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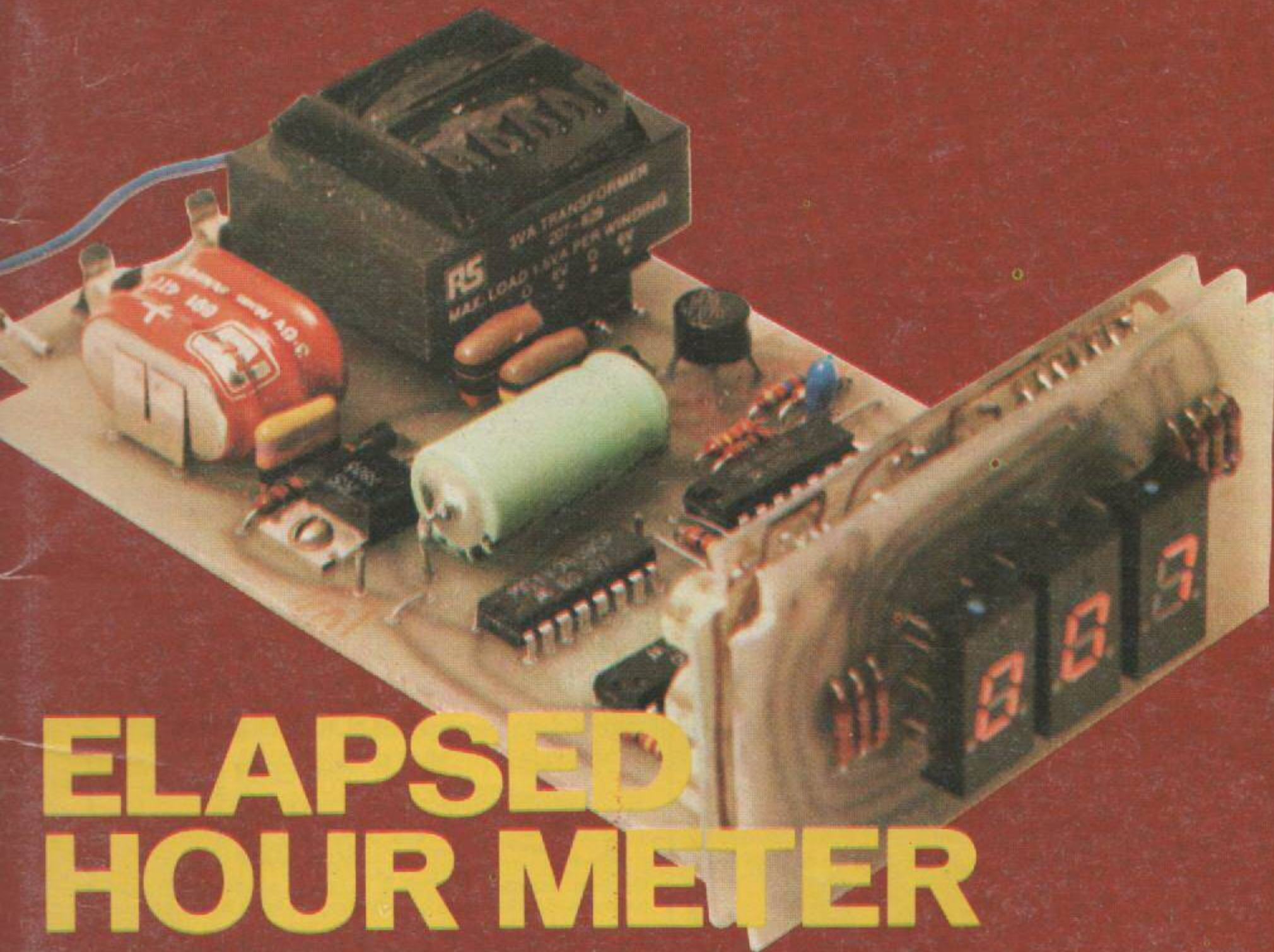
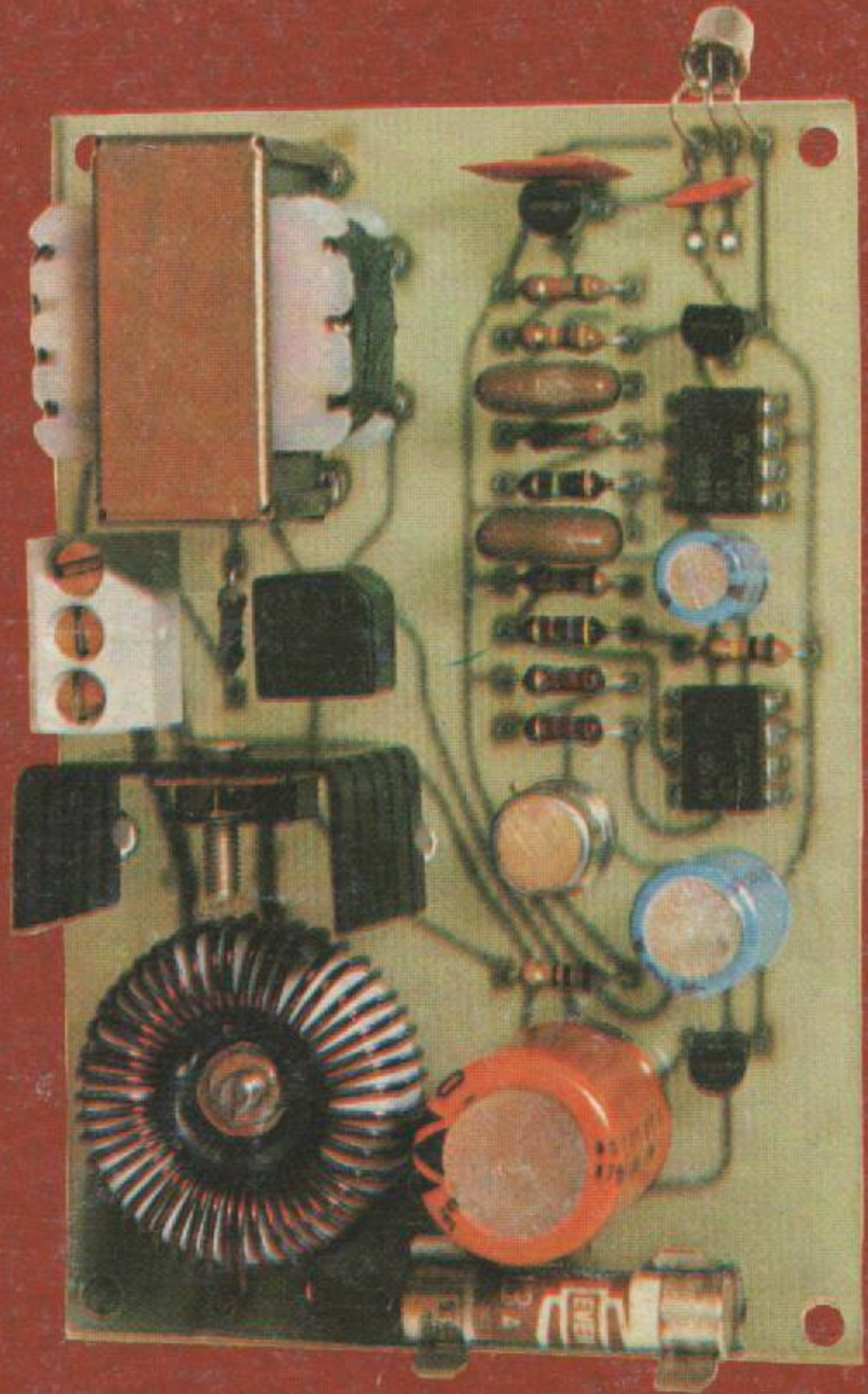
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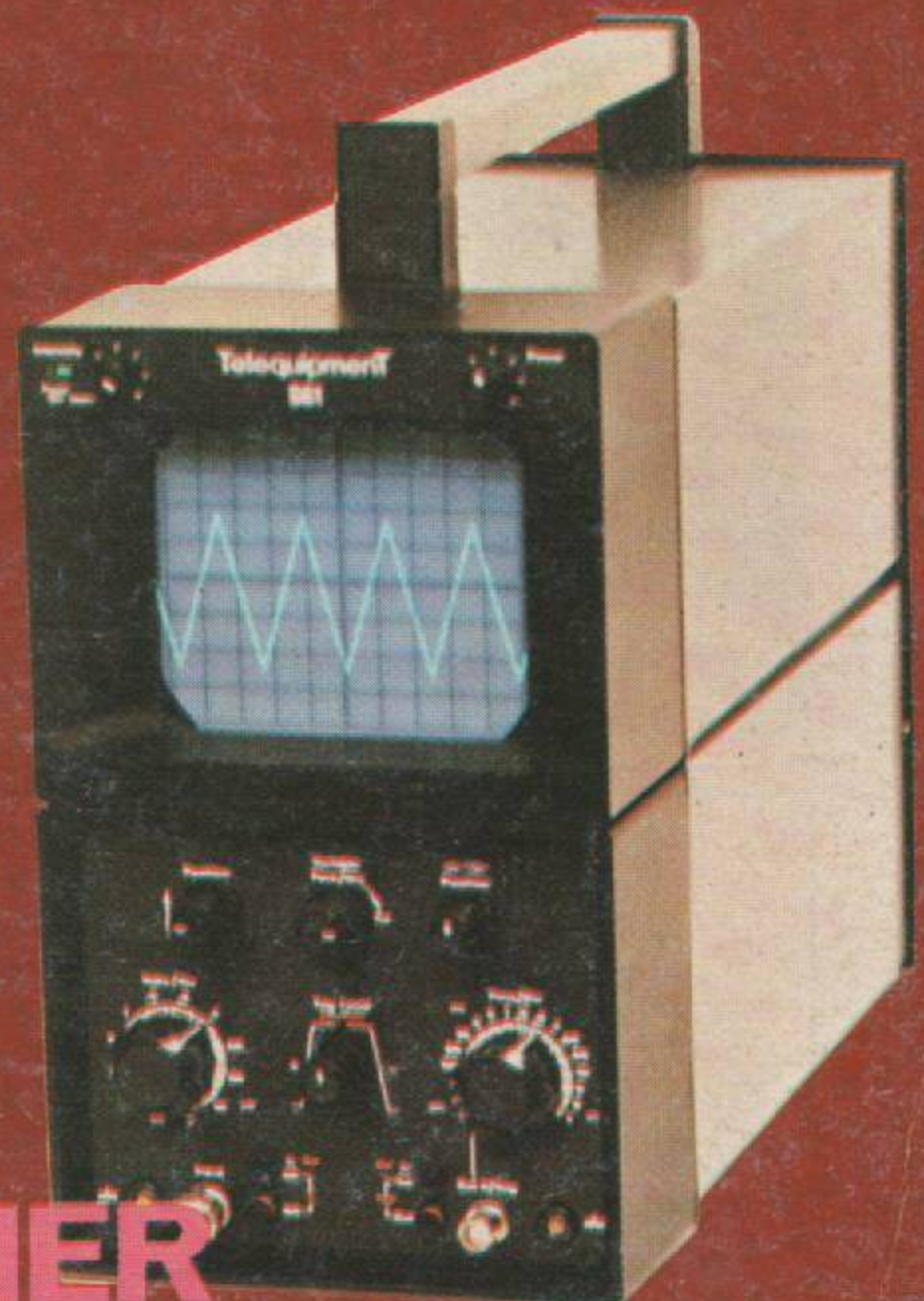
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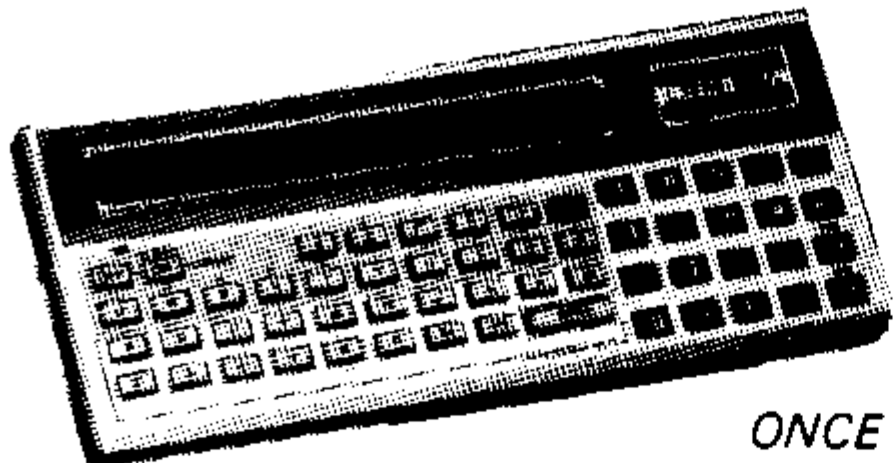
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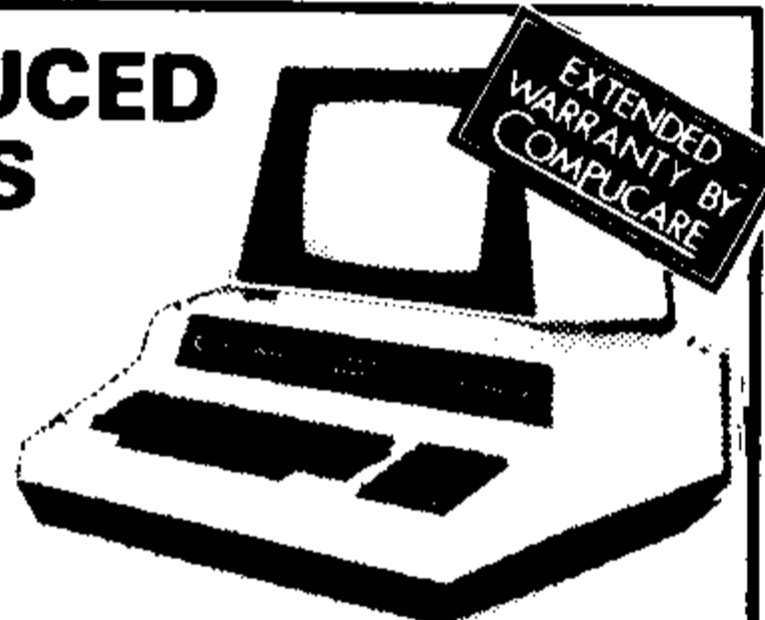
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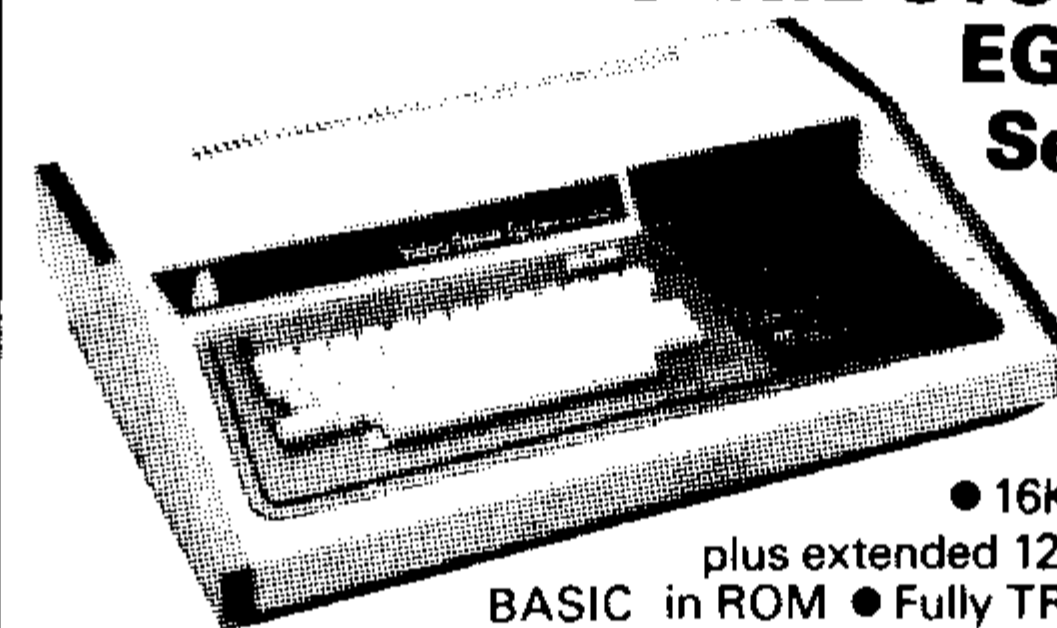
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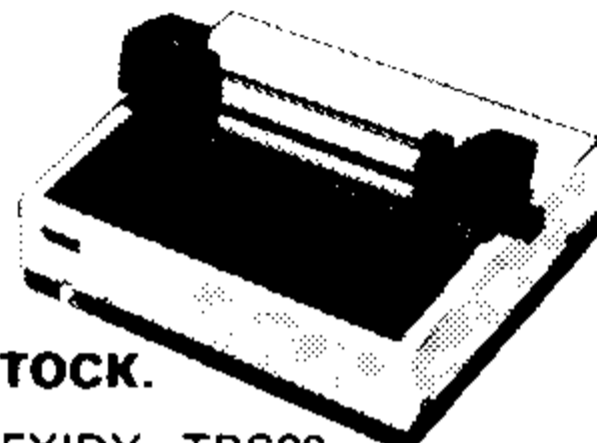
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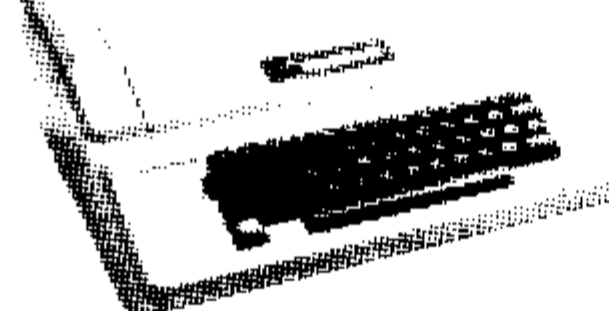
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No. 2

FEBRUARY 1981

CONSTRUCTIONAL PROJECTS

ELAPSED HOUR METER <i>by Chris Lare</i>	18
An accumulative counter measuring up to 9990 hours	
SLAVE LIGHT DIMMER <i>by Gilbert Davies</i>	26
Lighting control unit	
DIGITAL COUNTER TIMER Part 1 <i>by Dr. Mark Sawiki and Alex Kowalewski BSc.</i>	32
An eight digit universal counter/timer	
PE STARSPINNER Part 2	42
Construction and setting up	
PE MAGNUM MODIFICATIONS <i>by Andy Flind</i>	52
Some useful updating for this popular project	
INTERFACING COMPUKIT Part 2 <i>by D. E. Graham</i>	54
Decoding Module design	

GENERAL FEATURES

TANDY TRS80 <i>Reviewed by Dr. A. A. Berk</i>	28
A detailed look at Tandy's pocket computer	
SEMICONDUCTOR UPDATE <i>by R. W. Coles</i>	41
AM2960, HLMP31XX, HMP36XX	
MICROBUS <i>by D.J.D.</i>	48
Software for the MK14, ZX80 and Acorn System One	
INGENUITY UNLIMITED	64
Capacitive Touch Switch	

NEWS AND COMMENT

EDITORIAL	15
MARKET PLACE	16
New products	
READOUT	22
There's a computer club near you	
INDUSTRY NOTEBOOK <i>by Nexus</i>	24
An optimistic look ahead	
SPECIAL OFFER—TELEQUIPMENT S61 OSCILLOSCOPE	25
An essential piece of test equipment for the serious constructor	
POINTS ARISING	30
PE DMM, 125W Amplifier, Interfacing CompuKit	
SPACEWATCH <i>by Frank W. Hyde</i>	63
The continuing saga of Saturn	
PATENTS REVIEW	66
More thought-provoking ideas	

OUR MARCH ISSUE WILL BE ON SALE FRIDAY, 13 FEBRUARY 1981
(for details of contents see page 31)

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7412 150
7413 32
7414 38
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7425 28
7426 43
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BC327 15	BFX85 28	TIP33A 65	2N3055 48	40636 175

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C15W	390
CX17W	398
CCN15W	420
X25W	415
Spare bits	50
Elements	190
Iron stand	150

DIL SOCKETS (TEXAS) Low Wire profile/wrap

8 pin	10p	25p
14 pin	12p	35p
16 pin	13p	46p
18 pin	16p	52p
20 pin	22p	65p
22 pin	25p	70p
24 pin	30p	78p
28 pin	35p	85p
36 pin	—	105p
40 pin	—	109p

SPECIAL OFFER

2114-450ns	225
2114-300ns	295
2708	400
2716-5V	650
4116-16k	299



CMOS (CONT.)

4077	30
4078	28
4081	26
4082	25
4085	90
4086	90
4089	150
4093	53
4094	210
4095	95
4096	95
4097	340
4098	115
4099	150
4160	115
4161	115
4162	115
4163	115
4174	110
4175	120
4194	115
4408	790
4409	790
4410	750
4411	950
4412F	1250
4415F	480
4419	280
4422	570
4432	1050
4435	850
4440	999
4450	350
4451	350
4452	000
4490	350
4501	28
4502	105
4503	65
4506	75
4507	48
4508	48
4510	85
4511	98
4512	84
4513	225
4514	220
4515	250
4516	90
4517	415
4518	90
4519	80
4520	90
4521	210
4522	150
4526	98
4527	125
4528	100
4529	150
4530	90
4531	130
4532	120
4534	510
4536	310
4538	145
4539	120
4541	150
4543	150
4549	395
4553	399
4554	192
4555	85
4556	60
4557	425
4558	174
4559	450
4560	110
4561	199

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES		BRIDGE RECTIFIERS		SPEAKERS	
AA129	25	1A/50V	20	8Ω 0.3W	75
AAZ15	15	1A/100V	22	2" x 2"	75
BY100	24	1A/200V	25	2.5" x 3"	75
BY127	12	1A/400V	29	40Ω 2.5"	88
CRO33	158	1A/600V	34	64Ω 2.5"	80
OA9	45	2A/50V	35	80Ω 2.5"	80
OA47	18	2A/100V	44	8Ω 5W	250
OA70	12	2A/200V	46	7" x 4"	160
OA79	12	2A/400V	53		
OA81	15	2A/600V	55		
OA85	15	4A/100V	72		
OA90	8	6A/100V	73		
OA91	8	6A/200V	78		
OA95	8	6A/400V	85		
OA200	9	BY164	56		
OA202	9	VM18 DIL	50		
IN914	4				
IN916	6				
IN400/2	5				
IN4003	6				
IN4004/5	6				
IN4006/7	7				
IN4148	4				
IS44	20				
3A/100V	18				
3A/400V	20				
3A/600V	27				
3A/1000V	30				
SCR's		ZENERS		ALUM. BOXES	
Thyristors		Range: 2V7 to 39V. 400mW	8p each	3x2x1"	55
0.8A/30V	28	Range: 3V3 to 33V. 1.3W	15p each	2 1/2 x 5 1/2	75
0.8A/100V	30			4x4x1 1/2	75
0.8A/200V	35			4x2 1/2 x 2 1/2	80
1A/100V	42			5x4x2"	107
1A/200V	47			6x4x2"	110
1A/600V	70			7x5x2 1/2	190
3A/400V	75			8x6x3"	185
5A/300V	35			10x7x3"	250
5A/600V	43			10x4 1/2 x 3"	220
8A/300V	48			12x5x3"	250
8A/600V	85			12x8x3"	275
12A/300V	59				
12A/500V	92				
12A/800V	150				
15A/700V	195				
BT106	150				
BT116	150				
C106D	38				
MCR101	32				
TIC44	22				
TIC45	28				
2N4444	140				

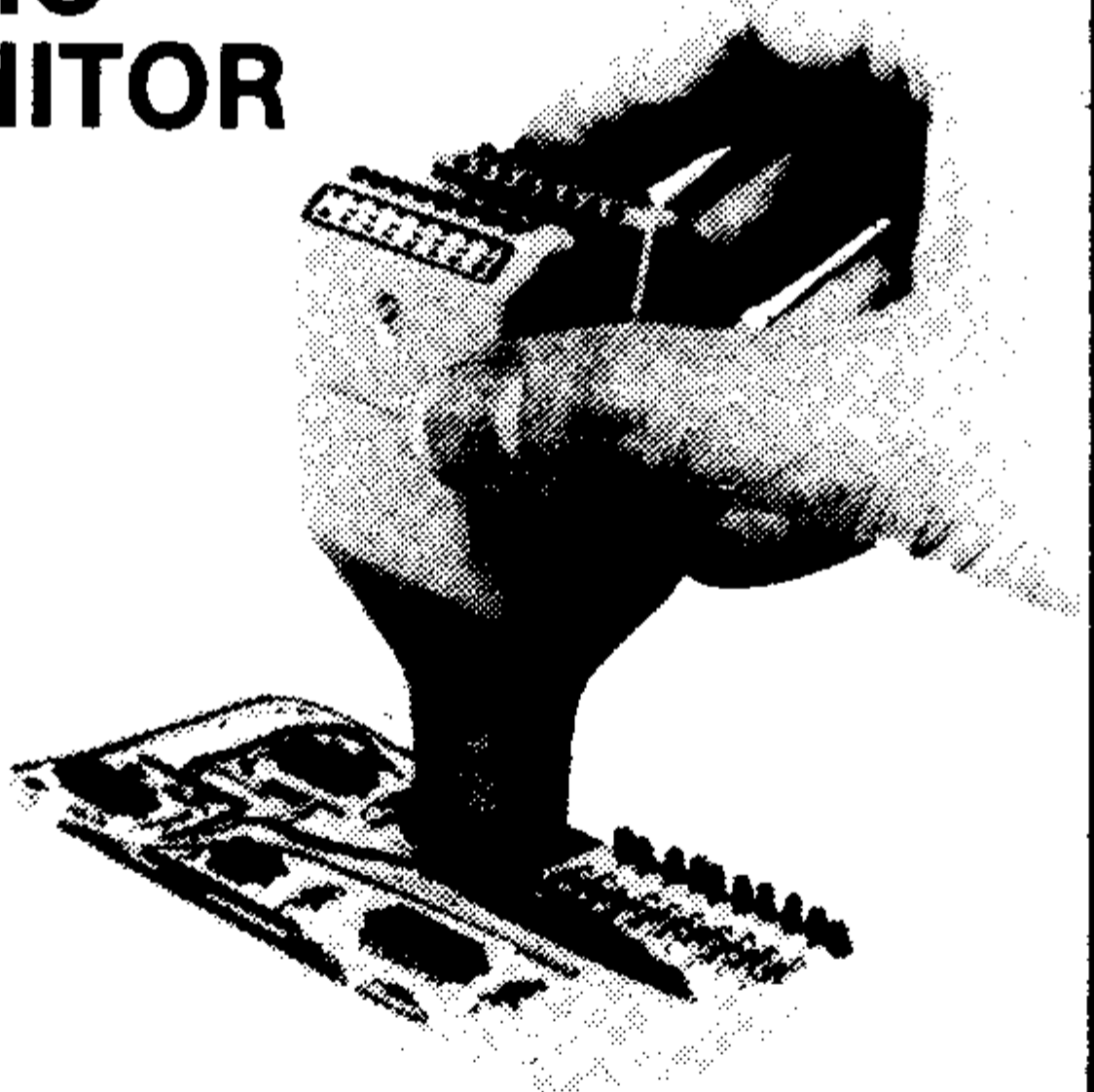
OPTO ELECTRONICS		VOLTAGE REGULATORS		CRYSTALS	
LEDS Plus. Clip	13	1A TO3 +ve -ve	220p	100kHz	300p
TIL209 Red 125"	18	5V 7805 145p	7905 220p	455kHz	370p
TIL211 Grn 125"	22	12V 7812 145p	7912 220p	1.28MHz	392p
TIL220.2" Red	15	15V 7815 145p		1MHz	295p
0.2" Yel. Grn. Amber	18	18V 7818 145p		1.6MHz	395p
Rectangular LEDS.	30	1A TO220 Plastic Casing		1.008MHz	383p
Red, Green and Yellow	30	5V 7805 60p	7905 65p	1.80MHz	385p
2N5777 45; OCP71	120	12V 7812 60p	7912 65p	1.8432MHz	300p
ORP12	63	15V 7815 60p	7915 65p	2.4576MHz	305p
LD271 Infra Red (emit)	40	18V 7818 60p	7918 65p	3.2768MHz	290p
TIL32 Infra Red (emit)	58	24V 7824 60p		3.57954M	150p
SFH205 (detector)	70	100mA TO92 Plastic Casing		4MHz	290p
TIL78 (detector)	70	5V 78L05 30p	79L05 65p	4.032MHz	323p
OPTO Isolators		SWITCHES		COMPUTER CORNER	
IL74	48	6V 78L62 30p		● SUPERBOARD II Ready-built & tested (requires PSU)	Only: £150
TIL 111/2 or 117	100	8V 78L82 30p		● PSU 5V/3A for above incl. UHF Mod. 610 Expansion Board (8K)	£24
7 Segment Displays		12V 78L12 30p	79L12 65p	● UK101 Complete Kit incl. instructions	£179
TIL 312 & 313 0.3"	105	15V 78L15 30p	79L15 65p	● Challenger 1P Cased	£188
TIL321 5" C.An	115	CA3085 95	LM323K 625	● Plastic Case for Superboard, fits UK101, NASCOM etc.	£25
TIL322 5" C.th	115	LM300H 170	LM325N 240	● Space Invaders for Superboard (4K)	£5
DL704 3" C.th	99	LM305H 140	LM326N 240	● PRINTER 800. Ideal for PET, Apple, TRS80, Superboard etc.	Only: £325
DL707 3" C.Anod	99	LM309K 135	LM327N 270	● VIDEO GENIE based on TRS80 16K RAM	Only: £299
DL747 6" An	180	LM317K 350	LM723 39	● STRINGY FLOPPY (economy of Cassette, speed of Disc)	Only: £169
8" Orange C.A.	250	78H05 5V/5A 595p	TBA625B 85	● SOFTY. Intelligent EPROM Programmer Kit Ready-Built & Tested PSU for above (Built)	£99
FND357 or 500	120	UA78HG +5 to +24V 5A 650	TDA1412 120	● TEX UV EPROM Eraser. Erases up to 32 ICs in 15-30 min.	£33
.3" Green C.A.	180			● UHF MODULATORS 6MHz	280p
±1.3" Red or Green	150			● UHF MODULATORS 8MHz	450p
Bargraph 10 seg. Red	225			● KEYPADS 4 x 4 matrix	350p
Liquid Crystal Display				● Model 756 ASCII Keyboard	£40
3 1/2 digit 775p; 4 digit 920p				● 10 x C12 Cassettes in stockable racks	£5.50
6 Digit LCD 950p				We stock a wide selection of Computer Books.	

DIL PLUGS (Headers)		TRANSFORMERS (mains Prim. 220-240V)	
14 pin	35p	6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA	98p
16 pin	39p	8VA type: 6V-5A 6V-5A; 9V-4A 9V-4A; 12V-3A 12V-3A; 15V-2.5A 15V-2.5A 215p..	
(DIL Sockets on opp. page)		12VA: 4.5-1.3A 4.5V-1.3A; 6V-1.2, 6V-1.2A 12V-5A 12V-5A	235p (30p p&p)
		24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-8A 15-8A; 20V-6A 20V-6A	320p (55p p&p)
		50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-8A 30V-8A	365p (60p p&p)
		100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A	695p (74p p&p)
		AUTO (Step Down) TRANSFORMERS: Prim: 240V Sec. 115V 50/60Hz 50VA: £5.95 (60p); 100VA: £7.40 (70p) 100VA: £9.95 (70p); 250V: £14.75 (85p) (N.B. P&P charge to be added above our normal postal charge.)	

'D' CONNECTORS (Cannon type)		EDGE CONNECTORS double type	
9 way	90p	2 x 10 way	156
15 way	120p	2 x 15 way	85p
25 way	180p	2 x 18 way	115p
37 way	268p	2 x 22 way	130p
		2 x 25 way	149p
		2 x 30 way	170p
		2 x 36 way	194p
		2 x 40 way	210p
		2 x 43 way	232p

Faster than a scope safer than a voltmeter

LOGIC MONITOR LM-1



Instant — simultaneous monitoring of the logic state of all IC nodes

- Just clip it over your IC
- LM-1 Instantly and accurately shows both static and dynamic logic states on a bright 16 LED display.
- LM-1 finds its own power.
- LM-1 cuts out guesswork, saves time, and eliminates the risk of short circuits.
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ONLY £28.70 (Excluding P&P and VAT)
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FOR IMMEDIATE ACTION — The C.S.C. 24 hour, 5 day a week service, Telephone: (0799) 21682, and give us your Barclaycard, Access, American Express number and your order will be in the post immediately.

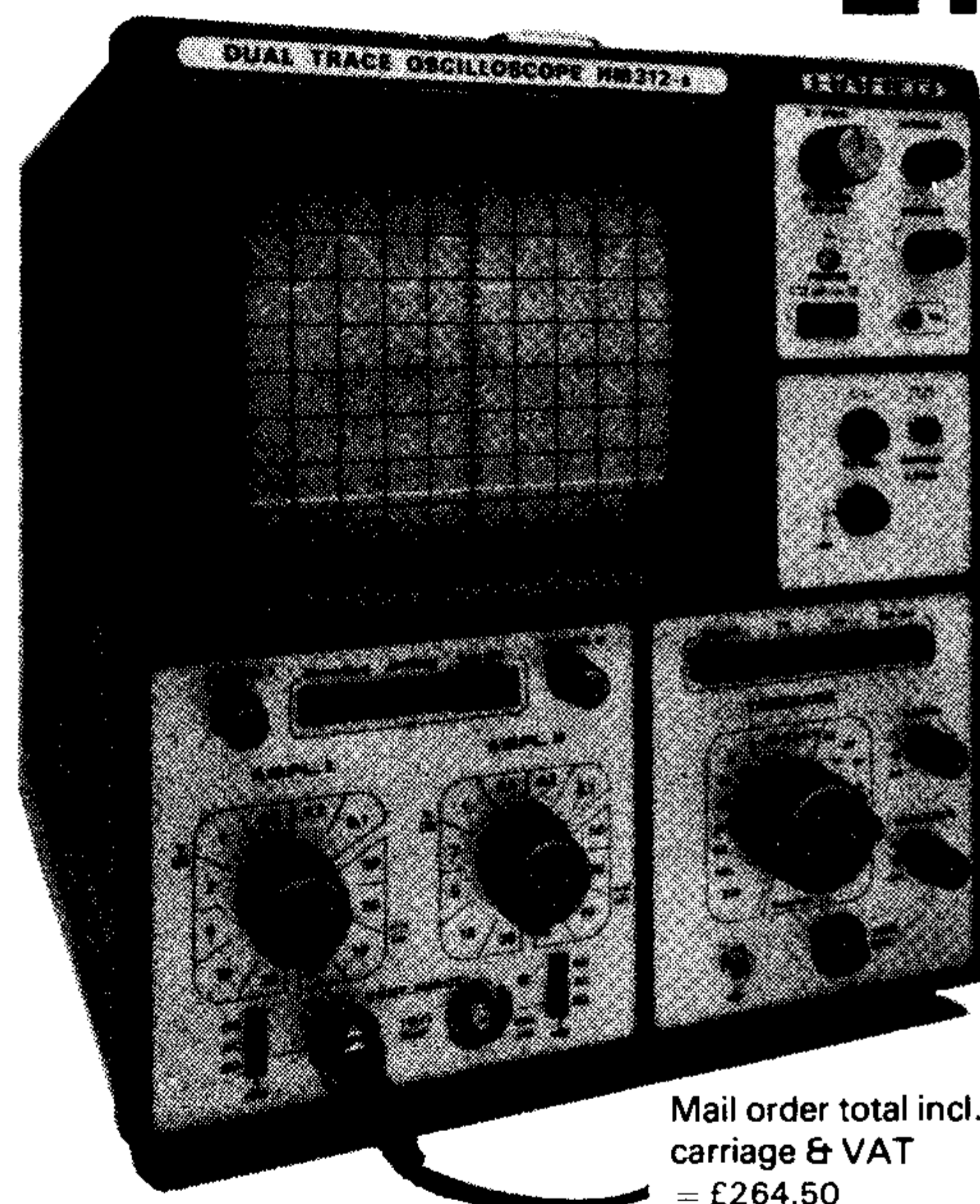
**Incredible Quality
Incredible Performance
Incredible Price!!!**



HM 307 Single Trace Oscilloscope
DC - 10MHz. Sensitivity 5mV/cm to 20V/cm. Timebase range 0.5µs/cm to 0.25/cm. Component Tester built in:- Test Voltage max. 8.6V r.m.s. Test Current max. 28mA r.m.s. Test Freq. 50Hz. CRT display 6 x 7 cm. Robust mechanical construction.

Unbeatable price of
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£138 (+VAT)



HM312 Dual Trace Oscilloscope.
DC-20MHz. Sensitivity 5mV-20V/cm. Time base range 0.5µs-0.2S/cm with x5 horiz mag to 100nS/cm, with variable control uncalibrated to 40nS/cm. CRT screen 8 x 10cm. Full XY using chll as X input. Bandwidth 2.3MHz. TV trigger.

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£220 (+VAT)

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Other models available:-
HM 412. 20MHz D.T. Sweep Delay **£350**
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Full specifications of all models available on request.

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Electronic Brokers



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3 CHANNEL SOUND/LIGHT CHASER

LB31000SLC

£32.70

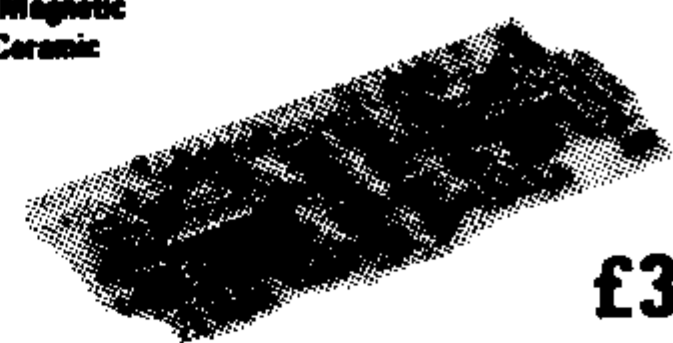


A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel, 5Hz to 70K. Controls: bass/mid/treble/master sensitivity/chase speed.

STEREO DISCO MIXER/PREAMP

LBPA3
M - Magnetic
C - Ceramic

£33.70



Magnetic or ceramic deck versions - please state

All the requirements of a stereo disco preamp on one board, left and right deck mixers/controls/mic. mixer/tones/mic. auto fade over decks and P.F.L. The unit can be used with either LB100/150/250.

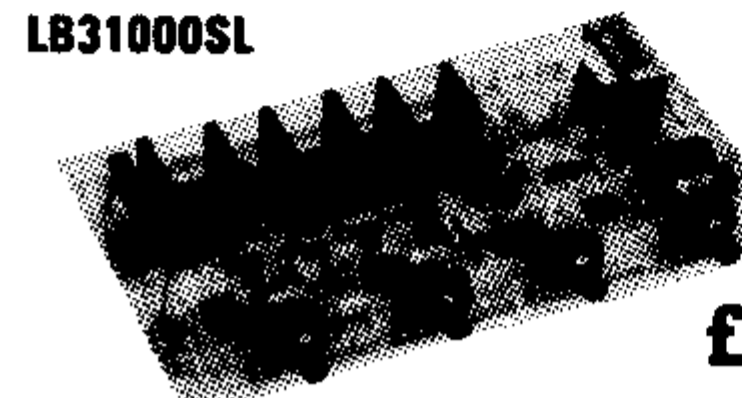
Full set of pots - **£8.63**

3 CHANNEL SOUND/LIGHT

LB31000SL

£22.70

All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity.



2/4/8 CHANNEL CHASER

LB81000LC

£28.00

An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

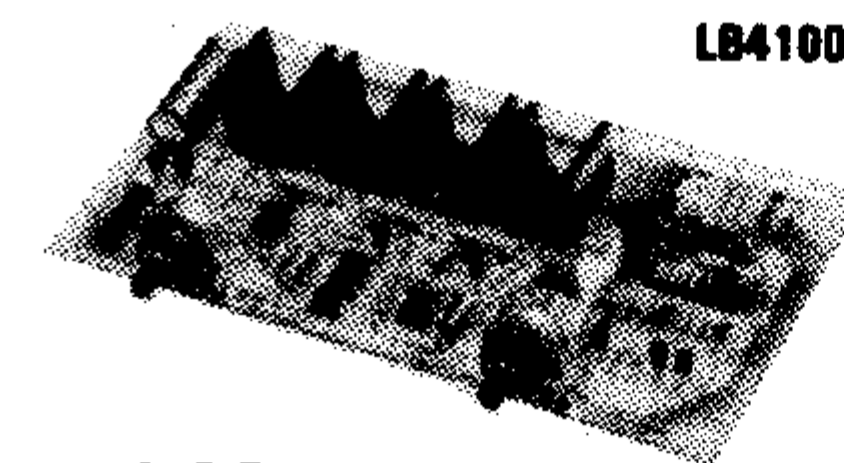


4 CHANNEL SEQUENCER

LB41000LS

£19.20

A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

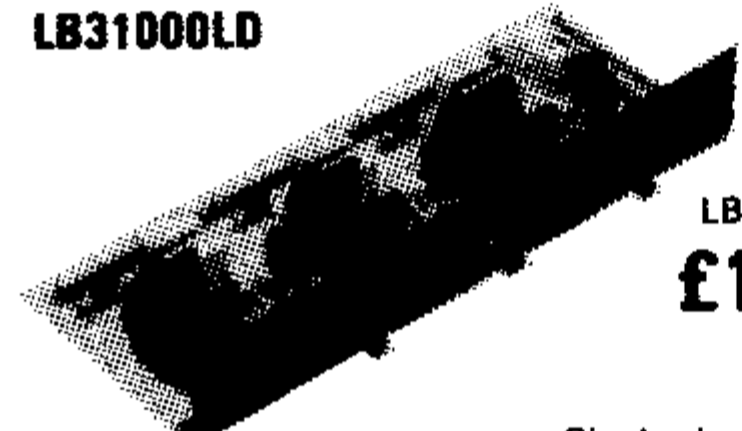


1 AND 3 CHANNEL DIMMERS

LB31000LD

£16.20

Power dimmer units for theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots for use with sliders -
LB31000LD (no pots) **£15.00** Sliders **75p** each.



Single channel version
LB11000LD **£7.20**

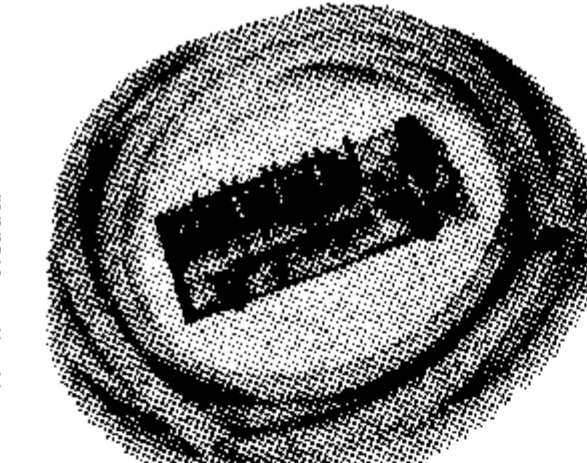
ROPE LIGHTS/DRIVER

LB41000LC-S

£24.20

ROPE LIGHTS
£45.40

A four channel chaser up to 1,000W per channel, with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control



24 feet ropes
Red/Yellow
Blue/Green

LBPA2
£17.20

LBPA1
£19.50

A four channel mixer and tone stage for mics, guitars, etc. Can be used with any LB amps. Set of pots **£2.74**.

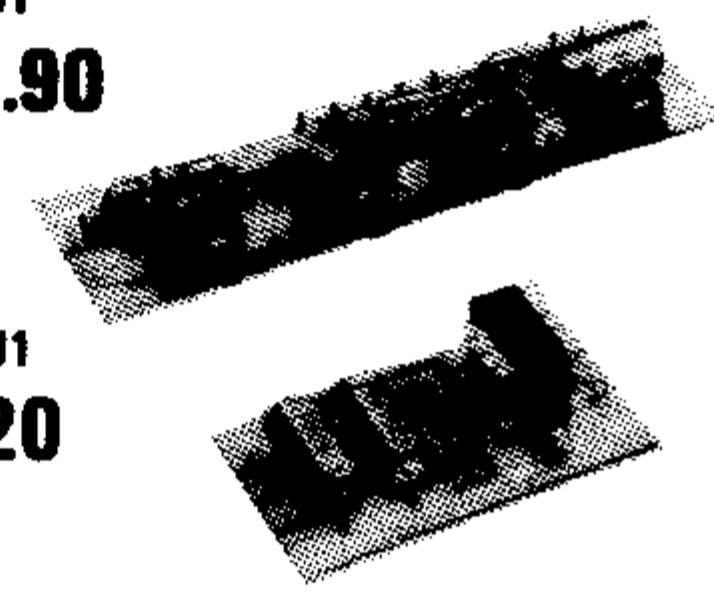
A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner, etc. Set of pots **£3.27**.

3-WAY ACTIVE CROSSOVER

LBAC01

£17.90

Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBAC01. (1 or 2).

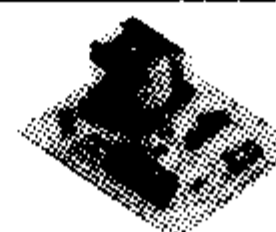


POWER AMPLIFIERS

Tough dealing power amps for use in sound systems. Open/short circuit protection and fused. Heavy gauge heatsinks and rugged o/p devices (all operate down to 4 ohms).

25W R.M.S.	100W R.M.S.	150W R.M.S.	250W R.M.S.
20Hz to 60K 0.07% THD 96DB S/N LB25	5Hz to 25K 0.1% THD 110DB S/N LB100	5Hz to 25K 0.1% THD 110DB S/N LB150	5Hz to 25K 0.1% THD 110DB S/N LB250
£11.20	£19.70	£29.20	£43.50

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.



LBRD1
£6.20

A de-thump unit for use with any LB power amps.

POWER AMP POWER SUPPLIES

LB25PS	LB100PS	LB150PS	LB250PS
£11.20 P/P £1.20	£16.20 P/P £1.40	£19.00 P/P £1.40	£26.50 P/P £1.70

FOR GUITARS, P.A. AND DISCO.

PIEZO HORNS
£5.75
P/P 50p



CELESTION LOUDSPEAKERS (ALL STANDARD CONE 8 OHMS)

G12-85 (12 inch 85W)	G12-100 (12 inch 100W)	G10-50 (10 inch 50W)
£20.70 P/P £1.70	£26.45 P/P £1.70	£14.70 P/P £1.70

NEW - MINI MODULES - NEW

Ingeniously designed mini pre-amplifier 'building blocks' for use in music and P.A. applications. You choose the type and number of units you require for your particular system and mount each module via its control direct onto your panel.
LBMM1 Pre-amp for mics, guitars etc.
LBMM2 Mixer for up to 6 LBMM1/2/3/4/5
LBMM3 Bass/boost/cut for either LBMM1/2/3/4/5
LBMM4 Mid-boost/cut for either LBMM1/2/3/4/5
LBMM5 Treble boost/cut for either LBMM1/2/3/4/5
LBPSU1 ± 15V supply for up to 12 modules
LBPSU2 ± 15V regulated for up to 50 modules
MM1 **£4.50**; MM2 **£5.20**; MM3 **£5.70**; MM4 **£5.70**; MM5 **£5.70**; PSU1 **£7.20**; RPSU **£14.50**.
Discount on MM1/2/3/4/5 10 to 24 - 20%, 25+ - 30%

Each module is manufactured from the highest quality components, fully tested, supplied with a connection and circuit diagram and guaranteed for twelve months.

All prices shown are VAT inclusive. Please include 50p post/packing except where individually stated. To mail order send cheque/P.O./registered card/Barclaycard or Access number. C.O.D. service £1 extra. For the new Autumn catalogue send 50p. (Full spec. shown.)

PLEASE NOTE THIS COMPANY HAS NO CONNECTION WITH LB ELECTRONICS OF HILLINGDON

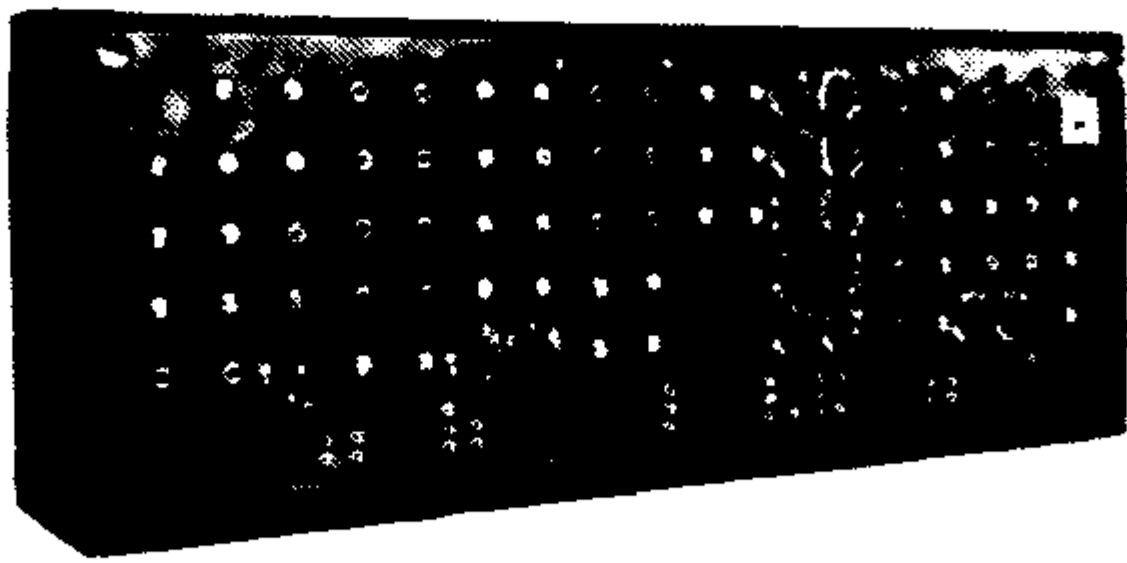


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ELECTRONIC MODULES

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D.I.Y. KITS FOR SYNTHESISERS, SOUND EFFECTS



BASIC COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits PCBs and parts are shown in our lists.

LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

P.E. MINISONIC MK2 SYNTHESISER

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

Set of basic component kits (excl. KBD R's & tuning pots - see list for options available) and PCBs (incl. layout charts)
KIT 38-25 **£80.14**
"Sound Design" booklet **£1.00**

P.E. 128-NOTE SEQUENCER

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.

Set of basic comps, PCBs and charts **£35.56**
KIT 76-7
Set of text photocopies **£1.36**

P.E. 16-NOTE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synthesisers.

Set of basic comps, PCBs and charts **£32.10**
KIT 86-5
Set text photocopies **£1.84**

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.
Set of basic comps, PCBs & charts

KIT 77-8 **£109.72**

ELEKTOR PHASING & VIBRATO

Includes manual and automatic control over the rate of phasing & vibrato, and has been slightly modified to also include a 2-input mixer stage.

Set of basic comps, PCB & chart **£21.67**
KIT 70-2
Text photocopy **67p**

ELEKTOR FORMANT SYNTHESISER

A very sophisticated synthesiser for the advanced constructor who puts performance before price.

Set of basic comps, PCBs (as publ.) **£255.45**
KIT 66-14
Set of text photocopies **£7.83**

ELEKTOR DIGITAL REVERB UNIT

A very advanced unit using sophisticated i.c. techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main unit basic comps and PCB (as publ.) **£49.95**
KIT 78-3
Extension unit basic comps and PCB (as publ.) **£39.95**
KIT 78-4
Text photocopy **86p**

ELEKTOR SEWAR

For use with Elektor Analogue Reverb to give greater flexibility to the reverb effects.

Basic comps, PCB (as publ.) **£18.19**
KIT 101-1
Text photocopy **60p**

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesisers.

Set of basic comps & PCB (as publ.) **£6.84**
KIT 87-2
Text photocopy **38p**

ELEKTOR CHOROSYNTH

A 2½-octave Chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet amongst many others. Experienced constructors can readily extend the octave coverage.

Basic comps, PCBs and charts but excl. sw's **£44.39**
KIT 100-8
Text photocopy **70p**

ELEKTOR ANALOGUE REVERB

Using i.c.s instead of spring-lines the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main unit basic component set **£29.23**
KIT 83-4
Additional Delay basic components **£20.07**
KIT 83-2
PCB (as publ.) to hold both kits included in Kit 83-4
Text photocopy **67p**

ELEKTOR FUNNY TALKER

Incorporates a ring modulator, chopper & frequency modulator to produce fascinating sounds when used with speech & music signals.

Basic comps, PCB (as publ.) **£9.60**
KIT 99-1
Text photocopy **40p**

ELEKTOR FREQUENCY DOUBLER

For use with guitars & other electronic instruments to produce an output one octave higher than the input. Inputs and outputs may be mixed to give greater depth.

Basic comps, PCB (as publ.) **£5.48**
KIT 98-1
Text photocopy **20p**

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A simple but effective substitute for a rotary cabinet. The output of an internal generator is phase-split and modulated by an input signal from an electronic guitar or other instrument. Output amplitudes, depth & rate are variable. May be fed to one or two amplifiers.

Basic comps, PCB & chart **£17.68**
KIT 102-3
Text photocopy **65p**

P.E. MINISONIC WAVEFORM CONVERTER

A simple converter that modifies the Minisonic sawtooth waveform to produce triangle and sine outputs. Ideally one should be used with each Minisonic VCO.

Basic comps, PCB & chart **£3.98**
KIT 96-1

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An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments.

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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 35p; other countries—send 75p.



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A voltage controlled filter extracted from P.E. Minisonic project.
Basic comps, PCB & chart KIT 65-1 **£8.45**

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Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.
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A high specification stereo mixer with variable input impedances.
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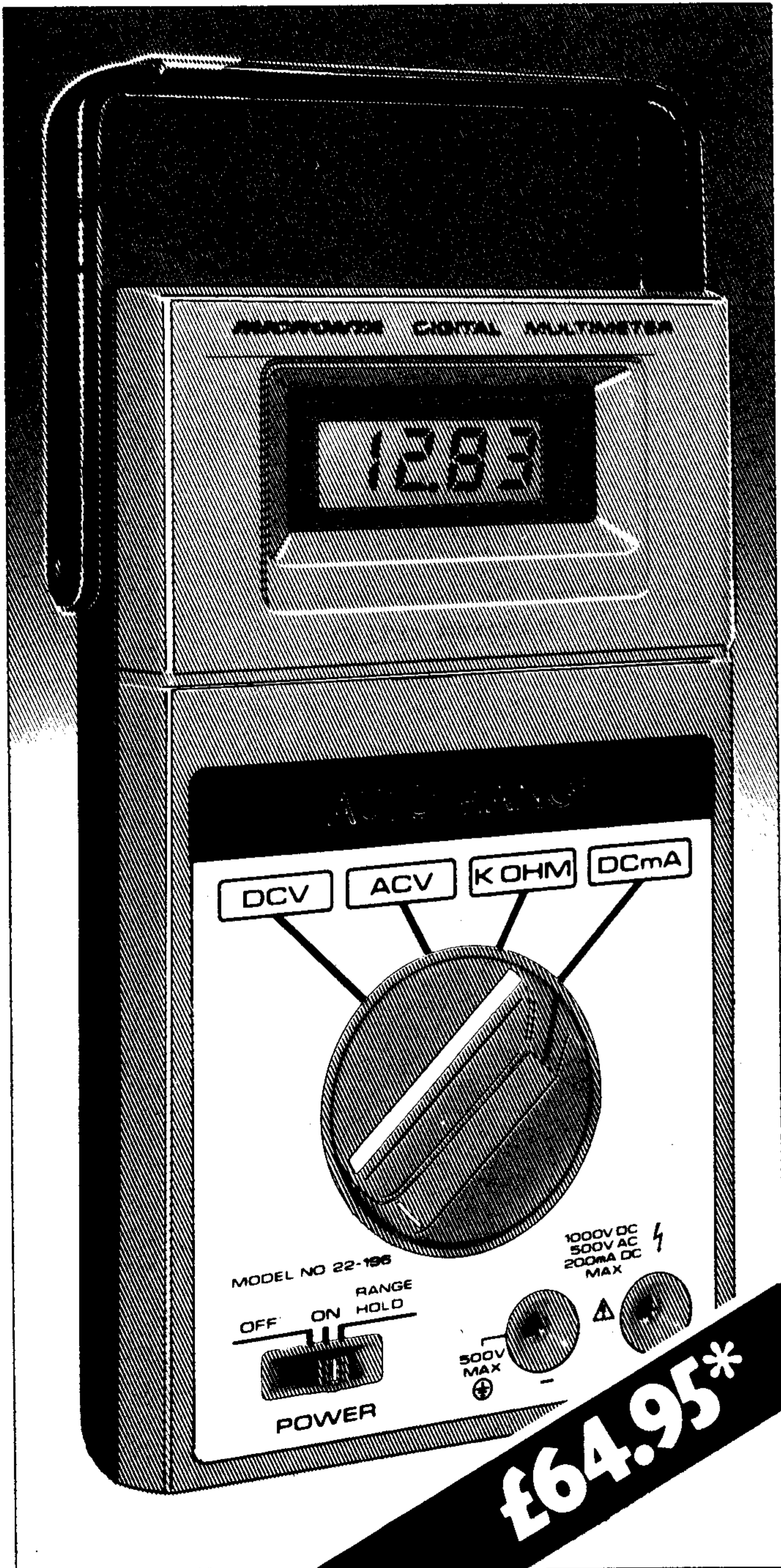
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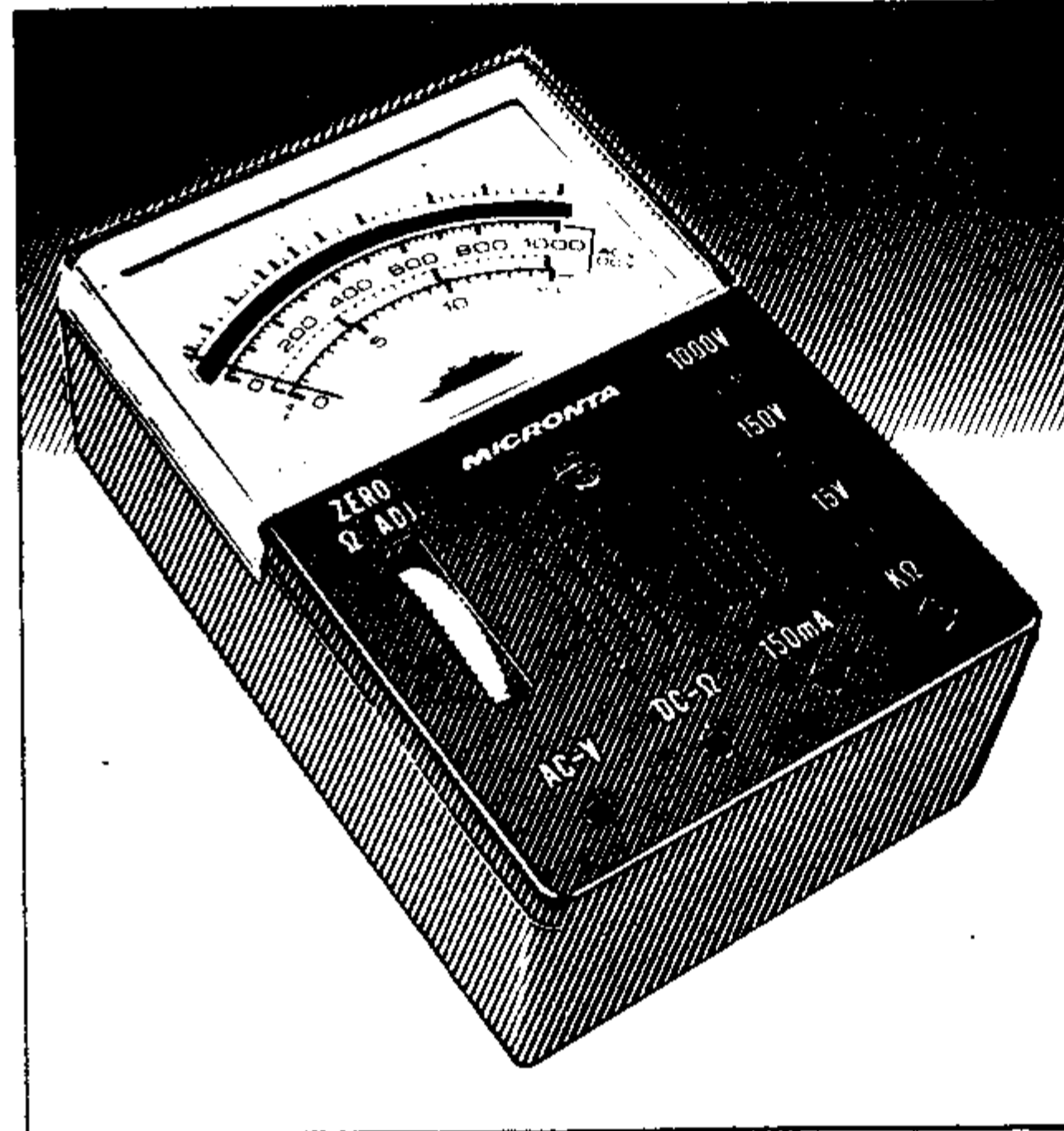
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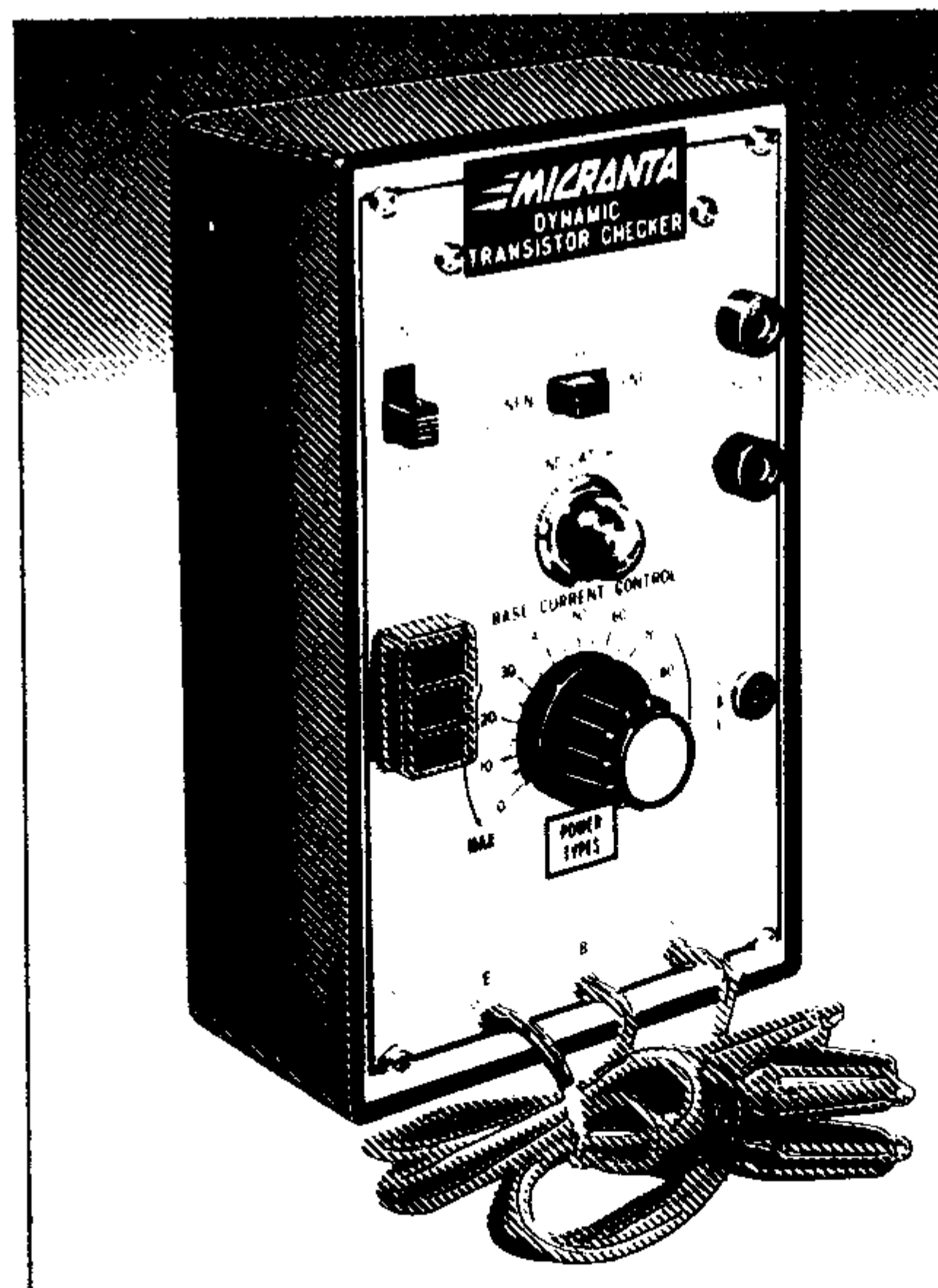
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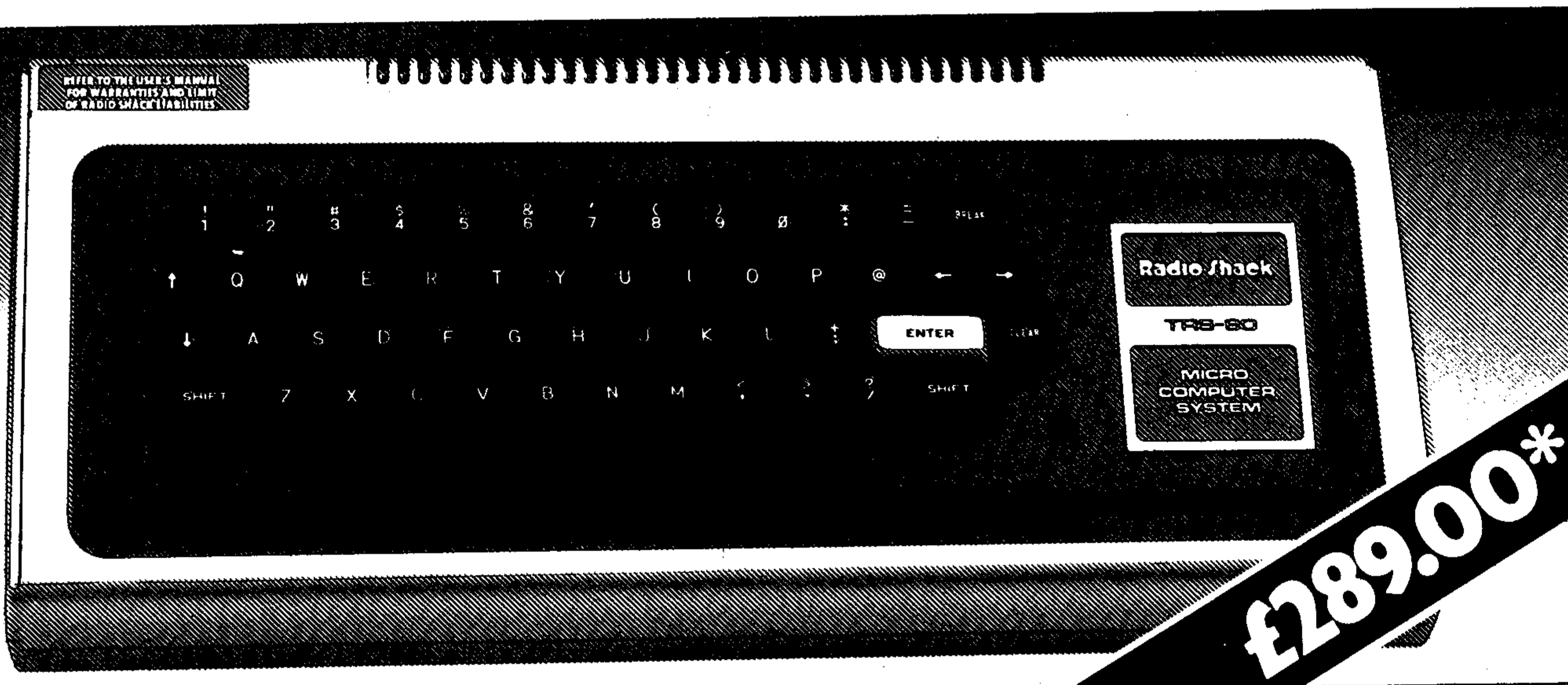
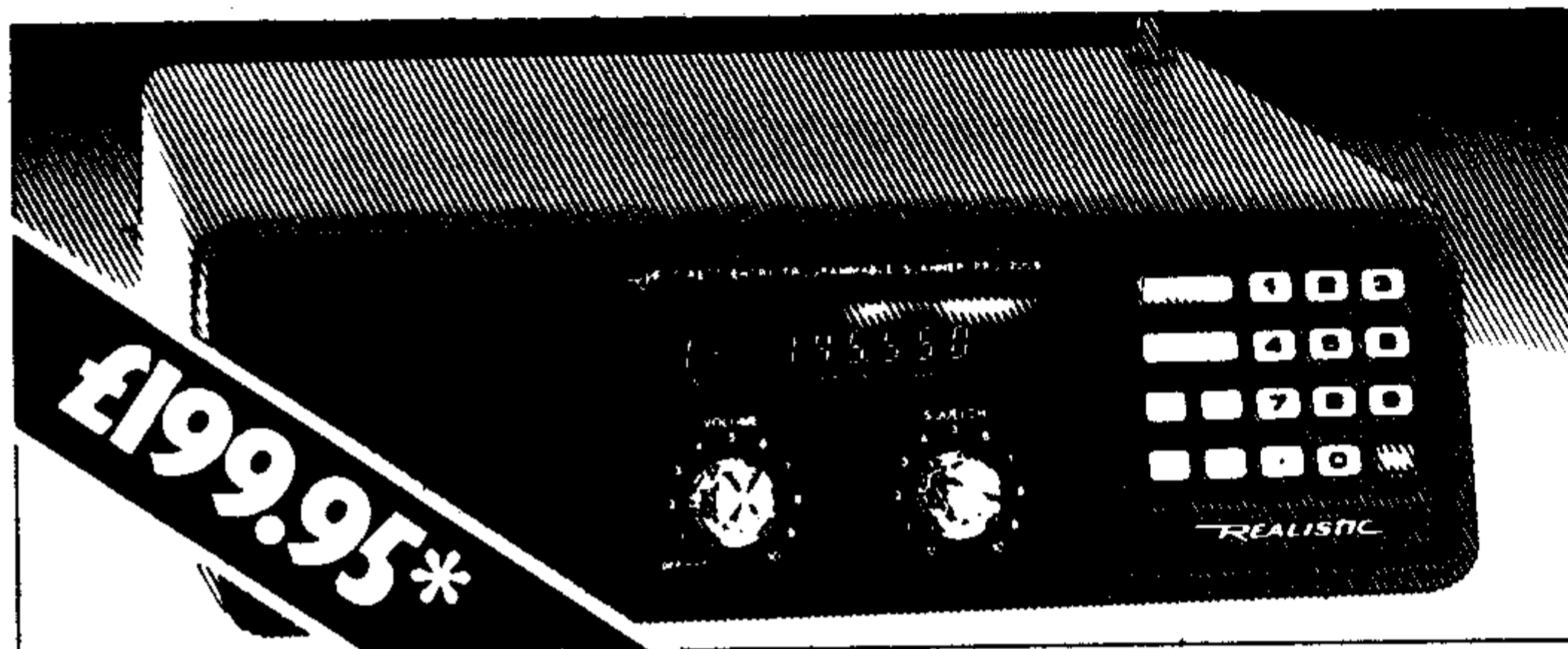


