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PRACTICAL
ELECTRONICS

AUGUST 1978 45p

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PRACTICAL
ELECTRONICS

VOLUME 14 No. 12 AUGUST 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our September issue will be on sale Friday, 11 August 1978
(for details of contents see page 929)

AND

PACKAGE P.A. SYSTEMS (2 Year Guarantee)

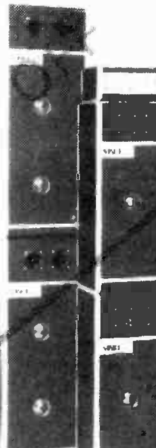
Complete with PIEZO horn columns fitted with 100 watt units (100 watt system illustrated)

100 Watt £149.50

Deposit £35.26

12 Months @ £12.91 or 24 Months @ £7.20

Includes 4 Channel 100 Watt Amplifier with Treble, Bass and Master Controls plus Leads and Twin Piezo Horn Columns (shown on right).



200 Watt £225.00

Deposit £50.80

12 Months @ £19.11 or 24 Months @ £10.66

zsix Mixed Inputs plus Three Sets of Bass and Treble Controls plus Slove Output and Master Control.

ACCESSORIES

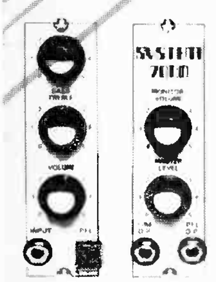
Melos Echo Unit £59.00

A high quality Cassette Tape Echo Unit giving long tape life, infinitely variable echo depth and speed control. Suitable for all mics. and instruments.

High quality Boom Stand £15.50. Floor Stand £9.90. ECM81 Condenser Mic. – Removable Lead – Good Anti-Feedback £19.95.* EM507 Condenser Mic. – Good Value £15.00. Phasers £19.80.

D.I.Y. MODULES FOR P.A. SYSTEMS Mono or Stereo

Make your own mixer – Mono/Stereo – up to 20 channels with these, easy to wire modules – Available as PCB's or assembled on panels.



Input Stages Up to 20	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Mixer/Monitor (One only per system)	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Power supply for up to 20 channels		£9.50	Blank panel	£1.00

Send for free brochure for complete specification

Saxon AP100 Amplifier £45

Four mixing inputs – 100W into 4 ohms
Wide range bass & treble controls
+ master – Twin outputs

Saxon 150 Amplifier £59

Four mixing inputs – 100W into 8 ohms
150W into 4 ohms – wide range bass
& treble controls + master

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ITT .1uf 100v.w. MINIATURE POLYESTER CAPACITORS @ 20p doz.
50 BC 107-8-9 TRANSISTORS Assorted Untested for 57p.
TBA 120S F.M. IC's with data. Untested. 6 for 60p.
LED's 0.2" Red @ 15p, Green @ 18p.
AUDIO I.C. LM 380 with circuits @ 80p.
1½" LOUDSPEAKERS 8 ohm at 75p.
200 ASSORTED ⅛, ¼ watt RESISTORS for 75p.
5 WATT NPN DARLINGTON TRANSISTORS 20p, 3 for 50p.
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MAINS/TRANSFORMERS 240 Volt, 55 Volt 10 Amp out @ £5.50.
MAINS TRANSFORMERS 240 Volt, 22-0-22 Volt 500mA out @ £1.60.
NKT 214 equivalent OC 71 @ 10p, 6 for 50p.
ZTX 108 TRANSISTORS at 7 for 50p.
50 2 WATT ZENERS Assorted Untested @ 57p.
SUB-MINIATURE TANTALUMS 4.7uf 10v.w at 5p, 6 for 25p.
McMURDO 8 PIN PLUGS @ 20p, SOCKETS @ 20p, COVERS @ 15p.
DIE CAST BOXES 4 x 2 x 1" @ 55p, 4$\frac{7}{16}$ x 2$\frac{7}{16}$ x 1" @ 65p, 4½ x 2$\frac{5}{8}$ x 1$\frac{3}{8}$" @ 85p, 6 x 3¾ x 2" @ £1.15.
500yd REEL OF PVC CABLE 25 Strand .004 for £3.
SILICON DIODES 400 PIV 1.2 Amp @ 5p, 600 PIV 2 Amp @ 10p.
MULLARD ELECTROLYTICS 2240uf 40v.w. @ 40p, 4500uf 25v.w. @ 40p, 5000uf 10v.w. @ 15p, 6400uf 16v.w. @ 25p, 8000uf 10v.w. @ 25p.
BAW 62 HIGH SPEED DIODES @ 12 for 35p.
CLOCK P.C. BOARD with Buzzar, Bridge Rectifier, Mercury Switch, Transistors etc for £1.
MOTOROLA WIDE BAND AMPLIFIER I.C. 450KHz To 45 MHz Type MC 1350 with data @ 50p.
UNMARKED GOOD 400mW ZENERS 3.6v, 6.8v, 10v, 11v, 12v, 13v, 16v, 24v, 30v, 33v, All at 10 for 40p.
ERIE RED CAP SUB-MINIATURE .01uf 100v.w. @ 5p each.
TV SAW FILTERS Untested at 3 for 35p.
MAINS TRANSFORMERS 240 Volt Input, 24 Volt Tapped at 14 volt 1 Amp @ £1.30 (P & P 25p).
TAA 435 AUDIO PRE-AMP I.C. with data @ 35p.
50 BRANDED AC 128 TRANSISTORS Untested for 57p.
¼" COIL FORMERS with core 5p, 6 for 25p.
50 ASSORTED TANTALUM BEAD CAPACITORS for £1.50.
.01uf 125v.w. 1% CAPACITORS for 10p each.
100 KHz PLUS 1 MEG 10X CRYSTALS at £2.
VERNITRON 10.7 MHz FILTERS @ 50p each.
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2000uf 100v.w. ELECTROLYTIC CAPACITORS at 60p each.
PHONO SOCKETS single @ 5p, Double @ 10p, 3 Way @ 15p, 4 Way @ 20p.
ILLUMINATED EDGEWISE SIGNAL LEVEL METERS at £1.35 each.
GENERAL PURPOSE P CHANNEL FETS with circuits 10 for 75p.
AUDIBLE ALARM SYSTEM with Transistors and I.C. Made for Car Seat Belts. No details at 75p.

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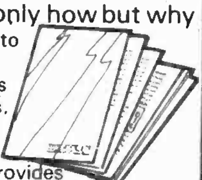

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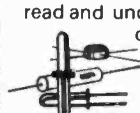

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BP10	Modern Crystal and Transistor Set Circuits for beginners	35p†
BP15	Constructors Manual of Electronic Circuits for the Home	50p†
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BP22	79 Electronic Novelty Circuits	75p†
BP23	First book of Practical Electronic Projects	75p†
BP24	52 Projects Using IC741 (or equivalents)	75p†
BP26	Radio Antenna Handbook for Long Distance Reception and Transmission	85p†
BP27	Giant Chart of Radio Electronic Semiconductor and Logic Symbols	60p†
BP29	Major Solid State Audio Hi-Fi Construction Projects	85p†
BP32	How to Build Your Own Metal & Treasure Locators	85p†
BP34	Practical Repair & Renovation of Colour TVs	95p†
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129	Universal Gram-motor Speed Indicator	10p†
160	Coil Design and Construction Manual	75p†
196	AF-RF Reactance—Frequency Chart for Constructors	15p†
202	Handbook of Integrated Circuits (ICs) Equivalents and Substitutes	75p†
205	First Book of Hi-Fi Loudspeaker Enclosures	75p†
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219	Solid State Novelty Projects	85p†
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RCC	Resistor Colour Code Disc Calculator	10p†

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No. 230 Beginners Guide to Television	Price £2·25†
No. 231 Beginners Guide to Transistors	Price £2·25†
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No. 236 Electronic Components	Price £1·80†
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NUTS AND BOLTS

BA BOLTS – packs of BA threaded cadmium plated screws slotted cheese head.

Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·20	$\frac{1}{2}$in 4BA	846	£0·32
$\frac{1}{2}$in 0BA	840	£0·75	$\frac{1}{4}$in 4BA	847	£0·25
1in 2BA	842	£0·65	1in 6BA	848	£0·40
$\frac{1}{2}$in 2BA	843	£0·45	$\frac{1}{2}$in 6BA	849	£0·21
$\frac{1}{4}$in 2BA	844	£0·52	$\frac{1}{4}$in 6BA	850	£0·25
1in 4BA	845	£0·44			

BA NUTS – packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	855	£0·72	4BA	857	£0·30
2BA	856	£0·48	6BA	858	£0·24

BA WASHERS – flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	859	£0·14	4BA	861	£0·12
2BA	860	£0·12	6BA	862	£0·12

SOLDER TAGS – hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	851	£0·40	4BA	853	£0·22
2BA	852	£0·28	6BA	854	£0·22

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0·11*
DPDT standard slide	1974	£0·14*
Toggle switch SPST $1\frac{1}{2}$ amp 250V a.c.	1975	£0·33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0·42*
Rotary on-off mains switch	1977	£0·50*
Push switch – Push to make	1978	£0·13*
Push switch – Push to break	1979	£0·18*

ROCKER SWITCH
A range of rocker switches SPST – moulded in high insulation. Material available in a choice of colours ideal for small apparatus.

Colour	No.	Price
RED	1980	£0·30*
BLACK	1981	£0·30*
WHITE	1982	£0·30*
BLUE	1983	£0·30*
YELLOW	1984	£0·30*
LUMINOUS	1985	£0·30*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0·50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0·55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0·70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0·85*
Push button SPST, 2 amp 250V a.c.	1962	£0·78*
Push button SPST, 2 amp 250V a.c.	1963	£0·83*
Push button DPDT, 2 amp 250V a.c.	1964	£0·98*

MIDGET WAFER SWITCHES
Single-bank wafer type – suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	£0·48*
2 pole 6 way	1966	£0·48*
3 pole 4 way	1967	£0·48*
4 pole 3 way	1968	£0·48*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V a.c.	1970	£0·25

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	£0·07*
$1\frac{1}{4}$in x $\frac{1}{4}$in chassis mounting	507	£0·12*
$1\frac{1}{4}$in car inline type	508	£0·15*
Panel mounting 20mm	509	£0·20
Panel mounting $1\frac{1}{4}$in	510	£0·30

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	6p	1A	615	5p	3A	619	5p
250mA	612	5p	1·5A	616	6p	4A	620	6p
550mA	613	5p	2A	617	5p	5A	621	5p
800mA	614	7p	2·5A	618	6p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW $1\frac{1}{4}$in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	5A	642
2A	637	3A	639		

All 6p each

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	$5\frac{1}{2}$in	2in	£1·25
156	11in	6in	3in	£2·12
157	6in	$4\frac{3}{4}$in	$1\frac{3}{4}$in	£1·30
158	9in	$5\frac{1}{4}$in	$2\frac{1}{2}$in	£1·76

ALUMINIUM BOXES. Made from bright ali., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	$5\frac{1}{4}$in	$2\frac{1}{4}$in	$1\frac{1}{2}$in	62p
160	4in	4in	$1\frac{1}{2}$in	62p
161	4in	$2\frac{1}{4}$in	$1\frac{1}{2}$in	62p
162	$5\frac{1}{4}$in	4in	$1\frac{1}{2}$in	70p
163	4in	$2\frac{1}{2}$in	2in	64p
164	3in	2in	1in	44p
165	7in	5in	$2\frac{1}{2}$in	£1·04
166	8in	6in	3in	£1·32
167	6in	4in	2in	86p

P.C.B. BOARDS

C26 4 pieces 8" x $3\frac{1}{4}$" (approx.) Single-sided fibreglass	80p
C27 3 pieces 7" x $3\frac{1}{4}$" (approx.) Double-sided fibreglass	60p

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1·50*
2025	MT150-0-12V, 0-12V RMS	£1·50*

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
2029	15V-0-15V 1 amp	£2·75*	P. & P. 66p
2030	30V-0-30V 1 amp	£3·45*	P. & P. 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in $\frac{1}{2}$ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Voltages available by use of taps:
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	$\frac{1}{2}$ amp	£5·50*	P. & P. 86p
2032	1 amp	£6·60*	P. & P. 86p
2033	2 amp	£8·40*	P. & P. £1·10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0.60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0·75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0·85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0·85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·05*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0·90*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0·60*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0·75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0·75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0·75*
127	5 pin Din plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0·80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·68*
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0·83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0·98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0·75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0·68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0·68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1·75*
178	AC mains lead for calculators etc.	£0.45*

AVDEL BOND CYANOACRYLATE G2

The wonder adhesive which works in seconds. Bonds plastic, rubber, transistors, components, permanently – Immediately! O/D143. ONLY **70p** *for a 2gm phial.*

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P&P. 35p unless otherwise shown.

BI-PAK

DEPT. PE8, P.O. Box 6, Ware, Herts

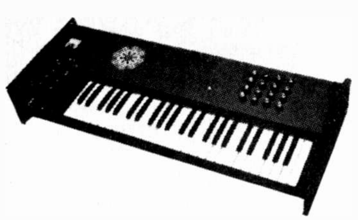
COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components

OVERSEAS enquiries for list Europe—send 20p: other countries—send 50p.



KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

Contact Assemblies (gold-clad wire) for use with the above keyboards (1 required for each note):

Type GJ: Single-pole change-over	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 27p
Type GC: 3 pairs of contacts, each pair normally open	each 36p
Type GE: 4 pairs of contacts, each pair normally open	each 45p
Type GH: 5 pairs of contacts, each pair normally open	each 57p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 53p

Printed Circuit Boards for use with GJ, GB and 4PS contacts (thus eliminating much interwiring) are available. Details in our lists.

RHYTHM GENERATOR

15-Rhythm Tempo, Timing and Logic control unit (excl. sw's but incl. PCB)	£12·90
10-Instrument Effects circuits	£13·56
PCB for Effects circuits	£4·25
Power Supply incl. PCB	£12·00

128-NOTE TUNE-PROGRAMMABLE SEQUENCER (P.E. Nov/Dec 77)

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. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£20·60
Power Supply (KIT 76-3)	£6·05
Trigger Inverter and Alt. Output (KIT 76-2)	£1·35
LED Counter (KIT 76-4)	£2·45
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2·61
PCB for KITS 76-2 & 4 (PCB 76B)	£2·54

P.E. STRING ENSEMBLE (PE Mar-July 78)

The new keyboard string-instrument synthesiser.

Basic component sets:

Power Supply (KIT 77-1)	£9.22
Tone Generator (KIT 77-2)	£14.93
Diode Gates (KIT 77-3)	£19.78
Chorus Generator (KIT 77-4)	£19.06
Voicing System (KIT 77-5)	£9.38

Printed Circuit Boards:

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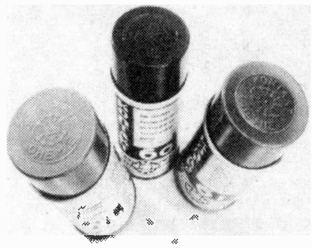

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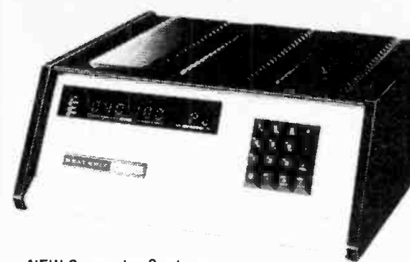

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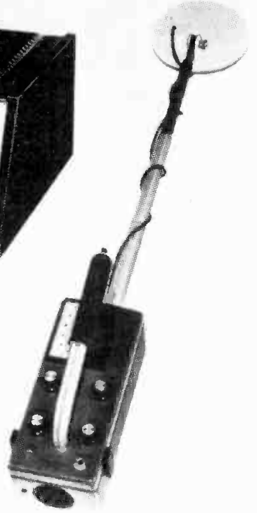

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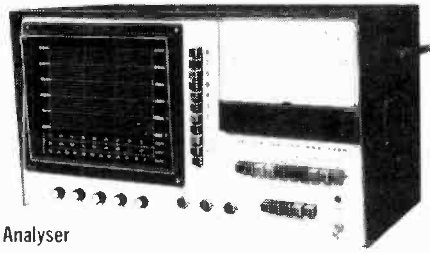

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4020	119p	7420	18p
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4022	94p	7427	28p
4023	21p	7430	20p
4024	83p	7432	28p
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4027	59p	7442	74p
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4029	118p	7446	123p
4030	62p	7447	102p
4031	249p	7448	130p
4032	108p	7454	19p
4033	157p	7470	39p
4035	130p	7472	28p
4041	87p	7473	39p
4042	85p	7474	33p
4043	99p	7475	48p
4044	96p	7476	40p
4045	150p	7480	46p
4046	131p	7482	91p
4047	95p	7483	90p
4049	65p	7485	106p
4050	65p	7486	36p
4054	120p	7489	399p
4055	140p	7490	57p
4056	140p	7491	82p
4060	117p	7492	57p
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4071	22p	74107	36p
4072	23p	74118	125p
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4078	24p	74123	103p
4081	23p	74144	345p
4082	23p	74145	83p
4086	24p	74153	62p
4501	19p	74154	138p
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VOLUME 14 No. 12 AUGUST 1978

FAST MOVING?

RECENT news of the development of further advanced passenger trains capable of 150 m.p.h. has triggered interest from overseas governments. The Japanese are known to have a particular interest in the systems used to tilt the trains by up to nine degrees on curves; this is an electro-hydraulic system, the design of which interests the Japanese Government. Let us hope that we can sell these systems, or at least the technology, to them rather than once again allow others to capitalise on our inventiveness.

INFORMATION

We have also noted one or two other improvements—the installation of "travel computers" at main line stations being one of particular interest.

A simple unit that quickly provides all train times and other general information at the push of a few buttons is a great boon to many travellers. The unfortunate part is that one must be at the station to use the computer. With the now inadequate telephone information system, one can spend a whole day trying to obtain train times, etc. as anyone who has tried recently in the London area will know.

With the widespread use of Viewdata still a good few years away, it is a problem which would appear to require an interim solution—perhaps the installation of a Viewdata terminal at all stations would assist!

ROBOTS

These are just two minor areas where we are seeing the immediate application of "the new electronics" and it is being widely reported that the advance of technology will change the whole face of industry and society. With approximately 70,000 industrial "robots" already in use in Japan is it any wonder that they are able to produce many items cheaper than Western countries. Although we in Britain are employing robots in increasing numbers, we are generally rather behind other industrial countries in this area, for a variety of reasons.

The knowledge that a revolution is about to commence is said to be partly behind the NEB plan to set up a micro-electronics company in partnership with a group of engineers. This controversial scheme has rocked the established companies in this country—few of which have made the necessary capital investment to enable them to compete with i.c. manufacturers in America and Japan.

The business of chip production was recently referred to as "silicon printing" by Dr. Ed. Sack of General Instrument Microelectronics, one of the few companies producing chips in Britain. It is sad to note that GIM was set up by a group of British engineers with American backing about 10 years ago to design and sell chips for the communications industry. However, many of its products are now selling well abroad but not in Britain because the technology employed is in advance of the British systems.

GIM see the next boom as being in games—particularly hand held ones—and toys. They have developed a remote control system for toy cars which employs two m.p.u.'s. GIM are also active in programmable TV games and have joined forces with EMI who will be selling software in cassette form. Perhaps their recent Queen's Award for export achievement will be augmented by a rapidly expanding home market!

Mike Kenward

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Touch Switch

G. DAVIS

THIS touch switch can be used to directly replace an ordinary household light switch without the need for either additional wiring or fixing. The unit is capable of handling a mains load of up to 300 Watts and if the quadrac CSR1 (a diac and triac combined) is mounted on a suitable heatsink this figure can be increased to 750 Watts.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Touch Switch is shown in Fig. 1. Gates "a" and "b" of IC1 are connected as a bistable multivibrator with gates "c" and "d" used as a buffer stage.

When the switch is off the output from the buffer stage (pins 10 and 11) is high and the transistor TR1 is on. Because TR1 is connected across the diode bridge D1 to D4, when it is on the capacitor C4 is prevented from charging. As the quadrac is switched on by a rising voltage across C4, when the transistor TR1 is on the quadrac and consequently the lamp are both off.

If when the lamp is off a finger is placed against the "ON" plate this capacitively grounds the plate due to the high input impedance of the stage and a voltage is developed across R1 and R2. This voltage takes the input of gate "b" high which results in the output of the bistable being switched from the low to the high state. This high state output from the bistable is inverted by the buffer stage to a low state and TR1 is turned off.

With the transistor off, capacitor C4 is no longer prevented from charging via R7 and the voltage across the capacitor increases. When this charging voltage reaches approximately 33V the quadrac switches the lamp on.

When the switch is off the "ON" touch plate is illuminated to enable the switch to be easily located in the dark.

The capacitors C1 and C2 filter any voltage spikes that may occur from motor starting surges elsewhere in the house, such as when a fridge or freezer is turning on. These spikes could cause false triggering of the switch.

CONSTRUCTION

The p.c.b. design for the Touch Switch is shown in Fig. 2 with Fig. 3 showing the layout of the components. Note that where R1 is joined to R2 and R3 is joined to R4 the components are not soldered to the board.

As the plain side of the printed circuit board is used as the frontplate for the switch (with all the components being mounted on the copper track at the rear of the board) only four drilled holes are necessary in the p.c.b.; two for fixing the switch to the wall and one in the middle of each touch plate.

After the holes have been drilled the p.c.b. can be sprayed the desired colour and then dry cellotape should be placed on the front panel over the two touch plate holes. If the board is then turned over clear epoxy resin can be used to fill the "ON" plate hole while the "OFF" plate hole should be filled with black epoxy resin. When both resins have set the cellotape can be removed.

The components should then be soldered onto the board keeping the leads as short as possible.

TESTING AND MODIFICATIONS

The "lamp" wire from the touch switch should be connected via the lamp to the neutral lead. If the power is turned on and a finger placed over each touchplate in turn the light should go on and off. Care should be taken to ensure the live and lamp wires are connected correctly otherwise the switch will not operate satisfactorily.

If the switch is to be used to drive a fluorescent light the circuit should be modified as shown in Figs. 4 and 5.

By incorporating the CR Network shown in Fig. 6 the light will remain on for a preset time period determined by the value of the CR network, i.e. if $C = 22\mu F$ and $R = 10M\Omega$ the delay is $22\mu F \times 10M\Omega = 2$ mins. ★

COMPONENTS . . .

Resistors

R1, R3	10MΩ (2 off)
R2, R4	4·7MΩ (2 off)
R5, R7	100kΩ ½W (2 off)
R6	100kΩ
R8	220kΩ

All 5% ¼W carbon unless otherwise stated

Capacitors

C1	150pF 50V Ceramic
C2	47pF 50V Ceramic
C3	22μF 16V Tantalum
C4	10nF 100V Polyester

Semiconductors

D1–D4	1N4148 (4 off)
D5	6·2V 400mW Zener
D6	1N4004
TR1	ZTX304
IC1	CD4001
CSR1	400V 6·5A Quadrac

Miscellaneous

Miniature wire ended neon RS type 586-015

CONSTRUCTOR'S NOTE

All the components including the p.c.b. can be obtained from G.J.D. Electronics, 105 Harper Fold Road, Radcliffe, Manchester.

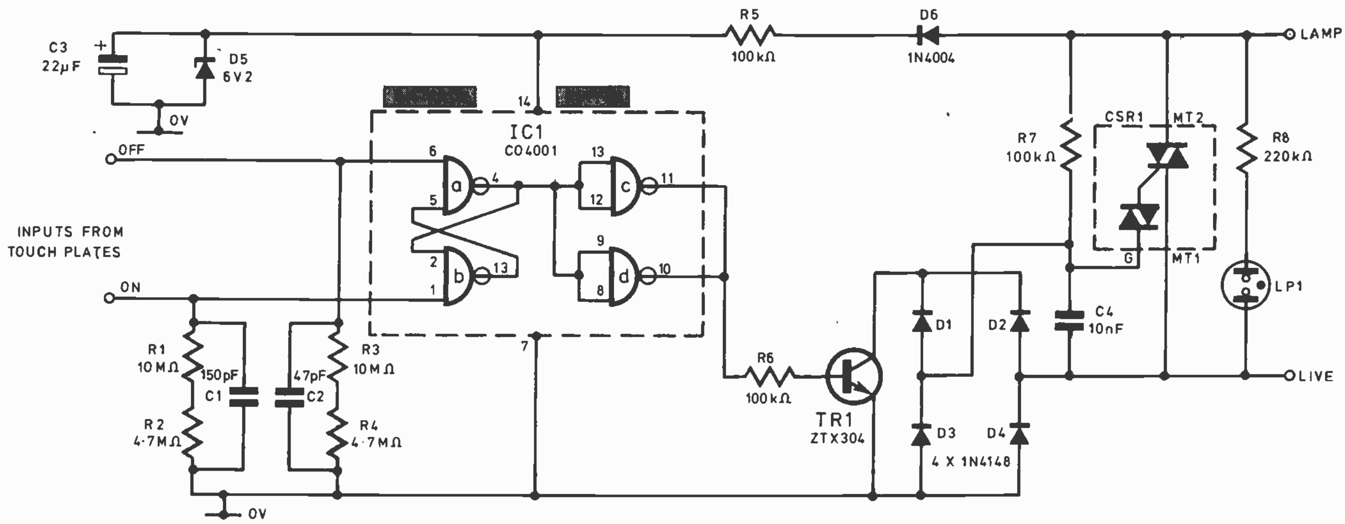


Fig. 1. Complete circuit diagram of the Touch Switch

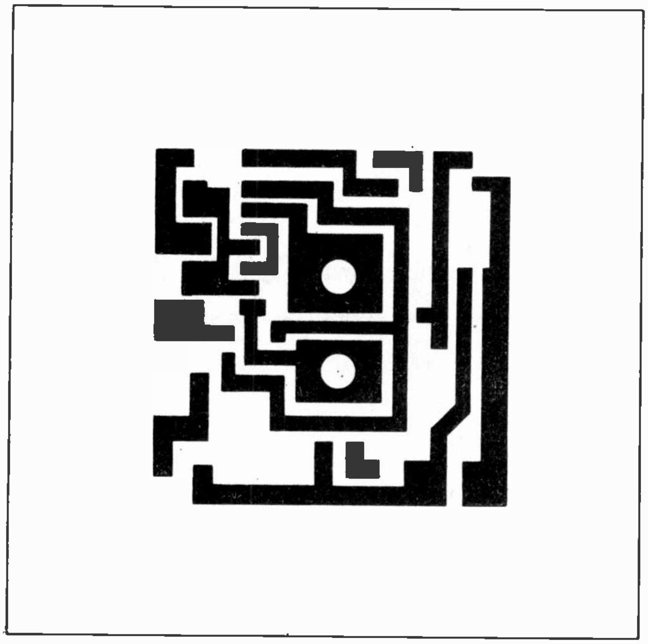


Fig. 2. Printed circuit board design

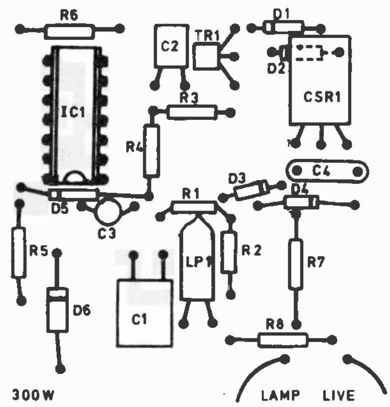


Fig. 3. Component layout for p.c.b.

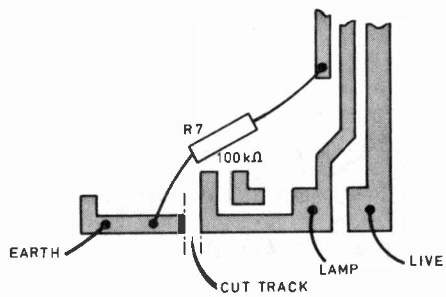


Fig. 5. Modification required to p.c.b. design for switching a fluorescent light

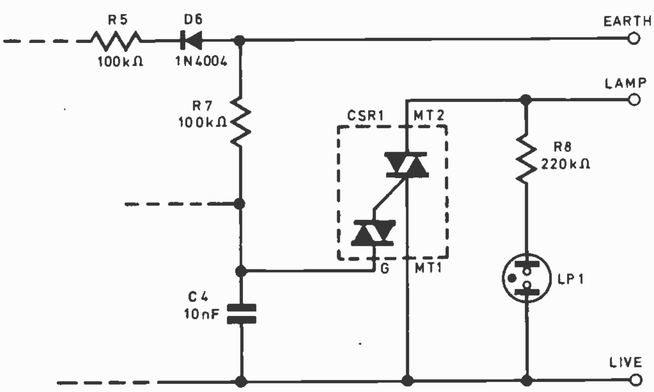


Fig. 4. Modification necessary for switching a fluorescent light

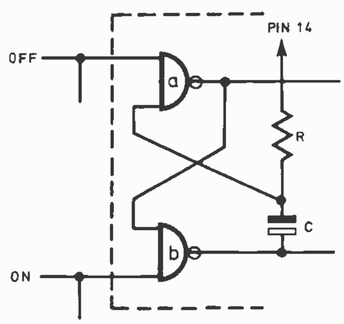


Fig. 6. Modification for obtaining a preset "ON" time period

four motorcycle games

ten ball games

see last month's P.E. for how to play them

Part 2
PE TV GAME CENTRE

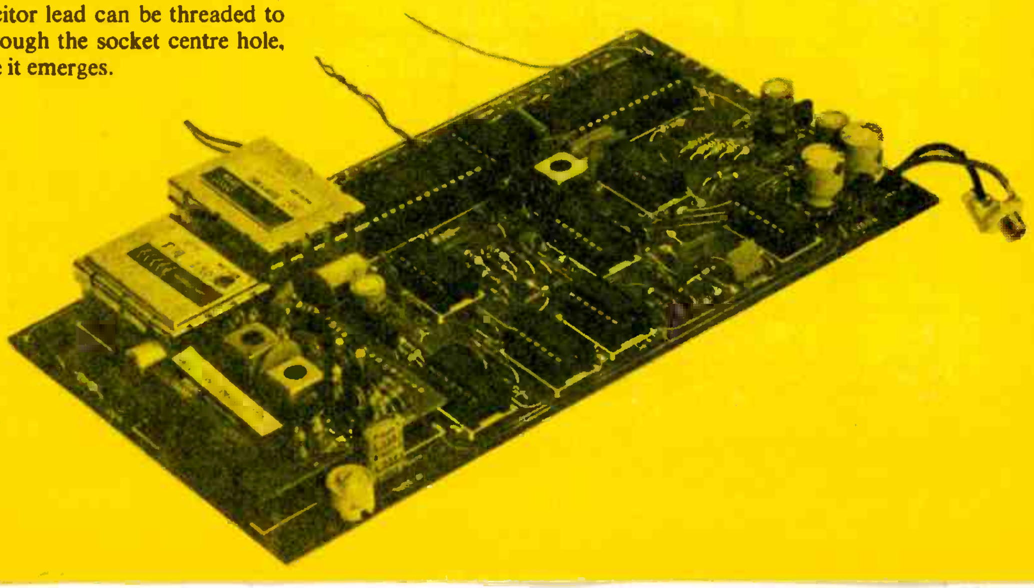
CONSTRUCTION

Mount all the switches and the potentiometer on the front panel and wire them up as shown in Fig. 2.1, using ribbon cable but leaving the p.c.b. end of the ribbon unconnected.

