cold water.

Take great care not to splash anyone, especially yourself! Make sure that the resulting solution is thoroughly mixed and then pour it down an ***outside*** *drain.*

On no account should you dispose of the solution undiluted or down an inside drain. [See also Counter Intelligence page 164]

Rule to Follow

Sometimes when in the construction of a p.c.b. one comes across the problem of how to get the holes for an i.c. in line and right distance apart and so on, but the problem can be solved with the use of the EVERYDAY ELECTRONICS constructors ruler presented free in your magazine some months ago. The holes intended for bending the leads of components can be used as a stencil.

Place the ruler on the p.c.b. and apply the etch resist pen to the board via the holes in the ruler, then take the ruler away and you have a perfect set of dots. The same is done for the other side of the i.c.

M. Stevenson,
Craigavad, County Down

Sharp's the word

I wonder if any of your readers could help me. I am the owner of a SHARP RD-708-V reel-to-reel tape recorder, for which I am in desperate need of a service sheet, the company being apparently uninterested in supplying one to one of its own agents. If anyone can help, could they please contact me.

C. P. Bolus,
102 Wellesley Street,
Shelton, Stoke-on-Trent, Staffs

A.C.C. Alive and Kicking

I am pleased to announce that the Amateur Computer Club is now very much alive and kicking following a somewhat dormant period last year. The A.C.C., one of the oldest if not the oldest amateur computer club in the world (founded in 1972), is a national organisation to promote interest in amateur computers and computing, to facilitate the exchange of information and ideas to help members with their home computer systems.

Membership is currently £3·50 p.a. (to be raised to £4·50 as of 1st January 1981) and is open to anyone with an interest in computers and computing, further details and membership forms (SAE please) from The Hon. Membership Secretary Jim MacDonald, 1 Carlton Court, Studley Grange Road, London W7 2LU.

Peter Whittle,
Chairman A.C.C.
Manchester M31 1NF.

Save on lighting

Being a fairly regular reader of your magazine, and also running a custom built Disco, I find your projects on lighting, such as Sound-to-Light, Chaser, etc. very good, but in these times when money is in short supply every penny possible must be saved. You always specify the use of Bulgin P550, but as these are very expensive, and when wired to three light boxes, all the light boxes are joined together making it very awkward to move. I have found that the USA two-pin plugs and sockets are ideal, being rated at about 7·5 amps, and no earthing is required if the boxes are made from wood i.e. chipboard.

A. Madden,
Portrack, Stockton-on-Tees

We now specify the Bulgin connector pair P550 as this has been adopted in commercial disco lighting products such as three-channel sound to light units. The P550 is made up from a P551 plug, and P552 panel mounting socket.

You are not obliged to use this connector, and if you have a safe, cheaper alternative, —as Mr. Madden has—then by all means use it.

JACK PLUG & FAMILY... BY DOUG BAKER

Mains Transformers

SOONER or later everybody gets fed up with buying batteries for domestic equipment and wants to change over to mains power. This calls for power supply units containing mains transformers.

A bewildering variety of types and descriptions are on sale. This article is intended to be a guide through the maze.

The particular reader's enquiry which suggested this *Down to Earth* was from someone who had come across voltage ratings like "6-0-6V" and wanted to know that they meant. It struck me as a very good question, especially when I remembered that an identical transformer might well be described with the term "12V CT". This sort of jargon can be very puzzling until you get used to it so I'll try to put in lots of these technical description terms and explain them as we go along.

Mains transformers of the type used in low voltage power supplies (sometimes called Battery Eliminators, or AC/DC Converters or just P.S.Us for "power supply units") should have a *PRIMARY* winding for connection to the a.c. mains and a *SECONDARY* winding for connection to the rectifiers which are required to turn the a.c. into d.c. A transformer of this two-winding construction, Fig. 1, is sometimes described as *DOUBLE-WOUND* to distinguish it from another type, the Auto Transformer which has only a single, *TAPPED* winding (Fig. 2).