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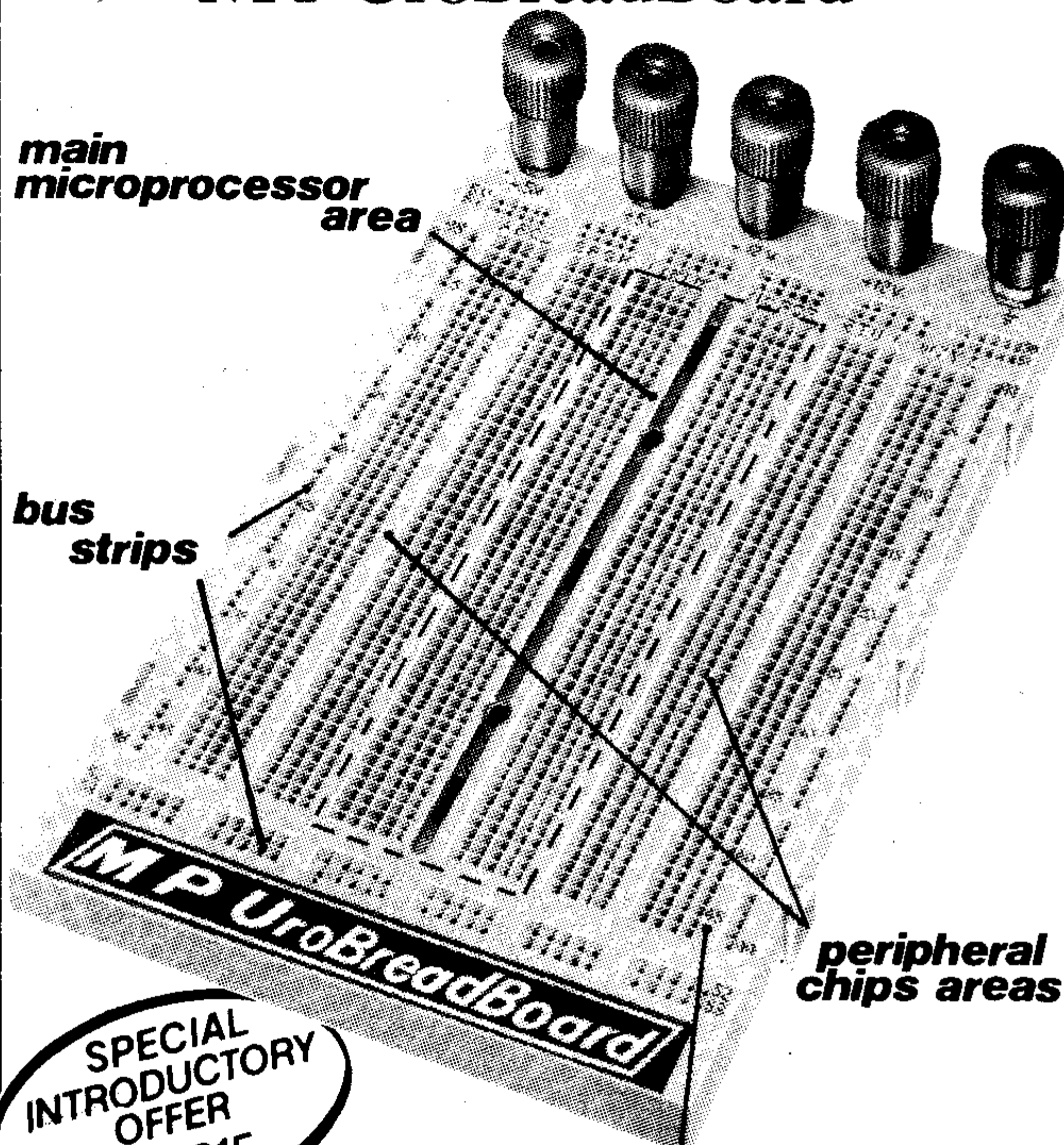


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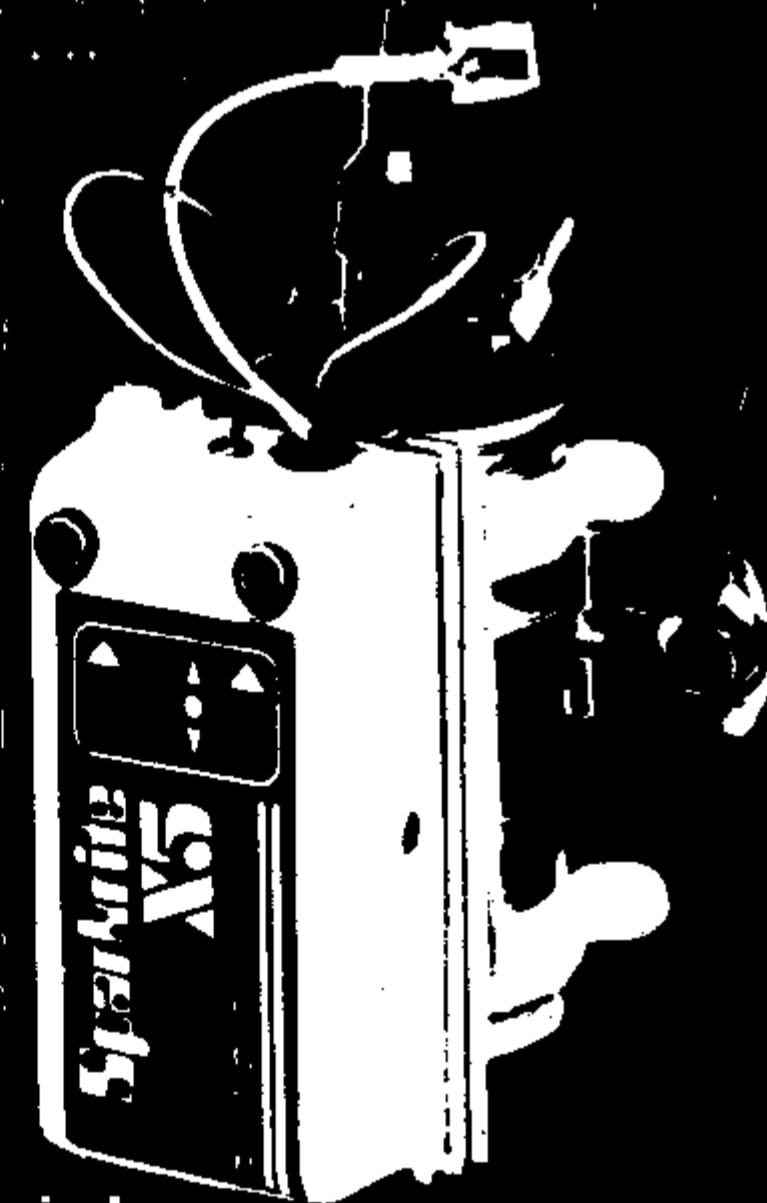
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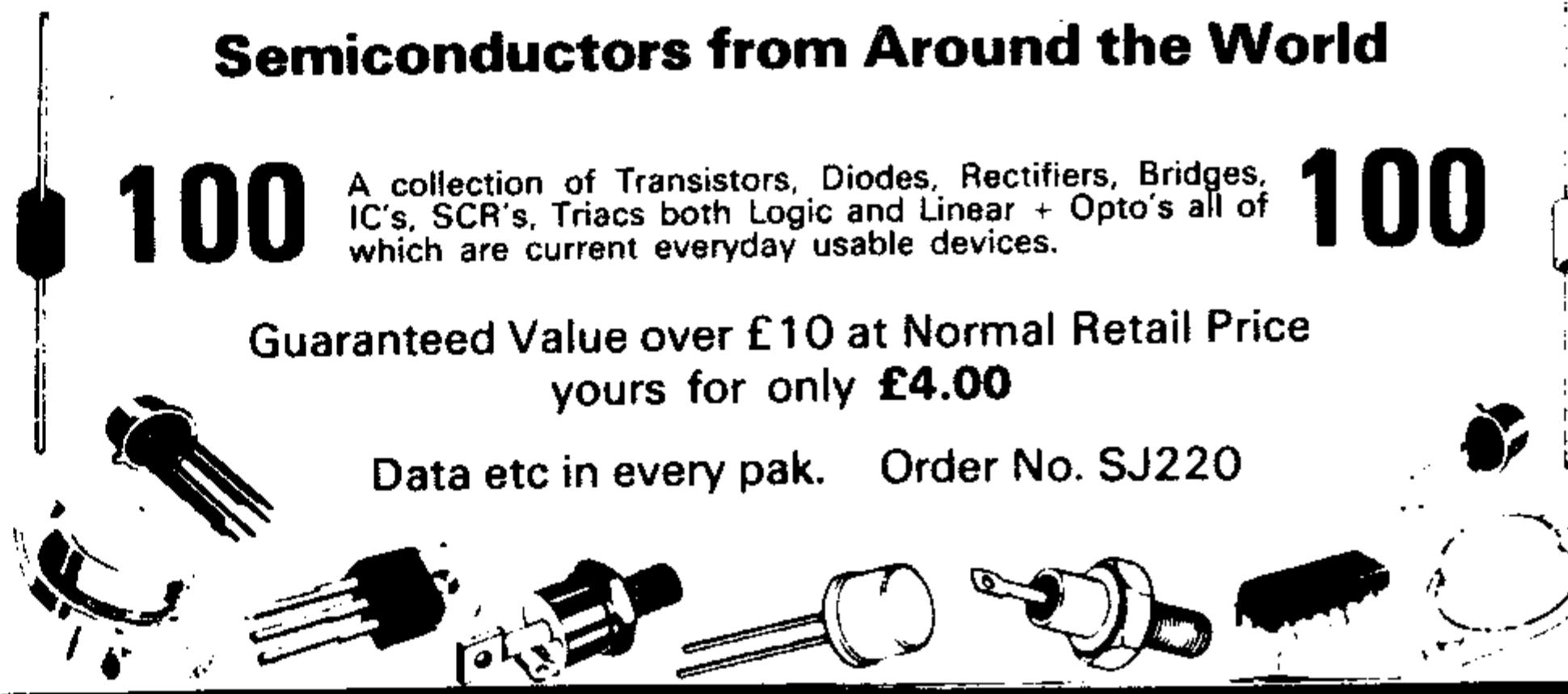


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SJ36 14 8 pin	SJ41 6 22 pin														
SJ37 12 14 pin	SJ42 5 24 pin														
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NE555	5 for £0.90														
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LM380	5 for £3.50														
72723 14 pin	5 for £1.75														
<p>HEADPHONE ACCESSORIES</p> <p>7 metre Headphone Extension Lead.</p> <p>O/No. 136. £1.50</p>	<p>ANTEX</p> <p>Antex X25 Iron - 25 watt soldering iron. OUR SUPER SALE PRICE. Great reduction.</p> <p>O/No. 1931. £4.00</p> <p>ST3 Iron Stand - Suitable for above - OUR Sale Price</p> <p>O/No. 1939. £1.25 each</p>	<p>SILICON TRANS.</p> <p>SJ25 100 Silicon NPN transistors all perfect & coded - mixed types with data - equivalent sheet - no rejects £2.50</p> <p>SJ26 100 Silicon PNP transistors all perfect & coded - mixed types and cases, data & equivalent sheet £2.50</p> <p>SJ27 50 Assorted pieces of SCR's, diodes & rectifiers incl. stud types, all perfect - no rejects, fully coded - data incl. £2.50</p>	<p>DISC CERAMIC CAP</p> <p>100 Disc Ceramic Cap. Mixed values covering complete range 3PF-4,700PF.</p> <p>SUPER VALUE</p> <p>O/No. SJ121. £1.00</p>												
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1507 10 Assorted colours & sizes	£0.65														
S122 10.125 RED	£0.50														
S123 10.2 RED	£0.50														
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<p>TRANSFORMERS</p> <p>MINIATURE MAINS Primary 240v</p> <table border="0"> <tr> <td>No. Secondary</td> <td></td> </tr> <tr> <td>2021 6v-0-6v 100mA</td> <td>£0.75</td> </tr> <tr> <td>2023 12v-0-12v 100mA</td> <td>£0.95</td> </tr> <tr> <td>2035 240v Primary 0-55v 2A Secondary</td> <td>£5.50</td> </tr> </table>	No. Secondary		2021 6v-0-6v 100mA	£0.75	2023 12v-0-12v 100mA	£0.95	2035 240v Primary 0-55v 2A Secondary	£5.50	<p>TRIACS</p> <p>4A 400v TO-202 non-isolated TAG136D £0.40</p> <p>8A 400v TO-220 isolated TAG425 £0.60</p> <p>Diac D32/BR100 £0.15</p> <p>SCR C106D plastic case £0.30</p>	<p>ODDMENTS</p> <p>16170 50 metres asst. colours single strand wire. £0.50</p> <p>16187 30 metres stranded wire mixed colours. £0.50</p> <p>16178 5 Main slider switches assorted. £0.50</p> <p>SJ76 1 Board containing 2x5-pin DIN sockets 180° & 2x2-pin DIN loudspeaker sockets. £0.30</p>	<p>KNOBBS</p> <p>SJ62 5 15mm chrome knobs standard push fit. £0.50</p> <p>SJ63 Instrument knob - black winged (29x20mm) with pointer. 1/4" standard screw fit. £0.15</p> <p>SJ64 Instrument knob - black/silver aluminium top (17x15mm). 1/4" standard screw fit. £0.12</p>				
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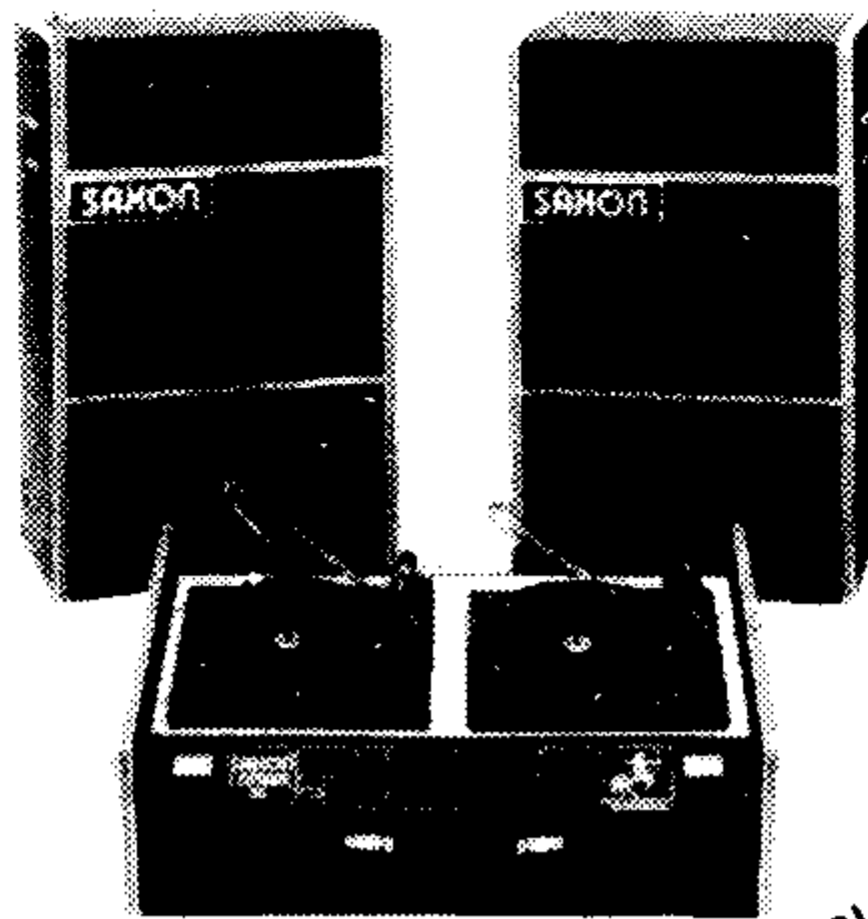
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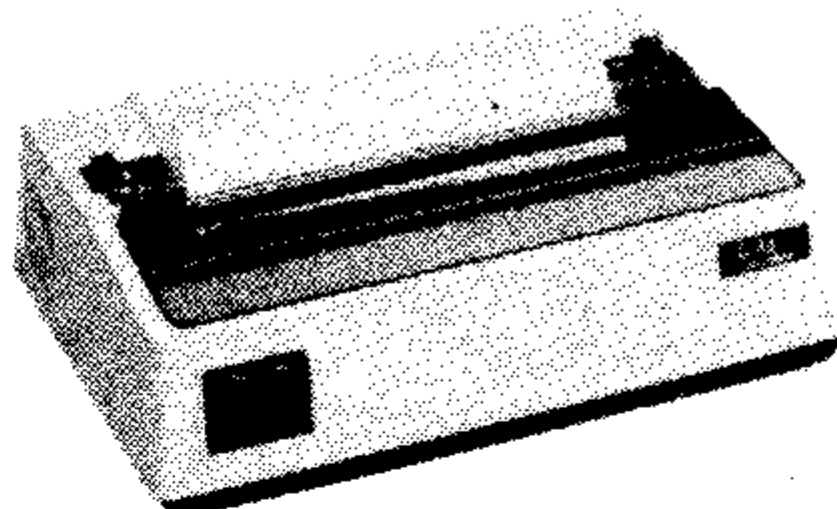
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TTP 452	8-33-2	5-68	120

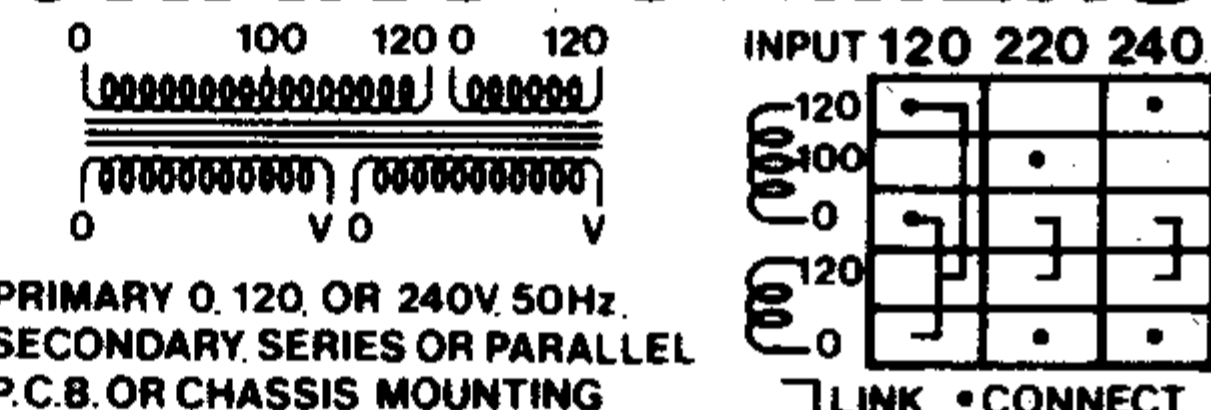
REF	AMPS	PRICE	P/P
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TTP 461	0-50-2	2-14	60
TTP 463	0-60-2	2-36	70
TTP 464	1-38-2	2-99	85
TTP 465	2-77-2	4-57	120
TTP 466	5-55-2	5-68	120

REF	AMPS	PRICE	P/P
TTP 467	0-25-2	1-79	50
TTP 468	0-38-2	2-14	60
TTP 470	0-50-2	2-36	70
TTP 471	1-04-2	2-99	85
TTP 472	2-08-2	4-57	120
TTP 473	4-16-2	5-68	120

REF	AMPS	PRICE	P/P
TTP 474	0-20-2	1-79	50
TTP 475	0-30-2	2-14	60
TTP 477	0-4-2	2-36	70
TTP 478	0-83-2	2-99	85
TTP 479	1-66-2	4-57	120
TTP 480	3-33-2	5-68	120

REF	AMPS	PRICE	P/P
TTP 495	0-13-2	1-79	50
TTP 496	0-19-2	2-14	60
TTP 498	0-25-2	2-36	70
TTP 499	0-52-2	2-99	85
TTP 500	1-04-2	4-57	120
TTP 501	2-08-2	5-68	120

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REF	AMPS	PRICE	P/P
TTC 448	0-5-2	1-85	50
TTC 447	0-75-2	2-20	60
TTC 449	1-0-2	2-45	70
TTC 450	2-08-2	3-10	85
TTC 451	4-18-2	4-70	120
TTC 452	8-33-2	5-85	120

REF	AMPS	PRICE	P/P
TTC 467	0-25-2	1-85	50
TTC 468	0-38-2	2-20	60
TTC 470	0-50-2	2-45	70
TTC 471	1-04-2	3-10	85
TTC 472	2-08-2	4-70	120
TTC 473	4-16-2	5-85	120

REF	AMPS	PRICE	P/P
TTC 495	0-13-2	1-85	50
TTC 496	0-19-2	2-20	60
TTC 498	0-25-2	2-45	70
TTC 499	0-52-2	3-10	85
TTC 500	1-04-2	4-70	120
TTC 501	2-08-2	5-85	120

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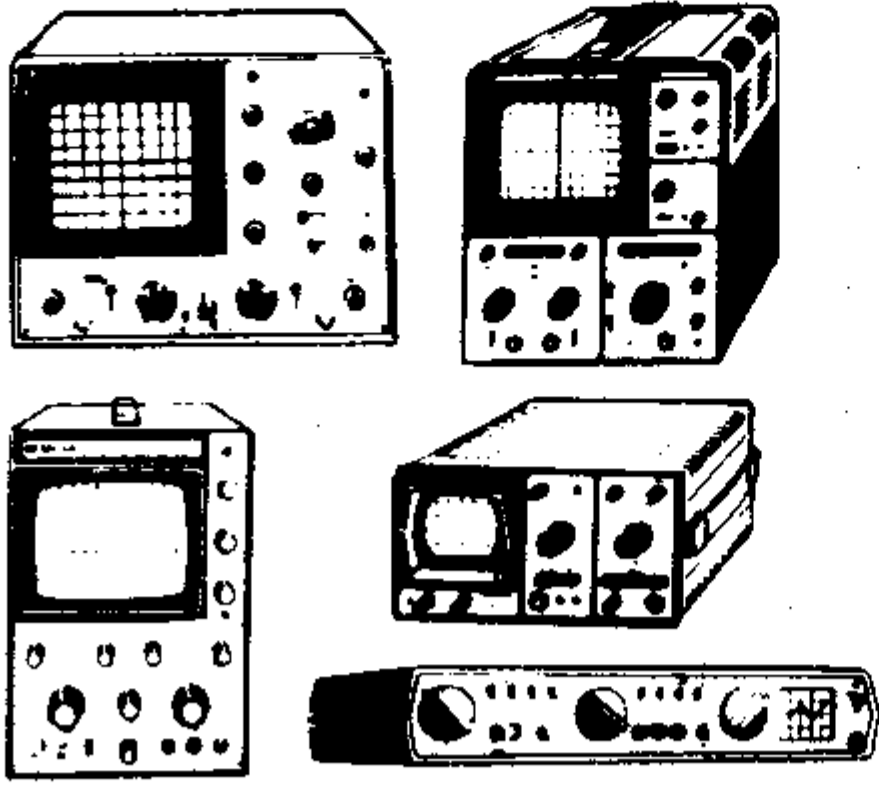
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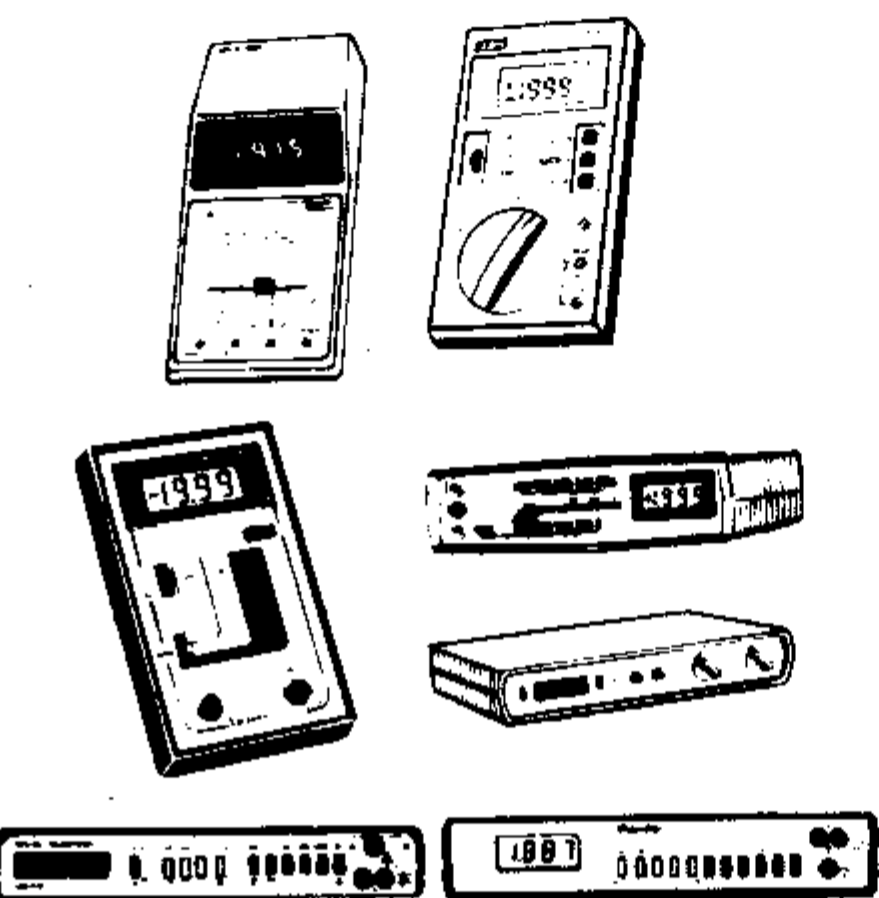
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HAND HELD

- (UK post etc 85p)
- TM352 3 1/2 Digit LCD plus 10ADC and Hfe checker £54-95
- PDM35 3 1/2 Digit 16 range LED (no AC current) £32-95
- ME502 3 1/2 Digit LED plus 10A DC and Hfe checker £43-95
- LM2001 3 1/2 Digit LCD 2 amp AC/DC 0-1% £51-70
- 6200 3 1/2 Digit LCD 0-2A AC/DC, Auto range £39-95
- 6220 As 6200 plus 10A AC/DC £49-95
- 6100 As 6200 plus Cont. test/range hold £59-95
- 6110 As 6100 plus 10A AC/DC £74-95

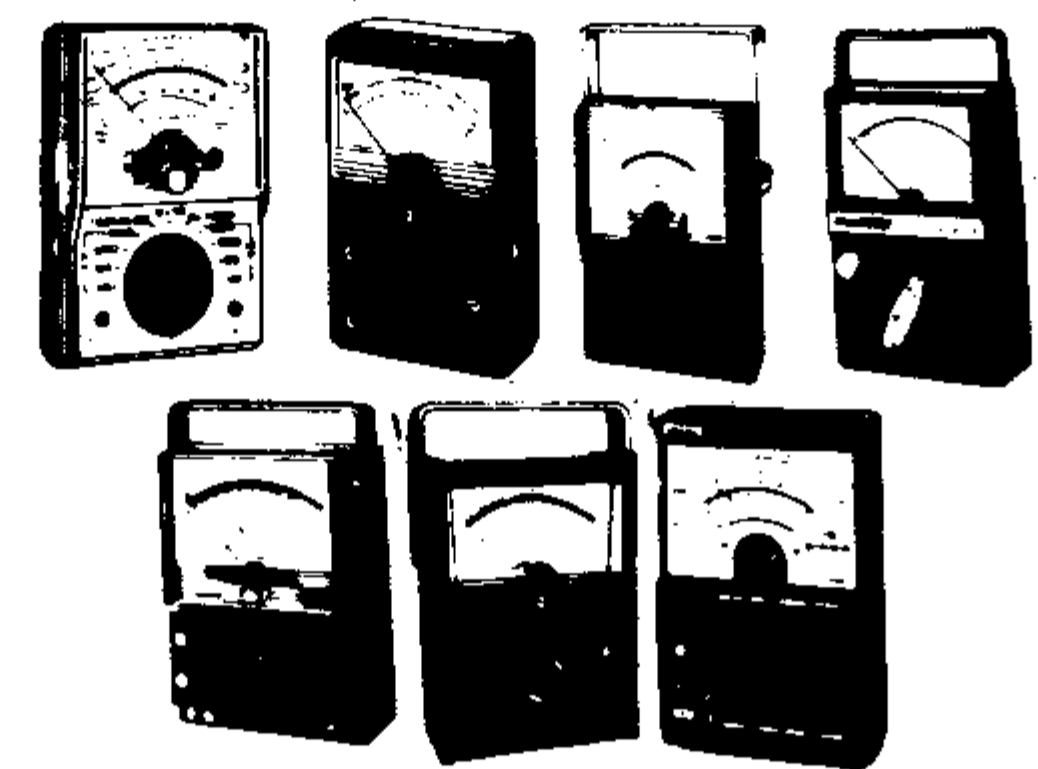
A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors—some with optional Nicads. All supplied with batteries and leads.

BENCH PORTABLES

- (UK c/p £1-00)
 - DM235 3 1/2 Digit LED 21 ranges, 0-5% AC/DC 2A £56-50
 - DM350 3 1/2 Digit LED 34 ranges, AC/DC 10A £78-50
 - TM353 3 1/2 Digit LCD AC/DC 2 amp £86-50
 - TM351 3 1/2 Digit LCD AC/DC 10 amp £107-95
 - LM100 3 1/2 Digit LCD AC/DC 2 amp £86-50
 - DM450 4 1/2 Digit LED 34 ranges, AC/DC 10 amp £107-95
- (DM series options: Carry case £8-80, Nicads £7-95, Mains adaptor £4-00.)

MULTIMETERS

(UK post etc 75p)

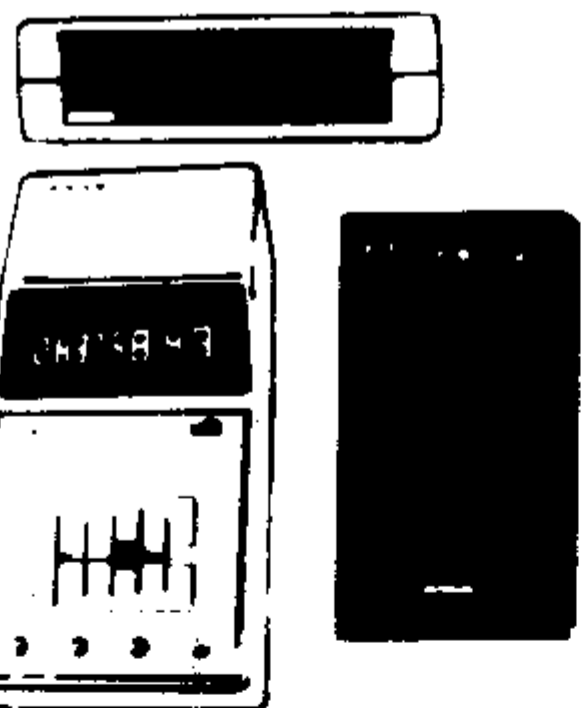


- KRT101 1K/Volt 10 range pocket £4-50
- ATM1/LT1 1K/Volt 12 range pocket £5-95
- NH55 2K/Volt 10 range pocket £6-95
- ATI 2K/Volt 12 range pocket de luxe £7-95
- NH56 20K/Volt 22 range pocket £10-95
- YN360TR 20K/Volt 19 range pocket plus hfe test £13-95
- AT1020 20K/Volt 19 range de luxe plus hfe test £16-95
- 7081 50K/Volt 36 range plus 10 amp DC £19-95
- TMK500 30K/Volt 23 range plus 12A DC/Cont. test £21-50
- AT20 20K/Volt 21 range de luxe plus 10A DC and 5KV DC £21-95
- AT205 50K/Volt 21 range de luxe plus 10A DC £24-95
- 7080 20K/Volt 26 range large scale, 10A DC plus 5KV AC/DC £26-95
- AT2050 50K/Volt 18 range de luxe plus hfe test £28-50
- AT210 100K/Volt 21 range de luxe 12A AC/DC £29-95
- 360TR 100K/Volt 23 range plus hfe checker and AC/DC 10 amps £34-95

FREQUENCY COUNTERS



Portable and Bench LCD and LED Counters up to 600mHZ. Prices include batteries and leads.



HAND HELD (UK post etc 85p)

- PFM200 20HZ to 200mHZ 8 Digit LED £54-50
- MAX50 100HZ to 50mHZ 6 Digit LED £61-00
- MAX550 30KHZ to 550mHZ 6 Digit LED £106-00

BENCH PORTABLES

- (UK c/p £1-00)
- MAX100 8 Digit LED 5 Hz to 100mHZ £89-00
- TF200 8 Digit LCD 10HZ to 200mHZ £158-95
- 7010A 9 Digit LED 10HZ to 600mHZ £169-00
- 200SPC 6 Digit 100mHZ LED built into 0-002HZ to 5-5mHZ pulse generator £437-00
- TP600 600mHZ Prescaler for TF200 £41-00

CSC ● SINCLAIR ● SPC ● OPTO ELECTRONICS

SOLDERLESS BREADBOARD AND KITS

- EXP350 £3-45
 - EXP300 £5-95
 - EXP660 £3-95
 - EXP600 £6-50
 - KITS
 - PB6 £9-95
 - PB100 £12-95
 - PB101 £17-95
- (UK c/p - EXP's 30p. KITS 55p)

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- (9-12 Volt 1/4" chucks)
- Small Drill plus 3 collets £7-25
- Medium Drill plus 3 collets £10-50
- Small Drill plus 20 tools £14-95
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- Mains Drill £13-95
- Mains Drill plus 20 tools £21-50

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Stockists of electronic equipment, speakers/kits, PA equipment plus huge range of accessories ● UK carriage/packing as indicated ● Export - prices on request ● All prices correct at 1/12/80 E & OE ● All prices include VAT.

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NEW

PRACTICAL ELECTRONICS PROJECT 125 WATT POWER AMP KIT

SPECIFICATIONS

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

The P.E. power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, the

output stage uses four 115 watt transistors normally only two would be used, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chassis is preformed and ready to use, supplied with all parts and circuit diagrams.



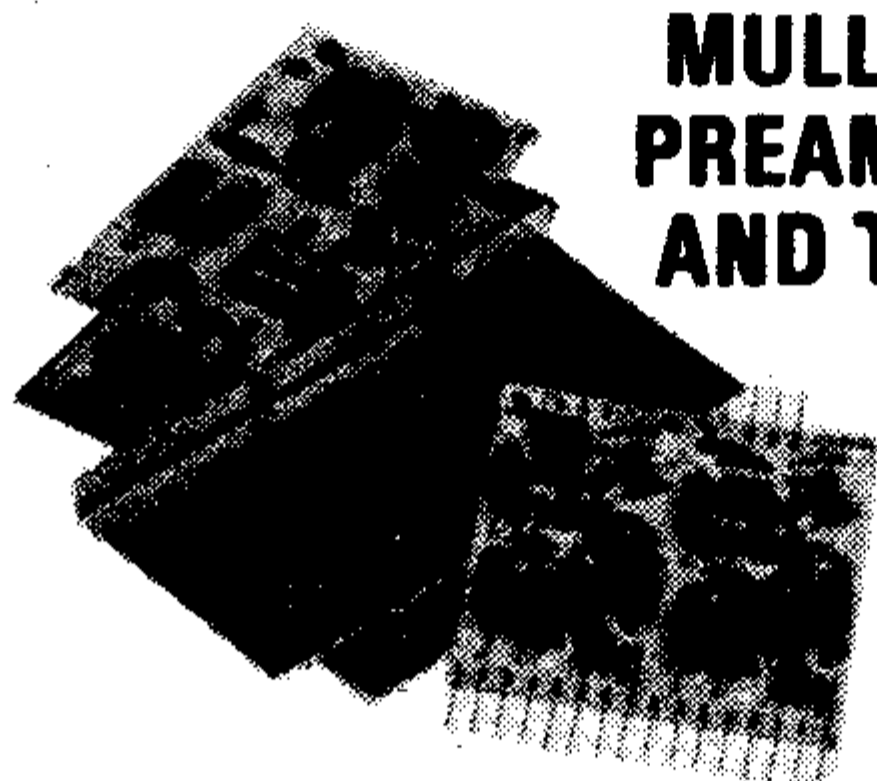
AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

£9.50 plus £1.00 p&p

125 watt power amp kit
ACCESSORIES £1.00 plus 20p p&p

Suitable L.S. coupling electrolytic
 Suitable Mains Power Supply Unit
£7.50 plus £2.75 p&p
 sufficient for one power amp

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES



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

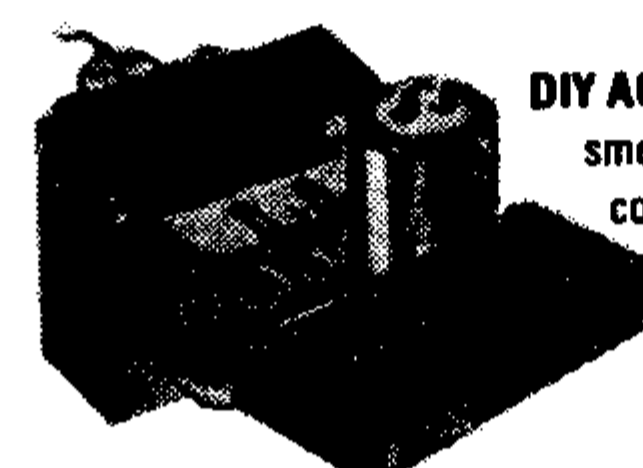
In easy to build form P.C.B.s backprinted, etched and drilled ready to use.

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

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

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

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



DIY ACCESSORIES Mains transformer smoothing capacitor rectifier 4 x slider controls, for base, treble and volume.

£3.00 plus £1.60 p&p

ACCESSORIES: Available only at time of purchase of Bargain Packs

12 + 12 WATT AMPLIFIER KIT NOTE: for use with 4 to 8 ohms speakers.

With up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit. Size 9 1/4" x 8 3/4" x 4" approx.

£13.95 plus £2.55 p&p

NOTE: for use with 4 to 8 ohms speakers.

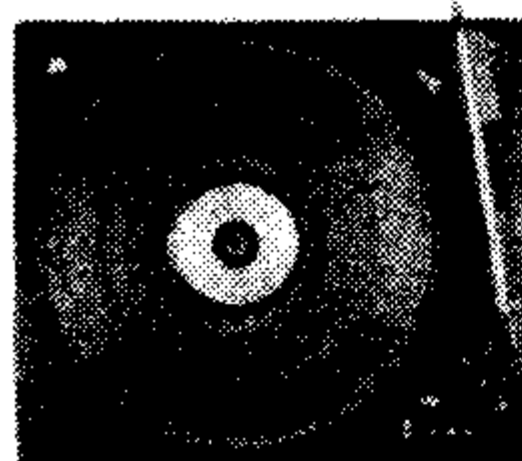
BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge



£8.50 plus £2.75 p&p when purchased with amplifier. Available separately **£10.50** plus £2.75 p&p.

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

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



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



£12.25 OUR PRICE plus £2.75 p&p Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037 Size approx 15 1/4" x 12 1/2"

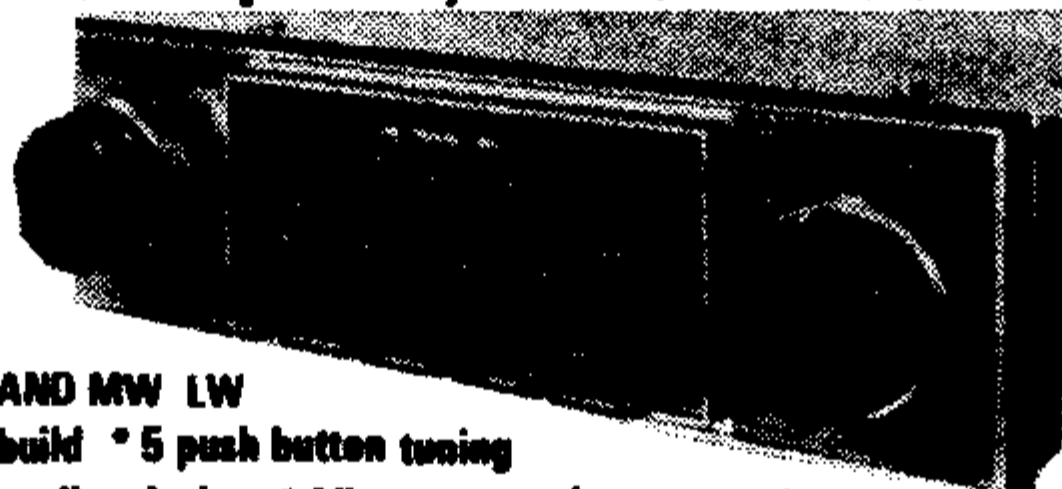


Hi Fi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge—**LIMITED STOCK. UNBEATABLE OFFER AT**

£27.50 complete plus £2.75 p&p

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

PRACTICAL ELECTRONICS CAR RADIO KIT £10.50 (Constructors pack 7) plus £1.75 p&p



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

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.

The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.

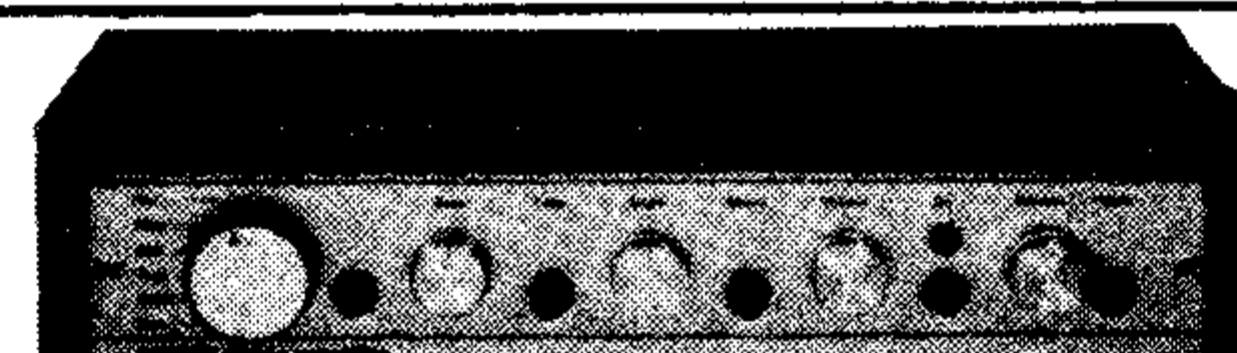
Complete with instructions.

CONSTRUCTORS PACK 7A

Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack, p&p £1.00. Pack 7A may only be purchased at the same time as Pack 7.

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

FEATURED PROJECT IN PRACTICAL ELECTRONICS.



30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder, DIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14 1/4" x 10" approx.

READY TO PLAY £32.90 plus £3.30 p&p



323 EDGWARE ROAD, LONDON W2 21B HIGH STREET, ACTON W3 6NG

ACTON: Mail Order only. No callers
ALL PRICES INCLUDE VAT AT 15%
 All items subject to availability. Price correct at 18.11.80 and subject to change without notice.
 For further information send for instructions

NOTE: 20p plus stamped addressed envelope. Persons under 16 years not served without parent's authorisation.

BARGAIN OFFER!!



ARISTON PICK UP
 Ariston pick-up arm manufactured in Japan. Complete with headshell. Listed price over £30.00 **OUR PRICE £11.95** plus £2.50 p&p

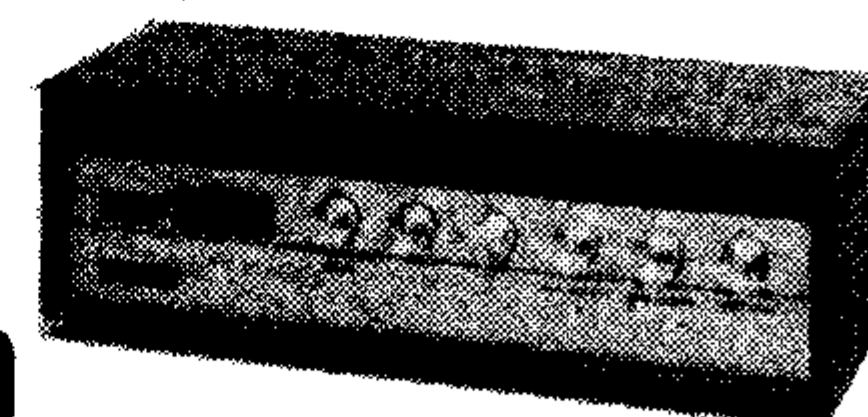
100 WATT MONO DISCO AMPLIFIER

Brushed aluminium fascia and rotary controls. Size approx 14" x 4" x 10". Five vertical slide controls, master volume, tape lever, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

£76.00 plus £4.00 p&p

50 WATT MONO DISCO AMPLIFIER

Size approx 13 1/2" x 5 1/4" x 6 1/2". 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.



£30.60 plus £3.20 p&p

CB OR NOT CB

AS THE CB battle reaches a peak with the big industrial companies now getting involved by putting in their response to the Green Paper, we begin to wonder if it is too late anyway. A view first expressed by PE back in August 1979 was that unless the Government got things moving the illegal use of 27MHz would grow to such an extent that it would be impossible to ever clear the band again.

The import and sale of 27MHz equipment has been "legally" going on for some time; the law is circumvented simply by cutting a link or wire in the transceivers to prevent the transmitter working. The break is pointed out to the purchaser, but of course the salesman cannot tell him to reconnect it!

There also appears to be a great deal of misunderstanding over what is legal, with some buyers assuming or being misled into believing that equipment working on frequencies other than 27MHz can be legally used. We should like to point out to any reader who is in doubt over the law that any transmitting equipment of this type is illegal unless it uses an amateur band and the operator has passed the Radio Amateurs Examination and has ob-

tained a licence. This includes, for instance, a number of remote telephone systems now being sold.

The use of 27MHz CB transceivers is totally illegal and there are many cases of fines and confiscation of equipment on record (during the first 9 months of this year 325 persons were convicted for unlicensed installation and/or use of 27MHz CB radios).

The problem is that it is not an antisocial crime, in that the use of CB does not normally do anyone any harm. The Government have said they are in favour of Open Channel, as they call it, and all we now need is a workable frequency—which they have repeatedly said will not be 27MHz—and the legalisation.

In the meantime only imported equipment is being sold, so no British company is making any money by producing the sets, and since their use is illegal, there is no type approval etc. We are simply creating a jungle.

PE AND CB

Next month PE will be publishing a converter capable of receiving transmissions between 26 and 30MHz. It is not our deliberate intention to encourage the use of 27MHz CB and we would like to make it quite clear to

readers that under the Wireless Telegraphy Act 1949 it is an offence to listen to CB transmissions without a licence. However virtually all v.h.f. f.m. receivers sold are capable of receiving transmissions that you cannot legally listen to. Our converter will tune to the perfectly legal 10 metre amateur band transmissions, but of course can also be used to listen to CB.

Should we publish a receiver that could encourage people to listen illegally? The question is a difficult one, and one that we have pondered for many months. Our feelings are that if one person breaks the law by listening, rather than buying a transceiver and transmitting, then perhaps we are helping, rather than hindering, the situation. We will publish and give you the chance to decide. Your views would be of interest.

We have written to the Home Office with some questions about these legal points and we will publish the correspondence next month. In the meantime let's hope Mr Whitelaw will get things moving and provide a usable band soon, before we are all forced to accept 27MHz and totally disregard the law.

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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to one published project only.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4.30 each to UK or overseas addresses, including

postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £11.80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

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.

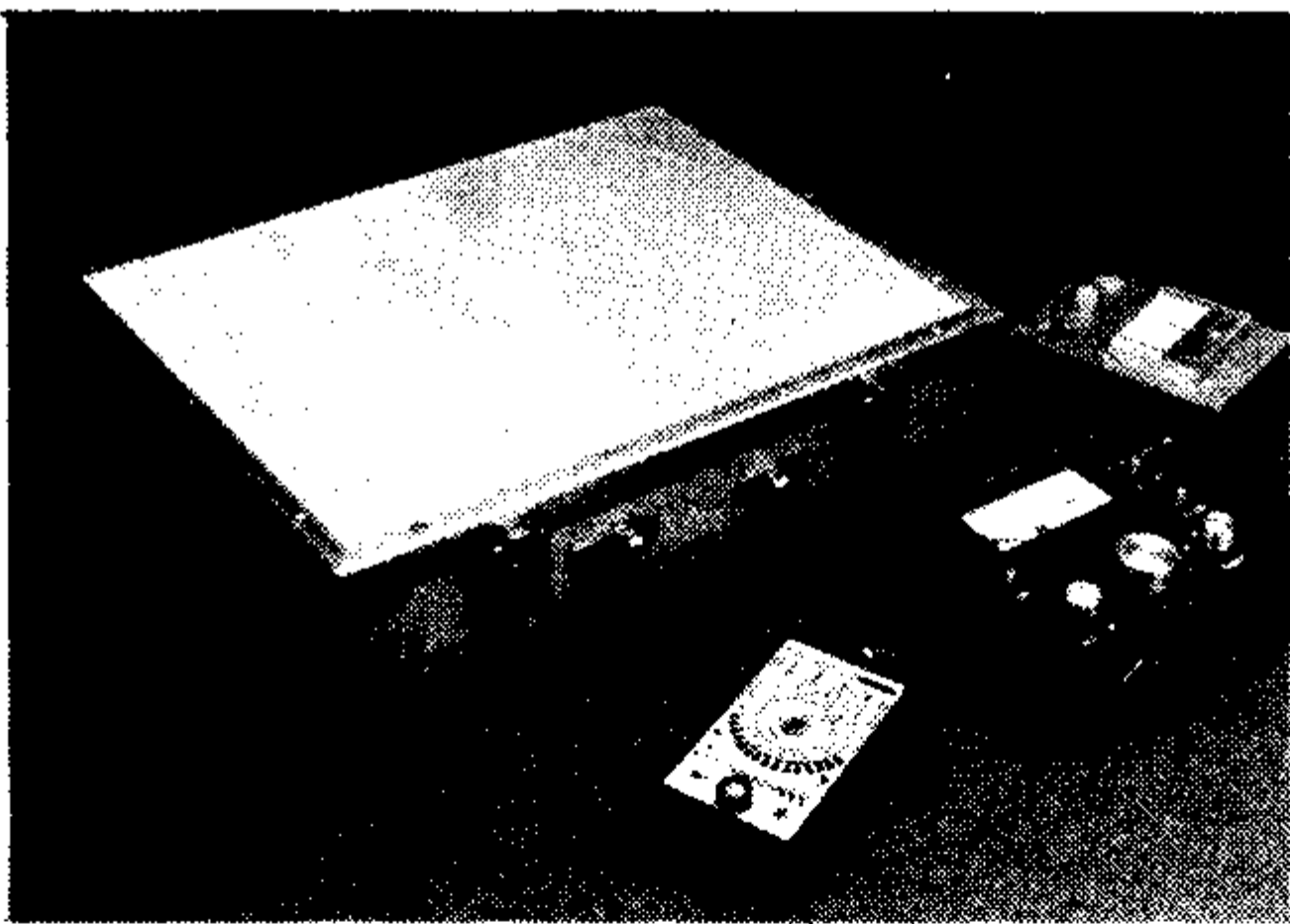
by
David Shortland

and
Jasper Scott

A CASE OF PROTECTION

A "brief case" for electronics engineers from Nefab in steel reinforced plywood is designed to protect fragile electronics components or instruments and is claimed to be unbreakable in normal use, yet is exceptionally lightweight.

The tough 4mm surfaces in natural wood finish are as durable as twice the thickness of softwood. They are further bonded by self-rivetting galvanized steel plate that gives four times the strength of conventionally rivetted steel. Double treated with thermoset resin, all surfaces are rust proof, anti-static, and resistant to flame, weather, alcohol and most solvents.



Weighing only 4½lbs (2.2kg), the case has a carrying handle, two catches and can be readily locked for greater security. Measuring 17" x 13½" x 4" (420 x 340 x 95mm), the Nefab all-weather safety case should look equally in place in the office or workshop. Priced at £25 including VAT, postage and packing, it is available from:

Nefab Ltd, 6 Osyth Close, Brackmills, Northampton NN4 0DZ. (0582 22943)

Q AND A ANSWERPHONE

Ansamatic Limited have just launched a sophisticated telephone answering system which acts as a message taker, information giver, dictation/transcription unit and recording machine. The new model combines the functions of two or three conventional systems, and adds a new dimension to telephone answering by leading a caller through what might be a very complex message by asking questions and giving the caller time to reply before moving on.

This ability is of benefit to organisations which receive numerous telephone calls of a similar nature such as orders for goods, spare parts, etc or sales representatives' reports. On being connected, the caller hears a message of explanation recorded by the user before the unit moves into its QA mode, asking questions (eg customer number, address, goods required, date required by, etc) and waiting for replies to be completed. The machine moves onto the next question when a gap of four seconds occurs in the caller's speech.

One major advantage of the system is that information is presented to the user in a standard format thus making the job of processing telephone messages considerably more efficient. It also ensures that the caller imparts all the information necessary for his or her call to be dealt with properly.

If the line of questioning on the user's cassette does not coincide with a caller's reasons for telephoning, that caller can still leave a message in the normal way.

Apart from its "QA" capability, the Doro 721 QA provides a range of other facilities. It can be used as a standard telephone answering machine, with variable announcement

messages up to 15 minutes long.

In addition, the unit will record two-way telephone conversations and features a switch to screen the incoming call. As a dictation machine the unit features both mini and standard cassettes, an electret condenser microphone, one-hand control for dictate, stop, playback and unlimited backspace, slider controls for tone, volume and playback either through the microphone or speaker.



The 721 QA also acts as a transcription unit, using either mini or standard cassettes, and featuring rotary speed control, fingertip control to automatic rewind and fast erase (with automatic shut-off at the end of either function on a standard cassette), adjustable automatic backspace for up to seven words, and adjustable lightweight headset and sturdy foot pedal.

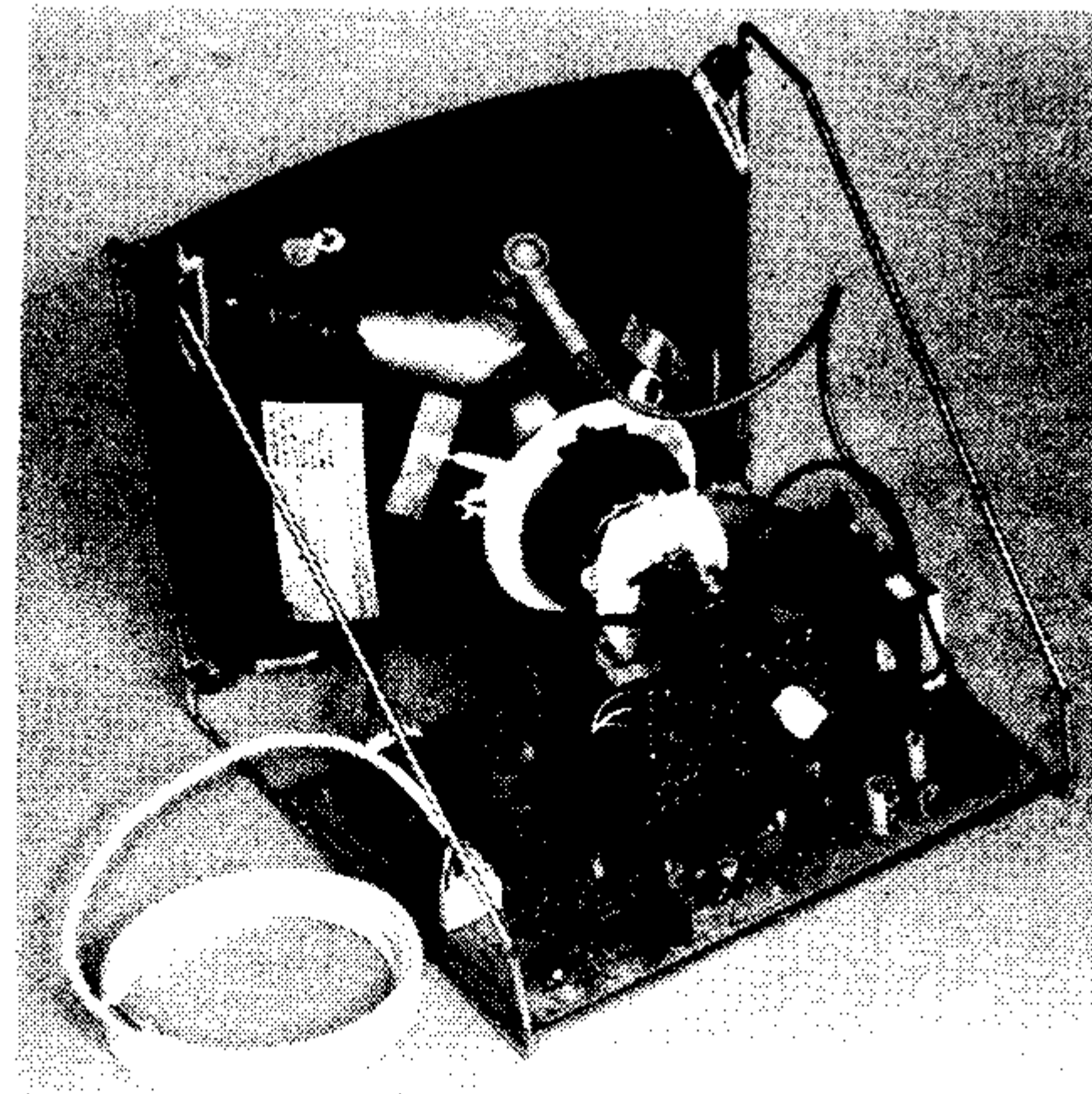
The Doro 721 QA is available from Ansamatic Limited either on a rental basis or at a purchase price of £575.00 (ex. VAT).

Ansamatic Limited, Viatron House, 928 High Street, Finchley, London N12 9SL

LCCD

A new idea in visual display has been developed by Microvitec Limited. At the heart of their design is a LCCD* (Low Complexity Colour Display), which has a direct digital interface for video data.

Currently, most manufacturers of small computer, Viewdata and video game systems requiring a colour display use standard or specially modified domestic television receivers. This often restricts the overall performance because such receivers are designed to operate from a broadcast standard signal where colour information is encoded on a composite video waveform and modulated onto an r.f. carrier. This creates various sub-systems and each processing stage introduces distortion, noise and bandwidth limitations.



The LCCD dispenses with all these sub-systems. It has a separate input for each of the red, blue and green channels. This offers the advantages of low complexity with high technical performance and direct compatibility via the logic interface with computer or alpha/graphic systems.

Because of the wide bandwidth of the LCCD it can display up to 80 characters per line on a 20" screen. For graphical displays resolutions of 492(H) x 585(V) are obtained. This makes it ideally suitable for small computer systems and information displays such as Prestel (UK Viewdata system).

Power consumption by the LCCD is low at around 50W. This has been achieved by using an efficient switch mode power supply which gives a high order of stabilisation against mains and load variations together with a 4kV isolation barrier.

The LCCD is offered with a 14 inch (72 characters per line) or 20 inch screen. It is despatched either as a complete boxed item for desk top use, or in a nickel plated steel frame, which can easily be built into one off systems. The same electronics are used for both the 14 and 20 inch models.

The price of the monitors start at £185.00 excluding VAT. **Microvitec Ltd, PO Box 188, Bradford BD8 9HH**

BOOK CATALOGUE

Babani Books have just published their latest catalogue of radio, electronic and computer books. The catalogue covers just under one hundred titles with a brief synopsis of each book.

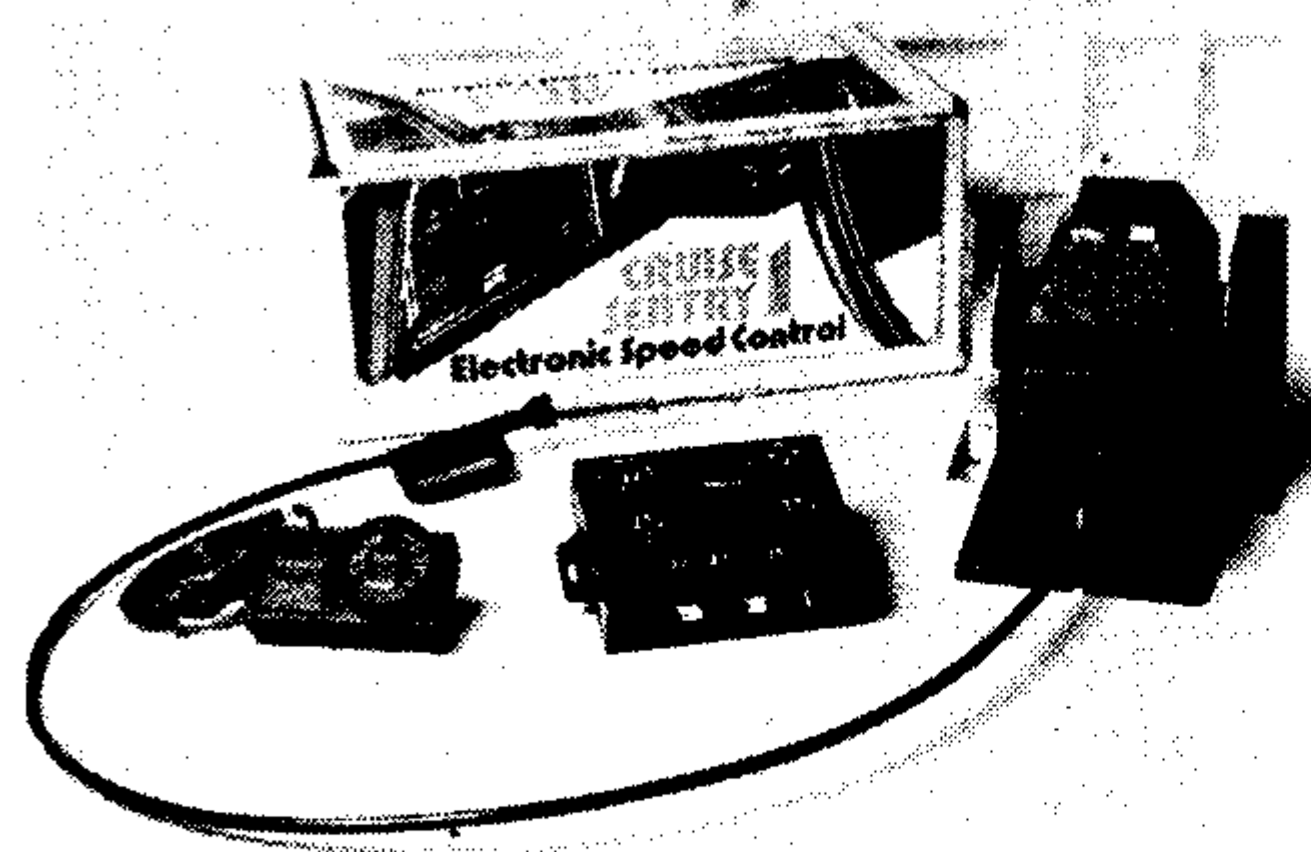
The catalogue is available free of charge by enclosing a SAE to **Bernard Babani Ltd., The Grampians, Shepherds Bush Road, London W6 7NF**

DIY CRUISE CONTROL

Traditional electronic cruise controls, achieve throttle control by means of a vacuum servo unit, which means that the installer has to cut into the vacuum line. Furthermore this system requires adaptor kits depending on the vehicle and has to be fine-tuned during a test ride following installation and whenever the vacuum in the manifold changes.