Insert the i.c.s lastly when assembling the p.c.b., removing them from the conductive foam packing only at the moment necessary. The games chips themselves (IC1 and IC2) should be inserted last of all. Some earthed tin foil laid out on the worktop surface will help to reduce the possibility of damage due to static electricity. It would be advisable to mount the modules early on so that the remaining component space is more apparent. On the UM1263 (sound modulator) it is necessary to remove the lid and solder a 100pF capacitor (C5) between the coaxial socket centre-pin and the p.c.b. The capacitor lead can be threaded to the inside of the modulator box through the socket centre hole, and then soldered at the point where it emerges.

board powered from external power pack

minimal setting-up procedure



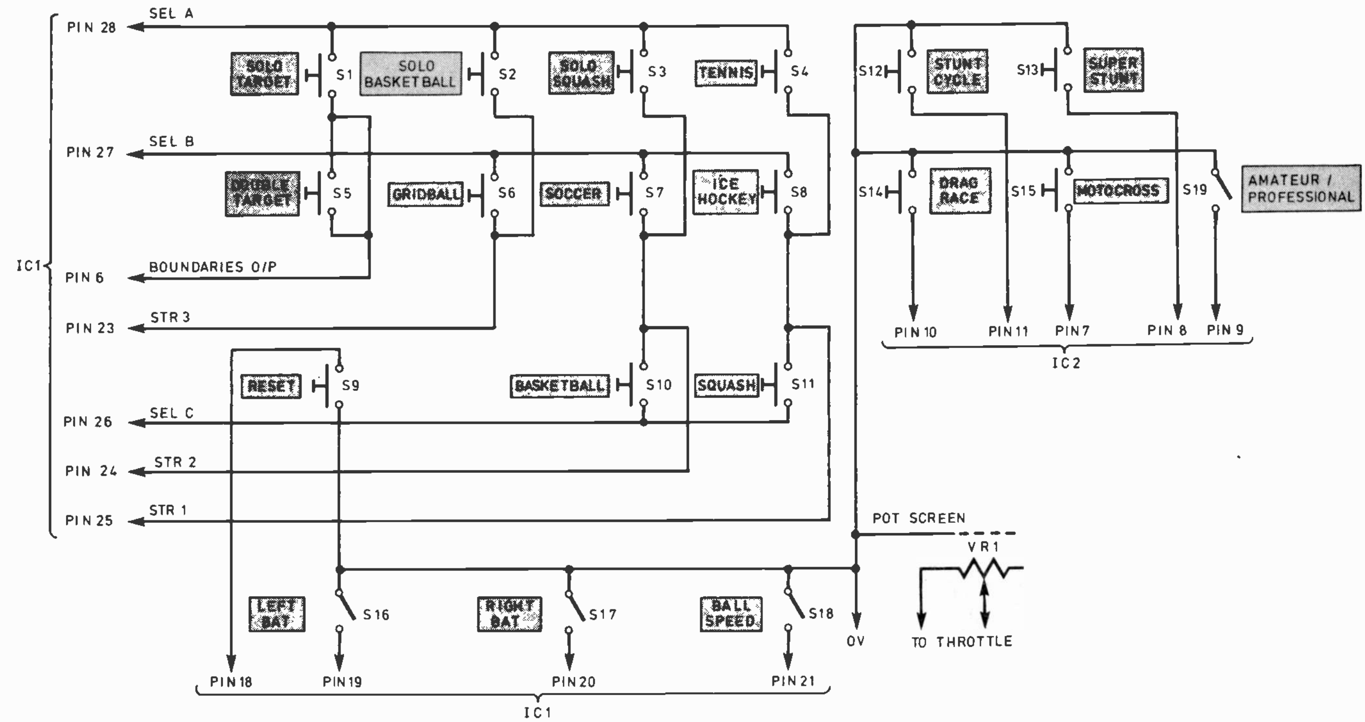
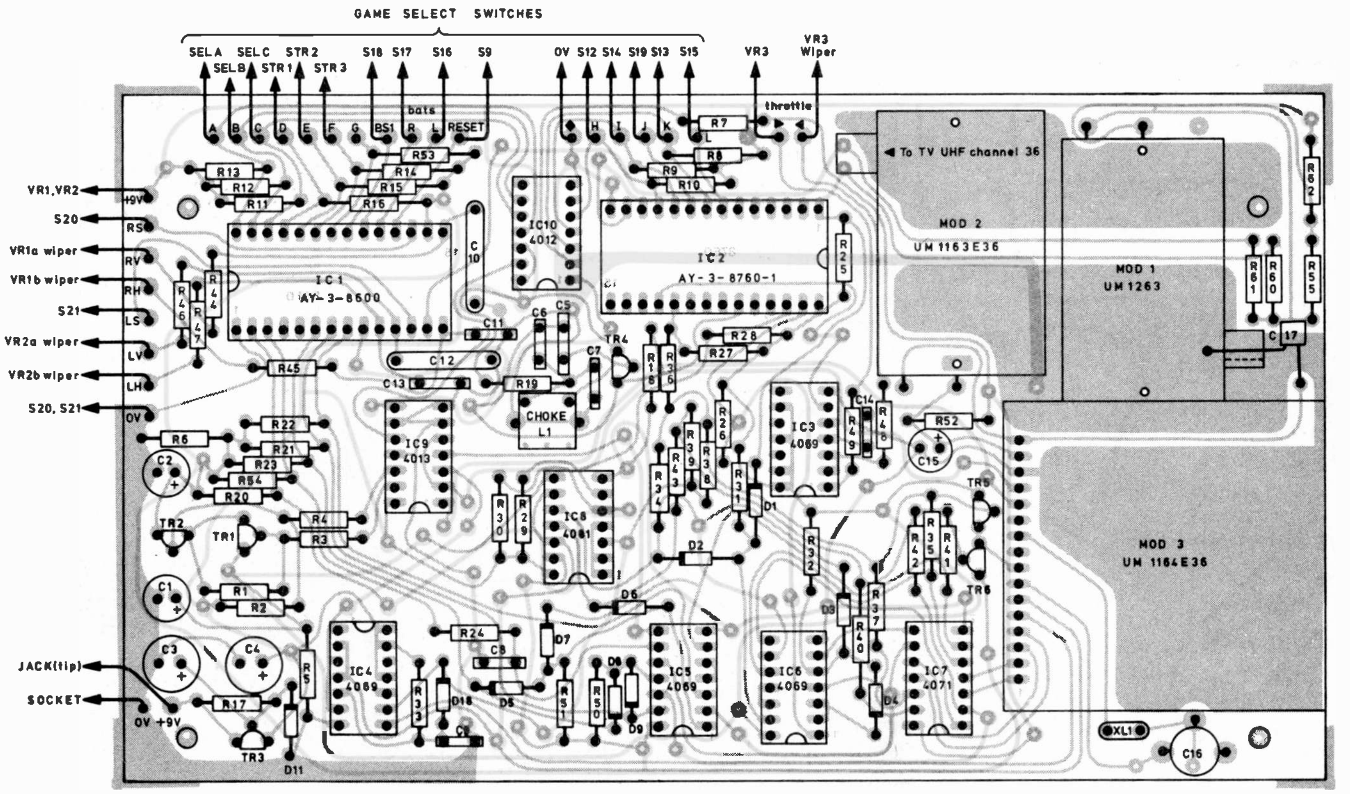


Fig. 2.1. Switch panel wiring diagram. This matrix wiring system was referred to in Part 1, Fig. 1 (wrongly as Fig. 10)

Fig. 2.2. Component board layout. Note that C17 couples the Sound Modulator output socket to the p.c.b.



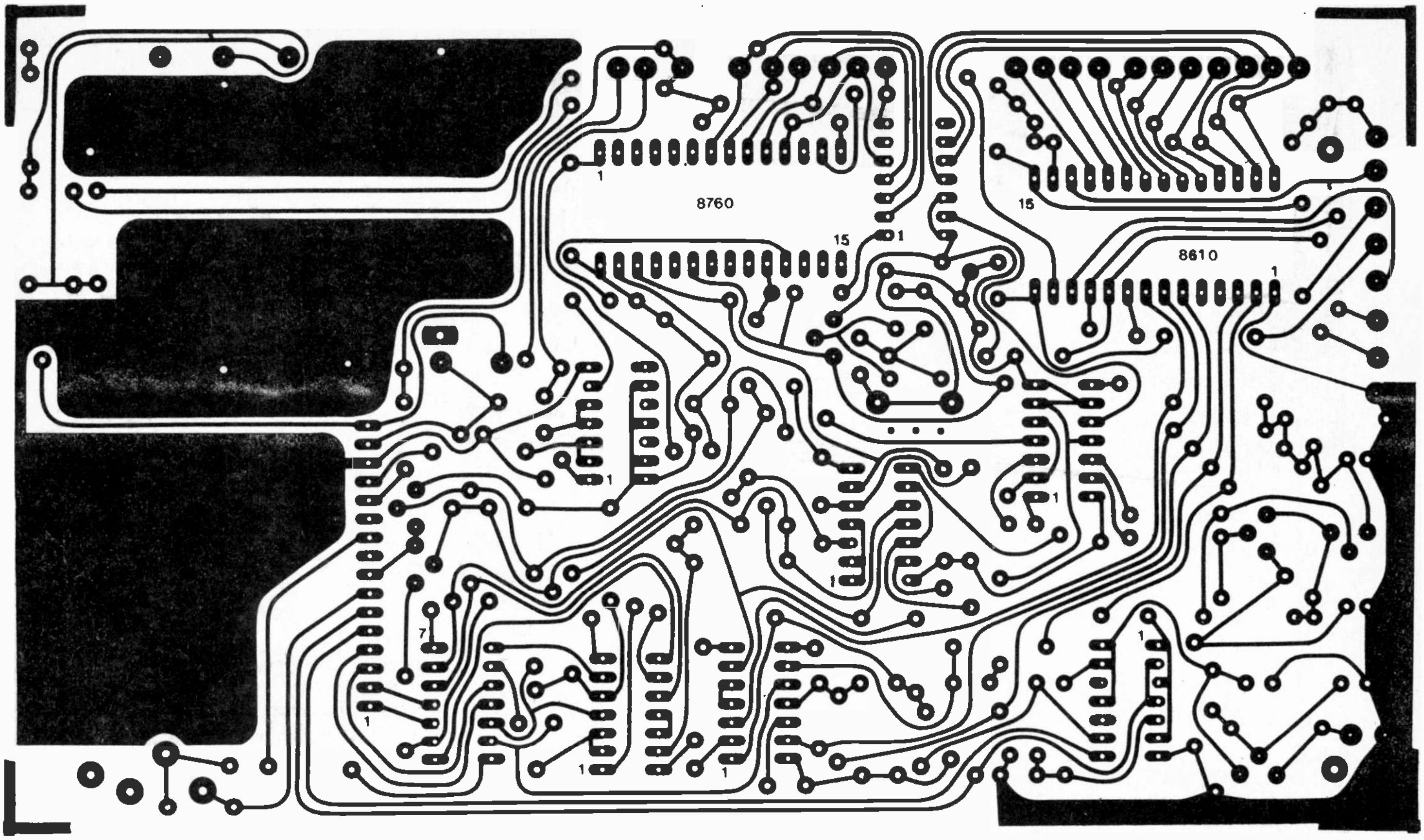
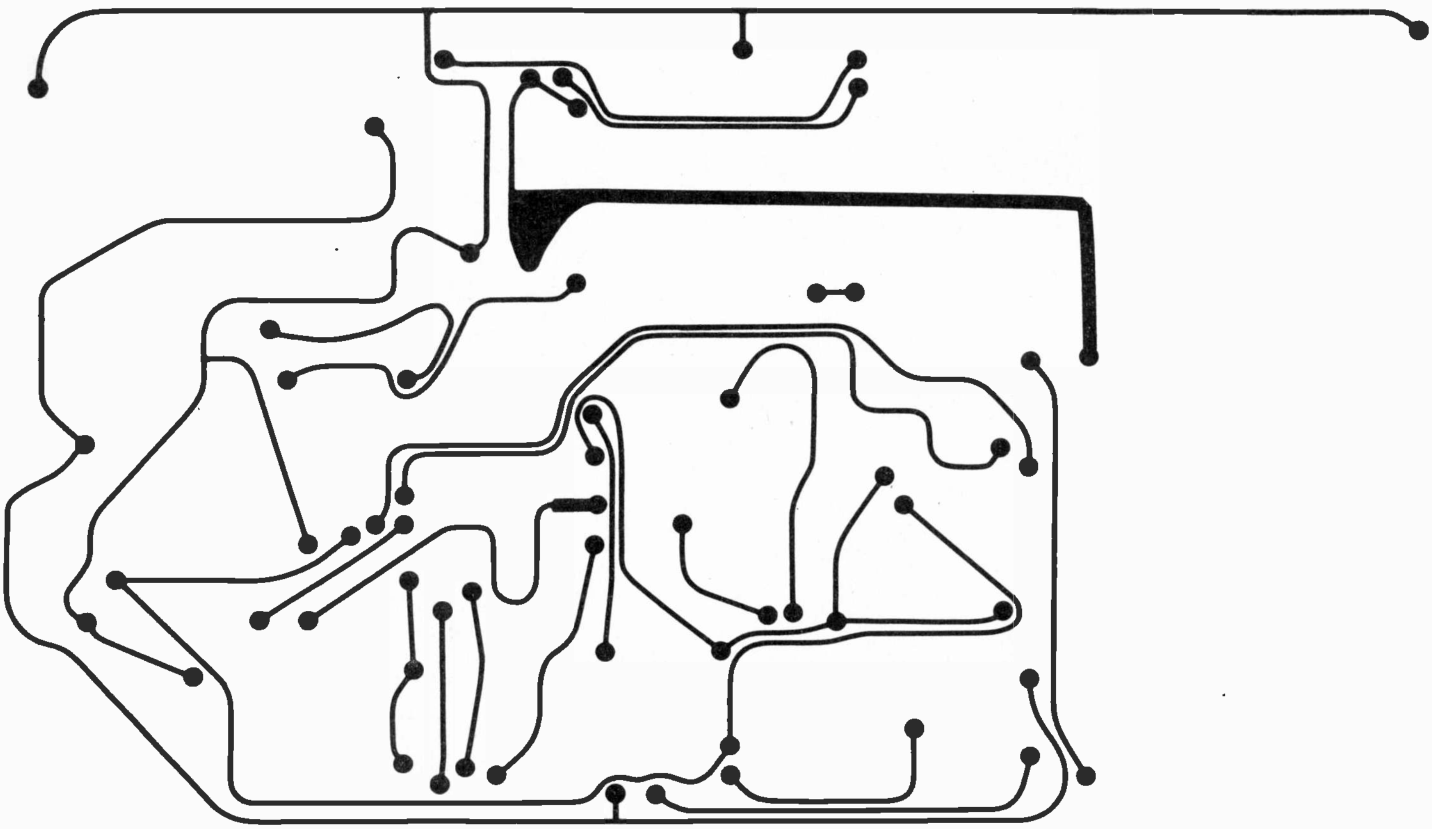
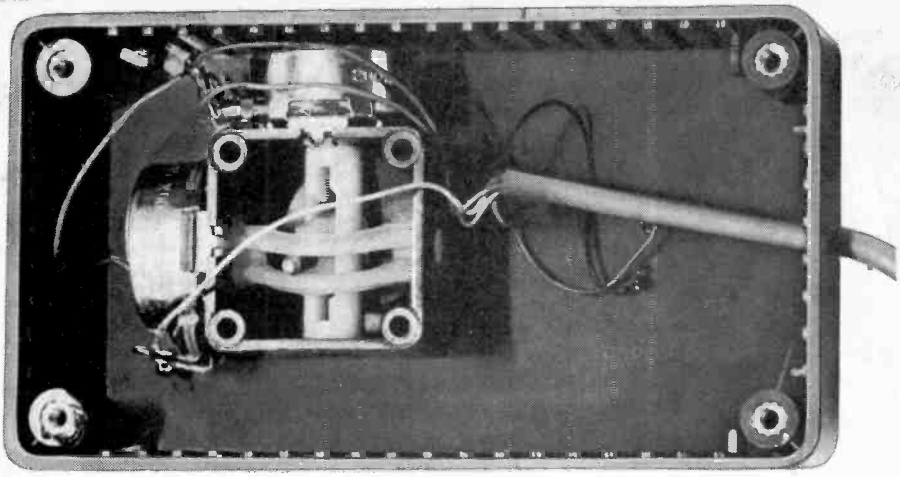


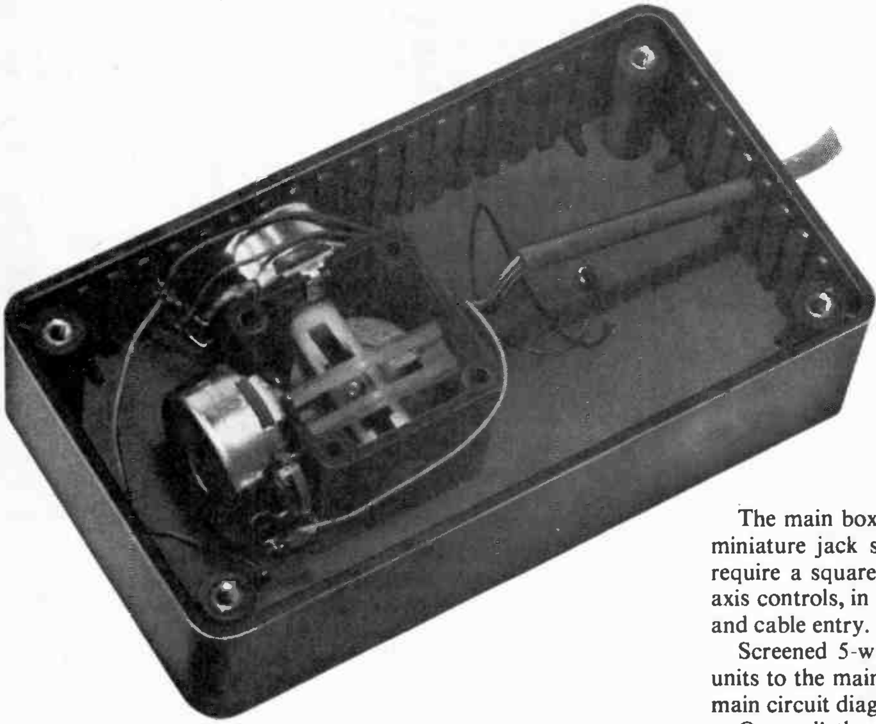
Fig. 2.3. Printed circuit layout (actual size)

Fig. 2.4. Component side p.c.b. (actual size)





The hand-held units (shown here with lid removed), contain dual-axis potentiometers for movement of the bat both up and down, and left and right across the television



The serve buttons supplied by Teleplay are mounted on the outside surface of the box, with only the connection tags passing through the lid

The main box should be cut for cable entry holes, and for the miniature jack socket (d.c. supply input). The hand-held units require a square hole of 15 × 15mm to accommodate the dual axis controls, in addition to further drillings for the push buttons and cable entry.

Screened 5-way cable is necessary to connect the hand-held units to the main box, and the wiring of these can be seen in the main circuit diagram.

Once all the switches and potentiometers are mounted and wired up, the p.c.b. can be fixed into the main box using self-tap screws, and then wired to the various controls. Low loss coaxial lead should be used for the aerial input signal to the television set, the other end of which is connected to the UM1163E36 vision modulator coaxial output socket.

The system is now ready to check out, but first look over the p.c.b. and wiring for possible dry joints, and ensure that all diodes and electrolytic capacitors are connected in the right polarity.

SETTING-UP

All modules supplied by Teleplay should be pre-tuned, but it may be necessary to adjust the oscillator frequency using L1, to lock the picture onto the screen. This should be done with the unit powered up and the television tuned to Channel 36. Fine tuning of the PAL colour encoder crystal is achieved by trimming XL1 (4·4336MHz).

The unit is powered by a mains adaptor unit which plugs straight into a 13A socket, and jacks into the Game Centre via a low tension lead (jack tip + Ve). ★

CORRECTIONS TO PART ONE

In part one, capacitors C10 and C12 were marked in the components list as 0·8μF. This should read 0·18μF.

TR1–TR3 are BC337 transistors, and the tunable choke should be 40μH R17 is 100Ωand *not* 1KΩ.

It is also necessary to add the following resistors to the components list:

R38, R39	8·2KΩ
R53	5·6KΩ
R54	2·2KΩ
R55	222KΩ
R60, R61	6·8KΩ
R62	100Ω
C17	100pF silvered mica

DIGITAL THERMOMETER

M. PLANT

IN order to provide a BCD to seven segment display of an analogue quantity, analogue-to-digital circuitry is required. Formerly this meant the use of a large number of discrete and integrated circuit devices which posed problems for the constructor of electronic instruments making use of these digital techniques. The availability of the Siliconix LD130 CMOS i.c. now enables the analogue to digital conversion to be performed with the one device plus a handful of additional components. Sophisticated instrumentation functions can now be obtained with a few components: the LD130 lends itself to the measurement of temperature, voltage, current, resistance, sound intensity, rotational speed, for example, indeed any physical quantity which lends itself to conversion into a voltage change which can then be processed digitally.

In this article the construction of a digital thermometer is described which has the following specifications:

Range	−99·9°C to +99·9°C
Transducer	*pn* junction diode
Display	3 digit 7 segment
Resolution	0·1°C
Over-and-under range indication	flashing display
Minus sign	illuminated l.e.d.
Power supply	6V (4 × 1·5V—HP7)

Initially the circuit was assembled on Veroboard and gave satisfactory results but a printed circuit board assembly produced improved performance.

THE LD130

Details of the internal operation of the LD130 will not be described here but are covered in the relevant Siliconix application note. As Fig.1 shows the LD130 is an 18 pin dual-in-line package which features the low power consumption of all CMOS devices: 25mW at ±5V power supply. The lower limit of the supply voltages is ±4·3V and the upper limit is ±8V (60mW consumption). The twin supply voltages must be matched to within 1·5V for correct operation of the device.

Internal counting is achieved through an oscillator which becomes functional when a single capacitor C4 is connected between pin 14 and ground. This capacitor and C1 together determine the sampling rate of the circuit. In use the i.c. samples the analogue voltage and displays its value in digital form at a sampling rate of $f_{osc}/6144$.

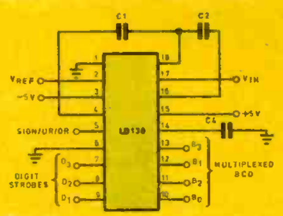


Fig. 1. Pin identity for the LD130

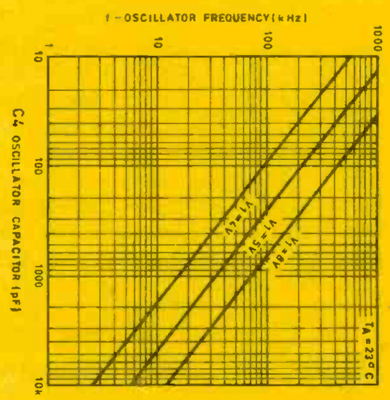


Fig. 2. Graph of frequency related to capacitor choice

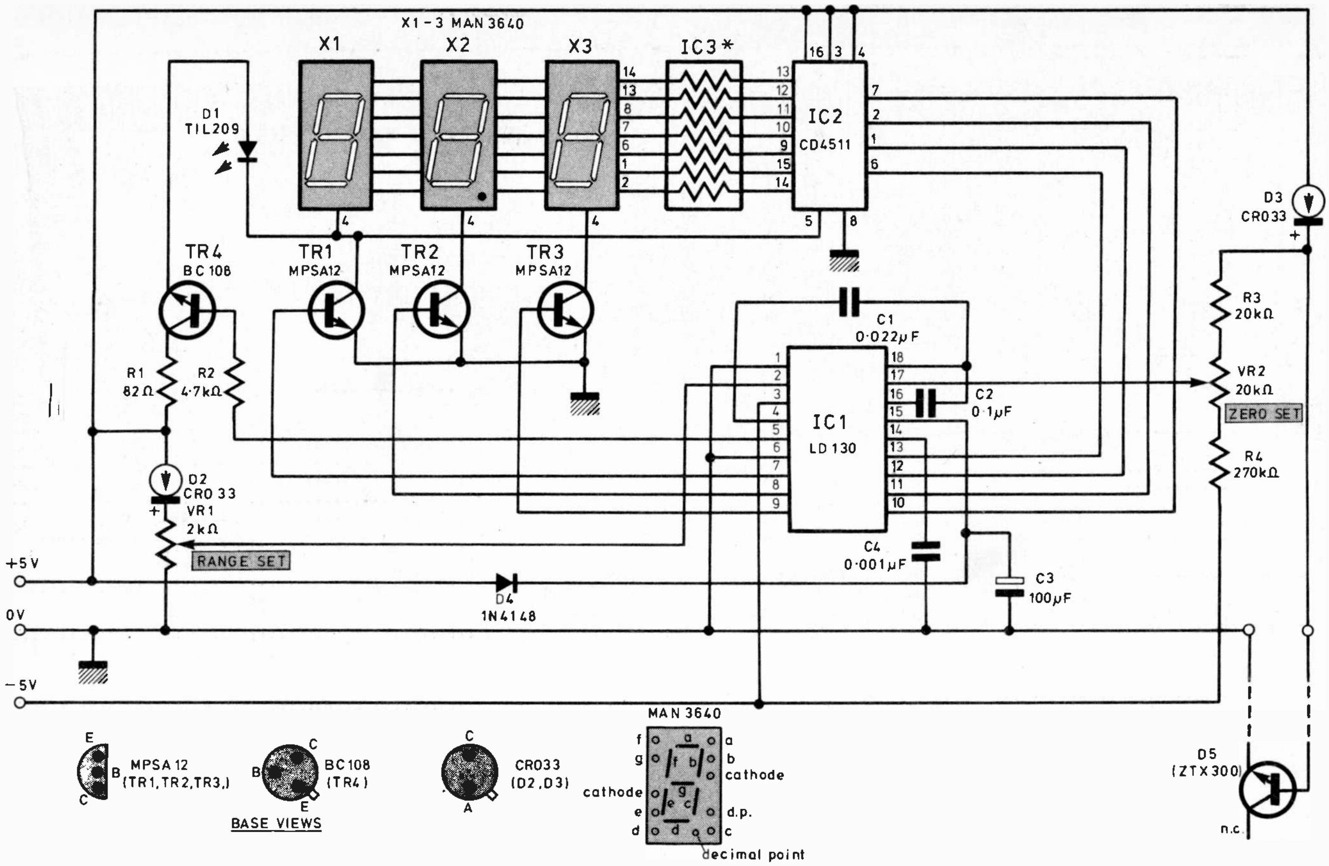


Fig. 3. Thermometer circuit

The oscillator frequency as a functon of C4 is shown in Fig. 2 for various values of the positive supply voltage V1. Thus at V1 = 5V and C4 = 0·001μF, f_{osc} is about 30kHz. Therefore the sampling rate is about 5Hz.

The value of the integrator capacitor C1 must be chosen according to the equation C1 = $(10^3/f_{osc})$μF approximately, that is, C1 should be of the order of 0·02μF. The value of the auto zero capacitor should be 0·1μF.

The sign and under-and-over range signal appears at pin 5. The analogue input is applied to pin 17 and a reference voltage (V_{ref}) is required at pin 2. The multiplexed outputs from pins 10 to 13 and the digit scanning signals from pins 7, 8 and 9 are connected as shown in Fig. 3.

CIRCUIT ACTION

The complete digital thermometer circuit omitting the power supply circuitry is shown in Fig. 3. The reference voltage V_{ref} for the LD130 is provided by the current regulator diode D2 in series with the potentiometer VR1, the wiper of which is connected to pin 2. This particular current regulator has a zero temperature coefficient and therefore VR1 is able to provide a stable voltage—V_{ref}.

The digits of the seven segment display are scanned by the LD130 pins 7, 8 and 9 via the *npn* Darlington current buffer transistors TR1, TR2 and TR3.

High gain Darlingtons were used (β = 50,000) although the constructor may use discrete pairs of *npn* transistors to obtain the same function. The l.e.d. D1, indicating the negative sign of the temperature, is driven by transistor TR4.

The digit segments of the common cathode displays X1-3 are driven from IC2 through the current limiting resistors of IC3. For increased brightness these resistors may be reduced to 100 ohms and, of course, individual 0·25W resistors may be used.

TRANSDUCER

Provided the forward current is much greater than the reverse saturation current, the voltage across a *pn* junction diode biased with a constant current varies by about −2·2mV/°C and thus provides a linear temperature-to-voltage transducer—D5. A proportion of the temperature dependent voltage across this sensor is selected by R3, VR2, and R4 voltage divider, one end of which is connected to the negative supply voltage in order that VR2 may be able to set the zero of the temperature scale.

For correct and stable operation of the thermometer, the LD130 must be provided with a short term stable positive supply voltage. As you will see from Fig. 2, any variation in the supply voltage produces a marked change in the oscillator frequency f_{OSC} which in turn leads to jitter of the display reading. This variation in positive supply voltage as seen by the LD130 is liable to be caused by the variable and high currents drawn by the display. These currents can vary from 4mA, when a digit is blanked, to about 100mA assuming say 12mA per segment for a display of 8.

These currents, flowing through the battery impedance and the copper tracks on the circuit board, cause the voltage seen at pin 15 of the LD130 to vary. Some a.c. decoupling at this pin is therefore provided by means of the diode D4 and the capacitor C3.

Note that this provides a positive supply voltage for the LD130 of 0·6V less than the battery e.m.f. The second circuit design feature which ensures display stability is the return of the analogue ground pin 1 of the LD130 direct to the ground connection of the power supply, i.e. the battery negative.

Rather than use a separate battery to supply the negative voltage with respect to analogue ground required by the LD130, an inverter is used to provide a −5V supply relative

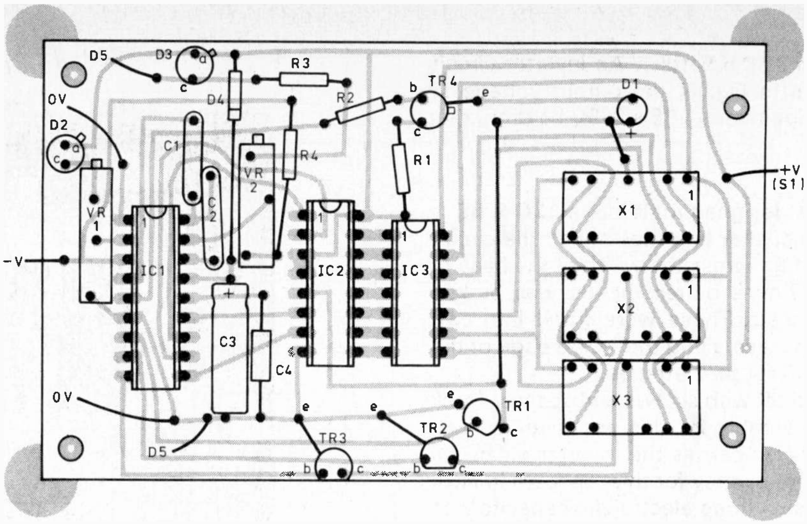


Fig. 4. Main board component layout

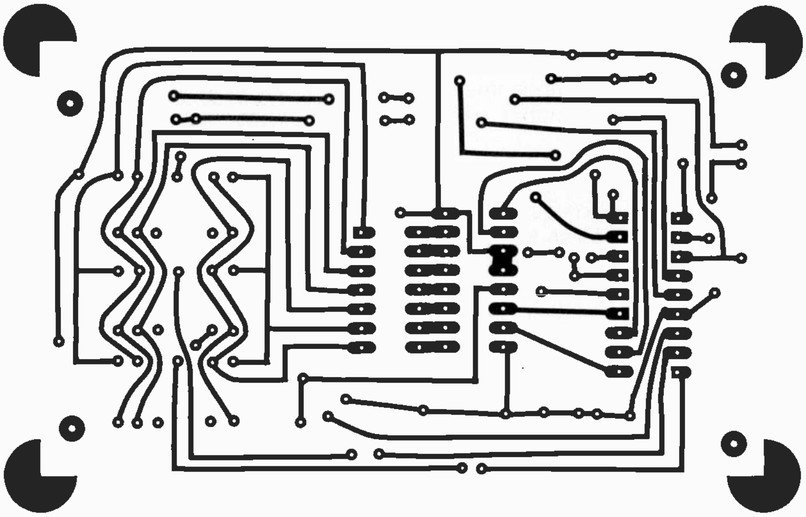


Fig. 5. Etching detail of main board

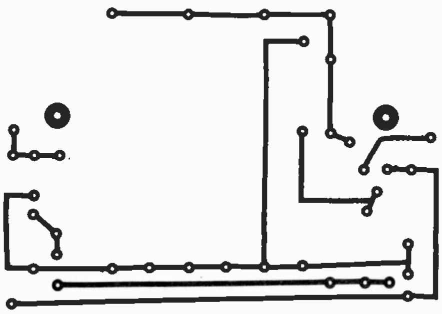


Fig. 6. Inverter p.c. detail

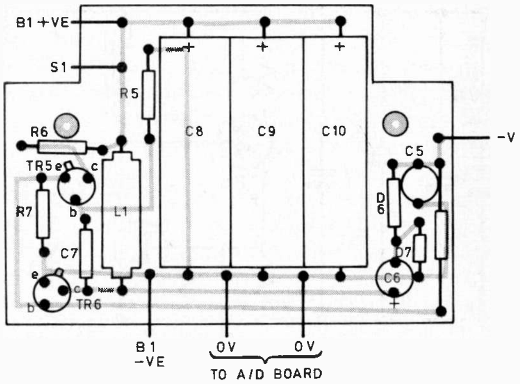


Fig. 7. Component layout

to the zero volts terminal of the battery. An inverter circuit suitable for this is shown in Fig. 8, the output voltage of which is D8's Zener voltage minus TR8's 0·6V be drop, that is 5·6V.