Isolation

Auto-transformers are often used as mains transformers but for one special job—to convert European mains voltages of 220-240V to American voltages of 110-120V, which enables some American equipment to be operated from European mains. Auto-transformers can be relatively cheap and efficient but they do not provide *ISOLATION* from the mains because one connection is common to both input and output.

In contrast, the secondary winding of a double-wound transformer, if properly insulated, is completely isolated from the mains and there is no chance of getting a mains voltage shock by touching the secondary of any equipment powered from it. This is an important safety point and is the reason why a well insulated double-wound transformer is the only type which should be used to make battery eliminators.

Equipment designed to work off a low-voltage battery may *not* be insulated to mains voltage standards!

Since the primary is completely isolated from the secondary it does not matter which side of the mains ("live" or "neutral") goes to which end of the primary. For the same reason a mains "earth" is not needed, though there is something to be said for earthing exposed metal with a three-core mains flex.

Primaries

Nowadays, the majority of small mains transformers have a plain primary as in Fig. 1, with just two connections for the mains input and no "tappings" to intermediate points on the winding. You may, however, come across primaries which are tapped to make them adjustable to the local mains voltage (which used to differ in different parts of the UK).

The circuit in Fig. 3 shows a rather complicated set of tappings. Forget, for the moment, that the 10V tapping at the bottom is there and connect the "0V tap" to one side of the mains. The other "leg" of the mains can now be connected to whichever of the top end tappings is closer to the local mains voltage. This gives a choice of 220V and 240V, but it is possible to add 10V to either of these by connecting the other side of the mains to the "10V tap" Instead of the 0V point, thereby accommodating 230V and 250V.

A transformer with all these tappings would be described as "Primary 10-0-220-240V". One with only the upper tappings would be "primary 0-220-240V".

This should not be confused with "primary 220-240V", which usually means a plain untapped primary whose design voltage is really 230V but which can be used at 220V and 240V without much error in voltage. Such a transformer will give voltages slightly above the nominal secondary voltage when connected to British 240V a.c. mains and slightly below nominal when used on Continental 220V a.c. mains. Battery operated equipment is usually sufficiently tolerant of voltage variations for this not to matter.

The problem of making a mains transformer adaptable for use on either side of the Atlantic is sometimes met by winding the mains primary in two separate and equal sections. See circuit diagram Fig. 4.

Each section is rated at 120V. For 240V mains they are connected in series as shown dotted. The letters *S* and *F* refer to the "start" and "finish" of a winding and it is important to connect correctly.

An alternative method of marking is to put dots at points of the same polarity and leave the other ends of the windings unmarked, as shown. For parallel (120V) connection, connect *S* to *S* and *F* to *F* (dot to dot and blank to blank).

Bobbin

Mains primary windings have thousands of turns and these form many layers of wire on the transformer's *BOBBIN*. Old transformers were often made with a sheet of paper insulation between layers, described as "fully interleaved". Modern precision windings and improved *ENAMELS* for insulating the wire make interleaving unnecessary in most cases.

Older transformers generally used a plain bobbin, often just a cardboard tube. The primary was usually wound first, then a layer of insulation, then the secondary.

Some modern transformers use a *SLOTTED* bobbin in the form of a plastics moulding with walls to separate the primary and secondary which are wound side by side.

After assembly some transformers are impregnated with wax to provide extra insulation and moisture-proofing.

Leadouts and Fixings

The leadouts which connect the windings to the outside world may simply be left hanging loose (*FLYING* leads) or may be terminated on tags or pins. These may be attached to the bobbin or be carried on a separate *TAG BOARD* fixed to the *CLAMP* or *YOKE* provided for most transformers to hold the *LAMINATIONS* which form the *CORE* or *STACK* firmly and so discourage vibration which can give rise to *LAMINATION BUZZ*.