Cruise Sentry employs a small electric servo unit to accurately control the throttle, which does away with the need to cut into the vacuum line, while speed related pulses can be simply derived from the coil, whether the vehicle has standard or automatic transmission, 4-6-8 cylinder engine, standard or electronic ignition. The unit is universal for most vehicles, does not require fine-tuning, is virtually maintenance free and can be installed in 2 hours.

With Cruise Sentry the driver can take his off the accelerator and cruise at a preset speed



to maintain safe, legal speeds, save fuel and reduce driver fatigue.

The preset cruising speed can be modified at any time, without the need to disengage the system. Cruise Sentry can be overridden by depressing the accelerator and will automatically resume the preset speed. The system can be disengaged by any one of 3 ways for driver safety, e.g. depress the brake pedal, "push-in" the speed dial or by the special inertia switch mounted to the firewall, which is activated when the vehicle is braked.

The unit is priced at £78.50 plus VAT and p&p. **Enviro Systems Ltd, Hampsfell Road, Grange-over-Sands, Cumbria LA11 6BE**

VIDEO CARE

Bib, well known for their wide range of hi-fi accessories have now come up with two useful products for the steadily increasing home video market.

The Bib Video Tape Eraser (pictured below) is able to erase both visual and audio signals from either VMS or Betamax cassette tapes. Bib point out that many machines do not erase tapes sufficiently, resulting in poor image quality and background noise. The Bib eraser has a powerful 2420 Gauss magnetic field to ensure that erased tapes are completely signal free.



TOUCH TESTER

A new test instrument from Non Linear Systems measures 10 parameters and 20 functions using 44 ranges.

The Touch Tpst 20 is a 3½ digit multimeter with 0.55" i.e.d. display and front panel touch keyboard for selection of function and range. On selecting the desired function the least sensitive range is automatically displayed and the optimum display reading is obtained by touching the decade touch pads. The selection of function and range is indicated by an audible tone and illuminated i.e.d. at each pad.

In addition to the usual multimeter func-

The Bib VHS Taper Cleaner incorporates a specially formulated cleaning tape in a standard VHS cassette. To clean the heads on your recorder the cassette should be "played" for about 15 seconds. There is enough tape in the cassette for at least 20 cleaning operations, which would give about 2 years service with normal use.

Available from good video retailers, the Tape Eraser is priced at £20.70 and the VHS Tape Head Cleaner at £9.98. Both prices include VAT.

DIY CLOSED CIRCUIT

Photo-Scan of Sunbury—specialist CCTV manufacturers and designers of professional surveillance systems for retail, commercial and industrial security—are offering special low cost CCTV packages to amateur enthusiasts.

The packages, based on workshop reconditioned 1" cameras and 17" monitors, are available on a low cost, ex-works, install-it-yourself basis.

A 'one camera' package comprises 1" vidicon camera, 25mm F1.9 lens, 17" monitor plus camera fixing bracket for £187 excluding VAT.

A similar 'two camera' package complete with video switcher is priced at £329. Photo-Scan will also supply economy co-ax cable supplied to length and fitted with connectors at a cost of £17 per 100 metres.

Photo-Scan say they will guarantee the equipment for replacement of faulty parts—and if the system is installed by themselves (charged extra on a time and materials basis), the guarantee includes labour.

Further information is available from: **Photo-Scan Limited, Dolphin Estate, Windmill Road, Sunbury-on-Thames, Middx. (09327 89741)**

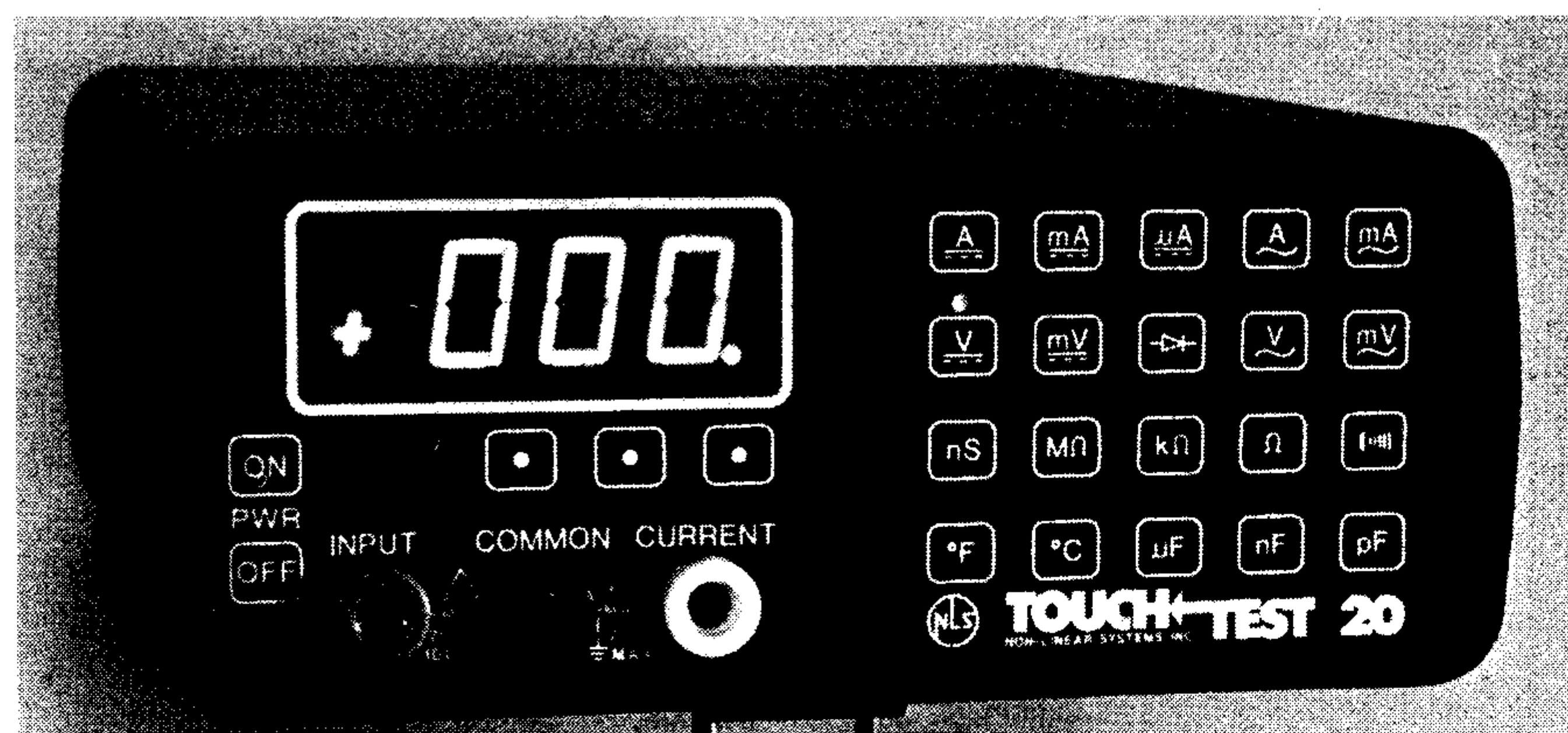
tions, the TT20 measures capacitance (1pF-200µF); temperature (-40 to +150°C); conductance (0.01nS-1.999nSiemens); diode test and audible continuity test.

Voltage ranges are 10µV-1kV d.c. (0.2%); 10µV - 750V r.m.s. Current 0.01µA - 10A d.c. and 10µA - 10A a.c.

Resistance 10mohms - 20 Mohms.

The TT20 is available as mains only or rechargeable battery/mains, it is priced at £195.00 or £215.00 with batteries and charger.

Lawtronics Limited, 139 High Street, Edenbridge, Kent TN8 5AX (0732 865191)



Elapsed HOUR Meter

CHRIS LARE

It is instructive, and often necessary to produce a logbook for types of equipment where regular servicing or replacement parts are required. In order for such a log to be meaningful the entries need to be accompanied by the total equipment usage time, rather than the date as is often used.

To enable such times to be measured an accumulative hour counter which increments when the equipment is in use is required. It is also obvious that the counter should not have to be read after every use, thereby defeating the object of such a counter, and so the counter must retain the current count from one usage to the next. Such a counter is called an elapsed hour meter. The design here is for a counter to measure up to 9990 hours (416 days continuous use); the current time being displayed on a 3 digit display in ten hour steps.

The prototype was developed to measure the failure rate of KT66 valves in a stereo amplifier, another has since found use in a transmitter.

DESIGN PHILOSOPHY

Although the easiest way to measure long periods of time is to use a slow running oscillator the problems of stability over a minimum 10,000 hours are considerable. To avoid these problems the count is derived from the 50Hz mains, which over a long time is accurate.

The meter requires that the current count is stored while the equipment it is monitoring is switched off. It would be possible to arrange a separate supply to power the counter but this was rejected for two reasons:

(a) Safety.

(b) The chance of a mains failure in 10,000 hours is almost a certainty.

Accordingly a small nickle cadmium battery is used to maintain power to the counter when the mains is removed. The battery is trickle charged when the mains is connected. The use of a battery back up implies the quiescent current must be very low, hence CMOS technology. Several timers and clocks do exist in single i.c. form, but all have a high quiescent current and cannot be used, thus discrete CMOS circuits from the standard logic family are employed.

No reset switches or fast count facility are provided external to the cabinet. These functions are obtained by shorting links on the p.c.b. since it is unlikely that they will be used much. There is no reason why they should not be connected to switches if required.

THE CIRCUIT

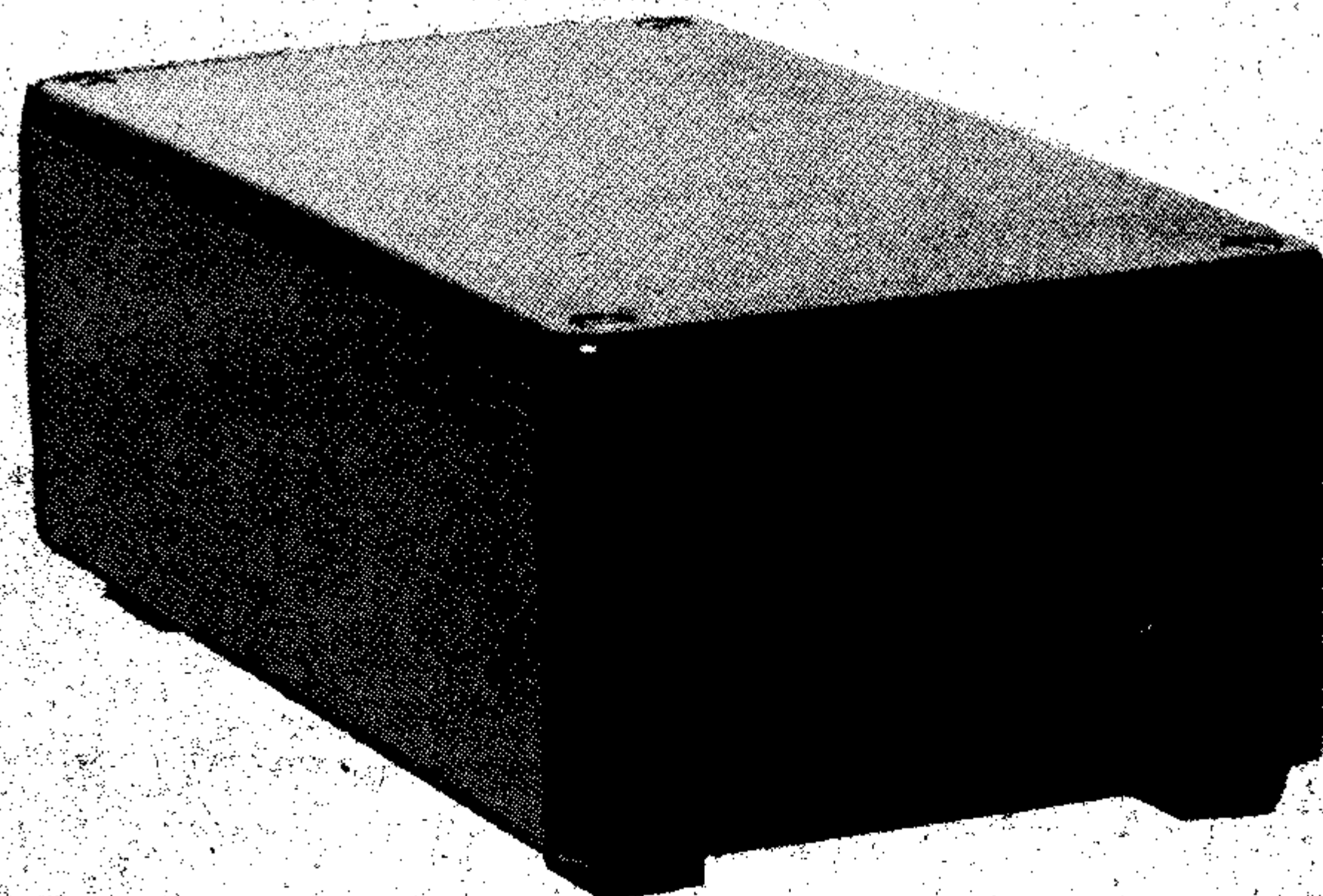
The circuit consists of three parts:

- (1) Power supply, 50Hz generator, and display blanking detector.
- (2) Divider chain.
- (3) '999' clock and display.

The power supply consists of a 3VA p.c.b. mounting transformer followed by a small bridge rectifier. The rectifier a.c. gives rise to 8 volts across C1, as well as driving the blank display detector. The detector consists of IC2 (a,b) together with C5 and R3. The time constant of C5 and R3 is fairly short and so the voltage on C3 tends to follow the presence of mains. IC2 (a,b) forms a simple Schmitt trigger to generate a clean edge from this voltage. Accordingly, the output of IC2b is high when mains is present and low if it is not.

The 8 volts on C1 is regulated to 5 volts, and then fed to the nickle cadmium battery via D2 and R1 so as to trickle charge the battery. Diode D2 prevents the battery discharging into the regulator when the mains is removed. The chosen battery has a 90 milliamp/hour capacity and should keep the data intact for 37 days without use. The battery is used to power all the CMOS except for the display driver, which takes a 5 volt supply direct from the regulator.

A 50Hz square wave is generated by IC2 (c,d) which is also connected as a Schmitt trigger, fed from the unrectified a.c. direct from one arm of the transformer.



Perspective on unit showing display window

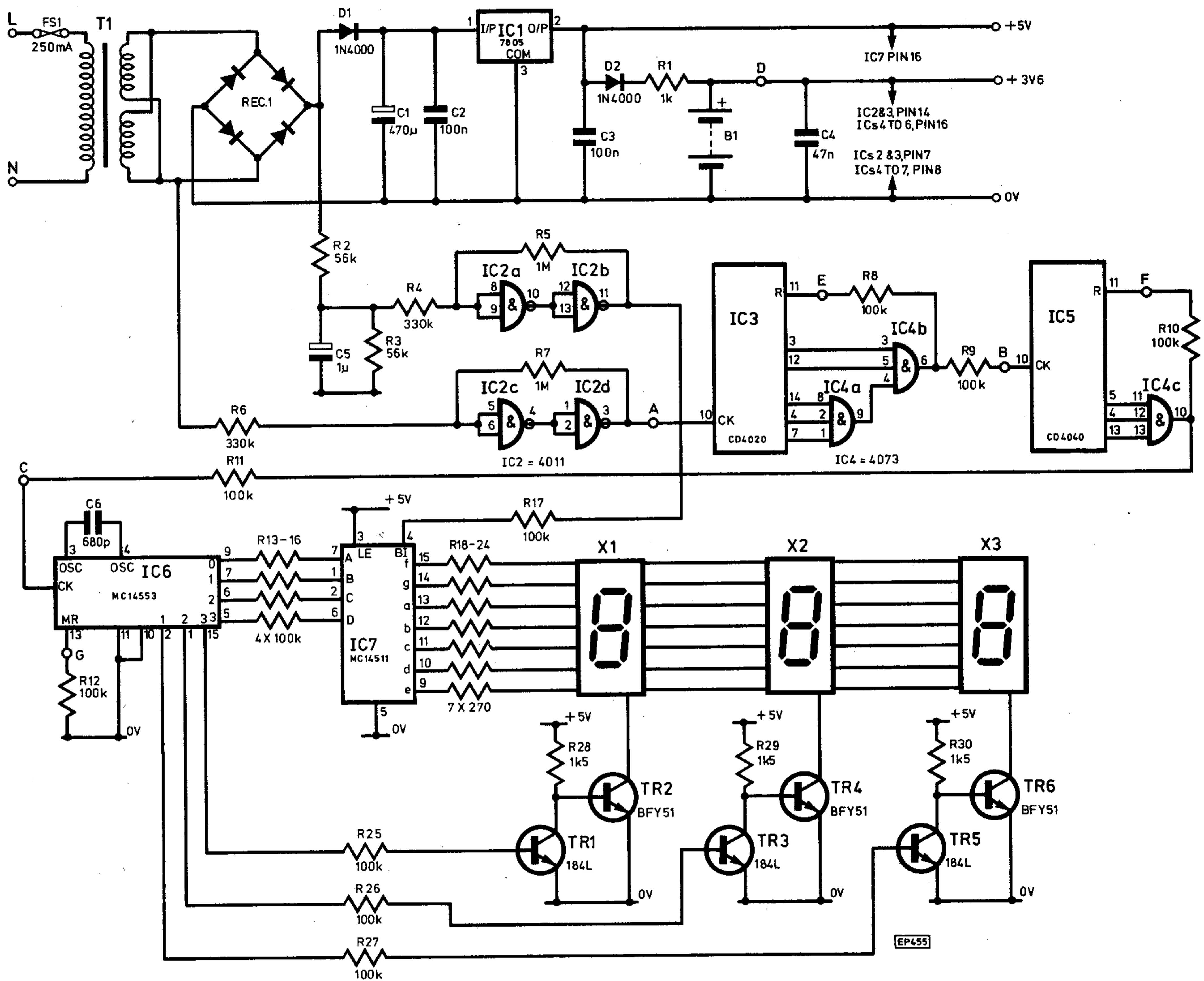


Fig. 1. Circuit diagram

COMPONENTS . . .

Resistors

R1	1k (100 required initially)
R2, R3	56k (2 off)
R4, R6	330k (2 off)
R5, R7	1M (2 off)
R8-17, R25-27	100k (13 off)
R18-24	270 (7 off)
R28-30	1k5 (3 off)
All 1/2 watt carbon	

Capacitors

C1	470µ 25 volt electrolytic
C2, C3	100µ polyester C280 (2 off)
C4	47n polyester C280
C5	1µ tant
C6	680p polystyrene

Semiconductors

D1, D2	1N4000 (2 off)
TR1, TR3, TR5	BC184L (3 off)
TR2, TR4, TR6	BFY50 (3 off)
IC1	7805
IC2	4011
IC3	4020
IC4	4073
IC5	4040
IC6	4553
IC7	4511
X1-3	DL704 (3 off)
REC1	REC70 or any 1 amp bridge

Miscellaneous

Battery p.c.b. type 90mA/hr, 3.6V (R.S. 591-477)
 Transformer 3VA p.c.b. type, 6V c.t. (R.S. 207-B29)
 Fuse 250mA A/S type and two p.c.b. fuse clips
 Box ABS 150x50x80mm
 Mains cable and grommet
 Display filter material
 P.c.b. pins.

The 50Hz is fed to IC3 which divides it by 9,000, and from there to IC5 which divides it by a further 200 (giving a total of 1,800,000 or 50Hz pulses in 10 hours). The dividers are arranged so that a reset pulse is generated by the AND gates when the correct number is reached; the reset pulse also clocks the following stage. In order that an external reset or fast count may be applied 100kilohm resistors are inserted in each reset lead. In this way a connection to pins E or B (Fig. 1) will not damage the previous output stage.

The table gives the connection details for the various functions that can be realised by interconnecting the pins. A slow count for example is obtained by joining pin A to pin B which injects 50Hz directly into the divide by 200 counter, giving a clock rate of 4 seconds.

Table 1

Functions available by interconnecting pins	
Reset 999 counter	D-G Note that displays blank
Reset ÷200 counter	D-F
Reset ÷9000 counter	D-E
Fast count (50Hz)	A-C
Slow count (4 secs)	A-B
Normal use	No connections

The pulses obtained every 10 hours is used to clock the '999' counter. This uses a 3 digit b.c.d. counter with multiplexed outputs, which minimises complexity. The b.c.d. output is decoded by IC7, which feature high current source outputs, which are in turn connected to three common anode displays. The multiplexer in the counter, IC6, selects the digits in turn by means of the 3 pairs of drive transistors. These invert the digit select from the counter as required. R18-24 limit the current through each display segment.

Obviously the display cannot be used when the mains is not on, and so the power down signal from the power supply section is used to turn off the display using the blank display input of the decoder/driver. This is not apparently necessary, as the displays go off when the supply is removed anyway since they are powered directly from the 5 volt rail. However, with the displays off the 5 volt rail fall much more gently, lessening the problem of data corruption. The 100kilohm resistors in series with the decoder inputs prevent damage to the gate inputs when power is removed from the chip.

CONSTRUCTION

The prototypes were built onto three printed circuit boards to give a compact system. This method of assembly allowed the finished boards to be housed in a fairly small ABS box, employing the layout shown in the photographs. The boards were designed to minimise the number of flying leads—indeed all the interconnections between boards can be made with short lengths of bare wires, and all the components are mounted on the boards. The actual 999 clock and display forms a very small module (65mm x 40mm x 20mm) and use may well be found for it in other projects.

Although the boards are fairly small they were produced quite successfully with an etch resist pen. During assembly it is suggested that sockets be used for IC6 and IC7, these being the most expensive and most likely to fail respectively. The displays were mounted 6mm proud from their board to bring them close to the outside wall of the box. Note that two pins of the display are cut off—do check very carefully before doing so. It is important not to solder the battery in until the board is complete. Once the battery is in the power cannot be removed, and CMOS does not like being inserted with power supplied. Do not short the battery.

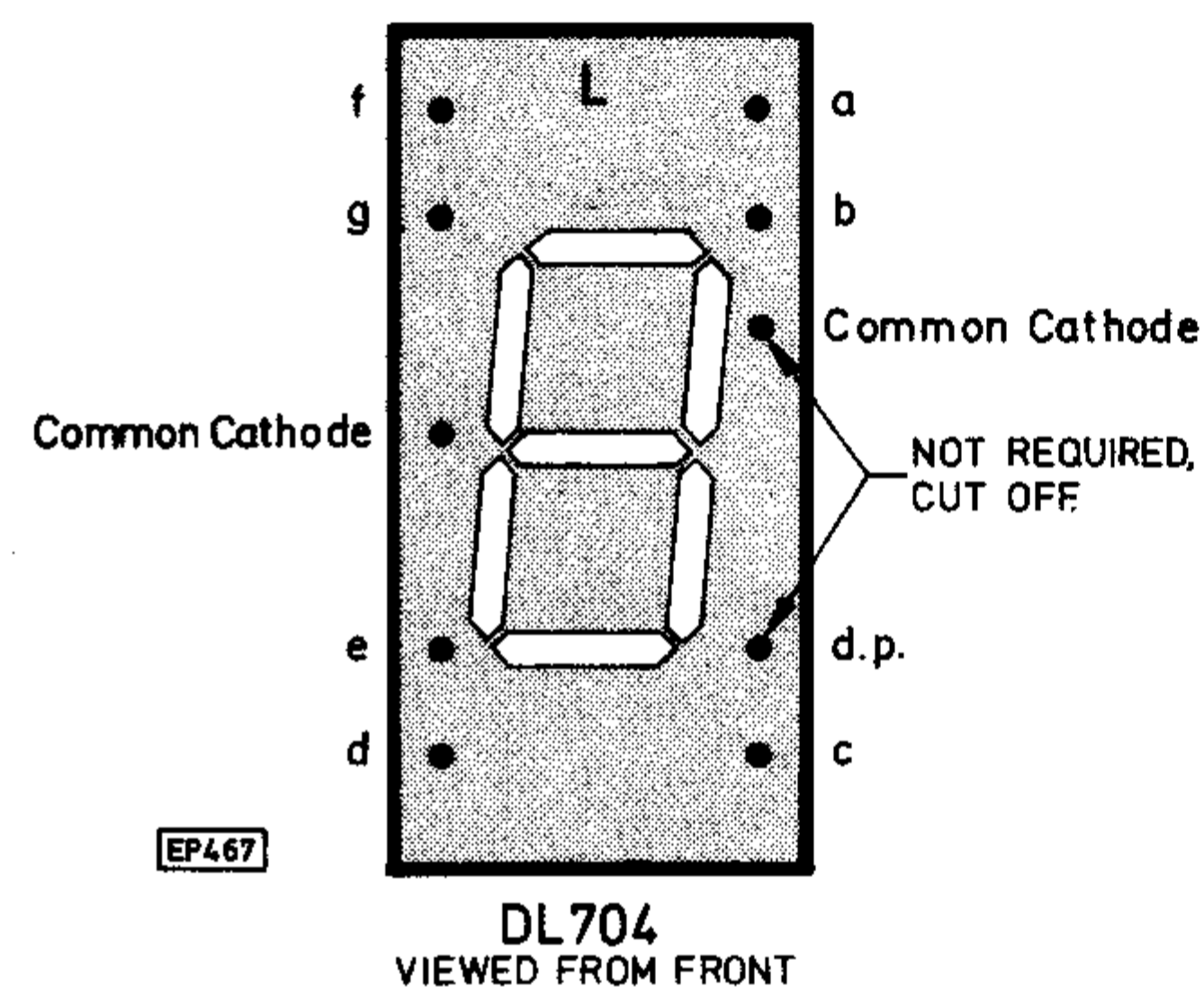
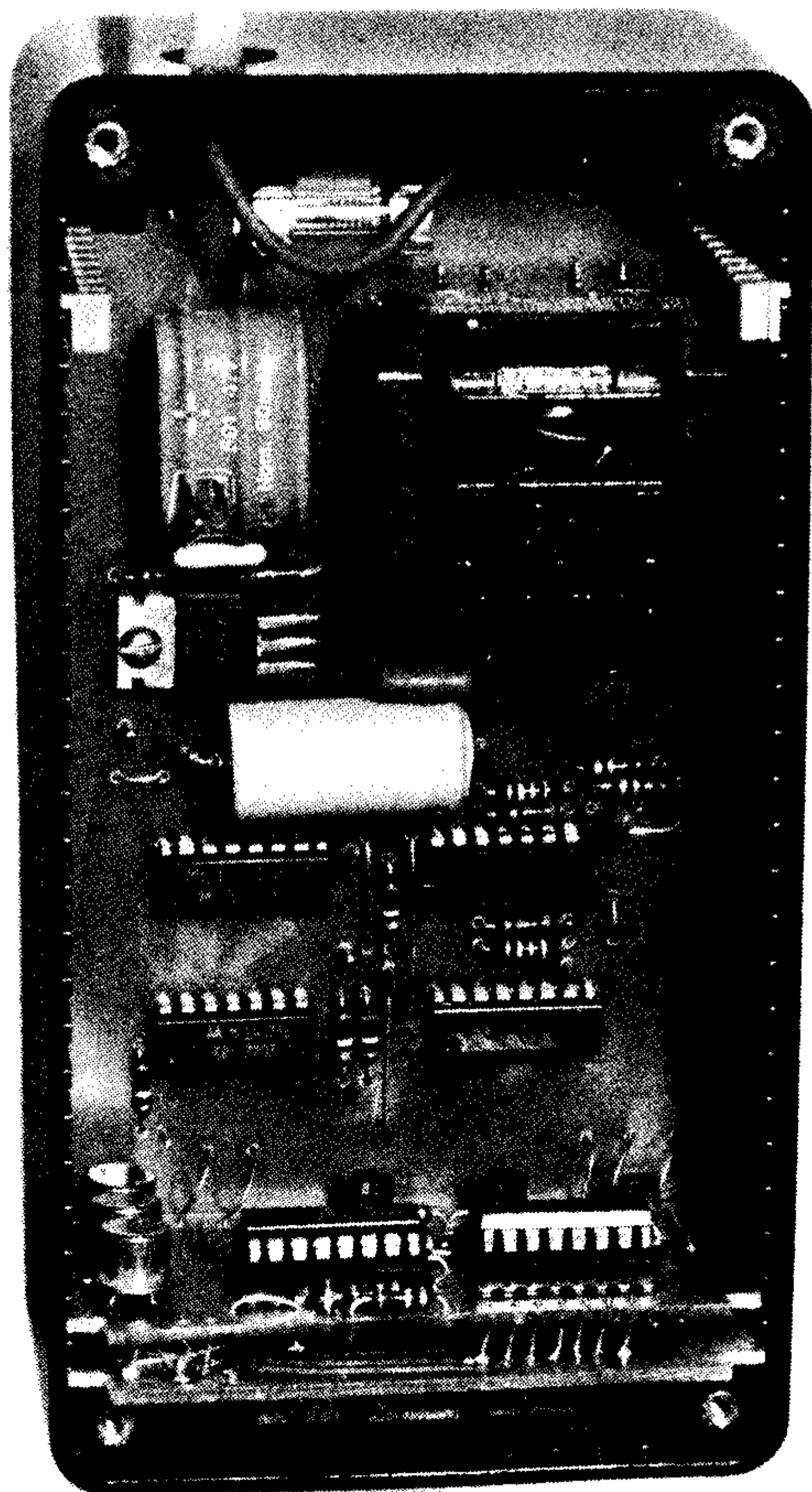
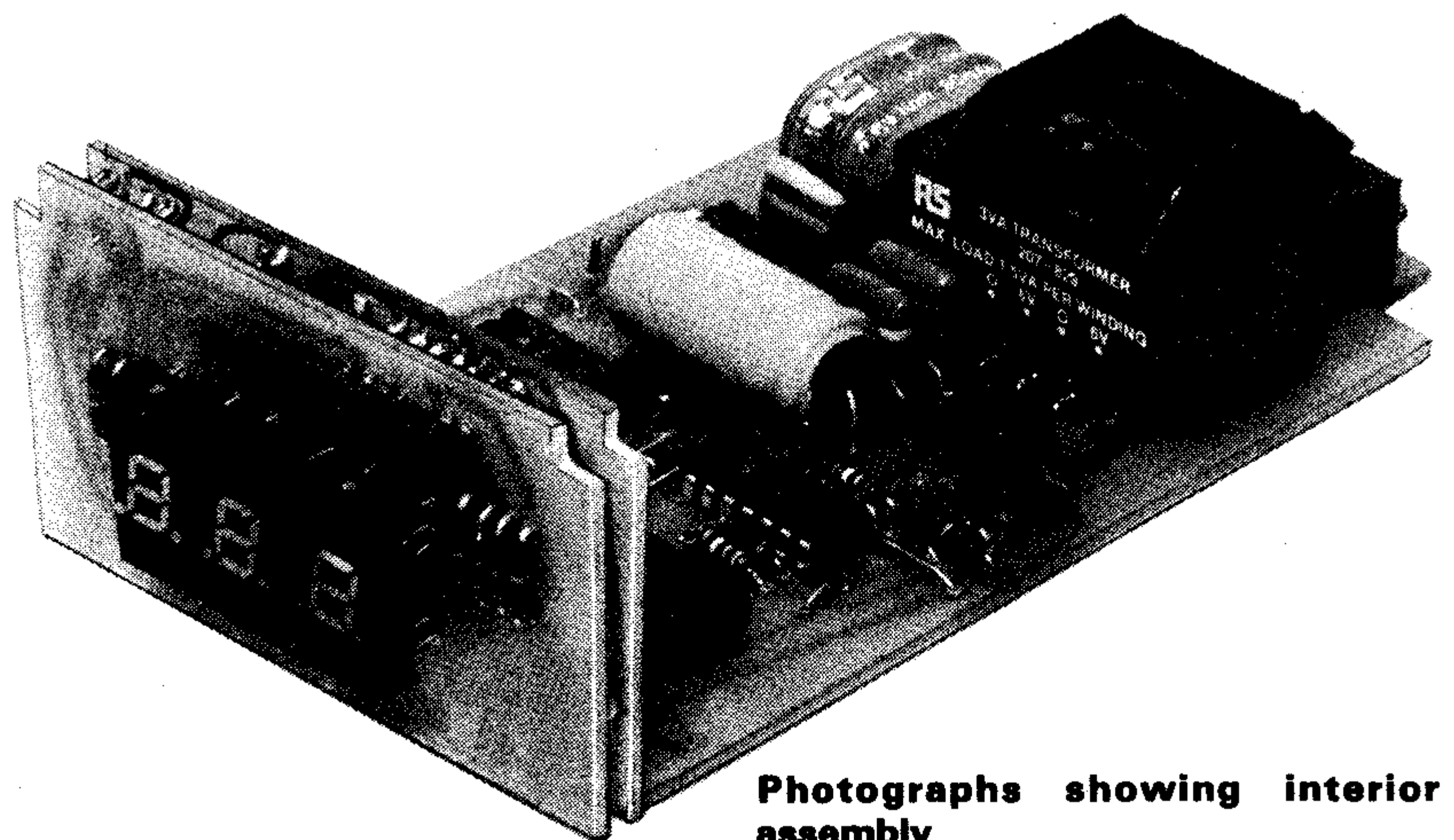
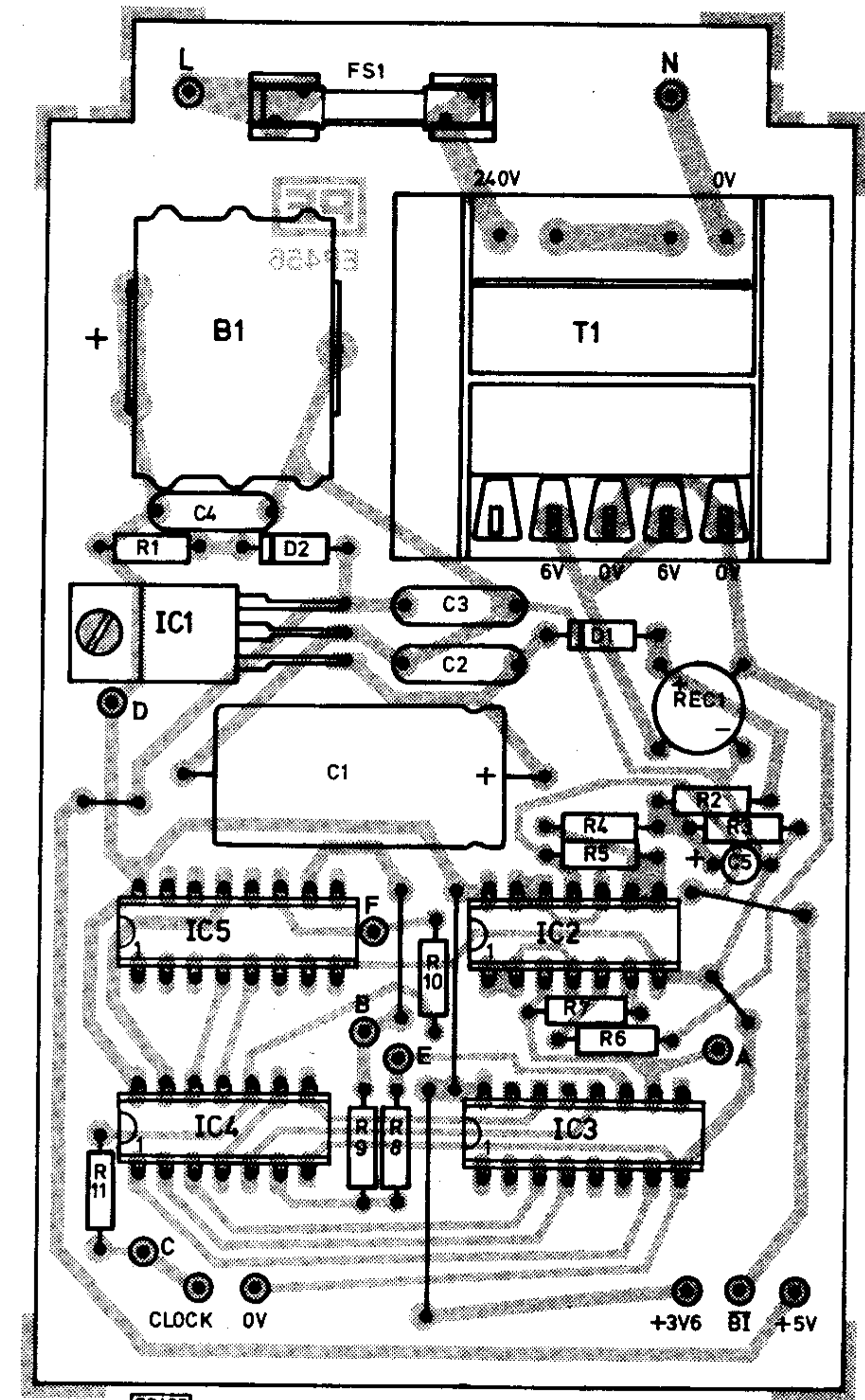


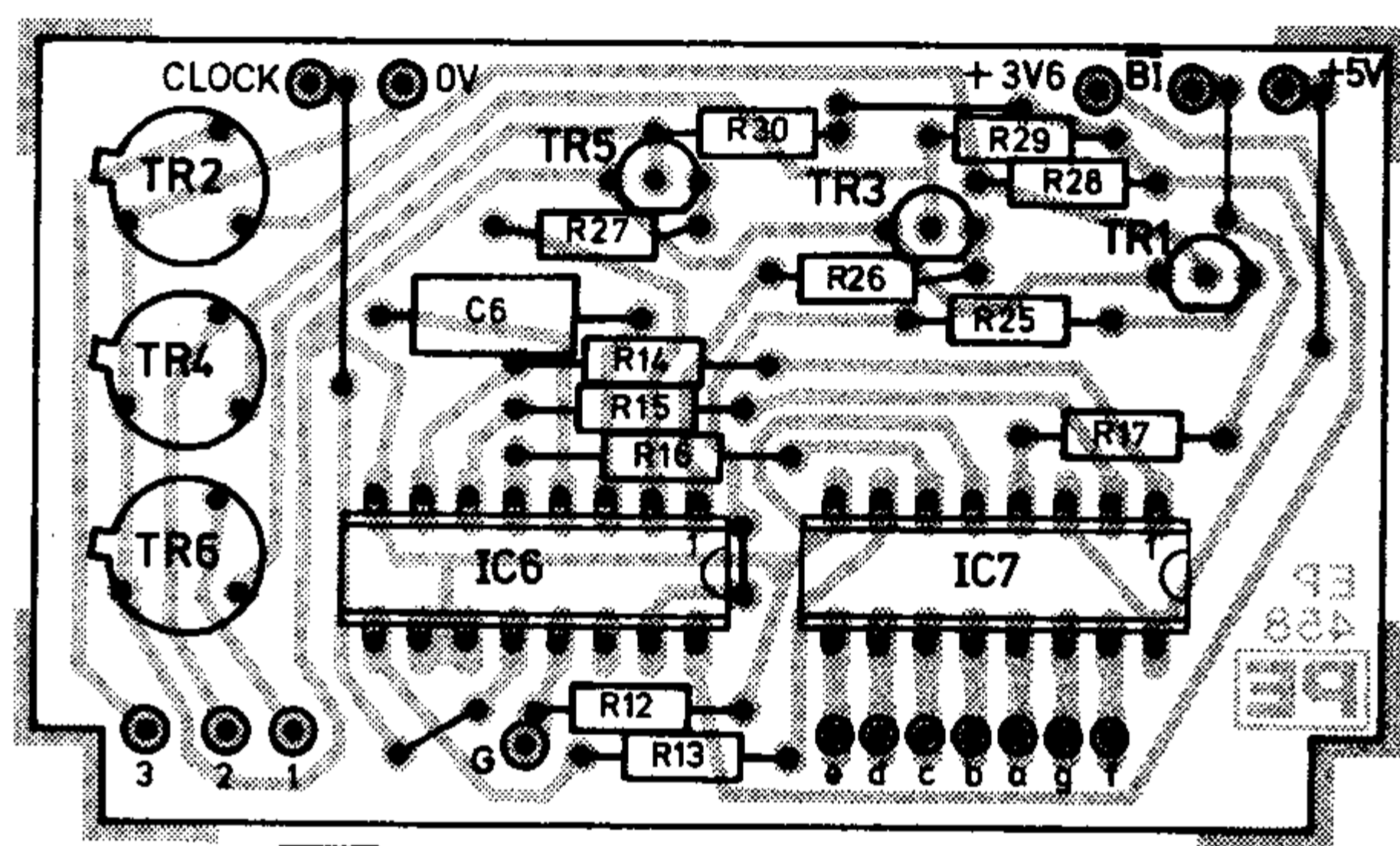
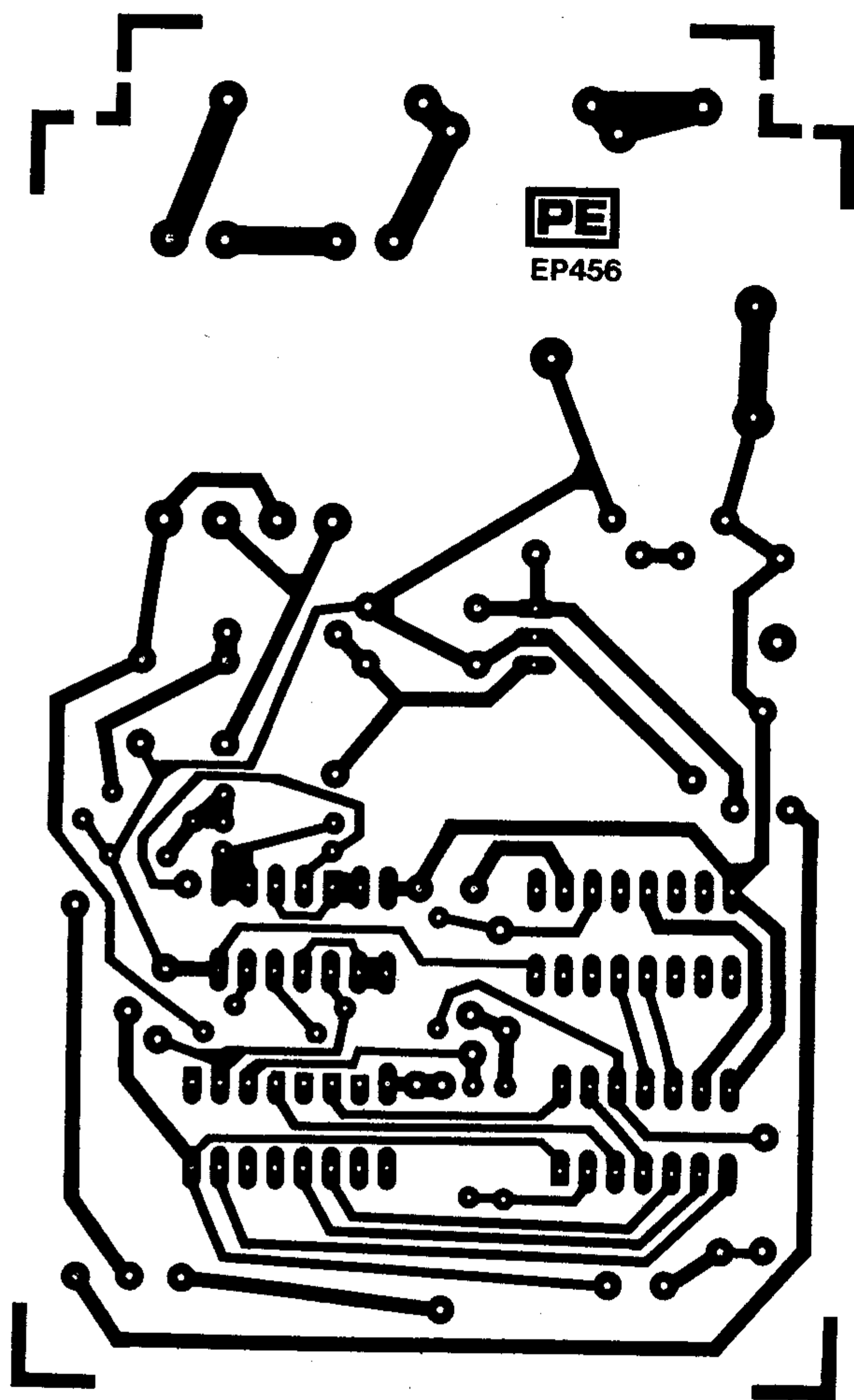
Fig. 2. Display pinout details



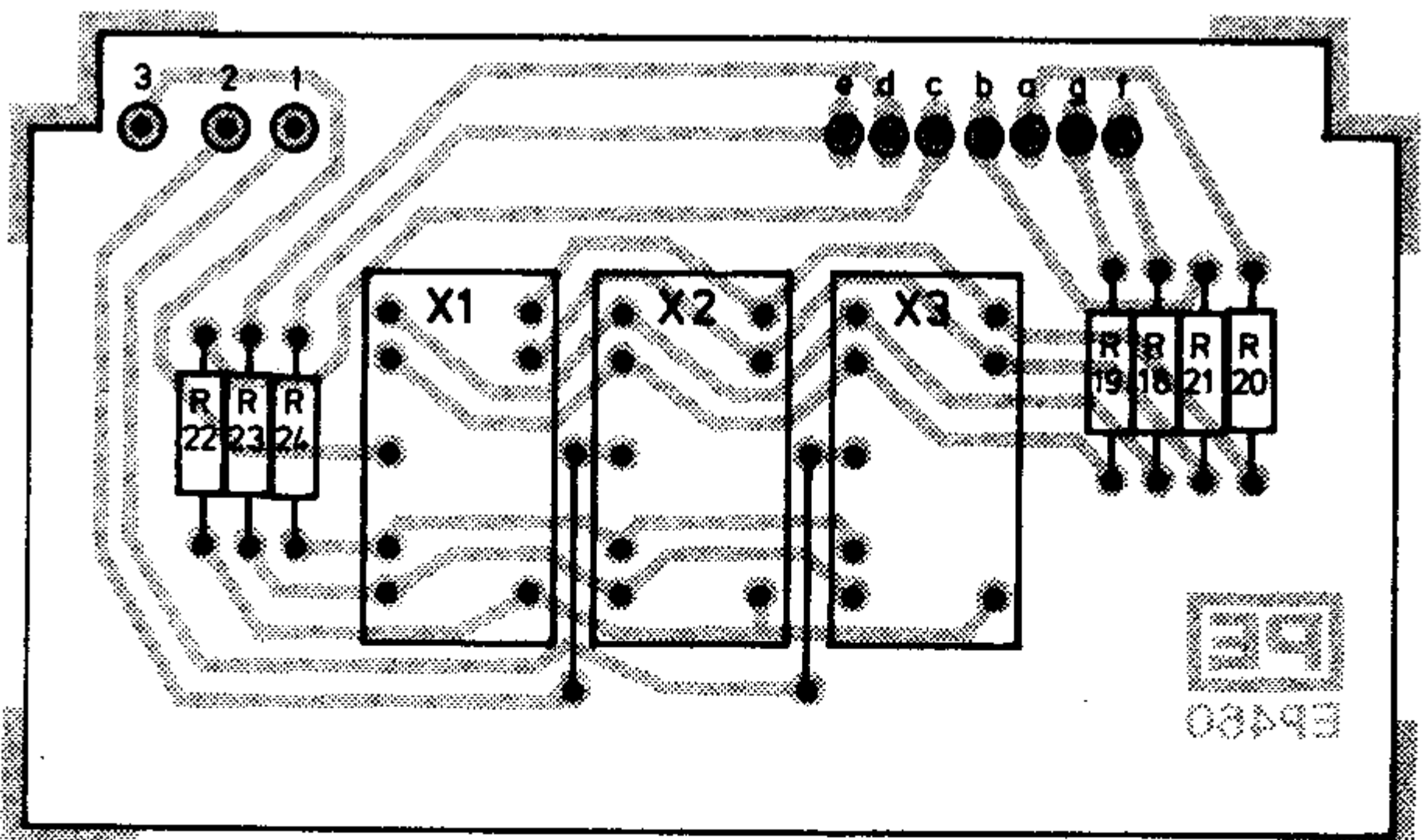
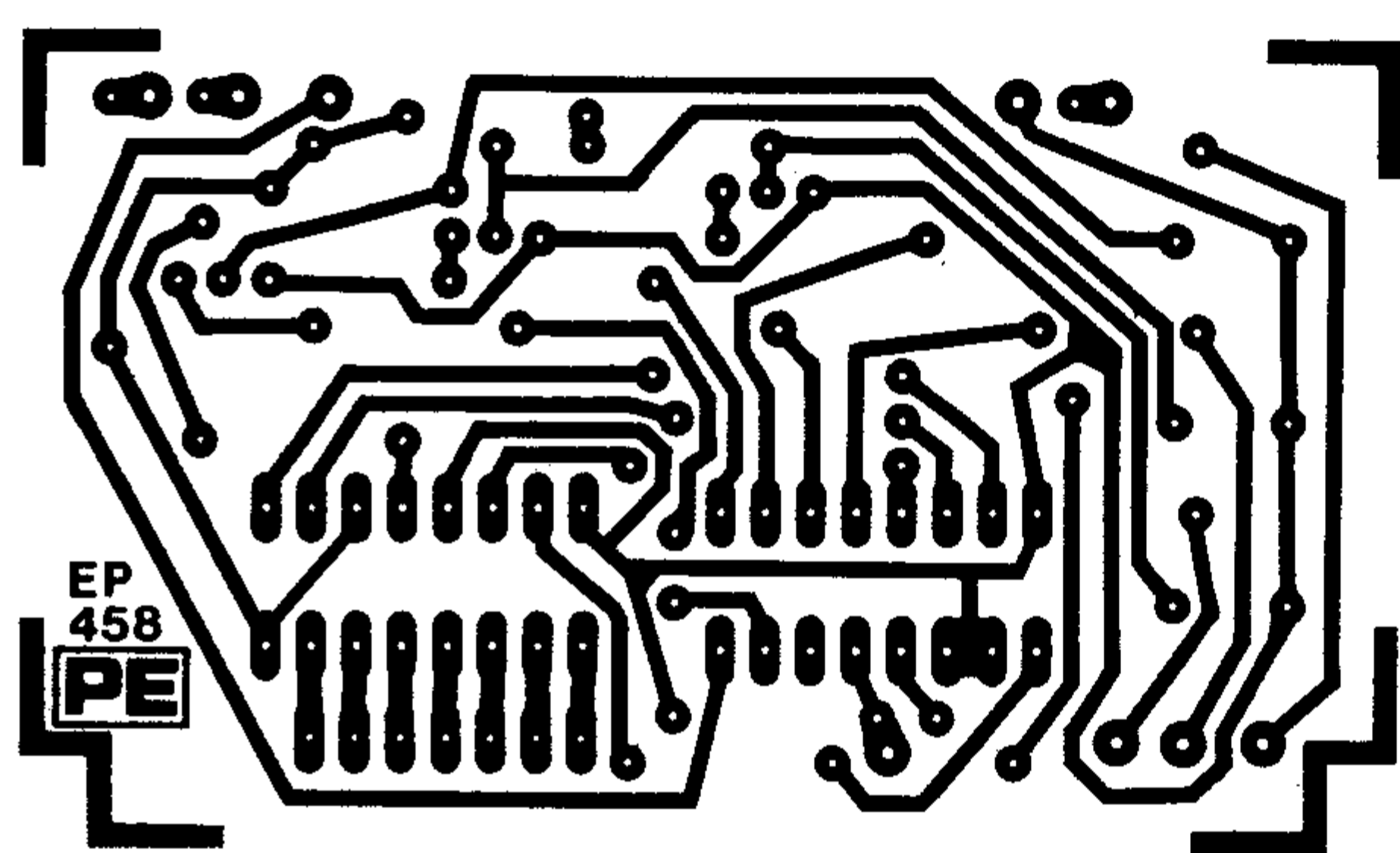
Photographs showing interior assembly



EP457



EP459



EP461

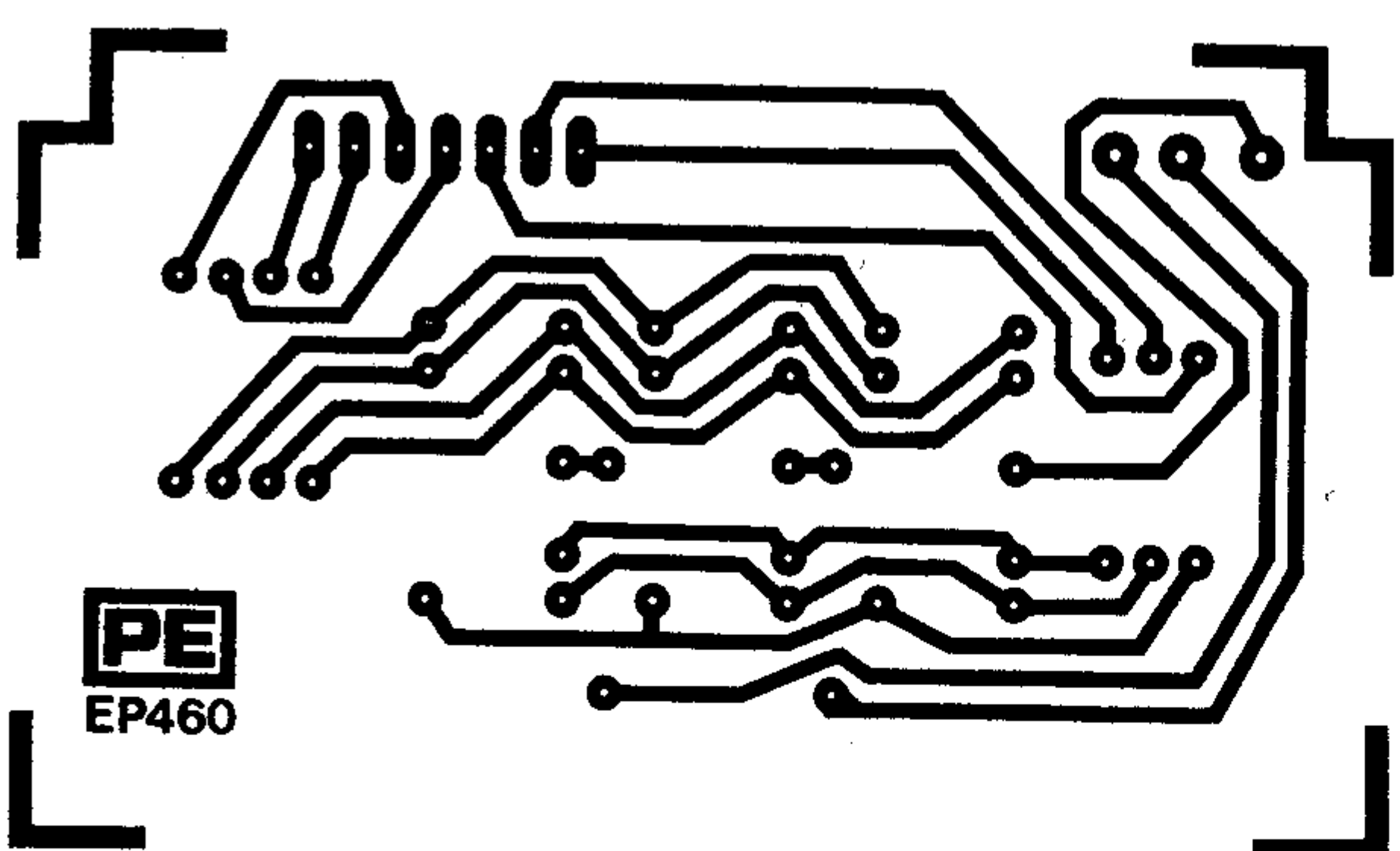


Fig. 3. Board details

To aid debugging it is suggested that the boards are interconnected with long flying leads initially, thus giving access to both sides of all the boards.

Before connecting the unit to the mains, cover the fuse and mains terminals with several layers of insulating tape. The need for care cannot be over emphasised.

TESTING

Plug in. Check the 5 volt rail and that the output of IC2d is high, and if a scope is available that a 50Hz square wave is present on the output of IC2b. Reset the 999 counter (D-G). Clock the counter quickly by using the fast count connection (A-C), and check all the segment drives. A count of 500 should be observed in 10 seconds. Check the divide by 200 counter by connecting for slow count (A-B), the display should increment at 4 second intervals. Finally, check the divide by 900 by measuring the voltage on IC5 pin 9. No connection is normally made to this pin since it is the Q1 output. The voltage should change every 3 minutes indicating a leading edge from the previous stage. When debugging, even with a scope, do not expect to be able to

see the reset pulses—they happen very quickly, within the propagation delay time of the i.c.'s.

CASING

The prototypes were mounted in ABS boxes, a window was cut in one end for the display, and a hole for the mains cable in the other. No mounting holes were used in the p.c.b.s because of the slotted construction of the box. Any method of mounting is suitable, but if the display is required on a front panel, remote from the power board, it is suggested that the 999 count board is also mounted on the panel since this saves wiring.

BEFORE USE

Once the unit is installed and there is no risk of accidentally shorting the battery it should be fully charged. Nickel Cadmium cells are supplied nearly discharged for this reason. To charge the battery, connect a 100 ohm resistor across R1 and leave the unit on for 24 hours. If for any reason the battery is ever completely discharged it may refuse to take charge, in this case replacement is the only solution. ★

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.

A Computer Club in London

Sir—Since Computerclub was formed back in July, we have been delighted with the progress we have made. We could not, of course, have known quite what to expect and so we can't say that our expectations have been exceeded! We can say that we are very pleased to have been evidently accurate in assessing a market need.

Membership is approaching 1500, companies are writing to us with unsolicited offers to members, special offers have been negotiated and Computerclub has gained almost universal welcome.

Members get discounts. Participating outlets are increasing sales without the cost of sale promotion and manufacturers are selling just as much—perhaps even more because of lower costs expanding markets. All round, everyone seems to be happy and that can't be bad.

You may be interested to learn that a high proportion of Computerclub members are occasional, if not regular, readers of *Practical Electronics*—we hope to be able to be more specific following the production of our Membership profile analysis.

We have almost finished producing our first Computerclub Newsletter and would like to offer your readers the chance to get a free

copy by writing to the address below enclosing a 12p stamped addressed envelope large enough to take our 16 page A4 Newsletter, or if they prefer, two 12p stamps and their name and address.

Roger Frampton,
Computerclub,
42 Great Windmill St.,
London W1V 7PA.

... and Harrow

Sir—The Harrow Computer Group meets on alternate Wednesdays at 7pm in Harrow College of Higher Education or, when closed, in the "Plough", Kenton. Details: 01-950 7068. Features are: lectures, magazine library, program exchange, demonstrations, advice, hardware & software debugging, nascom user group. Established two years ago, member of Association of London Computer Clubs, and free membership.

... and Southampton

Sir—We would like to publicise details of the Southampton Amateur Computer Club.

From October through to June we meet at 8 p.m. on the second Tuesday of each month, at the Medical Sciences Building, Bassett Crescent East, Southampton. Annual Subscription is £3.00, or £2.00 for students and

Senior Citizens. There are Special Interest groups for Z80 including Nascoms and Z8000, and for 9900. We also publish "Benchman"—the Club Newsletter, in conjunction with the Thames Valley A.C.C.

Further details are available from the Secretary, Andy Low, on Southampton (0703) 555605 ext. 34.

P. D. Maddison
Southampton University

... and even in Australia

Sir—I wish to advise *Practical Electronics* and its large readership of a new user group that is "AUSTRALASIA ZX80 USERS' GROUP".

The user group aims to promote the use and growth of the Sinclair ZX80.

The user group will be producing a newsletter which will contain listings of original programs submitted by members and friends, handy subroutines and other useful programming aids. Also included will be reviews on purchased software and hardware and a guide to where some may be purchased.

Anything of interest to the ZX80 user that comes to hand will be published and the newsletter will be stressing the harmful effect of software piracy on the industry.

It's good to see your magazine leading the way and giving a listing for the ZX80 user.

We would appreciate it if you could give our user-group a small mention in your magazine as we would like to correspond and obtain ideas and original software from as large a source as possible.

Anyone interested in the ZX80 may contact me as follows:—

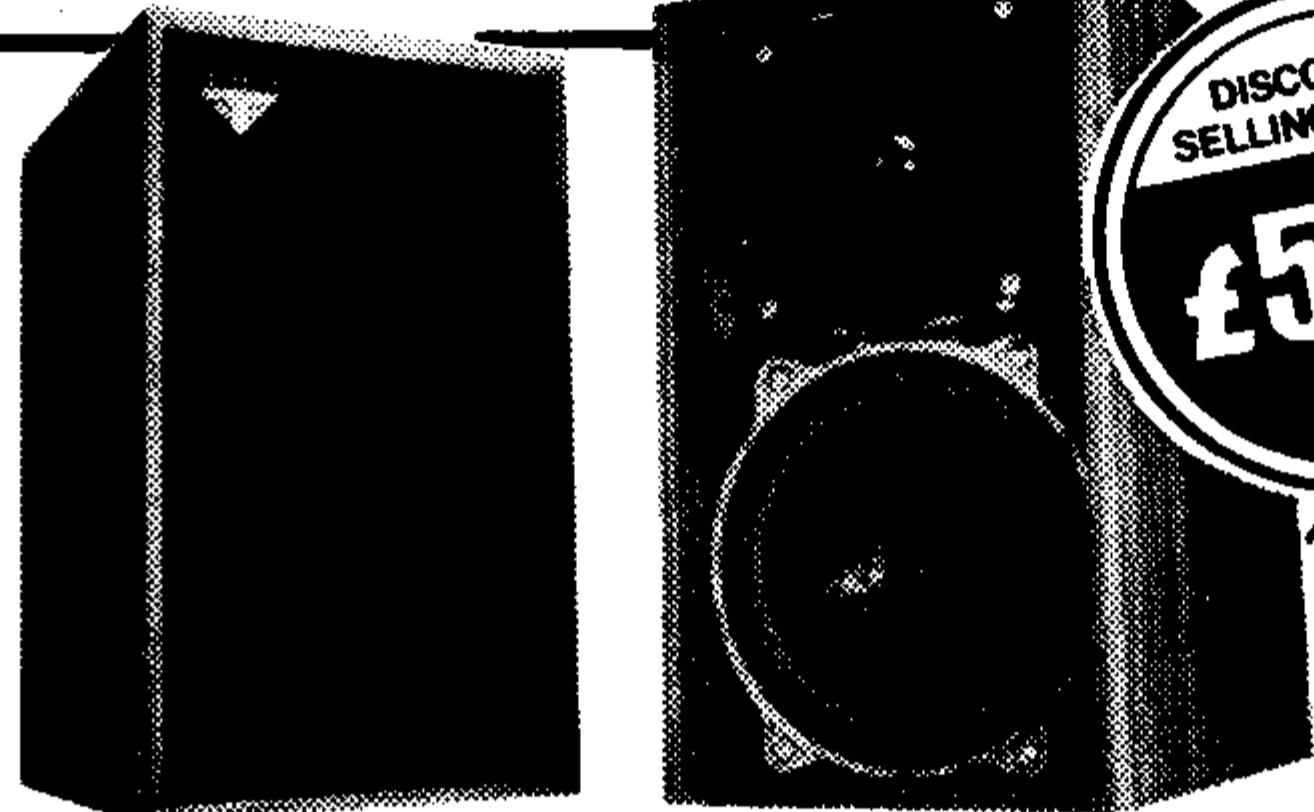
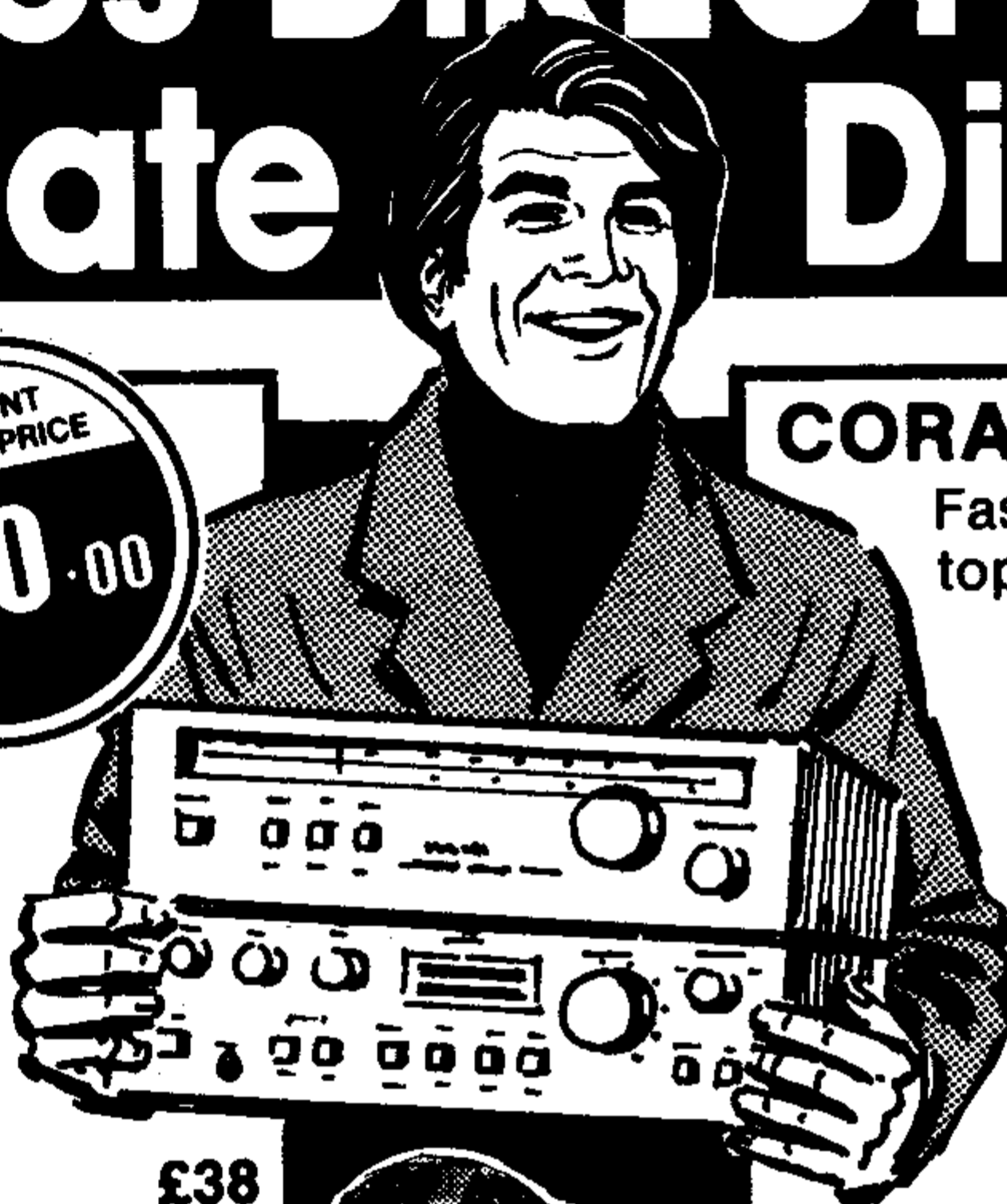
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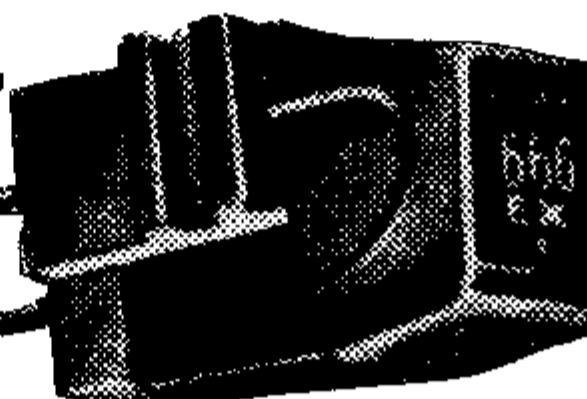
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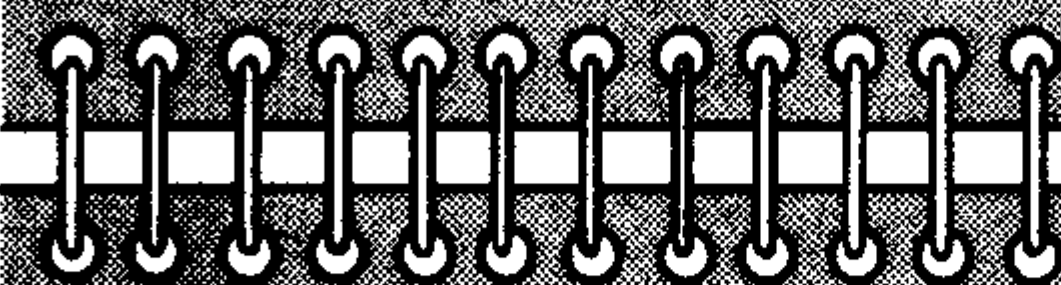
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INDUSTRY NOTEBOOK

By Nexus



Retrospect

Few industrialists will regret the passing of 1980. The recession was sharper and deeper than predicted in manufacturing industry and from mid-year onward it became increasingly clear that the economic strategy of the Government was not only painful in its immediate consequences but was also painfully slow in achieving results. The one heartening indicator was the reduction in the inflation rate which dropped ahead of target.