ASSEMBLY

The circuit boards were designed to fit into a 120 x 65 x 40mm box. Four 1·5V calculator batteries power the circuit and display and these just fit across the width of the base of the box. A four pack HP7 type battery holder was broken apart to obtain the terminals. These were fitted into two pieces of SRBP glued into place along the inside edge of the box. This provided a tight fit for the batteries.

The main board is stood off with screws and spaces. Track layout and component assembly for this are given in Figs. 4/5. The base of the box also carries the inverter p.c.b. the track layout and component overlay for this is shown in Figs. 6/7. This board also contains three electrolytic capacitors to soak up any voltage variation on the wires to the LD130 caused by large display current variations as explained above.

A twin power supply leaves the inverter board for the A/D p.c.b.; the negative lead going to pin 3 of the LD130, and 0V to the analogue ground connection pin 1 with the battery positive to pin 15 of the LD130 via diode D4.

It is recommended that a d.i.l. holder be used for the i.c.s so that thay may be reused unless the constructor has the facilities for desoldering i.c.s in the event of failure. IC1 and IC2 are CMOS devices and need the usual care when handling them, in particular do not solder components in place when power is supplied to the board and do not insert or remove these i.c.s when power is supplied.

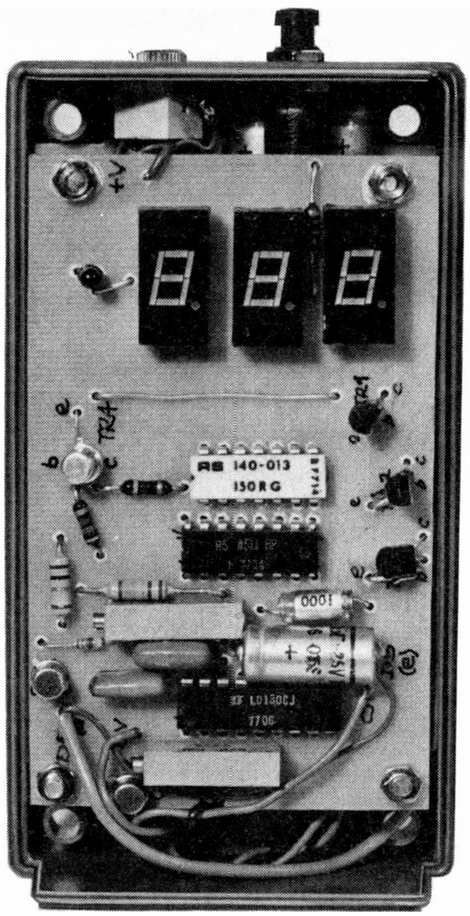
SENSOR

The *pn* junction temperature sensor is the base-emitter junction of any general purpose silicon bipolar transistor. Both the BC107 series metal can TO18 style and the ZTX300E line types were found suitable.

Using the ZTX300, the collector lead was cut off close to the encapsulation leaving only the base and emitter leads. Single core screened cable, core to base and screen to emitter was soldered to these transistor leads. One connection must be sleeved to avoid shorting.

Quick setting Araldite mixture was smeared over the sleeved and bared connections and the screened cable then threaded through a piece of nylon tubing or similar until the transistor sits tight against one end of the tube. The excess Araldite was then wiped off so that when the remaining was set it formed a water tight seal against the effects of moisture when the probe is in use.

The other end of the screened cable is terminated in a 2·5mm plug so that it can be plugged into a socket in the box at the side of the push switch. However to save expense the plug and socket can be dispensed with and the lead taken directly to the circuit board.



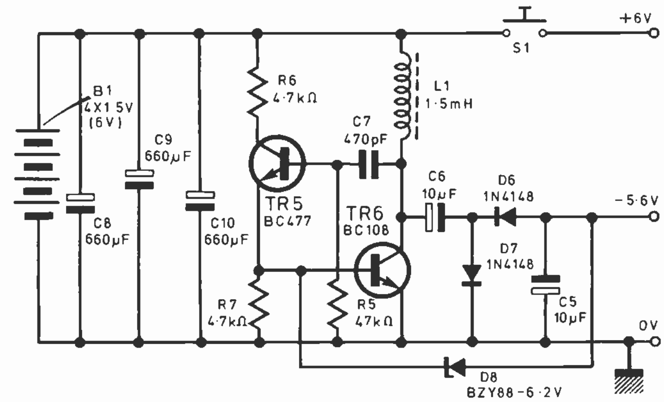
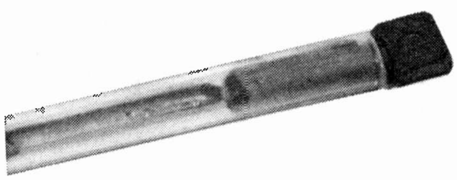


Fig. 8. Inverter circuit



The sensor

COMPONENTS . . .

Resistors

R1	82Ω
R2	4·7kΩ
R3	20kΩ
R4	270kΩ
R5	47kΩ (2 off)
R6–R7	4·7kΩ

All $\frac{1}{4}$W carbon

Capacitors

C1	0·022μF polyester
C2	0·1μF polyester
C3	100μF elect. 25V
C4	0·001μF polystyrene
C5–C6	10μF elect. 25V (2 off)
C7	470pf
C8–C10	660μF elect. (3 off)

Potentiometers

VR1	2kΩ cermet 20 turn variable
VR2	20kΩ cermet 20 turn variable

Inductor

L1	1·5mH

Semiconductors

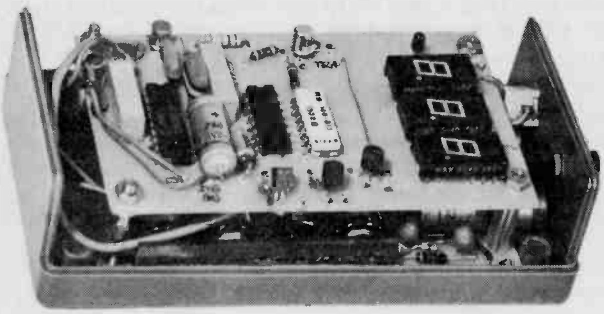
TR1–TR3	MPSA12 Darlingtons (3 off)
TR4	BC109
TR5	BC477
TR6	BC108
D1	TIL209
D2–D3	CRO33 current regulator diode (Siliconix)
D4	1N4148
D5	Sensor diode; ZTX300 (base/emitter only)
D6–D7	1N4148 (2 off)
D8	BZY88 6·2V
X1–X3	MAN3640 (Monsanto) (3 off)
IC1	LD130 (Siliconix)
IC2	CD4511
IC3	7 × 150Ω thick film resistor array (Stock No. 140-013—R.S.)

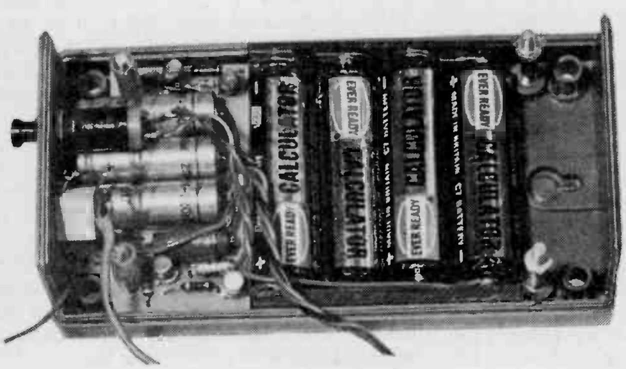
Miscellaneous

S1—on/off switch, 94 × 57mm (main board) 42 × 57mm (inverter board), B1–6V (4 × 1·5V) 2·5mm plug and socket, polystyrene case 65 × 20 × 40mm.

EXTRACTING THE DIGIT

Constructors should note that if resolution is not required to the nominal accuracy of 0·1°C, X3 in Fig. 3 can be omitted and the associated driver transistor TR3. Resolution is then to 1°C giving a steadier display which is more restful on the eye and slightly easier on the pocket!





CALIBRATION

When the boards have been assembled in the box, and all connections checked, the push switch may be pressed whereupon the display will do one of the following:

(a) Does not light: Check the operation of the switch and all circuit connections.

(b) Lights and all digits flash on and off rapidly. Adjust VR1 (Range) so that the voltage at pin 2 of the LD130, relative to ground, to 0·35V. This may bring the reading to a steady value, excepting rapid updating of the third digit. If not, adjust VR1 until the display is steady. Place the sensor body in some water at a steady temperature of say 25°C making sure base/emitter leads are not short ciruit. Adjust VR1 until the display reads this value.

Note that due to the operation of the LD130 the display will not stabilise at a precise tenth of a degree reading but will range by as much as 0·3°C around the true reading. With experience it will be possible to estimate the temperature to the nearest tenth. Heat some water in another container to say 75°C and place the sensor in it applying the same precautions as before and adjust the range potentiometer until the display reads 75°C. Return the probe to 25°C and readjust VR1 until the display reads this value. Repeat the procedure until the correct temperatures are displayed.

Finally check that the l.e.d. indicating negative temperature lights up when the sensor is in the fridge.

COMPONENTS

All components are readily available except for the i.c.s and current regulators. Both the LD130 and the CRO33s can be obtained from **Semiconductor Specialists (UK) Ltd.**, Premier House, Fairfield Road, Yiewsley, West Drayton, Middlesex. The Darlington pair MPSA12 digit driver transistors can be obtained from **Technomatic Ltd.**, 54 Sandhurst Road, London NW9. ★

FRANK W. HYDE

OUT OF THE ECLIPTIC

All spacecraft till now have operated close to the plane of the ecliptic, the plane in which the planets of the Solar System revolve around the Sun. In order to study the higher latitudes of the heliosphere, that is, the environment around the Sun, it is necessary to leave the thin disc of this environment occupied by the planets.

Most of the planets have orbits quite close to the plane of the ecliptic. These are at different angles ranging from approximately 7° for Mercury to 0° for the earth. The exception is Pluto which has an inclination of just over 17°. Thus with this one planet as an exception, the planets are contained in the narrow space at right angles to the place of the ecliptic of 14°.

Since the Sun is in an oblate spheroid, it follows that much of what can be directly viewed is subject to angular distortion, when the observing point is confined to a narrow angle. It is of paramount importance, in an attempt to understand the astrophysics of our own star, that a spacecraft is put in an orbit at right angles, or nearly so, to the ecliptic plane.

To this end the European Space Agency's first deep space mission will be set up, for a launch in 1983, of two spacecraft simultaneously. The launch will be a joint operation with NASA. Designated Out of Ecliptic (OOE) by the European Space Agency and Solar/Polar by NASA, these two spacecraft weighing some 300kg each will be directed toward Jupiter. It is necessary to use the "sling shot" technique to achieve the orbits required. As the two craft near Jupiter, the trajectories will diverge.

One spacecraft will go round Jupiter from north to south and the other from south to north and then toward the Sun, one toward the southern hemisphere and the other to the northern hemisphere. They will be in the vast unknown volume of space round the Sun.

Under certain conditions, the Sun, in addition to the solar wind, emits particles of very high energy. Streams of such particles are capable of producing "blast" waves in the solar plasma. Lethal gamma-ray bursts could be produced in this manner. It will be possible, it is hoped, to measure the amount of protection that the solar wind provides in inhibiting the intrusion of particles and radiation from galactic sources. From the data acquired by the vehicles it will be possible to discover the precise values for the loss of mass and energy of the Sun. The changes in the acceleration of the Solar Wind can be recorded and related to the other scientific measurements.

The effects of Novae and super Novae are already known in relation to the environment. Recently Hoyle and Wickramsinghe have written on the subject of debris and cometary matter bringing hostile organisms into the Earth's environment. The protection afforded by the high activity of the Sun is a direct effect. An examination of the effects on both Man and the environment can be correlated with the weather and health. This alone would justify the mission of the two spacecraft.

A total of eight experiments will be put aboard each of the spacecraft. One of these is an entirely British package. Dr. Peter Hedgecock of Imperial College is the principal investigator of the project involving a sensitive magnetometer. It is designed to measure the interplanetary magnetic field drawn out from the Sun by the plasma flow. The measurements will be used to provide a map of the Sun's magnetic field in the heliosphere. This will also help to show how lethal radiation is deflected from Earth by the solar magnetic field.

THE SHIVERS OF THE SUN

In April this year there was a European Conference on Solar Physics at Toulouse. It is remarkable that these conferences suddenly serve as a reminder that, matters obvious, are frequently shrouded in mystery.

The mystery is usually provided by the assessment of the mechanism involved. Yet by the very nature of the body, many photographs and films of the surface show violent and continual activity. Perhaps this is an elaborate way of saying that seeing is not necessarily believing. So it is implied that corroboration is a necessity.

In the matter of the "Shivering Sun" it seems obvious that the internal activities at the temperatures of the elements involved, would lead to a disturbed state. To the three groups of astronomers, who independently came to similar conclusions in this matter some time ago, there must at least have been some considerable satisfaction that their position was unscathed.

It must be said that one of the observers only, saw physical and direct changes. It is certain that more will be heard of this. To be more serious, the phase measurements made by Hill at various frequencies do at least give some clue as to the "ringing" of the Sun.

URANUS

Another star occulation by the rings of Uranus has disclosed that there are in fact, 8 ring systems around this remarkable planet. This observation also disclosed that one of the rings varies in width. At the point where the ring is nearest to the planet it is narrower than at the point farthest from Uranus. This ring also appears to precess. These observations were made with the 2·5 metre du Pont telescope at Campas Observatory in Chile by Eric Persson of Hale Observatories. The rings are very tenuous for until a star is occulted by them it is not possible to see them with any certainty.

LANDSAT 3

The first pictures from Landsat 3 show considerable improvement over those of the first two Landsats. The type of imaging on Landsat 3 is different from that on the previous vehicles. The Return Beam Vidicon (RBV) system has now been accepted as a useful tool for the purpose required. Disappointment with Intelstats 1 and 2 was partly due to the system used and also to a degraded camera system. Landsat 3 was launched in March this year and has vindicated the Intelstat project. The RBV system does have a higher order of resolution that the MSS (Multispectral Scanning) system previously used.

The pictures from Intelstat 3 show that objects of 50 metres in length can be resolved and areas of 0·25 hectare. This higher resolution is also accomplished by two cameras instead of four. The two cameras image two adjacent areas of 99 kilometres square. The spectral band width is 0·5–0·75μm. Further improvements in resolution were obtained by doubling the focal length of the lens systems on the cameras. Such items as roads, railways and areas like lakes and reservoirs are clearly seen and provide useful information for both Earth resources scientists and resources surveyors.

There seem to be one flaw in the whole matter and that is the objections from the armed services. They seem to fear that too much information is being revealed by way of maps and other means, which may reach unauthorised persons. It is a sad reflection on the integrity of technology when equipment is deliberately degraded in the interest of the services. It seems quite illogical, since what one nation can do another can do also, especially in the matter of observation where the altitudes involved are around 900 kilometres.

HALLEY'S COMET

In previous SPACEWATCH reports Halley's comet has been the object of assessment for a special mission. After the fiscal set-back which seemed likely to kill it years ago there are now second thoughts. NASA has now accepted that it would be a valuable mission. Because of the heavy commitments to EXOSAT and the Large Space Telescope, there may be some hard bargaining.

The new mission is for a two in one project designed to widen the scope of the experiments. A flight past Halley's Comet would be followed by a swing by the Earth and a show flyby of another comet Tempel-2, in 1988. This project would be the first to use solar-electric propulsion, to attain the high velocity which can match the speed of the comets. It is thought that there is a likelihood of the mission now getting under way.

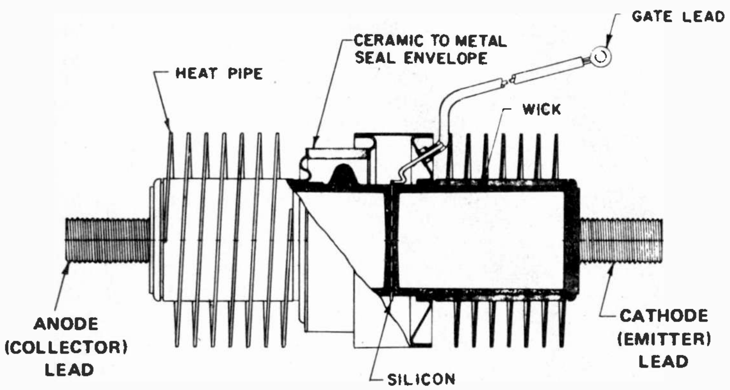
News Briefs

HEAT IN THE PIPELINE

ONE could only *guess* what it would be called, but it *had* to come, and RCA brought it onto the electronics scene. It's called the "transcalent" device, and it's a new class of power semiconductor which uses heat pipes to cool off hot junctions.

These lightweight devices feature integral heat pipes bonded directly to large silicon wafers capable of handling currents of hundreds of amperes. The first devices available include rectifiers, thyristors and transistors.

The integral heat pipes in these devices minimise thermal resistance and increase radiator fin efficiency, thereby permitting RCA to produce semiconductors significantly smaller and lighter than conventional semiconductor/heatsink assemblies of similar power ratings. Typical size reduction is by a factor of four, and weight reduction by a factor of seven.



Transcalent thyristor construction

Other advantages of RCA's heat-pipe/integral-fin construction technique include improved resistance against overloads and high-current surges, and the opportunity either to reduce the silicon-junction temperature for enhanced reliability, or to operate at full ratings at high ambient temperatures.

Installation is also simplified by the elimination of separate heatsinks.

The first RCA transcalent devices available are the P95000EB Series of 250A, 500W rectifiers with blocking voltages up to 1,200V, the P95400EB Series of 400A, 500W thyristors with blocking voltages up to 1,200V, and the P95200EE4 100A, 500W n.p.n transistor.

The rectifiers and thyristors use compact radiator structures resulting in a weight of only 340g, and a volume of less than 230 cubic centimetres. The transistor uses a different radiator structure with a dissipation capability of 500W, yet the device weighs less than 1kg and occupies a volume of less than 1,100 cubic centimetres.

Any of these devices can be supplied with radiator structures to accommodate either air or liquid cooling. Thermal resistances are of the order of 0·1 to 0·2°C/W, and operating ambient temperatures at full ratings range up to 50°C.

The transcalent device is appropriate for a wide range of commercial and military applications involving fixed, mobile or aerospace equipment. Typical uses are in welders, electro-chemical platers, power conversion and distributing systems, motor-speed controls, military-vehicle drives, radar power supplies and aircraft power systems.

EAGLE'S LAUNCH

ON May 21 Eagle International unveiled over 132 new editions to its range of consumer and industrial electronics products, including new hi-fi, public address, security, business and educational equipment. The biggest ever launch in Eagle's history.

Many of these new products are being displayed at the 1978 Radio Show, where the Eagle International stand is in the Piccadilly Hotel, Piccadilly.

The centre piece of the range of consumer products is 20 new hi-fi separates including five loudspeakers, four amplifiers, three receivers, two tuners, two turntables and a front-loading cassette deck. Eagle are also introducing a number of audio products and accessories, such as headphones, cartridges, table radios, and ribbon aerials. Important additions to the public address range with new disco and group PA systems have also been made.

Among the new products in the security field are domestic burglar and fire alarm equipment, including one single-zone combined fire/intruder panel, suitable for private homes and smaller offices or industrial premises.

Eagle is also introducing five test equipment products including multimeters; three emergency lighting products, two headsets specifically designed for educational purposes, and eight intercoms.

NEW MICROPROCESSORS

A NEW 16-bit microcomputer, the Intel 8086, has been formally introduced, and is Intel's highest performer yet, being seven to twelve times faster than the 8080 at program execution. It joins the 8085A and 8048 industry standard micro families, and employs the same software development tools as MCS–80 and MCS–85. To protect the customers' software investment, the 8086 is source code compatible with the 8080A and 8085 via a translator package.

The 8086 provides all the previous features with 16-bit arithmetic, signed 8- and 16-bit arithmetic dynamically relocatable programs; design features multi-processor configuration support, and it can address a megabyte of memory. The standard clock rate is 5MHz (8MHz optional).

The Intel HMOS process has put 29,000 transistors on a chip only 225mm^2 *which is better than the average home constructor can manage!*

Another new device from Intel is the 8022, and this will be of much more interest to the amateur because it is the first micro with an on-board analogue to digital converter! This most useful addition to the microprocessor is accompanied by an input port which can be directly connected to a "touch-panel" keyboard.

The 8022 has twice the program memory (2 kilo bytes) as that of the 8021. With a dual input A to D converter, variable threshold 8-bit input port of 100mV sensitivity, zero-crossing capability, and an extra test pin for conditional jumps, this microprocessor has to be a device we shall hear a lot more of.

The A to D converter is of the successive approximation type accepting inputs up to 5V, and requires an external voltage reference source.

Machine code instructions select which input is to be used, whilst the converter runs continuously, updating a results register every 40µs. This speed of conversion allows multiplexing of the two analogue inputs, to provide many analogue channels without complex hand-shaking, or converter stop/start instructions.

Test pin 1 of the 8022 will detect sinewave zero crossing, so that when used in conjunction with mains control, the system can switch power via triacs, etc. at the optimum time for minimum generation of electrical noise. This "symmetrical" zero-crossover switching is also preferred by the Electricity Generating Board.

The 8022 is housed in a 40-pin package, and has an internal clock generator which requires one external component—a crystal or resistor. There are also two high current drive outputs.

The Proto-Board®

Now circuit designing is as easy as pushing a lead into a hole.

No soldering.
No de-soldering.
No heat-spoilt components.
No manual labour.
No wasted time.

With a Proto-Board you can hook your circuit together as quickly as you can think.

And you can have second thoughts, and third thoughts, equally quick and easy, till you've got the whole thing right.

Then you can solder up if you want to, but most engineers don't because the Proto-Board push-fit connectors are highly reliable.

And everything is visible; come back next week and you 'read' the circuit immediately.

Contact terminals are arranged in sets of five, each connected across the back, and in the Model 203A illustrated you get 1770 contacts, in six rows of 59 × 5, plus four double power rails, each with 100 contacts connected lengthwise and two horizontal power units with 40 contacts each. Many other models; see chart. Proto-Board breadboards will accept transistors, ICs, LSI packages, resistors, capacitors, LEDs, trimmers, relays etc.; most plug straight in.

Try one. You'll wonder how you ever managed without it.

Model Number	No. of Solderless Tie-points	IC Capacity (14-pin DIP's)	Unit Price	Postage & Package	VAT	Total Price	Other features
PB-6	630	6	£ 9.20	£1.00	£0.82	£11.01	Kit—10 minute assembly
PB-100	760	10	11.80	1.00	1.02	13.82	Kit—with larger capacity
PB-101	940	10	17.20	1.25	1.48	19.93	8 distribution buses, higher capacity
PB-102	1240	12	22.95	1.25	1.94	26.14	Large capacity, moderate price
PB-103	2250	24	34.45	1.50	2.88	38.83	Even larger capacity; only 1.73 pence per tie-point
PB-104	3060	32	45.95	1.50	3.80	51.25	Largest capacity; lowest price per tie-point
PB-203	2250	24	55.15	1.50	4.53	61.18	Built-in 1%-regulated 5V, 1A low ripple power supply
PB-203A	2250	24	74.10	1.50	6.10	82.30	As above plus separate ½ Amp +15V and −15V internally adjustable regulated supplies

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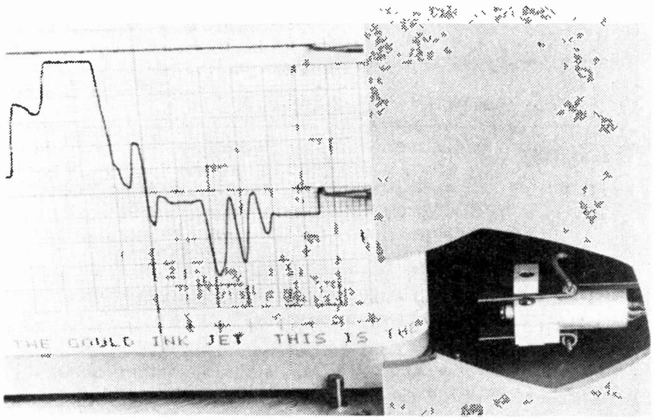
News Briefs

CHARGED AND ARRESTED

An ingenious system for printing has been employed to produce a unique device for depositing alphanumeric characters on moving chart recorder paper, by Gould Instruments Division.

Primarily intended as an add on unit for their standard "continuous stream" ink chart recorders, Gould have developed this improved system (pictured below) whereby ink is virtually "shocked" into a set of minute uniform particles, and charged to a high potential so that it can be electrostatically deflected along one axis. The position on the paper at which a particular ink particle is arrested will depend upon the potential of the deflector plates at that time.

The characters are described as "highly readable" and are formed on a 5 × 7-dot matrix. They appear along the edge of the oscillograph paper to allow annotations concerning relevant parameters *whilst the recording is being made.* In some cases this can allow event triggered recording, to save chart paper, with the nature of each trace and event details in juxtaposition. The "ink jet" device is instructed with ASC11 words which can originate from a manually operated keyboard or perhaps a minicomputer system for fully automatic monitoring.



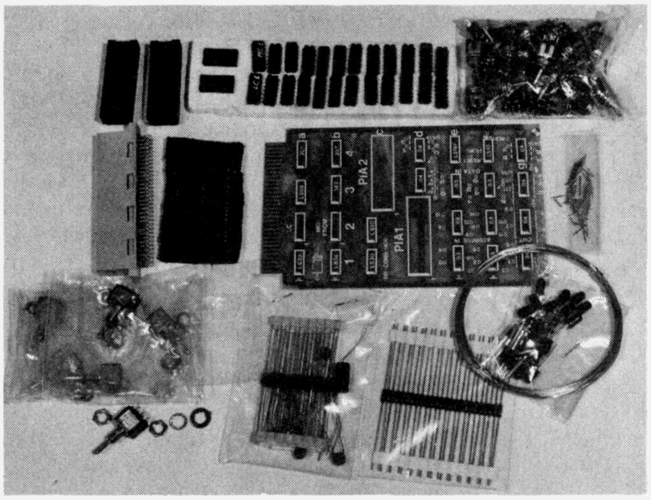
The mechanism works like this: the basic impulse jet consists simply of a glass capillary tube with an orifice at one end, a coaxial piezoelectric driver, and a plastics supply line leading to an unpressurised ink reservoir. The piezoelectric driver is pulsed, and the shock waves squirt a metered amount of ink through the jet, just like a tiny microscopic valve-less pump. This art of obtaining ink particles of consistently equal masses and velocities is important for the next step; which is to charge the particles and electrostatically deflect them with a staircase waveform, and know for certain where they are going to be headed for afterwards.

As the paper advances under the head, the deflection staircase waveform builds up each character in raster fashion (5 rows of 7 dots), the pump "spitting" out (or missing out) ink at the appropriate times, controlled by the electronics.

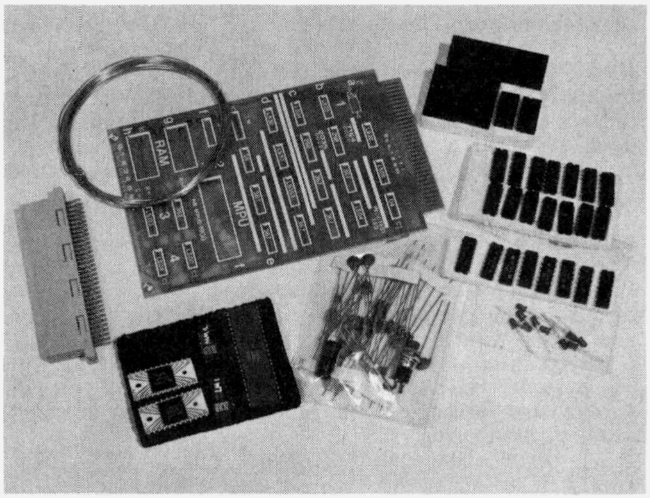
Some of the statistics are: character width held constant over a 1,000:1 chart speed range (from 0·05mm/s to 50mm/s), achieved through paper/character generator speed synchronisation. The mechanism is silent, and could print on almost anything without damage. A single 10^3cm cartridge will print over two million characters.

A real-time clock module is also available for time scale print-out along the oscillograms.

MICROPROCESSOR Kit Review... By P. A. Birnie



Contents of the CON-COS box as supplied in the kit.



MAIN-COS components as supplied in the kit.

THE APPEARANCE in the market-place of a bewildering number of microprocessors has sparked off the home computer industry—first in the U.S.A. and later in the U.K.—and has resulted in an equally bewildering number of "systems" for the amateur. These range from the simplest "keys and lamps" systems, which are more useful as teaching aids than as home computers, through the hex. keypad/hex. display systems to the keyboard and v.d.u. systems running in BASIC and capable of performing the most sophisticated of computing tasks.

Recent months have seen the emergence of several "keys and lamps" systems from such firms as Ritro and Newbear Computing, and these are designed primarily as a means of "getting started" in home computing while at the same time offering the facility of later expansion to virtually any level of system complexity. The system reviewed here is the Ritro AMI-COS system, which is 6800 based and when operational allows the user to run programs entered by means of keys in hex. machine code, and read out the "answers" on two l.e.d. arrays, i.e. it is intended primarily as a cheap means of getting into microprocessor computing.

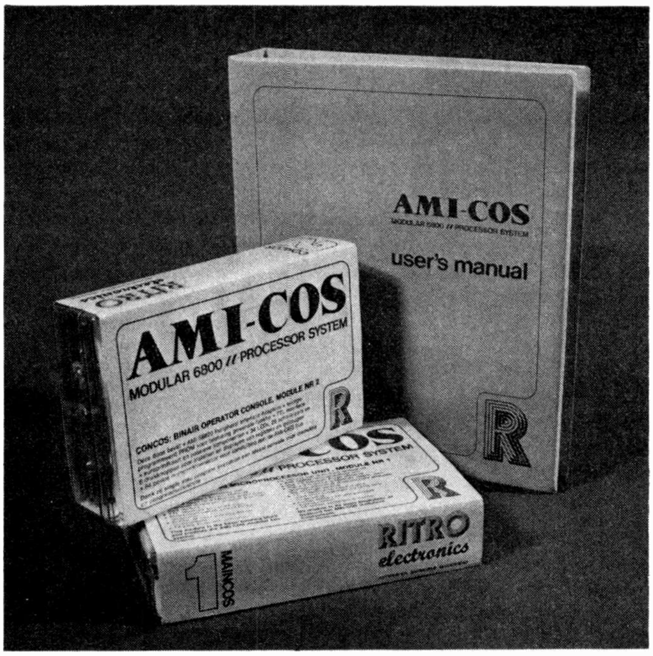
As can be seen in the photograph, an array of 16 l.e.d.s and 16 switches allows the address bus to be monitored on l.e.d.s and have addresses entered onto itself by keys. A similar array of 8 l.e.d.s and 8 switches performs the same functions on the data bus. Other switches allow single step or clocked operation, automatic address increment when inputing data, access to the 6800 register, interrupts and other functions. In other words, access is given to all parts of the system to allow the basic principles of microprocessor operation to be rapidly learned and later applied to the solution of problems by relatively simple programs.