In surface mounting transformers the ends of the yoke are often formed into

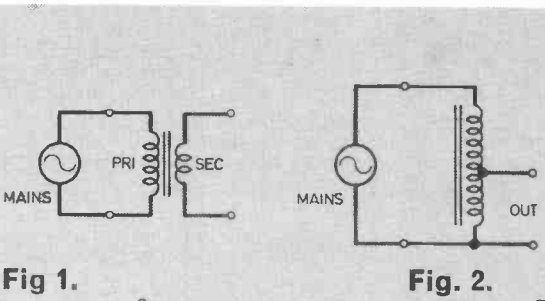


Fig 1.

Fig. 2.

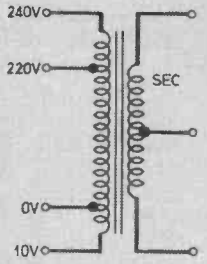


Fig. 3.

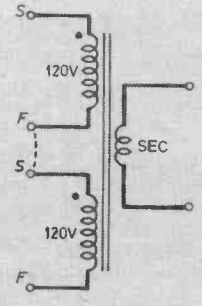


Fig. 4.

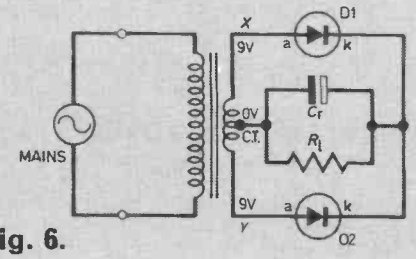


Fig. 6.

fixing *FEET* or *TAGS* for printed-circuit mounting or both. The printed-circuit tags (or *LUGS*) are straight projections designed to pass through slots in the board and then be twisted to lock the transformer in place.

Feet, on the other hand, have bolt holes which enable the transformer to be bolted or screwed to a baseboard and are therefore more useful to the amateur.

Miniature transformers for printed-circuit board mounting (*p.c.b.* mounting) may have no fixings on their yokes but rely for support on pins, moulded into their bobbins, which also serve as terminating tags for the windings.

Screen

Despite their solid appearance transformers are easily damaged. For example, a screwdriver carelessly poked into a winding may cause a break or short or both. For this reason some transformers are provided with metal cups or *SHROUDS* which cover their windings.

Another "extra" is the *ELECTROSTATIC SCREEN* or *SHIELD*. This is a layer of metal foil placed between windings to prevent high-frequency currents from leaking from winding to winding via the insulation.

Each winding acts like the plate of a capacitor and the insulation like the dielectric. The inter-winding capacitance may be a few hundred picofarads. This presents an enormous barrier to mains frequencies but not to radio frequencies.

An earthed shield shorts these high-frequency currents and discourages (for example) the "hash" from the household's electric drill or vacuum cleaner from getting into a radio via the mains connection.

Secondaries

Plain secondaries with untapped windings are suitable for feeding *BRIDGE RECTIFIERS*. A bridge rectifier, Fig. 5, contains four diodes connected to steer current from the secondary in the correct direction into the *RESERVOIR CAPACITOR* C_r and therefore provide d.c. for the *LOAD* R_l which in practice is the piece of equipment being powered by the p.s.u.

Diodes D1 and D3 conduct on one half cycle and D2, D4 during the next, and so on. The rectifier can be drawn as a bridge, Fig. 5 (a) or as a lattice Fig. 5 (b). These circuits are electrically identical.

If no load is connected C_r usually charges to 1·5-2 times the nominal secondary voltage. So a 10V (nominal) secondary produces about 15-20V off-load. As more and more current is taken by increasing loads (decreasing values of R_l) the output voltage falls until at maximum permitted current it is usually rather less than the nominal r.m.s. voltage of the secondary.

This sagging of the output voltage can be described by a number called the *REGULATION*:

$$\text{Regulation} = \frac{\text{(No-load voltage minus full-load voltage)}}{\text{No-load voltage}}$$

and it is often expressed as a percentage. Note that this has nothing to do with *STABILISATION* of voltage which is something that requires extra circuitry.

If you require a substantial amount of current from your power supply unit you may be offered a Battery Charger Transformer. These are frequently designed on the assumption that about 3V will be lost in the rectifiers, so a "6V" charger transformer may deliver 9V and a "12V" type deliver approximately 18V.