Everyone suffered from the squeeze but the electronics companies coped far better than most with some entering 1981 with a good year of trading behind and record order books for the years ahead. An exception was the volatile consumer goods sector where fierce competition from overseas coupled with reduced consumer demand compounded the problems.

The collapse of the Rank Toshiba joint TV manufacturing venture is one side of the coin although Toshiba will still produce in the UK with a greatly reduced labour force. The other side is the boldly conceived Ferguson TX range of TVs from the Thorn stable, launched with a massive publicity campaign. In the low-cost monochrome market Fidelity Radio was able to resume a five-day working week with the August-launched portable described as a resounding success. The ups and downs of consumer electronics are not confined to the UK. Even Phillips at Eindhoven, pioneers in cradle-to-the-grave paternalism, had to make people redundant during 1980.

Britain's capital goods electronics and aerospace industries achieved a sparkling performance in spite of the difficulties at home and uncertainties in overseas markets.

The year was dominated by the debate on the economy. Former hot topics like the impact of the 'chip' and the energy crisis were all but forgotten. Even the loss to the

West of oil supplies from Iran and Iraq, almost unthinkable a couple of years ago, seemed remote and insignificant.

On the international political scene there was a general swing to the right culminating in the predicted but nonetheless dramatic election of Governor Reagan to the US Presidency. What effect the rightward swing will have is by no means apparent but it should, on the whole, prove beneficial for international trade.

The year ahead will be no less difficult than 1980 although there is a consensus that an upturn in business may be expected by the mid-year, assisted by falling inflation and interest rates.

Plessey

A useful illustration of what is happening to industry in general is the progress of Plessey over the past four years. Plessey is a British-based multinational with worldwide trade. It was huge and sprawling and very respectable. But not very profitable and frequently tipped as ripe for takeover by the much smaller, tighter run and aggressive Racal Group.

Something needed to be done and a new strategy started taking shape in 1975 with the establishment of a Chief Executive Office which would lead the company into a new style of management, particularly in marketing skills and planning. Along this road were painful decisions, including major surgery to rid the company of the cancer of loss-making subsidiaries, accompanied by strenuous efforts to improve productivity by the potentially profitable residue.

Inevitably there have been massive redundancies. The workforce of 48,000 last June was 5,000 less than in June 1979 and not much over half of that employed five years ago. Far fewer people, for example, are required to manufacture electronic telephone exchanges than the old labour-intensive electro-mechanical systems. But there have been other staff economies, too.

The broad result is that Plessey is breaking record after record with sales now running at £800 million p.a. and profit last year of £60 million. The forward order book which stood at £500 million in 1976 is now £1.2 billion.

Worker performance is also newly impressive. In 1976 each person employed represented, on average, sales of £7,374 and contributed £524 profit. In 1979-80 the figures were £14,180 and £1,135 respectively. After taking inflation into account there is still a marked gain in productivity and profitability and worth a self-congratulatory pat on the back.

Plessey's task, however, is by no means over. They are only a little over halfway there. For Plessey's major international competitors are claimed to be achieving £25,000 of sales and £2,000 of profit per employee.

As well as the struggle for productivity there is the struggle to keep abreast, preferably ahead, in technology and new products. In 1979-80 R & D in Plessey amounted to over £135 million, some 18

per cent of turnover, but much of this was funded by customers.

From Plessey whole-year profits the Government gained £19 million in taxation, enough to keep the National Health Service financed for about 20 hours or British Leyland alive for another few weeks.

The drive for productivity and efficiency exemplified by Plessey is spreading throughout all manufacturing industries. There appears no practical alternative even though the social cost is so high.

Technology

Two of the important technological breakthroughs are fibre optics and the Josephson computer. The first is already with us though not yet exploited on a massive scale. The second is still on the horizon and remains problematical.

At the Sixth European Conference on Optical Communications at York no less than 270 papers were submitted for presentation. The Programme Committee selected 84 for the four-day sessions attended by more than 800 delegates. Several practical systems are undergoing field trials in many parts of the world. At the same time there is frantic work in laboratories which may yet influence future applications and technical standards. Most observers expect operational systems in service by the mid-80s. Early systems will need to be flexible in order to take advantage of last-minute advances in the technology. But nobody doubts that fibre optic communications will be a business bonanza in the years ahead.

In the early '60s one of the big technical topics was superconductivity achieved through low temperature engineering. In 1962 Brian Josephson discovered a switching effect in insulating materials cooled to near absolute zero temperature.

US and Japanese scientists have been building on Josephson's discovery with computing applications in mind. The objective is much faster operating speed, exceptionally low power consumption and very small size. A Josephson-type mainframe computer, according to one assessment, could do the job of an IBM 370/168 twenty times faster and be packaged in a 15cm cube taking only 7W of power. Such a computer could be with us in ten years time. It is difficult to believe that superconducting switches might replace silicon semiconductors. But twenty years ago it was hard to believe that the transistor could ever replace the valve. The Josephson computer would, indeed, be a comparable leap in the technology.

There have to be snags. First the problem of fabricating the equivalent of 'chips' to accuracies of a few tens of atoms. Not so difficult is the cryostat to house the 'mainframe' and cool it to four degrees Kelvin. But assuming all goes well with the 'mainframe', no existing or projected peripherals operating at ordinary room temperature could operate at anywhere near the speed of the computer itself. Experience teaches us, however, that nothing is impossible—it just takes a little longer to achieve.

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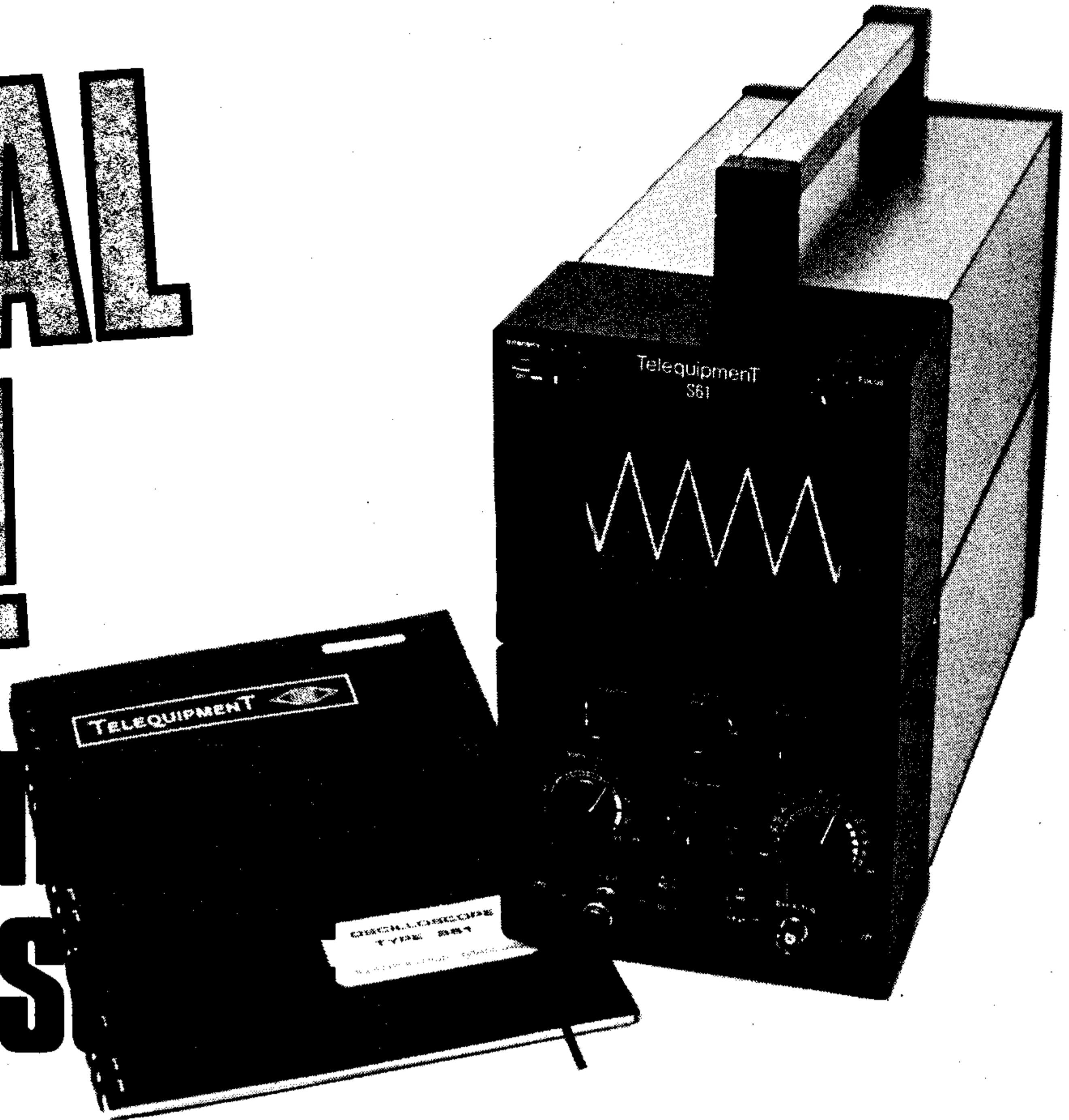
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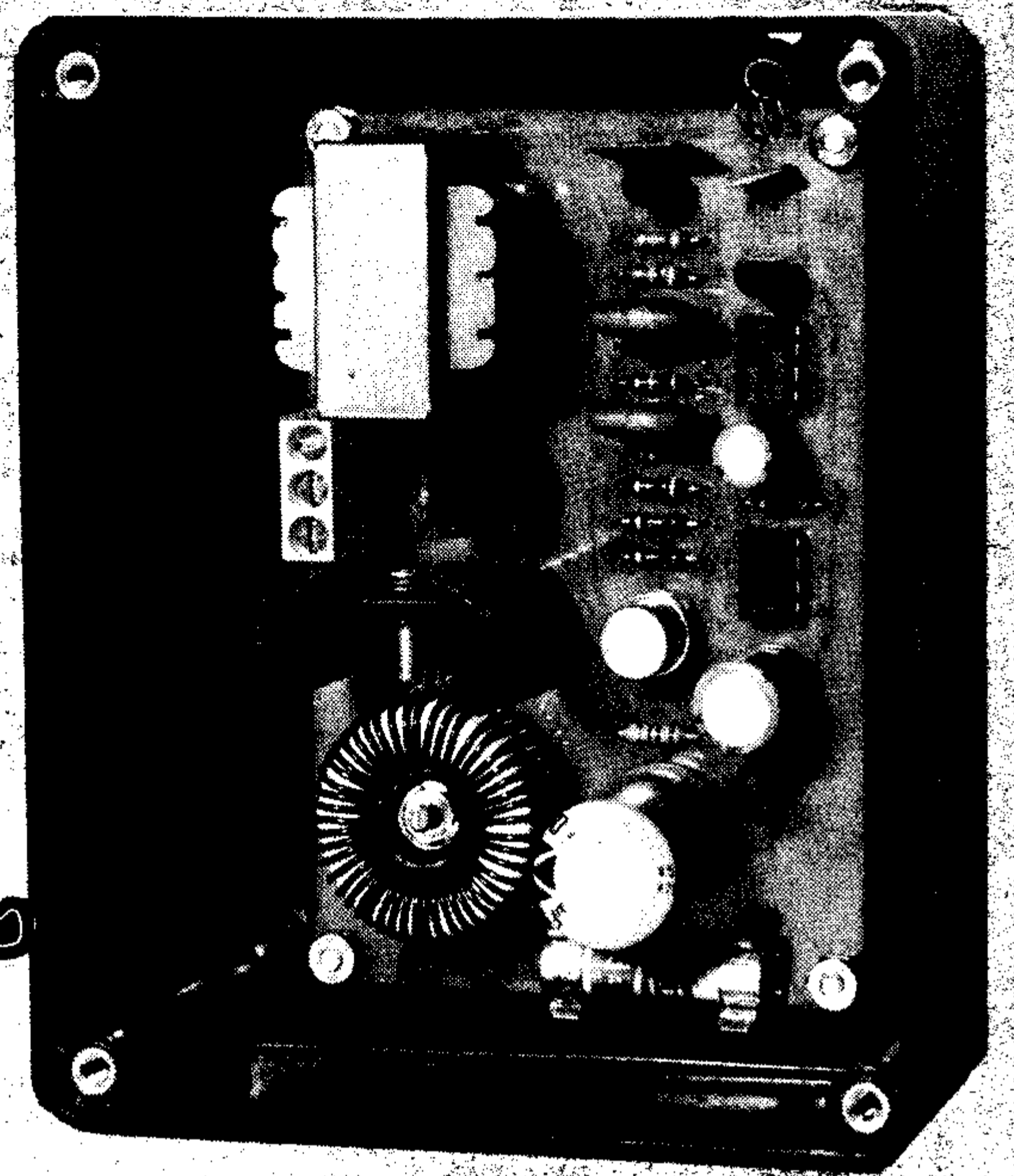
From: Carston Electronics Ltd., Shirley House, 27 Camden Rd., London NW1 9NR. Tel. 01-267 5311/2.

Please complete both parts of the coupon in BLOCK CAPITALS

Please note: Although Carston Electronics specialize in supplying second user equipment the Telequipment S61s are brand new and supplied in the manufacturer's packing—probes are not provided, but are available as an extra from Carston.

SLAVE LIGHT DIMMER

GILBERT DAVIES



THIS slave unit has been designed to follow a master triac controlled dimmer system. No electrical connection to the master is required provided each unit is supplied with the same electrical phase.

The dimmer which can be made to control full colour lighting by the use of filters receives light from the master (triac controlled). The signal is processed to derive trigger pulses, in coincidence with the master, triggering the slave triac (TR1) and controlling the lamp irrespective of both the ambient light and the illuminance from the master dimmer.

PRINCIPLE OF OPERATION

The voltage waveform applied to a filament lamp is integrated by the lamp. If the received light from the master is differentiated the waveform driving the lamp can be reconstructed. This waveform enables timing pulses to be generated in the slave unit to trigger the slave triac and control the lamp.

CIRCUIT DESCRIPTION

The circuit diagram of the Slave Lighting Dimmer is shown in Fig. 1.

The photo-transistor (TR1) receives light from the master triac controlled lamp. The photo transistor achieves optimum bias via the constant voltage source formed by TR2, TR3, R1

and R2 over a wide range of lighting conditions by maintaining the output of the emitter of TR1 at around half the supply voltage.

The received signal is differentiated by IC1, R3, R4 and C1 and the integrating effect of the filament lamp is compensated for.

The output of IC1 is fed through C2 to the comparator circuit which consists of IC2, R5, R6, R7 and C3. The resistor chain selects the comparator level at approximately 300mV. The inverting input of IC2 is a.c. coupled to ground by C3 and the positive transition from the output of IC1 passes through C2 forcing the non-inverting input of IC2 high causing its output to go positive switching TR4 on via the potential divider R8, R9. The drive pulses from TR4 are fed to the triac via resistor R11. The inductor L1 acts as a radio interference suppressor.

The resistor R10 acts as an interference rejection filter with IC3 stabilizing the supply voltage to 12V d.c. The capacitors C6 and C7 provide filtering of noise and interference.

CONSTRUCTION

The complete unit is mounted on a p.c.b. The design of the board is shown in Fig. 2. with the component layout in Fig. 3. Before soldering the inductor L1, make sure the

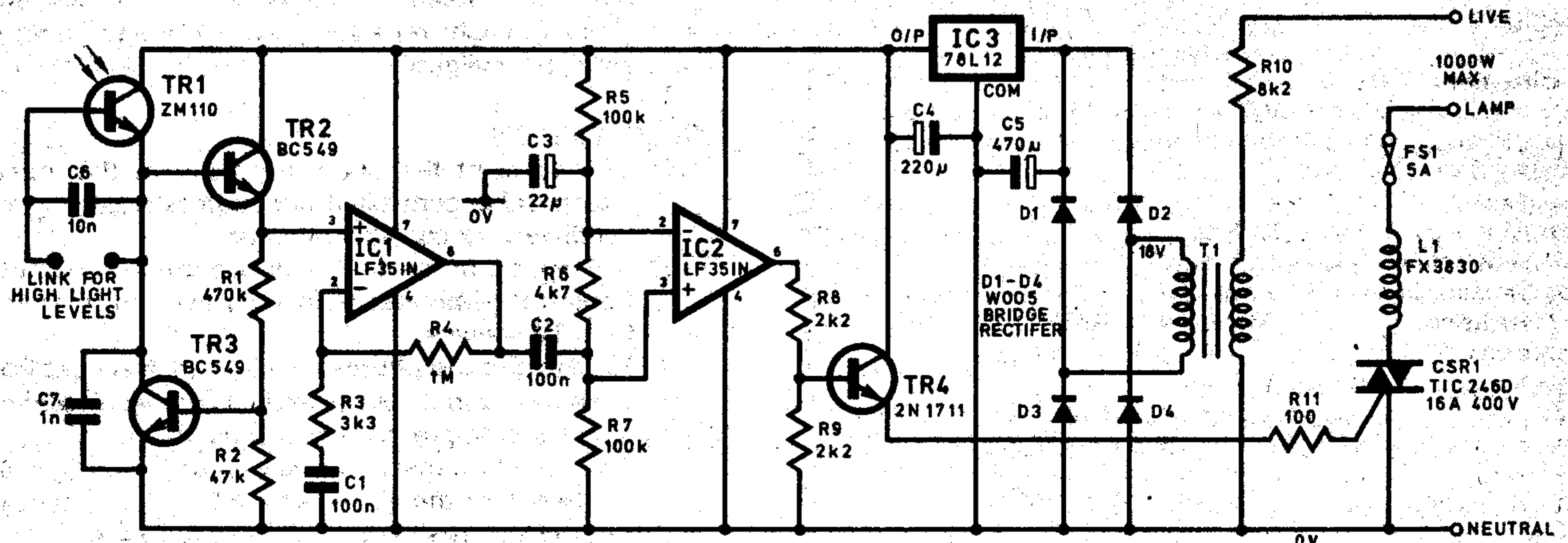


Fig. 1. Circuit diagram for the Slave Lighting Dimmer.

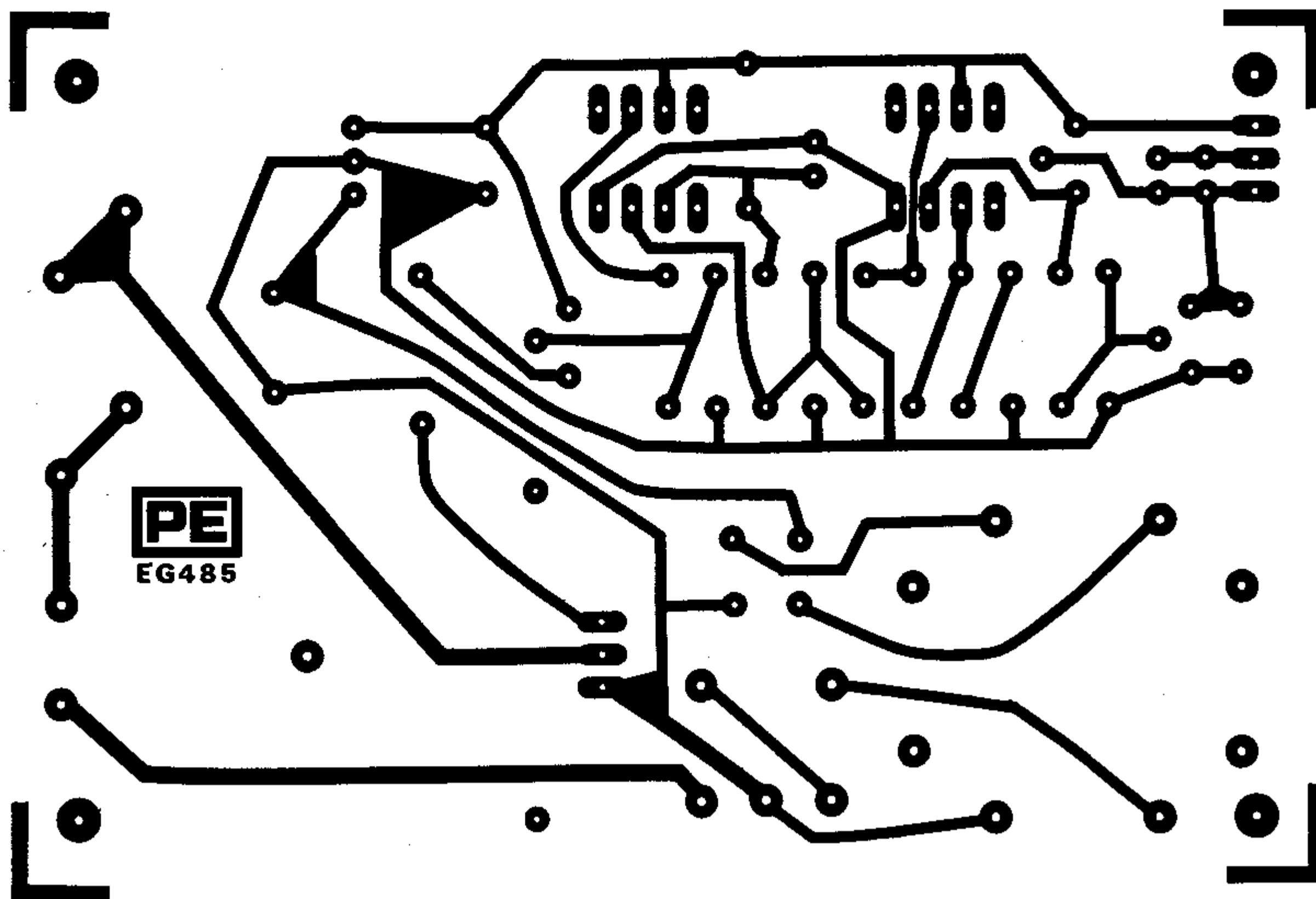


Fig. 2. The p.c.b. design.

COMPONENTS...

Resistors

R1	470k
R2	47k
R3	3k3
R4	1M
R5, R7	100k (2 off)
R6	4k7
R8, R9	2k2 (2 off)
R10	8k2
R11	100

All resistors 1/2W 5% carbon

Capacitors

C1, C2	100n 250V polyester (2 off)
C3	22µ 16V elect.
C4	220µ 16V elect.
C5	470µ 16V elect.
C6	10n 50V ceramic
C7	1n 50V ceramic

Semiconductors

D1-D4	1A 50V bridge (W005)
TR1	ZM110
TR2, TR3	BC549 (2 off)
TR4	2N1711
CSR1	TIC246D 16A 400V triac.
IC1, IC2	LF351N (2 off)
IC3	78L12

Miscellaneous

T1	Mains transformer 50mA 18V sec.
L1	FX3830 bobbin with 40 turns of 22 s.w.g.
Case	ABS 115 x 95 x 45mm
FS1	5A fuse
Fuse holder	p.c.b. type
Terminal block	3 way
Heatsink	(RS type 401-863)
p.c.b.	

Constructor's Note

A complete kit of parts for the Slave Light Dimmer is available from **GJD Electronics, 105 Harper Fold Road, Radcliffe, Manchester, M26 0RQ.**

APPLICATIONS

- (1) To control additional triac controlled lighting.
- (2) Light reinforcement for stage work—by filtering the photo-transistor tracking of different coloured lamps can be obtained.
- (3) Low power master lamps can be used to control the slaves to reduce size and power of stage lighting consoles.
- (4) To switch additional lamps from non-dimming mains lamps.

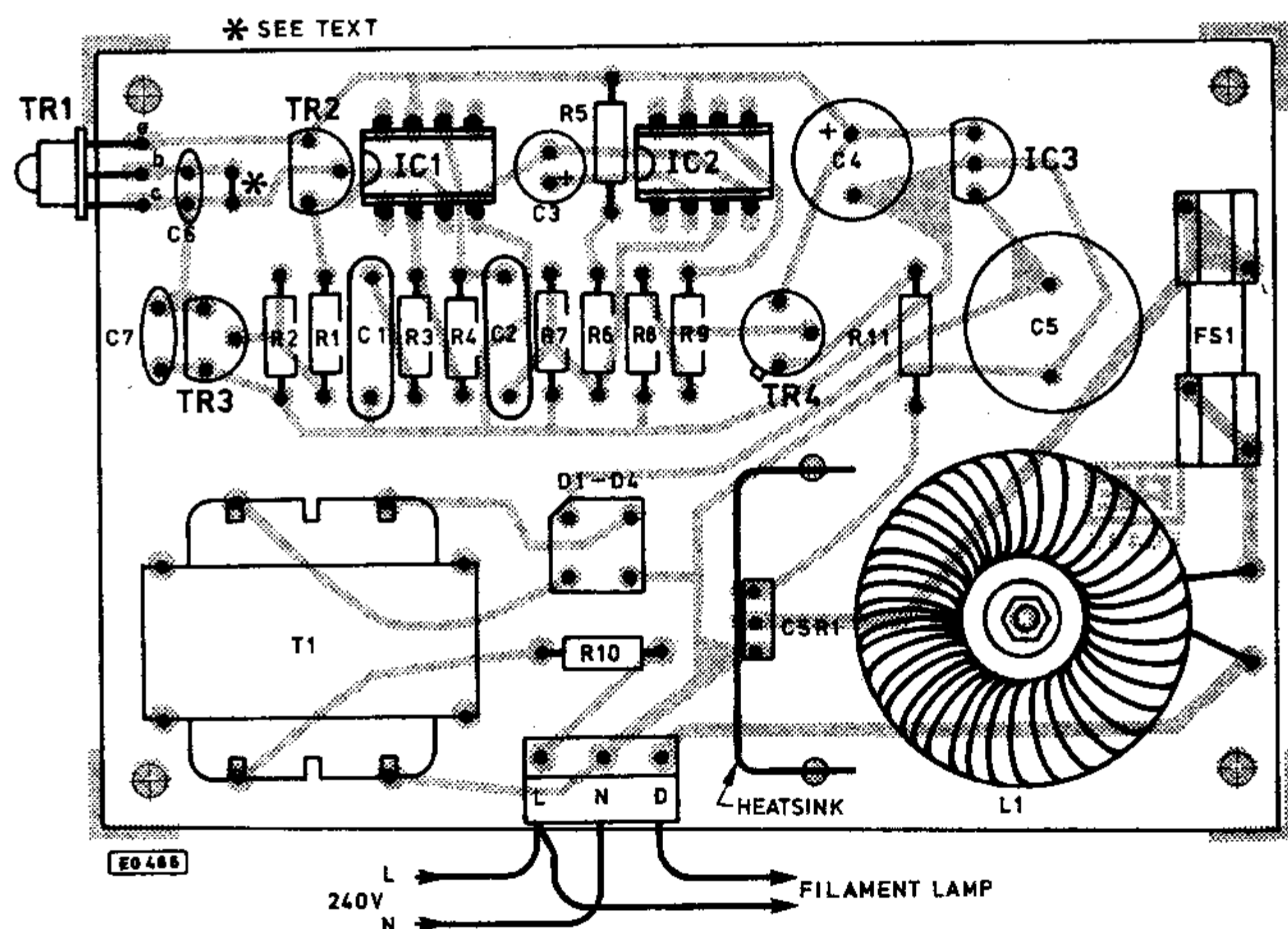


Fig. 3. Component layout.

enamel is removed from both ends for approximately 10mm. The photo-transistor should be mounted 10mm off the board to enable its final position to be adjusted when the board is fitted into the case. After all the components have been soldered and checked the p.c.b. can be mounted into the case and the two case holes drilled: one for the mains lead and filament lamp lead, the other for the photo-transistor.

Although the unit does not rely on the wattage of the master lamp, lamps over 150W may cause sufficient 'lag' to cause incorrect unit operation.

Daylight being 'steady' light will not cause the unit to operate although light received from the master lamp must exceed ambient daylight.

INSTALLATION

- (1) Try to point the photo-transistor at the master lamp being controlled although reflected light is sufficient for correct operation.
- (2) A deep red or infrared filter in front of the photo-transistor eliminates activating the unit from light from TV screens.
- (3) Try to point the photo-transistor so that light from the slave lamp does not exceed light received from the master to prevent interaction effects.
- (4) If the photo-transistor receives too much light the unit will turn the slave lamp off, if this occurs insert the link as shown in the circuit diagram.



TANDY POCKET COMPUTER



Dr. A.A. Berk

AT last, the calculator and computer have met in a compact and versatile little unit which is truly hand held. As you read through the following, just cogitate on the immense confusion with which your non-technical friends will view this device in the light of the usual question as to the difference between a calculator and a computer. In the last year or two we have seen bottom-end of the market micros ascend from Hex-keypad and digit "things" to VDU and QWERTY keyboard machines "speaking" BASIC. The computer described below is the same size as one of the Sharp calculator ranges, but has a full QWERTY keyboard, floating point BASIC with full scientific functions, 24-character alphanumeric display (l.c.d.), cassette storage as well as full calculator functions and 100 per cent retained memory upon switch-off (which it does automatically after seven minutes if not in use). The total amount of spare memory available at any time is shown by the MEM function. After "NEW" there are 1424 steps of BASIC memory or 178 memories (variables) in a common memory format.

The cost of this machine is £119, and the cassette interface a further £17.95. These prices include VAT. It should be pointed out, however, that the apparently identical machine can be purchased from Sharp, the manufacturers presumably, for slightly less cost. Perhaps the TRS80 version is superior in some way—unfortunately, a Sharp version was not to hand at the time of writing.

HARDWARE AND ACCESSORIES

As can be imagined, the amount of hardware crammed into this machine is quite remarkable. Several VLSI chips with very large numbers of pins are soldered to two p.c.b.s. One of the largest components visible within the box is not the battery, but a sound transducer to produce a "beep". The batteries used are four "button" mercury cells giving 5.4 volts. Three hundred hours of operation are claimed from this source, and the operational power is stated as 0.011 watts. When the power is off, the batteries are probably limited largely by shelf-life, though all memory is maintained while the batteries are present. 1.9K of memory is available in a format which is common to both programming and variable storage. This will be explained below.

On one of the p.c.b.s within the machine, there is a RESET switch which is accessed through a hole in the back of the case. This is presumably to release the computer from any spurious states or loops which it may encounter at any time. It has the effect of completely clearing memory of both programs and data, if the machine is 'on' at the time—if off, no harm to stored information is sustained.

The keys are excellent, soft to touch and definite, and their spacing does not feel too closely packed—despite the full alphanumeric capability. There is no key-rollover at all, indicating, as one would expect, that the device is designed for single finger use.

The display is composed of 24 five-by-seven dot-matrix characters. Their readability is excellent under normal daylight conditions, but the display is a little too inset into the machine for comfortable reading under a reading lamp—a shadow is cast over the display which is vaguely irritating, and, of course, angle of view is important as with any l.c.d. display.

At one end of the case, which is almost entirely metallic and quite robust, there is a 9-pin female connector designed to accept a plug located on the cassette interface housing. This is described later.



The machine is supplied with a Manual, quick reference card and two keyboard overlays for labelling user-defined keys. The soft black case for the machine is well padded and protects against most normal knocks and scratches.

MANUAL AND SOFTWARE PROVIDED

The Manual is not meant for beginners to BASIC, and it is highly recommended that a book such as the TRS 80 Level I Manual be read before attempting to program this machine if you are just starting. However, the doyen will find the book concise, informative and well written. There is a good index and an excellent reference summary.

There are some simple programs in the back of the book for experience in handling the machine, and the list includes the inevitable Biorythm and Guess-Number programs. Normal Distribution, Days Between Dates and Impedance in an a.c. series circuit also appear.

Tandy advertise quite a few tapes of software from about £9, and these include such headings as Personal Finance. Unfortunately, I was unable to find any of these tapes and cannot comment on their usefulness.

MODES AND CALCULATOR FUNCTION

The machine has four modes of operation, which are indicated at the top of the display. They are DEF, RUN, PRO, RESERVE. In the PRO mode, a BASIC program with line numbers may be written. In RUN, any stored program may be run, or the machine may be used as a calculator utilising all the BASIC scientific functions. RESERVE and DEF are used to personalize the lower two rows of alphanumeric keys (18 in all).

In the RUN mode, calculations are performed immediately by simply typing in the calculation, with functions and brackets etc., and pressing ENTER. The 10-digit answer, with two-digit ten's exponent, if necessary, appears automatically on the right of the display. The value of any variable may be examined simply by typing its label (A, B, C—A(1), A(2) etc.) and pressing ENTER.

Normally, on a BASIC computer, when an "immediate" mode calculation has been performed, the line of source data is lost and must be retyped. On this computer, the left and right arrow keys allow the line to be examined and amended or added to at will. If an error has been signalled, during execution, the line may be recalled to discover that the cursor is "sitting" on top of the faulty element of the calculation—a very useful function for long expressions. All the usual BASIC functions are included as well as full inverse trig. functions and logs to base 10 and e. The usual relations (<, > etc.) may be used as normal.

In the RESERVE mode, any function, expression or portion of a BASIC program may be reserved, to act upon a single key stroke. The total size of this reserve memory is 48 steps. For instance RUN 130 or COS may be programmed into the "A" key. In the RUN mode, SHIFT (A) would act as RUN 130 or COS—the latter requiring an argument to be typed in. In the PRO mode, the reserved data may be taken straight from the reserved keys. Thus, for instance, RUN 130 may be added into the program simply by pressing SHIFT (A).

The DEF mode allows each of several programs and/or routines within a program to be executed by a single stroke. Single-letter labels are allowed in this version of BASIC, and the routine starting at label C, for instance, is executed by SHIFT (C) in the DEF mode. In this manner, any number of programs may be stored in memory and executed by single keys.

SPECIAL FUNCTIONS

When output is required to be displayed, the PRINT statement is used as is normal in BASIC. The difference is that the program stops after printing each output and waits for the user

to press ENTER to signify that the display has been read. A PAUSE function is also available to exhibit the output for about 0.85 second instead. A PRINT USING type function may be used to format the display to some extent when printing variable numbers of characters in a field.

In the DEF mode, a special method of entering data is available. If the function AREAD is included in the first line of the program, any display contents present when the routine is started are immediately transferred into any variable following AREAD. This provides a method of transferring data from routine to machine through the display. It is this type of function which provides a real hybridisation of the calculator and computer.

Other useful functions of the BASIC include a BEEP function to produce any number of beeps from the machine, and a MEM command to view the amount of memory remaining (in STEPS and in VARIABLES). Three different angle representations are allowed: DEGREES, RADIANS and GRAD. These are accessed by commands which change the machine's mode. Just as with memory, the angle mode and machine status mode are remembered when the machine is switched off.

It should be noted that variables on the machine take up eight times as much space as BASIC steps. Memory is flexible and may be used for either. However, there are 26 fixed memories which are referred to as A, B, C—Z. These are reserved as numeric and string variables only. String variables may store up to seven characters—A\$, as usual, is a string. To contact the rest of the variables, A(n) format or A\$(n) must be used. If n is less than 26, however, the variable assumed is just one of the alphabetic ones, e.g.:—A\$(4) = D\$.

The INPUT statement is available, in the usual manner, for allowing an operator to input data from the keyboard during program execution. As can be appreciated, the BASIC offered by this machine is by no means of a minimal variety, but it is rather slow. For instance, it takes 6 seconds to count up to 20 in the FOR loop:—

```
10 FOR I = 1 to 20: NEXT I
```

and 20 seconds to execute:

```
10 FOR I = 1 TO 20: F = 45*SIN (12.356): NEXT I
```

Just the same, the package has plenty of facilities. FOR statements may use the STEP function, and may be nested up to four levels. STOP, CONTINUE, CLEAR, multiple line statements, etc. all exist. LET is optional except after IF, END is only used to separate different programs stored in memory for the DEF function, for instance. Numeric valued expressions are allowed in most statements where a number is normally required. These facilities all make program writing easy and sophisticated.

DEBUGGING AND TROUBLESHOOTING

Much thought has been given to program development in a machine with just 24 characters as output. Such features as recallable text in immediate "RUN" mode for editing have been mentioned.

Listing is a particular problem with just one short line of text. The manufacturers have thus included two special keys to allow the operator to list the text in either direction line by line. The LIST command, followed by a line-number, recalls the given line, and use of the up or down arrow keys steps up or down the program at will. The left and right arrow keys allow viewing of text which disappears off the screen, as well as insertions and deletions of characters in a line.

A most useful feature for troubleshooting is the DEBUG function. Very similar to a TRACE, DEBUG is typed in RUN mode, and from then on running a program is performed by typing a RUN followed by the down arrow key. Each pressing of the down-arrow causes the next line-number in the sequence to be displayed and its contents executed. Pressing the up-arrow causes the current line contents to be displayed.

To further aid debugging, six error codes are offered. If one is signalled during a RUN, the exact position on the line at which the mistake is located may be discovered by pressing the 'up' arrow. The cursor will be positioned next to the error.

CASSETTE STORAGE

The cassette interface unit is a separate case into which the computer is plugged. The unit is powered by three penlight cells. The interface plugs into MIC, EAR and REMOTE for complete control. I found the cassette facility refreshingly impervious to temperament, and unaffected by vast changes in the volume setting. The only trouble I encountered was in recording a program with both MIC and EAR connected—excessive noise appeared on the tape until the EAR connection was removed. However, I am willing to concede that it may have been a peculiarity of my particular machine (not the Tandy one shown). Apart from that, recording and playback appeared faultless. CSAVE and CLOAD are used as normal for the TRS80, and named files are compulsory. The beeper is used to allow the operator to hear data being recorded and played back as a monitor on correct operation—a most desirable feature. PRINT # and INPUT # are both allowed for the storage and retrieval of data involving cassette.

Two other functions are also included for cassette use. The familiar CLOAD? function allows a program recorded on tape to be compared with the one in memory for checking purposes. A new type of function "CHAIN" followed by a file name may be included within a program. When encountered during execution, the file named is searched for on tape, transferred to memory and executed automatically. If a line-number also follows "CHAIN", the file is loaded as before and then executed

from that line number. This is a clever and complex statement which allows a chain of routines on tape, too long in toto for storage in memory, to be executed one after the other.

CONCLUSIONS

The computer is very compact, and is a triumph for "state-of-the-art" electronics. Its memory is quite small but used in a very efficient manner. The execution is slow, but it can be left to cogitate on its own for as long as you like, produce an answer in a set of variables and then switch itself off, retaining program and solution for your later perusal. The cassette is slow but untemperamental and will allow a very long program to be executed in sections.

All in all, the computer is much more than a toy, though I suspect that its latter attraction will be its major selling point. As a means of storing data and supplying answers to calculative problems straight from the pocket, it is unparalleled. Uses could include the storage of data and common routines which an investor, engineer or scientist is forced to use and refer to continually in the field from day to day. It could be adapted to being a diary, a data storage unit, a super calculator all rolled into one. The major limitation, once again, is its comparatively small memory—looking at the inside, it would appear that expansion of this feature is not possible.

This is a remarkable little machine, and perhaps one should be more forgiving of the limitations given the present level of technology. However, I should be most interested to discover at which market segment this machine is aimed—or should one accept the design as yet another offering on the altar of Progress and Fashion?

POINTS ARISING

INTERFACING COMPUKIT 1

PE January 1981

Unfortunately, due to production difficulties some errors crept into Part 1, and for this we apologise.

The second line under "Capacitors" in the component list should read: C2, C5, C8-C13 100n (8 off).

Items six and seven under "Miscellaneous" should read: 1—2 x 22 pin 0-1in. edge connector, and 1—2 x 25 pin 0-1in. edge connector.

In Table 1.2, the polled keyboard is addressed incorrectly and should read: DFOO, and similarly the ACIA port should read: F000-F0FF. In Table 1.7, pin 24 goes to W10. Pin 14 goes to R5, and pin 13 goes to R4.

The following applies to Table 1.8. Pin 3 connects to R0, pin 5 to BDIR, pin 12—W9, pin 20—BL3, pin 21—BL4, pin 22—R3, pin 23—R2, pin 24—BL7, and pin 25—NMI.

On the lower side of the latter three pins the BL signals should also be NOT.

Table 1.9. Address 61317 (audio) is R5 to SK6.

In the photograph of the Decoder Module, the left-hand edge connector is for SK6.

PE DMM (July 1980)

In Fig. 2 the top of R31 should connect to the junction of C2, R15, R16 as shown in Fig. 5.

125W AMPLIFIER (*PE October 1980*)

We have been asked to correct any impression given that the 125W Amplifier project published in our October issue was in any way connected with Bi-Pak Semiconductors.

Bi-Pak of Ware, Hertfordshire, have been selling an AL250 module for the past five years, although our 125W Amplifier appears similar to the AL250 there was no collaboration or connection with Bi-Pak in the production of the article and our project was in no way a kit version of the AL250.



BOOK REVIEWS

TOWERS' MICROPROCESSOR SELECTOR

By T. D. Towers

Published by W. Foulsham & Co. Ltd., 120p. 10in x 7in. Price £14.95.

This new selector in what has proved a popular series covers specifications of the basic family of central microprocessor units and LSI central circuits such as RAMs, ROMs, PROMs, interface units etc.

In the detailed data table of the selector the descriptions of the microprocessors and related microcircuits are set out on a separate lines arranged in alphanumeric order.

The tabulations with related appendices cover the applications and family relations of chips together with manufactures, package and lead-out identification and possible second source suppliers.

In addition the appendices provide information on MPU training and development systems and manufacturers' house code numbering systems together with a bibliography on MPU subjects.

G.G.

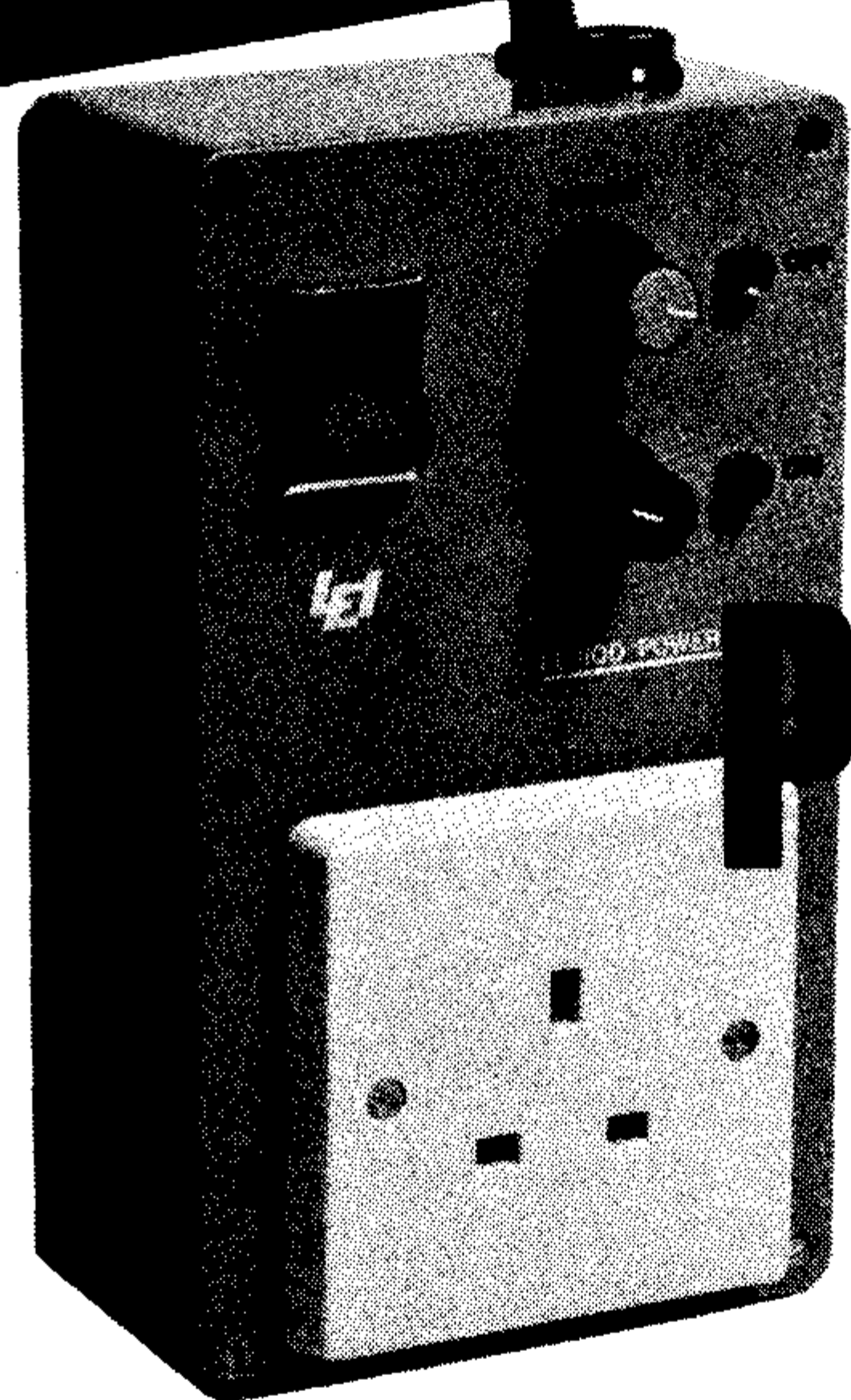
NEXT MONTH

27-28 MHz CONVERTER

Listen in with our converter.

Add this unit to your car radio and it becomes capable of receiving transmissions in the 27 and 28MHz bands.

FREE... DIODE IDENTICHART



MICROPHONE MIXER



A simple mixer designed for using three microphones when making stereo recordings. Signals from the centre microphone are mixed into the left and right channels avoiding the "hole in the middle" effect.

PERIOD POWER TESTER

Designed to provide a stringent test on electronic equipment by continually switching the mains supply on and off at short intervals. This unit is particularly useful for testing equipment used for public demonstrations or performances.

PRACTICAL

ELECTRONICS

OUR MARCH ISSUE WILL BE ON SALE FRIDAY 13 FEBRUARY 1981

Digital COUNTER/TIMER

PART 1

Dr. MARK SAWIKI and ALEX KOWALEWSKI B.Sc.

THIS ARTICLE describes the design and construction of a universal low-cost digital counter-timer which can provide a simple and quite efficient solution to a whole range of frequency and time measurements, which with this instrument can be achieved quickly and conveniently. A fully integrated digital counter with a high stability quartz crystal stabilised high frequency oscillator (temperature stability defined over a -20°C to 70°C range), permits the frequency, period, frequency ratio A/B, time interval (A/B) and unit totalising counter, to be measured and monitored with greater accuracy than in most low-cost constructions.

The heart of the instrument is the 8 digit Universal Counter (Intersil ICM 7216 A) i.c., and a 10MHz crystal is used to guarantee a 0.1 microsecond resolution. For operational convenience and simplicity the instrument circuit is designed to display time in microseconds and frequency in kHz. The intention was to produce a design enabling precise frequency measurements up to 10MHz, at a relatively low cost, however, the use of a simple pre-scaler technique may easily extend the frequency measurement capability up to 100MHz if required.

The Universal Digital Counter-Timer has a pair of high impedance separate input channels with a full range voltage coverage for most applications. Three ranges (on both channels) can be selected, i.e. 3V, 30V, 300V—protected up to standard UK mains voltage level.

For increased versatility of the instrument, an independent internal SQUARE WAVE test oscillator is also provided with an output capability of $\pm 0.6\text{V}$ with reasonable freedom from amplitude bounce. The frequency coverage of 80Hz to

800kHz is divided into four sub-bands, the one required being selected by means of a frequency selector switch and with a fine rotary control potentiometer for precise tuning. The test oscillator output is short circuit protected, and the maximum frequency level can be easily extended up to about 1.2MHz if necessary.

PRINCIPLES OF OPERATION

A block diagram of the Universal Counter-Timer is shown in Fig. 1. The complete system can be divided into the following eight sections:

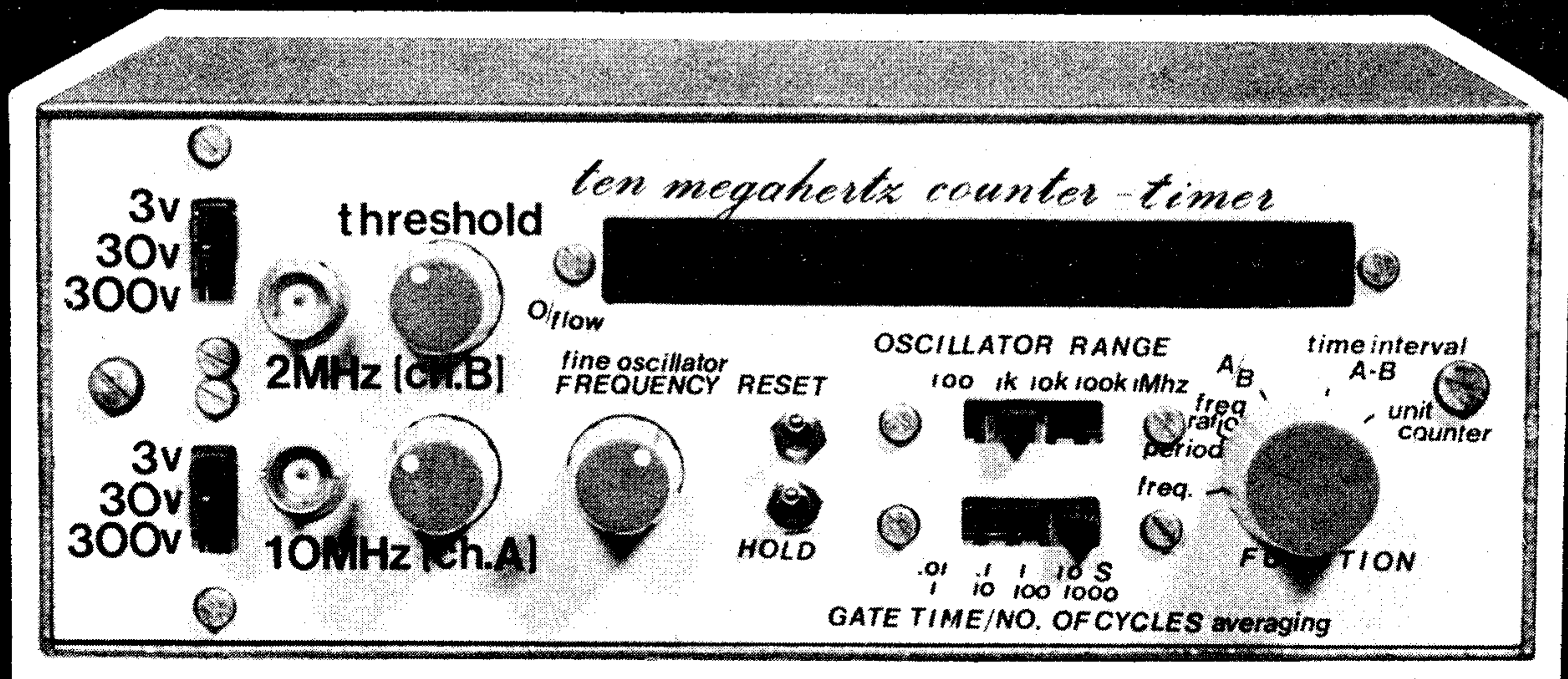
- Attenuator Block (input A)
- Attenuator Block (input B)
- Pre-amp Block (input A)
- Pre-amp Block (input B)
- Counter-Timer Block
- Internal Oscillator Block
- 8 Digit Display Board
- Regulated Power Supply

Constructionally, the whole Counter-Timer circuitry is planned into the three p.c.b.s, i.e.

- Main Board
- Display Board
- Power Supply Board.

Both channels A and B attenuator components are soldered directly onto the respective input selector switches, also three timing capacitors are placed outside the oscillator circuit on the Main Board.

The Display Board houses all eight 7-segment displays, as well as an "overflow" i.e.d. indicator. The Display Board



SPECIFICATION

PRE-AMPLIFIERS A & B

Performance

Frequency range: 7Hz–8MHz. Ref. 3dB point or better
 Maximum Sensitivity: 30mV r.m.s. Ref. 1kHz
 Maximum Input Level: Mains (240V r.m.s.)
 Input Voltage Ranges: Nominally 3V; 30V; 300V; protected up to mains voltage.

Controls

Input Impedance: 1M Ω in parallel with approx. 20pF
 1) Individual Range Selector Switch
 2) Individual Threshold/Trigger Level controls

Inputs

Pair of 75 Ohms—BNC series sockets on both channels. Recommended coupling: 75 Ohms low-loss Coax cable and BNC series plugs

INDEPENDENT INTERNAL TEST OSCILLATOR

Performance

Nominal Output Level: $\pm 0.6V$ (1.2V Peak to Peak)
 Output Form: Square wave
 Frequency Range: Better than 80Hz–800kHz (with 10 volts supply goes up 1.2MHz)

Controls

1) Coarse Frequency selector switch calibrated at:
 100Hz–1kHz
 1kHz–10kHz
 10kHz–100kHz
 100kHz–1MHz
 2) Fine Frequency Rotary Control (1–10 variation)

Output

Single BNC series socket (75 ohms)—short circuit protection.

NOTE:

Oscillator spec. depends on accuracy of resistors and capacitors used for v.c.o. Prototype instrument uses: 5% tolerance resistors and 10% tolerance capacitors. For high performance 1% tolerance resistors and 5% tolerance capacitors are required. Mainly because of variation of v.c.o. chip ($\pm 15\%$ frequency), therefore some trimming of values will be required.

COUNTER TIMER SECTION

Performance

Frequency Range, Channel A: d.c. to 10MHz (Frequency Mode)
 Frequency Range, Channel B: d.c. to 2MHz (ratio, time interval modes)
 Period Range: 0.5 μ sec to 10 secs.
 Period/Time Interval Resolution: 0.1 μ sec. Ref. 10MHz timebase
 Accuracy (Frequency Mode): 0.1Hz in the least significant digit. Ref. 10 sec. accumulation time.
 Gate Times (Accumulation times): 0.01 sec; 0.1 sec; 1 sec; 10 sec. Ref. Frequency counter mode.
 Number of Cycles, averaging: 1 cycle; 10 cycles; 100 cycles; 1000 cycles. Ref. period/frequency/Ratio and time interval Modes.

Controls

Display: 8 digit (7 segment l.e.d.s) with automatically positioned decimal point) multiplexed common anode display (13 x 9mm)
 Overflow: $\frac{1}{4}$ in. red l.e.d. indicator
 1) Function rotary selector switch i.e. Frequency; Period; Frequency Ratio: $\frac{A}{B}$; Time Interval (A–B); Unit Counter
 2) Gate Time/Number of cycles Selector Switch
 3) Reset Switch (Zero's Display in all modes)
 4) Hold switch (holds count in unit counter mode) Hold—same as Reset in all other modes)

POWER SUPPLY UNIT

Mains input
 Requirements
 Fuse
 Physical
 Dimensions
 Weight

Regulated 2 x LM309K (5 volts/1.2A) dual. Rail supply: +5V; 0V; –5V: Internal foldback, overload and short circuit protection. Complete unit consumes approx. 150mA @ 5 volts per rail

220–240 volts 50/60Hz
 500mA—Antisurge (20mm)
 91 x 204 x 153mm
 Approx. 2,185 grams

p.c.b. will accept both types of displays, i.e. with RH and LH decimals. For simple wiring conversion see relevant note in Fig. 1.

Both input A and B Attenuator/Pre-amplifier circuit diagrams are identical and corresponding schematic diagrams are presented in combined form in Fig. 2. The input attenuator circuit is extremely simple with voltage dividing network and three-position voltage selector switch calibrated at 3V, 30V, 300V. The output signal from the channel attenuator feeds directly into the relevant pre-amplifier section, which then can be divided, because of its functional role, into the following:

- Input protection stage
- Impedance buffer, and approx 20dB gain stage and high speed TTL (Schottky) compatible comparator.

The protection at this stage consists of a high resistance/voltage breakdown series resistor of 1M parallel with

47nF/400V capacitance, followed by a combination of four clamping diodes, i.e. a pair of 1N914s and Zener BZX 83C2.7.

The high voltage breakdown 1M/0.5W resistor can be obtained from Maplin, as standard high-stab carbon resistors are not recommended for this work, because of insufficient high voltage breakdown parameters.

Turning to the impedance buffer stage, the main design objectives are:

- High input impedance
- High gain (20dB)
- Output impedance must be low enough to drive NE529 comparator
- Must work from 5V supply

Finally, the network frequency response is maximised (maximum gain-bandwidth product). Use of a pair of f.e.t.s (2N5245) seems to be a reasonable answer.

Now a little field effect transistor theory. A practical small

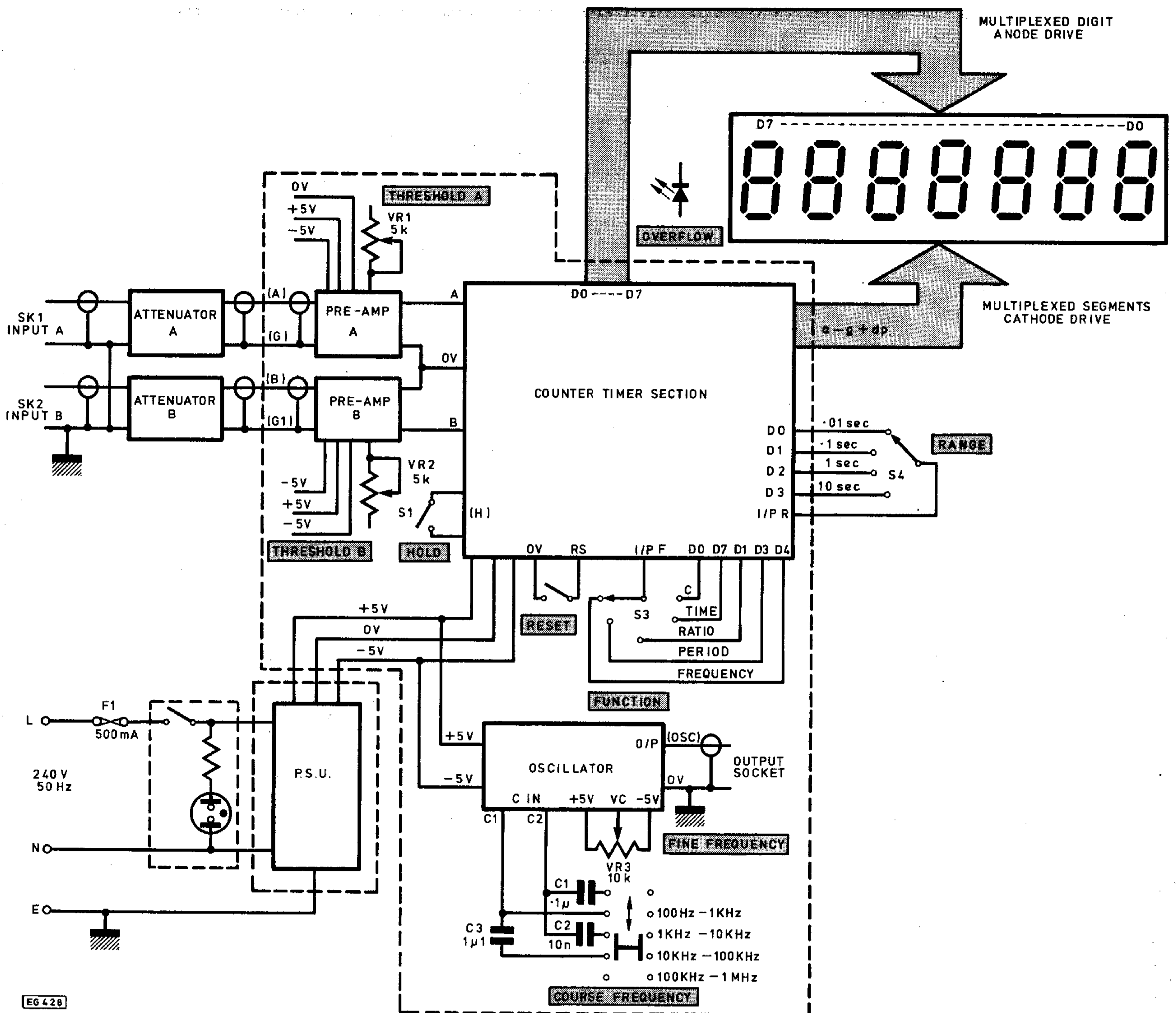


Fig. 1. Block diagram. Note on Overflow l.e.d. indicator. (a) For RH decimals: cathode to d.p. segment drive rail, and anode to D7. (b) for LH decimals: anode to D6. Do not connect decimals on D7 and D6

signal model of an f.e.t. is shown in Fig. 3.

Our impedance buffer stage employs a pair of such devices connected in series, i.e. as presented in Fig. 4.

The operational extrinsic elements we shall consider now, are those under d.c. and a.c. work conditions. From the simplified diagram (Fig. 4), you can see that under normal d.c. conditions transistor TR1 acts as a source follower giving a stable quiescent voltage (V_{out}) of approx. 2.5V. Under a.c. conditions TR1 becomes a constant current source due to the presence of C10 capacitor, bootstrapping its gate voltage. Due to the high slope impedance, gain is high; this applies also to the large bandwidth which is maintained due to constant current drive. The obvious advantage of this type of configuration over a simple constant current source is the highly superior d.c. stability.

The 2N5245 f.e.t.s have been chosen because of their quite good performance combined with relatively low cost.

It might be worth noting that frequency response, in-

cluding the input protection stage (maximum gain bandwidth product) is calculated using a computer model admittance analysis program, written specially for this project and run on a TRS 80 Tandy system, 16K BASIC level II. The source program occupies about 10K RAM and uses double precision (16 digit) for internal calculations.

Calculated gain is about 21dB at 10.9MHz and the corresponding frequency response characteristic is shown in Fig. 5.

The last part of the pre-amp stage now is the Comparator Design is based on the application of a SE/NE 529 Analogue Voltage Comparator, being a high speed Schottky device. Among the many advanced features of this i.c., are the following:

- 10 nsec propagation delay.
- complementary output gates.
- TTL compatibility.
- wide common mode and differential voltage range.