THE HARDWARE

The kit of parts consists of two plastic boxes containing MAIN-COS and CON-COS and a large thick instruction manual—MAIN-COS being the name given to the circuit module containing the 6800 microprocessor and peripheral circuitry, CON-COS, on the other hand, is a circuit module which interconnects the operation panel and MAIN-COS. Both modules are impressively packed in the appropriate conducting foam or polystyrene packaging and each plastic box is slipped into a sleeve which outlines the contents and overall function of that module, and it is at this point that a problem, which was to recur, came to light. The MAIN-COS sleeve is printed in Dutch and English, but the CON-COS sleeve is printed only in Dutch, which proves no problem with such words as "processor", but rather more tricky when one is confronted with "drukknoppen" (pushbuttons?).

The manual consists of an A.4 sized loose-leaf book about 25mm thick with sections on construction of the MAIN-COS and AMI-COS modules, theory of the 6800, sample program derivation and general background of the devices used in the system. Unfortunately, the manual contains only about 50 pages of actual constructional information, about one half of its total being devoted to a reprint of device data sheets—very useful background, but few constructors will need or want to plough through this material. A section devoted to a very clear explanation of the 6800 instruction set is very well produced and the author found the information was more easily understood than that given in the Motorola Programing Manual.

A further section deals with program writing and associated flow-diagram production; the explanations are very clear and two programs are written from flow diagrams through to machine code listing. These programs, an 8 bit binary to three word BCD convertor and a "running light" program, are subsequently handy as an easy way of checking on correct function of the system when completed. The shortest section of the manual is entitled "General Mounting Directions", and is intended to give guidance on constructional techniques. The advice given is at a very basic level and is obviously translated from some other language, which has caused some amusing "directions" to be given—mentioning a "soldering rod", and requesting that a joint should be kept still "during the hardening process" *(please see the footnote concerning the construction section of the manual).*



Presentation of the kit including the complete manual.

CONSTRUCTING MAIN-COS

The circuit board used for MAIN-COS is a simple eurocard size double-sided fibre glass board *without* plated through holes and thus the first task is to make a number of through board connections using the 0·8mm wire supplied. The manual says to cut 149 pieces and link as shown in a photograph of the board. Unfortunately, due to the poor quality of this photograph, it requires considerable care to link all the required holes and not link holes subsequently to be occupied by i.c. legs or component leads, particularly as the figure of 149 seems to be excessive—137 links being used in this prototype. While completing this task, ample opportunity is given to examine the circuit board, which is to a very high quality with a gold-plated double-sided 64 way edge connector and relatively high packing density of i.c.s and a few discrete passive components.

The next activity involves inserting a 7404 inverter package and a "test l.e.d." and probe. This assembly is extensively used during construction, in conjunction with "forcing wires" or earth-connected wires, to de-bug the system as it is assembled. This allows the experimenter, without even a multimeter, to confidently construct the kit—a very helpful idea. Assembly of the board is performed in several stages, each stage being followed by a comprehensive test routine using tables which instruct one to monitor with the test l.e.d. and "force" with forcing wires at specified points, thus checking each i.c. and its interconnections step by step.

The construction of the clock generator in microprocessor systems is frequently a cause for concern, but the AMI-COS module simply uses two back-to-back monostables (74123) with fixed resistors and capacitors, resulting in the prototype constructed by the author, in a clock frequency of 750kHz and a mark/space ratio of about 1:1. This frequency and mark/space ratio can, of course, only be checked using an oscilloscope, so, if the constructor requires a given clock ratio to allow real-timing in software, then he will need to have access to such an instrument.

The final stage in construction involves inserting the 6800 microprocessor and two ROM chips and applying a + 5 volt supply, at which point the processor board *tests itself out* using a diagnostic program contained in the ROM's. A set of eight small l.e.d.s flashes-through a defined sequence, testing, among other things, data and address lines, RAM locations and the presence of other modules. Failure of any test results in the appropriate l.e.d. being lit, allowing relatively easy debugging of the MAIN-COS module—a very neat solution to the problem of testing microprocessor systems in general, and all the more remarkable for its appearance in a basic system such as this. Assuming the manual has been followed, then the MAIN-COS board should function correctly, and may be set aside pending the construction of CON-COS; Fig. 1 shows a block diagram of MAIN-COS.

CONSTRUCTING CON-COS

CON-COS occupies a second eurocard which again has to have a number of through holes linked, the number given in the manual—92—being correct this time. Again, the picture

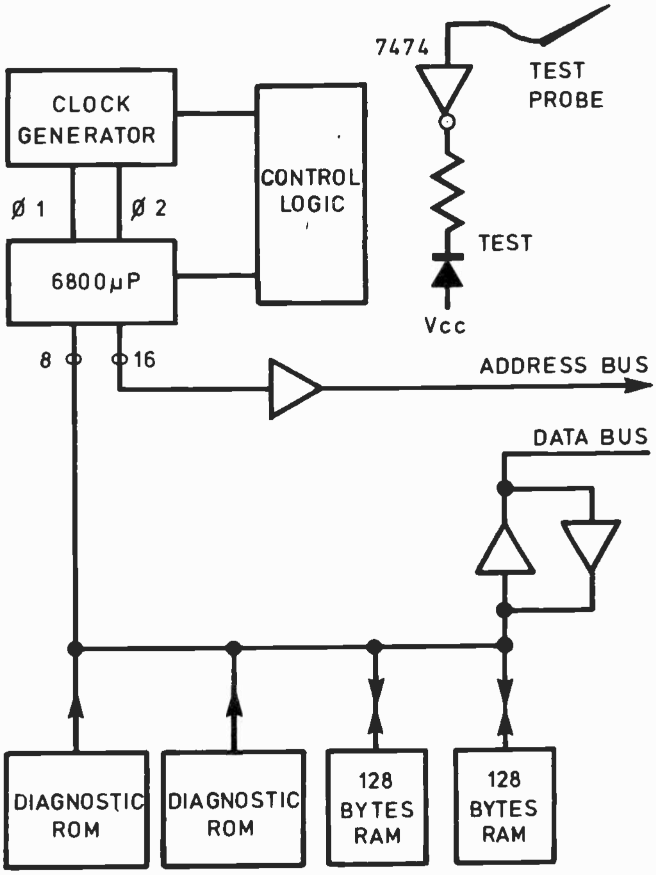
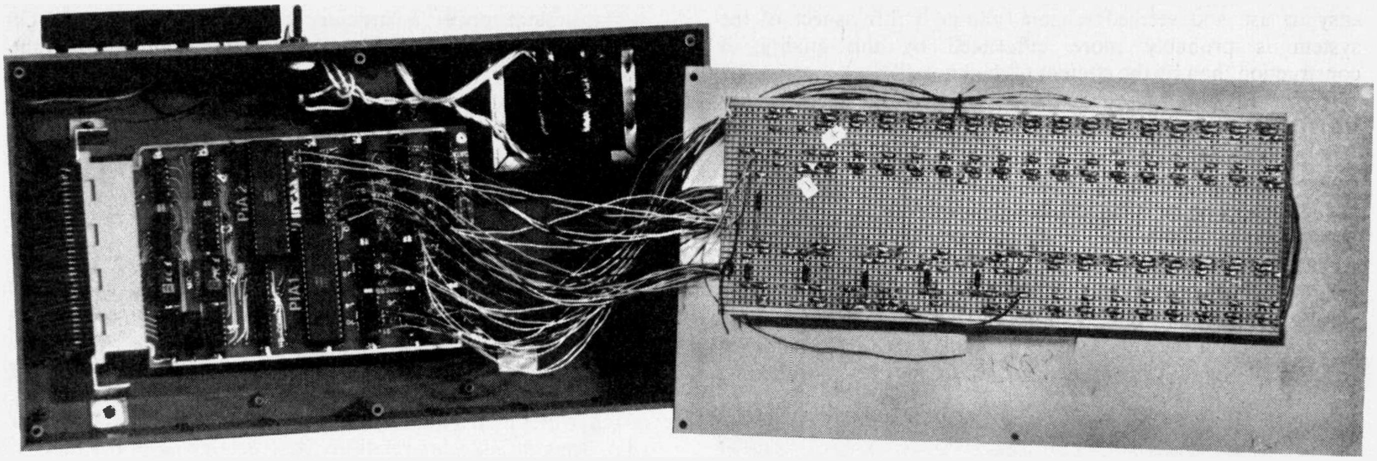


Fig. 1. MAIN-COS block diagram.



Construction of the kit in the Desko case. Veroboard was used for switch and l.e.d. wiring.

showing the positions of the holes is of very poor quality and a diagram would have been much more useful. Construction continues in stages, a test schedule allowing a thorough check to be made of all devices and interconnections. At any rate, this is the intention, but this part of the constructional information is bad, having many errors, causing much cross-reference to the circuit diagrams (see footnote). If the constructor has sufficient ability to overcome these problems, then construction and testing of the board is relatively straightforward and results in a module which controls the interface between MAIN-COS and a front panel—Fig. 2 shows the block diagram of CON-COS.

The final part of construction consists of mounting the switches and l.e.d.s in the CON-COS kit of parts on a panel, or, as was done by the author, on the front plate of a Desko, sloping front case (TEK 364 from West Hyde Developments).

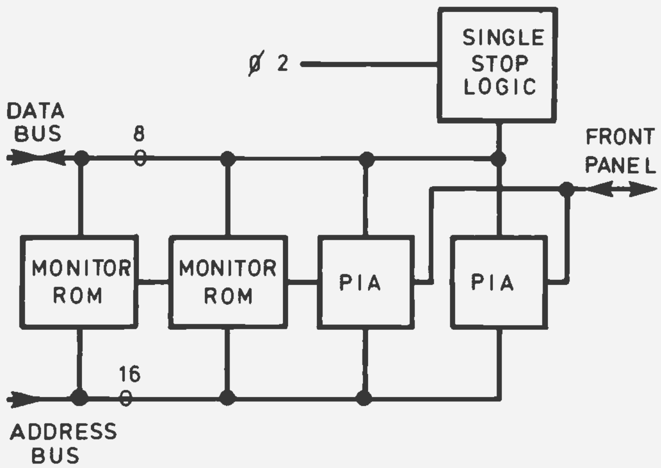


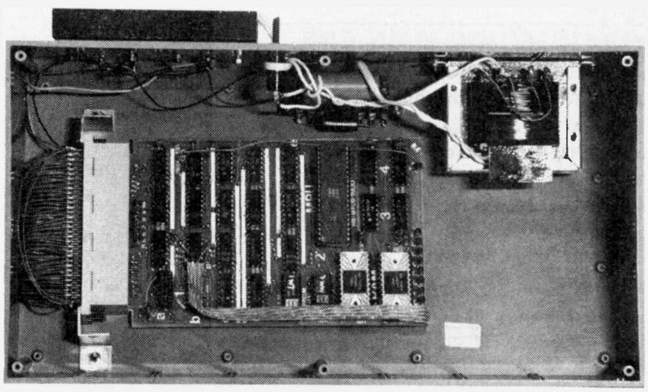
Fig. 2. Block diagram of CON-COS.

The switches and l.e.d.s can either be mounted on a sheet of Veroboard or a printed circuit board which can be obtained as an optional extra from Ritro. The front panel must be connected to CON-COS using insulated wires which are soldered direct on to the board rather than connecting via the edge connector, effectively tying the panel and CON-COS together by a harness of 61 wires. A simple power supply giving 2 amps at + 5 volts must be provided by the constructor to drive the MAIN-COS and CON-COS modules.

TESTING AND PROGRAMMING

Testing of the completed system is carried out in two parts. Firstly, the test program in the two ROMs in MAIN-COS is used in conjunction with the RESET key to check out the system using the eight test l.e.d.s on MAIN-COS. This test program also clears the front panel displays and prepares the system for the second part of the test. This final test is probably best performed using the "running lamp" program—an 18 hex. byte program which causes all l.e.d.s to light except for one, which "runs" along the data and address displays at a rate which can be varied by making small changes to the program.

The program can be stepped through one instruction at a time or at full system clock rate to allow an easy check of the system performance. The author's attempts were rewarded in success, after several "hiccups" caused by errors in the front panel circuit



MAIN-COS and power supply construction.

diagram, which effectively caused some switches to be "upside down" on the panel, so that, for instance, the switch which selects either program counter or index register was inverted when connected "as diagram". In practise, this prevents one easily entering a program as the RAM address of the program bytes is not displayed on the front panel and apparently indicates that the auto-increment of the program counter is not working—all very confusing and the source of several hours of head scratching!

Having sorted out these problems, the system proved very easy to use and seemed reliable, although this aspect of the system is probably more influenced by the quality of construction than by the content of the kit itself.

VERDICT

The purpose of any "keys and lamps" microprocessor system must be primarily to introduce the *newcomer* to microprocessors to the intricacies of what is a complex subject. In this respect, AMI-COS, **as presented to us,** cannot be said to be a complete success. The circuit boards and hardware are all top quality and the concept of step by step checking, using a built-in test l.e.d., is excellent. The use of the microprocessor to check itself and the system out with the aid of test programs in ROM is similarly a very well thought-out concept, and yet all this good engineering is spoiled by a poor set of assembly instructions.

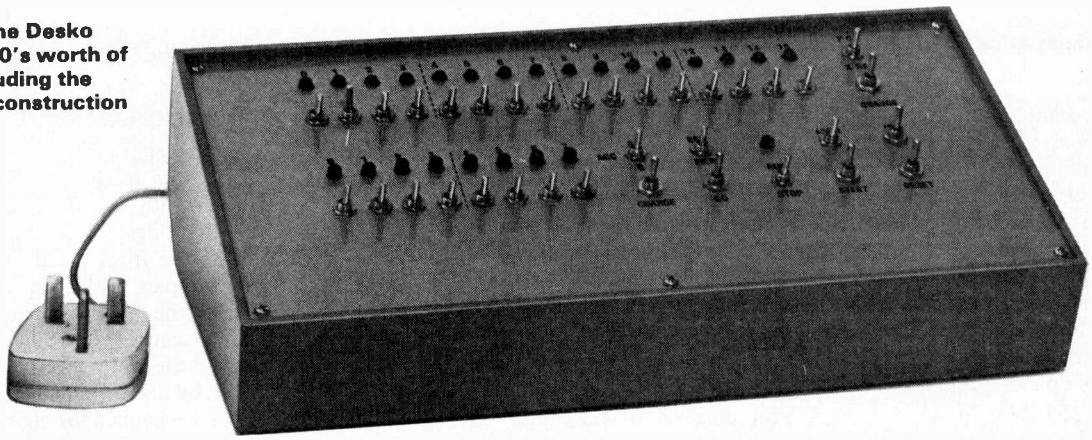
The system, once constructed, is excellent as a "tutor" in microprocessors, when used in conjunction with the relevant sections of the manual, but, at a price of £166·50 plus VAT, seems expensive when, for only small additional outlay, a system running on keyboard and TV set-v.d.u. could be obtained.

For more information contact Ritro Electronics (UK) Ltd., Grenfell Place, Maidenhead, Berkshire.

FOOTNOTE

As a result of our kit construction and findings concerning the manual, Ritro and Mr. P. Birnie have got together and the construction section of the manual has now been completely rewritten. ★

The completed unit in the Desko case. Approximately £20's worth of extra components (including the case) were used in the construction of this unit.



P.C.B. ASSEMBLY JIGS

W. ENGLISH

ONE of the main problems involved in soldering p.c.b.s and stripboard is being able to hold the boards in an accessible position to enable a satisfactory joint to be made.

The two assembly jigs described here show how this can be accomplished with both large and small boards.

CONSTRUCTION (TYPE 1)

A very simple but effective jig for holding small pieces of board is shown in Fig. 1. It consists of a piece of 12mm plywood 130 × 130mm onto which is glued a wedge shaped piece of 15mm softwood cut to an angle of 30 degrees.

To complete the device, a spring clothes peg with the jaws modified as shown below is glued to the slope of the wedge.

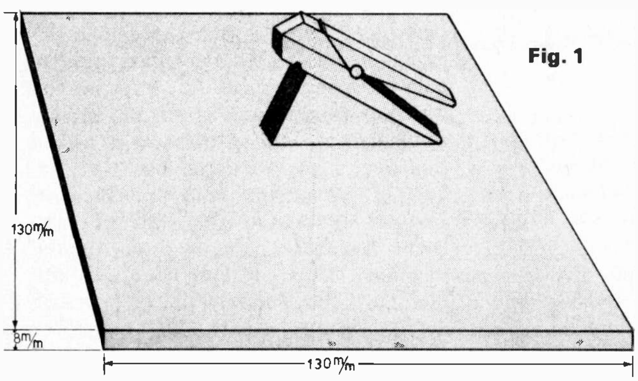


Fig. 1

CONSTRUCTION (TYPE 2)

The assembly jig shown in Fig. 2 is capable of accepting boards up to 300 × 140mm. If larger sizes are to be used, then the relevant dimensions can be scaled up.

The board to be soldered is gripped in slots cut into two bars, one of which is movable to take boards as narrow as 20mm. A self-tapping screw through the metal band at each end of the movable bar enables it to be clamped so that the board is held firmly. A detail of this is given in Fig. 3.

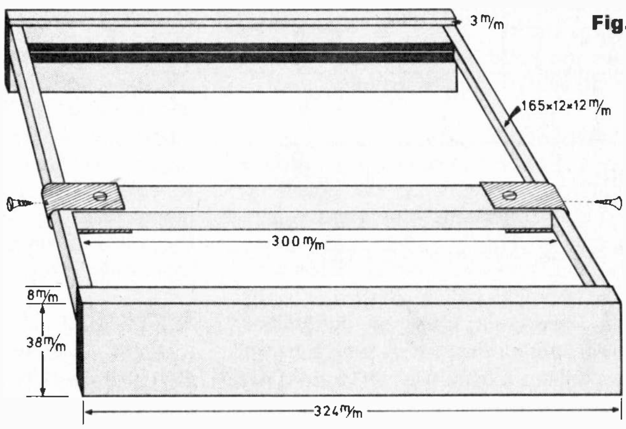


Fig. 2

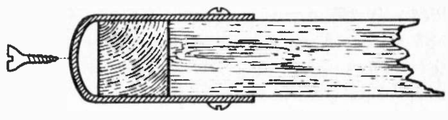


Fig. 3

Making P.C.Bs

A. R. Damper

MANY readers of P.E. are newcomers to the construction of electronic circuits, and will most probably construct simple projects on tagstrips or Veroboard. It will not have escaped their notice that most large published projects give details of a printed circuit layout. The reason is simply that printed circuit boards (p.c.b.s) are simple to make (once you know how!), and provide a much neater and professional looking end-product. Smaller published circuits often give a Veroboard layout or no constructional details at all. This article is intended to be a guide for those wishing to make p.c.b.s from circuit diagrams for the first time. Single-sided boards only will be considered. Double-sided boards are mostly used in more complex projects, and when published in magazines, can usually be obtained ready made.

There are two main types of board material to choose from, SRBP and glass-fibre. In general applications either may be used, the SRBP being cheaper but not as strong as glass-fibre. In higher quality applications where maximum isolation between tracks is essential, glass-fibre boards are preferable. For small general projects SRBP is quite adequate.

AN EXAMPLE

The object of the exercise is to produce a conductor network on the board by covering, or masking the areas where copper is to remain, and then dissolving away the remaining areas. However, before the tracks can be marked onto the board the layout must be determined from the circuit diagram. A simple circuit (one stage amplifier), provides an example. See Fig. 1.

The circuit is a simple one with no interconnections to other parts of a complex design, enabling the layout on the board to follow the layout of the diagram. Now see how this circuit can be transformed into a finished p.c.b. The points marked with and "O" represent the need for a hole in the board to take a component lead. At point "A" there are four holes necessary; one for a capacitor lead, two for resistors, and one for the transistor base lead. If the components were now to mystically vanish, Fig. 2 results, and the Os indicate where the holes are to be drilled. This is the general layout and only gives a guide to the track layout.

The resistors are probably low-wattage and can therefore be mounted vertically; consequently the distances between the two holes for Rs need only be about 6mm. However, C2 is an electrolytic capacitor, and for an amplifier having a low pass characteristic, may be of large value, hence large size. The holes for C2 may need to be 50mm apart. So from Fig. 2, Fig. 3 is produced taking into account the component sizes. It is therefore very important that the components are obtained prior to building the board if their size is unknown. Figure 3 still shows the track from the *component side of the board* and must be reversed to give the layout as it will be etched. To ensure that the input and output are isolated, it is always best to fill in large otherwise empty spaces with conductor, and earth it making sure there is one continuous path to earth. This gives the final full size layout as in Fig. 4, the shaded area being the "filled-in" portion carried out after the main track is applied.

METHOD

There are quite a few different types of etch resists on the market. In the author's opinion the best board is produced by a combination. Until recently the resist used was painted onto the board (enamel paint and nail-varnish being common), but these did not lend themselves to small scale work such as integrated circuit connections. Then etch-resist pens appeared which enabled the circuit to be drawn directly onto the board, and although they sound fine, the author has found that they often "run" to produce very thick lines unsuitable for fine work. Without running these pens down, the dry transfer system seems the cleanest and simplest method. It is also fairly cheap, and if a mistake is made, the offending line can be scraped off. So, the author recommends that for the main track, dry transfers are used whilst the larger filled-in areas are covered with nail varnish, paint or etch-resist ink.

MAKING THE BOARD

Having worked out the final layout as in Fig. 4 the board can be prepared. Firstly cut from a larger sheet, a piece of copper-clad board of the required size, using a hack-saw with a *fine* blade and then file the edge smooth. The surface of the copper must now be thoroughly cleaned to remove all grease, dirt and finger-marks. A good method is to rub the surface *gently* with a cloth after sprinkling a little "Ajax" or similar cleanser onto the board. This is very effective and no trouble whatever has ever been experienced with the fine scratches produced. The board is then rinsed in fresh water and dried.

Dry transfer systems are sold by many P.E. advertisers and complete packs consists of ten sheets, each carrying a different symbol such as lines, drilling points, transistor and i.c. sockets, etc. whilst extra individual sheets are usually available also. It is advisable to buy extra sheets of lines, as these are most frequently used. The author once used Letraset sheets of symbols and line rules, before this system became available, and in certain circumstances such as when fine lines are needed, Letraset is still handy. However, these sheets are more

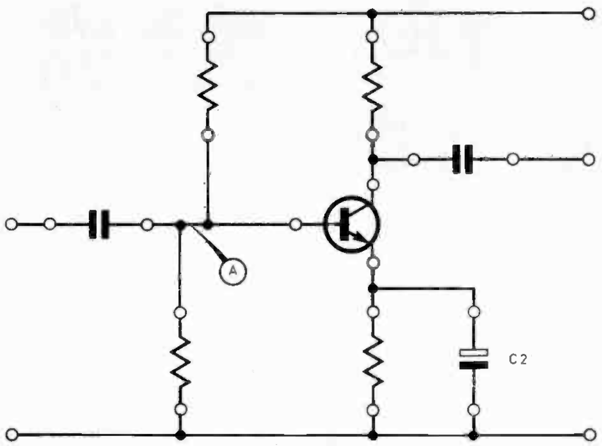


Fig. 1

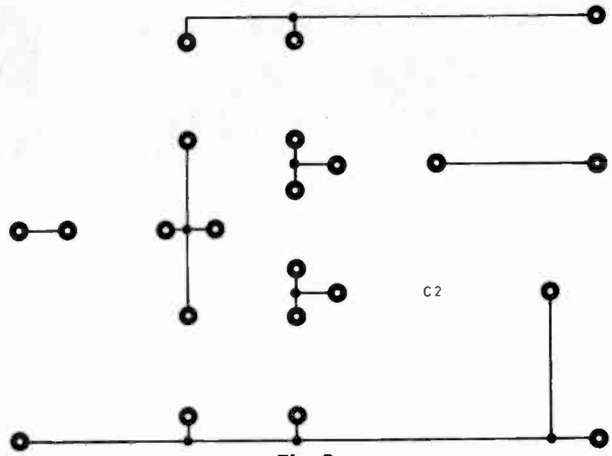


Fig. 3

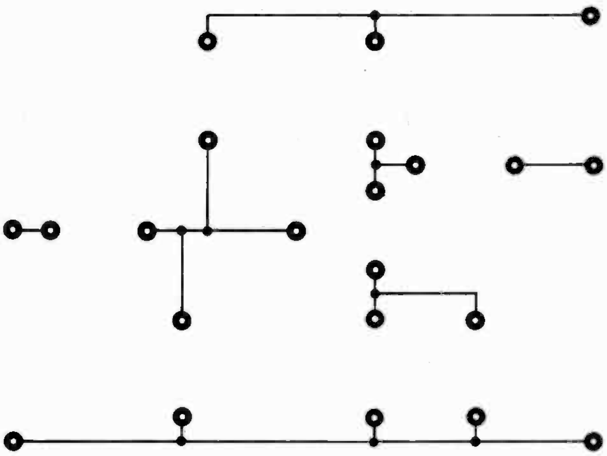


Fig. 2

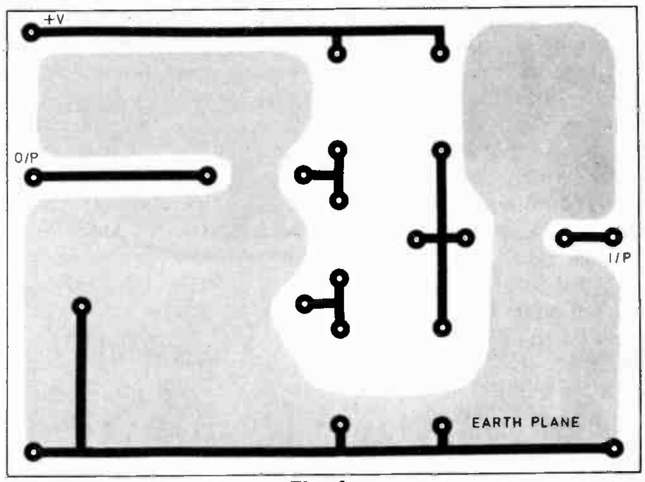


Fig. 4

expensive and therefore only used when necessary. Letraset is useful for applying lettering to the board to identify component positions. If Letraset is included in the masking the etchant should be reduced to around half the normal concentration, as this type of transfer may start to loosen. The p.c.b. transfer system is of course unaffected by the full strength solution.

Working from the layout, the transfers should be applied by placing the required symbol face down on the board and rubbing the backing sheet gently with a bluntish pencil. When transference is complete, the backing sheet is carefully peeled away and the remaining transfer symbol gently pressed onto the copper to secure it. Clean hands are necessary for this operation. Should something go wrong, the transfer can be removed by scraping it off with a finger-nail or blunt instrument.

When all the lines (as in Fig. 4) have been applied, the larger *shaded* area can be filled in with etch-resist ink or paint. The board should then be left to dry.

ETCHING

The etching solution used is ferric chloride, which is also obtainable from advertisers in this magazine. The solution is made up as follows. For each pound weight of ferric chloride, one pint of cold water should be added, and placed in a plastics container (a plastics orange juice bottle with the top sawn off is ideal). The ferric chloride should then be added slowly, stirring all the time with a piece of wood or plastics rod. Don't add too much at a time because the solution gets hot, and it becomes necessary to stop and let it cool. *Never add water to the crystals,* because the heat generated is enormous and the steam produced might shower you with hot ferric chloride, or melt the plastics container. If any ferric chloride gets on your skin, wash the area thoroughly with water. Store the solution in a plastics container with a secure stopper.

To etch the board, pour some of the etchant into a shallow plastics or glass tray and lay the board face down on the solution. This allows any by-product from the etching process to fall away from the surface of the board. If the board sinks, or you would rather see what's going on, lay the board face-up in the bottom of the container, but keep the solution moving by gently rocking the container. When etching is complete, remove the board with non-metallic tweezers and rinse in cold water. After drying, the resist can be removed by rubbing the surface with medium or fine grade "wet and dry" paper obtainable at d.i.y. shops. The holes can then be drilled with a 0·8mm drill. Some components will have larger diameter leads and the appropriate drill should be at hand. To give the drill a start, it is useful to mark the position with a centre-punch, but be *very gentle* otherwise the board may crack. ★

Market Place

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

GETTING STARTED

Delta Distribution is a very new company initially concentrating on power supply transformers, regulators and common i.c.s. Good, fast service is their intention and they are at present setting up mail order and telephone credit services with Access and Barclaycard.

The product range will be expanded as soon as possible and the current price list is available from **Delta Distribution Co., 75 Willowtree Ave., Gilesgate Moor, Durham, DH1 1DZ (0385 62760).**

SOUND ON VISION

An all British invention, the Videograph, has recently been announced. It converts sound from a record, tape, organ or synthesiser into a display on a domestic colour or black and white TV screen.

Two inputs allow direct display of stereo sound as independent left and right channels, or alternatively a mono signal may be used to feed, for example, low frequencies to one channel and high frequencies to the other.

When used with a colour TV the waves are orange and blue, while the background performs an eight stage colour cycle.

Connection to the TV is directly via the aerial socket.

The Generator Kit costs £12 and the UHF Colour Modulator Kit is £6·95. Cabinet and controls cost £6·95 + £1 p&p.

Ready built units are available at £39·95. All prices include VAT.

William Stuart Systems Ltd., Dower House, Herongate, Brentwood, Essex.

AMERICAN COMPUTER BITS

Another supplier of computer bits and pieces has arrived on the scene; Interam Computer Systems Ltd, who are geared up to service both the hobbyist and small businesses.

As we move further into the "software age" more of these suppliers are sure to pop up, with all sorts of novel odds and ends. Among the literature sent for our perusal by Interam were details of such things as the Cybernetic Systems 1000 Speech Synthesiser. This p.c.b. can be programmed to talk, using standard English and American phonemes, callable using ASCII characters. It is described as a real conversation piece!

Then there is the Newtech Model 6 Music Board which is S-100 bus compatible, and with built-in audio amp and loudspeaker can be programmed to produce melodies, rhythms, sound effects, morse code, touch-tone synthesis, and much more.

And yet another American product available from Interam, is the George Risk 753 ASCII Keyboard module with 53 keys on the popular ASR-33 format and 3 user definable keys.

What is PROROM? This is an 8K EPROM memory board with on-board programming circuitry intended to make high programming charges a thing of the past, and made by Mountain Hardware (USA).

Much much more is available from Interam; disk systems, optical tape readers, a Z80 c.p.u. system, software, and many American books and magazines.

More details are obtainable from **Interam Computer Systems Ltd, 59 Moreton Street, Victoria, London SW1.**

ONE-CHIP TV SOUND SYSTEM

The TDA 1190 is a 12-pin silicon monolithic i.c., mounted in a "batwing" plastic power package. The device which performs all the functions needed for a TV sound system has an audio output power of typically 4·2 watts into a 16Ω load with a supply voltage of +24V. The TDA 1190 is particularly suited to use with 5·5MHz (PAL) sound systems.

The package provides a FM IF amplifier and detector of high sensitivity which only requires the addition of few extra components and a single tuned coil. AM rejection is excellent; figures of 55dB being typical. An active low pass filter is used to attenuate IF harmonics. Other features include an on-chip audio power output stage and a d.c. volume control.