Split Secondaries

Another common arrangement is the *CENTRE-TAPPED* secondary, this is designed to drive a *PUSH-PULL* rectifier as shown in Fig. 6. Here D1 conducts during one half-cycle, taking current from the upper half of the winding and D2 on the next, taking current from the lower half.

The a.c. voltage between *X* and *Y* is twice the nominal voltage. This means that if desired the centre tap may be left unconnected and a bridge rectifier driven by the 18V to give twice the output voltage of the push-pull circuit.

The current rating must then be halved to avoid overloading the transformer. A 9-0-9V winding may equally well be described as "18V CT" where CT means centre-tapped.

More and more transformers are made with *SPLIT SECONDARIES* (Fig. 7). The two separate secondary windings can then be connected in series Fig. 7 (a) to give twice the voltage or a centre-tapped secondary or in parallel Fig. 7 (b) to give twice the current of a single winding. Or they can be used separately, of course.

When connecting windings in parallel it is essential to connect *S* to *S* and *F* to *F*, otherwise you end up with a burned-out transformer.

Current Ratings

A transformer is essentially a voltage changing device. The amount of current it delivers depends on the size of the load and it is up to the user to ensure that this current is within its ratings.

Makers quote the maximum current which may safely be drawn. Thus a transformer described as "220-240V, to 9-0-9V, 100mA" can deliver safely up to 100mA.

Unfortunately, this specification, though typical, is not clear. Does it mean 100mA a.c. or 100mA d.c. after rectification?

If you take 100mA d.c. with the rectifier circuits we've been using then the a.c. drawn is 140mA! It is safest to assume that a.c. is meant in which case the d.c. drawn should not be more than 70 per cent of the rating.

Magnetising Current

Even with no load a small current from the mains flows in the primary. This is called the *MAGNETISING CURRENT* and it flows because the primary is an inductance and therefore has a finite reactance or impedance.

The mains voltage drives current through this impedance and it is, of course, a wasted current and should be small. For a miniature transformer even 10mA represents a fair proportion of the on-load input current.

A badly-made core or shorted turns on a winding can greatly increase the off-load current and may cause overheating. Check by running off-load for an hour or so to see if the transformer gets hot.

Intermittent Ratings

Transformers for power supplies are normally designed for continuous operation. For other tasks, however, a transformer may be called upon to work flat out for a short time then stand idle.

A typical example is in electric welding where enormous currents are needed but only while the welding electrode is in contact with the work. Between contracts the transformer can cool off.

It is possible to design transformers to cope with large outputs for short periods only. They are then given an *INTERMITTENT* rating which may be far greater than the *CONTINUOUS* rating.

The intermittent rating is used in conjunction with a *DUTY CYCLE* which says for what proportion of the time the transformer may be used. Thus a transformer which can deliver 100A for not more than one minute in every ten minutes could be rated 100A, 10 per cent Duty Cycle.

The electronics enthusiast may come across transformers with intermittent ratings for ringing doorbells or clock chimes or similar short-duration tasks.