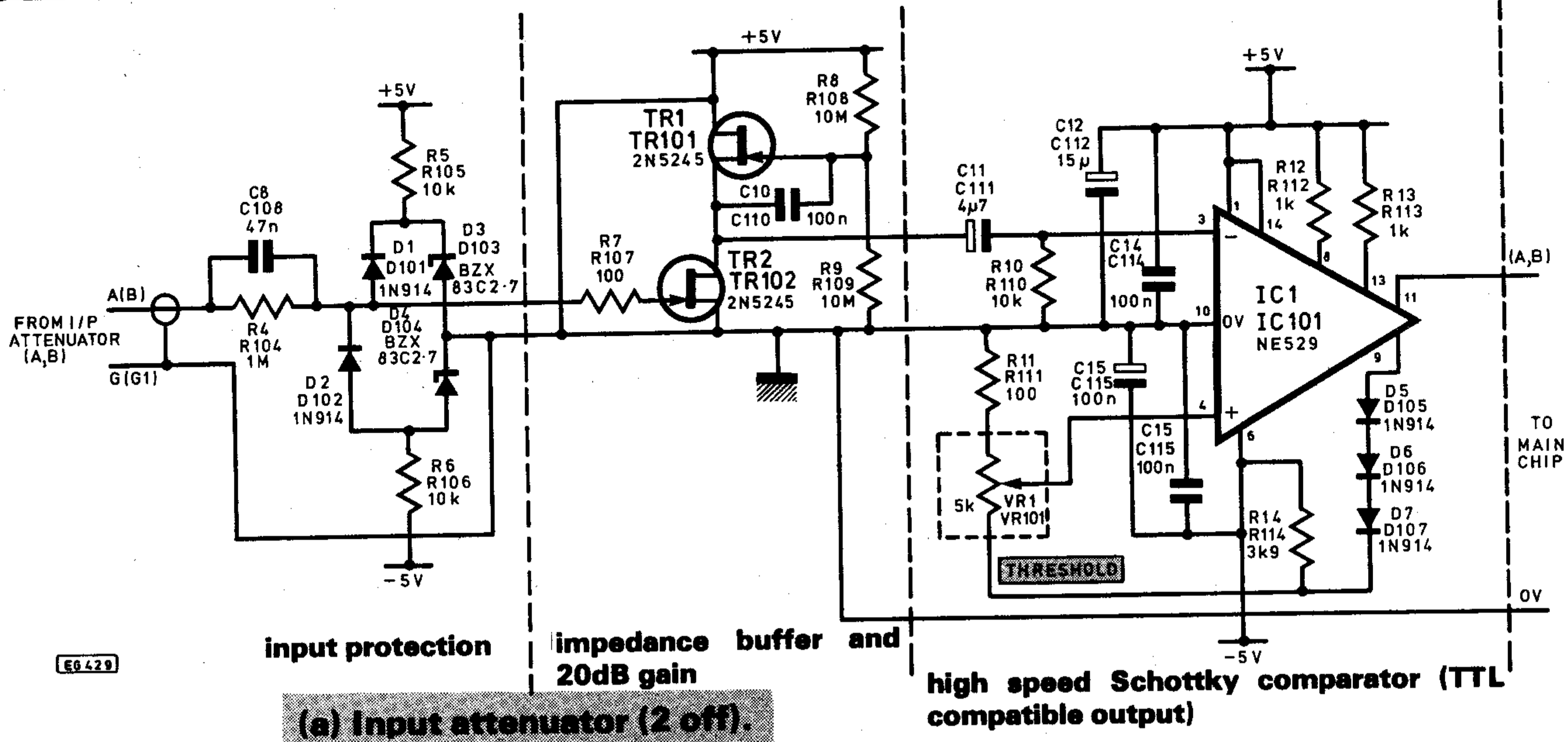


Fig. 2. Input circuits.

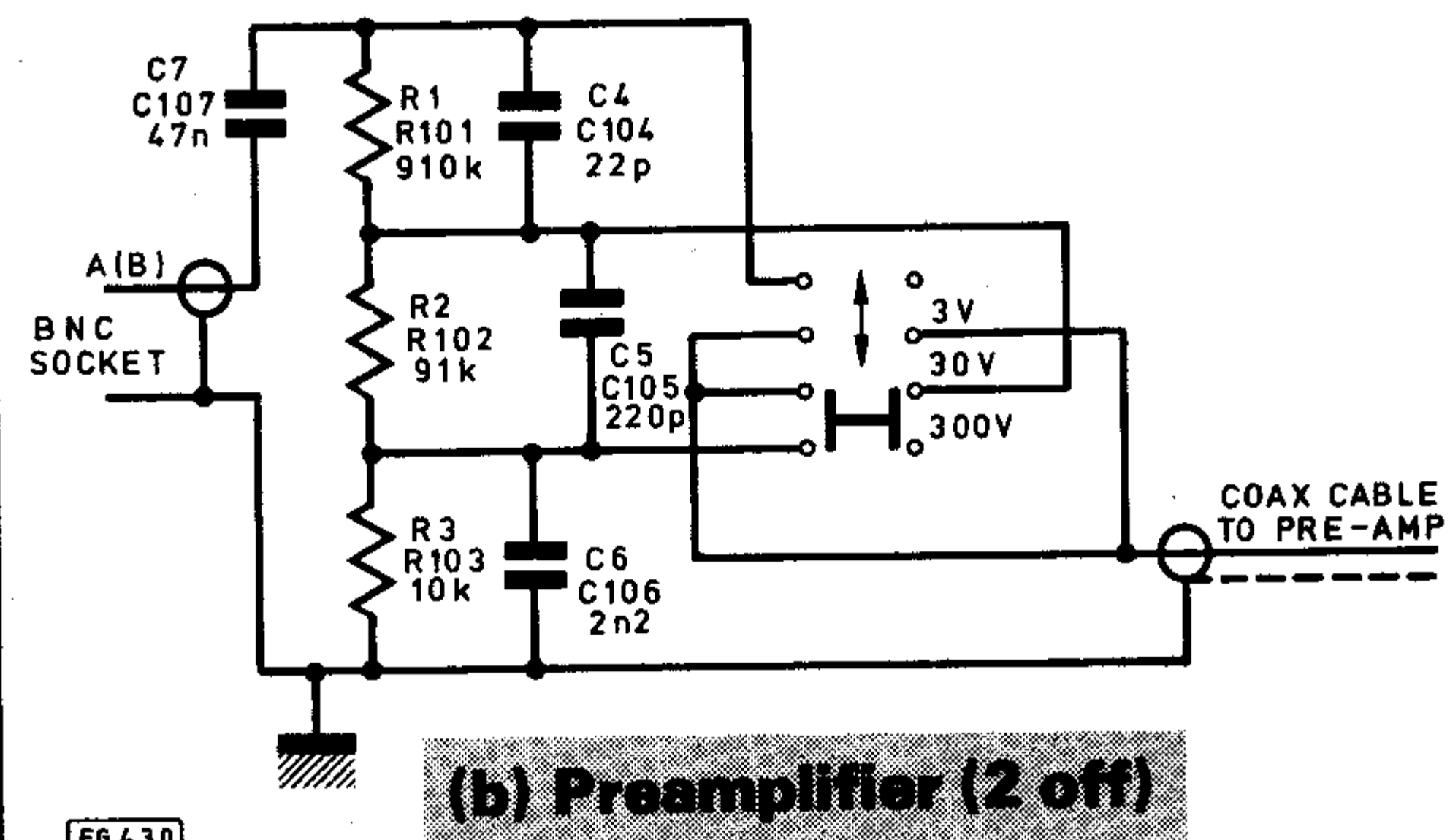


Fig. 3. Practical small signal model of single f.e.t. Note: C_{ds} is usually negligible

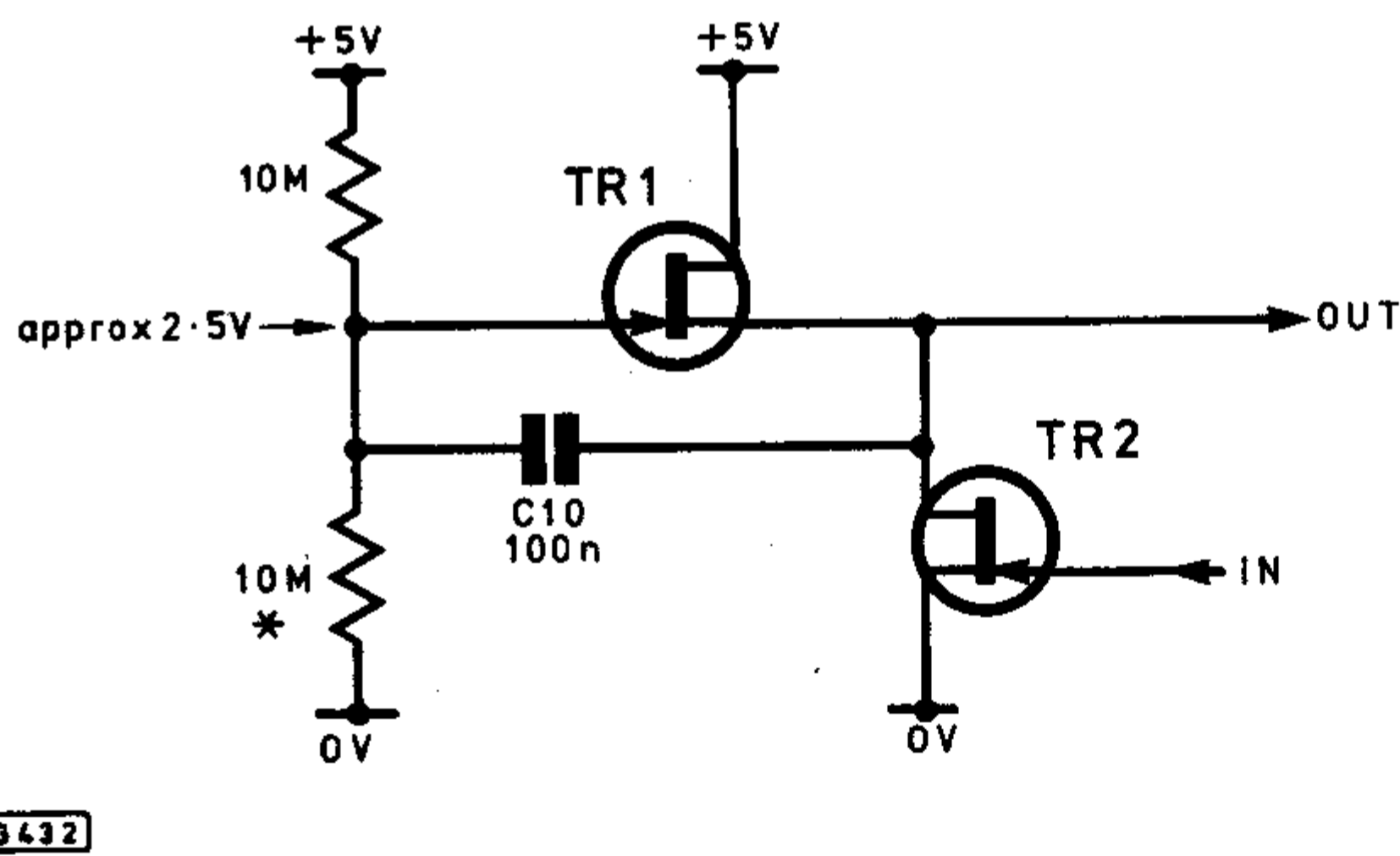


Fig. 4. Impedance Buffer and 20dB gain. *Preserves high slope impedance

$$\text{Gain} \approx \frac{Y_{fs}}{2(Y_L + Y_{os})}$$

where Y_L = load admittance
 $Y_L \gg Y_{os} \dots$ Load defines gain
 Since load is fixed, gain is stable

EG 430

EG 432

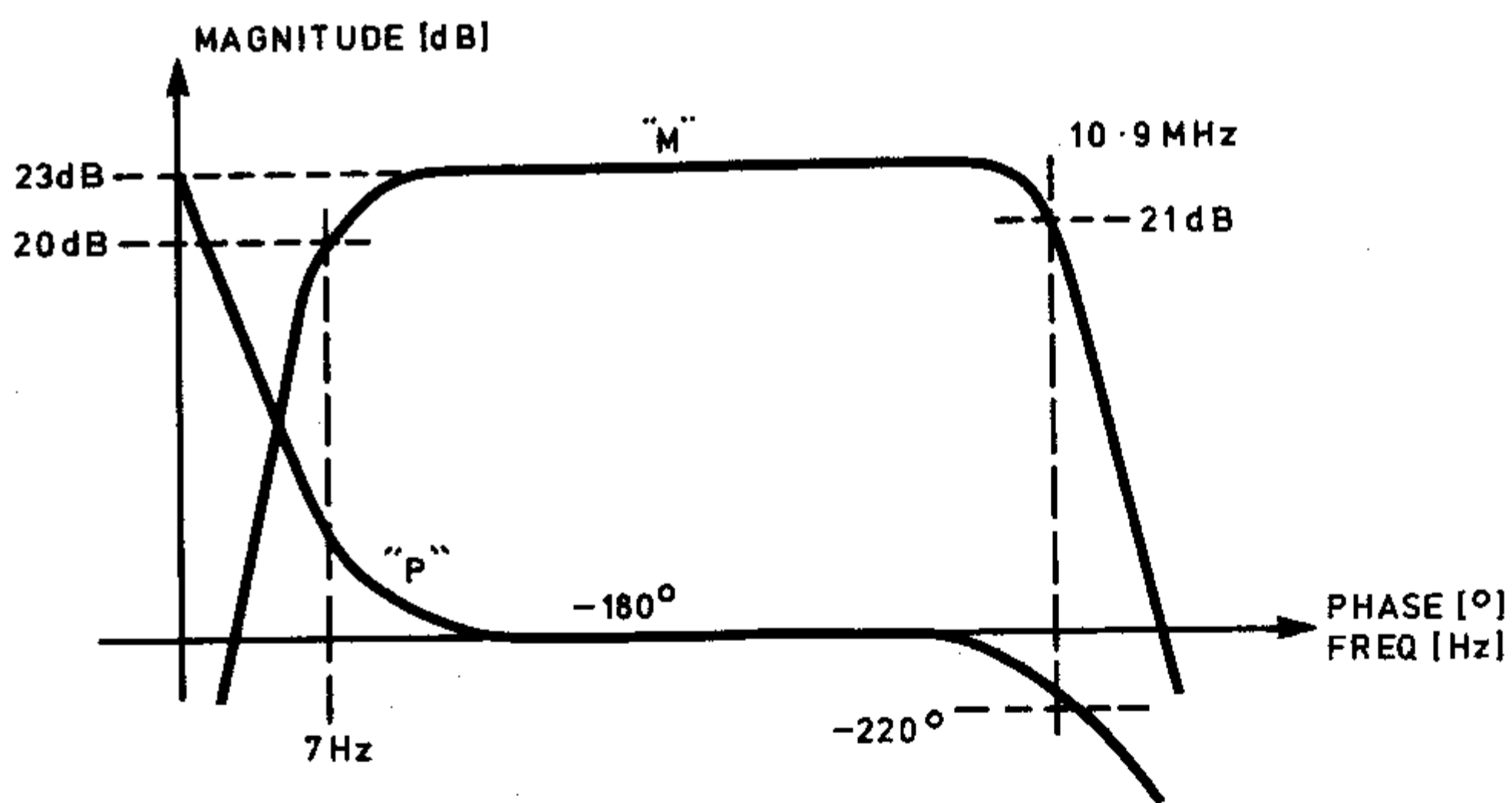
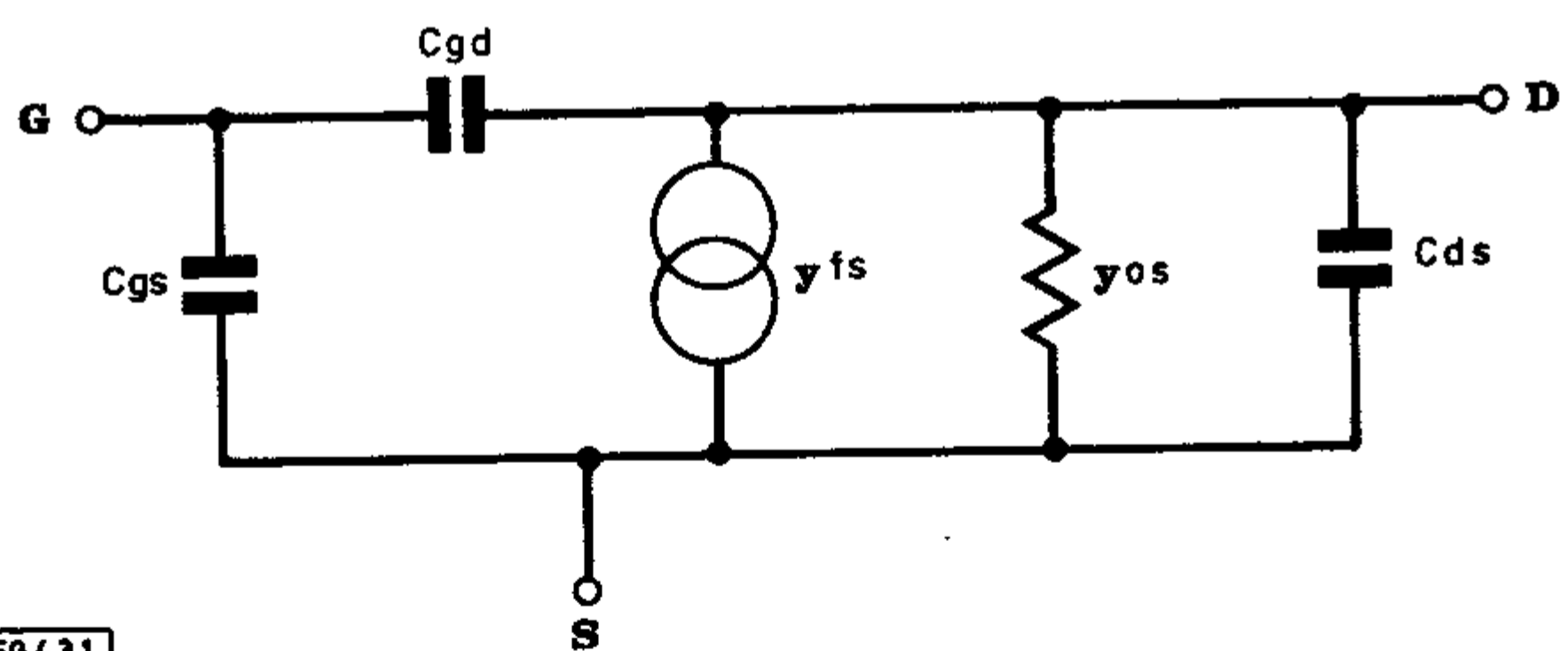


Fig. 5. Magnitude/phase/frequency relationship

COMPONENTS . . .

Resistors

R1, R101	910k (2 off)	} pref. hi. stab. metallised 1%
R2, R102	91k (2 off)	
R3, R103	10k (2 off)	
R4, R104	1M, 1/2W 5% hi. stab. metallised (2 off)	
R5, R6, R10, R19-R23, R110	10k (11 off)	
R7, R11, R107, R111	100 (4 off)	
R8, R9, R108, R109	10M (4 off)	
R12, R13, R112, R113	1k (4 off)	
R14, R17, R114	3k9 (3 off)	
R15	200k	
R16	12k	
R18	4k7	
R24	4M7	
R25	8k2	} Adjust to span 10:1 range in frequency for full Vc—control variation; 5% 1/2W hi. stab. metallised type
R26	130k	
R27	1k8	
R28, R29	1k 1/2W 5% hi. stab. metallised	

All resistors 5% 1/2W hi. stab. metallised unless otherwise stated.

Capacitors

C1	100n/160V polyester	
C2	10n/160V polyester	
C3	1µ1/160V polyester	
C4, C104	22p/400V ceramic (2 off)	} 10% tol.
C5, C105	220p/100V ceramic (2 off)	
C6, C106	2n2/100V ceramic (2 off)	
C7, C107	47n/400V polyester (2 off)	
C8, C108	47n/400V with high voltage breakdown (2 off) (Maplin)	
C9, C21, C109	2µ2/10V tant. bead (3 off)	
C10, C14, C15, C17, C110, C114, C115	100n/63V min. disc. cer. (7 off)	
C11, C111	4µ7/10V (2 off) } tant. bead	
C12, C13, C23, C112, C113	15µ/10V (5 off) }	
C14, C15	2n2 disc. cer. (2 off)	
C16	33µ/10V tant. bead	
C18, C19	39p min. disc. cer. (2 off)	
C20	100p styroflex type	
C22	100n polyester	

C24, C25	2200µ/25V elect.
C26, C27	220n polyester
C28, C29	470n polyester

Potentiometers

VR1, VR2	5k	1W rotary moulded carbon track + insulated spindle
VR3	10k	

Transistors and Diodes

TR1, TR2, TR101,	2N5245 f.a.t. (4 off)
TR102	
TR3	BC107
D1, D2, D5-D9, D101, D102	
D105-D109	1N914 (14 off)
D3, D4, D103, D104	BZX83C 2V7 Zener
B1, B2	1A rectifier stack (RS 261-328) (2 off)

Integrated Circuits

IC1, IC101	NE529 Schottky comparator (Signetics) (2 off)
IC2	CD4069B
IC3	ICM 7216A Intersil counter (see text)

Miscellaneous

S1, S2 SPST sub. min. rocker or push button switch, n.o. (2 off)
 S3 1-pole 5-way rotary switch
 S4, S5 2-pole 4-way slide switch min. (2 off) (S4 may be single pole)
 SK1, SK2 75 Ohm BNC socket (2 off)
 7-seg. 0.3in. com. anode displays with RH or LH decimals (see text)
 example: RS586-526 (8 off)
 l.e.d. overflow indicator (1 off)
 Mains socket: 3-pin "Euroconnector"
 20mm glass fuse + holder 500ma @ 240V
 Neon illuminated mains on/off switch
 Instrument case (see text) e.g. RS 509-901
 Knobs, ribbon cable, nuts & bolts etc.
 10MHz crystal (see text)
 14-pin & 28-pin i.c. sockets for IC2 & IC3
 Mains transformer: 240V/OV-6V + OV-6V @ 20VA (RS 207-138)
 P.c.b.s & general hardware
 NOTE: For RH and LH decimals see Fig. 1

In fact, SE/NE 529 will run at $\pm 5V$ supply and has both inverting and non-inverting outputs. As mentioned above, output levels are compatible with t.t.l. and this is necessary because of the use of an Interisl counter-timer chip. Referring to Fig. 2. the comparator circuit mode of operation employs differential inputs used with feedback to form a Schmidt trigger with variable hysteresis about the 0V level. (See Fig. 6.)

Since output has TTL levels, while hysteresis about zero is required, three diodes (3x 1N914) are used as a level shifter. Finally, 5 kohm potentiometers are used as Threshold level controls, mounted individually in Channel A and B on the instrument front panel.

To conclude both input attenuator and pre-amplifier stages, a word about input protection—a practical feature not always respected in amateur constructions. The most

important protection features of this part of the instrument can be listed as follows:

- 1) High series resistance (1Mohm) effectively limiting current, with parallel capacitance to stop h.f. losses due to resistive character, still sufficiently small to pass only 0.5mA if mains (50Hz) is applied.
- 2) Combination circuit of clamp diodes to limit voltage applied to TR2 (Field Effect Transistor) gate to about $\pm 3V$, especially with Zener diodes used to keep the pair of diodes normally *reverse biased*. This protection network still works with the power off—so the instrument is *always* safe!!
- 3) Resistance of 100 ohms limits current through gate of junction TR2, to approx 30mA (50mA is max level for 2N5245). This resistor value is kept small to maintain high frequency response.

Last but not least, the SE/NE 529 Analogue Voltage Com-

parator is a Signetics device and its pin configuration is shown in Fig. 7:

Coming to Fig. 8, we find the Counter-Timer section, and associated small additional circuit acting as induced delay (this will be explained later on). As mentioned earlier, the heart of the PE Universal Counter is the ICM 7216A Intersil i.c. and its internal block diagram as well as pin configuration is presented in Fig. 9.

The ICM 7216A Universal Counter integrated circuit is superbly documented by the manufacturer and therefore the necessary minimum information about the i.c. is included in this article.

As mentioned earlier, the circuit of our counter timer has provisions for two types of decimals (i.e. RH or LH) which do exist amongst commercially available 7-segment displays. The delay section of Fig. 8 provides this option, and if you use RH d.p. displays, you should use delayed output, i.e. marked (*) on Fig. 8, or directly pin 4 output (on 7216 chip) for RH decimals. The delay section circuit is very straightforward, using a single 14-pin CMOS Hex Inverter—CD4069B, working at a positive 5V rail and ground (0V), buffered by *single n.p.n.* transistor.

At this point, we shall turn for a moment to all the 7216A external components and controls as shown on both Fig. 1 and Fig. 8. The Hold switch or push-button which works as

in most commercial counters, is connected between the +5V rail and pin 27, marked Hold (H) on Fig. 8. Reset switch or push-button is grounding pin 13 on the 7216A chip marked Reset (RS) on Fig. 1 and Fig. 8. Function rotary selector switch has its Common connected via a 10k resistor to pin 3 on the 7216A chip and the functional positions are as follows:

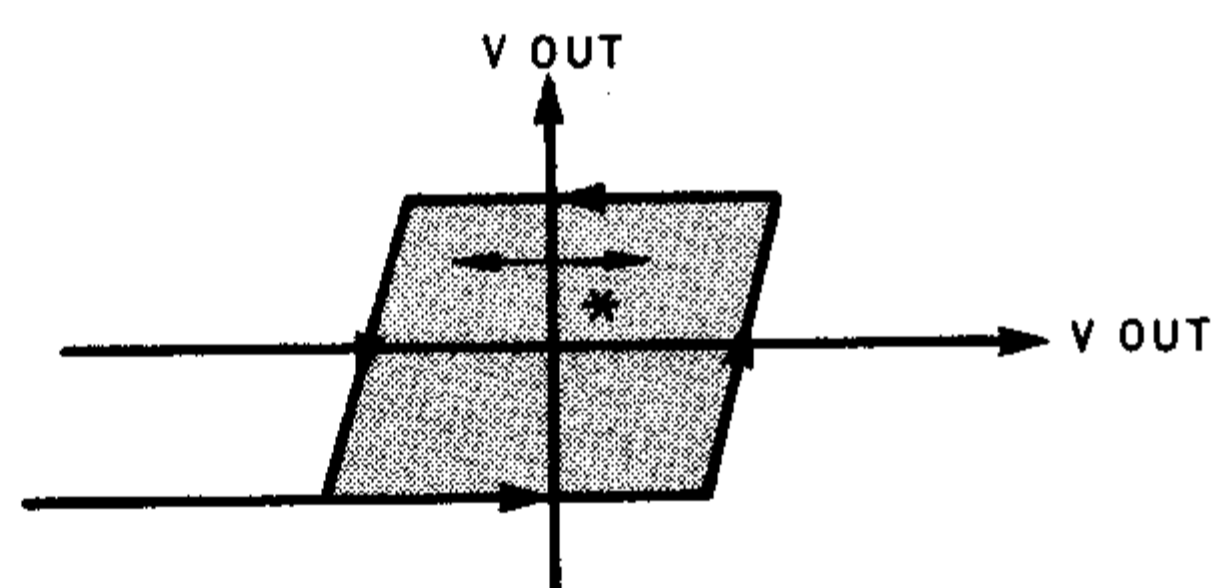
Frequency	connected to D3
Period	connected to D4
Frequency Ratio	connected to D1
Time Interval	connected to D7
Unit Counter	connected to D0

as illustrated in Fig. 1 and Fig. 8.

Range selector switch has its Common connected again via 10k resistor to pin 14 on 7216A chip and the range operational positions are as follows:

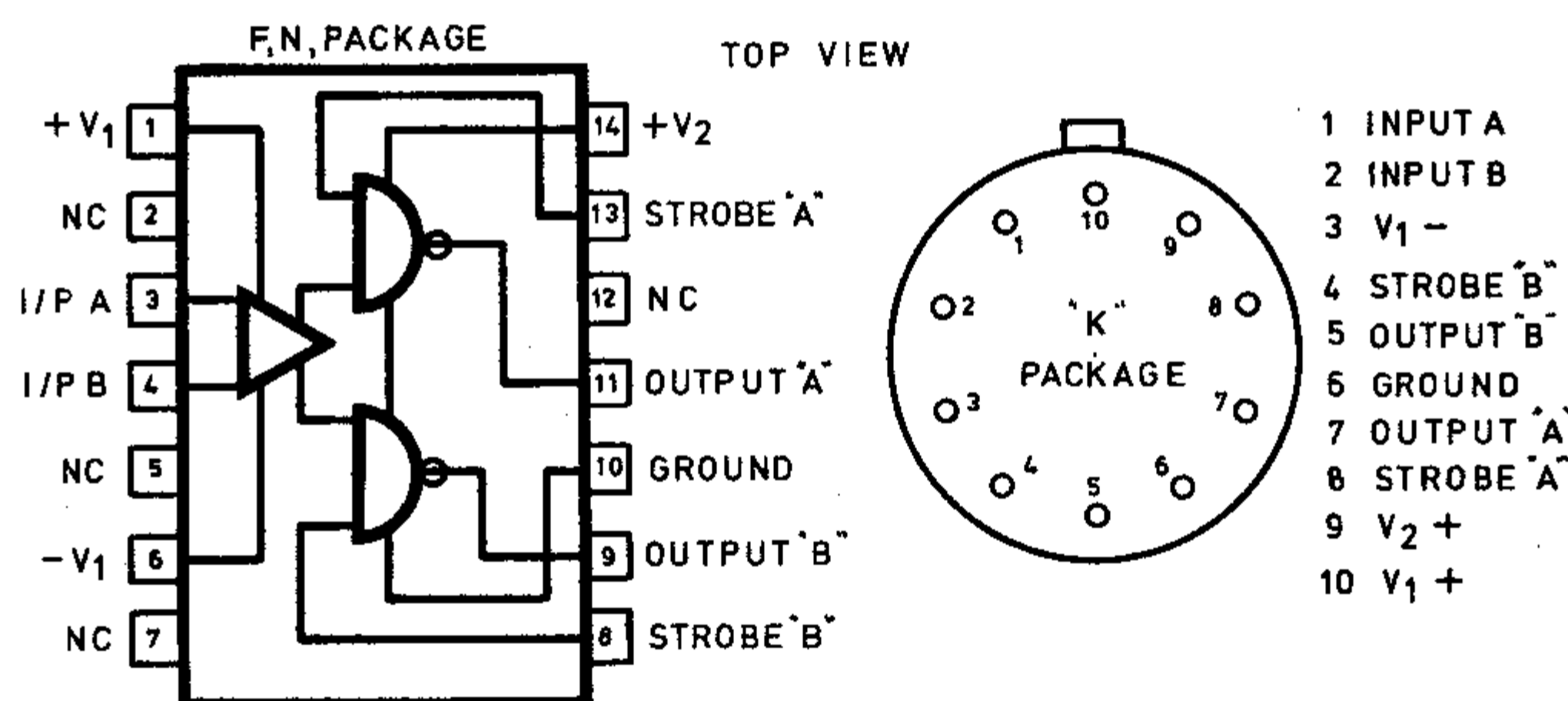
0.01 sec	connected to D0
0.1 sec	connected to D1
1 sec	connected to D2
10 sec	connected to D3

as explained on Fig. 1 and Fig. 2



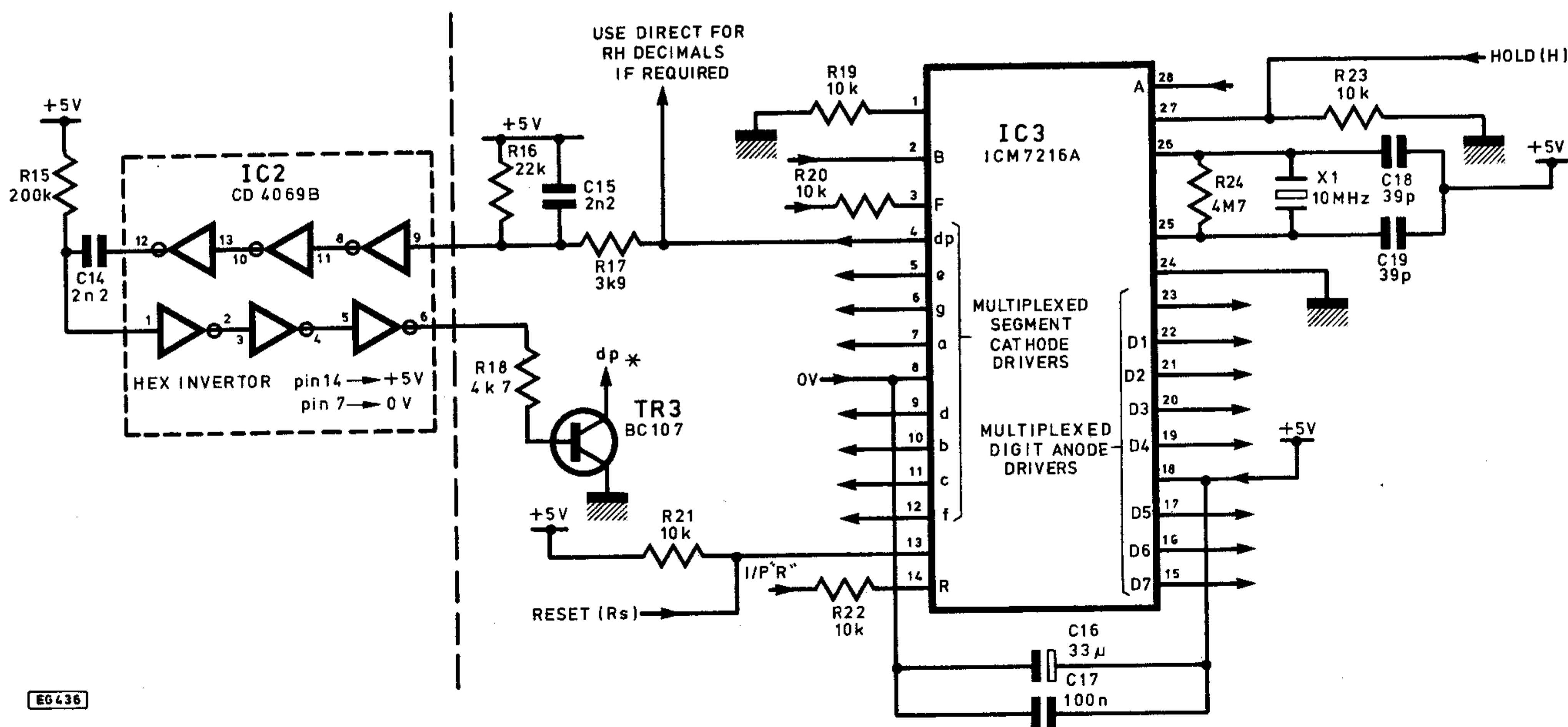
EG 434

Fig. 6. Variable hysteresis. *Set by threshold control



EG 435

Fig. 7. The SE/NE 529 Comparator. The d.i.l. package is used on the prototype



EG 436

Fig. 8. Counter/timer section

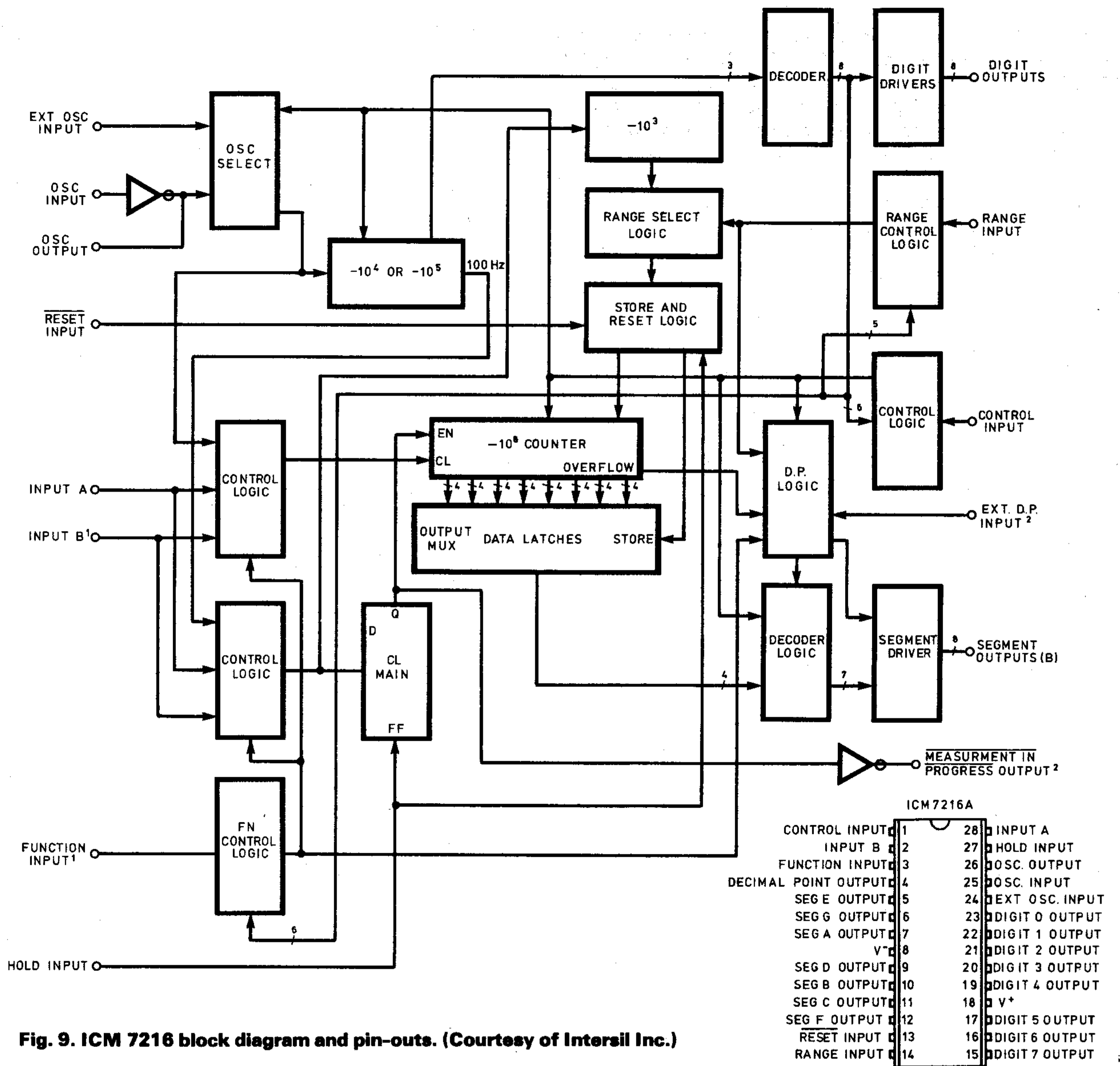
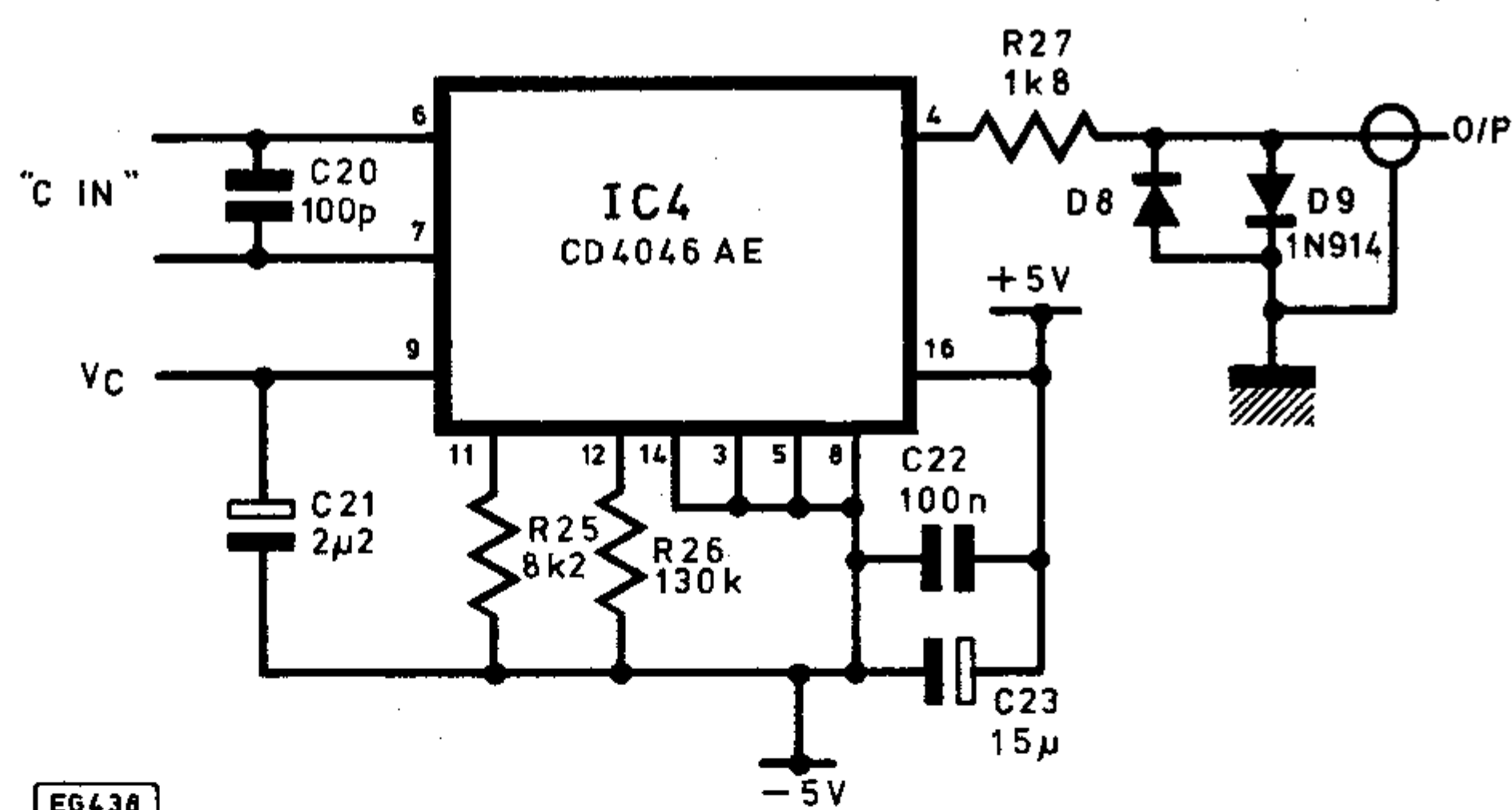


Fig. 9. ICM 7216 block diagram and pin-outs. (Courtesy of Intersil Inc.)

EG437



EG438

Fig. 10. Oscillator

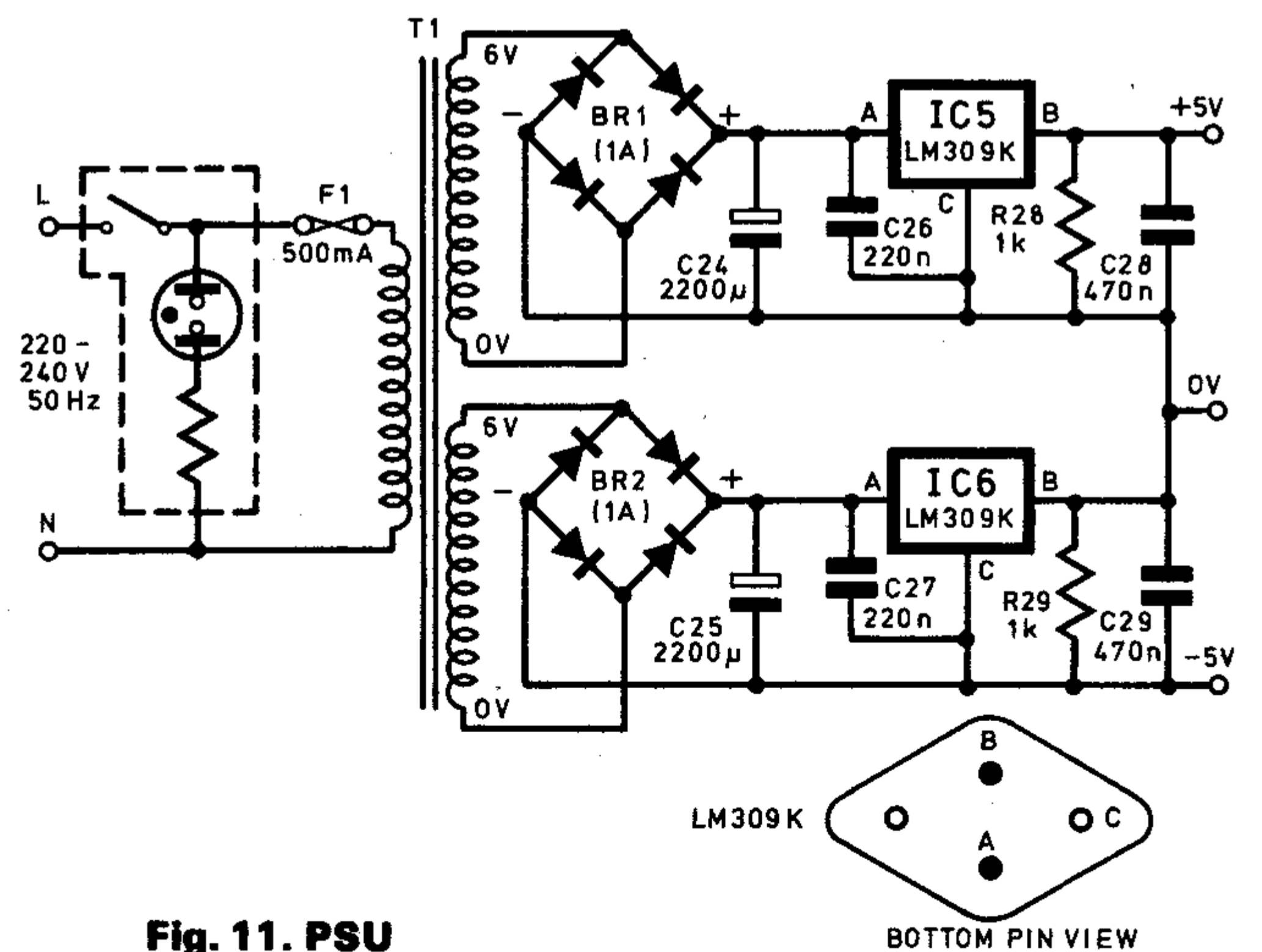


Fig. 11. PSU

The 10MHz crystal input and associated components are terminated on pins 25 and 26. (See Fig. 8). Pins 15, 16, 17, 19, 20, 21, 22 and 23, i.e. D₇, D₆, D₅, D₄, D₃, D₂, D₁ and D₀ provide multiplexed digit anode drivers for 8-digit-each 7-segment 0.3in common anode displays. In the prototype, the authors used an RS type: 586-526 device in red.

Corresponding to the above, and naturally, also multiplexed segment cathode drive pins on 7216A are: a, b, c, d, e, f, g and d.p. (pin 4) discussed earlier.

As mentioned earlier, and shown in Fig. 1, the Main Board p.c.b. containing independent oscillator network is based on the use of the popular CD 4046AE phase locked loop i.c., where only the oscillator section is used. The oscillator uses both positive and negative 5V supply rails and its complete schematic diagram is shown in Fig. 10. The output signal is connected via a 1k8 resistor directly to the BNC socket provided on the rear panel of the instrument. The circuit is simple and well known, therefore its description is limited to a few points. The Course Frequency control has 4 positions selecting the following bands:

- 100Hz-1kHz
- 1kHz-10kHz
- 10kHz-100kHz
- 100kHz-1MHz

The timing capacitors are soldered directly to the switch and a pair of leads (marked C1 and C2 on Fig. 1 (or C IN on Fig. 10) should be made of two wires from ribbon cable to make a quasi-balanced pair. The fine frequency control uses

10k linear potentiometer with its ends connected to $\pm 5V$ rails. For full frequency control variation two resistors are connected from negative 5V supply to pins 11 (approx. 8k2) and pin 12 (approx. 130k). To be more precise, the values of these resistors should be adjusted individually to span 10:1 range in frequency for full V_c control variation. This oscillator covers the range of approx. 80Hz to 800kHz; however, with 10V supply, goes easily up to 1.2MHz as checked during experiments.

Finally, the power supply unit (shown in Fig. 11) providing stabilised $\pm 5V$ obtained from a pair of ubiquitous 309K type regulators. The instrument consumes approximately 150mA at 5V per rail, and the transformer used is RS type: 207-138, rated at approximately 20VA.

The rectification is not critical as regards type, and the prototype uses a pair of 1A bridge rectifiers (RS261-328), where their outputs are smoothed by pair of 2200 μ F/25V electrolytics.

IMPORTANT NOTE

A pair of capacitors i.e. 33 μ F/10V tantalum type, and small ceramic 100 μ F capacitors are soldered onto the copper side of the main board as close as possible to the relevant pins (8 and 18) on the 7216A chip. ★

NEXT MONTH: *Construction and p.c.b. assembly.*

Countdown

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below.

BEX Feb 4-5. Pavilion, Bournemouth. **K**
Microsystems (exhibition and conference) March 11-13. Wembley Conf. Centre, London. **ZI**
INSPEX March 16-20. NEC, Birmingham. **ZI**
Seminex (seminars only) March 23-27. Imperial College, London. **HI**
BEX (Business Equipment) March 25-26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition March 31-April 2. Wythenshawe Forum, Manchester. **T**
Laboratory April 1-2. Glasgow. **I**
BEX April 8-9. Centre Hotel, Liverpool. **K**
Laboratory April 8-9. Manchester. **I**
All Electronics Show April 22-24. Grosvenor House, Park Lane, London. **FI**
Computer Graphics April 28-30. The Barbican Centre, London. **O**
BEX April 29-30. Dragonara Hotel, Leeds. **K**
Entertainment May 9-17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show May 10-13. Nuremberg, West Germany. **I**
The European Consumer Electronics Show May 10-13. Nuremberg Fair Centre, W. Germany. (Trade) **I**

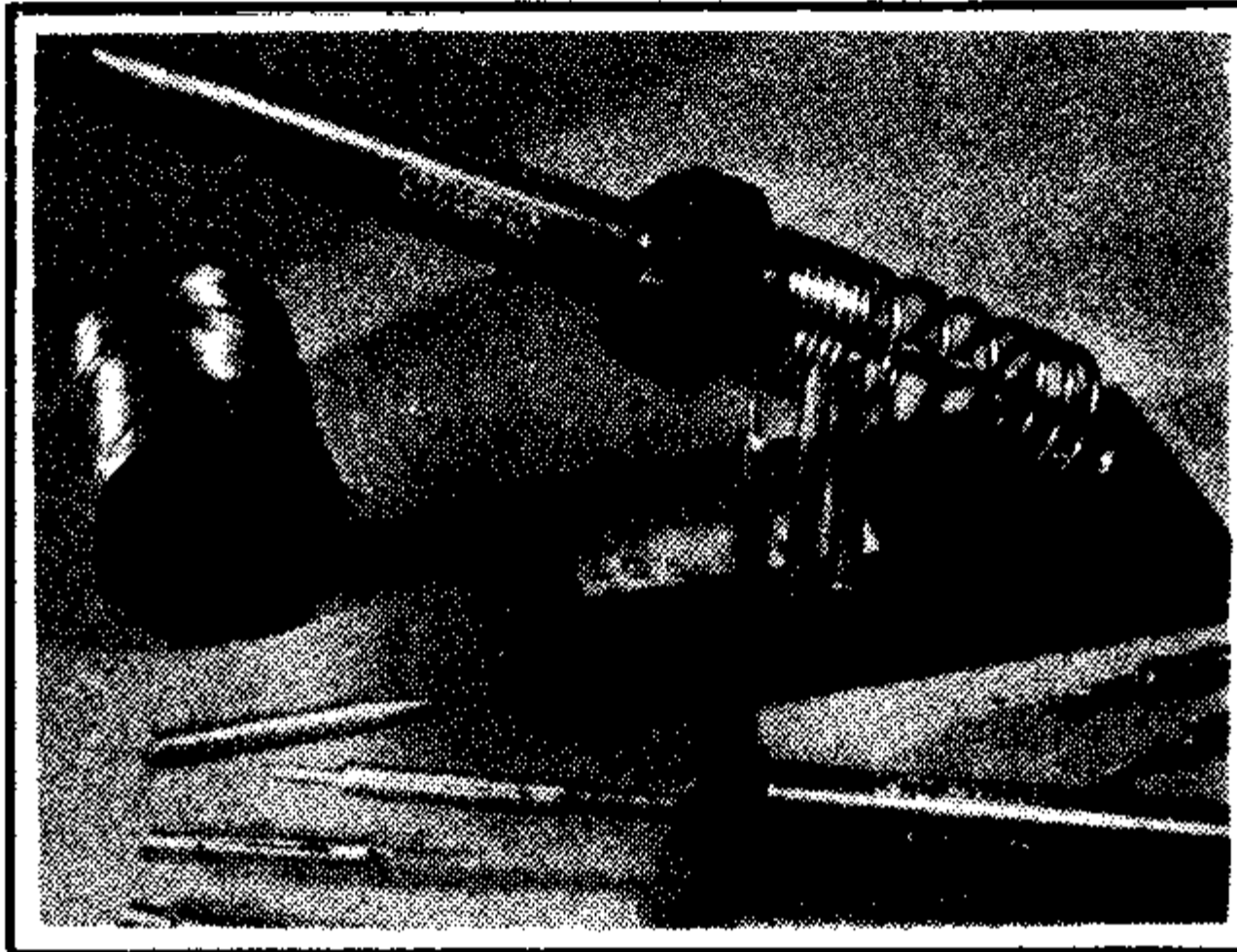
BEX Train May 11-22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo May 12-14. Brighton Metropole. **I**
East Suffolk Wireless Revival May 24. Sports ground of Ipswich Civil Service Sports Association, Straight Road, Ipswich. **VI**
Scotalex June 2-4. Royal Highland Exhibition Hall, Ingleston, Edinburgh. **AI**
Semlab June 2-5, Grand Hall, Olympia, London. The international scientific, educational, medical and industrial laboratory equipment exhibition. (Trade). **I**
Transducer Tempcon June 9-11. Wembley Conf. Centre, London. **T**
Components (Electronics Components Industry Fair) June 9-12. Earls Court, London. **I**
International Word Processing Exhibition & Conf. June 23-26. Wembley Conf. Centre, London. **Z**
Solar Energy Exhibition Aug. 23-28, Brighton. **M**
Laboratory Sept 8-10. Grosvenor House, Park Lane, London. **I**
International Business Show Oct. 20-29. NEC, Birmingham. **A2**
Electronics 82 (Sub-titles International Electronics Control and Instruments Exhibition) May 24-28, 1982. NEC. **I**

I Industrial Trade Fairs. ☎ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Road, Bournemouth
M Montbuild. ☎ 01-486 1951
O Online Conference. ☎ 0895 39262
T Trident International Exhibitions. ☎ 0822 4671
AI Institute of Electronics. ☎ 0706 43661
VI Jack Tootill, Ipswich. ☎ 0473 44047
ZI IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ☎ 01-837 3636
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ☎ 01-439 8556
B2 Brintex Exhibitions Ltd., 178-202 Great Portland Street, London W1N 6NH. ☎ 01-637 2400

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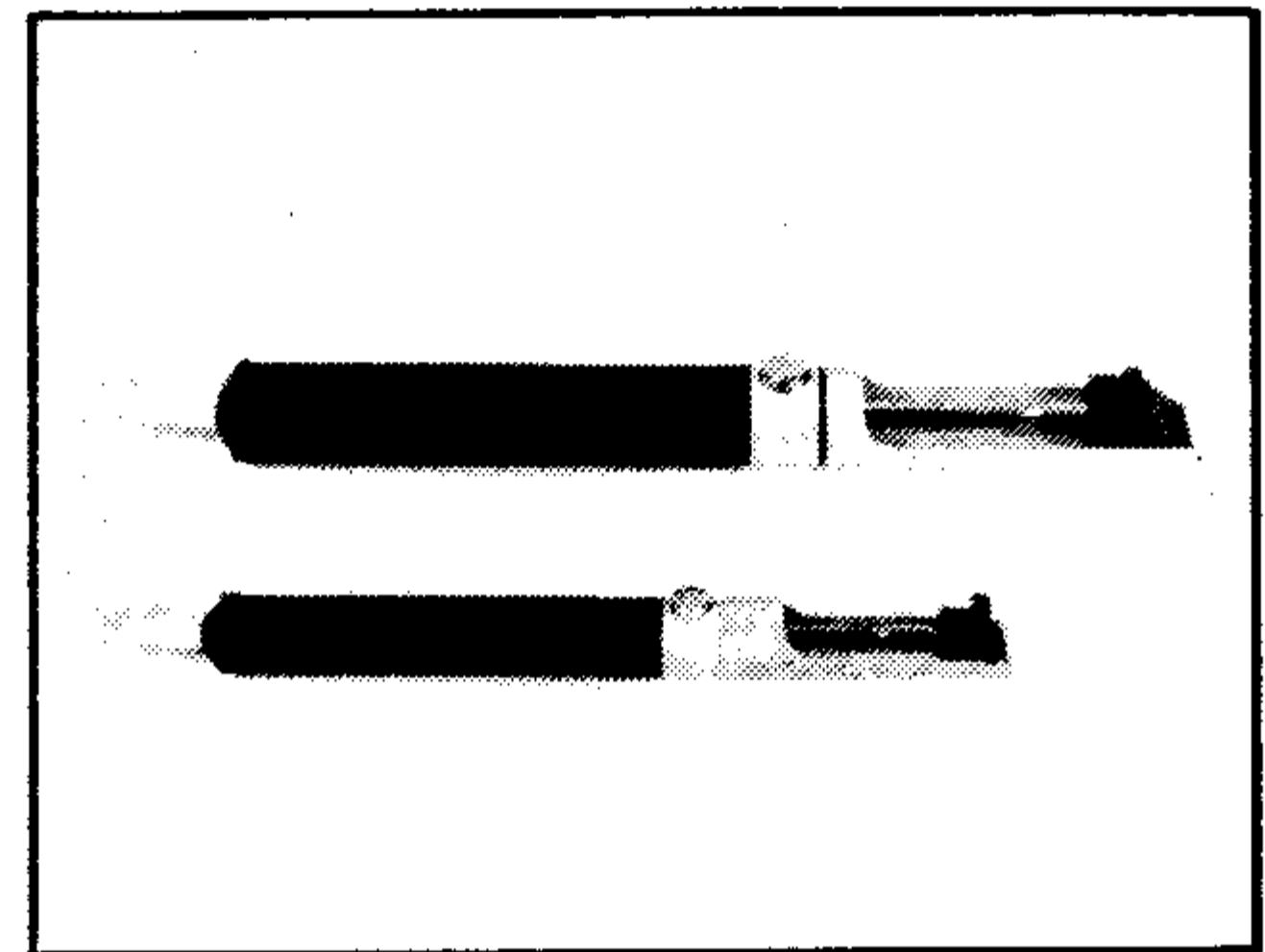
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RAM SUCCESS

As readers of this column will be aware, semiconductor random access memory devices are getting smaller (in size), bigger (in capacity), less demanding (of power supplies), faster, cheaper and generally easier to use. All of these improvements have been made possible by advancements in semiconductor technology which have resulted in even smaller device geometries and associated interconnection line widths.

The thing to remember is that for every microprocessor sold, there are associated orders for numerous other components—especially RAM chips. This fact almost makes the microprocessor devices "loss-leaders", a necessary inconvenience needed before reluctant customers will buy all those memory parts which are actually much better for company profits! The importance of the RAM chip cannot be overestimated. Industry demand for these devices is increasing exponentially, and the memory size of a typical computer system, be it micro, mini or mainframe is zooming up to make room for even more sophisticated tools such as language compilers and operating systems. Cheap RAM memory is not only used by "ordinary" computer either. The availability of cheap storage has made possible a new breed of image processing systems which store and manipulate video pictures as huge arrays of binary numbers where each picture point has an associated storage word of "n" bits to code colour and intensity information. Applications for these new tools are growing and currently include such bizarre extremes as the image enhancement of Voyager pictures from Saturn, and the special effects to be seen on "Top of the Pops".

... AND FAILURE

Unfortunately, there is a sting in the tail of this RAM success story. As memories get larger and larger, the chances of memory errors also increase, and as every microcomputer owner knows, memory errors, even one bit errors, can create havoc with otherwise "tame" programs.

Memory errors, like other forms of Black Magic, come in two varieties—hard and soft. Hard errors are usually "stuck" memory cells caused by the random malfunction of on-chip devices, due to a latent manufacturing defect for example. Soft errors come and go, and often cannot be duplicated. They can be due to a variety of phenomena notably "pattern sensitivity" wherein a particular memory cell malfunc-

tions only when surrounding cells contain a specific unfavourable bit pattern, and more recently (and as a direct result of shrinking device geometries) the dreaded Alpha particle induced errors caused by the decay of slight traces of a radio active isotope in the ceramic package material or even by background cosmic radiation.

Whatever the cause, these errors are not tolerable in many computer systems, and AMD for one has decided to do something about it. The spearhead of their attack on RAM errors is the AM 2960 Error Detection and Correction Unit, a very fast bipolar LSI device which can offer a dramatic improvement in memory reliability in the face of both hard and soft errors.

The principles of data protection have been known for a long time. The trick is to store not only the data bits but also an associated group of check bits generated using a version of the Hamming code. When the data bits are read back from the memory these check bits are regenerated and compared with the stored check bits. If the two sets of check bits match the stored data is correct, if not the differences are used to generate information on the type of error and its location so that corrections can be made. The problem in the past has been that microprocessors and computer CPUs cannot afford to wait for long while the checking and correcting process goes on, and the large conglomeration of TTL logic required for the checking and correcting process would have added unacceptable delays to every memory cycle.

The AMD 2960 solves this problem by putting all the logic on one very fast chip so that a sixteen bit word can be checked and corrected as it is read from the memory, for a time penalty of only about 50n/s. To protect a memory based on 16 bit words, 6 check bits must be added but the new AMD chip will detect single or multi bit errors which occur in either the data or the check bits, and will correct any single bit data errors.

With memory devices becoming so cheap and so large, it will soon be standard practice to protect all memories in this way.

LED NEWS

L.e.d. lamps have been with us for many years now, and it seems difficult to imagine what life was like without them. Apart from the revolution they caused when first introduced, there have been few surprises and today we have a "mature" technology supplying "jelly bean" parts.

There have been developments, particularly in packaging techniques and in increasing apparent light output by the use of reflectors and improved chip design, but the main improvement has been in price as more and more manufacturers have entered the market. With this sort of foundation already established, there are incentives to "make a better l.e.d.", and this month I can report on two such developments which should make life easier for us users before long.

From Hewlett Packard comes a nifty new l.e.d. series which does away with the need for an external current limiting resistor and reverse protection diode. Reverse protection diodes, by the way, are needed when an l.e.d. is powered from an a.c. source of more than a few volts. Although the l.e.d. can act as its own rectifier diode its reverse blocking voltage is so low that nasty things can happen when an a.c. supply is used, unless a diode with a higher breakdown rating is used in series. In effect, the incorporation of the resistor and the diode gives a device with characteristics similar to an incandescent lamp, making them easy to use but less flexible in that each lamp now has a rated operating voltage.

The new devices come in two series, the HLMP 31XX series of standard brightness units, and the HMP 36XX series of high efficiency types which are more expensive. All three standard l.e.d. colours (red yellow, green) are available, and 5 volt and 12 volt operating types cover the most popular supply voltages. All l.e.d. lamps in these series come in the popular panel mounting T1 $\frac{3}{4}$ package.

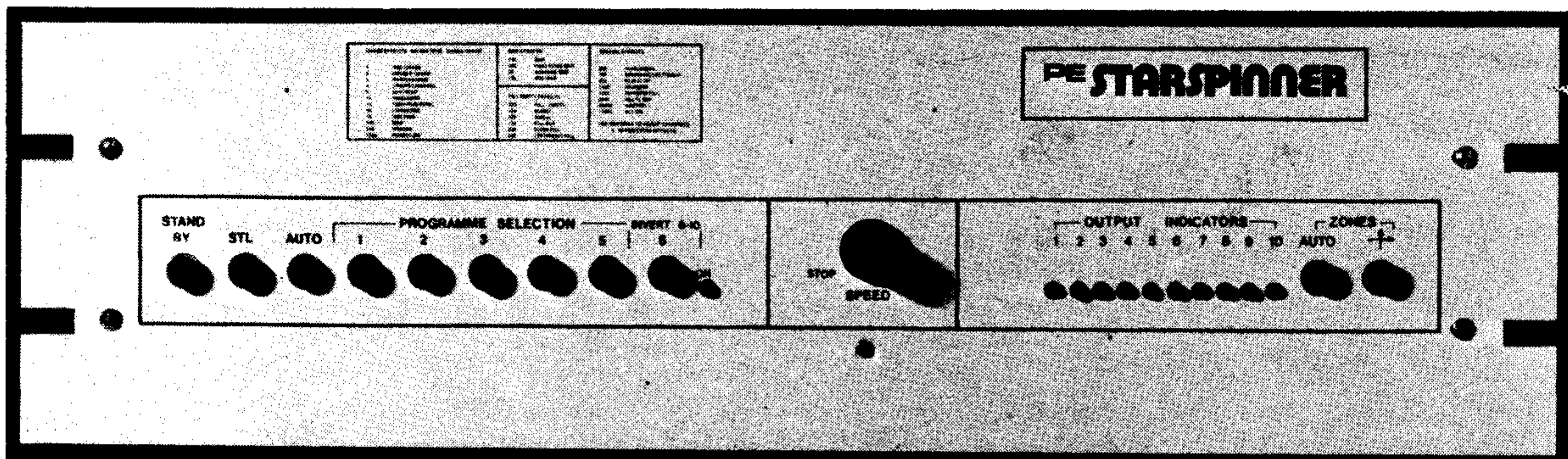
BRIGHT FUTURE

From Japan comes news of a breakthrough in l.e.d. efficiency and brightness. The Matsushita Electronics Corporation is about to introduce a new range of l.e.d. lamps with a light output more than ten times that of standard devices, and anyone who has looked in vain for a glimmer of light from their l.e.d. on a bright sunny day, will appreciate *that* development.

The secret of the new devices is a swop from the standard Gallium Phosphide semiconductor material to Gallium Aluminium Arsenide which gives a better current/light-output relationship and higher efficiency.

The only snag is that it seems likely that you will be able to have any colour so long as it's red!

Part 2



PE STARSPINNER

THE circuit diagram for the output and matrix/zone selection is shown in Fig. 2.1. The signal from each channel is taken to a pair of opto-isolators. These are the darlington type providing good current transfer. Since the active signal is a '0' the signals are taken to the cathodes. The anodes of the twenty opto-isolators are commoned together and taken to the phase control/zero switching circuit described in the power supply section. The anodes receive from this section of the circuit a short pulse every half cycle of the mains supply. This would normally be immediately after the zero voltage crossover point but provision is made for the unit to be operated into inductive loads such as pinspots, and therefore the point of appearance of the firing pulse can be altered.