Although primarily intended for use in TV sets the device can be used in inexpensive FM radios and other FM receiver applications at IF frequencies up to 10·7MHz.

For further information contact **Fairchild Camera and Instruments (UK) Ltd, 230 High Street, Potters Bar, Herts.**

SOLDERING TOOLS

For many years the name Adcola has been synonymous with soldering irons. "Adcola '78" is a very well produced booklet about the other products manufactured by "The soldering equipment people".

Perhaps initially written for volume production solderers this booklet makes useful reading for any hobbyist.

The advantages of thermostatically controlled "soldering stations" are well documented. Their main improvement over the commonly used "thermal balance" iron is a more rapid rise to operating temperature and an ability to maintain a set temperature during repetitive working.

Among the numerous sizes and profiles of plain copper and iron plated bits is an 80° p.c.b. tip. Iron plated bits oxidise much less quickly than plain copper and are claimed to have a ten times greater working life.

Of particular interest to project builders is a desoldering bit for 14 or 16 pin i.c.s although it does require to be used in a 27–30 watt iron. Adcola also supply an i.c. puller. This is a simple spring loaded extractor used to withdraw i.c.s. from a board after a desoldering bit has melted the surrounding pin solder.

Other desoldering aids are a heated tip with suction bulb, a desoldering gun and various sizes of desoldering braid.

For quick access to both sides of a rigidly held p.c.b. Adcola's Variclamp deserves consideration. This is a lightweight portable holding device which can hold items in any preset position.

The right tools make the job easier and help towards a good finish. The range of cutters, nippers, pliers, shears and strippers gives the craftsman constructor the means of achieving professional quality boards.

Copies of "Adcola '78" and a full price list may be obtained from **Adcola Products Ltd, Adcola House, Gauden Road, London SW4.**

TRISTATE L.E.D.

A light-emitting diode which produces red or green emission according to the polarity of the applied voltage is now available from Distronic. Known as the Xciton XC5491, the device uses a back-to-back double-diode configuration which produces red or green light of equal intensity for both colours.

The forward bias is typically 2·2V at a current of 10mA with a dynamic resistance of 25Ω. The maximum continuous forward current is 25mA for both colours and the operating temperature is –55°C to +85°C.

The XC5491 is supplied in a T-1-3/4 package measuring 0·2in diameter × 0·34in height, and is supplied with wire-wrappable leads.

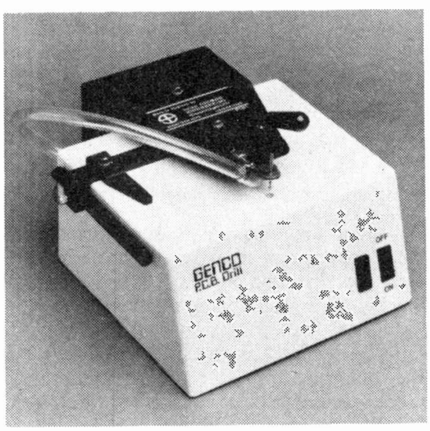
For further information contact **Distronic Limited, 50–51 Burnt Mill, Elizabeth Way, Harlow, Essex.**

CHUCKLESS P.C.B. DRILLING MACHINE

A p.c.b. drilling machine operating on a new design system allows inexperienced operators to drill perfect p.c.b.s immediately.

The unit has no chuck and does not require guide bushes for turbo shank tungsten carbide drills.

The drill bits run in vee-blocks at the end of the drill arm allowing extremely accurate running at 15,000 r.p.m. Belt idler pulleys run on ballraces and the mains motor is silent running.



An integral vacuum attachment for efficient swarf removal will optionally accept standard Hoover vacuum cleaner attachments if required.

The ultra lightweight drill arm can be easily raised and lowered to allow modifications to p.c.b.s where components are already in place. The machine will accept drills from 0·35mm to 2mm diameter.

Standard fitments include back stop and side gauge—fully adjustable in both X and Y axis, and a jig to ensure accurate location when fitting drill bits.

The unit cost £140 with accessories and is available from **P.B. Electronics (Scotland) Ltd, 9 Radwinter Road, Saffron Walden, Essex.**

STORAGE SCOPE

The new oscilloscope available from Gould Advance, is a general purpose two channel digital storage oscilloscope and waveform digitizer which features several new facilities, including an X-Y display and a sensitivity of 100μV/cm combined with isolation from earth to avoid hum and ground loop problems.

It is based on an 8-bit analogue/digital converter operating at a 1MHz sampling rate into a 1k bit store to provide a –3dB bandwidth up to 600kHz.

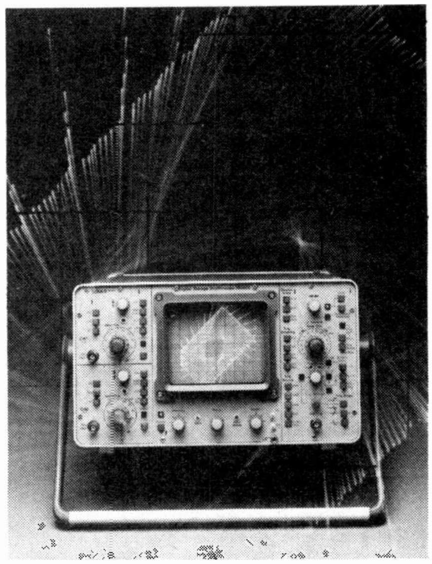
In addition to facilities for displaying the sum or difference of the input signals, the instrument has a comprehensive range of signal conditioning and trigger facilities, including a "trigger-window" feature which is unique in oscilloscopes. In this mode, trigger occurs whenever the input goes outside either of two levels, symmetrically spaced above and below the original trigger level.

Internal trigger sensitivity is equivalent to 2mV of signal at frequencies from d.c. to 1MHz, and external sensitivity is better than 100mV up to 1MHz. Trigger coupling allows selection of d.c. or a.c. with high-frequency and/or low-frequency rejection if required.

An important feature of the digital storage system is a signal delay switch, which inserts a quarter scan length delay into the digital signal path, so that events happening prior to the trigger event may be viewed on the screen.

An 18-position rotary switch varies the speed rate over a very wide range, 100μs/cm to 50s/cm, while an X-expand control offers the facility of expanding the display horizontally, even after storage has taken place.

In addition to the normal dual-channel form of display against a time axis, channel 1 can



be displayed against channel 2 in the X-Y mode.

A split-trace facility is incorporated; in the single-trace mode, alternate samples of the input signal are frozen, so that an image of the signal may be stored and superimposed on the display of the current input waveform.

The digital storage system incorporated in the Gould Advance 0S4100 offers considerable advantages over conventional tube-storage oscilloscopes incorporating expensive limited-life storage tubes. The X-Y facility means that the instrument is ideally suited for looking at transients where more than one variable is involved.

For further information including price contact **Gould Instruments Division, Roebuck Road, Hainault, Essex.**

RADIOCODE CLOCK

A clock which has been specifically designed to receive the time and date information which is transmitted by the National Physical Laboratory from Rugby on MSF 60kHz is available from Circuit Services.

By decoding the Rugby signals the clock can set itself automatically within two minutes of being switched on and displays either the time or the date. No subsequent adjustments are necessary because the clock is capable of accounting for both leap years and BST.

Its estimated range is around 1,000 miles and for continental use the clock has an add-on-hour facility or alternatively, a modified version can be supplied which receives a similar signal from the DCF77 transmitter at Mainflingen, West Germany. This allows the clock to be used in Eastern Europe where the MSF transmission may be weak.

The unit can be supplied with an alarm/timer module which enables the clock to control other equipment at certain times for precise periods. A record/replay unit can also be supplied which allows the time or date to be recorded on one track of a conventional tape recorder while the other tracks monitor instrument outputs, transients, etc. On replay the recorded time is shown on the Radiocode Clock display. In this mode the clock operates

exactly as if it was receiving a normal transmitted signal. Once the tape has been started on replay, the clock circuitry requires around two minutes to synchronise with the code. After synchronisation has taken place any events recorded on other tracks of the same tape will be timed to within approximately 10mS of their occurrence.

Another advantage of this system is that if the Rugby transmitter should happen to break down during an important recording period, the back up crystal clock will take over and provide an accurate time reference.

For further information contact **Circuit Services, 6 Elmbridge Drive, Ruislip, Middx.**

HONEY AT 2·50?

The Casio F-100 digital chronograph can display time, calendar, or a stopwatch function. The 1/100th second stopwatch measures net and lap times and can record 1st and 2nd place times.

Timekeeping is ±15 seconds per month and gains or losses of up to 30 seconds are easily adjusted by pressing two buttons and zeroing in on a time signal. A complete setting of hours, minutes and seconds takes a little longer.

The calendar display is similarly easy to set, and looks after itself with only the 29th February to contend with.

Although water resistant the watch should not be subjected to swimming, bathing or even car washing. The manufacturers say the display may disappear if kept under constant sunlight but will reappear after normal temperature resumes. Battery life is approximately 18 months.

It is not understood why the function buttons on the watch are coloured grey, yellow, brown and green whereas the user's guide refers to them as B.L.C. and A.

If you want to brush up on your watch knowledge in German, French, Spanish or Italian then Casio's user's guide serves as a miniature Hugo's. Soon, perhaps, the average music centre will have Stoppuhrfunktion: Travail buttons; oxido de plata batteries; and interfaced Luce shows.

The English language and the traditional clock face are disappearing into an oriental

sunset. The last two lines of The Old Vicarage, Grantchester by Rupert Brooke survived the attack by Peter Sellers' cafe waitress but what hope have they against the digital time display.

Stands the church clock at ten to three?
And is there honey still for tea?

F-100, £19·95, **Tempus, 19-21 Fitzroy St., Cambridge, CB1 1EH.**

DAWN CHORUS DEVICE

Aptly named the Wren, this new quartz movement miniature alarm clock by Smith's Industries is a mere 59mm high.

The hands and hour positions are luminous and the moulded case is available in white with a black or gilt dial, or brown with a gilt dial.

The recommended retail price is £12·90.

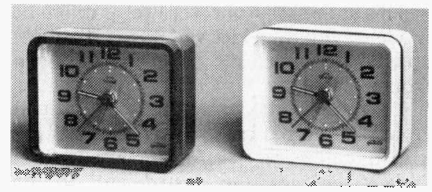
AMPLIFONE

This telephone amplifier fits nearly under a standard instrument and not having any wiring to the telephone can be installed instantly.

Dialling and ringing tones and voices are amplified enabling the caler to hear incoming sound "hands off". The flight deck is simplified to one combined On/Off switch and volume control.

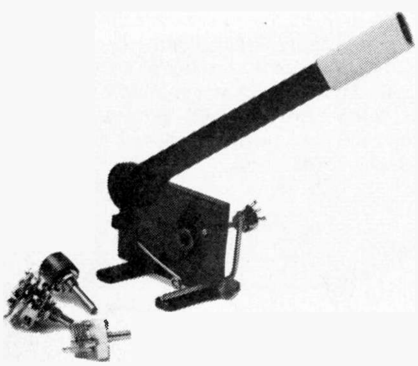
Posted and packed price is £10.

Southern Developments, 120 High Street, Billingshurst, Sussex, RH14 9QS.



SHAFT SHEAR

Manufactured from hardened Swedish tool steel, this guillotine-type tool will cut copper, aluminium, mild and stainless steel, and plastics rod of the following diameters: $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{4}$in, and 3, 4, 5, and 6mm.



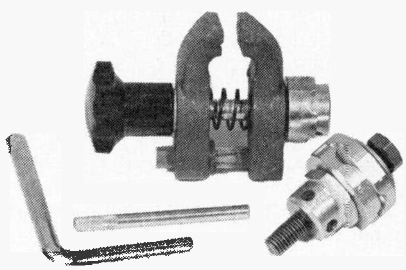
Shock and vibration have caused problems when the spindles of sensitive components have been sewn or cut on a lathe; but the Telpro Shaft Shear may be used to cut the spindles of even delicate helical potentiometers, since it does not transmit shock or vibration.

A further advantage is that it gives such a clean, smooth cut that no filing or other finishing operation is needed before control knobs are fitted.

Manufacturers are **Tele-Production Tools Ltd., Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9Nw.**

MINI VICE

This, Design Centre selected vice, needs only a $\frac{5}{16}$ inch clearance hole in a work bench to give an infinitely positionable third hand. It is an ideal addition to the Home Radio Electronic Workshop (below) and is also supplied by them, at £5·50 + 8 per cent VAT and 85p postage, but post free if supplied with an Electronic Workshop.



TRAVEL

If you have ever been evicted from the kitchen table just as you were getting your project into a "critical" mode you will understand the marketing theory behind The Electronic Workshop. At the first sign of an approaching ketchup bottle the self contained unit can up and away to the safety of the cupboard under the stairs.

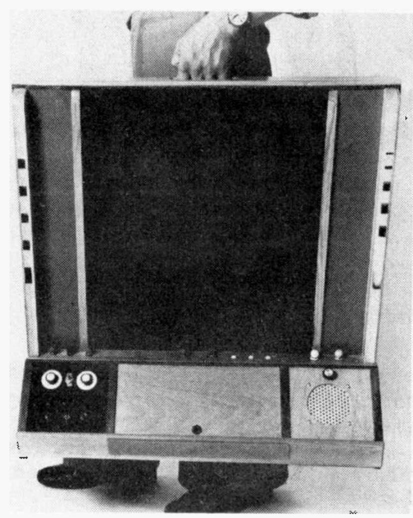
The working surface is two feet wide and 20 inches deep. Rubber mat covers the centre area and formica protects the side portions. Pieces of pine $1\frac{1}{2}$ inches high form the outer edges and also double as tool holders.

At each end of the back section is a flush 13A shuttered mains socket. The right hand compartment contains a power pack, giving 0–20V at 1A. The left hand compartment houses a small 35Ω speaker and volume control. The centre compartment acts as a tool box and dispenser for reels of solder, plain wire and tinned copper which feed out of three holes into the work area.

The price of the workshop complete, but for wiring up, is £45. Ready wired, £54. VAT and carriage, £4·56.

Home Radio (Components) Ltd. 240 London Road, Mitcham, Surrey CR4 3HD.

Please note that the photograph shows a mark one version which had AC and DC controls on the power supply. The present workshop has a single control.



Market Place

DIGITAL THERMOMETER REVIEW

There are many different types of digital thermometer now available which cover a very wide temperature range.

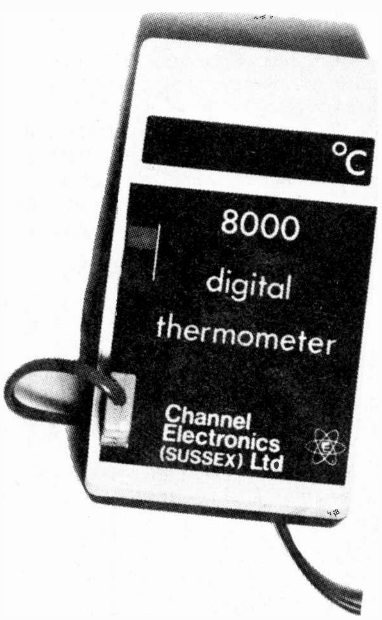
The hand-held types use CMOS technology to ensure low power consumption with either l.e.d. or l.c.d. indication.

The shape and type of sensor depends on the particular application for which the unit is required, i.e. medical, surface, liquid, powder or gas measurements.

800 SERIES

This series incorporates twelve different models with a wide variety of thermocouples to cover the temperature range from $-150°C$ to 1,750°C.

To ensure maximum life is obtained from the internal batteries a three position switch: momentary-off-on is used. This facility enables the instrument to be either switched on only for the instant at which it is required, or maintained continuously on. HP7 batteries are included with the unit and rechargeable cells with a charger are available as an optional extra.



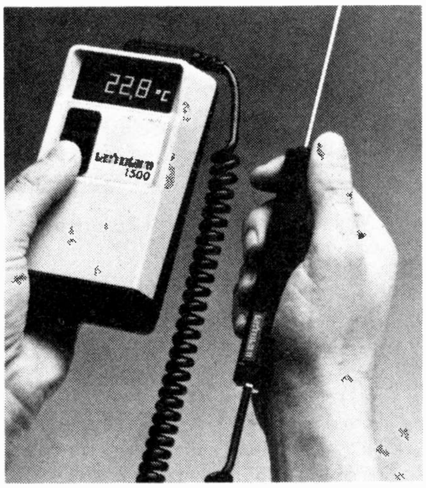
The 8000 series vary in price from £94.00 to £125.00 subject to the temperature range and resolution required.

Further details can be obtained from Channel Electronics Ltd., PO Box 58, Seaford, Sussex.

THERMISTOR PROBES

The Technoterm 1500 uses precision thermistors with negative temperature coefficients in their probes. This enables response times of between 6 and 10 secs to be achieved over a temperature range of $-40°C$ to 140°C, depending on the type of probe chosen.

A wide range of probes is available to suit most applications. Accessories include nickel cadmium batteries, recharger and a handy dispenser for silicone paste which reduces the response times on rough surfaces.

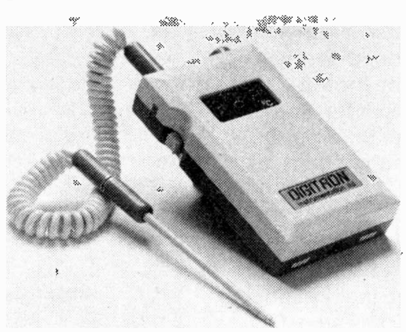


The Technoterm 1500 is priced at £169.00 and is available from Thermographics Ltd., 16 Canal Street, Congleton, Cheshire.

CLINICAL TYPE

The 4755 has been designed specifically for medical and environmental measurements and is available in two ranges, 33°C to 42·9°C (clinical) and 1°C to 48°C (environmental).

The medical unit is capable of retaining the highest temperature detected within a patient and to prevent cross infection both the instrument and the sensor can be sterilised. To avoid the need for sterilisation after each test disposable sheaths for the sensor are supplied with the unit. The response time of the thermometer is 15 secs with rechargeable cells as an optional extra.



The Digitron 4755 is available priced £92.00 from Digitron Instrumentation Ltd., Mead Lane Industrial Estate, Hertford, Herts.

TEMPSTIK

The Tempstik thermometer has been designed to meet the low cost instrument need and is capable of measuring a temperature range of $-100°C$ to 200°C with reasonable accuracy.

The instrument has a liquid crystal display and is powered from a PP3 battery which is not included.

The Tempstik which is priced at £73.00 is available from Process Measurement Ltd., 8 High Street, Littlehampton, West Sussex.

BENCH TYPE

The 7000 series was designed for bench or rack mounted applications and is mains operated. The temperature is indicated on three or four 14mm Sperry gas discharge displays. Thirteen models are available for the temperature range $-100°C$ to 1,800°C.

All the models in this series can be fitted with an alarm circuit which consists of two totally independent alarm points each having its own relay and front panel l.e.d. The relay contacts which are rated at 240V 2A provide normally open, common and normally closed outputs at the rear of the unit.

The price of the 7000 series is between £109.00 and £149.00 depending on the temperature range chosen.

For further information contact Jenway Ltd., 26 Broomhills Industrial Estate, Rayne Road, Braintree, Essex.

MOTOR SPEED CONTROL

R.F. MACK

THIS circuit was developed to control the speed of a small model vehicle driven by a permanent magnet electric motor, and provides the following features:

1. A wide range of continuous speed control down to about 200 r.p.m. motor speed.
2. Substantially constant speed despite changes in mechanical resistance due to inclines, cornering, or surface variation—carpet to lino, for example.
3. Substantially constant speed despite changes in electrical resistance—varying track length in a model railway, for example.
4. Economical low-speed operation, unlike some op-amp based controllers.

PRINCIPLE OF OPERATION

The controller makes use of the fact that when the permanent magnet motor is temporarily disconnected from the drive battery, it acts as a generator driven by the wheels of the free-wheeling vehicle, with the generated voltage representing the actual speed of the vehicle.

The controller compares this generated voltage with a voltage selected to represent the desired speed, and when the vehicle speed is less than the desired speed the controller momentarily reconnects the battery to the motor.

This process is repeated continuously, resulting in the motor being fed with a stream of fixed magnitude pulses, with a repetition rate governed by the external conditions, as shown in the waveform diagram.

CIRCUIT DESCRIPTION

A voltage representing the desired speed is fed to terminal A. This voltage may be derived in various ways, the potential divider VR1 being shown as an example. Transistor TR1 compares this voltage with the generated voltage from the motor via filter components R9, C3, and switches on TR2 when the actual speed is less than the desired speed. Monostable M1 then produces a fixed magnitude pulse at

COMPONENTS . . .

Resistors

R1	10kΩ
R2	10kΩ
R3	39kΩ
R4	39kΩ
R5	470Ω
R6	1kΩ
R7	10Ω 2W
R8	1kΩ
R9	39Ω
R10	1kΩ

(¼W carbon except where otherwise stated)

Capacitors

C1	0·022μF plastic
C2	0·1μF plastic
C3	0·047μF plastic
C4	0·01μF ceramic
C5	0·01μF ceramic
C6	0·01μF ceramic

Semiconductors

TR1	BC107	TR4	AD142
TR2	BC157	D1	AAY12 (see text)
TR3	BFY50	IC1	SN74123

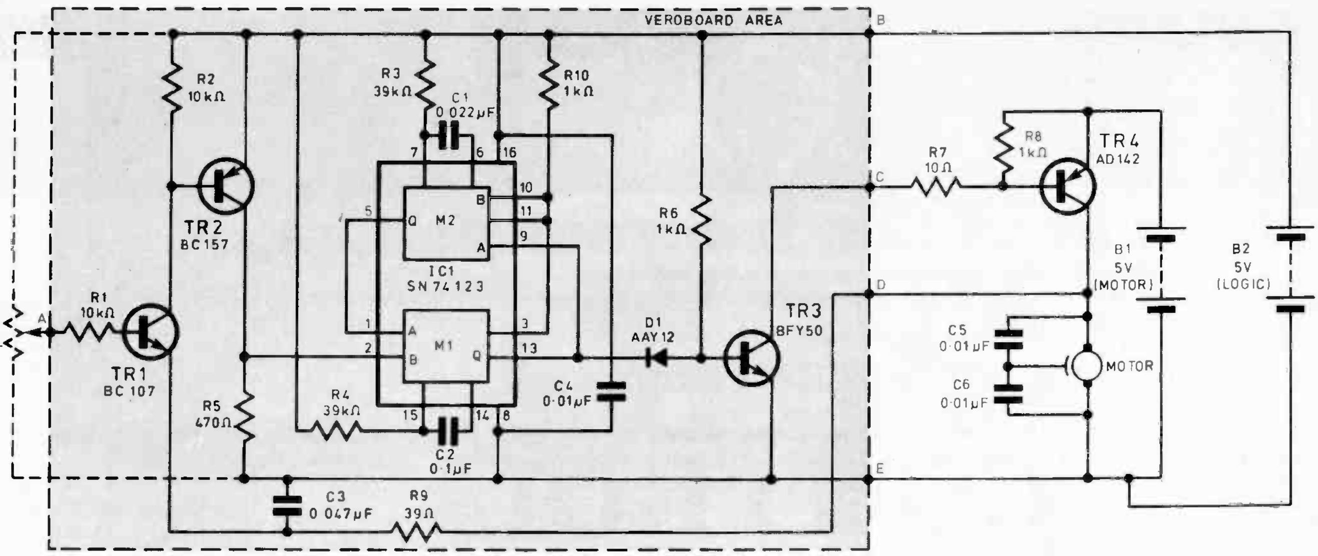
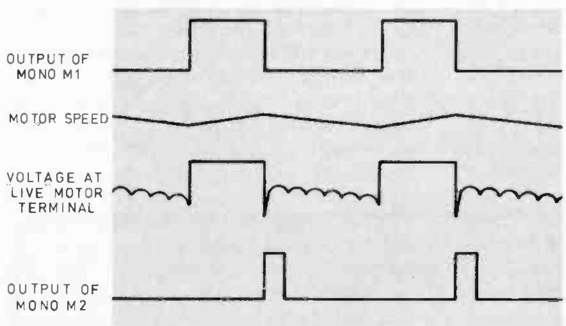


Fig. 1 (above). Circuit diagram; Fig. 2 (below) waveforms



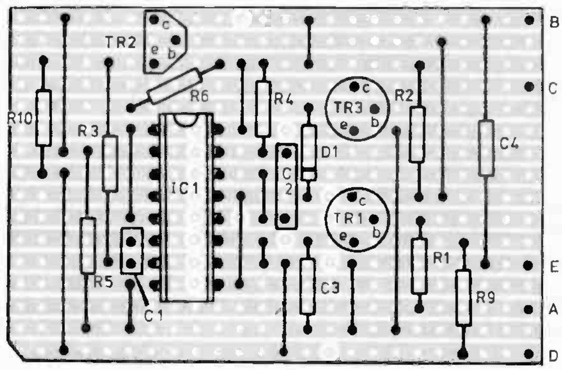


Fig. 3. Board layout

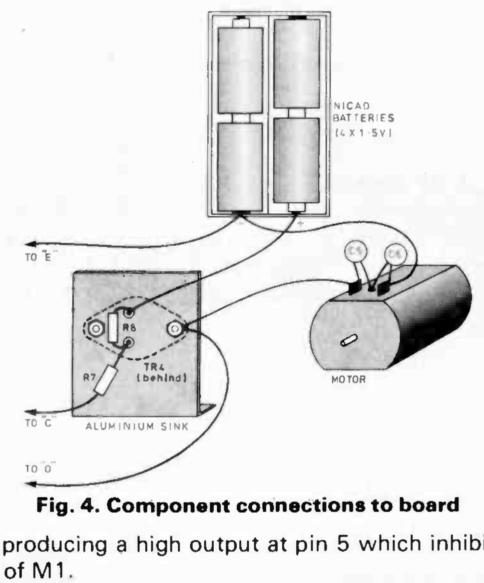


Fig. 4. Component connections to board

pin 13 of the i.c. and applies power to the motor via TR4, which is an AD142, chosen for its low saturation voltage at high current levels.

Diode D1 is provided to prevent the monostable output terminal from being held low by the base-emitter junction of TR3, and must be a gold bonded germanium component to ensure that TR3 turns off adequately when required.

When the power is removed from the motor inductive effects cause a negative voltage spike at the motor terminal D, as shown in the waveform diagram, so monostable M2 is provided to prevent re-operation of M1 until this back-e.m.f. has decayed and the voltage across the motor truly represents the vehicle's speed.

Separate Nicad batteries were used to avoid interference problems caused by the large surges of motor current and the sensitivity of the TTL monostables.

MONOSTABLES

The 74123 is a dual retriggerable, resettable monostable multivibrator providing an output pulse whose duration and accuracy is a function of external timing components.

There are two inputs per function, one active low and one active high. This permits triggering on either the positive going leading edge or negative going trailing edge of a pulse. Triggering is independent of input transition time or pulse width.

Since the switching voltage requirement for silicon is higher than the germanium with no pulse output from M1, D1 conducts and TR3/TR4 remain off.

With a pulse output, D1 is blocked and TR3 conducts so that TR4 provides current to the motor.

To prevent the pulse period being extended with the appearance of the inductive spike, Q output is routed back to M2 producing a high output at pin 5 which inhibits the Q output of M1.

As can be seen from the waveform diagrams the pulse widths at M1 and M2 outputs have been preset by choice of R4-C2 and R3-C1 respectively, the pulse period being a function of the product of these.

CONSTRUCTION

All components except TR4, R7, R8, C5 and C6 are mounted on a piece of 0·1in x 0·1in Veroboard as shown. ★

readout

. . . a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Audio compass

Sir—A number of compasses have been, and are being, adapted to provide an audible signal for use by blind yachtsmen. However, none of these provide all the facilities that I, as a blind helmsman, would like to have incorporated into one device.

The device that I want would comprise the following: a unit which will generate an electronic signal indicating the boat's direction, detected by the strength and/or direction of the compass's magnetic field; a calculator-type keyboard to be used to enter desired courses and alterations to them; an audio output stage; and, at the heart of it all, a microprocessor to control and coordinate everything.

I have a good knowledge of programming and a basic knowledge of electronics. But I need help to design and construct this device. If you would like to help me with this, please contact me, preferably by telephone, 01-591 5491 (home) or 01-432 6277.

Kenneth C. Knowles,
3 Sheringham Drive,
Barking, Essex,
IG11 9AL.

CB v TV continued

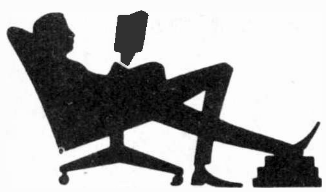
Sir—I read with interest your article "CB Radio" under Industry Notebook in the May edition of *Practical Electronics.*

While one is delighted at the content of the article with regard to the recognition of the TV receiver front end problem and the development of better systems, it is a pity that your last paragraph, re interference, is typical of the uninformed and hysterical comment in the electronic/radio press concerning CB Radio. Over the last year comments like this have caused concern to laymen and authority alike.

Of course the great mass of population would not take kindly to TV interference caused by CB Radio and rightly so. But before you spread alarm and despondency a little investigation on your part would have revealed that interference (or prevention of it) stood high on the list of priorities produced by the CB pressure groups. Indeed their call was for VHF/UHF spectrum with low power (2W) FM. Not the AM/SSB kilowatts on 27 MHz which has been responsible for the interference problem in other countries.

A. J. Cawthorne,
T.ENG(CEI). FSERT. G3TDJ.
Bude, Cornwall.

Nexus comments: "As a licenced amateur Mr Cawthorne will be aware of the problems of TVI and of controlling abuses of radio usage however well the regulations are framed and policed. We all start off with good intentions. If, in fact, CB users with kilowatt outputs do exist this proves the point. There is no reason to suppose that British CB enthusiasts, once they catch the bug, will be content with 2 Watts or even 20 Watts. Mr Cawthorne will also be aware that his fellow fully-licenced amateurs, supposedly responsible, are often tempted to abuse their conditions of licence. We cannot assume that CB enthusiasts with on-demand permits, no RAE, and no signed log-books, will be better behaved."



BOOK REVIEWS

IC 555 PROJECTS
By E. A. Parr
Published by Bernard Babani Ltd
141 pages 180 × 115mm. Price £1·45

ONE of the most versatile i.c.s available to constructors in recent years has been the 555 timer. This book explains the operation of the timer in detail and then describes the basic circuits that can be built around it.

Specific applications for the device are a collection of designs which have appeared in P.E. and other magazines and are given under four headings; model car, model railway, alarm and general circuits.

Variations of the 555, namely the 556, 558 and 559 which are the dual and two quad versions available are also briefly covered. Practical notes are given on how to construct the circuits with tables to determine the values of the timing capacitors. Many readers will find this book useful both for constructing the circuits and as a handy pocket reference book on the 555 timer.

D.J.S.

OP-AMPS; THEIR PRINCIPLES AND APPLICATIONS
By J. B. Dance
Published by Newnes Technical Books
88 pages, 135 × 215mm. Price £2·25.

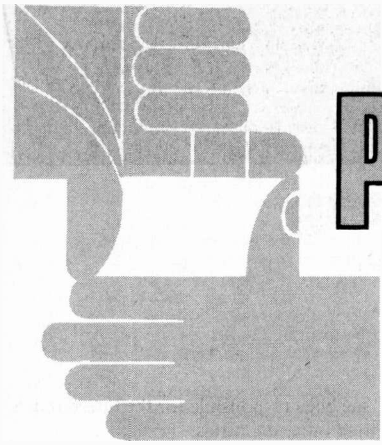
SO MANY books published have been along the same lines as this, and indeed on exactly the same subject, that it is perhaps better to stick to the bare facts.

The book has been written for the non-specialist engineer and home constructor. A non-mathematical approach has been adopted, and internal workings of devices area not discussed in any depth; only applications.