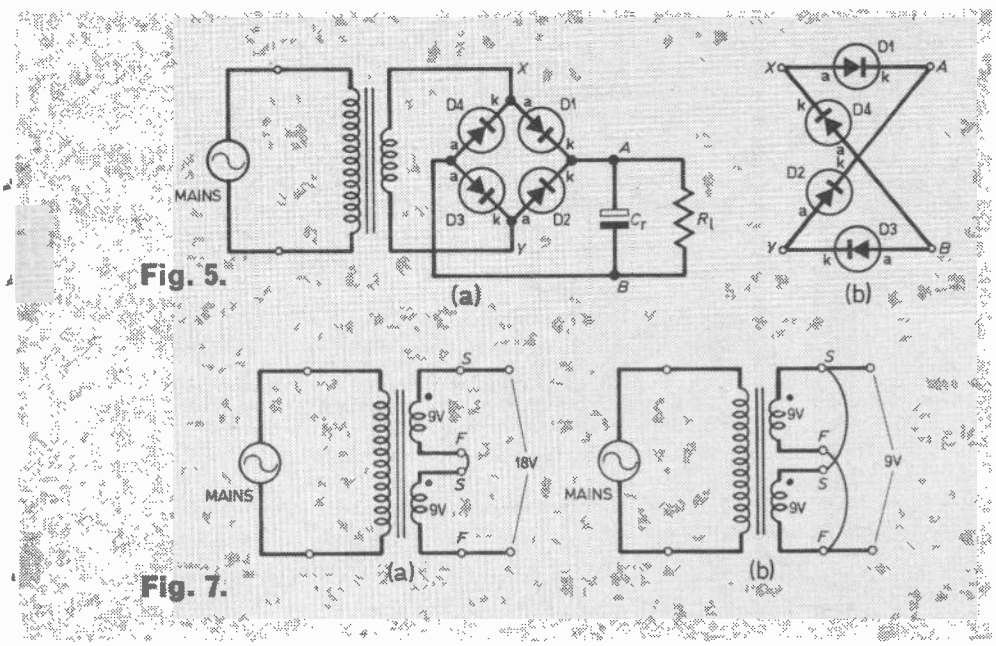


Fig. 5.

Fig. 7.

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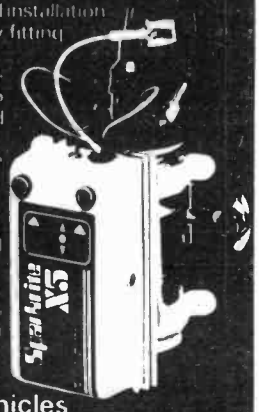

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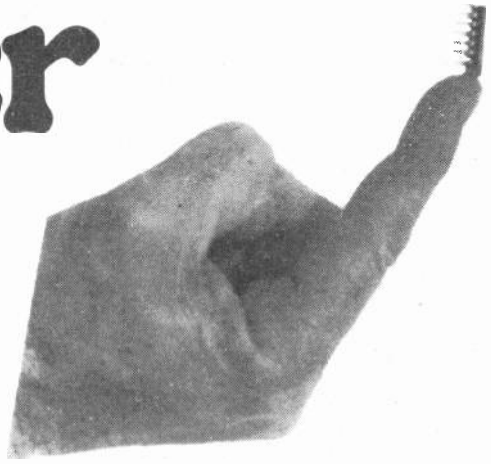

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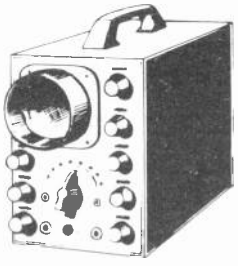

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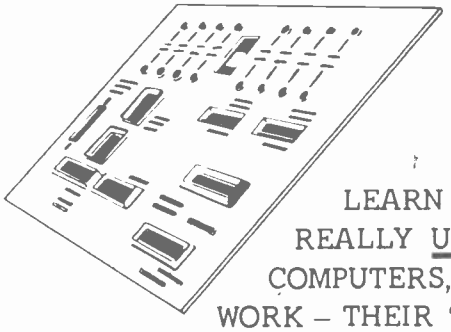

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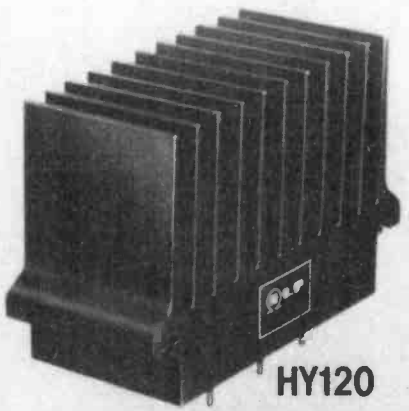