From the cathode of each opto-isolator is also taken a 270 ohm resistor. The other sides of these resistors are commoned in groups of ten, one group being for those opto-isolators controll-

ing the live rail and the other for those controlling the neutral rail. Each common line is clamped to the zero voltage line (all opto-isolator anodes) to prevent interaction between channels. These two commoned lines are taken to the collectors of a pair of BC172 transistors (TR8, 9) whose bases are driven via 1k resistors from the J and K outputs of a JK flip-flop (IC37) and also directly from the manual matrix/zone selection button. In the manual mode the manual/auto button delivers 5 volts to the selected 1k base feed resistor, but in the automatic mode, the 5 volts is diverted to pin 4 of IC37 enabling it to respond to the trigger pulse from the main clock. Accordingly, either one or the other sets of opto-isolators are over-riden thus deciding the choice of matrix/zone in use.

An unregulated supply is provided for each mains rail and the opto-isolator transistors are used as emitter followers to drive the triacs through 22 ohm resistors. Each triac has a 'snubber'

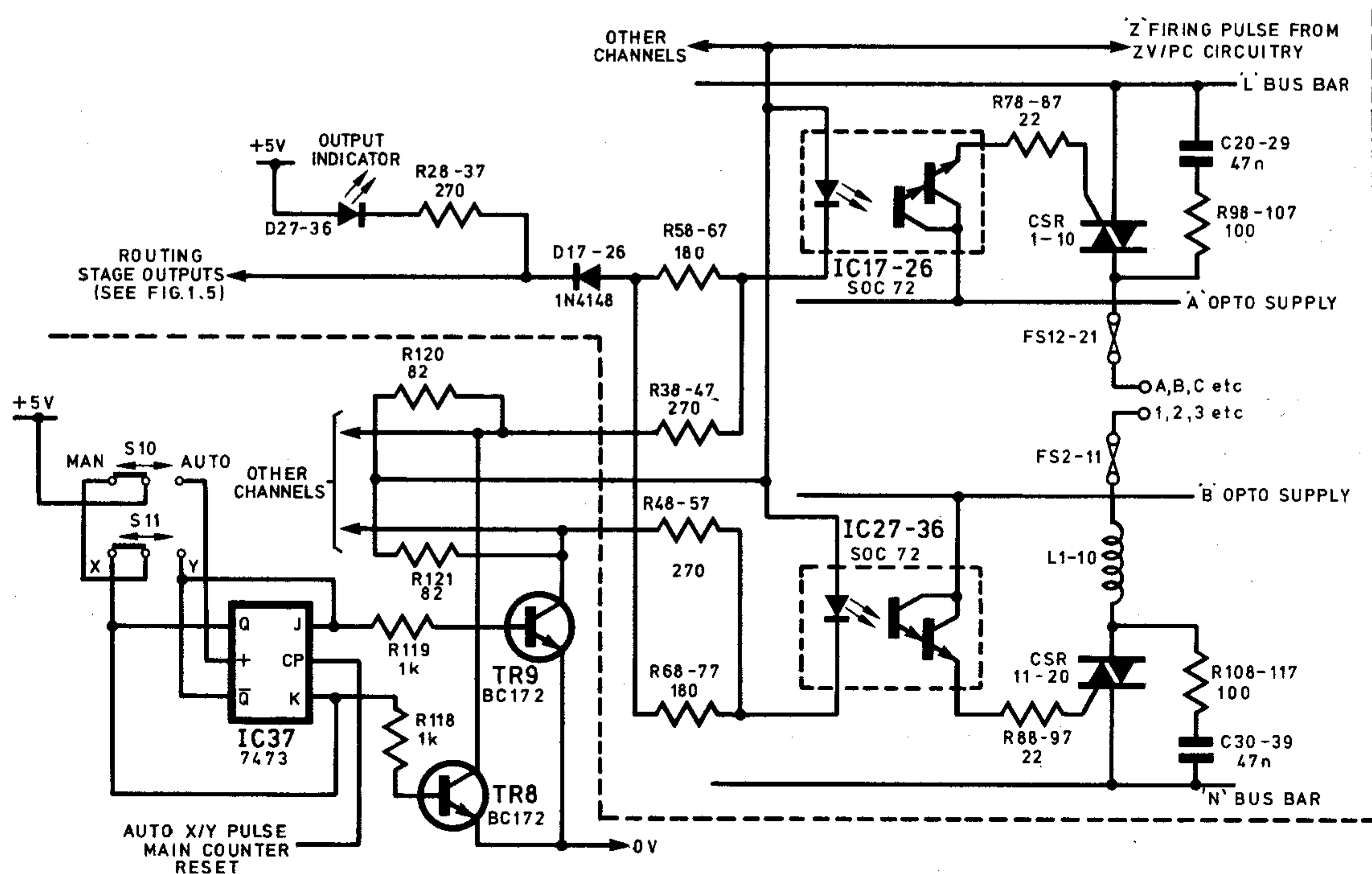


Fig. 2.1. Output and Matrix/Zone selection circuit.

EG471

network connected across it. The resistance value is higher and the capacitor value lower than might be expected. This is because, when using inductive loads, the use of normal values such as, say, 33 ohms and 100n can result in sufficient ringing taking place to lock the triacs 'on'.

POWER SUPPLY AND PHASE CONTROL/ZERO SWITCHING

The p.s.u. circuit diagram is shown in Fig. 2.2. The very nature of the unit necessitates four separate supply sections; two provide isolated and unregulated d.c. for the output stage at a nominal 4 volts. Regulation is unnecessary since the actual power used is negligible due to the short length of firing pulse. Thus each supply consists of a full wave bridge and a 330 μ reservoir capacitor. The third supply consists of a bridge rectifier, 1,000 μ reservoir capacitor and LM309 regulator. The output of this regulator supplies all the TTL, the clock and also +5V to pin 24 of the EPROM.

The fourth supply consists of a 24 volt a.c. centre tapped winding with a bridge rectifier producing a smoothed nominal ± 12 to 15 volts for the 741 op-amp (IC2) +14 to 16 volts for pin 19 of the EPROM (IC6) and, via a combination of a 220

ohm 1W resistor and 4.7 volt Zener diode, -5 volts for pin 21 of the EPROM. Although the EPROM requires three separate supply voltages it can be seen that, with the requirements of the 741, there is little problem, especially since the EPROM is extremely tolerant as far as variations in the 12 volt requirement are concerned. No attempt is made on the unit to switch the main power supply, because of the high currents involved. Instead, the unit has a 'standby' button which simply switches supply to the mains transformer.

To meet the requirements for interference suppression the unit features zero-voltage switching. However, in order that the unit may be used on inductive loads where the zero voltage crossing point does not coincide with zero current, the circuit allows for delay of the firing pulse. The output of the bridge rectifier on the 24 volt centre tapped winding is blocked by a 1N4001 diode before the reservoir capacitor. This does not affect the d.c. supplies obtained from this section of the supply but does allow a 100Hz signal to be taken to a limiter stage where it produces a 100Hz square wave with a large mark-space ratio (Fig. 2.3.). The collector of TR1 is only positive whilst the level of the 100Hz input to the base is less than 0.5 volts. This corresponds to a mains voltage of about 5 volts peak which may be con-

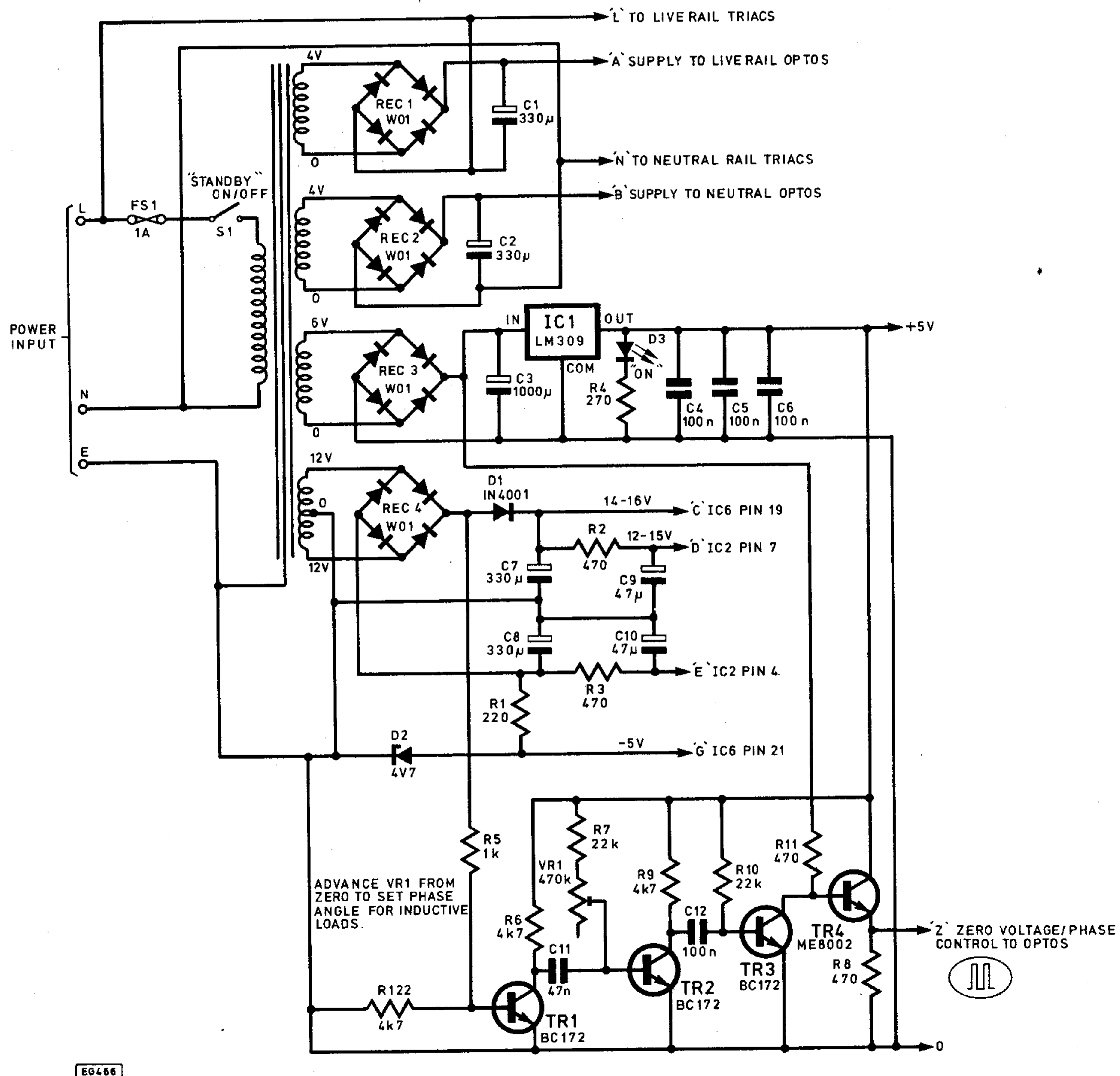
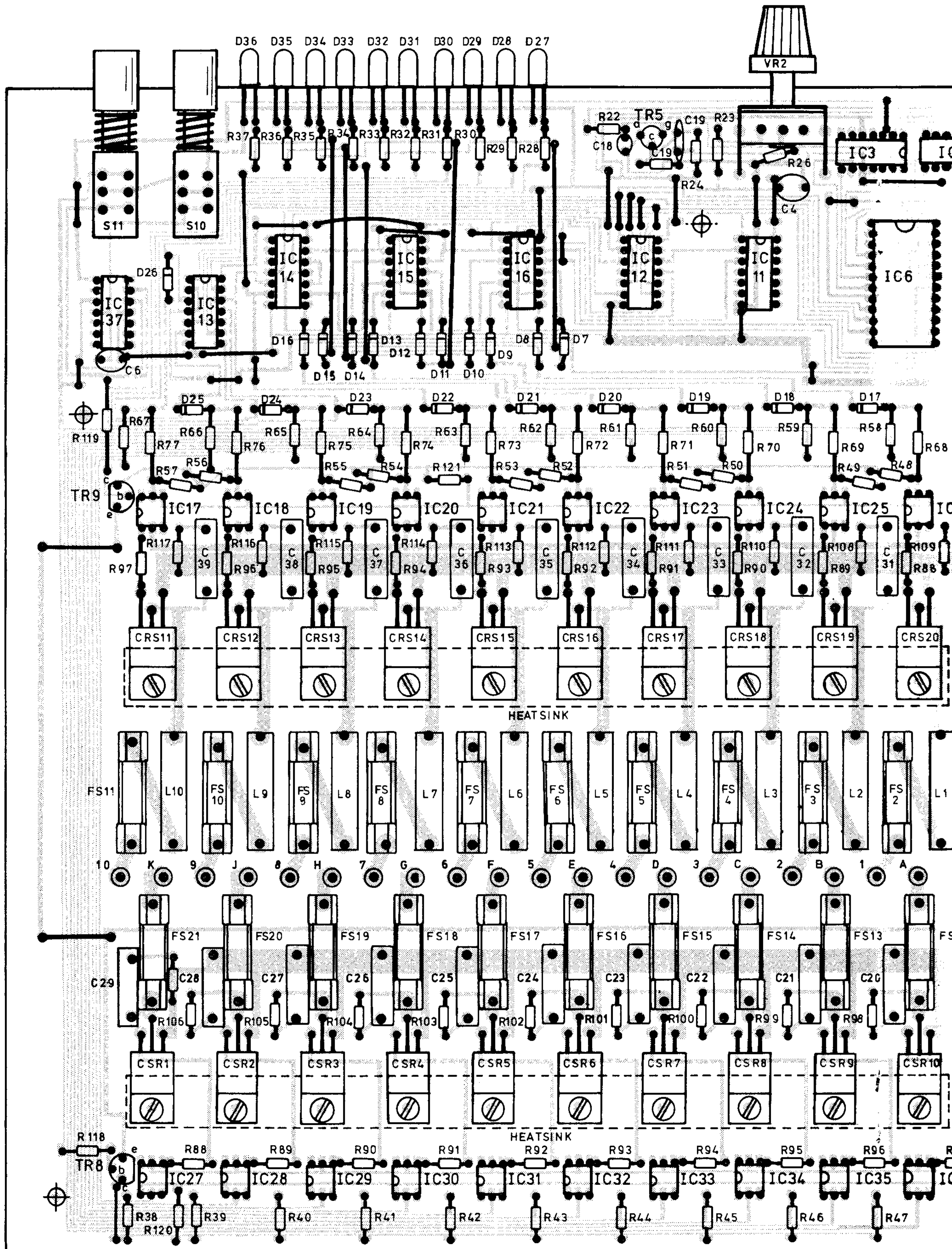
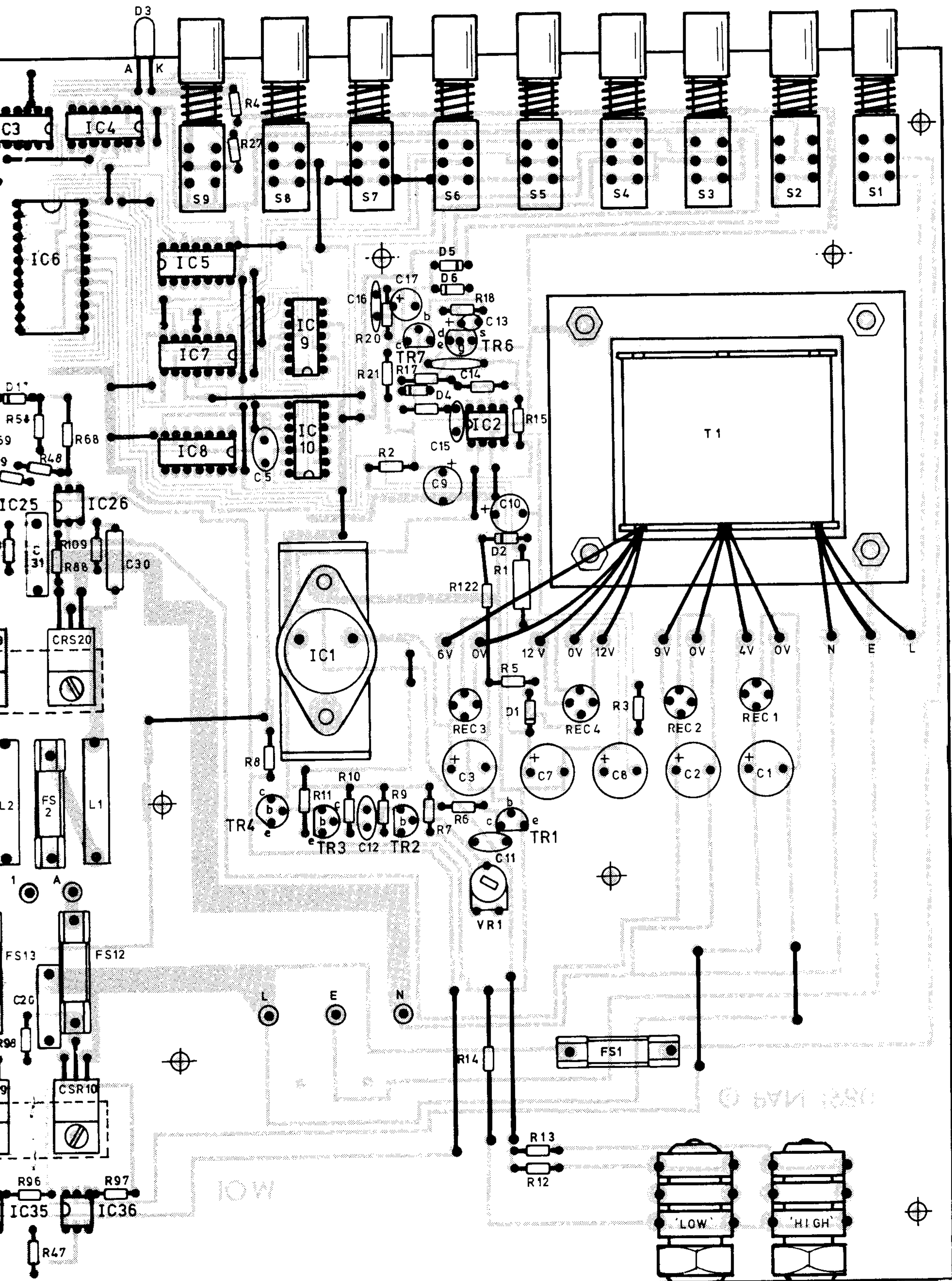


Fig. 2.2. Circuit diagram of the p.s.u.



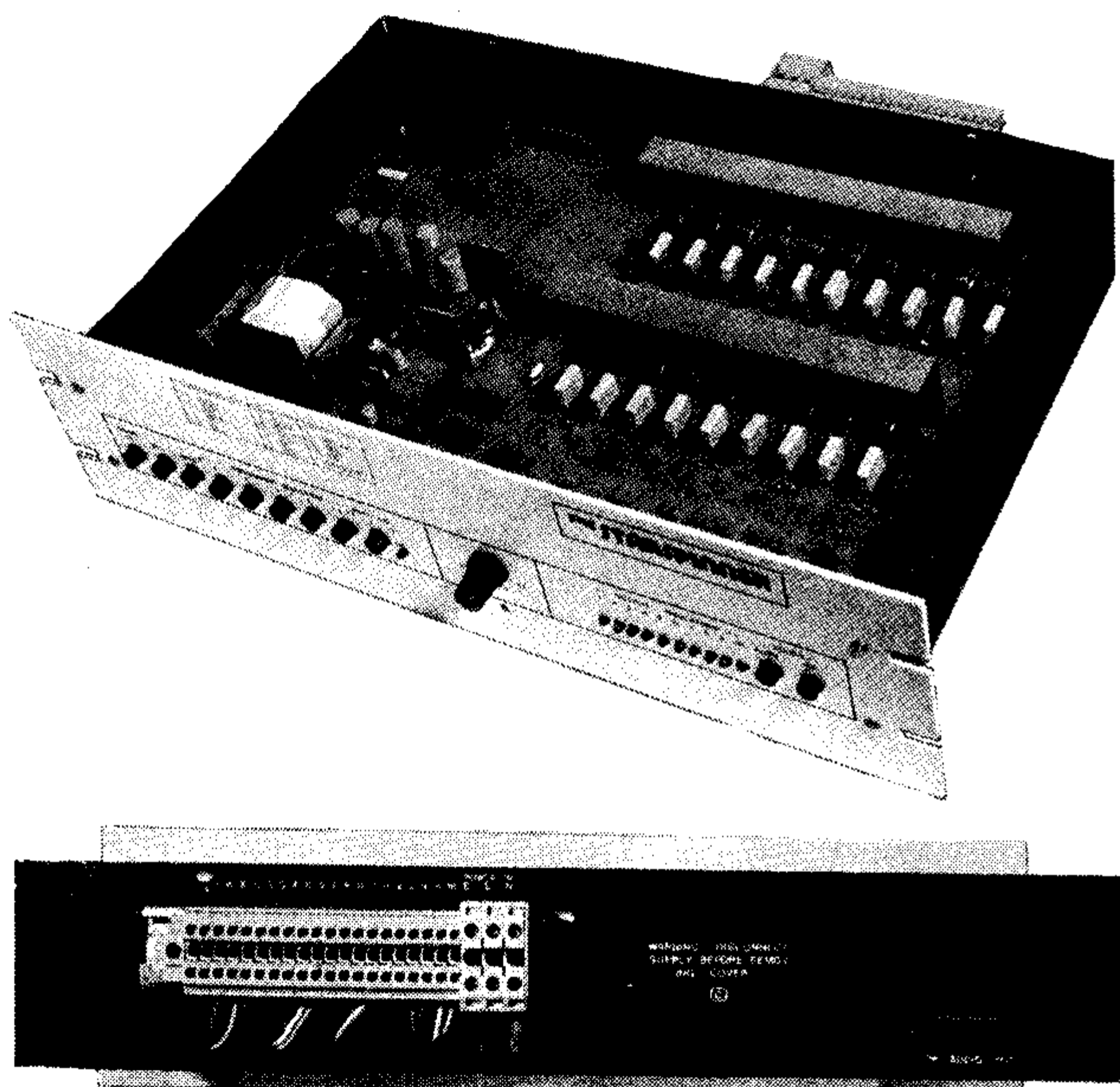
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Fig. 2.4. Component layout for



Component layout for the p.c.b.

sidered to be zero for all intents and purposes. The 47nF coupling capacitor charges quickly through the collector load of TR1 and the base emitter junction of TR2. As TR1 switches off TR2 base is reversed biased and remains so until the charge on the capacitor has leaked away through the combination of preset VR1 and series resistor R7. The resultant signal at the collector of TR2 is a square wave of variable mark space ratio, with the positive going edge at zero voltage and the negative going edge decided by the time constant of the RC combination. This circuit is repeated with fixed component values to give a short pulse



located at the position of the negative going edge (Fig. 2.3).

The pulse at the collector of TR3 is then delivered to the base of an emitter follower TR4, which supplies the opto-isolators commoned anodes. Note that the collector load of TR3 goes to IC1 input in order to give sufficient drive to TR4.

CONSTRUCTION

The EPROM should be left in its conductive foam until the rest of the board has been assembled and soldered. The unit, with the exception of final terminations, is mounted on one p.c.b. Fig. 2.4. shows the component layout of the board. The power and output terminations on the original unit were via DIN type rail equipment. The triacs are mounted on brackets made from $\frac{1}{8}$ " (3mm) aluminium. The top of the bracket is turned over 1" and the cover of the unit, made from 14 s.w.g. aluminium is screwed onto these brackets as well as to the case proper. This fulfils two requirements. Firstly, using silicon compound to ensure good thermal connection, the lid acts as a heatsink. Secondly, the rigidity of this form of assembly stops the whole board rocking on the stand-offs when the buttons are operated.

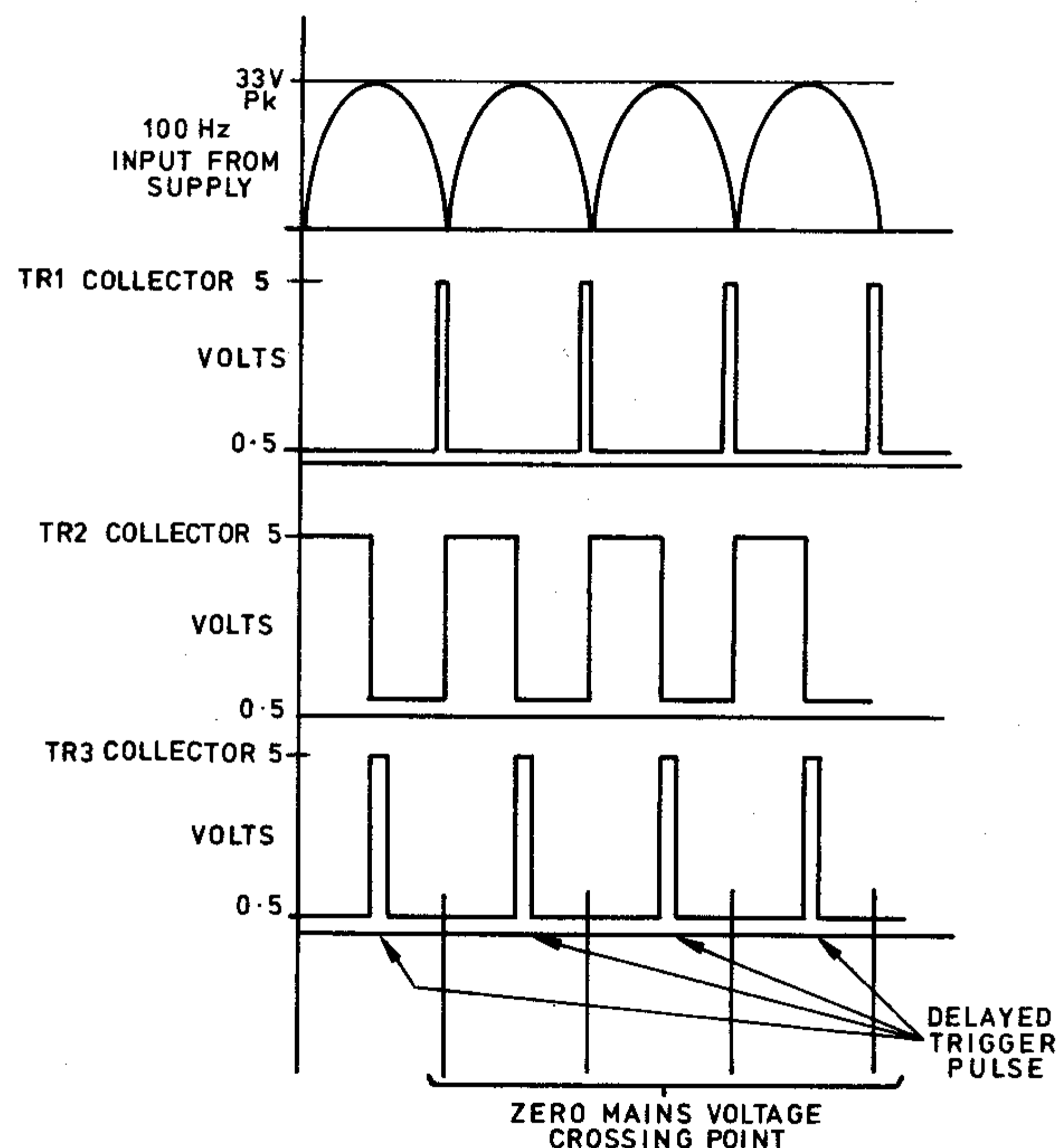
The triacs used in this project have insulated tabs. Should different devices be used check that they have insulated tabs. If they do not, insulating washers and bushes must be used and a megger or flashtester should be used to check that the triacs are truly isolated from the case. So often, it is forgotten that although such a piece of equipment is designed for entertainment purposes, it is still deadly if not treated with respect. In particular do not forget to take an earth wire directly from the incoming earth terminal to the mounting rail or other part of the chassis. Also take the transformer screw wire to a tag under one of the mounting screws.

TESTING

There is no reason at all why the unit may not be tested initially without lamps connected. The advantage in this case is

that there will then only be the incoming power leads and the sound to light signal, and twisting and turning of the board to find faults, should you be so unfortunate to have any, that is, will be easier without an extra twenty wires attached. Before turning on, use a meter set to the lowest ohms range to check the power lines for shorts. Reference to Fig. 2.4. shows the location of supply lines and the voltages to be expected once the unit has been turned on.

Remember, before you turn on, that although most of the circuitry is at ground potential, the mains wiring occupies a large



EG469

Fig. 2.3. Zero voltage switching waveforms

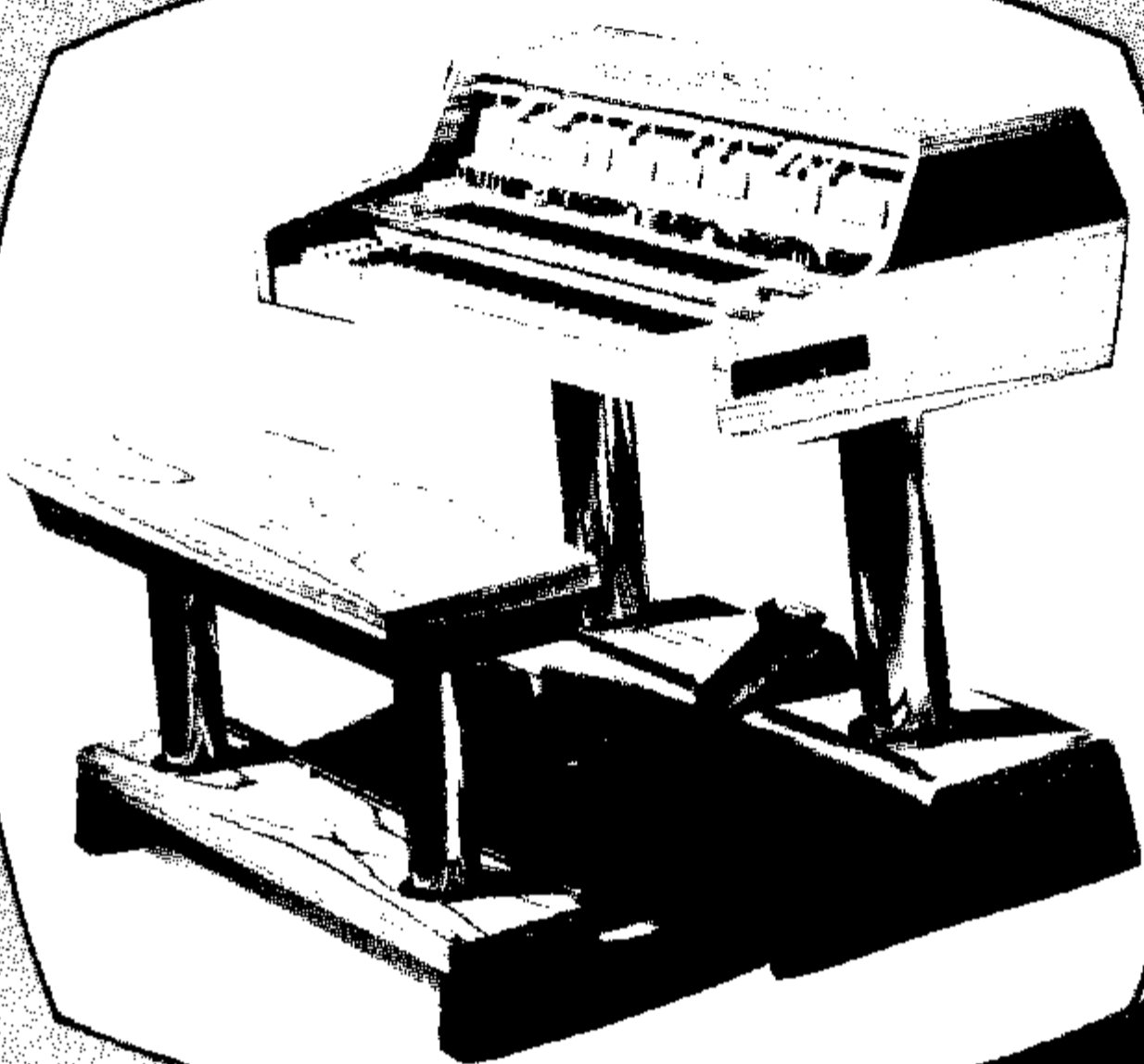
proportion of the board's area. Make a habit of attaching one test lead with the supply disconnected and using one hand to make measurements. When the unit has been turned on, immediately check the TTL 5 volt supply, the supply to pins 19 (+15V), 21 (-5V) and 24 (+5V) of the EPROM, the smoothed supply to the 741 op-amp (IC2) +12 and -12 volts. With the exception of the +5 and -5 volt rails, the voltages are far from critical. All being well you should now be able to operate the program buttons and speed control to get a display on the mimic indicators. Connect an audio signal to one of the inputs (200mV to 5 volts to that input terminated in 100k or 2 volts to 50 volts to that input terminated in 1M), operate the sound to light button and thus check the correct working of the audio section. If the audio lead is reversed, i.e. amplifier output 'live' going to unit input 'earth' the audio section will not work. However R14 prevents shorting of the amplifier output.

Before connecting up your lights to the unit, the preset phase control must be set: to zero (full anticlockwise) for non-inductive loads or at the correct phase angle for inductive loads. If an oscilloscope is available this may be coupled, via a potential divider network across a triac, the unit set to static display (buttons 1-5 in, button 6 out) and the matrix selection to manual with either matrix/zone selected. Do not forget that the oscilloscope should be connected via an isolation transformer. With an inductive load connected the unit is then switched on and the preset adjusted until the triac switches properly. Then run a dynamic rather than static program and check that the control is not too far advanced or the triacs locking on.

Having done all this the complete set of lamps may be connected and the unit checked through all its functions. ★

WERSI

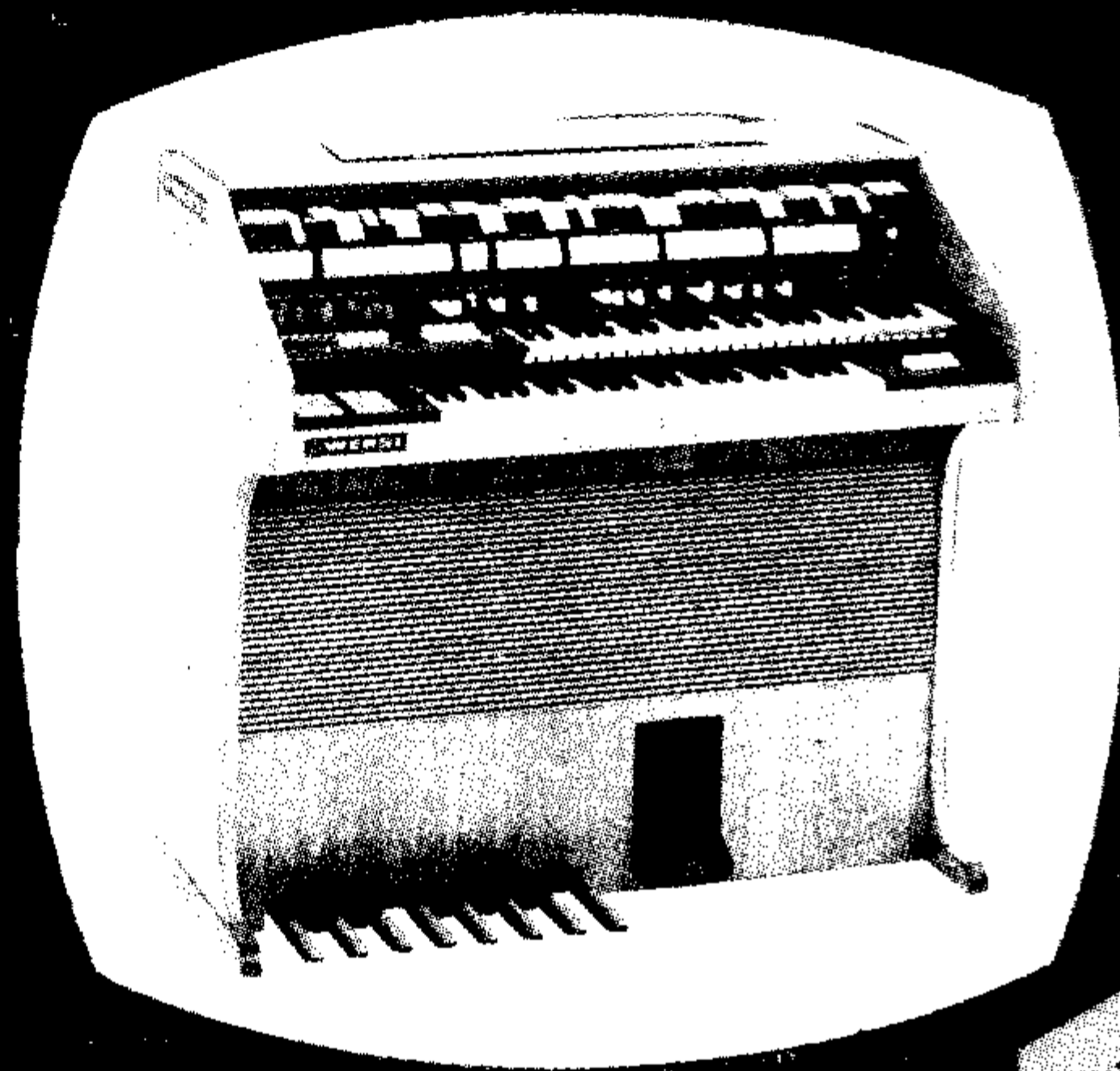
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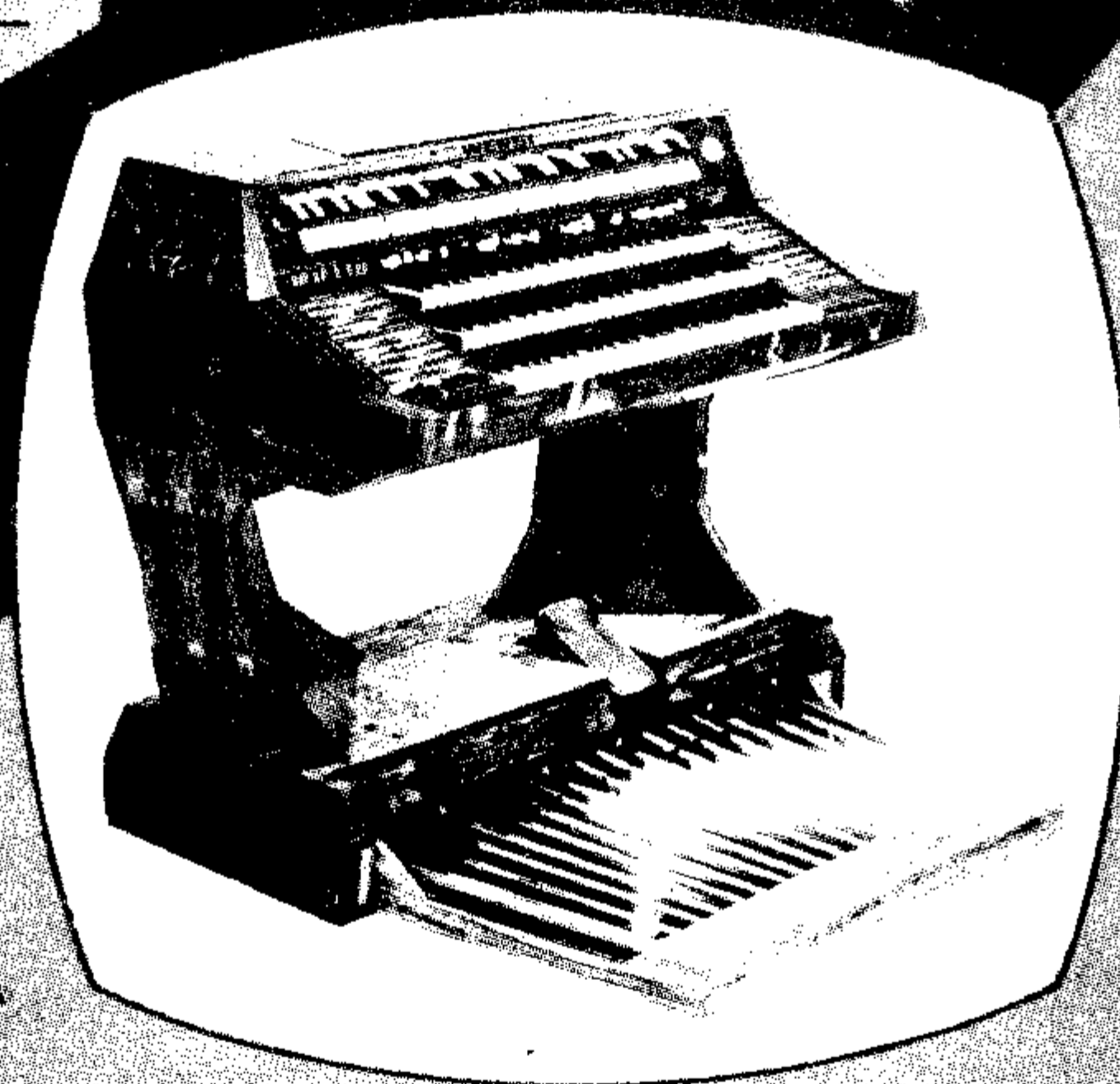
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MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS MONTH'S Micro-Bus contains an assortment of topics for the MK 14, Acorn System One, and Sinclair ZX80.

TELEPHONE CALL-COST CALCULATOR

If you have been dismayed by the size of your telephone bill lately, the following program for the MK 14 might be the answer; it gives a continuous reminder of the cost of a call at any time of day, and to anywhere in the UK. The program was submitted by *Adrian Dickens*, whose Digital Capacitance Meter program was featured in *Micro-Bus* last June, and he explains its operation as follows:

"Having entered the program into the

computer (remember to place it near to the telephone!) go to address OF32 and press GO. If the program has been entered correctly OF32 C4 will remain on the display. Now refer to the selector chart, Table 1, and decide which range to select. This will depend on the time of day, day of the week, and distance of the call. Remember this range, and dial the

required telephone number; when the handset is lifted up at the other end press the correct range number, and you will be able to see your 3.5 pence units being spent. When you have finished your conversation, and have been suitably shocked by the price being displayed on the computer, press 0 and the computer will be ready for your next call."

Table 1. Range codes for the different times of day, and different distances.

	MONDAY-FRIDAY		WEEKENDS	
	9am-1pm	8am-9am 1pm-6pm	6pm-8am	
LOCAL	1	4	7	7
up to 56km	2	5	4	4
over 56km	3	6	8	8

```

; TELEPHONE CALL-COST CALCULATOR
;
FFFF VAR = -1 ;VARIABLE VALUE
OO30 COST = OO30 ;COST COUNTER
;
0000 .-=OF21
OF21 E8 DATA: .BYTE OE8,OFA,OFE,ODC
OF25 F7 .BYTE OF7,OFD,O7O,OF4
OF29 .-=OF32 ;PROGRAM START
OF32 C4OF START: LDI OF ;SET POINTERS
OF34 36 XPAH 2
OF35 C400 LDI 0
OF37 C83B ST COUNT+1
OF39 32 XPAL 2 ;P2=OF00
OF3A C401 LDI 1
OF3C 37 XPAH 3
OF3D C484 LDI O84
OF3F 33 XPAL 3 ;P3=KYBD
OF40 3F HOLD: XPPC 3 ;EXECUTE KYBD
OF41 O808 NOP
OF42 O8 NOP ;COMMAND RETURN
OF43 O1 XAE ;NUMBER RETURN
OF44 98FA JZ HOLD ;ILLEGAL RANGE
OF46 F420 ADI DATA-1 ;GET RANGE DATA
OF48 C802 ST RANGE+1 ;PUT IN DISP
OF4A C2FF RANGE: LD VAR(2) ;RANGE DATA
OF4C C815 ST TIME+1 ;PUT IN COUNTER
OF4E C400 LDI 0
OF50 CA30 ST COST(2)
OF52 CA31 ST COST+1(2) ;CLEAR COST
; MAIN LOOP
OF54 O2 UPDATE: CCL ;INCREMENT CALL
OF55 C230 LD COST(2) ; COST BY
OF57 EC35 DAI O35 ; 3.5 PENCE.
OF59 CA30 ST COST(2)
OF5B C231 LD COST+1(2)
OF5D ECOO DAI 0 ;ADD CARRY
OF5F CA31 ST COST+1(2)
OF61 C4FF TIME: LDI VAR ;LOAD COUNTER
OF63 C859 ST WAIT+1
OF65 C40B LDI OB
OF67 33 XPAL 3 ;P3=SEGMENT CODES
OF68 C400 LOOP: LDI 0
OF6A C906 ST 6(1) ;SELECT ROW
OF6C C100 LD (1) ;ZERO KEY PRESS?
OF6E E47F XRI X'7F
OF70 98BF JZ START ;IF YES, JUMP..
OF72 C4FF COUNT: LDI VAR ;COUNTER
OF74 F401 ADI 1
OF76 C8FC JF76 C8FC ST COUNT+1
OF78 9842 JZ WAIT ;LOOP COMPLETE
OF7A C230 LD COST(2)
OF7C D40F ANI OF ;LOWER DIGIT
OF7E O1 XAE ;PUT IN EXT
OF7F C380 LD -128(3) ;GET SEGMENT CODE
OF81 C901 ST +1(1) ;DISPLAY DIGIT 1
OF83 C400 LDI 0
OF85 8F06 DLY O6 ;TIMING DELAY
OF87 C230 LD COST(2)
OF89 1C SR
OF8A 1C SR
OF8B 1C SR
OF8C 1C SR ;UPPER DIGIT
OF8D O1 XAE
OF8E C380 LD -128(3) ;GET SEGMENT CODE
OF90 C902 ST +2(1) ;DISPLAY DIGIT 2
OF92 C400 LDI 0
OF94 8F06 DLY O6 ;TIMING DELAY
OF96 C231 LD COST+1(2) ;UPPER BYTE
OF98 D40F ANI OF ;LOWER DIGIT
OF9A O1 XAE
OF9B C380 LD -128(3) ;GET SEGMENT CODE
OF9D C903 ST +3(1) ;DISPLAY DIGIT 3
OF9F C400 LDI 0
OFA1 8F08 DLY O8 ;TIMING DELAY
OFA3 C480 LDI O80 ;DECIMAL POINT
OFA5 C904 ST +4(1) ;DISPLAY DIGIT 4
OFA7 C400 LDI 0
OFA9 8F09 DLY O9 ;TIMING DELAY
OFAB C231 LD COST+1(2) ;UPPER BYTE
OFAD 1C SR
OFAE 1C SR
OFAF 1C SR
OFB0 1C SR ;UPPER DIGIT
OFB1 O1 XAE
OFB2 C380 LD -128(3) ;GET SEGMENT CODE
OFB4 C905 ST +5(1) ;DISPLAY DIGIT 5
OFB6 C400 LDI 0
OFB8 8F08 DLY O8 ;TIMING DELAY
OFBA 90AC JMP LOOP
OFBC C4FF WAIT: LDI VAR ;COUNTER
OFBE O2 CCL
OFBF F401 ADI 1 ;INCREMENT
OFC1 C8FB ST WAIT+1 ;STORE
OFC3 988F JZ UPDATE ;ANOTHER UNIT
OFC5 90A1 JMP LOOP ;NO - CONTINUE
OOO0 .END

```

Fig. 1. MK14 program displays the cost of a telephone call.

PROGRAM VARIABLES

The program follows the unusual practice of modifying instruction operands in the program, rather than accessing separate variables; these operands are denoted by VAR in the listing of Fig. 1. The data for each range is stored in the table DATA; each byte is the negative of the number of multiples of 5 seconds that constitute one unit of cost. Thus range 3, the most expensive rate, has a code of FE or -2, corresponding to a rate of 10 seconds for 3.5p. When the range key is pressed its value is used as an offset to pick up the corresponding DATA constant. This is stored at OF62, and for each unit being counted this constant is written to OFBD, where it is incremented once for every 256 executions of the main display loop. The main display loop, from LOOP to WAIT, displays the current value of COST as a number of pence, and uses DLY instructions to adjust the timing so that 256 executions take exactly 5 seconds. The cost per unit is set at 3.5 pence, but if the PO decides to increase its charges this can easily be updated by putting the new charges at OF58.

Note that since the program modifies its own instructions it cannot be put into ROM as it stands; it should be altered so that the instructions at OF4A, OF61, OF72, and OFBC use four RAM locations as variables.

MEMORY LISTER

The following memory lister should prove useful to owners of the 6502-based Acorn System One; it was submitted by R. A. Austin of Essex who explains:

```

; MEMORY LISTER
;
RDHEXD = $FE60      DISPLAY A
QHEXD1 = $FE64      DISPLAY X AND X+1
DISPLY = $FE6C      DISPLAY ROUTINE
;
MAP = $00           M ADDRESS PTR.
REPEAT = $0E        REPEAT FLAG
SPEED = $20
;
0000                *=$OE80
OE80 A0 00          START LDY EO      RAM I/O CHIP
OE82 A2 00          LDX EO      SET UP INDEX
OE84 B1 00          LDA (MAP),Y   REGISTERS.
OE86 20 60 FE      JSR RDHEXD   GET DATA IN A
OE89 20 64 FE      JSR QHEXD1   DISPLAY IT
OE8C A9 1F          LDA E$1F    DISPLAY ADDRESS
OE8E 85 0E          STA REPEAT   SET DISPLAY FOR
OE90 A9 40          LDA E$40    SINGLE SCAN.
OE92 85 20          STA SPEED    SET UP DELAY
OE94 20 0C FE      JSR DISPLY   AND STORE
OE97 C6 20          DEC SPEED   DISPLAY IT
OE99 D0 F9          BNE SHOW     ALL DONE?
OE9B A6 00          LDX MAP      LOW ADDRESS BYTE
OE9D E8            INX
OE9E 86 00          STX MAP      STORE IT
OEAO A5 00          LDA MAP     IS IT ZERO?
OEA2 D0 02          BNE NOC      IF SO...
OEA4 E6 01          INC MAP+1   INC HIGH BYTE
OEA6 4C 80 OE      JMP START   CONTINUE.
;
.END

```

Fig. 2. Program for the 6502-based Acorn System One steps through memory locations displaying their contents.

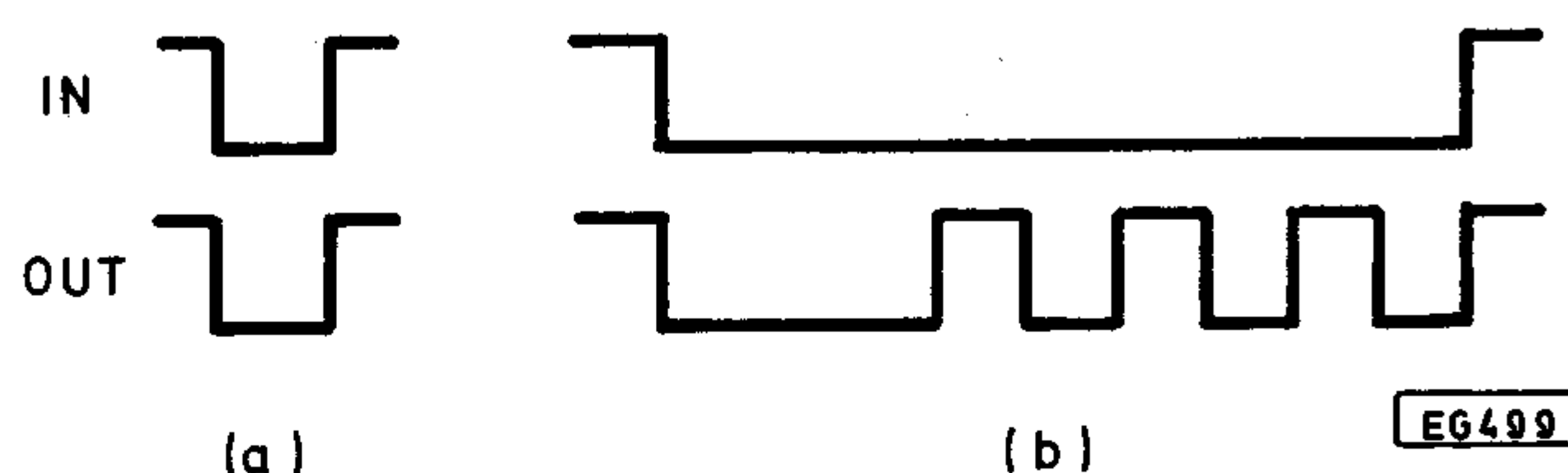


Fig. 4. Waveforms at input and output of auto-repeat circuit for (a) key typed rapidly, and (b) key held down.

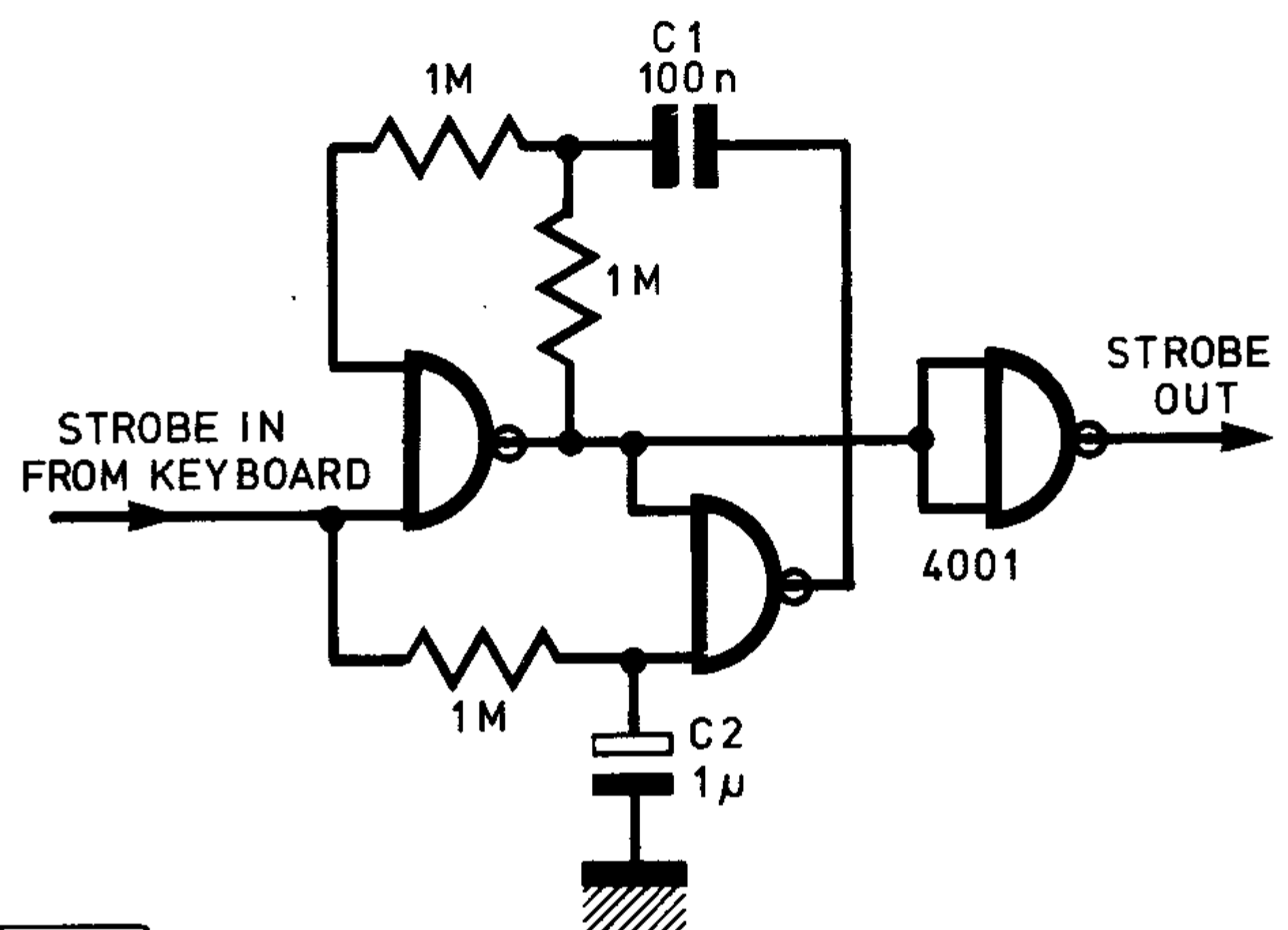
"The memory lister can be used, having completed a program and wishing to write it down, rather than using the "up" key (which can lead to sore fingers with large programs), to run through each address and show the contents. This leaves both hands free to jot down the hex codes."

The program, shown in Fig. 2, should be executed from START, and it will display the contents of successive locations starting from the last address accessed with the Memory Modify function. The time for which each location is displayed can be altered by changing the value at OE91. The program resides in the RAM I/O chip at OE80, but can be relocated providing that the jump address at the end is altered accordingly.

KEYBOARD AUTO-REPEAT

The simple circuit of Fig. 3, submitted by Nick Toop of Cambridge, provides an auto-repeat function for a parallel keyboard. It connects in the strobe line from the keyboard and, when triggered by a strobe input, toggles the output after a preset delay. If a key is typed quickly, as in Fig. 4(a), the output simply follows the input. However, if the key is held down for longer, as in Fig. 4(b), the strobe output oscillates giving the same effect as repeatedly typing the key.

The circuit uses a single quad 2-input CMOS NOR-gate package; as it stands it is designed for keyboards with a negative strobe, but can be altered for a positive strobe by moving the inverter from the output to the input. The repeat rate is determined by the value of C1, and the delay by C2.



EG498

Fig. 3. Circuit adds auto-repeat function to a keyboard.

```

; MEMORY CLEAR
;
0000                .=$OF20      ;RELOCATABLE
OF20 FF            PBYTE: .BYTE  OFF ;PROTECTION BYTE
OF21 C400          START: LDI    0
OF23 CD01          ST          @1(1) ;ZERO LOCATION
OF25 COFA          LD          PBYTE
OF27 9CF8          JNZ        START ;OK TO CONTINUE
OF29 C4FF          DONE:  LDI    OFF ;HAVE REACHED
OF2B C8F4          ST          PBYTE ;PUT PBYTE BACK
OF2D C510          LD          @16(1) ;JUMP PROGRAM
OF2F 90F0          JMP        START ;CARRY ON.
;
0000                .END

```

Fig. 5. Program for the SC/MP micro zeroes all memory without destroying itself.

lines 50 and 60 of the program refer to the graphics character 'shift A' (grey square). The game is played by entering the coordinate of the piece to be moved, followed by one of the instructions 'UL', 'UR', 'DL', 'DR' (i.e. up left... down right), or 'H' (huff). For example, to move the piece in square (3,5) to (4,4) enter:

```

35 NEWLINE
UR NEWLINE

10 REM DRAUGHTS-BOARD PROGRAM
20 CLS
30 PRINT "12345678"
40 LET A=1
50 PRINT "#+#+ +$+";A
60 PRINT "+#+ +$+$";A+1
70 LET A=A+2
80 IF A<8 THEN GO TO 50
90 INPUT N
100 IF N=0 THEN RUN
110 IF N=1 THEN LIST
120 LET A=N/10
130 LET B=N-A*10
140 LET M=B*10+A
150 INPUT A$
160 IF NOT (A$="UL" OR A$="UR"
OR A$="DL" OR A$="DR" OR A$="H")
THEN GO TO 90
170 LET D=0
180 IF A$="UR" THEN LET D=-9
190 IF A$="DR" THEN LET D=11
200 IF A$="DL" THEN LET D=9
210 IF A$="UL" THEN LET D=-11
220 GO SUB 500
230 LET X=PEEK(F+M)
240 IF NOT A$="H" THEN GO TO 28
0
250 GO SUB 500
260 IF X=12 OR X=13 OR X=140 OR
X=141 THEN POKE F+M,0

```

Fig. 6. Draughts-Board program.

The program moves pieces on the screen by PEEKing and POKEing the display file, pointed to by the system variable D-FILE. Subroutine 500 finds the first end-of-line character (76 hex) after D-FILE, and the program works relative to this. Lines 290 and 310 determine whether there is an opponent's piece in the location chosen to be moved into; i.e. if the move is a capture. If a move is chosen lines 330 and 340 move the piece along the

```

270 GO TO 90
280 GO SUB 500
290 LET Y=PEEK(F+M+D)
300 IF X=Y OR X=Y+128 OR Y=X+12
8 OR (X=12 AND TL$(A$)="L") OR (
X=13 AND TL$(A$)="R" OR NOT (X=1
2 OR X=13 OR X=140 OR X=141) THE
N GO TO 90
310 IF NOT Y=0 THEN GO TO 370
320 GO SUB 500
330 POKE F+M,0
340 POKE F+M+D,X
350 IF (X=13 AND A=2) OR (X=12
AND A=7) THEN POKE F+M+D,X+128
360 GO TO 90
370 GO SUB 500
380 IF NOT PEEK(F+M+D*2)=0 THEN
GO TO 90
390 POKE F+M,0
400 POKE F+M+D,0
410 POKE F+M+D*2,X
420 IF (X=13 AND A=3) OR (X=12
AND A=6) THEN POKE F+M+D*2,X+128
430 GO TO 90
500 LET F=PEEK(16396)+PEEK(1639
7)*256
510 IF PEEK(F)=118 THEN RETURN
520 LET F=F+1
530 GO TO 510

```

display file by displacement D. If a capture has been chosen lines 390 and 410 move the piece two places (2*D) and line 400 erases the captured piece.

"Lines 350 and 420 crown a piece as it reaches the other side of the board by inverting the graphics (adding 128 to the character code). Lines 160, 260, 300 and 380 reject any invalid move; e.g. taking your own piece, or moving backwards. When the game is over, entering a 0 will print a new board, or entering 1 will bring the ZX80 back to command mode.

"The program fits into the 1K unexpanded memory without any trouble, although a LIST instruction will only reveal three or four lines at a time because most of the memory is taken up."

```

12345678
# # # # # # # #
# # # # # # # #
# # # # # # # #
# # # # # # # #
# # # # # # # #
# # # # # # # #
# # # # # # # #

```

Fig. 7. Draughts-Board display.



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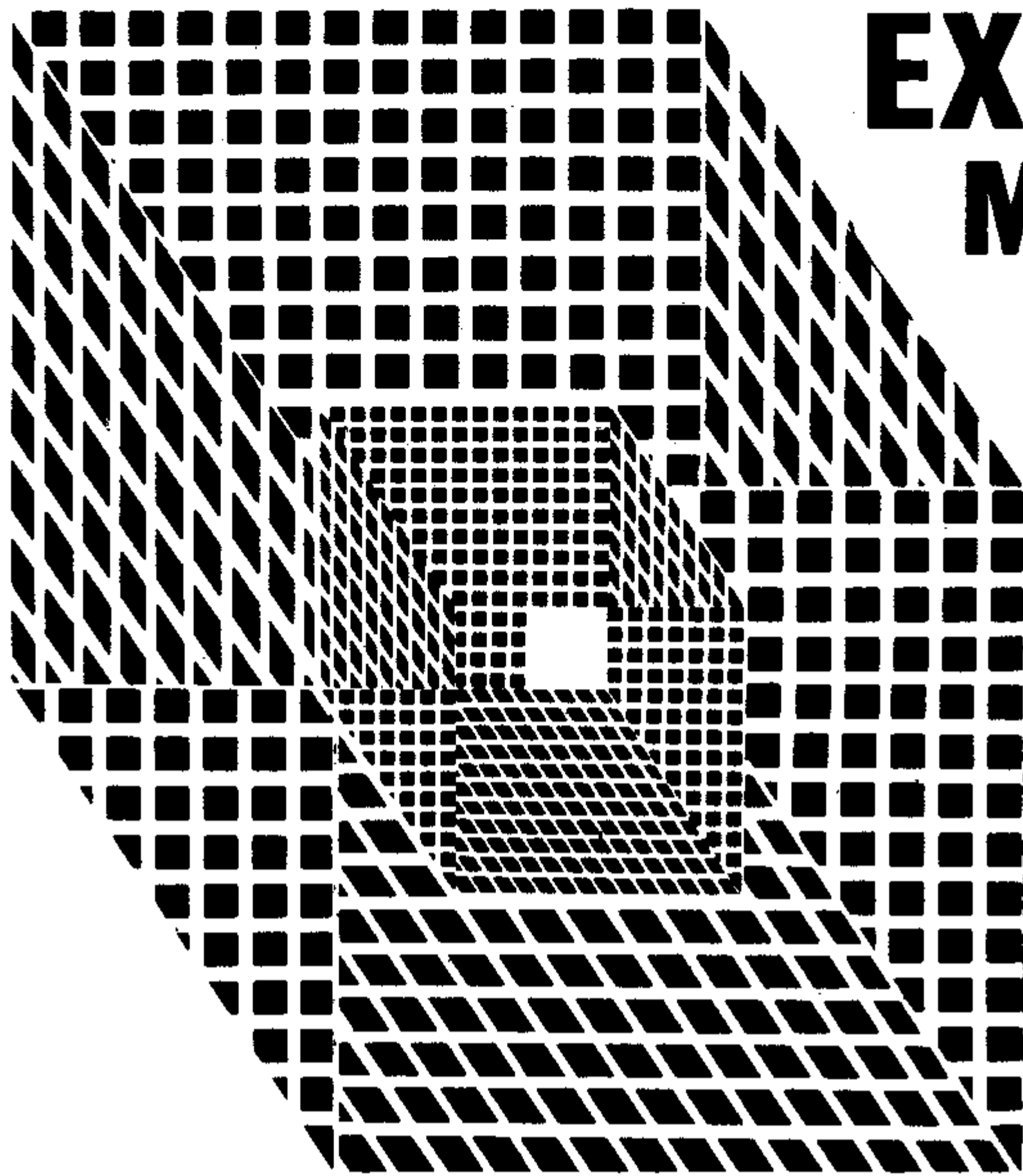
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PE MAGNUM MODIFICATIONS...

ANDY FLIND

SINCE the original Magnum design was published some worthwhile improvements and modifications have been carried out to the prototype, which constructors might like to incorporate into their own machines. This is also a good opportunity to answer a few of the more frequent queries regarding this design.

INSTABILITY

Some constructors have run into problems of instability, usually in the form of hunting around the threshold point. Despite its high gain and sensitivity the Magnum is an exceptionally stable circuit, so if you have a stability problem it follows that there must be a cause somewhere. A not too obvious cause of such a problem is the family telly, as the line timebase of a UHF TV is very close to the Magnum's search frequency. Depending on just how close your Magnum's oscillator is to the TV line output frequency the result can be anything from a mushy, imprecise threshold setting to a quavering effect or even a slow, regular drift, caused by the two frequencies beating together. Fortunately most actual search sites don't have TVs nearby, so most of the problems you'll encounter from this cause will be during indoor testing only. Another possible source of such trouble which needs only a brief mention is that the connection point for the separate 9V output battery positive was marked "+5V6" on both circuit and layout drawings in the original article. This has been mentioned in "Points Arising".