The initial three chapters are devoted to the 741 i.c., followed in Chapter 4 by external frequency compensation. Chapter 5 covers f.e.t. input op-amps, and the last two chapters go into i.c.s for audio applications. At the end of the book there is a glossary of op-amp terminology.

Although the original concept of operational amplifiers was that of performing mathematical operations, no devices for performing mathematical functions are included, as part of the author's aim of keeping the book at a simple practical level. There are clear and well printed working circuit diagrams throughout, each with component values given, and anyone seeking to understand operational amplifiers could do worse than read this material, which is an updated version of the *Electronics Australia* series "Op-Amps Without Tears."

M.A.



PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent **Price 95p each**

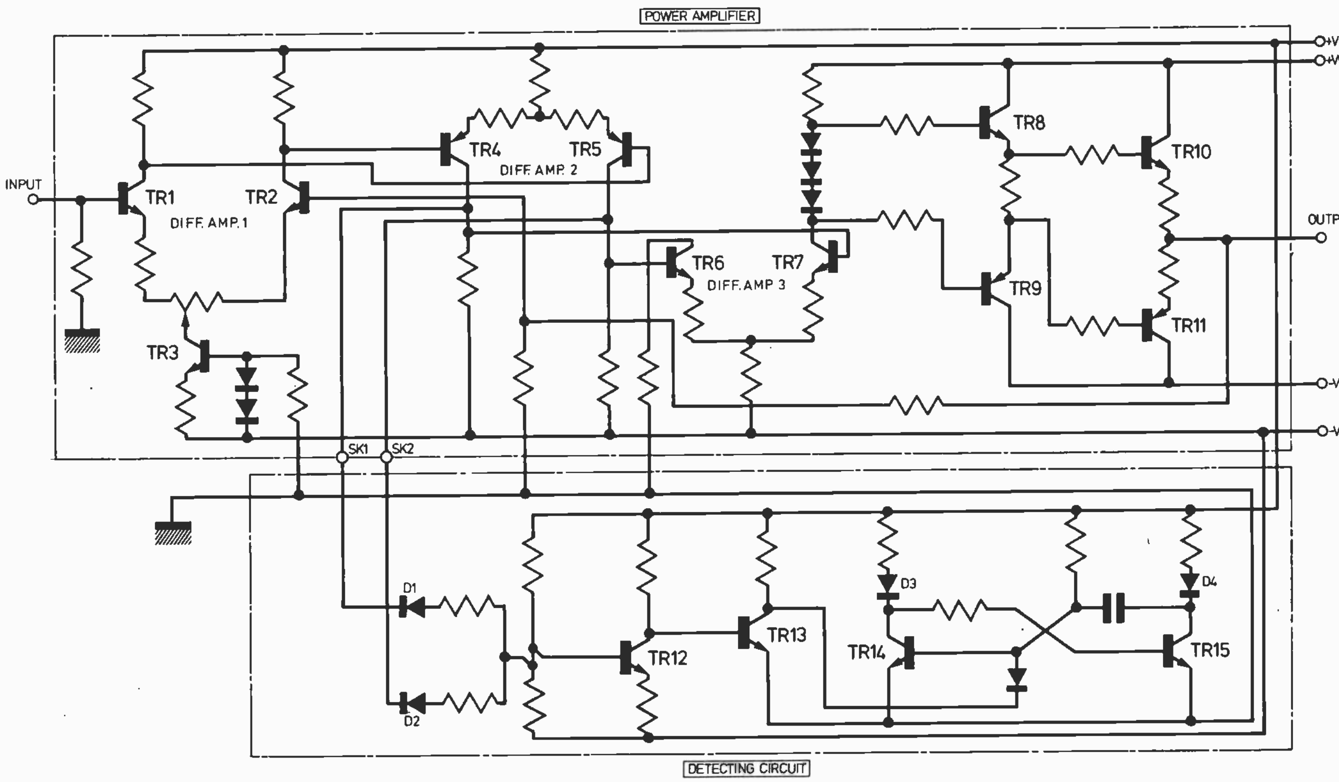
SIGNAL CLIPPING INDICATOR

The Sony Corporation has already patented (BP 1 439 241) protective circuit for shutting down an audio amplifier when the impedance value at its output falls below a preset value, for instance due to short-circuiting of the driven loudspeaker. Now, in BP 1 458 857, Sony describes a circuit which will indicate clipping of the output signal as, for instance, may follow from over driving the amplifier into distortion.

The circuit shows a power amplifier with three differential amplifiers (Diff. Amp. 1, 2, 3) and a push-pull output. The signal path from the output to the base of TR2 forms an in-phase negative feedback loop. Detecting terminals SK1 and SK2 are connected to the collectors of TR4, TR5 respectively of differential amplifier 2.

In normal operation, similar signals of a few volts are delivered to detecting terminals SK1 and SK2. Transistor TR12 of the detecting circuit is conductive, and hence TR13 is non-conductive. This causes TR14 of the monostable multivibrator to be conductive, and transistor TR15 non-conductive. As a result, the light emitting diode D3 is energised to emit green light which indicates that the power amplifier is operating normally.

When the amplifier is subjected to excess load or the load is short-circuited or the output signal is clipped, the voltages at terminals SK1, SK2 approach that of the voltage source $-V_{CC1}$ for the differential amplifiers. As a result, D1 or D2 is biassed to $-V_{CC1}$, TR12 goes non-conductive and TR13 conductive. D3 extinguishes and the red l.e.d. D4 illuminates, to indicate overload or clipping.

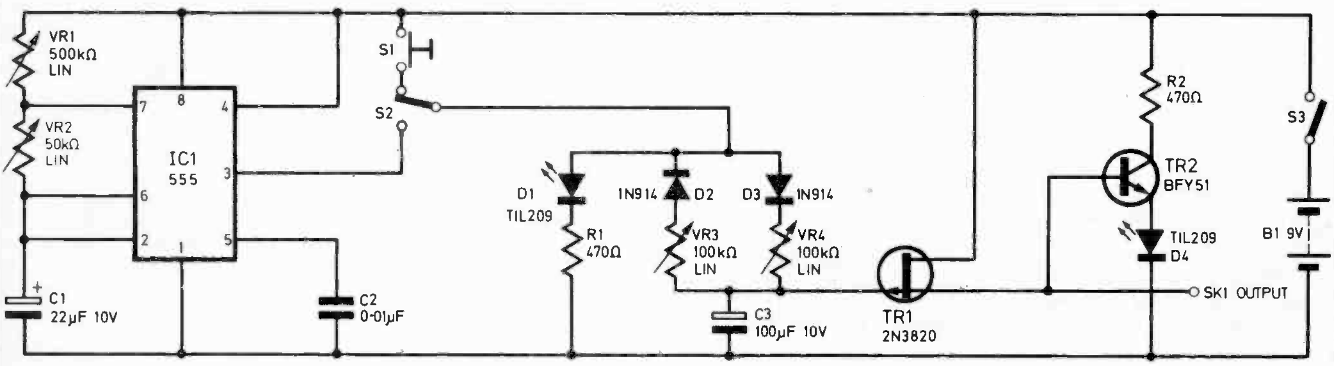


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.



ENVELOPE SHAPER

THE circuit shown above is for an attack/release envelope shaper with automatic triggering.

IC1 is a 555 timer connected in the astable mode with VR1 controlling the duration and VR2 the width of a pulse. No series resistors are used to enable maximum span and flexibility of operation. Automatic triggering is obtained by S2 with S1 used for manual triggering.

The pulse from the output of IC1 (pin 3) is fed via S2 through D3 and VR4 (which controls the attack time) and charges C3 which in turn switches on TR1.

When the pulse is finished C3 is discharged through VR3 and D2 to D1 and R1. The purpose of D1 and R1 is to form a discharge path for C3 and to indicate when a pulse is applied to C3. The discharge time of C3 depends upon the setting of VR3. As C3 gradually discharges TR1 is turned off.

The cycle of the envelope shaper is monitored by D4 which in turn is controlled by TR2.

To operate, the circuit requires 100 to 200mA and can be driven either by a 9V PP3 battery or a separate power supply unit.

Stephen Trouse,
Australia.

pH METER

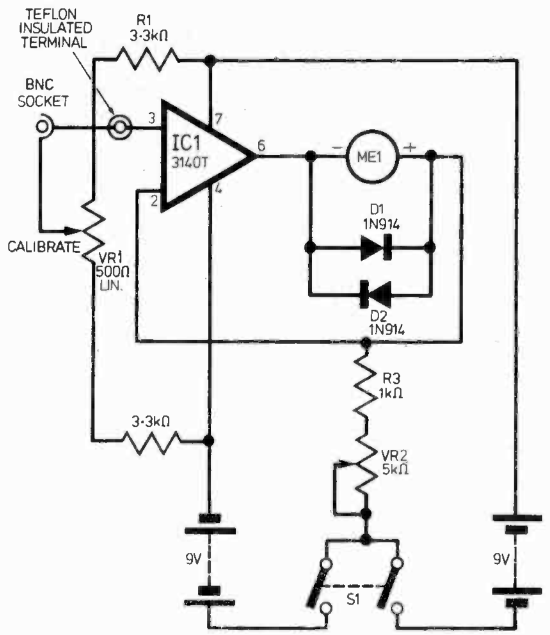
With only a few components, a modern pH meter (acid/alkali level) can be built using the relatively new RCA 3140T operational amplifier.

Stripboard is not suitable because of the close proximity of the tracks, and so the TO5 style op amp should be used with its leads spread out and terminated on a good quality p.c.b. with lead 3 of the i.c. soldered to a teflon insulated terminal. From there, a stiff bare copper wire should connect to the input socket.

The meter ME1 can be a cheap $\pm 100\mu A$ movement and it should be easy to re-mark the scale from 2 to 12pH, with 7pH at the centre (being neutral), or from 0 to 14pH. The unit can be powered from two PP3 9V batteries.

With the electrode in a pH7 solution (distilled water will do) adjust VR1 for a reading of 7. Now place the electrode in a buffer solution of pH4 (acidic solution for calibrating) and adjust for a reading of 4. An alkaline buffer solution (above pH7) could be used instead. The instrument is now calibrated. See P.E. March and April 1977 for pH theory.

Walter Hediger
Switzerland

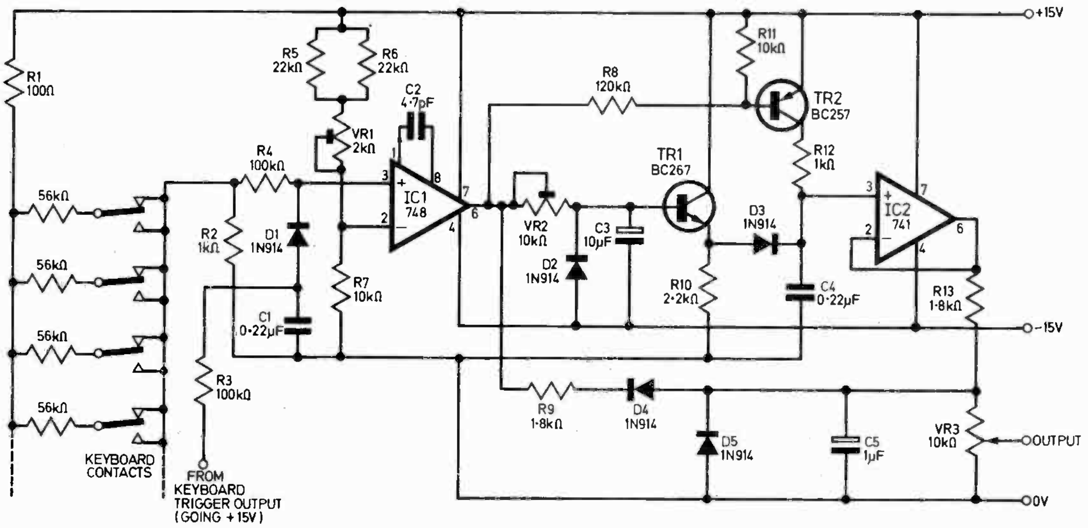


TOUCH SENSITIVE KEYBOARD

THE circuit described here was designed to provide a synthesiser keyboard with an additional control voltage output, whose magnitude is proportional to the velocity at which a key is struck. This voltage can, for example, be used to control the maximum aplitude which a note attains during the attack time to give the keyboard a piano-like feel, in that it is sensitive to how "strongly" the music is played.

The circuit, shown below, requires an extra set of changeover contacts on the keyboard. IC1 detects when any contact spring is touching neither of its contacts. Thus the output of IC1 will switch negative for a duration which is inversely proportional to the key velocity. During this time, capacitor C3 is discharged through VR2 to a voltage proportional to the key velocity. TR2, in switching on, charges C4 to a voltage governed by the charge on C3. The output is prevented from going positive at this time by D4 and D5. When the contacts remake, TR2 shuts off preventing any further charge on C4, whose voltage is now buffered by IC2 and passed to the output. C3 now re-charges ready for the next cycle. This sequence of events is prevented from re-occuring when the key is released by the keyboard trigger signal, which inhibits IC1 during this time. VR1 sets up the key detection circuit, and should be adjusted so that the output of IC1 gives a negative pulse when a key is pressed slowly. VR2 sets up the velocity/voltage relationship, and is adjusted to give the required output voltage range.

P. R. Williams,
Stevenage,
Herts.



CALCULATOR–DECADE COUNTER

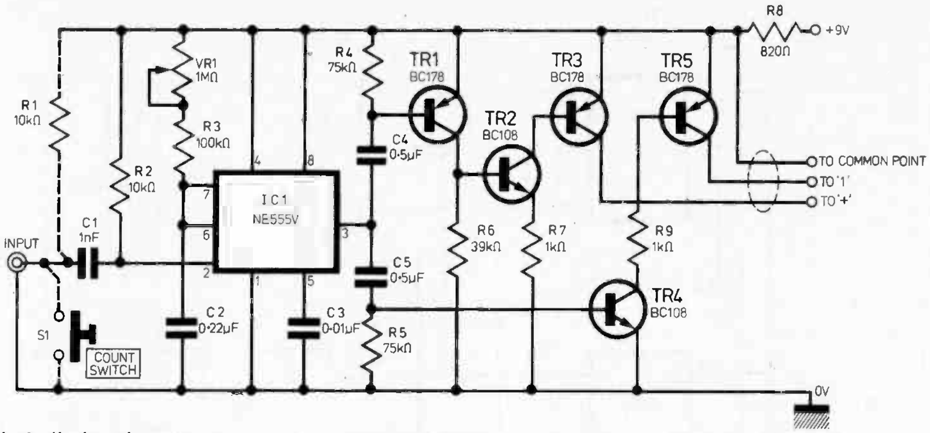


Fig. 1

A conventionally-built decade counter can be rather costly and complicated compared to a calculator with the same digit capability. However, by using the adding function, a calculator can be converted into a decade counter by entering the key sequence 1+, 1+, 1+, 1+, . . . etc. electronically. The corresponding display will then be 1, 2, 3, 4, . . . etc. The given circuit is designed for adding on to the CBM SR 7919D calculator, with part of the calculator circuit board shown, showing the three take-off points required (Fig. 2).

The circuit essentially consists of a monostable multivibrator driving two switching circuits. This circuit operates on an independent supply and it is advised not to decouple the supply with an electrolytic capacitor. When the monostable receives an input, it generates an output pulse of a given duration. The leading edge of this pulse triggers the "1" input while the trailing edge triggers the "+" input; forming the "1+" sequence for a single input.

The time delay of the monostable is made variable by VR1 so that it can be set just above the minimum duration at which the calculator counter will operate. Even then the time delay (time between the "1" and "+" input) shows to be quite high which means that the maximum frequency input is low. In fact in my set-up, the maximum counting rate is only about 4 per second!

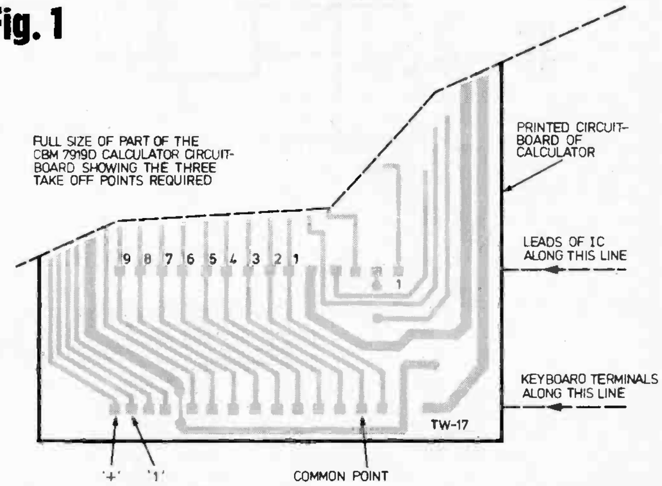


Fig. 2

This counter can be used in applications where low and extremely low counting rate suffices when the time out signal feature of the calculator can be utilised.

For example, by feeding a crystal derived 1Hz input, the counter can be used as a precision seconds timer. Similarly it can be used as a counter for registering the number of people entering a building, etc. by adding the resistor and switch as shown in dotted lines in the diagram.

Furthermore the calculator-counter may be connected to a conventional counter to increase its counting capacity. In this way the inherent low counting rate of the calculator-counter can be compensated. For example, the unit digit of the calculator-counter will become the thousand digit if appropriately connected to a conventional 3 digit counter.

Pek Yaw Kee,
Sarawak,
East Malaysia.

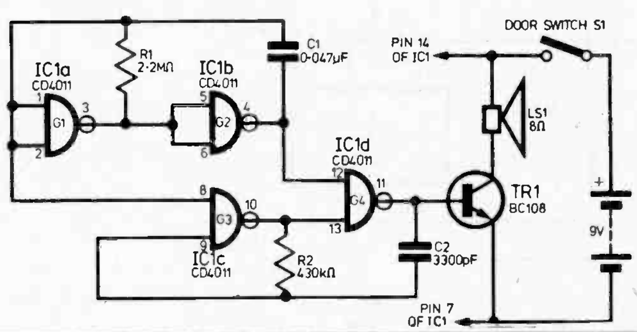
CMOS DOORBELL

This i.c. doorbell is built around a CD4011 nand gate package, using only a handful of readily available components, and forms two oscillators.

The basic tone for the bell is produced by the high frequency oscillator (G3, G4, R2 and C2), and is interrupted by the low frequency oscillator (G1, G2, R1 and C1). These component values can of course be varied to produce different interrupt rates or basic tone.

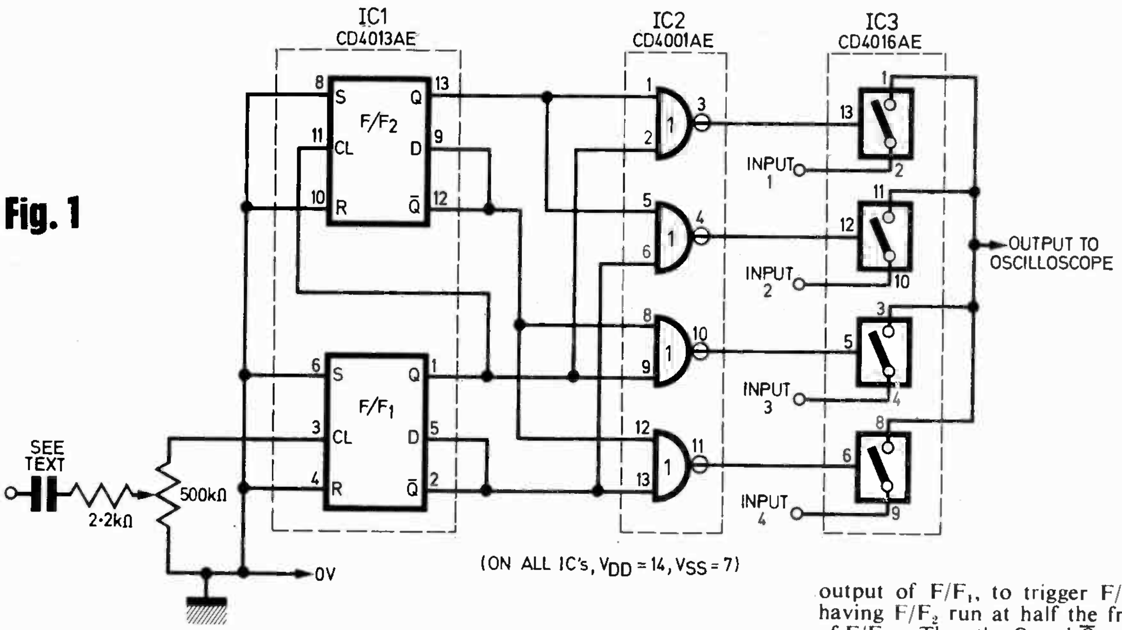
The output is fed to a BC108 transistor which drives an 8Ω loudspeaker, and a PP3 battery can be used to power the circuit. The prototype was housed in a plastics case measuring 116 × 80 × 35mm.

A. W. Cunningham, Glasgow.



TRACE MULTIPLIER

Fig. 1



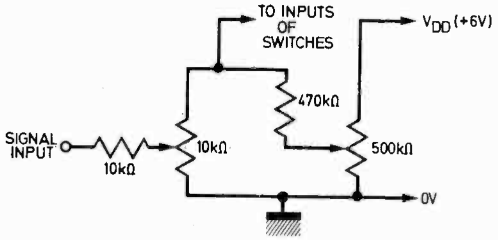


Fig. 2

This circuit, while using only three common CMOS i.c.s allows four separate signals to be displayed on a single beam oscilloscope with independent vertical position and amplitude controls. Instead of using an internal free-running oscillator, this circuit employs the sweep output of the oscilloscope to trigger the switches and therefore displays the first trace on the whole of the screen before displaying the second in the same way, the switch being triggered by the negative going pulse of the sawtooth wave from the sweep output as it moves back to the other side of the screen.

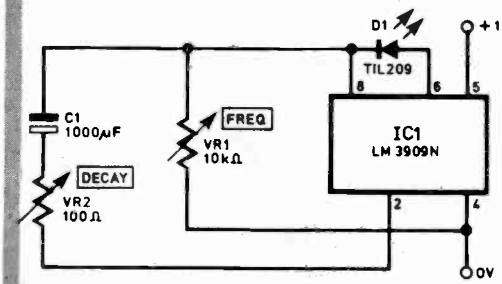
As the sweep output of most oscilloscopes often exceeds 50V, a series capacitor, series resistor and potentiometer are used to modify the wave and trigger flip-flop. Four sequential outputs are obtained by using the Q output of F/F_1, to trigger F/F_2, thus having F/F_2 run at half the frequency of F/F_1. Then the Q and $\bar{Q}$ outputs of both flip-flops are connected to the inputs of four NOR gates as shown, whose output only goes high when both inputs are low. The outputs of the four gates therefore go high in sequence and trigger the electronic switches which allow the four inputs into the oscilloscope one by one.

Each input, before reaching the switches must be attenuated to a useful amplitude relative to the others, and also must be given a different height on the screen to the other traces. This is achieved by the circuit in Fig. 2, which must be repeated for each input. For this reason, it is best to use preset potentiometers as eight normal potentiometers would cost more than the CMOS circuitry itself.

It may be necessary to use a different capacitor on the input from the oscilloscope's sweep output, but this depends on the voltage range of the output. We have found that a 0·02μF 200V capacitor works admirably where the sweep output is 100V peak-to-peak.

A. Hetherington,
Nevilles Cross,
Durham.

LED FLASHER



Flashing l.e.d. indicators are most often used to indicate a hazard. But there are times when a rather less insistant winking indication, would be appreciated, indicating to proceed at caution.

This circuit which uses an LM 3909N l.e.d. Flasher/Oscillator i.c., has a pulse frequency that can be varied by VR1, from 10–60 pulses per minute.

With the decay control VR2 set to zero, the time of each pulse of light from the l.e.d. corresponds to the discharge time of C1, this discharge time can be lengthened, by increasing the resistance by means of VR2, between the positive of C1 and pin 2 of the i.c. So that each pulse of light fades away instead of switching abruptly "off".

Decay time of up to 1 second can be obtained with the components shown. It should be noted that a long decay is not possible with a fast frequency.

M. Miller,
Reading,
Berks.

12v CONVERTER
for Weller TCP 1 & 2 Irons
D. J. BRADBURY

WHEN working on an automobile electrical system it can be very useful to have a soldering iron that will operate from the vehicle's battery. This relieves both the inconvenience and possible hazards involved in arranging external supplies such as a main extension lead.

The unit described in this article is a 12V to 24V d.c. converter designed to supply Weller TCP1 and TCP2 temperature controlled soldering irons from a standard car battery. The converter is housed in a small die-cast box which will also serve as a stand for the iron when it is not in use.

CIRCUIT DESCRIPTION

A 24V Weller iron consists of a 45 to 48W heating element in series with a magnetic "Curie" effect temperature switch. Because of this switch the iron only takes current when the soldering bit falls below its correct operating temperature. Thus to work efficiently the converter circuit must be able to supply 50W to the soldering iron and yet take minimal quiescent current when its load is open circuit.

The circuit shown in Fig. 1 achieves both these aims, operating at an efficiency of over 80 per cent whilst the iron is warming up and taking only micro-amps when the iron reaches its correct temperature.

When the circuit is connected to a battery and the soldering iron plugged in, bias current is fed to the base of TR1 via the transformer T1, diodes D1, D2 and the iron. This starts to turn TR1 on, causing its collector voltage to fall, enabling the transformer to increase the voltage applied to the load. The load thus biases TR1 on harder until the transistor finally saturates, giving a peak voltage of approximately 28V across the soldering iron.

While the transformer has a voltage across its windings, a magnetising current slowly builds up until the ferrite transformer core is saturated; it then rises rapidly as the core loses its high relative permeability. When the collector current of TR1 reaches about 10A, the transistor no longer receives sufficient base drive to remain saturated and so its collector voltage begins to rise. This causes the load voltage to fall, reducing the base drive of TR1 which further reduces the load voltage and by this feedback action the transistor is turned off.

When TR1 is turned off, its collector voltage rises rapidly above the supply due to the magnetising current flowing in the transformer. Also the output voltage of the transformer goes negative, reverse biasing diodes D1 and D2, so isolating the transformer from the load. The magnetising current causes the unloaded transformer to 'ring' for half a cycle at a frequency mainly determined by its inductance and the value of C1. The high voltage half cycle 'ring' reverses the flow of the magnetising current and as a result defines the length of time for which TR1 does not conduct.

This period must be kept short if the converter is to be efficient. However, the shorter the time the higher the voltage required across T1 to reverse the magnetising current. Since part of this voltage appears across TR1 a compromise was chosen for the converter that gives the

COMPONENTS . . .

Resistors

R1	1Ω 2·5W wirewound

Capacitors

C1	0·047μF polyester
C2	150μF 16V elect.

Semiconductors

D1, D2	ZS271 (2 off)
D3	1N5401
TR1	BD243B

Transformers

Length of 22 s.w.g. enamel covered copper wire
Bobbin (type DT2205, ITT Part No 52352B)
Ferrite pot core (type FX 2241, ITT Part No 52707B)

Miscellaneous

*4mm banana sockets (2 off)
*3 pin 1·5A Bulgin P430 socket
Diecast box 120 x 95 x 30mm
Support spring (Weller SK185, ITT Part No 66304X)
Funnel (Weller SK1527, ITT Part No 18668E)
FS1 Fuseholder Bulgin F55 with 5A fuse

*See text

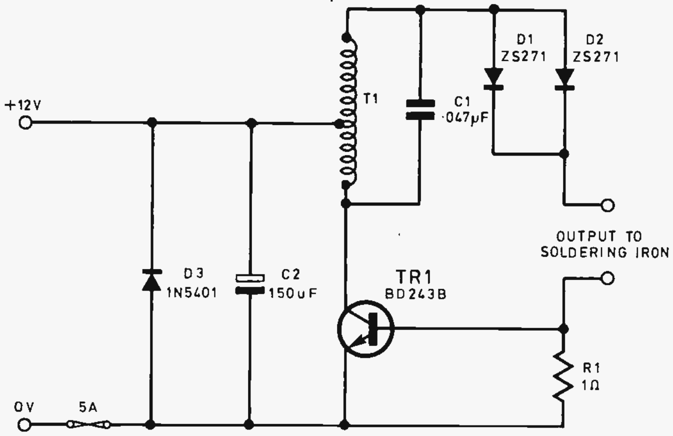


Fig. 1. Circuit diagram of the Converter

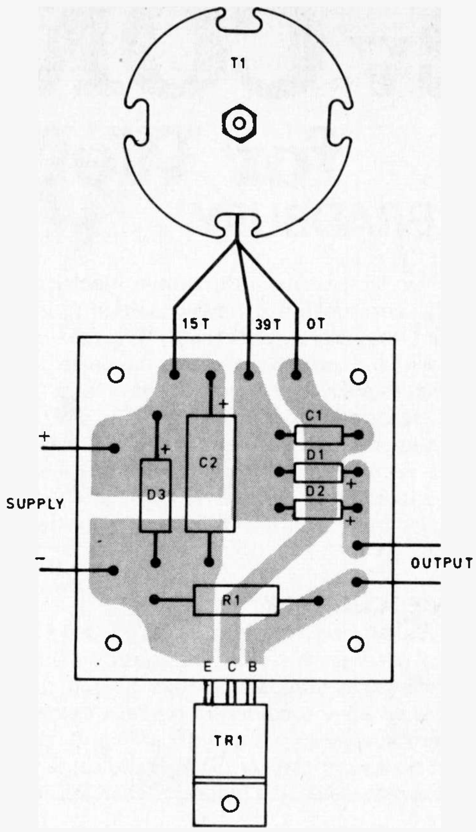


Fig. 2. Printed circuit board design

Fig. 3. Component layout and wiring diagram

transistor a peak collector-emitter voltage of 55V during its off period which lasts for about 25 per cent of the full oscillation cycle.

When the magnetising current flowing in T1 is finally reversed, the output voltage of the transformer swings positive and turns TR1 on again thus starting another cycle. The converter continues to oscillate in this manner, feeding 24V r.m.s. to the soldering iron until its working temperature is reached and the magnetic switch opens.

As the bias for TR1 is supplied through the load, when the temperature switch opens the converter ceases to oscillate. In this condition the only current taken by the circuit is the leakage in TR1, C2 and D3, the sum of which is very small.

When the iron cools, the magnetic switch will close, and so the converter will reheat the bit. The unit will thus operate intermittently, maintaining the soldering iron at its correct working temperature.

The diode D3 has been included in the circuit to protect the converter against reverse polarity connection to the battery. Normally the diode is reverse biased and so it draws little current from the circuit. However, if the supply connections are accidentally reversed the diode will take a heavy current and blow the 5A fuse before the converter circuitry is damaged. Although a series diode would have the advantage of saving the protection fuse if the battery polarity is wrong, it was not used in this case as it would have to pass a current of 5A under normal operating conditions and so for a silicon device would nearly double the power losses of the converter.

CONSTRUCTION

The prototype was constructed using the printed circuit board layout in Fig. 3 with the component overlay shown in Fig. 4. If the printed circuit board is to be traced, constructors should remember that the copper tracks will carry high currents and so it is recommended that the diagram is followed closely, keeping the tracks as wide as possible.

Once the board has been etched, cleaned and drilled, the components and lead out wires may be soldered. The supply input leads should be fitted with large crocodile clips for making connections to the battery. Although the power dissipation in TR1 is not very high, it is necessary to mount the transistor on the converter box to keep the device within its temperature ratings. To facilitate this, the transistor is soldered to the back of the printed circuit board with its leads left long so that they can span the gap between the box and the circuit.

The transformer for the converter consists of a 39 turn coil wound with 0·71mm dia. (22 s.w.g.) enamel covered copper wire mounted inside a 30mm dia. ferrite pot core. The coil should be neatly wound in layers on the plastic bobbin with a tapping taken 15 turns from the start of the winding. As the converter oscillates at a frequency of about 4kHz, the transformer can be the source of an annoying audible whistle. To minimise this, when assembling the pot core halves smear a thin layer of grease on the mating surfaces to dampen core vibrations.