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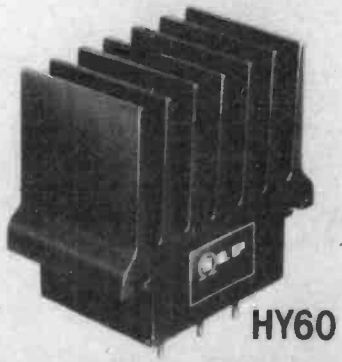

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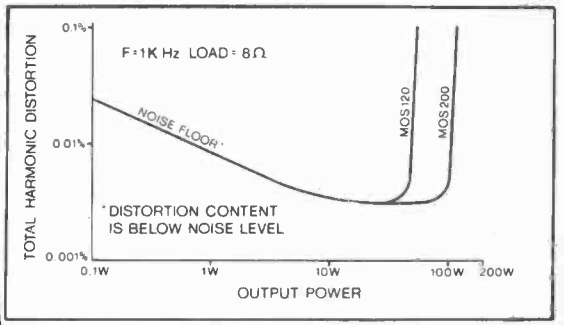

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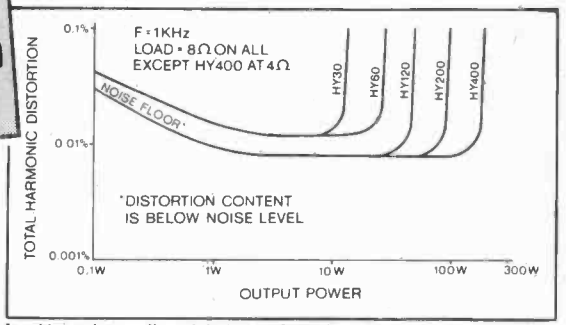
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



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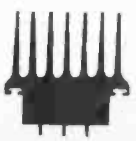

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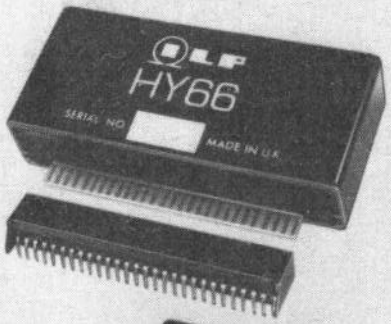

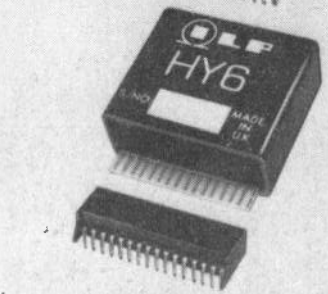

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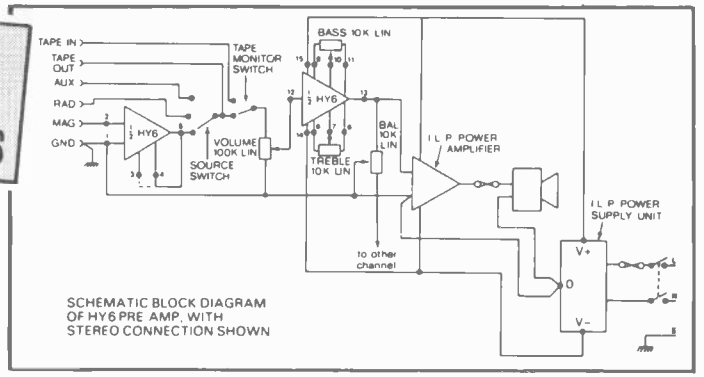

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Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.
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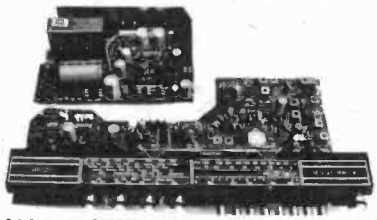
Push Button Controls Mono, Tape, Disc, A.F.C., FM(VHF), LW, MW, SW.
Power Output 7 watts RMS per channel into 8 ohms (10 watts music)
Tape Sensitivity output typically 150mv. Input 300mv for rated output.
Disc Sensitivity 100mv (ceramic cartridge).
Stereo Beacon Indicator LED or bulb.
Size Tuner—2¾" × 15" × 7½" approx. Power amp.—2" × 7½" × 4½" approx.
Price £23·50 + £2·50 Postage and Packing.