Another frequently raised point is that false signals can be produced by knocking the coil. On the prototype it takes quite a hard knock to do this, the false signal is easily recognisable as such and the continuous autotuning deals with it immediately. The cause of the signal is movement of the coil lead relative to the coil, so it can be minimised by taping the lower part of the lead to the stem to permit it as little free movement as possible.

Several constructors have complained that the meter isn't sensitive enough. This is easily cured; change R49 and R50

to 1k, D7 and D8 to 0A47, and VR6 to 4k7, then set up as before. This increases the meter sensitivity by about two or three times, which on the prototype proved to be just right.

ADD-ON BOARD

Now for a rather more complex modification. Reaching for the "Mode" switch every time an object was detected proved to be something of a chore, particularly as the free hand was likely to be holding a trowel and covered with mud, wet sand or whatever. It was therefore decided to incorporate a means of changing mode from the tuning button, and a small add-on circuit board has been designed to do this. This has been in use for some time now; it makes discriminating much easier and a great deal quicker.

The circuit of this modification appears in Fig. 1. The principle of operation is simple; every time the "Tune-Hold" button is pressed a half-second timer is started. If the button is released before the timer period is complete a mode-change is initiated. Thus a quick prod of the button changes mode, but normal operation simply holds the tuning as before. Three CMOS chips are used to achieve this, two 4011s and a 4016. Two gates of the first 4011, IC1a and IC1b, are connected to form a monostable with a period of about half a second. The second two gates on this chip are unused. The output from IC1a is normally low and goes high during the timing period, but so long as the button is kept pressed the output from R4 will be held low via D2. The signal for the tune-hold input on the main board is provided via D1.

The four gates of the second 4011 are connected to form a changeover switch which changes state every time its input is taken high briefly, and its complementary outputs are taken to the inputs of a 4016 quad switch. This gives two pairs of single-pole switches which open and close alternately, and these can be wired to provide the two changeover switches required for mode switching. Because it uses common CMOS chips this circuit is cheap to build and uses next to no additional power from the batteries.

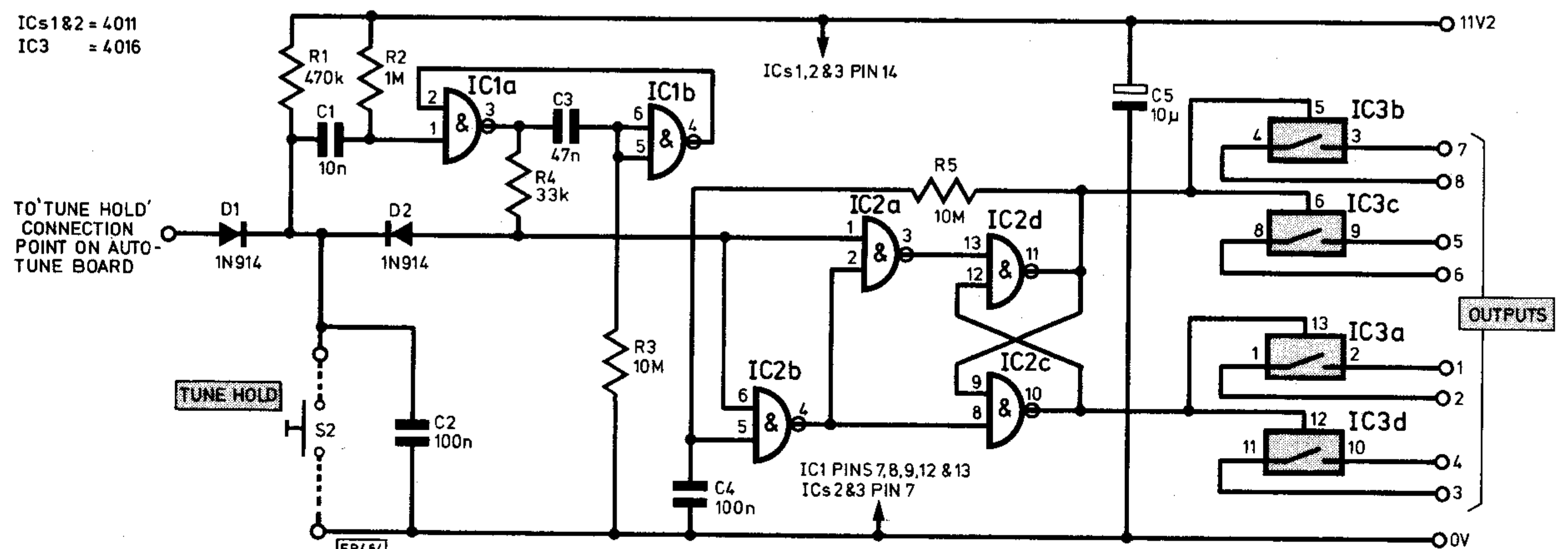


Fig. 1. Pushbutton mode change unit circuit

COMPONENTS . . .

Resistors

R1	470k
R2	1M
R3, R5	10M (2 off)
R4	33k

Capacitors

C1	10n polyester
C2, C4	100n polyester (2 off)
C3	47n polyester
C5	10µF 16V tantalum bead

Semiconductors

IC1, IC2	4011B (2 off)
IC3	4016UBE
D1, D2	1N914 (2 off)

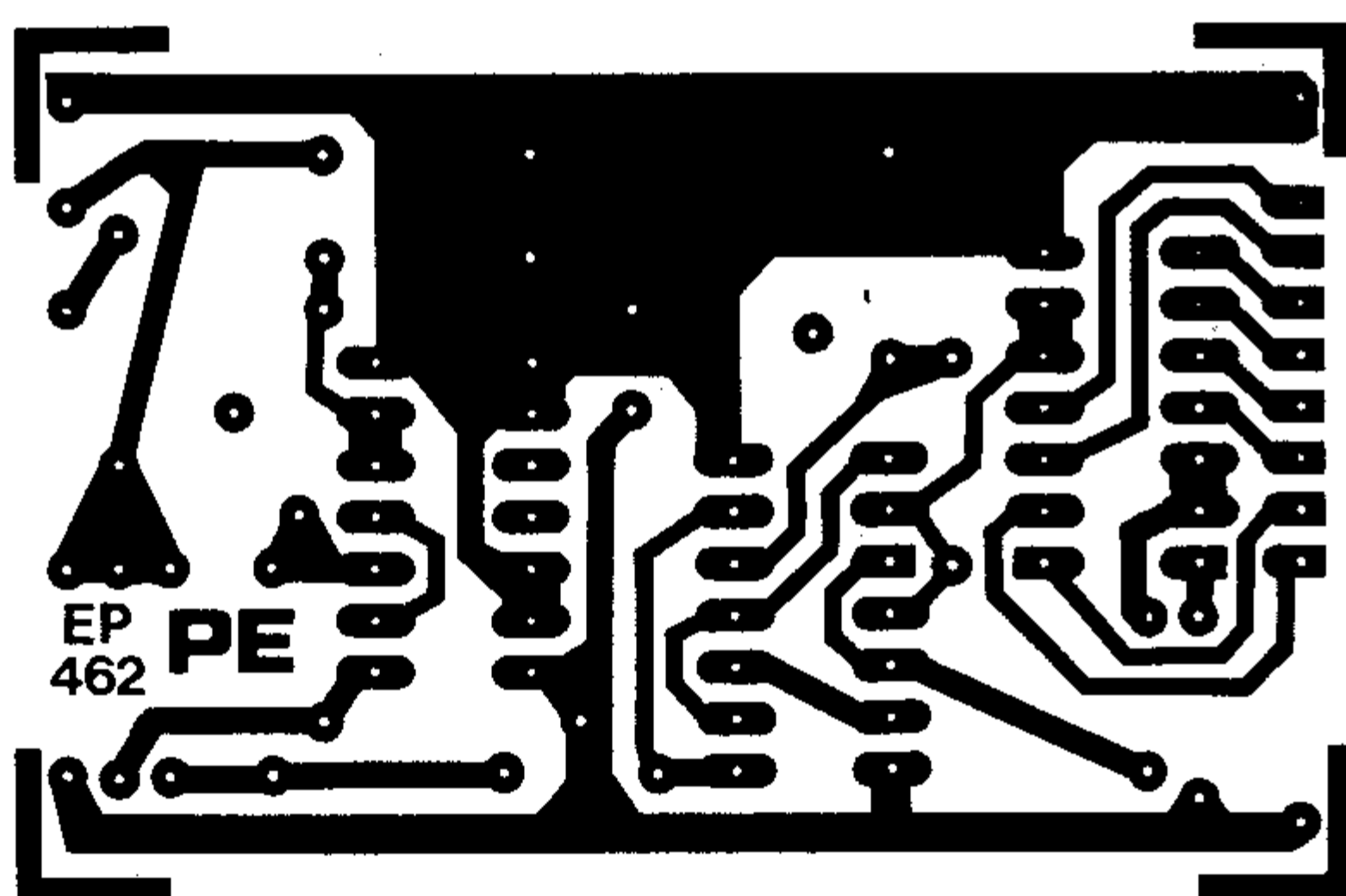


Fig. 2. Printed circuit (actual size)

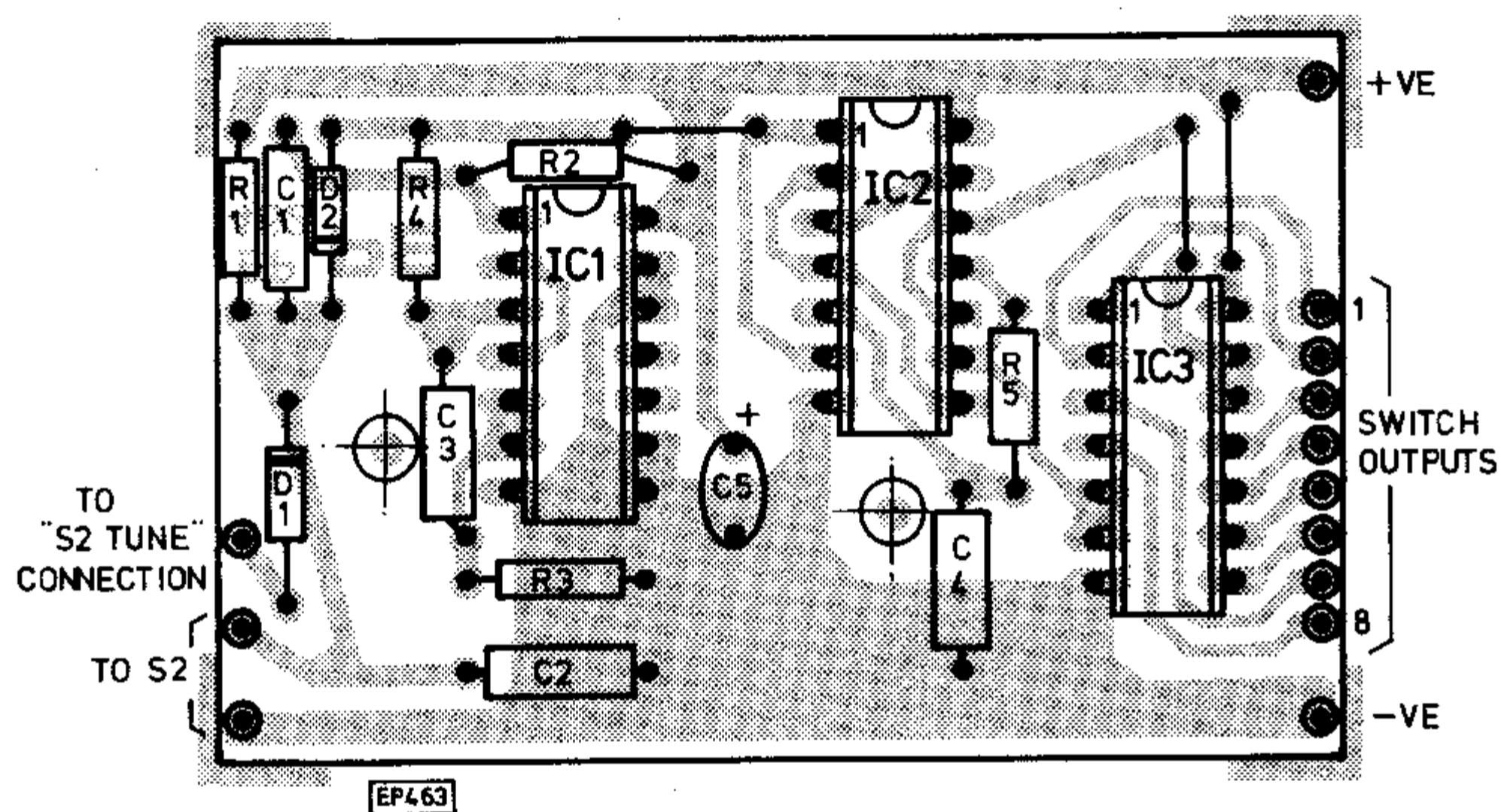


Fig. 3. Component layout

LAYOUT

The circuit has been designed on a small p.c.b. which mounts directly onto two of the lugs in the specified Vero case, next to the meter. Fig. 3. shows the layout of the components. Construction should be straightforward providing the usual CMOS precautions are observed; there is room for sockets for the three chips. Wire tails of suitable length should be attached to the unit before it is secured into the case with a couple of self tapping screws.

Connecting the unit into the main circuit is probably the most complicated part of this modification. Fig. 4. shows how the complete circuit is changed with this unit installed;

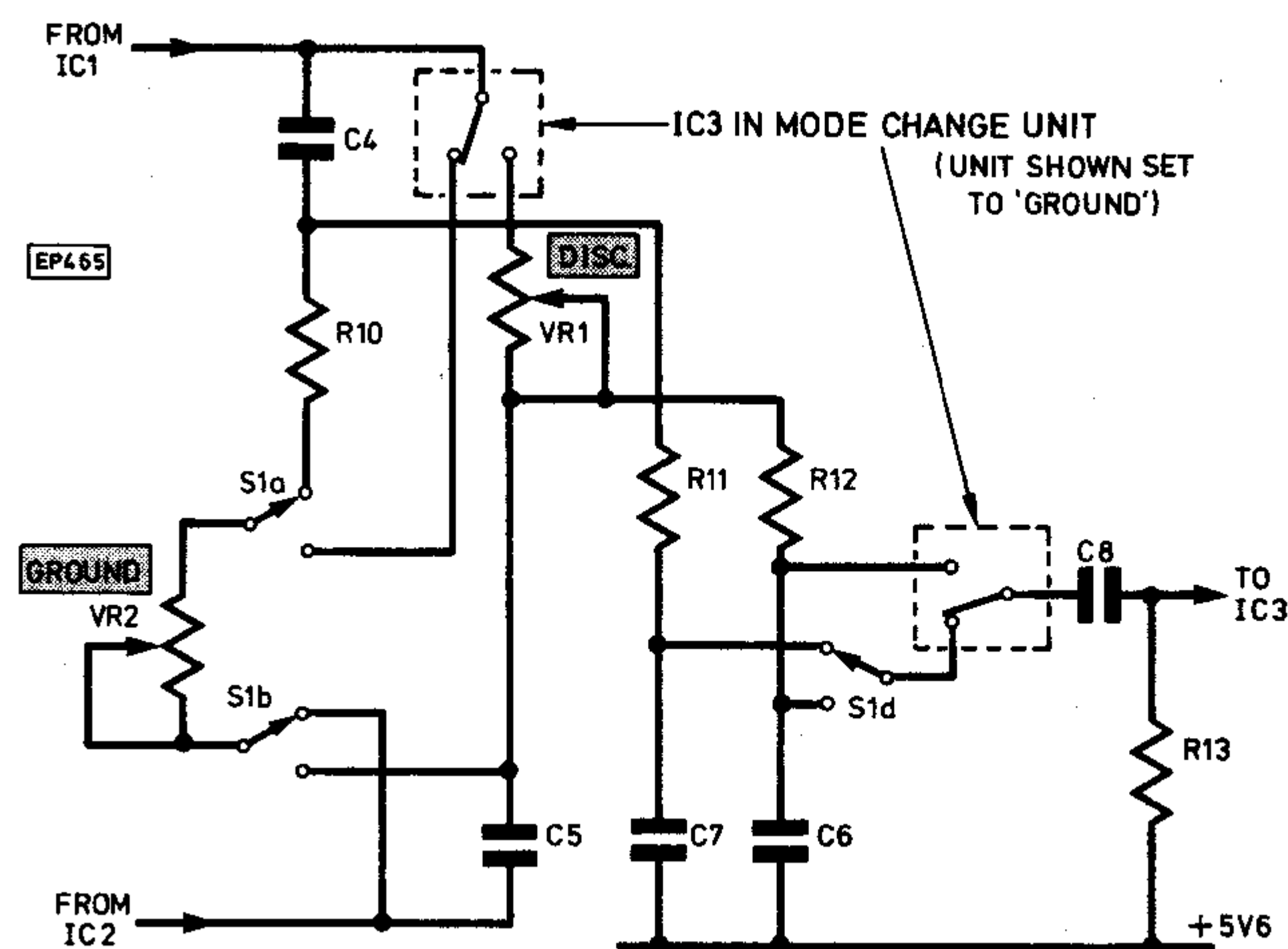


Fig. 4. Effect of adding mode change unit to main circuit

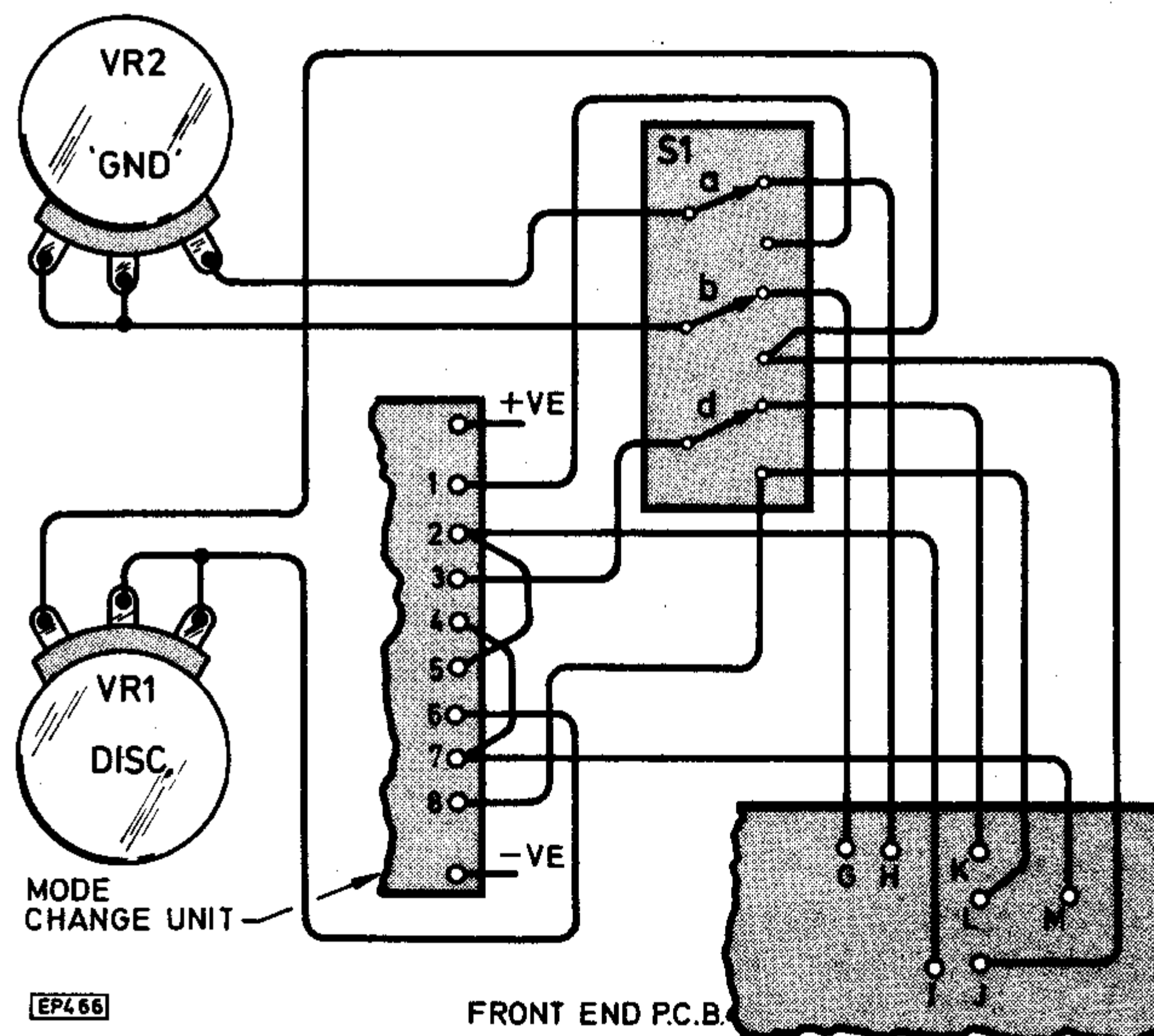


Fig. 5. Interconnections

note that S1, which was a 4-pole 3-way switch is now a 3-pole 2-way, with the two positions marked "Ground" and "Beach". It may be possible to use your existing switch; many rotary switches have an adjustable stop which can be used to limit the number of positions available. Fig. 5. shows how the actual interconnections are made. Not shown are the power supplies, which are taken from the 0V and +11V2 points on the power supply board, and the "Autotune" connections; button S2 connects straight into the new unit, and the single output lead from D1 goes to the old "S2" connection on the main board—the one going to TR3's gate. The other original S2 connection point is now unused.

There is, of course, no indication of which mode the unit is in when using this system. Actually this presents no problems, as when initially setting up it's in the mode whose control causes a meter deflection when moved. Once set up, there are two ways of telling. A mode-change causes an initial meter deflection before the autotune resets it; it will usually jump one way on switching to "Discrim", and the other on going back to "Ground". Also of course, "Discrim" is the mode with the ground effect! In practice it takes no time at all to get used to the new way of changing mode and the increased speed and ease with which detected objects can be checked out should be greatly appreciated by all users. ★

Interfacing COMPUKIT

Part 2 D.E.Graham

THIS MONTH we discuss the use of the MC 6821 PIA on the Decoding Module, and look at the way in which digital data may be input to CompuKit using both this, and sets of tristate buffers.

The 6821 PIA

Motorola's 6821 PIA provides two 8-bit input-output ports together with interrupt and peripheral control facilities. It achieves this through the operation of six internal registers; three for each port. One of these carries the actual data passing through the port, a second determines the direction in which data is carried, while the third is a control register largely associated with the generation of interrupts, and the operation of control lines to peripheral devices. Somewhat unusually, although the chip uses six registers, it occupies only four addresses, and as a consequence accessing its registers is not as straightforward as it might be.

It circumvents the problem by using bit 2 of each control register to determine whether the other two addresses refer to the data direction register or to the port data register. Table 2.1 gives the disposition of the six registers, and the four corresponding addresses used in the Decoding Module. Accessing the two control registers is quite straightforward. The command `POKE 61341, W` will place the value `W` into the control register of port A, while `POKE 61343, W` will do the same for port B. In order to access the data direction register, bit 2 of the control register must first be set to zero. `POKE 61341, 0` will achieve this for port A. The command `POKE 61340, Y` will then configure port A for input if `Y=0`, or for output if `Y=255`. Bit 2 of the control register must then be set to 1 (eg. by `POKE 61341, 255`) to achieve access to the port itself, and this completes the initialisation procedure. PEEKing or POKEing to 61340 can now be used for input or output of data.

This is not really as difficult as it sounds, and Table 2.2 gives the four complete sets of commands for configuring either port for 8-bit input or output. Note that on Reset, or at switch-on, all registers are automatically zeroed, so that a number of commands in this table may be omitted in certain situations; and of course it is only usually necessary to configure the ports once at the beginning of a program, and all further Reads or Writes can be accomplished with a single PEEK or POKE.

In the examples discussed so far, the data direction register has been loaded with either a zero (for input) or 255 (for output). In practice each of the 8 bits of the two ports is individually controllable in this respect, with one binary digit of the data direction register controlling one bit of the corresponding port; a zero signifying input, and a 1 an output. Thus whilst placing 255 (11111111 binary) in the data direction register will configure all 8 bits for output, the number 15 (00001111 binary) would cause the top 4 bits to be set for input, and the lowest 4 for output, and so on.

Although the registers of ports A and B are addressed in an identical fashion, the two ports differ electrically in certain respects. Both have a drive capability of two TTL gates. But on input, the output circuitry of port B adopts a tristate condition, whereas that of port A does not. Port A's inputs are accordingly taken high by internal pull-up resistors, and require an effective resistance of 1k or less to earth in order to render them low. The voltage sensitivities of the two ports is also somewhat different. Port A takes voltage lower than about 1.4 as a logical zero, and higher than about 1.6 as a logical 1, whereas the two corresponding voltages for port B are about 0.7 and 3.0.

In a later article in this series we will look at the use of the peripheral control lines of the 6821. We now turn to the construction and testing of the Decoding Module.

Table 2.1. 6821 Registers

Address	Control Bit		Function
	Reg A	Reg B	
61340	1	X	Port Data Register
61340	0	X	Data Direction Register Port A
61341	X	X	Control Flag Register
61342	X	1	Port Data Register
61342	X	0	Data Direction Register Port B
61343	X	X	Control Flag Register

Table 2.2

OUTPUT		
For output on Port A P=61340 POKE P+1, 0	For output on Port B P=61342 POKE P+1, 0	Function codes for data direction register
POKE P, 255	POKE P, 255	sets data direction to output
POKE P+1, 255	POKE P+1, 255	code for peripheral register
Further commands of <i>POKE P, W</i> will now place <i>W</i> on Port A or B		
INPUT		
For input on Port A P=61340 POKE P+1, 0	For input on Port B P=61342 POKE P+1, 0	Function code for data direction register
POKE P, 0	POKE P, 0	sets data direction for input
POKE P+1, 255	POKE P+1, 255	code for peripheral register
calls of PEEK (P) will now return the data at port A or B		

CIRCUIT OPERATION

A full circuit of the Decoding Module is given in Fig 1.5. Device IC1, a 13-input NAND gate, provides the complete decoding of the base address of the system. As the circuit stands, with a single inverter in address line A12, this is EF80 hex (61312 dec). It will be seen however, that a number of pads are provided to engage two further inverters in address lines A11 and A13. This allows the user, by cutting tracks and wiring between the pads on any of the three lines A11-A13 to set the base address at 7 other possible locations. The various permutations are given in Table 1.10. It should be noted that the top two of the 8 possible base addresses fall within the UK101's 2K monitor, and should therefore be avoided! The remaining 6 base addresses and accompanying blocks are unused by both the Compukit and the Superboard II. Since however, all software for the series will assume a base address of EF80, it may be simplest to leave all three sets of pads unaltered.

The output of IC1 is taken to IC2, a 74LS138 3-to-8 line decoder, which decodes address lines A4-A6 to produce eight 16-byte blocks (BL0-BL7). The decoding of these blocks has not been made conditional of $\emptyset 2$ since they are generally intended for use with multi-register devices which often possess a separate master Enable pin, which when connected to $\emptyset 2$ satisfies all timing requirements of the chip. Some devices, such as the 6522 VIA, require the chip select lines to settle before $\emptyset 2$ goes high; so that if the output of IC2 had been made conditional on $\emptyset 2$, no settling time would be given, and the device would not respond to the CPU's attempts to select it.

Device IC3, a 74LS154 4-to-16 line decoder, provides the sixteen address-decoded Write lines in response to BL0, R/W and $\emptyset 2$. The outputs of both the 74138 and the 74154 are active-low, and a number of IC3's outputs have been inverted for convenience of subsequent use. Lines W5 and W6 have, in conjunction with R6, been further decoded to provide a pair of signals BDIR and BC1 for use with an AY-3-8910 or 8912 programmable sound generator. This decoding is all that the PSG requires to both write to, and read from its full complement of registers, and details of the use of these lines will be given later in the series.

IC4 (74LS138) decodes 8 Read lines in response to address lines A0-A3, $\overline{BL0}$, R/W and $\emptyset 2$. The reason why 16 Write lines have been made available, and only 8 Read lines, is largely the additional Write requirement imposed by the use of 7-segment I.e.d. readouts, to be featured later. The addresses of these 24 lines are given in Table 1.9. As will be seen, a number of these have been ear-marked for particular projects in the series.

The NAND gate IC8A is used to produce the DD control signal. This is brought low when a Read is carried out at any of the addresses within the 128-byte block used by the module. The reason why it is not simply connected directly to the inverted R/W line is that this would cause the data bus of the CPU to receive extraneous noise from all interfaces during every memory Read cycle, whereas with the present circuit, interfaces are only given access to the CPU when the 128-byte block is called up.

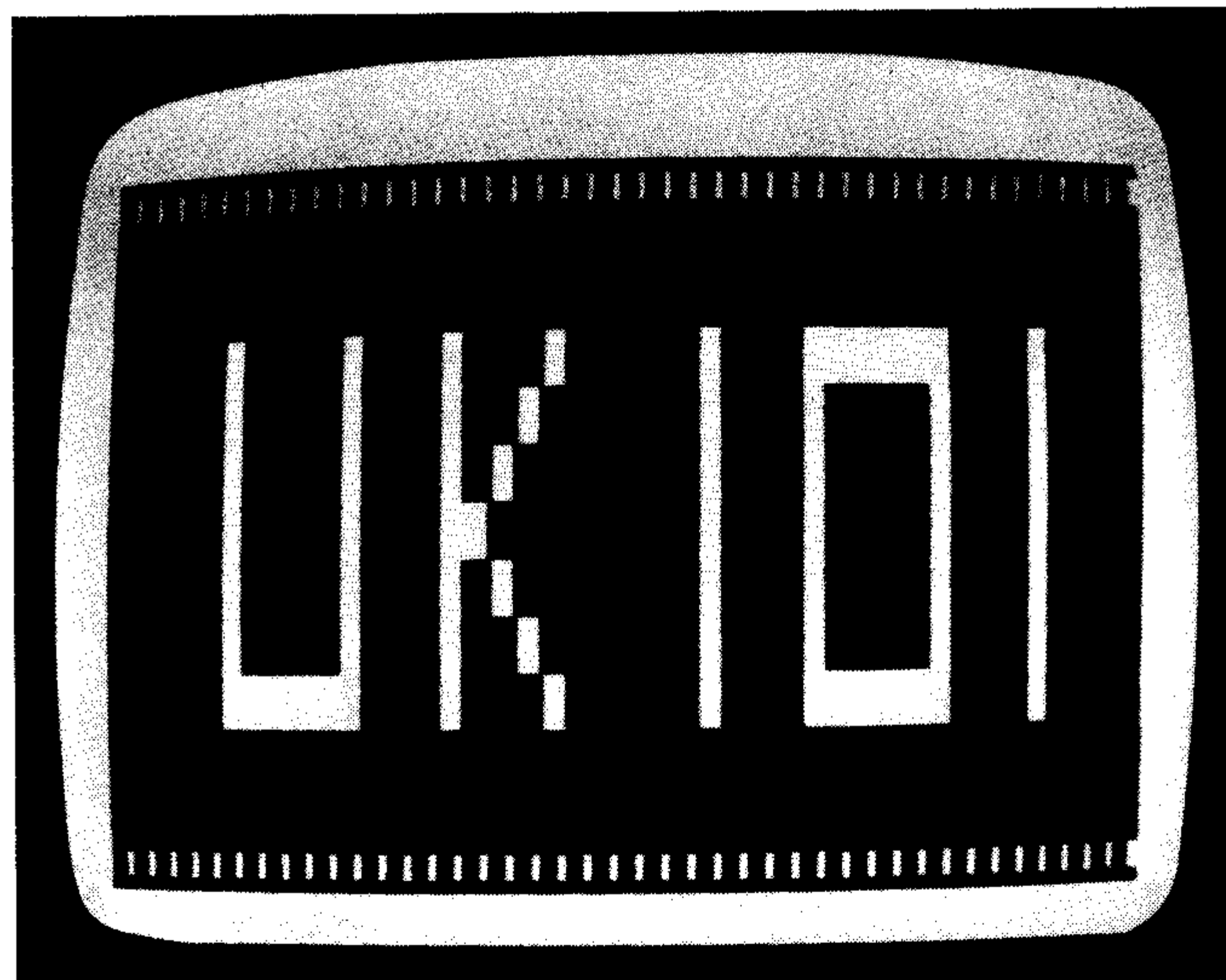
As may be seen from Fig. 1.5, the 6821 PIA (IC9) is selected by the $\overline{BL1}$ line. Address lines A2 and A3 are wired to

high-Enable Chip-Select pins 22 and 24, so placing the four addresses used by the PIA at the top of Block 1 (61340-61343 dec). Lines A0 and A1 are used internally by the PIA for decoding within the 4-byte block. Since block 1 is 16 bytes wide, there is clearly room for a further 3 PIAs to be located within it. This could be accomplished by wiring additional PIAs exactly as for IC9, but with inverters in either A2 or A3 or both; although it would probably be easier to locate them in one of the 6 unused blocks (BL2-BL7) whose signals appear on SK6.

The PIA's pin 25 is a master Enable against which all of its operations are timed. It is connected directly to the $\emptyset 2$ clock. Pin 34 is a 6502-compatible \overline{RESET} line. This has not been taken to the UK 101's Reset circuitry; one of the reasons for this being that the Compukit \overline{RESET} signal does not actually appear at the expansion socket. Pin 34 is taken instead to a pair of pads intended for the connection of a pushbutton which may be used to simultaneously reset all devices wired to the Decoding Module. Capacitor C4 is used to give a power-on Reset. It does this by simply holding the \overline{RESET} line low for a fraction of a second after power-up. A similar technique can be used on the Compukit itself: connecting 100 μ F from pin 40 of the 6502 to earth will ensure that the D/C/W/M? message appears instantly at switch-on.

The Decoding Module power supply circuitry is quite straightforward, and employs a 7805 regulator to produce +5 volts at about 500 mA, and a zener stabiliser to give -5 volts at about 30 mA. The Module draws about 100 mA from the positive supply, leaving ample in reserve for driving external devices. The negative supply is generally intended for use with dual polarity analogue i.c.s that will be encountered in D/A and A/D conversion later in the series, and is not used by the Module itself.

The power supply requires a 9-0-9V a.c. transformer rated at 1A. It should be possible to tap Compukit's 3A transformer for this purpose providing it is not already heavily loaded.



Large characters produced by the joystick drawing routine

SK1 — TO COMPUKIT EXPANSION SOCKET — 1 off 2 X 22 pin edge connector
 SK2 — 40 PIN DIL — ALLOWS FOR FURTHER EXPANSION OF COMPUKIT
 SK3 & SK4 — 16 PIN DIL SOCKET — PORTS A & B OF PIA
 PIA
 SK5 — 24 PIN DIL SOCKET — DECODING MODULE OUTPUT
 SK6 — 1 OFF 2 X 25 PIN 0.1" EDGE CONNECTOR — DECODING MODULE OUTPUTS

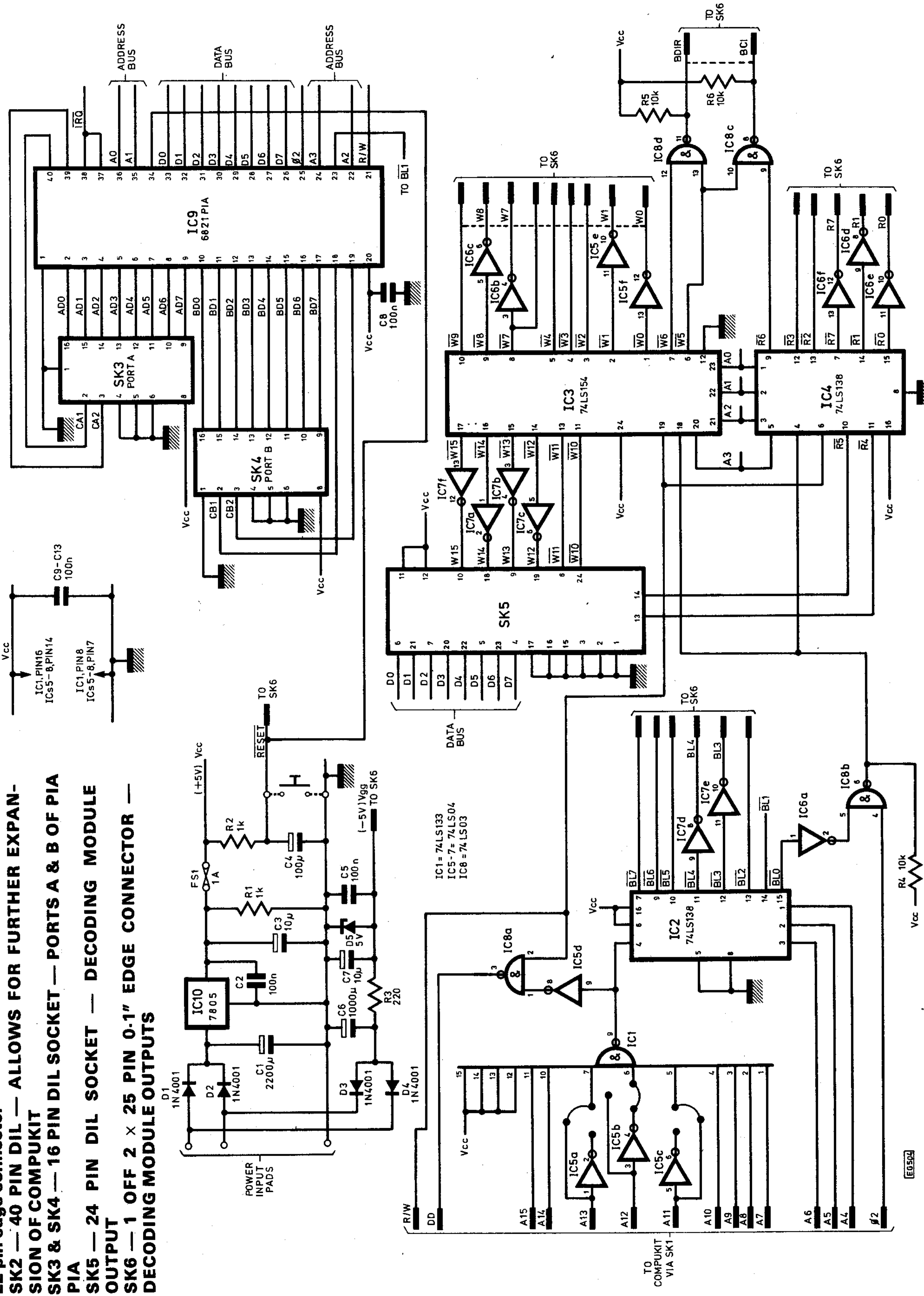


Fig. 2.1. Full circuit diagram. See Points Arising in this issue, concerning Part 1

Fig. 2.1. Full circuit diagram. See Points Arising in this issue, Concerning Part 1

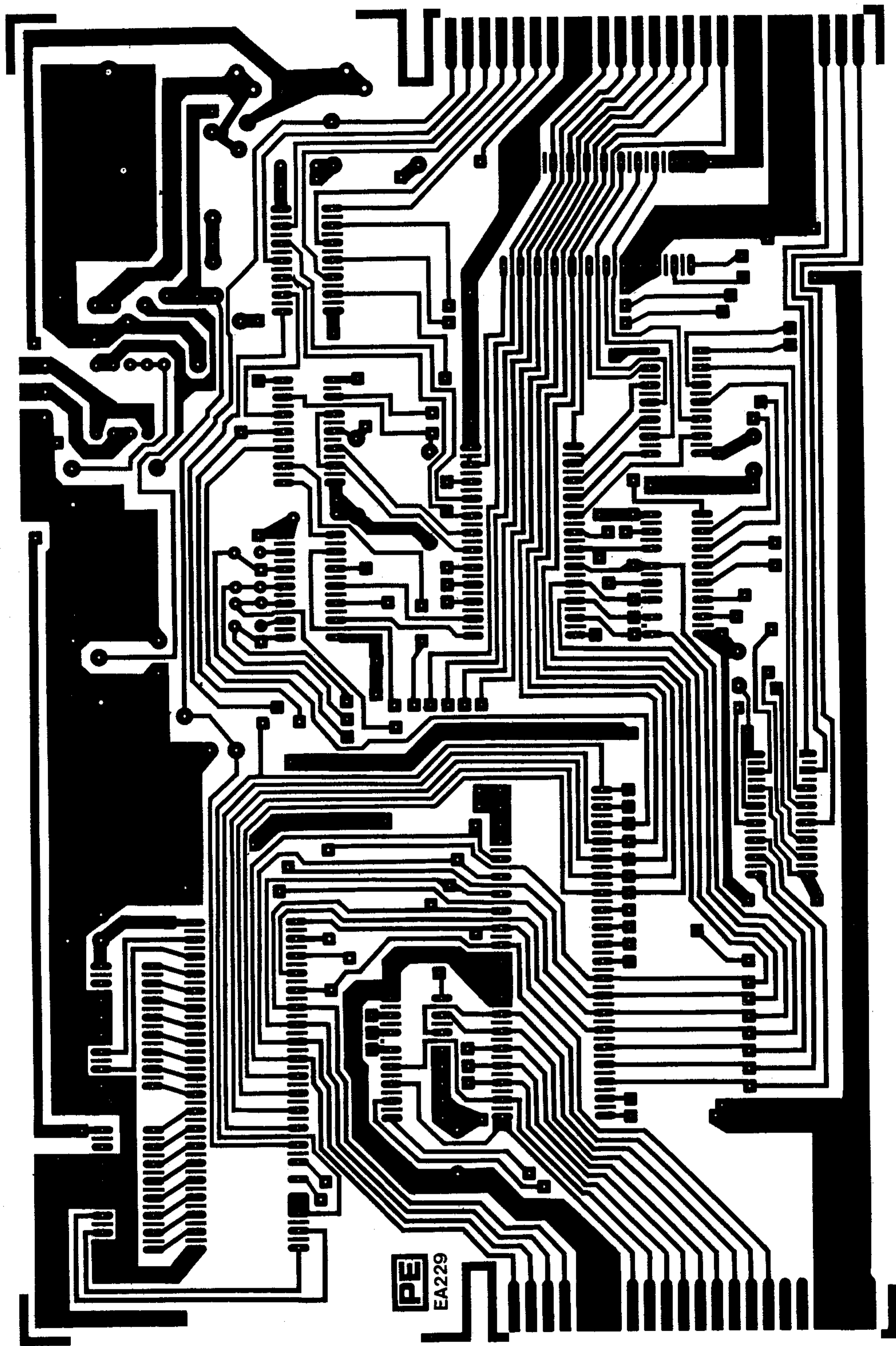


Fig. 2.2. Copper-side p.c.b. layout (actual size)

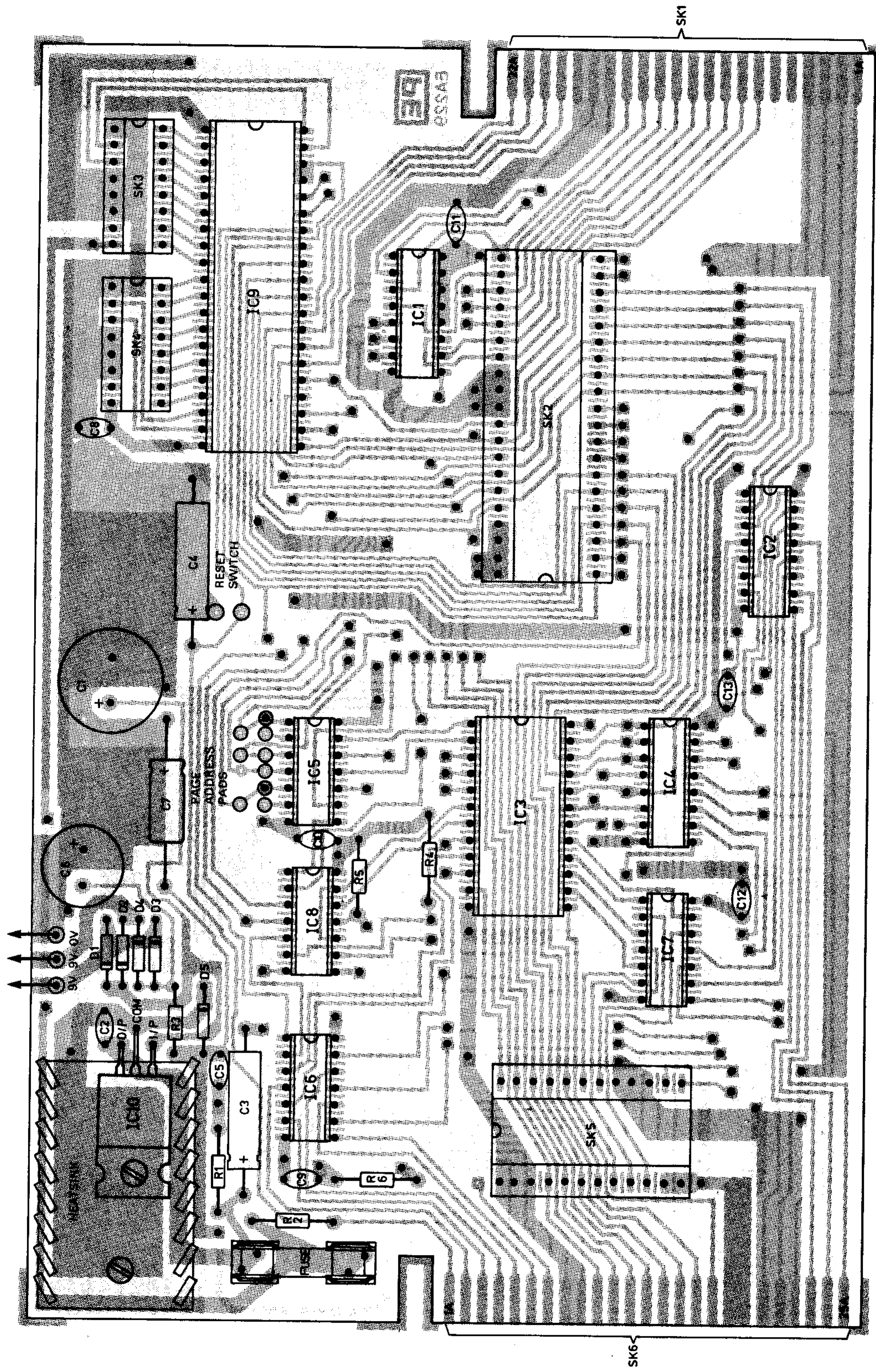


Fig. 2.4. Component layout. A complete kit of parts for the Decoding Module, including i.c.s, p.c.b., headers, edge connectors, ribbon cable etc., (but excluding transformer & 8T28s) is available from: Technomatic Ltd., 17 Burnley Road, London NW10. Price: £27.50 exc. VAT. Post free

EA230

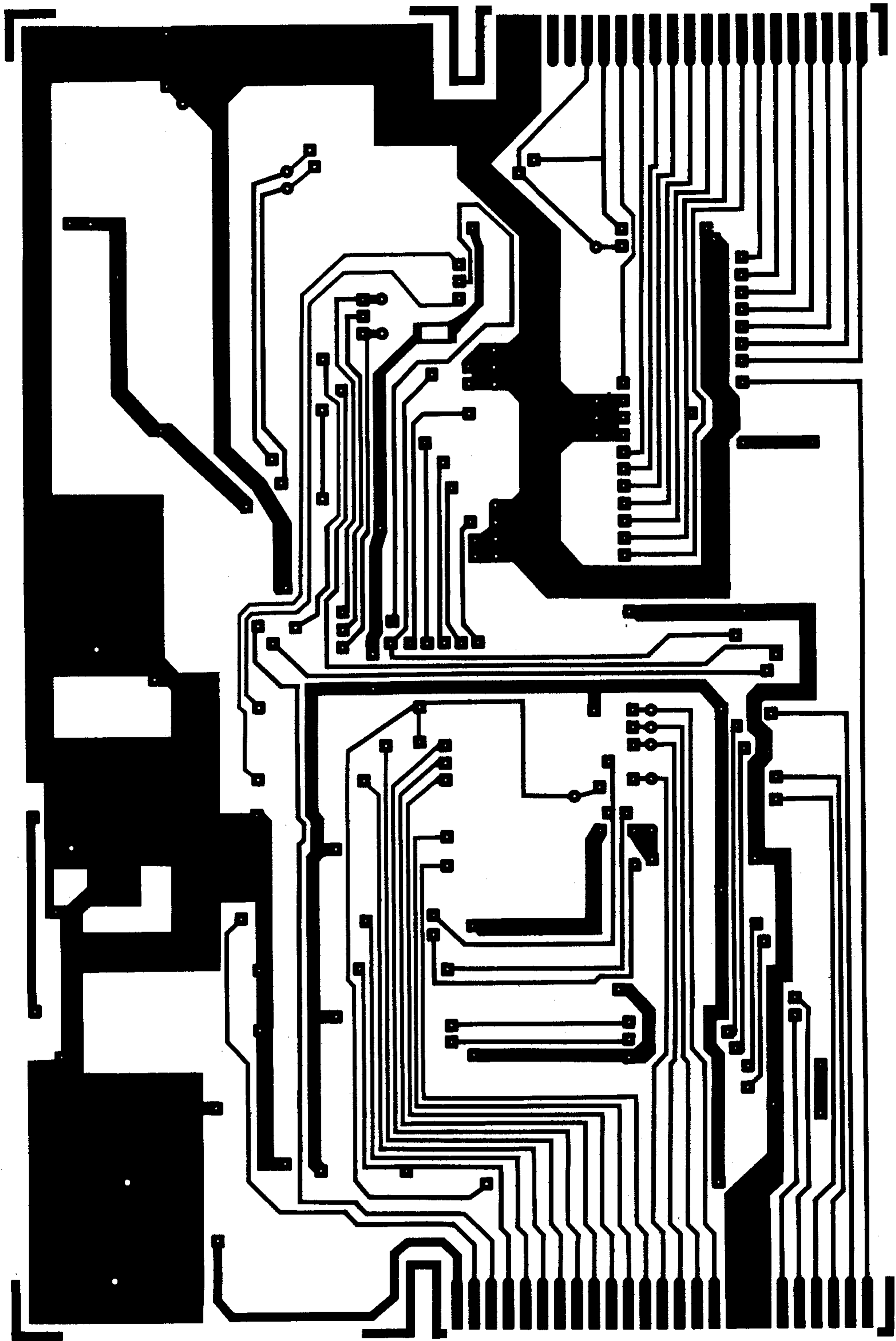


Fig. 2.3. Component-side p.c.b. layout (actual size)

CONSTRUCTION

Construction of the Decoding Module should pose no real difficulties to those experienced with soldering. It might be useful to put in all i.c. holders and other components before tackling the through-holes. The positions of these are indicated in the component overlay drawing, and may be identified in almost all cases as holes surrounded by a square rather than a round track on both sides of the board. All through-pins should be separately soldered on both sides of the board, and a check made that *both* joints are in tact at the end of the operation. The voltage regulator, IC10, should be mounted on the heat-sink with a 6BA bolt or similar.

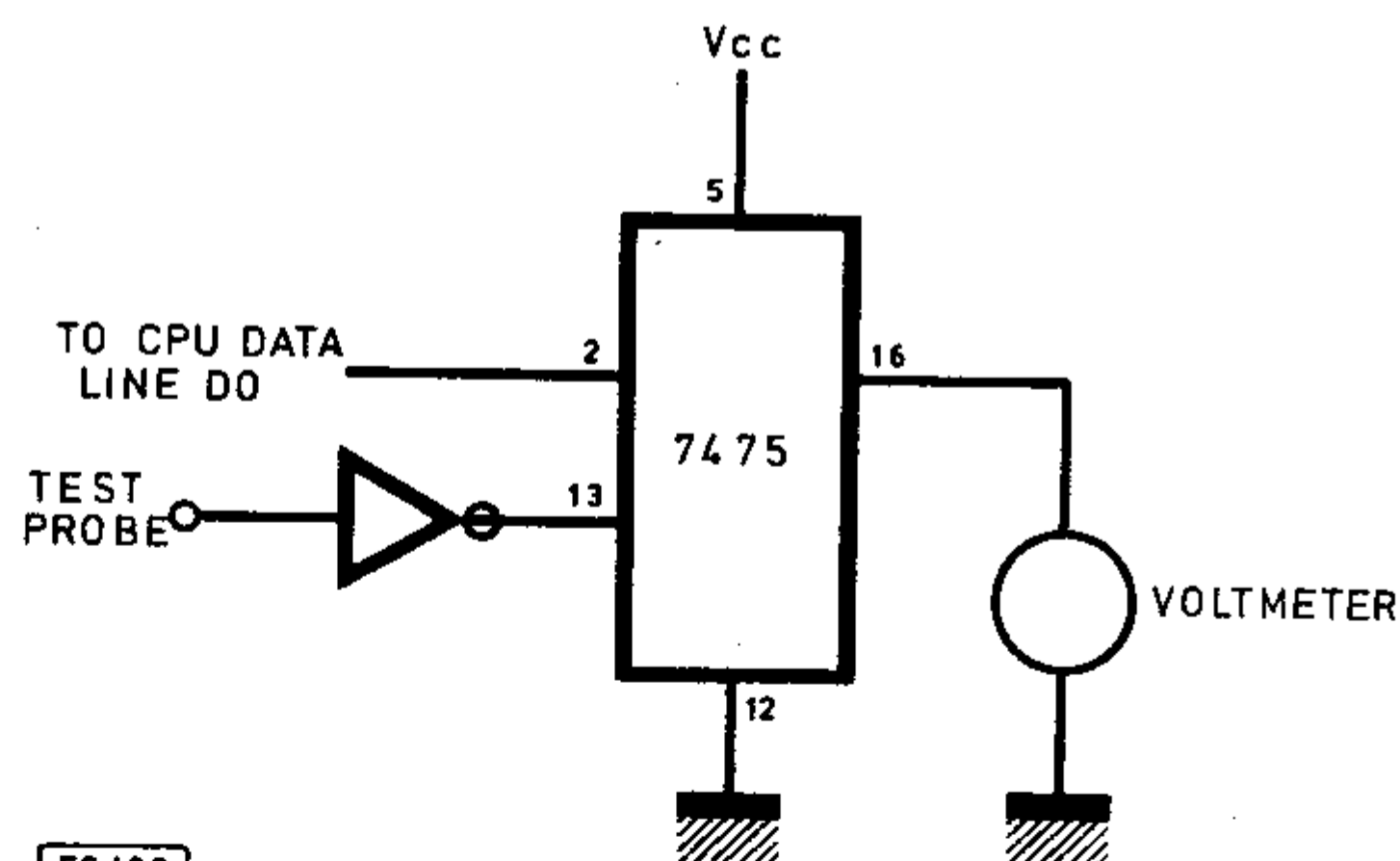
Note that if it is intended to tap Compukit's PSU transformer to supply the Module, the connection should be made *directly* to the transformer tags, and *not* to the three pads on Compukit's board. This latter precaution will reduce mains hum due to the earth loop, keeping it within reasonably acceptable limits.

TESTING

After checking with an ohm-meter that the PSU lines are not shorted to earth, connect the Module to the 9-0-9 V supply with the fuse and all i.c.s except IC10 removed. If this produces 5 volts, the remaining i.c.s may be inserted, taking particular care with IC9, since this device may be damaged by high voltages. With all i.c.s inserted, the Module should draw about 100mA (measured in series with the 1A fuse).

Next, connect the Module to Compukit's expansion socket. This should not cause any significant change in current consumption. If Compukit "locks up" at this point and refuses to Reset, then there is probably a short in the $\emptyset 2$, R/W, data or address lines, or the DD line has been brought permanently low. Check for these possibilities with an ohm-meter (with the Module disconnected from Compukit and from its power supply), or by disconnecting the leads to SK1 one at a time until the fault clears.

When all appears to be well, connect a high impedance voltmeter to pin 16 of SK3. This should read about 4.5 volts. Ensure that IC6 has been reset, and then execute POKE 61340, 255. This sets port A to output, and should cause the voltage on pin 16 to drop to about 0.2 volts. Now execute POKE 61341, 255 (to call up the peripheral register) followed by POKE 61340, 255 (to put 1s in the output register). This should cause the voltage on pin 16 to rise to about 4.5 volts, and should indicate that ICs 1, 2, and 9 are operational. If pin 16 refuses to go high on resetting the 6821, this indicates a fault not associated with the decoding. If it is high, but failed to go low on POKEing 61340, then the fault could either be in the connections to the 6821 or a failure in the decoding.



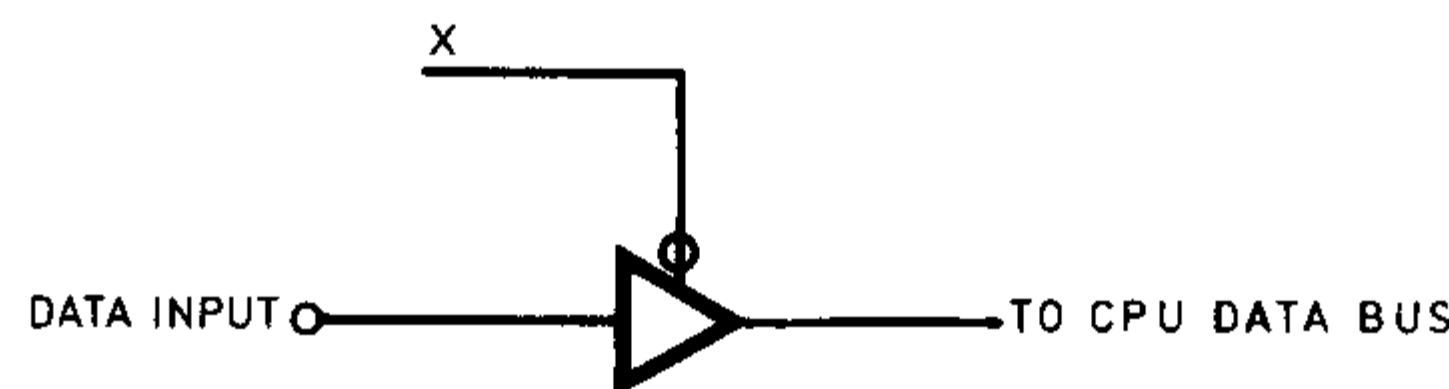
EG493
Fig. 2.5. 7475 Latch for testing the module

To check the decoding you will either need an extremely good oscilloscope, or a bistable latch. Fig. 2.5 shows a 74LS75 latch and inverter wired up for this purpose. The first point to check is the output of IC1. Connect this to the test probe, and POKE any address within the 128 byte block.

used (ie 61312-61439) with a 1 and then with a zero alternately. The voltmeter on the latch output should follow this, so verifying that IC1 is decoding the base address. The sixteen outputs of IC3 may also be tested with the probe. To test for the full operation of the Read circuitry a tristate buffer should be used (see below). Some indication as to the functioning of IC4 may be obtained by using the data latch of Fig. 2.5. This should read a '1' when connected to the outputs of IC4 when PEEK commands are executed at the appropriate address.

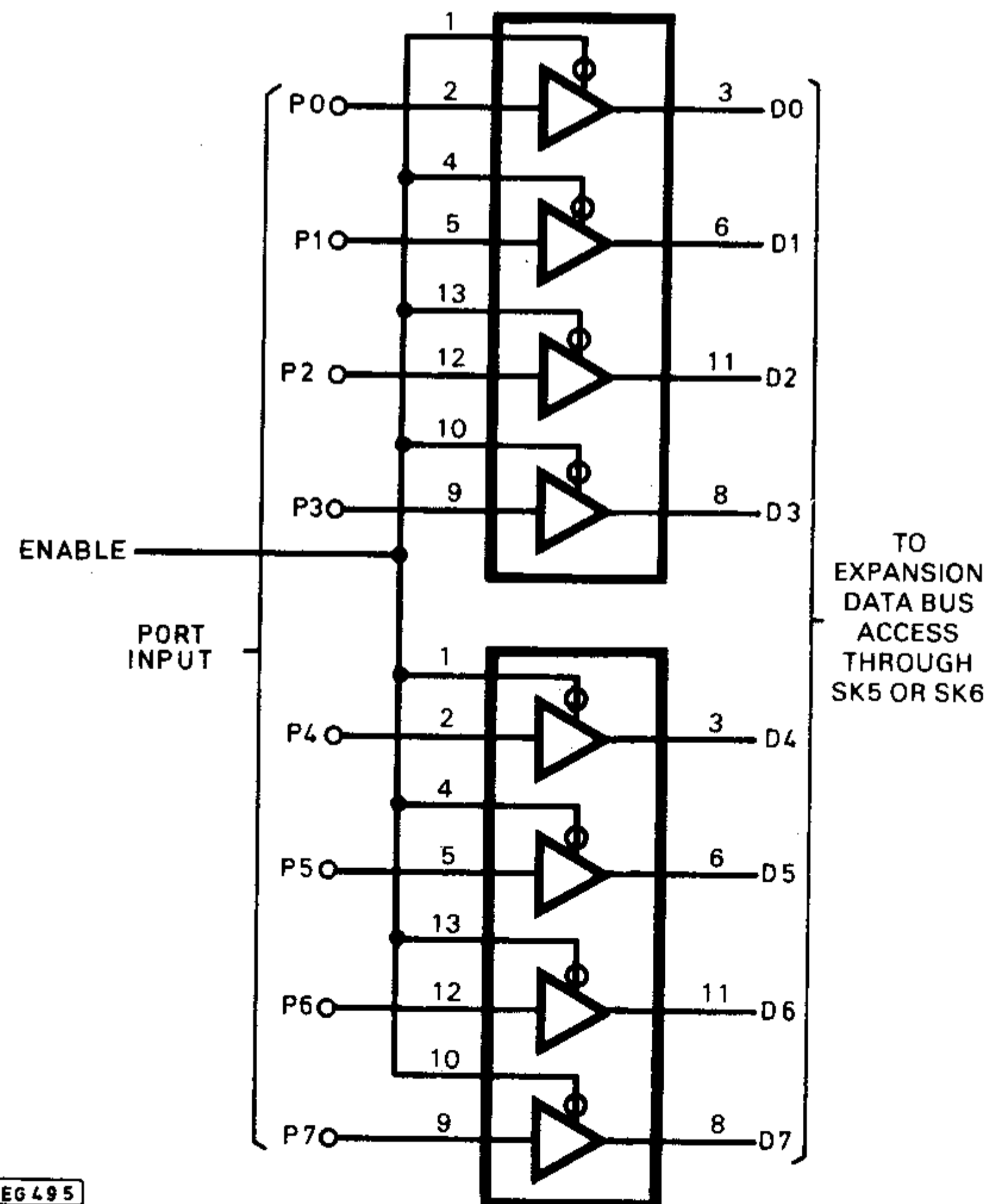
DIGITAL INPUT TO THE COMPUKIT TRISTATE BUFFERS

Digital data may be input to Compukit either directly using the Decoding Module's PIA, or indirectly through the use of tristate buffers. The function of the latter is simply to keep peripheral circuits isolated from the CPU data bus until the exact moment that data is required from it. Fig. 2.6 shows a tristate buffer buffering a single data line. With X high data will pass freely to the CPU, but when it goes low the buffer adopts a high impedance state. Eight such devices would be required to buffer a full 8-bit data bus, in which case the Enable lines X would all be connected to the same address-decoded line from the Decoding Module. A PEEK to the given address would then allow the CPU to read the data at the buffer inputs, and as soon as the Read was complete, the CPU would return the buffers to a high impedance state.



EG494
Fig. 2.6. Tristate buffer on single data line

The chief advantage of using this method over the PIA are its lower cost, and the fact that it does not require initialisation before use. This must of course be balanced against the extra complexity of wiring involved. There are also a number of more complex buffers on the market (eg the 74241) which are easier from the wiring point of view, but this is offset by their greater cost per bit.



EG495
Fig. 2.7. 74LS125 8 bit port

In the event that more input ports are required than the Decoding Module PIA provides, Fig. 2.7 gives the circuit of a pair of 74LS125s wired as an 8-bit input port that may be used directly with the Module. The Enable, being active-low, is directly compatible with the Decoding Module's non-inverted Read lines.

SWITCHES AND JOYSTICKS

The 6821 and PIA or a 74125 port can be easily used for the input of information from switches or push-buttons. Fig. 2.8 shows one way in which this may be achieved. The resistor value of 1k used here is appropriate for either port of the PIA or for a 74125 port.

Interfacing a games joystick for digital operation is also easily accomplished (the more complex interfacing of joysticks for analogue control will be dealt with in a later article). The two-axis joystick consists of two linear potentiometers of about 100k mounted at right angles, and can be conveniently interfaced in a similar manner to the switches. Fig. 2.9 gives the circuit for a control box containing 4 push-buttons and a joystick. The 1k resistors may be mounted inside the box, and a single 10-strand ribbon lead used to connect this to the Decoding Module.

A truth table for the four least significant bits of this circuit is shown in Table 2.3. As may be seen, there are nine possible configurations, including the four diagonal directions. The great advantage which the use of switches and joysticks confers over the polled keyboard for games and other uses is that it is possible to activate any number of switches etc. simultaneously without blocking the input. In the case of the joystick alone this simply means that "diagonal" instructions can automatically be accepted as well as "vertical" or "horizontal" ones. But it also implies that any combination of the four push-buttons may be simultaneously acted upon.

It is also a simple matter to extract the relevant information from the binary data at the port. The easiest way to do this is to use the extremely useful AND operator in CompuKit's BASIC. If this operator is used on decimal numbers rather than on expressions, it converts those numbers to binary, and behaves like a set of eight 2-input AND gates. Thus the instruction PRINT 13 AND 25 will give the result 9.

Converting 13 and 25 to binary and ANDing them we can see why.

```

13  00001101
25  00011001
-----
9   00001001

```

The only bits which are 1 in both numbers are the first and the fourth, which gives the binary representation of 9. This function makes decoding of the joysticks and other digital data an extremely easy matter.