The transformer is fastened to the converter box using a 1in. long countersunk 2BA bolt with nut and spring washer. The spring washer should be placed between the box and the transformer as in this position it acts as a vibration insulator. Do not overtighten the retaining nut as no advantage is gained by doing so and it could result in breaking the brittle ferrite cores.

The 120 × 95 × 30mm die-cast alloy box used to house

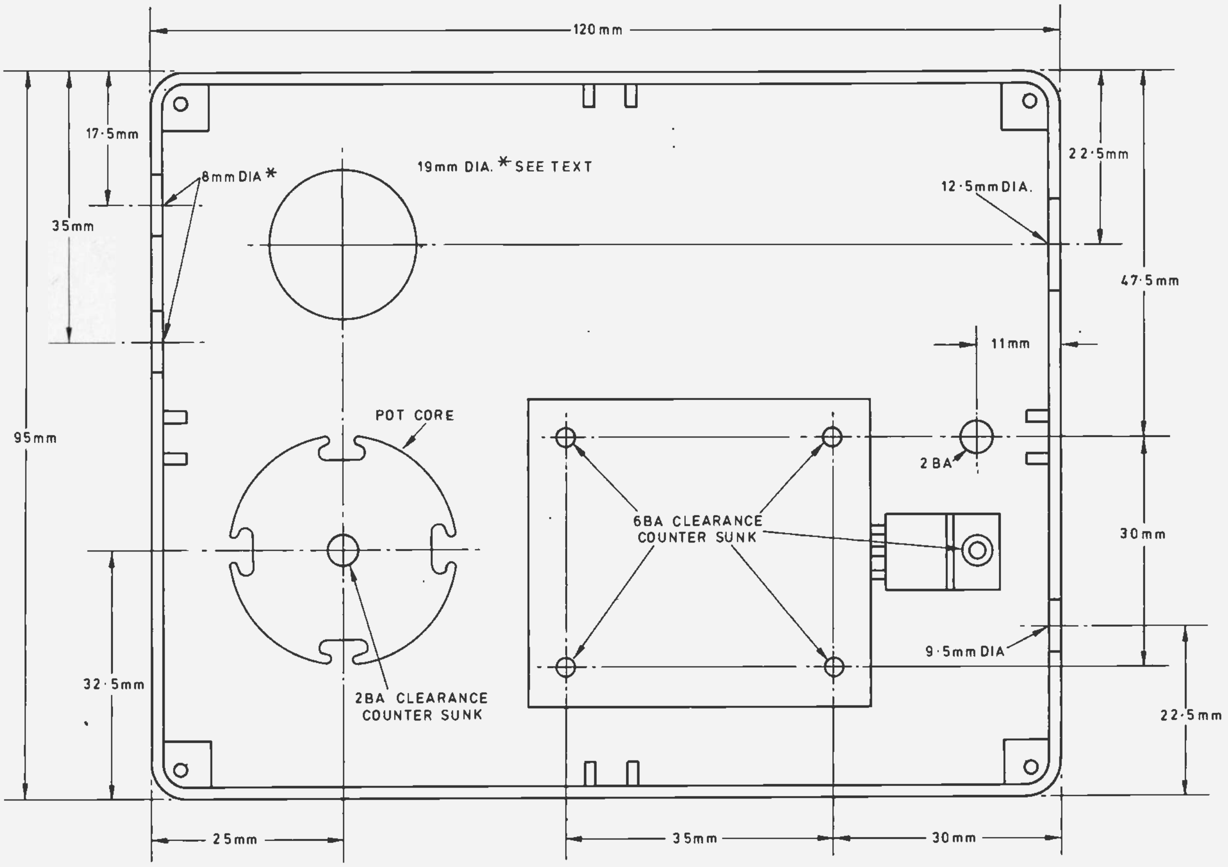
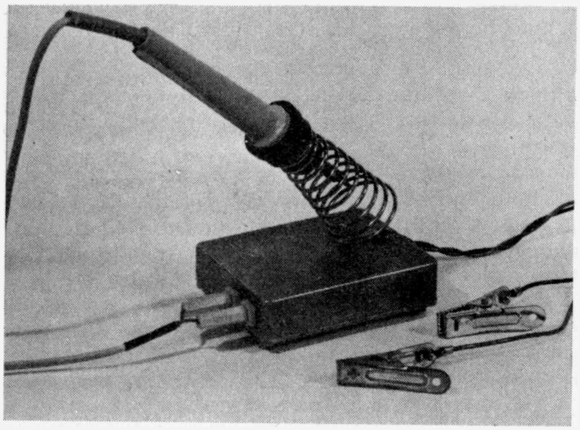
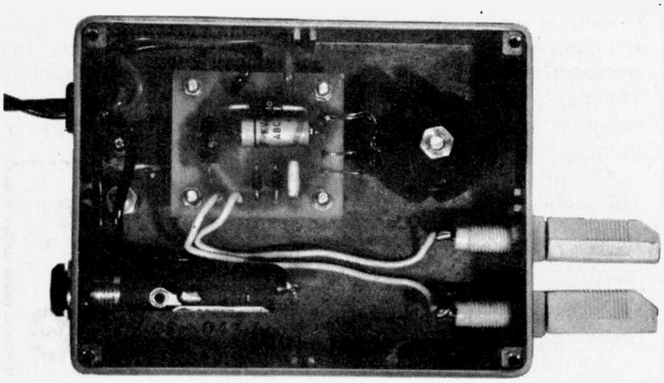


Fig. 4. Case drilling and mounting details





the converter was drilled to the dimensions shown in Fig. 4. Since the two Weller irons have different connector arrangements the diagram includes the holes for both types of sockets.

The position of the hole to mount TR1 is not given in the diagram as it will depend on how the transistor was soldered to the printed circuit. The correct location can be found by placing the component board in position inside the box and marking the hole through the transistor tab after having checked that the device is lying flat. When the transistor is mounted it should be electrically insulated from the box by using a mica washer and plastic bush.

TESTING

Having completed the converter and checked its wiring, plug in the soldering iron and connect the unit to a 12V battery, being careful to observe the correct polarity. The converter should emit a soft whistling sound and the following voltages may be measured from the negative end of C2 using a moving coil voltmeter. TR1 collector +12V, TR1 base +0·8V, soldering iron output +20V.

If there are any serious discrepancies in the voltage readings, disconnect the battery and recheck the converter for faulty components, dry joints and wiring errors. In cases where the converter cannot be heard to oscillate and all the voltage readings are zero, check the fuse and the battery polarity. Never use fuses rated at more than 5A or those with "slow blow" characteristics as they may result in damage to D3 or TR1 under fault conditions.

If the converter is operating correctly it should oscillate for between 1 and $1\frac{1}{2}$ minutes from switch-on, after which time the soldering iron will have reached its working temperature and the soft whistle will cease. The converter may be occasionally heard as it reheats the bit. ★

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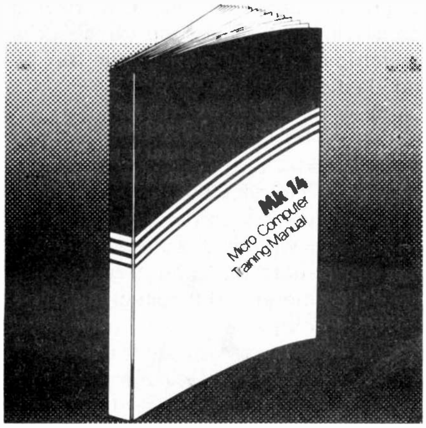

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Phil Pittman, Wireless World, Nov. 1977.

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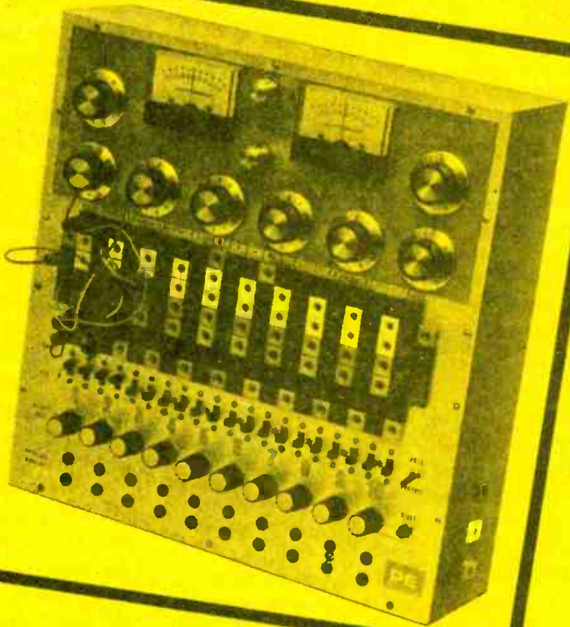
NEXT MONTH!

ANALOGUE COMPUTER

This analogue computing system which is capable of solving differential equations faster than its digital counterpart has the advantage of being easily programmed irrespective of equation complexity.



Electronic COMBINATION LOCK

Suitable for use in either home or garage, this mains operated combination lock employs four decade switches and a double entry code for increased security.

METRONOME...

In addition to providing a variable beat tempo adjustable from 33 to 220 beats per minute, this unit gives an emphasised beat at the beginning of a bar for the common musical time signatures.

PRACTICAL
ELECTRONICS

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, 11 AUGUST, 1978

Semiconductor UPDATE...

FEATURING MD4301 AD3500

R. W. Coles

ALARMING DEVELOPMENT

One of the problems of using modern large scale integrated circuits is that we, the users, have become obliged to surrender a lot of our design independence to the semiconductor manufacturers.

To ensure volume sales of their chips, the manufacturers tend to build devices which are aimed at the widest possible market, and we, as willing customers, have had to forego some of the "oddball" applications that we could indulge in when using discrete transistors and individual amplifiers or logic gates.

Of course, a ray of hope *is* visible in the shape of the microprocessor, but unless you happen to be a confirmed "Micro-nut" there are still many fearsome obstacles to deflect you from *that* path, not least the cost of it all.

When you think about it, the bastions of the LSI industry are calculators, clocks, microprocessors, voltmeters, and TV games, and precious little else. Not exactly a fertile ground for the amateur who wants the benefits of LSI but who can cope with only so many variations on the digital clock theme before trading the whole lot in for a pair of beam-tetrodes and a 50-Watt soldering iron!

The point I am trying to make is that any *original* large scale integrated circuits that do turn up deserve a rousing welcome from our beleaguered band, and this month I have managed to turn up a beauty!

I refer to the **MD4301,** from the Canadian firm of Mitel, (no—don't groan, you can get them from Rastra Electronics Limited!), which is unassumingly labelled a "CMOS Alarm Circuit." Inside its tiny fourteen pin plastic package, the MD4301 has an amazing array of odds and ends which enables it to act as, among other things, a complete fire alarm system with all the practical bits and pieces you would design in yourself, given the chance.

There is a comparator circuit, which will trigger an alarm condition for a 150mV voltage differential between its two inputs.

There is an audio oscillator which is turned on by an alarm condition, a 300mA switch output to drive a horn or siren, and a separate pulsed l.e.d. driver for local power-on indication.

There is also a "low-battery" detector which gives an unobtrusive but hard to ignore output of 50 milliseconds each minute on all alarm outputs when the battery voltage gets too low for comfort, (which shouldn't be too often, because the standby battery drain is a miserly 25 microamps!)

There is an alarm trigger "in" and "out" which allows any number of MD4301 circuits to be cascaded so that any one active unit can trigger all the others for a full scale fire alert, and other variations and options too numerous to mention.

To use the MD4301 in a self contained fire alarm system, you need only hook it up to an ion chamber smoke detector cell, a nine volt battery, a horn or siren and a few discrete components. A much more exciting and useful prospect than building yet *another* digital clock!

3½ IS TWICE AS GOOD AS 3

Some time ago I featured a 3 digit single chip voltmeter device in this column, and suggested that the traditional moving coil meters with their inherent fragility and accuracy limitations would soon be losing ground to the newcomer. A new chip from National brings the demise of springs and jewelled bearing even closer. They have managed to cram a complete 3½ digit voltmeter system on to a single LSI chip, a system which up to now had taken at least two chips, and usually many more, to implement.

A 3½ digit display is actually twice as good as a 3 digit display because you get a full scale output of 1999 instead of 999, double the dynamic range and precision of earlier single chip systems.

The new chip is coded **AD3500** and it contains not only the digital conversion circuitry but also the l.e.d. segment drivers, the system clock and the analogue "front end".

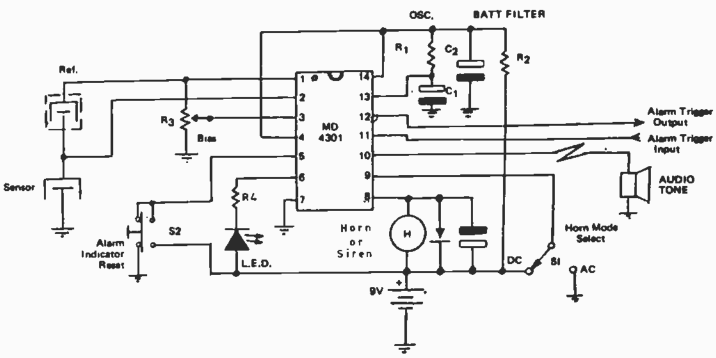
The chip uses low consumption CMOS technology and runs from a single plus five volt supply, so building a digital multimeter with the AD3500 should be child's play!

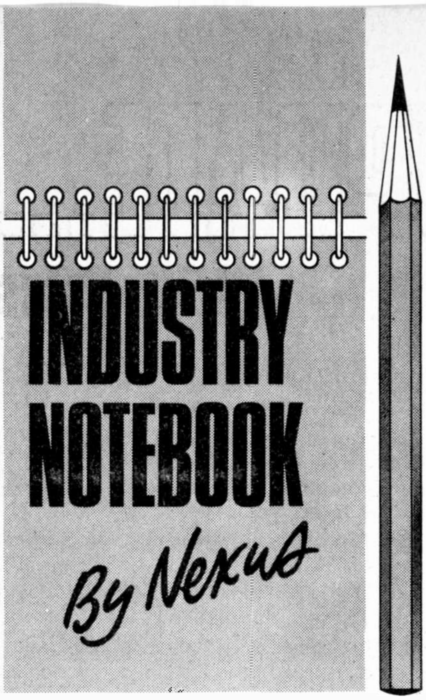
To build a complete voltmeter all you need to add (apart from some kind of power source) is an l.e.d. display, a low cost 75492 digit driver, a voltage reference, and a handful of discrete resistors and capacitors—the whole thing could be fitted on to a circuit board about 8cm square.

The addition of a range switch and a few extra resistors would allow a full complement of voltage and current ranges, and with a constant current source added, resistance ranges would be possible.

If you wanted to be really cunning, you could use the over-range outputs provided by the AD3500 to control an auto-ranging system which did the range changing for you using reed relays or solid state analogue switches, very useful for hands-free trouble shooting!

In terms of accuracy, the new device beats the moving coil meter hands down with a ±0·05 per cent specification. You will probably degrade that figure with your external components of course, but the traditional meter is hard pressed to deliver even 2 per cent accuracy!





The Pay-Off

Further to my recent reports on overseas investment, especially in the United States, it is worthy of note that Racal has now formed a Data Communications Group headed up by D. Leighton Davies. Leighton, a B.Sc.(Hons) graduate from the University of Wales, was ten years with Solartron and in senior positions with GEC Computers and Automation, and STC, before becoming managing director of Racal-Milgo Ltd in 1969, then a tiny UK operation owned 50/50 by Racal in the UK and Milgo Inc in the USA. It was virtually a marketing company set up to exploit Milgo products outside the Americas.

First-year turnover was in the tens of thousands of pounds. Now, less than ten years later, Leighton heads up a wholly British-controlled data communications group of world standing with a predicted £75 million profitable turnover in the current financial year and operating from manufacturing, systems engineering and marketing bases in Reading, Frankfurt, Tokyo, Miami and Sunnyvale, and through an associated company in Rio de Janeiro and Brazilia. The present huge boost in turnover came from Racal's recent acquisition of Milgo Inc and Vadic Inc in the USA and further acquisitions are being sought.

Just one example explains what overseas investment is all about. Racal-Milgo Inc, Miami, Florida, has just signed a contract with Eastern Airlines for a System 200 Management Centre to streamline Eastern's data network covering 300 locations in North America and the Caribbean. As well as the Management Centre (which monitors and controls a network of up to 16,256 communications devices and modems on as many as 64 channels) the Eastern Airlines contract includes orders for hundreds of high-speed modems. No British company confined to a UK base would have been considered for such a contract, let alone win it. The Eastern Airlines contract plus many others in the US is a pay-off for Britain.

It works in reverse, too. North Thames Gas would not have bought £120,000 of equipment to improve its data links from a company based solely in Miami, Florida. But North Thames Gas were very happy to contract with Reading-based Racal-Milgo with its full local engineering support, even though a percentage of the equipment is built by the now British-owned Racal-Milgo in the USA. For this type of business you need to be on the spot.

Outlook

Public opinion polls are not invariably reliable but a recent poll of electronics goods manufacturers has shown a downturn in optimism (as distinct from downright pessimism) on future prospects, especially in exports in the capital goods sector where a number of respondents are clearly suffering the effects of stronger foreign competition. Paradoxically, except for the hard-pressed consumer sector, the great bulk of returns showed increased business and general buoyancy. Best sector of all is automatic test equipment (ATE) with a boom in the home market, perhaps because of the shortage of good test engineers as well as their cost, and of course it is much easier to introduce labour-saving equipment into the progressive electronics industry than into moribund industries where job protection is a worker obsession, perpetuating out-moded processes.

Apropos my remarks in earlier paragraphs on overseas investment, there is still plenty of movement at home too. Racal, already mentioned, is spending £1·5 million on microelectronics development, Pye has just completed a £5 million complex housing 1,200 workers for mobile radio, Decca Communications has acquired the whole of the h.f. radio business of Granger Associates of California, and English Electric Valve has added 100,000 sq. ft. of manufacturing space through purchase of the former Marconi-Elliott i.c. plant at Witham, Essex.

Poland Buys British

The controversial Polish order for British shipyards, heavily subsidised by the taxpayer, has turned up trumps for Redifon who landed the contract for all the electronics packages on the 22 ships involved. Redifon has undertaken to plan and commission all the equipment, together worth many millions. For starters Redifon will supply 44 of their new R1000 Series communications receivers worth, possibly, £5,000 or more each, and this is just the fringe.

Decca Marine has also done well in the Polish market recently by contracting £330,000 worth of Decca Navigator receivers and plotters to the Polish fishing fleet operating in the Baltic. There are now some 500 Polish ships fitted with the Navigator. The Japanese have also recently contracted to expand their Decca Navigator coverage with new chain stations so that all four major Japanese ports will now have Decca coverage.

Employment

I note that the IEE Annual Report comments on the scale of recruitment advertising in the past year, so high that special recruitment supplements had to be issued with the Institution journals. Anticipated revenues from situations vacant adverts were handsomely exceeded and a total of £1,000 a day was received in the year from this source.

The shortage of engineers is tending to push up salaries and I notice far more firms offering posts in the £5,000–£7,000 bracket than formerly. But is this enough when one reads that a London bus driver can make £6,000 a year plus perks like free travel? Glancing through the ads the cash plums are still overseas provided you can put up with the climate and general conditions. Up to £21,000 in Libya, £20,000 in Iran, £18,000 (tax free) in Saudi Arabia.

Such salaries are only for senior people with long experience on major products but even scaled down to average engineer level it seems overseas salaries in the Middle East are still more than twice that which can be earned at home and nearly all carry tax concessions.

More of the gentle sex are entering engineering but it is still a mere trickle. Of 190,000 chartered engineers registered in the UK there are only 200 women, less than half of whom work in industry. Of the women I note that the three senior ladies on the secretariat of the Electronic Engineering Association are all designated in the Annual Report as Ms whereas none of the men, not even the Director, is dignified by Mr.

More on Mats

The French company Thomson-CSF is also in the field of mobile automatic telephones (MATS) and claims to have 8,000 subscribers world-wide using their equipment linked to public or private telephone exchanges. Their new microprocessor-controlled car telephone has a capacity of 16 pre-programmable numbers of up to 24 digits each. There is clearly going to be keen competition for this fast-growing business.

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

SCOPE FOR GRAPHICS

OSCILLOSCOPES were used for troubleshooting with the earliest computers, and so it is hardly surprising that they soon became permanently connected as a convenient way of displaying drawings produced under computer control. Since then the CRT has remained the most widely used peripheral for high-speed graphical output.

An oscilloscope can only display a single point at a time, so to present a line or a picture it is necessary to refresh the scope by repeating the same sequence of movements of the spot over and over again; at least 30 times a second if the picture is to be seen without flicker. There are two main ways of controlling the spot from a computer, and both will be covered here. One is to store the co-ordinates of every point to be displayed in memory, and use these to drive the display. The other method is to generate the individual point co-ordinates as they are to be displayed from a "display file" which contains shorthand commands for drawing lines, circles, characters, etc. A program illustrating this approach will show how lines can be generated given the co-ordinates of their endpoints.

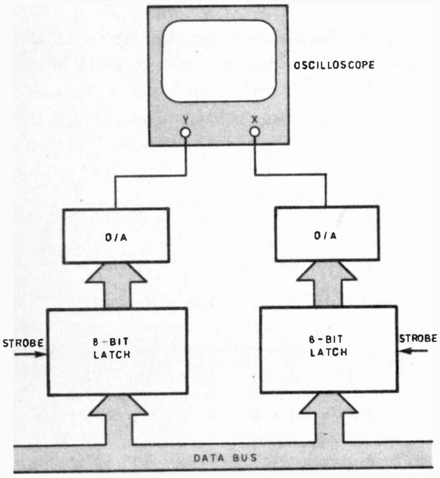


Fig. 1. Block diagram showing the circuitry needed for a microprocessor-controlled graphics display using an oscilloscope.

SCOPE INTERFACE

The configuration needed to control a CRT from a computer is shown in Fig. 1. The two D/A converters determine the number of possible point positions; with two 8-bit D/A converters one can display any point on a 256 × 256 grid. The outputs of the D/A converters drive the X and Y inputs of the scope, and these should be d.c. coupled. Since there is no need for timebase circuitry or for sensitive input amplifiers it should be possible to construct a suitable display quite simply. The prototype used two Ferranti ZN425E 8-bit D/As, and these were interfaced to the microprocessor by two 8-bit latches and some addressing circuitry; alternatively a MC6820 PIA could have been used.

The program in Fig. 2, which is for the M6800 micro, illustrates the method of generating a display from the co-ordinates of every spot position. BUFFER is the address of the list of co-ordinates, and with the list shown the program will display a short diagonal line from (0,0) to (4,4). In this and the next program the D/As are assumed to be located at addresses $8100 and $8101. If a PIA is used to interface them with the micro a few instructions will have to be added at the start of the programs to configure it correctly.

```
                      NAM    DRAW
                *  DISPLAY COORDINATE PAIRS FROM MEMORY *
                *
     8100       XAXIS  EQU    $8100     D/A OUTPUT
     8101       YAXIS  EQU    $8101     PORTS
                *
0000 0002       NEWPR  RMB    2
                *
0002 CE 0018    DRAW   LDX    £BUFFER
0005 A6 00      NEXT   LDA A  0,X
0007 E6 01             LDA B  1,X
0009 B7 8100           STA A  XAXIS
000C F7 8101           STA B  YAXIS
000F 08                INX
0010 08                INX
0011 8C 0022           CPX    £BUFEND
0014 27 EC             BEQ    DRAW
0016 20 ED             BRA    NEXT
                *
0018 00         BUFFER FCB    0,0,1,1,2,2,3,3,4,4
     0022       BUFEND EQU    *
                       END
```

Fig. 2. Program for the M6800 which displays co-ordinate pairs from memory.

INTERPOLATION PROGRAM

This method of storing the co-ordinates of every spot position really eats up memory; to draw a square border around the screen would require about 2k bytes of memory (1,022 co-ordinate pairs). It has the advantage that any arbitrary drawing can be displayed; however most graphs and diagrams can be broken down into a number of straight line segments, so a far more economical approach is to store only the co-ordinates of the endpoints of the lines in memory, and generate the points in between as they are needed. Lines other than diagonals or horizontals and verticals cannot be exactly represented on a square lattice, so the program must generate the best approximation.

The program of Fig. 3 does just this—given the two endpoints of a line it generates the intermediate points. It has the feature that it needs no division or multiplication operations, so it can be used to generate fairly complex displays in real time. With the co-ordinate pairs shown at FIRST the program will draw a triangle between the points (0,0), (7,3), and (0,6). The first side of this triangle is shown in detail in Fig. 4: the approximated line is composed of three diagonal moves, (1,1), and four horizontal moves, (1,0).

PROGRAM FLOWCHART

The flowchart of Fig. 5 shows how the program works, and will help those unfamiliar with the M6800 to implement the algorithm on another micro. First of all the two unit vectors DIAGAB and SINGAB are calculated; some combination of these will make up the required approximation to the line. Each point of the line is generated from the previous point by adding either the diagonal move vector, DIAGAB, or the horizontal/vertical move vector, SINGAB. The choice of which to add is determined by the test variable TEST.

```
                      NAM    PLOT
               *
               *
     8100      XAXIS  EQU    $8100    D/A OUTPUT
     8101      YAXIS  EQU    $8101    PORTS
               *
0000 0002      NEWPR  RMB    2        POINTS TO COORDINATE PAIR
0002 0002      DIAGAB RMB    2        DIAGONAL MOVE
0004 0002      SINGAB RMB    2        SINGLE MOVE
0006 0002      TEST   RMB    2
0008 0001      TOTAL  RMB    1        TOTAL NO. OF MOVES
0009 0001      DOUBLE RMB    1        NO. OF DOUBLE MOVES
000A 0001      SINGLE RMB    1        NO. OF SINGLE MOVES
               *
000B CE 0098   ENTRY  LDX    £FIRST
000E DF 00     NEWLIN STX    NEWPR
0010 CE 0101          LDX    £$0101
0013 DF 02            STX    DIAGAB
0015 CE 0000          LDX    £$0
0018 DF 04            STX    SINGAB
001A DE 00            LDX    NEWPR
001C A6 02            LDA A  2,X      NEXT A,B PAIR
001E E6 03            LDA B  3,X      OF COORDINATES
0020 A0 00            SUB A  0,X
0022 24 04            BCC    APOS
0024 40               NEG A
0025 70 0002          NEG    DIAGAB
0028 E0 01     APOS   SUB B  1,X
002A 24 04            BCC    BPOS
002C 50               NEG B
002D 70 0003          NEG    DIAGAB+1
0030 11        BPOS   CBA
0031 24 09            BCC    AGEB
0033 36               PSH A
0034 96 03            LDA A  DIAGAB+1
0036 97 05            STA A  SINGAB+1
0038 17               TBA
0039 33               PUL B
003A 20 06            BRA    CONT
003C 36        AGEB   PSH A
003D 96 02            LDA A  DIAGAB
003F 97 04            STA A  SINGAB
0041 32               PUL A
0042 97 08     CONT   STA A  TOTAL
0044 D7 09            STA B  DOUBLE
0046 10               SBA
0047 97 0A            STA A  SINGLE
0049 1B               ABA
004A 44               LSR A
004B 5F               CLR B
004C 90 0A            SUB A  SINGLE
004E 97 07            STA A  TEST+1
0050 C2 00            SBC B  £0
0052 D7 06            STA B  TEST
0054 A6 00            LDA A  0,X
0056 E6 01            LDA B  1,X
0058 7D 0006   TESTM  TST    TEST     WHAT MOVE?
005B 2A 14            BPL    DOUBLM
005D 9B 04     SINGLM ADD A  SINGAB
005F DB 05            ADD B  SINGAB+1
0061 36               PSH A
0062 96 07            LDA A  TEST+1
0064 9B 09            ADD A  DOUBLE
0066 97 07            STA A  TEST+1
0068 96 06            LDA A  TEST
006A 89 00            ADC A  £0
006C 97 06            STA A  TEST
006E 32               PUL A
006F 20 12            BRA    OUT
0071 9B 02     DOUBLM ADD A  DIAGAB
0073 DB 03            ADD B  DIAGAB+1
0075 36               PSH A
0076 96 07            LDA A  TEST+1
0078 90 0A            SUB A  SINGLE
007A 97 07            STA A  TEST+1
007C 96 06            LDA A  TEST
007E 82 00            SBC A  £0
0080 97 06            STA A  TEST
0082 32               PUL A
0083 B7 8100   OUT    STA A  XAXIS    DISPLAY POINT
0086 F7 8101          STA B  YAXIS
0089 7A 0008          DEC    TOTAL
008C 26 CA            BNE    TESTM
008E 08               INX
008F 08               INX
0090 8C 00A3          CPX    £LAST
0093 27 03            BEQ    BACK
0095 7E 000E          JMP    NEWLIN
0098 7E 000B   BACK   JMP    ENTRY
               *
               *  DRAW A TRIANGLE  *
009B 00        FIRST  FCB    0,0,7,3,0,6,0,0
     00A3      LAST   EQU    *
               *

                      END
```

Fig. 3. Program for the M6800 to display lines from the co-ordinates of their endpoints.

The photograph of Fig. 6 shows a pentagram drawn by specifying the five corner co-ordinates twice each in the correct order, and illustrates the maximum complexity that can be achieved before flicker becomes intolerable. It is also possible to produce moving displays by inserting instructions at BACK to alter the co-ordinates in the "display file" between each sweep of the drawing. With slight modification the program could be used to calculate the path of a moving object, such as a tennis ball in a microprocessor-controlled game.

PROGRAMMING SWITCHES

Sometimes within a program one wants to jump to one of several addresses depending on the value of a variable. For example, a program might perform a different function depending on a number typed in or a key pressed; the "switch" routine would then cause a jump to the relevant section of code. In a high-level language like Basic or Fortran this function is achieved by a statement like:

GO TO N OF 50, 20, 45, 77, 12

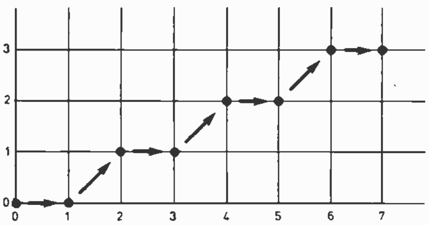


Fig. 4. Points generated by the interpolation program of Fig. 3 for the line joining (0,0) to (7,3). The initial values of the variables used by the program are shown.

where 50, 20, 45, etc. are labels in the program which will be jumped to if N = 1, 2, 3, etc. This can be implemented in machine code on a micro by means of a "jump table" containing the addresses of the various different routines.

The great variety of branch-on-condition instructions available in the M6800 micro makes possible the unusually compact "switch" shown in Fig. 7. LABEL 0 to

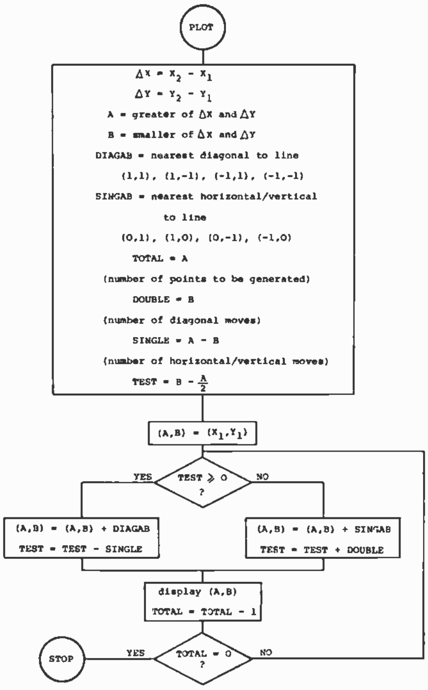


Fig. 5. Flowchart showing the operation of the main section of the interpolation program in Fig. 3.