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TTP 447	0·75•2	2·14	60
TTP 449	1·0•2	2·36	70
TTP 450	2·08•2	2·99	90
TTP 451	4·18•2	4·57	125
TTP 452	8·33•2	5·68	130

0-9v 0-9v

REF	AMPS	PRICE	P/P
TTP 460	0·30•2	1·79	50
TTP 461	0·50•2	2·14	60
TTP 463	0·60•2	2·36	70
TTP 464	1·38•2	2·99	90
TTP 465	2·77•2	4·57	125
TTP 466	5·55•2	5·68	130

0v-12v 0v-12v

REF	AMPS	PRICE	P/P
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TTP 468	0·38•2	2·14	60
TTP 470	0·50•2	2·36	70
TTP 471	1·04•2	2·99	90
TTP 472	2·08•2	4·57	125
TTP 473	4·16•2	5·68	130

0-15v 0-15v

REF	AMPS	PRICE	P/P
TTP 474	0·20•2	1·79	50
TTP 475	0·30•2	2·14	60
TTP 477	0·4•2	2·36	70
TTP 478	0·83•2	2·99	90
TTP 479	1·66•2	4·57	125
TTP 480	3·33•2	5·68	130

0-24v 0-24v

REF	AMPS	PRICE	P/P
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TTP 496	0·19•2	2·14	60
TTP 498	0·25•2	2·36	70
TTP 499	0·52•2	2·99	90
TTP 500	1·04•2	4·57	125
TTP 501	2·08•2	5·68	130

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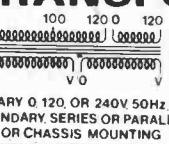

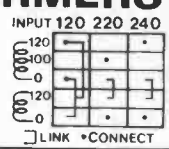

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TTC 449	1·0•2	2·45	70
TTC 450	2·08•2	3·10	
TTC 451	4·18•2	4·70	125
TTF 452	8·33•2	5·85	130

0v-9v 0v-9v

REF	AMPS	PRICE	P/P
TTC 460	0·30•2	1·85	50
TTC 461	0·50•2	2·20	60
TTC 463	0·60•2	2·45	70
TTC 464	1·38•2	3·10	90
TTC 465	2·77•2	4·70	125
TTF 466	5·55•2	5·85	130

0v-12v 0v-12v

REF	AMPS	PRICE	P/P
TTC 467	0·25•2	1·85	50
TTC 468	0·38•2	2·20	60
TTC 470	0·50•2	2·45	70
TTC 471	1·04•2	3·10	90
TTC 472	2·08•2	4·70	125
TTF 473	4·16•2	5·85	130

0v-15v 0v-15v

REF	AMPS	PRICE	P/P
TTC 474	0·20•2	1·85	50
TTC 475	0·30•2	2·20	60
TTC 477	0·40•2	2·45	70
TTC 478	0·83•2	3·10	90
TTC 479	1·66•2	4·70	125
TTF 480	3·33•2	5·85	130

0v-24v 0v-24v

REF	AMPS	PRICE	P/P
TTC 495	0·13•2	1·85	50
TTC 496	0·19•2	2·20	60
TTC 498	0·25•2	2·45	70
TTC 499	0·52•2	3·10	90
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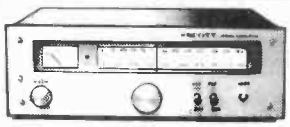

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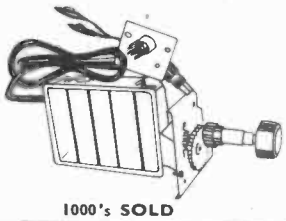

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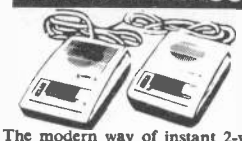

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