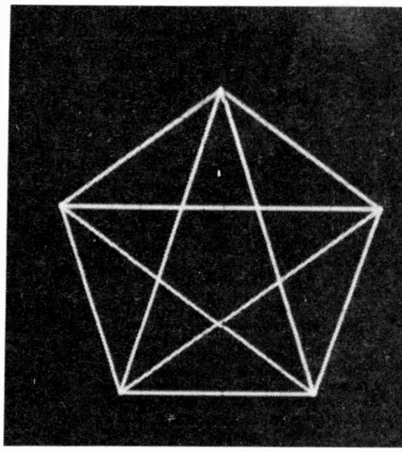


Fig. 6. Pentagram display generated using the interpolation program described in this article.

```
                      NAM    SWITCH
               *
0000 B6 0100   SWITCH LDA A  N
0003 06               TAP             PUT A IN STATUS
0004 25 08            BCS    XX1
0006 2E 0E     XX0    BGT    LABEL0
0008 26 2C            BNE    LABEL2
000A 28 4A            BVC    LABEL4
000C 20 68            BRA    LABEL6
000E 2E 16     XX1    BGT    LABEL1
0010 26 34            BNE    LABEL3
0012 28 52            BVC    LABEL5
0014 20 70            BRA    LABEL7
               *
```

Fig. 7. Eight-way switch for the M6800, achieved by putting the control variable into the status register and testing its effect on the condition codes.

LABEL 7 are the eight addresses which are branched to for values of N from 0 to 7 respectively, giving an 8-way switch. In this example the addresses are assumed to be $10 bytes apart at $0016, $0026, $0036, etc.

Constant Display FREQUENCY METER

J. BECKER

AN ELEMENTARY PIECE OF WORKSHOP OR LABORATORY EQUIPMENT

IT is often undesirable to engage an oscilloscope or other versatile apparatus to merely monitor frequency, and to this end the "Constant Display Frequency Counter" specification has been kept simple. The unit is not crystal controlled, but uses an elementary low frequency oscillator which necessitates far less dividing down circuitry, the whole unit thus comprising just a few readily available components. This would be an encouraging project for the beginner.

CLOCK GENERATOR

The 1Hz clock signal is produced by IC1a (see Fig. 1), whose rate depends upon C1, VR1 and R1. The pulse width generated is about 45ns. and this enables the system to "read" the count almost instantaneously.

The monostable IC1b is repetitively triggered by the output from the multivibrator to produce pulses of about 70ns, controlled by C2 and R2, and which in fact occurs fractionally afterwards due to propogation delay in the i.c. of about 20ns. This second pulse is used to reset the counter at the end of each cycle.

DECADE COUNTERS AND LATCHES

The input pulses to be counted are amplified and shaped by TR1 and fed to a series of decade counters (IC2–6), each of which successively divides the signal by 10. Each group of four outputs from each of the decade counters is taken, BCD fashion, to the Data inputs of the quad-latch i.c.s, IC7–11.

When the clock inputs of the latch i.c.s are held at a logic zero, the outputs remain in their previous logical states, but at the clock input positive excursion to logic 1, the ouputs follow the logic states of the Data inputs. Consequently the outputs from IC2–6 will effectively be ignored by IC7–11 until they receive the "read" pulse from IC1a, at which time, and for the duration of the pulse, the latch outputs will follow the logical states of the decade counters. Upon cessation of the "read" pulse the gate outputs will hold their new logical states and ignore further changes at their Data inputs—until they receive the next "read" pulse!

DECIMAL DECODERS AND DISPLAYS

Following the latches, IC12–16 are decoders providing outputs suitable for the numeric displays X1–5. The outputs from the decoders logically follow the outputs of IC7–11 and will only change state when these change state, thus each indicator will continue to display a particular number until the latches alter outputs.

The decade counters are reset at the start of each cycle by the arrival of the pulse from IC1b approximately 20ns after the "read" pulse from IC1a. The result is that if the same number of pulses is counted by a particular decade stage in two or more consecutive sampling cycles, then the relevant display will not change its number, and will only do so if a consecutive count is different from the previous one. Thus if the frequency stays the same the display will appear to be static even though the sampling is still continuing once a second.

POWER SUPPLY

The a.c. voltage from transformer T1 is rectified by D1–4, and the d.c. ripple is reduced by C4. IC17 reduces and stabilises the main power rail to a nominal 5V. d.c. It is internally protected against thermal or current overloading, and if overloaded will automatically shut itself off until the cause is

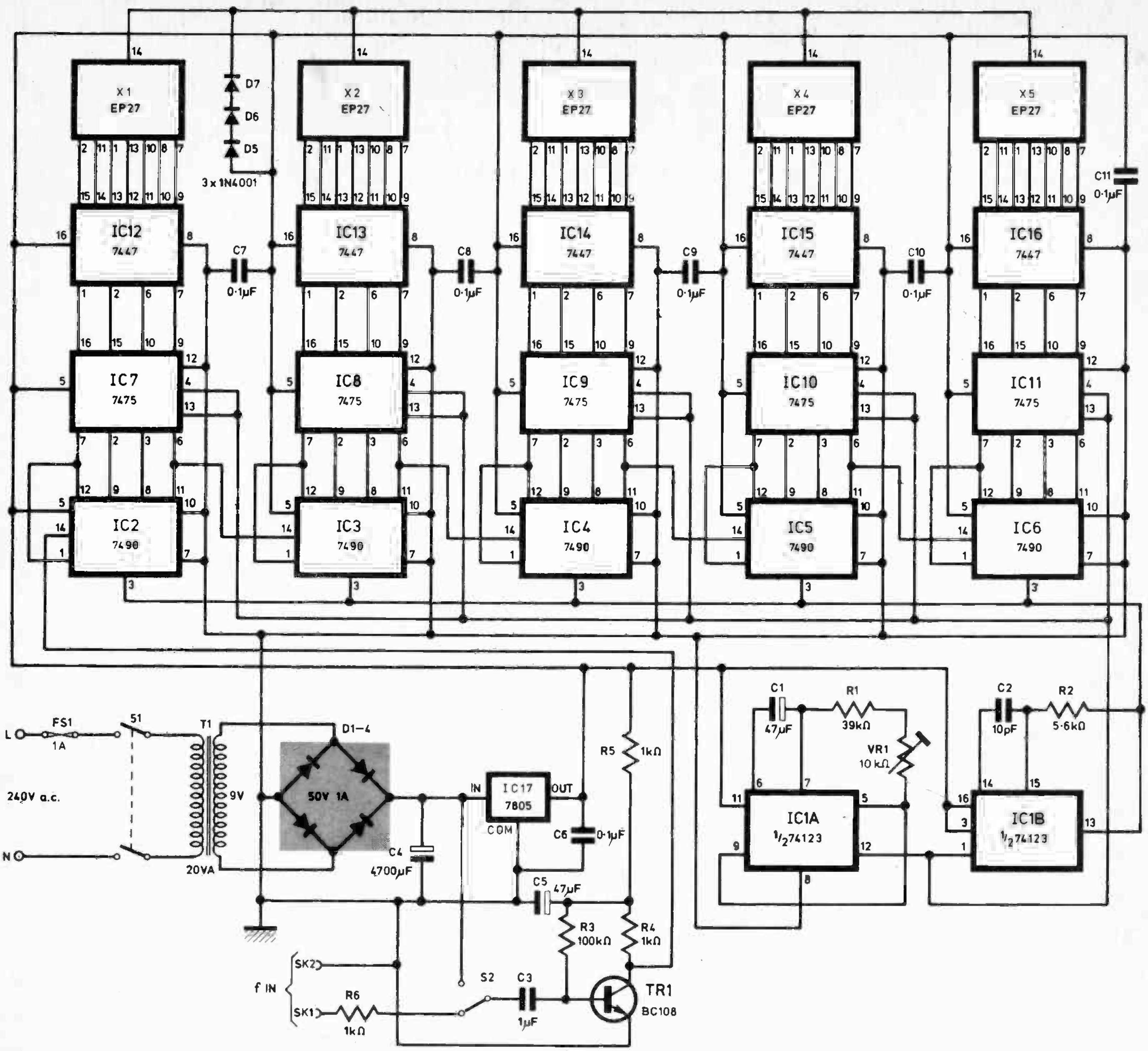
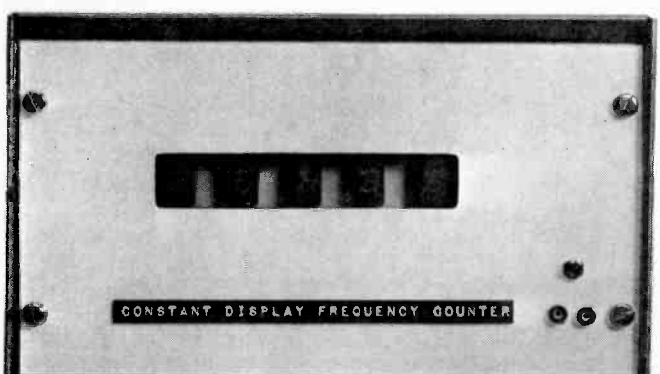
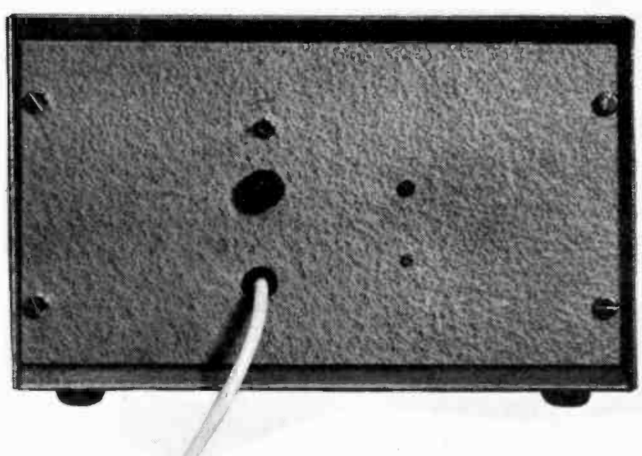


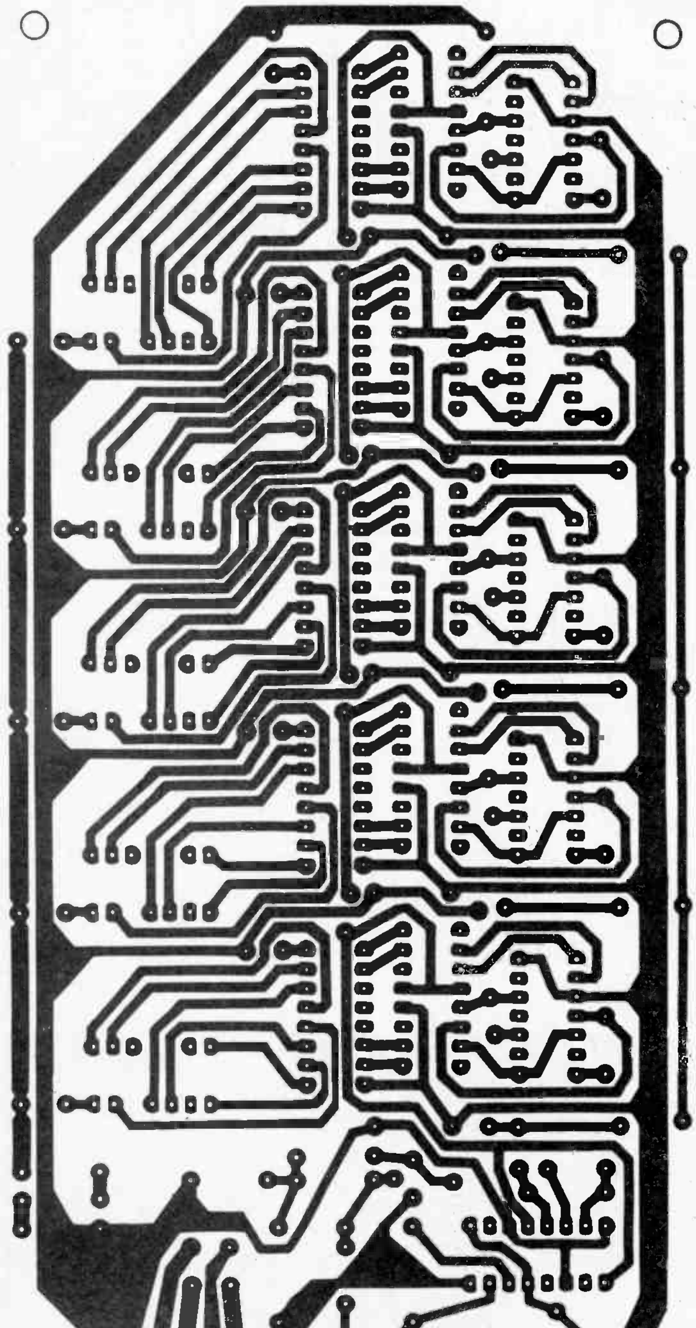
Fig. 1. Full circuit diagram of Frequency Counter





removed, whereupon it will revert to normal operation. In this particular unit it is essential that it is bolted to the metal case in order to provide an adequate heat sink, as it is being used close to its specified limits. The displays have an acceptable voltage range of 2·2V to 3·4V, and are driven from the regulated supply via three IN4001 diodes, each of which reduce the voltage by about 0·7V to provide a supply line of about 3V. Because of the high currents flowing (nearly 1A), the power line connections between the p.c.b., IC17 and C4 must be made using fairly heavy duty wire, and only in the manner shown. Failure to do so could result in unreliable performance of the counter, and "jittery" triggering of the clock generator.

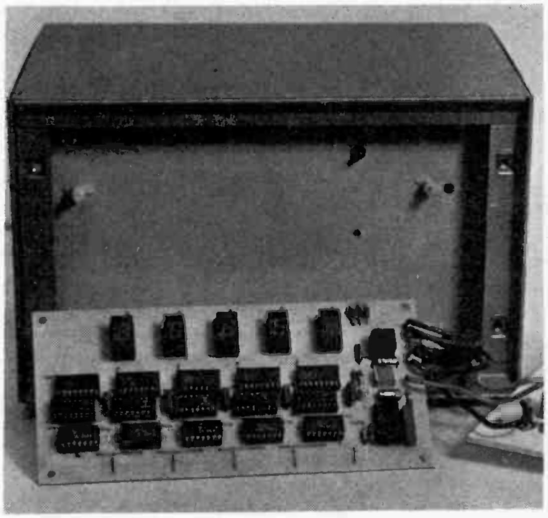
Fig. 2. Printed circuit board full size



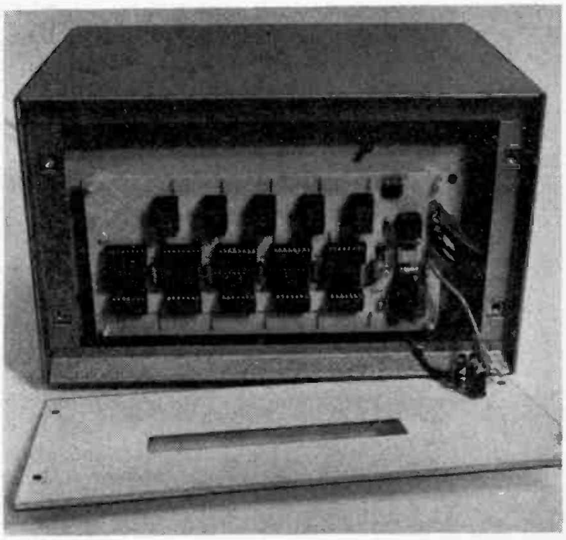
CONSTRUCTION

The original front panel is re-mounted internally on two blocks of wood fixed to the side panels, and with the p.c.b. mounted on it. This assembly is set back just enough for the displays to level with the front panel mounting-flange of the box. A clear perspex sheet is used as the new front panel, and should be painted on the inside with emulsion (white on the prototype), after masking off the viewing window and lightly sandpapering the remaining surface area.

The mains switch, panel mounting fuse holder, transformer and reservoir capacitor are mounted in the rear section of the box. It is also advantageous to fix a tag strip on the back panel



The original front panel is re-mounted internally in the box to provide a base on which to mount the p.c.b. A new front panel is them made of clear perspex and painted, leaving a display window.



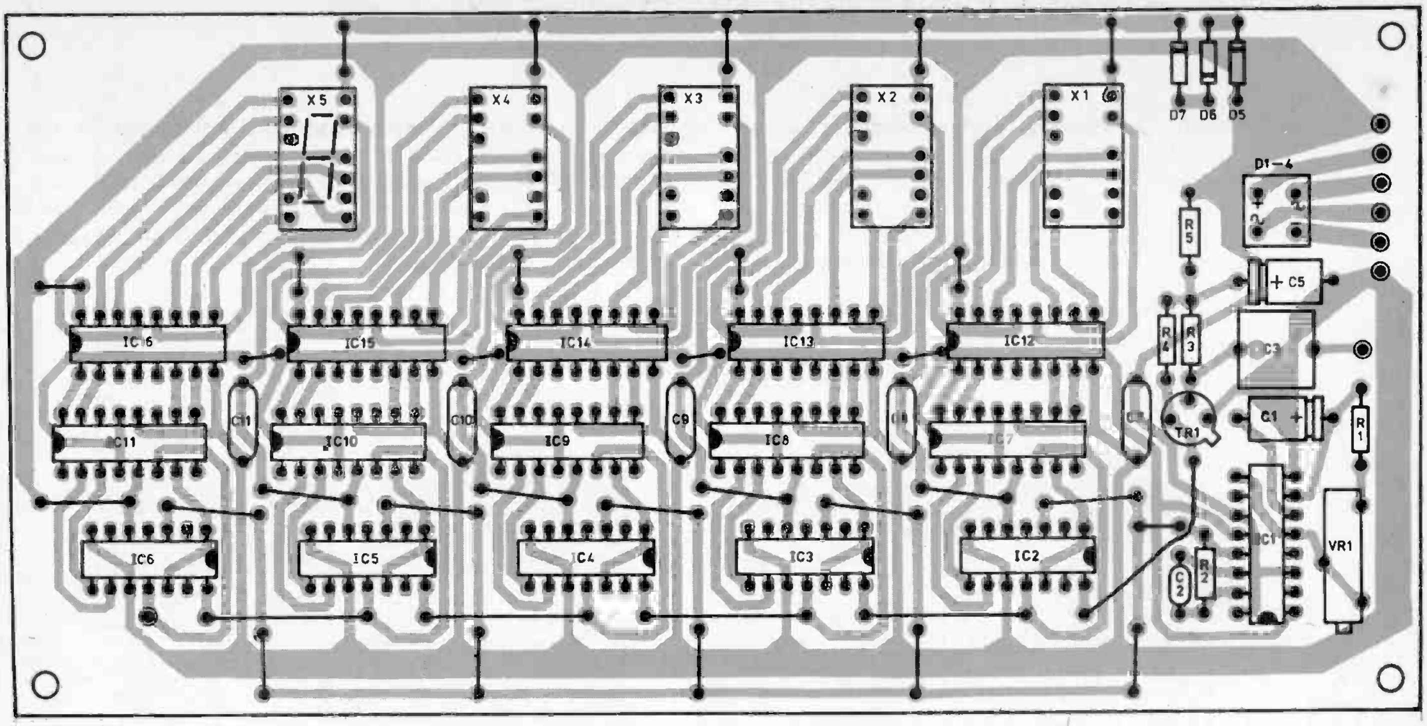
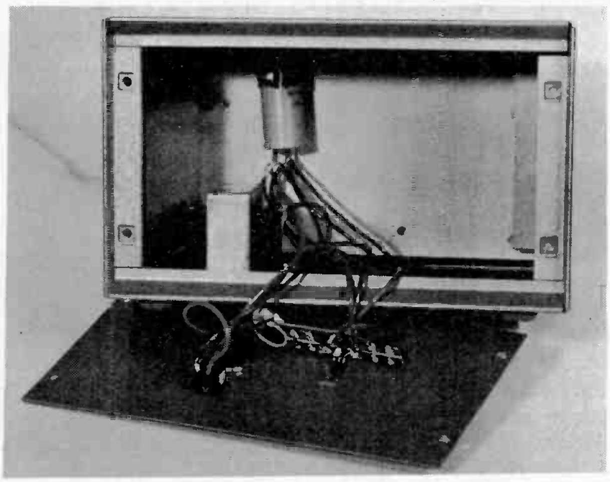


Fig. 3. Component layout (not full size)



along with switch and fuseholder, to facilitate the necessary low tension wiring junctions.

The p.c.b. is shown in Fig. 2, and the component layout of this is shown in Fig. 3.

SETTING-UP

Following the usual checks for short circuits between tracks, preferably with a magnifying glass, and for possible assembly errors, the unit should be switched on and allowed to warm up for a few minutes. Then a known frequency can be fed in, and VR1 adjusted so that the display read-out is correct for that frequency. A hole is provided in the case immediately below VR1 to provide screwdriver access. In the absence of a good signal generator, the 440Hz of "Concert A" of a musical instrument, or the note of a mechanical tuning fork of the same frequency, can be fed into the counter via a microphone and suitable preamplifier. Alternatively the residual 100Hz ripple on C4 can be fed in, and a switch is included to enable this, but the

COMPONENTS . . .

Resistors

R1	39kΩ
R2	5·6kΩ
R3	100kΩ
R4–R6	1kΩ (3 off)

All resistors ¼W 5% carbon film

Potentiometers

VR1	10kΩ 15-turn cermet preset

Capacitors

C1, C5	47μF electrolytic (2 off)
C2	10pF polystyrene
C3	1μF min polyester
C4	4700μF 25V electrolytic
C6–C11	0·1μF polyester (6 off)

Semiconductors

IC1	74123
IC2–IC6	7490 (5 off)
IC7–IC11	7475 (5 off)
IC12–IC16	7447 (5 off)
IC17	7805 5V 1A regulator
TR1	BC108 or BC109
X1–X5	EP27 7-seg display (5 off)
D1–D4	50V 1A rectifier stack
D5–D7	IN4001

Miscellaneous

S2	S.P.D.T. toggle switch
S1	D.P.S.T. toggle switch (mains)
F1	1 amp fuse and holder
SK1–2	2mm sockets (red and green)

T1 0–4·5V 0–4·5V 20VA transformer (Type R.S. 207–122)

Printed circuit board, capacitor clip for C4, tag strip, probe leads, metal case (RS 509888)

All components including p.c.b. are available from **Phonosonics**

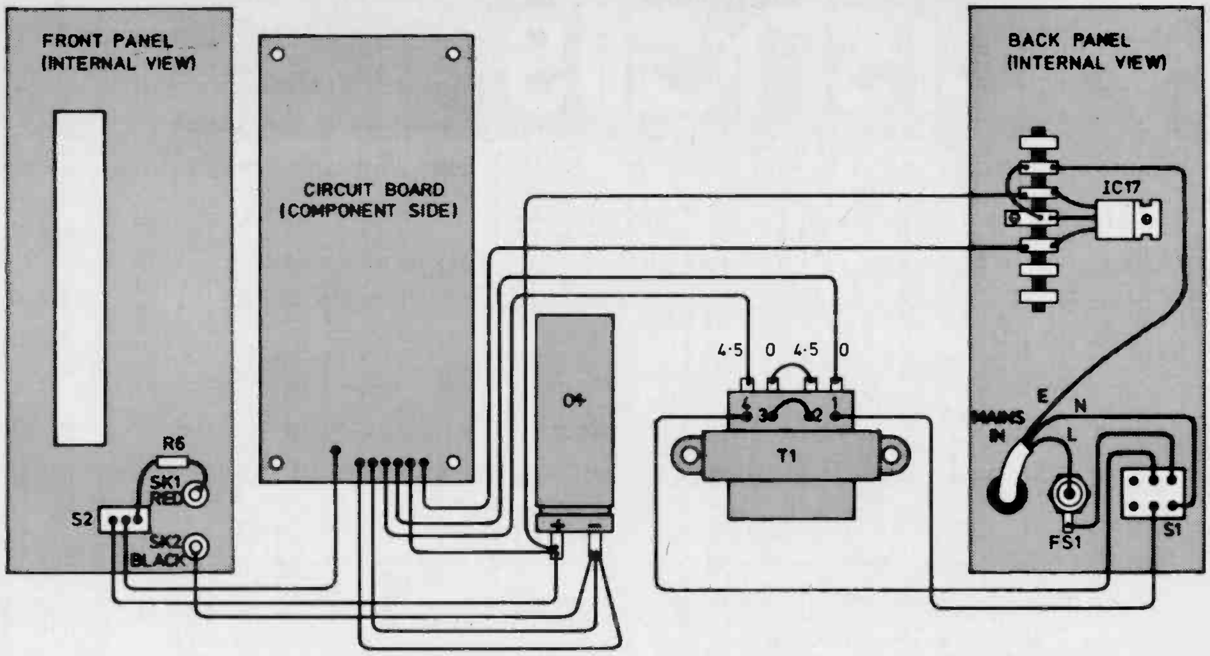


Fig. 4. Wiring diagram. Use either double wires or heavy gauge wire when connecting up C4

higher the calibration frequency the greater the potential accuracy. However, beware that many oscillators can be far less stable than the counter; indeed with the prototype the most stable oscillator tested was the Tone Generator of P.E. Joanna, but even that was found to drift when checked against a mechanical tuning fork.

ALTERNATIVE SAMPLING RATES

If a sampling rate other than 1Hz is required, C1 may be increased or decreased without limit, but the resistance total of R1 and VR1 must be kept within the limiting range of 5kΩ to 50kΩ unless additional circuitry is used. Also if an external potentiometer is contemplated in place of VR1, the fixed resistor (of at least 5kΩ) must also be kept physically close to IC1.

The clock rate frequency to be expected from changes to C1 may be approximated by assuming that doubling the capacitance will double the frequency count, and halving it will halve the count. However, in practise the actual count time is likely to vary from that calculated due to component tolerances and capacitor leakage currents, especially with electrolytic capacitors. In respect of tolerances, the actual values obtained from a nominal value can vary by as much as ±5% for R1, ±20% for VR1, and −10% to +50% for C1. Capacitor leakage currents will depend, of course, upon the specific types used.

STABILITY

The unit was checked by the author against the frequencies generated in the P.E. Joanna, which itself was kept in tune against a mechanical tuning fork, and after the initial warm-up period the counter was found to be stable within about 1 pulse per thousand, although the clock rate of IC1a was found to be slightly dependent upon ambient temperature. However, although a more accurate clock pulse might be achieved by making use of the 100Hz ripple available from C4, it was felt that the extra components required did not justify the marginal improvement. ★

POINTS ARISING

LINEAR CAPACITANCE METER *(June 1978)*

Note that in Fig. 2, resistor R9 in series with S3 (run switch) should be marked R19.

In Fig. 4, the underside link (dotted) should go to IC1 pin 7 and not pin 6. An extra wire link is necessary between IC7 pins 12 and 5.

Do not miss out the track cut on Fig. 4, which lies to the right of the junction of R1 and R2, and which has not shown up very clearly in print.

The common line between B1 and B2 should be wired to 0V on the component board (not shown in Fig. 4). Also link pin 5 to pin 12 on IC7. A track break is necessary to isolate S2a wiper from IC5 pin 4.

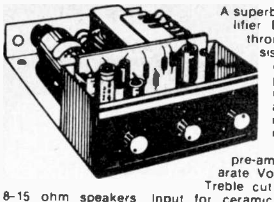
See Market Place, July 1978 for 1 per cent components.

FREE OFFER ENDS

P.E. CHAMP *(April and June 1978)*

Our stocks of Intel Programming Manuals and MCS User's Manuals have now exhausted, and unfortunately we cannot therefore continue the free offer of these books. No further requests shall be dealt with, but stamped self-addressed envelopes already in the post will be returned.

SUPERSOUND 13 HI-FI MONO AMPLIFIER



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A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integral pre-amp with Bass, Treble and two Volume controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metalwork, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification, Power output 14 watts R.M S per channel into 5 ohms. Frequency response ±3dB 12–30,000Hz. Sensitivity better than 80mV into 1 MΩ. Full power bandwidth ±3dB 12–15,000Hz. Bass boost approx to +12dB. Treble cut approx to −16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1A.

Overall size 12in wide x 8in deep x 2½in high.

Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S A E

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Pye VHF FM Tuner Head covering 88-108 MHz 10·7 MHz I.F. output, 7-8V + earth. Supplied pre-aligned, with full circuit diagram with precision-geared F.M. gang and 323PF + 323PF A.M. Tuning gang only £3·15 + P. & P. 35p.

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Size 11⅝in × 14⅝in × 1⅛in deep. Weight 19oz. Power handling 20W R M S (40W peak). Impedance 8 ohm only. Response 40Hz–20KHz. Can be mounted on ceilings, walls, doors, under tables, etc. and used with or without baffle. Send S A E for full details. Only £8·40 each + P. & P. (one 90p, two £1·10). Now available in either 8in round version or 4½ x 8½in rectangular, 10 watts R.M.S. 60Hz–20KHz £5·25 + P. & P. (one 65p, two 75p.).

SPECIAL OFFER. 6½in long throw, roll surround, ceramic magnet 8 ohm 10 watt speaker chassis. Specially suitable for Hi Fi £3.95 75p P. & P.

2in PLASTIC CONE HF TWEETER 4 ohm. £3.50 per matched pair + 50p P. & P.

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MAN 3A 3mm led displays 50p, Min. Nixie 5870ST 75p. POT CORE unit, has six pot cores including one FX2243 (45mm) and two FX2242 (35mm) 3 TO3 sil. power transistors on heat sink, 3 20mm panel fuseholders and panel with various transistors, diodes and a 5 amp plastic SCR, £1.75 plus 75p postage.

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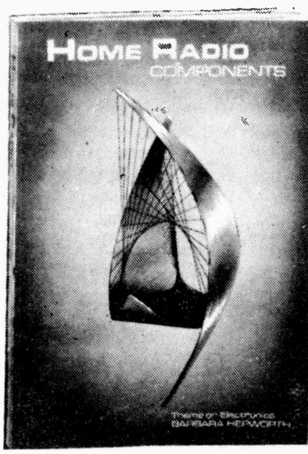

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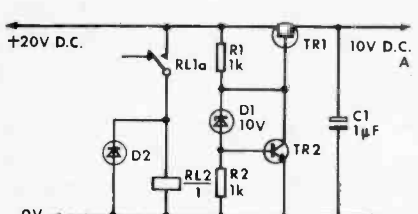

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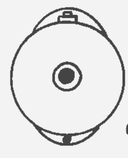

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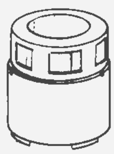

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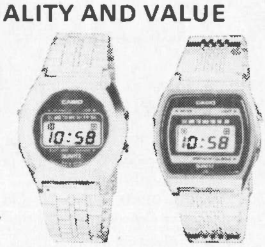

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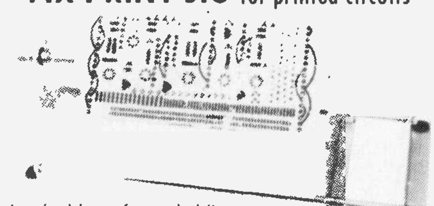

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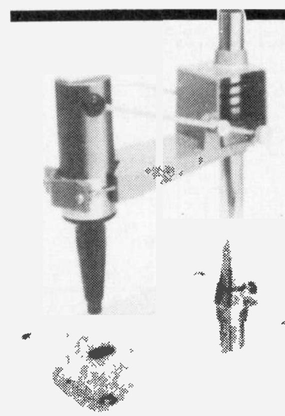

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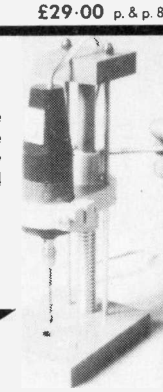

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