To test whether the joystick is in the "up" position one can simply PEEK the corresponding port and AND the result with the binary number 00000010. Clearly, the result will only be non-zero if the second bit of the joystick data is also non-zero; ie if it is in the "up" position. Similar operations can be performed for the other three bits, and since each operates completely independently of the others, the diagonal positions will automatically be catered for. Thus the following four program lines could be used to move a cursor in eight different directions across CompuKit's screen. X and Y are the horizontal and vertical screen positions, and A the address of the port.

```

100 IF(PEEK(A) AND 1) >0 THEN Y=Y+1
110 IF(PEEK(A) AND 2) >0 THEN Y=Y-1
120 IF(PEEK(A) AND 4) >0 THEN X=X-1
130 IF(PEEK(A) AND 8) >0 THEN X=X+1

```

In order to demonstrate these principles in action, a simple program is given for screen writing, using the joystick

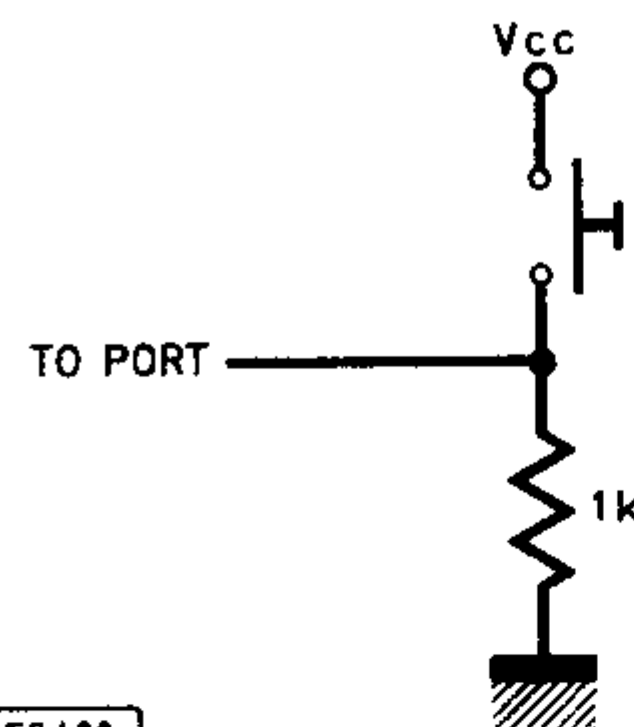


Fig. 2.8. (Left) push button inputs

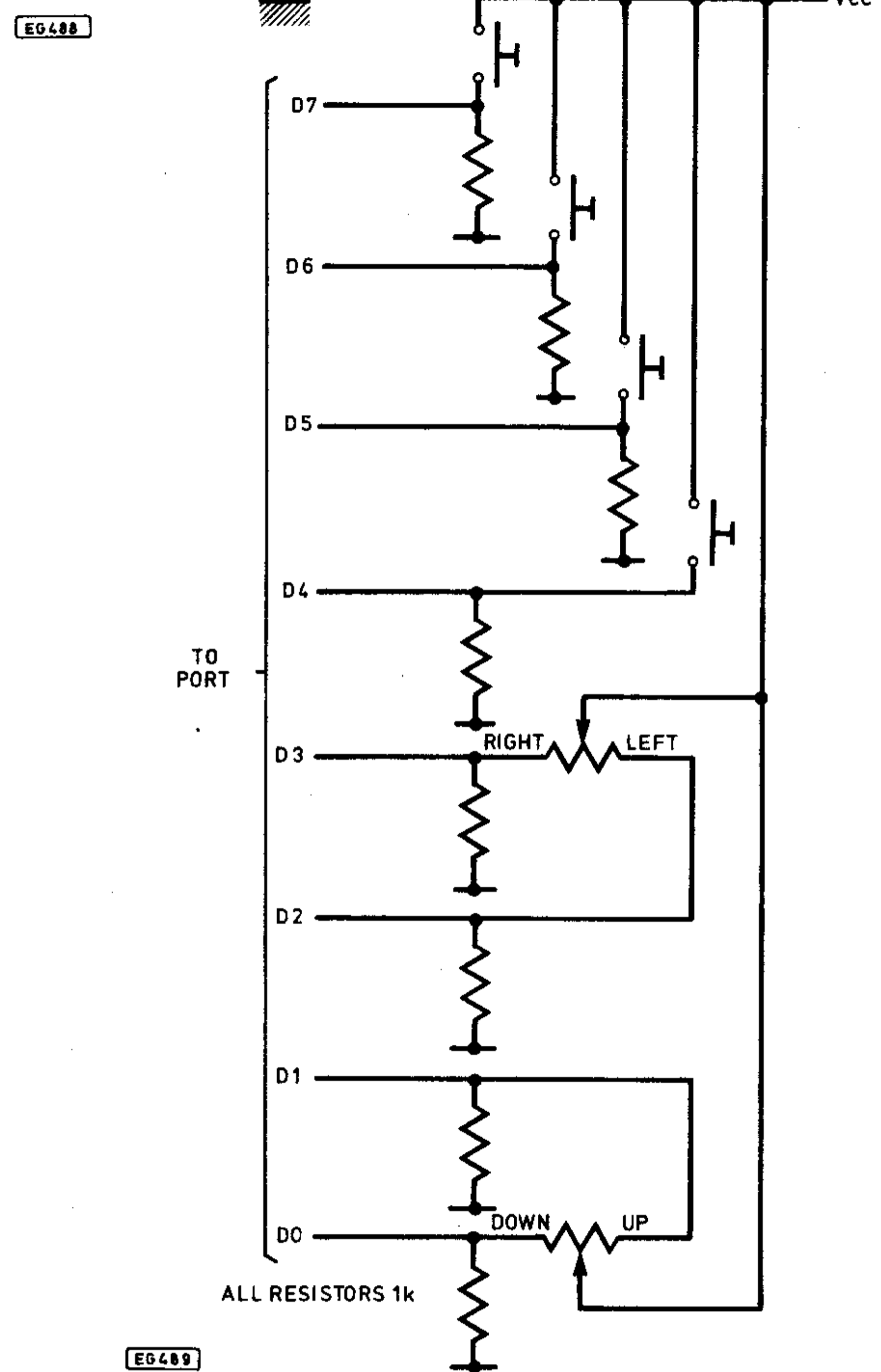


Fig. 2.9. (Below) Joystick control box

Table 2.3. Truth table for Joystick

Position of Joystick	Four Least Significant Bits			
	P3	P2	P1	P0
Centre	0	0	0	0
Down	0	0	0	1
Up	0	0	1	0
Left	0	1	0	0
Right	1	0	0	0
Down and Left	0	1	0	1
Down and Right	1	0	1	0
Up and Left	0	1	1	0
Up and Right	1	0	1	0

and push-button circuit of Fig. 2.9. The joystick is used to move a flashing cursor to any point on the screen, and the four buttons have the following functions: 1 (at bit 4) Draw, 2 Erase, 3 Change character, 4 Clear screen. The program, which is listed in Table 2.4 is extremely short, but allows intricate graphics work to be executed on the screen.

The techniques used here could obviously be implemented in a number of different ways for games purposes, and one could easily add a second joystick to allow for two-person games. In next month's issue, when we will be discussing digital output techniques, we will give circuitry and

software for adding a 7-segment l.e.d. display to indicate the position of the cursor in the above program. This is a useful complement and enables the program to be used to set up graphics work for transferral of both BASIC and 6502 code programs.

OK	300 POKEVP,C1
LIST	310 GOTO170
80 REM P.E. INTERFACING UK101 PROG 2	OK
90 REM JOYSTICK DRAWING ROUTINE	LOAD
95 REM (WITHOUT LED DISPLAY)	
100 FORI=0TO15:PRINT:NEXT	OK
110 V=53260	LIST
120 X=23:Y=8	30 REM P.E. INTERFACING UK101 PROG 3
125 VP=V+X+64*Y	40 REM UK101 LOGIC TESTER
130 P=61340	50 REM NOTE - RETURN KEY GIVES SCREEN
140 C=161	55 REM RECORD OF LOGIC STATES
150 POKEP+1,0:POKEP,0	60 V=54125
160 POKEP+1,255	70 P=61340
170 Q=PEEK(P)	80 POKEP+1,0:POKEP,0
180 IF(QAND64)=0THEN200	90 POKEP+1,255
184 C=C+1:IFC=191THENC=128	100 FORI=0TO15:PRINT:NEXT
186 POKEVP,C	110 PRINTTAB(13);"UK101 LOGIC TESTER"
188 FORI=0TO300:NEXT	115 PRINT:PRINT
200 IF(QAND1)>0ANDY<15THENY=Y+1	120 PRINTTAB(11);"D7 D6 D5 D4 D3 D2 D1 D0"
210 IF(QAND2)>0ANDY>0THENY=Y-1	130 PRINT:PRINT
220 IF(QAND4)>0ANDX>0THENX=X-1	200 POKE530,0
230 IF(QAND8)>0ANDX<47THENX=X+1	210 FORI=0TO7
240 IF(QAND128)>0THEN100	220 Q=PEEK(P)
250 VP=V+X+64*Y	230 POKEV-3*I,((QAND(2*I))/(2*I))+48.1
260 C1=PEEK(VP)	250 NEXT
265 POKEVP,35	270 POKE530,1
267 FORI=0TO100:NEXT	280 POKE57088,223
270 POKEVP,C	290 IFPEEK(57088)=247THEN120
280 IF(QAND16)>0THEN170	300 GOTO200
290 IF(QAND32)>0THENPOKEVP,32:GOTO170	OK
	LOAD

Table 2.4. Left
Table 2.5. Above

LOGIC TESTER

It is a very simple matter to use one or more of the ports developed with the Decoding Module for the purpose of testing logic state in digital circuitry. This simply involves connecting test clips to the eight lines of a particular port, and using these in conjunction with the appropriate software. Table 2.5 gives the listing of a program which displays the logic states of the eight lines of port A of the PIA. If 74125s are to be used in place of the PIA, then line 70 should be changed so as to set P to the appropriate address, and line 80 and 90 deleted. Line 230 uses the AND operator to determine the value of a given input line, and it performs this once for each of the eight data lines, using the FOR loop at program line 210. The 48.1 at the end of line 230 should really be 48.0. Its function is to convert a zero or 1 into the ASCII code for those characters, and the number 48 will normally achieve this; but since Compukit thinks that $2 \uparrow 16$ is 65536.2 (rather than 65536.0), 48.1 must be used so as to convert correctly.

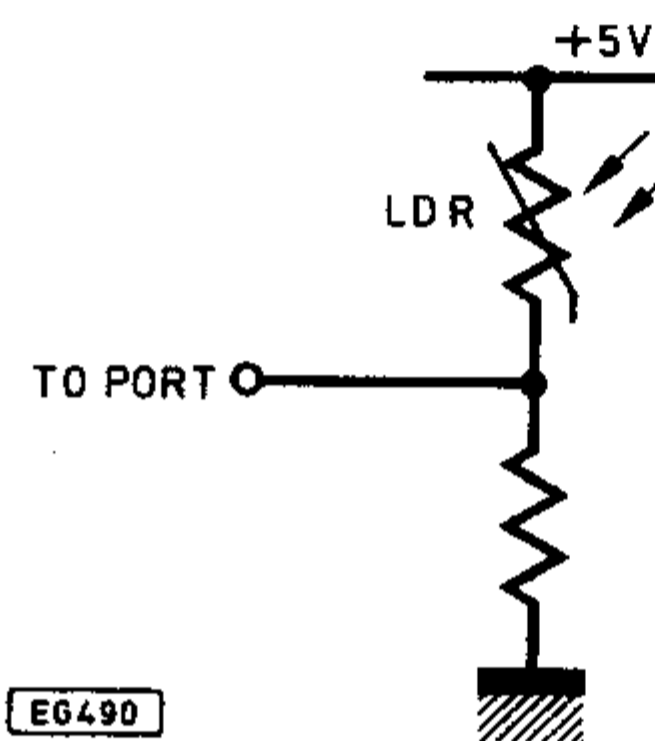
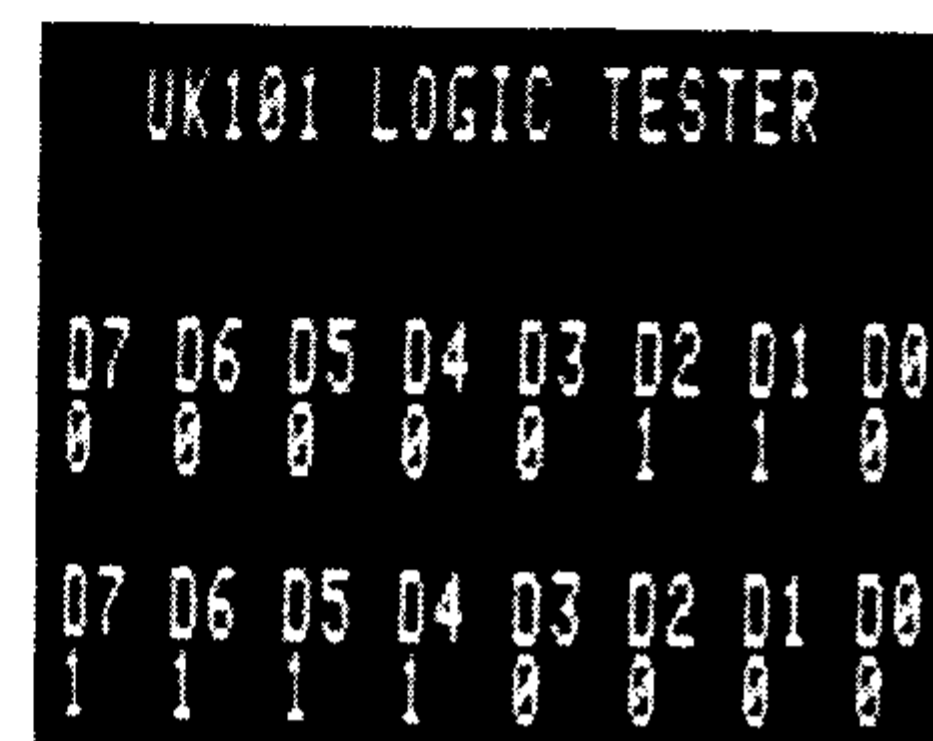
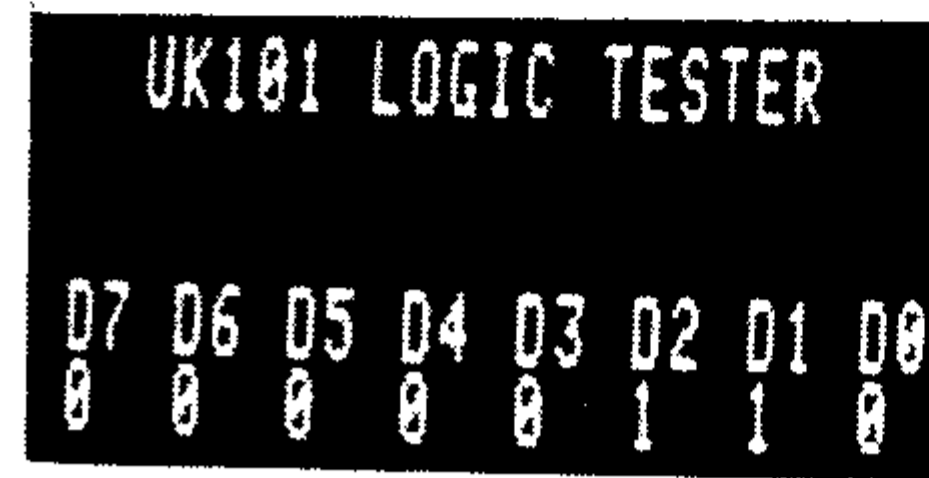
The photographs show Compukit's screen during the running of the program. Pressing Return at any time causes the current logic states to be printed as a record higher up the screen as may be seen. Note that since the program is written in BASIC, the response time is relatively slow.

OTHER INPUTS

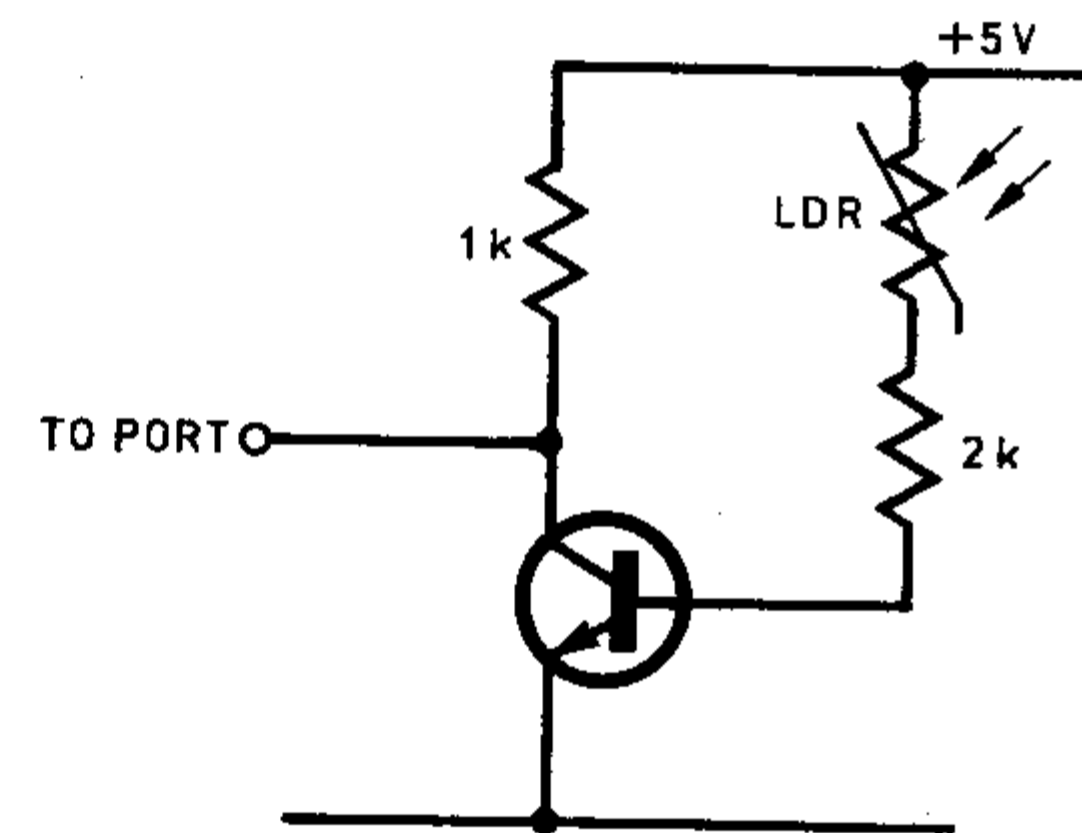
There is of course no limit to the variety of devices that can be interfaced using the 6821 PIA or a 74125 port. In fact any device capable of producing a transition between about 0.5 and 3.5 volts (less for port A of the PIA) can be directly connected to them. We shall briefly look at the implementation of light and sound detectors, although here, as in many other cases, far greater information can be derived from such sources using analogue to digital conversion techniques, to be treated later in the series.

Light dependent resistors such as the ORP 12 are amongst the easiest light detectors to interface because their parameters change over many decades for relatively small changes in illumination. It is even possible to wire these directly to the port using a 1k resistor to ground as shown in Fig. 2.10. If it is required to detect lower levels of light than this circuit permits, a simple transistor amplifier may be used as in Fig. 2.11. With the high gain 2N2926G transistor this is capable of detecting very low levels of light.

If desired, a potentiometer could be inserted in the base circuitry of the transistor so as to provide some degree of level control. The circuit of Fig. 2.11 differs from that of Fig. 2.10 in that it takes the port low when light is present. This effect can easily be reversed in software by subtracting the data read at the port from 255. This will cause each of the eight inputs of the port to be effectively active-low rather than active-high.

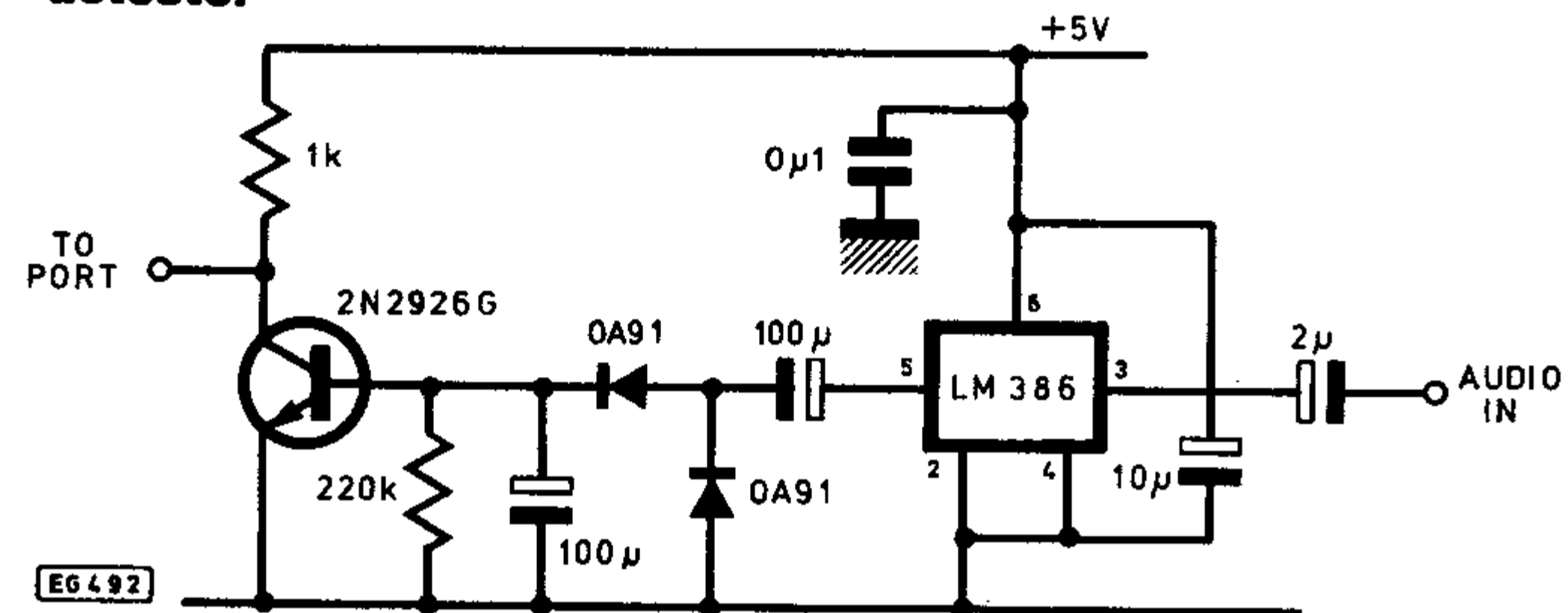


EG490

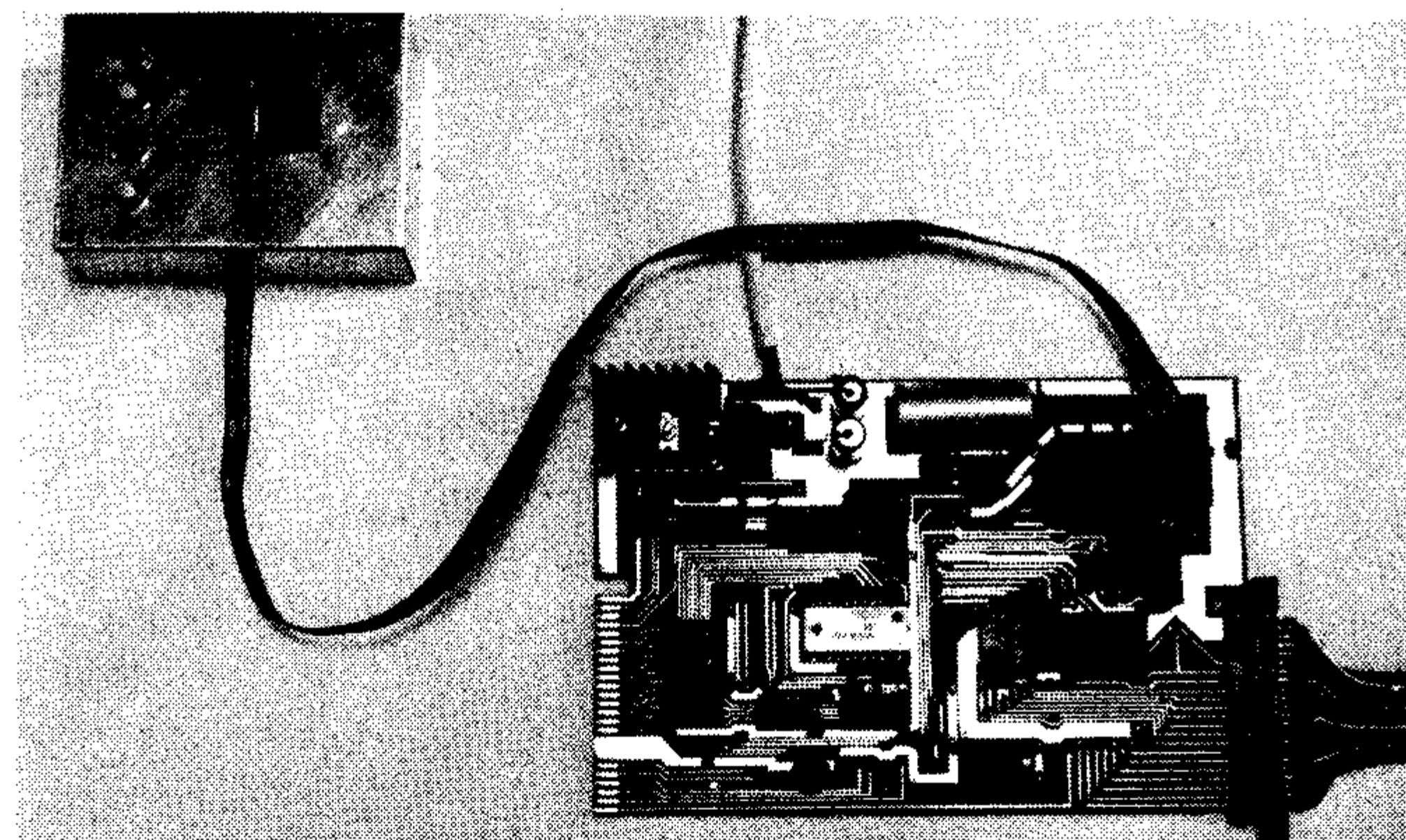


EG491

Fig. 2.10. (Above) LDR directly connected
Fig. 2.11. (Right) High Sensitivity light detector



EG492



Sound detection is again easily accomplished. Fig. 2.12 gives the circuit of a simple audio detector using an LM386 audio amplifier, which will run happily at 5 volts. The amplifier is sufficiently sensitive for the circuit to operate with a high output dynamic microphone, but if greater sensitivity is required, a preamplifier should be used. In setting up this and other digital interfaces it will be found that the Logic Tester program of Table 2.5 can be used to provide a convenient way of monitoring the state of the port in use.

Next month we will look at the use of the PIA and data latches to output digital data from the Compukit, and will discuss various applications including an IC tester for devices of the 7400 series.



SPACEWATCH

FRANK W. HYDE

THE SATELLITES OF SATURN

In the continuing saga of Saturn something old is proved and something new is seen. There are activities which confirm the Lagrange points which have so far been known only in connection with the Trojan asteroids. Comte Joseph Louis Lagrange studied the problem, often known as the Three Body Problem, because of the difficulty of separating or analysing the perturbations when a third body is introduced into a stable two body system. Lagrange held that it was possible to have a stable system with three bodies if they were at the angles of an equilateral triangle. This would appear to be the case of the moons of Saturn.

The last issue of *Spacewatch* referred to the peculiar spoke like features that were seen from the distance of the first encounter. Also it was noted that although the speed of the inner and outer edges of the rings was different these features endured over a long period. At first it was thought that they were opaque and preventing light passing through. Yet another surprise was in store for these areas were not black apparently but clear when seen from the underside after the spacecraft had dipped down below them. This has raised many questions, for on the first thinking there are things happening which cannot readily be reconciled with our present system of physics.

As the spacecraft approached the planet at a speed of more than 9.57 miles a second, greater detail and more "structure" appeared. Hundreds of "ringlets" filled the spaces between the major rings. It had been thought that the satellites would cause divisions in the rings, but there are not enough satellites to cause so many divisions as have appeared. There are quite serious problems with the theories currently held about these features alone. It appears from the pictures returned, that the old theories about the rings may in some part be substantiated since there is evidence that they are made up the debris round the planet, dust, ice, etc. The close-up

views were expected to show up the atmosphere of the satellite Titan, the largest in the Solar System, and possibly enable a glimpse of its surface. However this was not possible though it may be that later analysis and processing of the pictures will afford more detail.

It perhaps, is well to note that Saturn is twice as far away from the Sun as Jupiter. At this distance Saturn receives only a quarter of the light and energy from the Sun that Jupiter does. In fact Saturn radiates about 15 per cent more heat than it receives. This is some support for the theory that perhaps Saturn has a core about 20 times the mass of the Earth but about the same size, and made of rock. The atmosphere is banded like that of Jupiter but not so bright. It would seem however that the constituents of the atmosphere are similar. That is, that there are jet streams of ammonia and other compounds spinning round at different speeds according to latitude. The rotation period of the planet has been established at 10 hours 30 minutes. By reason of the fact that there are colder temperatures involved the clouds form at lower levels and the whole is overlaid by a haze. They are therefore not so bright as on Jupiter.

The itinerary of the new exciting period in the history of mankind, still continuing at the moment of writing has been so far:

November 6. Voyager photographs Saturn and its rings then the satellites Titan, Rhea, Dione, Mimas and Iapetus.

November 7. Pictures of Saturn and the rings were used to locate other possible satellites in addition to the 14 moons verified so far. Moon Rhea is photographed to see why it is bright on one side and dark on the other.

November 8. Photographs of the moon Tethys, Enceladus, Rhea and Dione in addition to more pictures of Saturn.

November 9. The Infrared scanner checked the "heat" level across the disc.

November 10. Studies of Titan's atmosphere and seeking for a glimpse of the surface. More than 400 pictures transmitted to Earth.

November 11. The close approach to Titan. The spacecraft measures Saturn's magnetic field and searches for high energy particles.

November 12. The spacecraft flew within 77,000 miles of the planet's cloud tops, past the South pole and then behind Saturn and then up through the ring plane. At this point the vehicle was travelling at about 19.25 miles per second. The closest approach to Saturn coincided with the close approach to Tethys (260,000 miles), Mimas (67,000 miles), Enceladus (126,000), Dione (100,600 miles), and Rhea (44,739).

November 13. Photographs from over Saturn's North pole. Observation of Aurora and lightning from dark side of the planet.

November 14. Closest approach to Iapetus (1,250,000 miles).

November 15-18. Further search for satellites.

Now some more details. Observation of the satellites as the approach was made, white blobs dark streaks and blotches were seen on them. The photochemical smog layer of Methane Acetylene and Ethylene on Titan made it look like a cotton ball of orange colour. No opening in the smog gave any view of the surface. However some dark areas

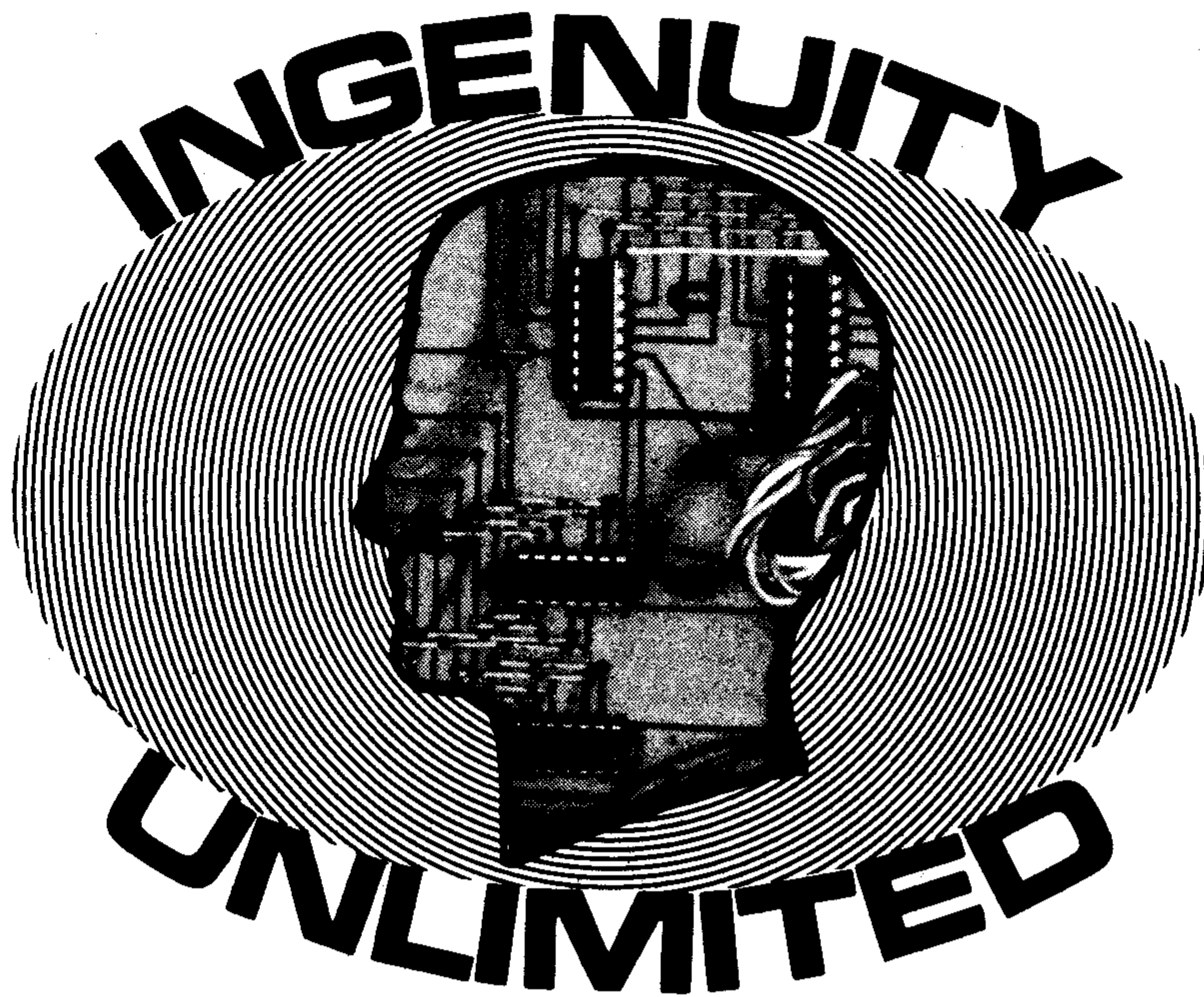
could be seen at the poles of the satellite and there appeared to be a difference between the northern and southern hemispheres. The southern hemisphere seemed brighter than that of the northern hemispheres.

Rhea has a white spot which shines in the way that a sheet of ice might do in the sunlight. Iapetus even with sunshine over the whole disc looks like an apple, all white except for a great black piece which looks rather as though a bite had been taken from it. A puzzle here is why does Iapetus have a surface that reflects light like the Earth's Moon on one part while another part reflects little or no light at all. Dark and light splotches can be seen on Dione.

The three new moons found by Voyager 2, designated by numbers are giving clues as to why the rings of the planet are separated. The most recently discovered moon, number 15, which was found on November 8, is about 100km across. It circles Saturn just outside the A ring. The other two moons discovered by the spacecraft cameras, numbers 13 and 14, are on either side of the narrow F ring. According to Bradford A. Smith and Edward Stone these moons could be regarded as "sheep dogs!" That is to say that they appear to keep order among the rings, involving a complicated change of energy. Studies from Earth have shown that dust and ice form the particles of which the rings are made. These appear to move out of the plane of the rings due to the fact that the orbits vary as they move from the inside to the outside of a ring. For example, if a particle is regarded as a "dusty snowball" and moves out of the A ring into the slower orbit of moon number 15 outside the A ring, the "snowball" is slowed down by the moon and falls back into the lower orbit. The two other moons, numbers 13 and 14, on either side of the F ring do the same thing. Similarly the mechanism that operates with two other moons appears to work as follows: The moons S-10 and S-11 whose orbits are only 50 kilometres apart could be expected at least to make a disastrous approach to each other, but they do not. The two moons move in the same direction but the one nearer the parent body moves faster than the other one 50 kilometres further out. As the moons come together the inner one will be pulled into a higher orbit and will slow down, the slower moving moon will fall to a lower orbit and speed up, thus the two moons do not collide but transfer from one orbit in exchange. Surely this must be unique in discoveries of science.

From Earth there are three broad rings visible in the telescopes. These are the innermost C-ring then the B-ring, the A-ring with a narrow F-ring. There is an additional ring which cannot even be seen on the Voyager pictures.

The broad rings are found to consist of more than 100 smaller rings. These are the puzzles. What keeps the rings apart? Why are the outer tenuous rings intertwined like a rope? The Casini division which looks black is not filled with dark matter, but with a number of thin rings. Photographs taken of the rings in ultra-violet light seem to indicate that the material is different for each ring, or, perhaps the material is the same but reactions we do not understand are taking place, maybe due to the effects of the high level magnetic field.



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.

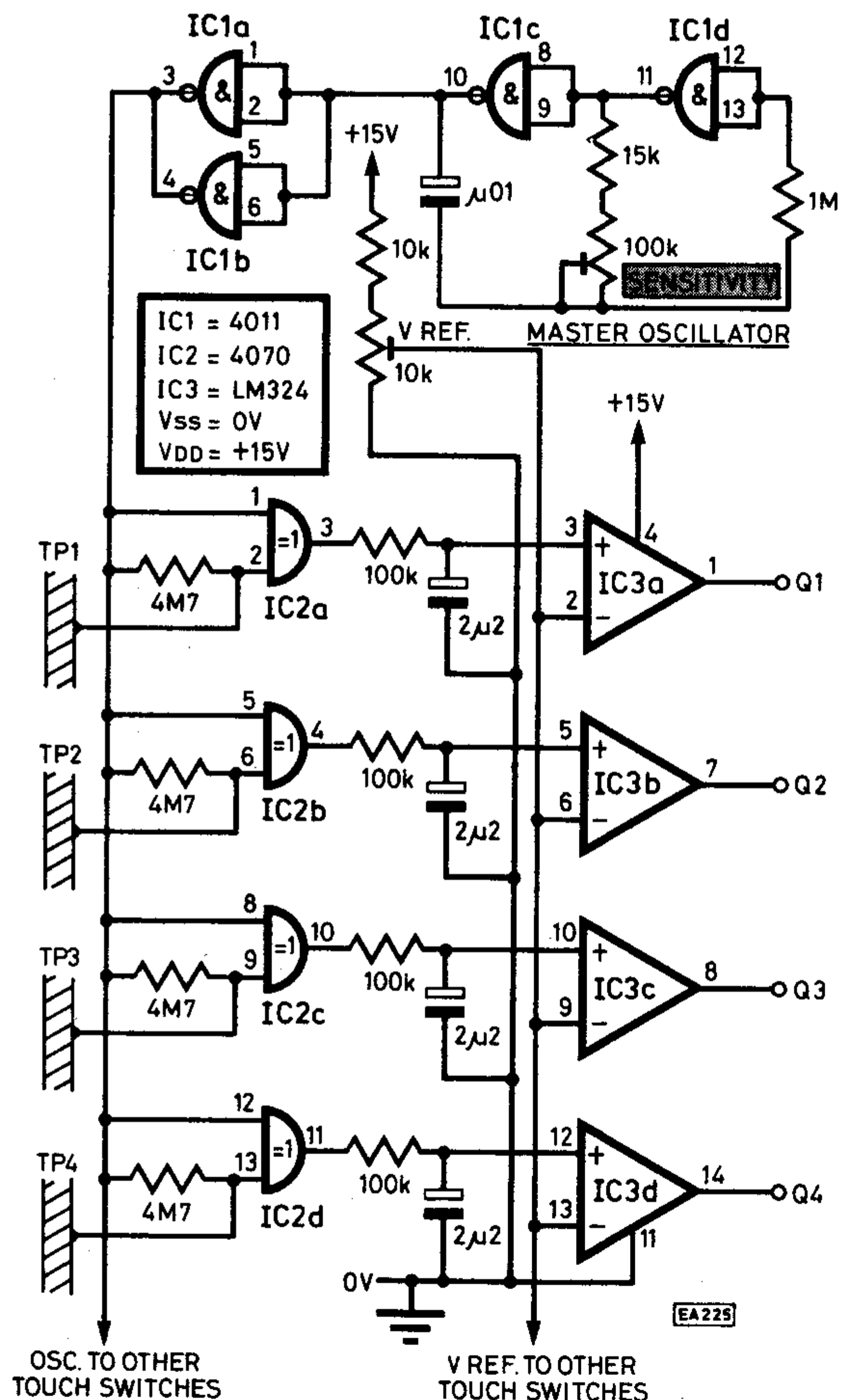
Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

CAPACITIVE TOUCH SWITCH

MOST common touch switches are of the skin resistance type where a finger is used to bridge an electrical contact. Switches of this type are very difficult to make mechanically to give a professional appearance . . . drawing pins are a common resort, and home constructed contacts can look poor as well as being prone to surface oxidation. By sensing the capacitance to ground between a finger and a concealed touch plate, one can get rid of both these problems.

A circuit of such a switch for driving CMOS is shown. IC1 is used to provide a buffered oscillator circuit which drives a phase comparator circuit made up from IC2 an EX-OR device. The sensor plates TP1 to TP4 are connected to the oscillator output via a high value resistor. The phase between the touch plate signal and the oscillator output is measured by the EX-OR gates. As a finger is brought near to the plate the capacitance loading the plate to ground through the finger causes a phase lag of the plate signal. After passing through a low-pass filter this is seen as an increase in phase comparator output which is then detected by quad comparator IC3, causing the relevant Q output to go high.

The touch plates consist of one inch square copper pads on a $\frac{1}{8}$ in printed circuit board. The blank side of this is painted and switch touch positions labelled with Letraset. Construction is critical and leads from the sensor plates must be kept below 1 in to minimise stray capacitance. This is done by mounting boards containing 4070, LM324 devices on the back of the switch panel perpendicular to it. Veroboard is not recommended.



The circuit is set up by monitoring the voltage at one of the IC2 outputs. The sensitivity control is adjusted to give a mean level of about 1 volt at this pin. On bringing a finger up against the switching area a rise in the appropriate output should be noticed. The voltage reference should be

set so that the comparator just triggers at this level. The zero voltage supply line should preferably be connected to the mains earth line.

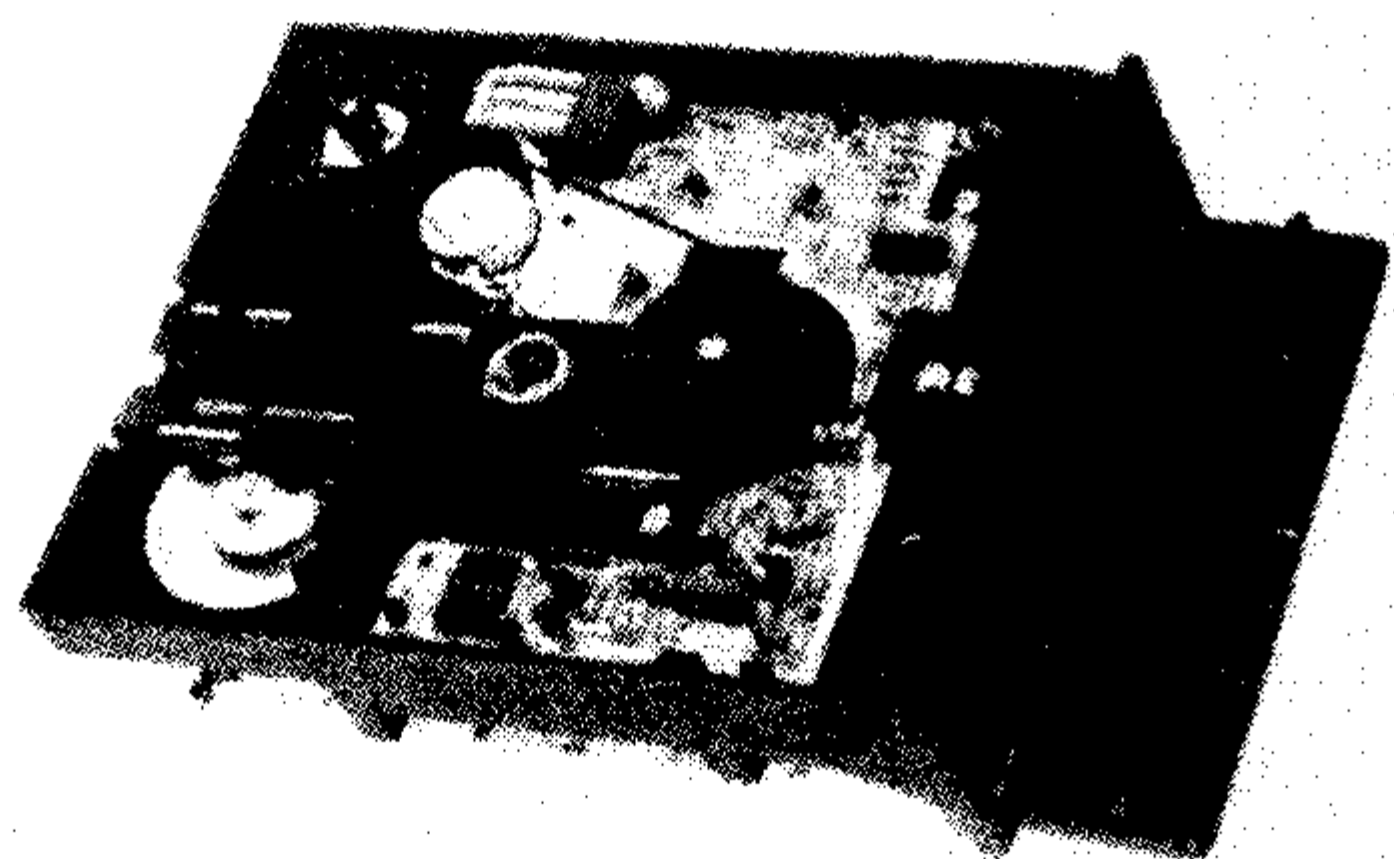
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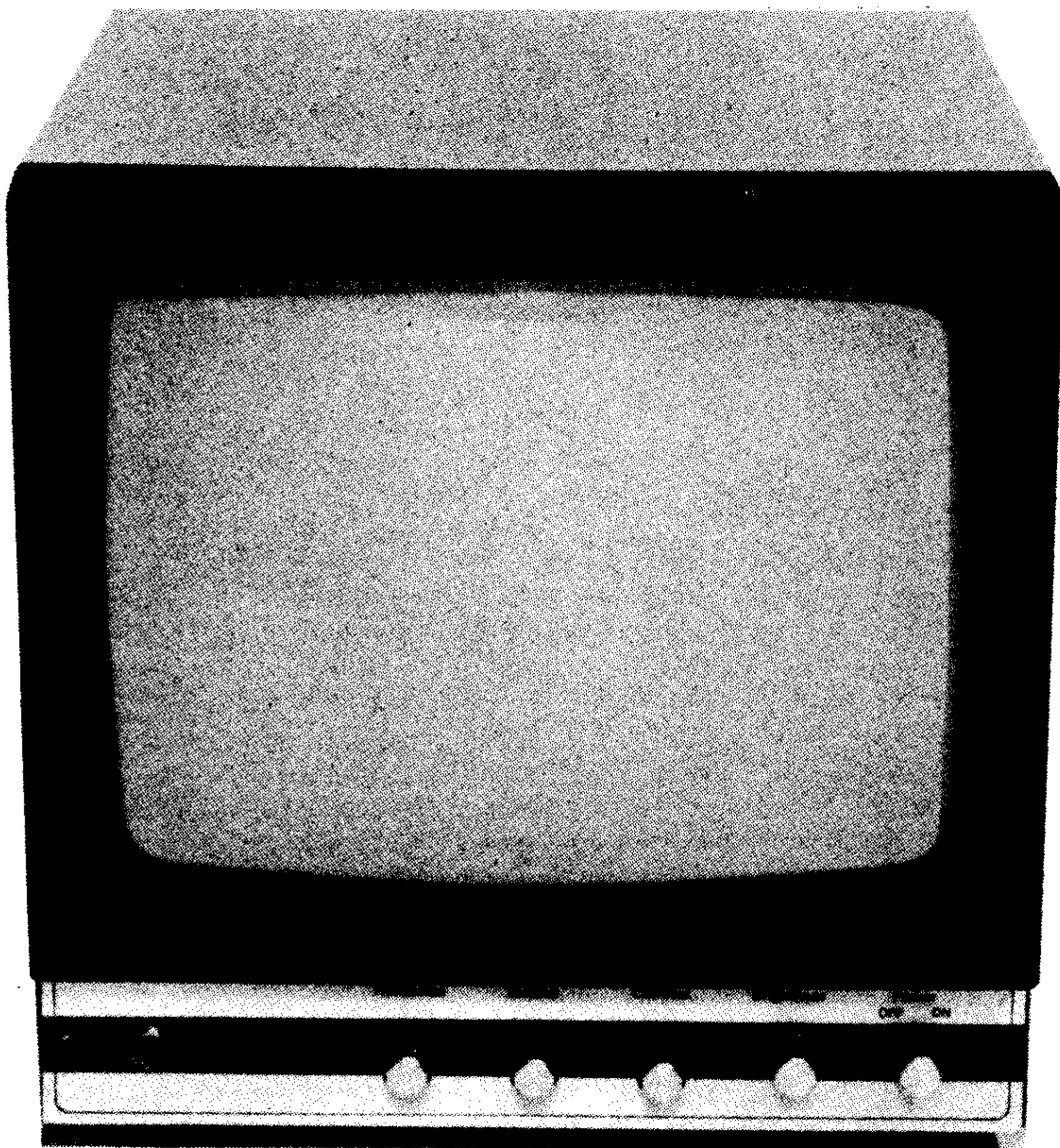


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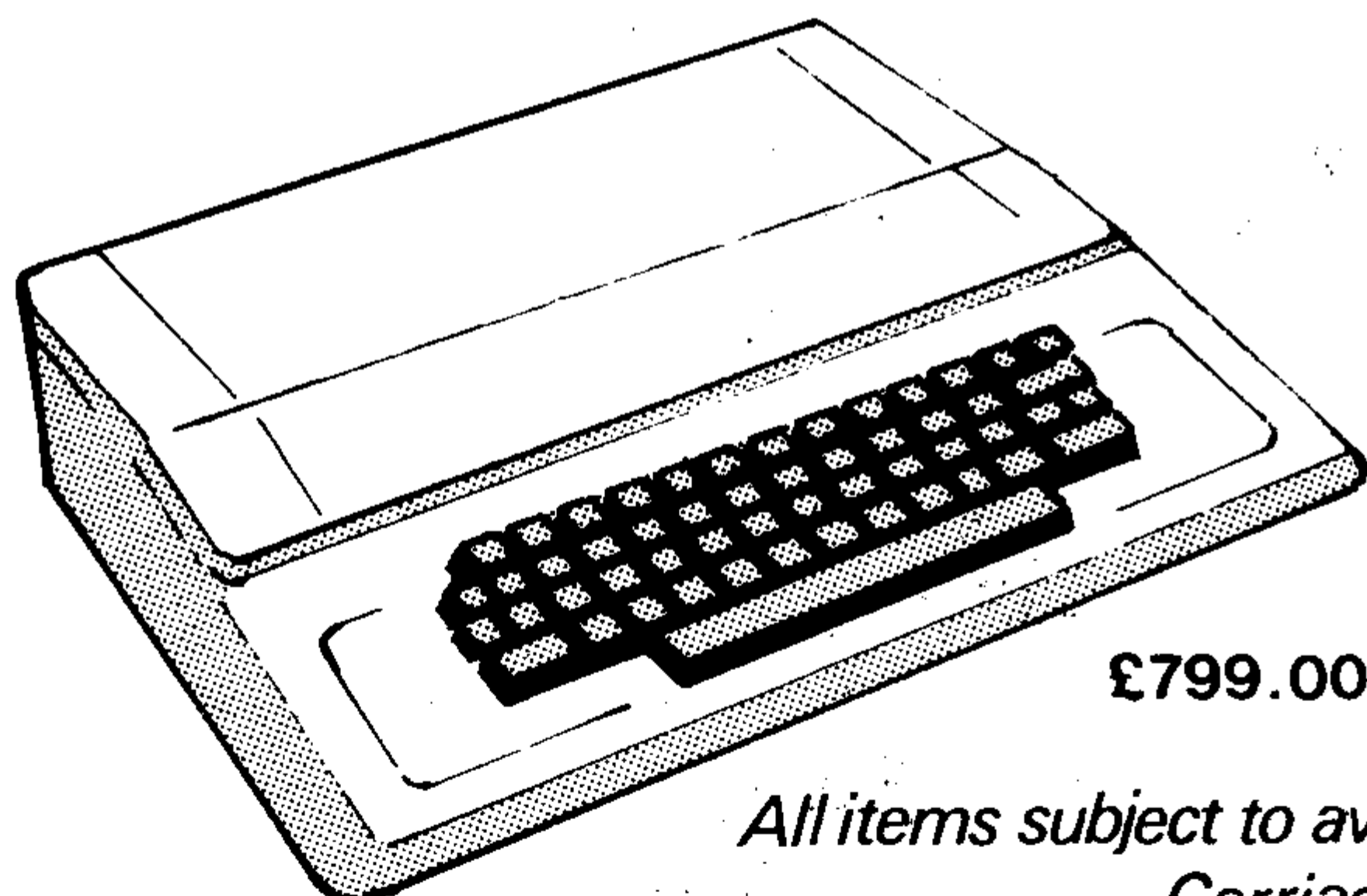
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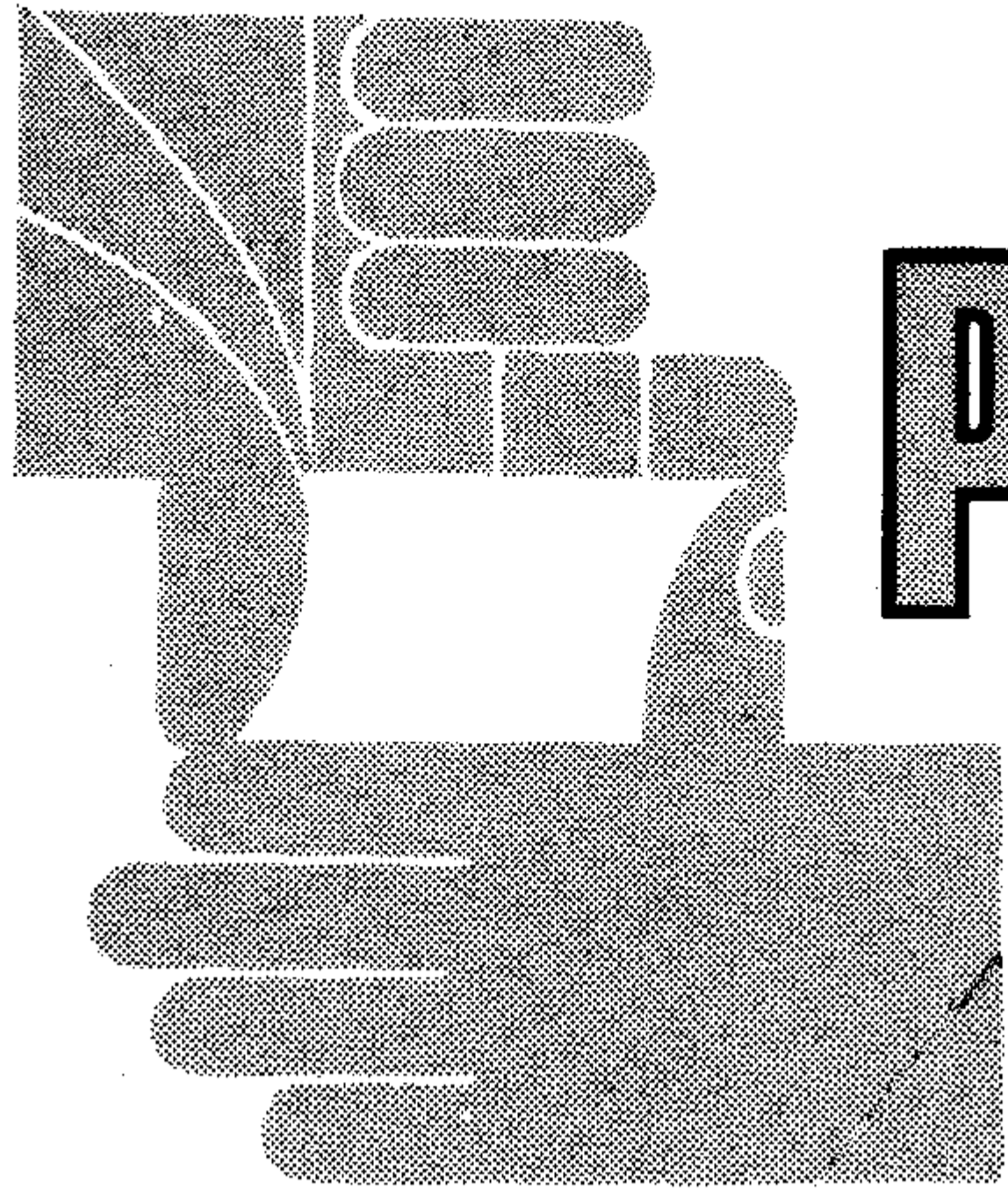
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PATENTS REVIEW...

HEALTH MONITORS

Two patent applications published recently in the UK describe devices intended to safeguard the health of the wearer, for instance anyone undertaking strenuous exercise.

British patent application 2 032 764 dates from October 1978 and was filed by Carlos Biset of Argentina. This patent merits only brief mention because the idea is speculative—i.e. the inventor has come up with more of a problem than a solution.

The aim is to provide a device like a wrist watch which automatically reveals data on a wearer who collapses. The idea is to use a miniature tape player which will reproduce sound from a tape when triggered into operation by an impact switch. Fig. 1 shows the switch. Arm 18 is spring biased into latching slot 25, but when jolted (for instance when the wearer takes a fall) the arm jumps temporarily out of the notch and is forced against slide switch 8 to close contacts 26, 27. This completes the circuit for the mini-tape announcer. Although potentially valuable (the device could save a life if it announced blood group, name, address and phone number at a crucial moment) the patent is silent on the real design problems e.g. how to provide a tape player of sufficiently small size to be incorporated in a bracelet. Hobbyists may like to address themselves to this problem. As a challenge

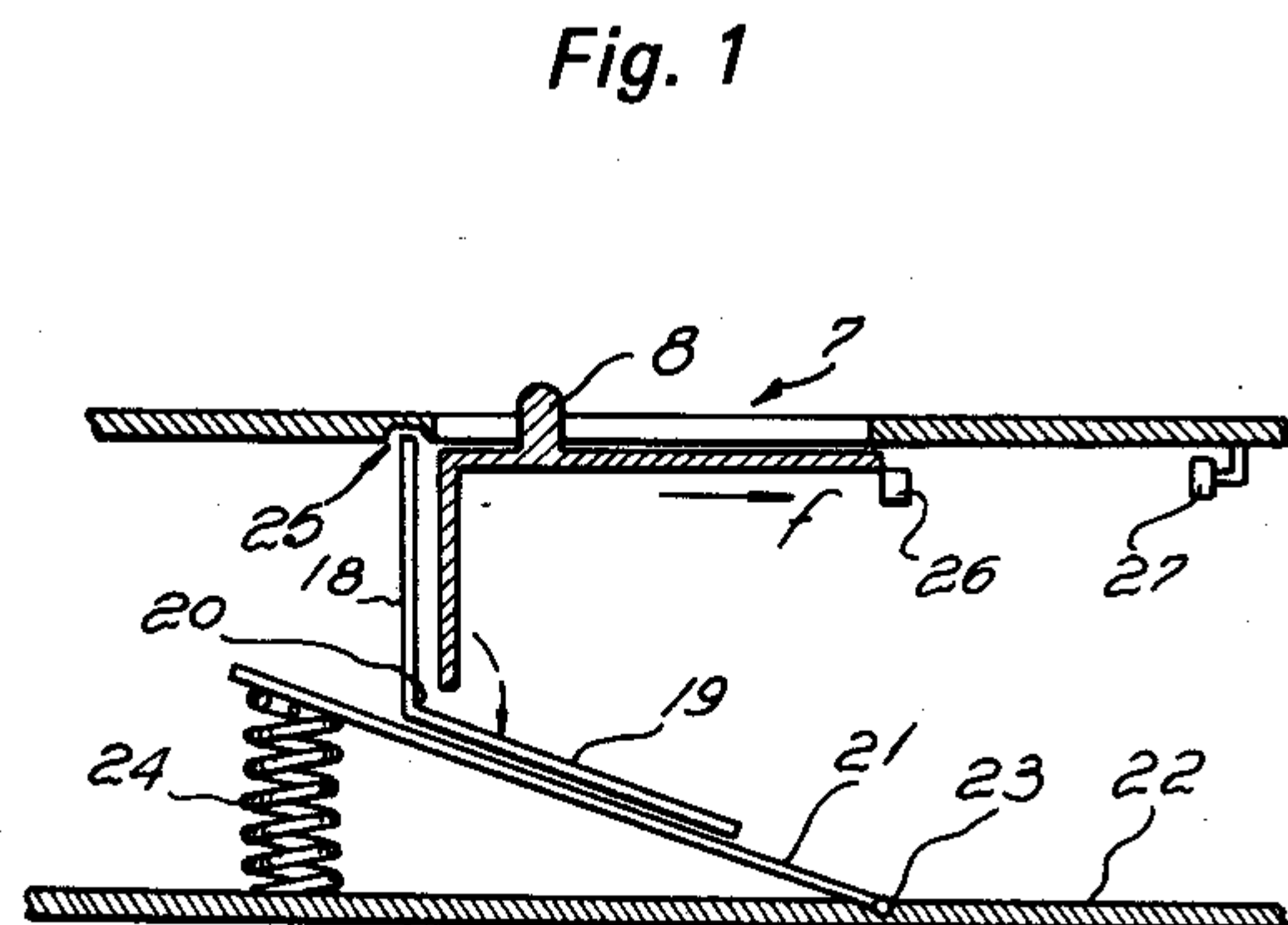


Fig. 1

it is worth noting that at the recent Photokina exhibition in Cologne, Sony of Japan demonstrated a video camera no larger or heavier than a Super 8 sound film camera, which incorporates a mini-cassette recorder capable of recording not only sound but colour video as well. The Sony recorder module is in fact nothing more than a very cleverly scaled down version of a current Sony Betamax recorder.

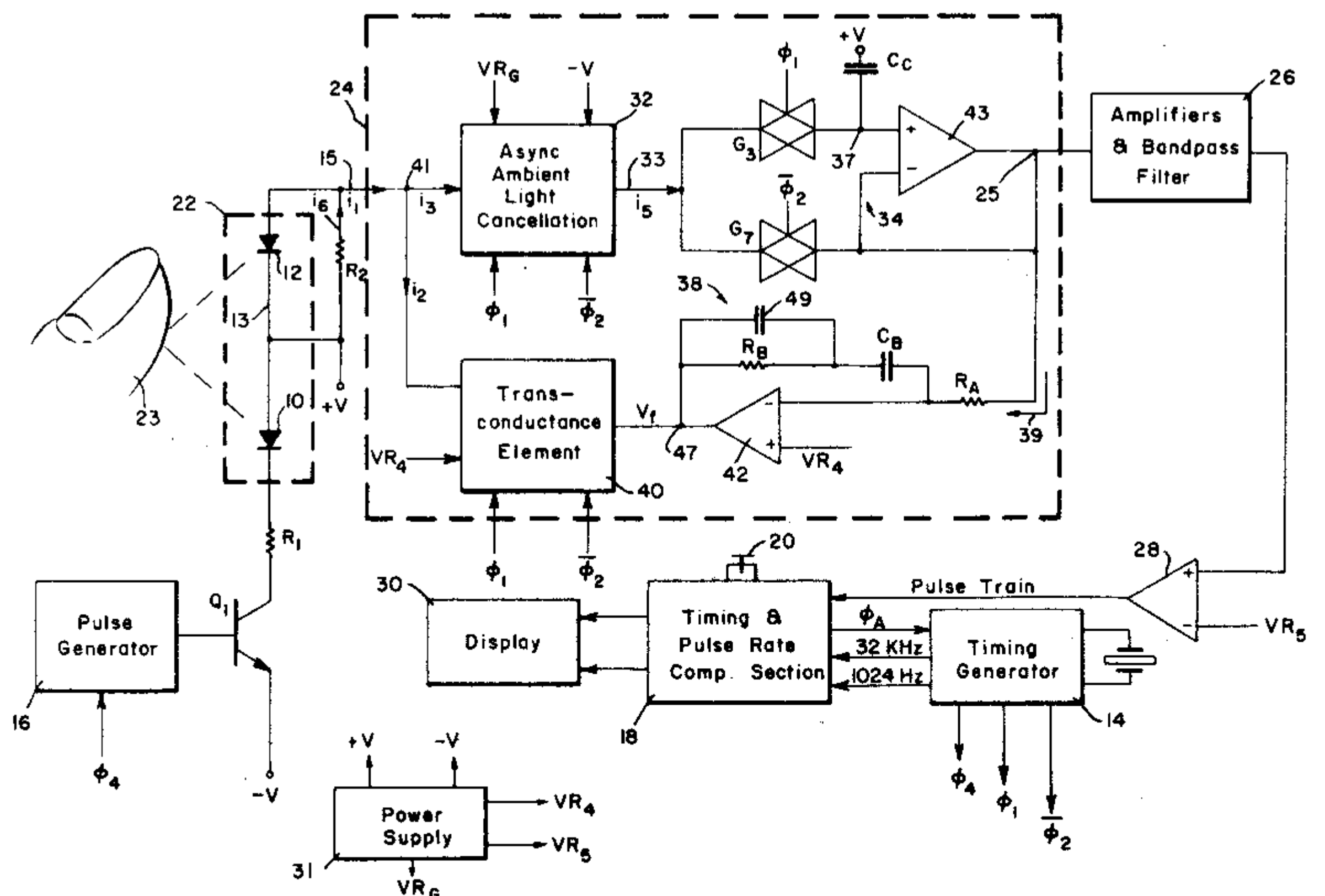
British patent application 2 039 364 dates from December 1978 and comes from the Hughes Aircraft Company of California, the aerospace giant started by the late Howard Hughes.

For some time it has been known that the human pulse rate can be read optically, by sensing light pulses reflected from a finger. The tiny blood vessels or capillaries change in size as the heart beats, and this varies their reflectance (the blood capillaries dilate when the systolic pressure wave arrives and the reflectance drops). Attempts at obtaining a direct pulse readout have so far been bedevilled by the confusing effect of ambient light, especially when it is pulsed at mains frequency. Feedback bias control has been used to distinguish between ambient and system light, but the circuits take 20 or 30 seconds to stabilise

and draws more power than a bracelet can provide from batteries.

Hughes describes circuitry which is claimed to stabilise in 2 or 3 seconds, and can be worn like a watch calculator by athletes. In Fig. 2 an i.e.d. 10 produces infra-red light and detector 12 picks up reflections from the finger surface. The i.e.d. is driven with constant current pulses at a fixed rate which is chosen to distinguish clearly from local mains frequency and its harmonics—e.g. 73Hz for US standard 60Hz mains. Generator 16 provides a 31 microsecond pulse of 2mA to the base of drive transistor Q1 every 13.67 microseconds, to give the necessary 73Hz rate. The output of photodiode sensor 12 is routed to conditioning section 24 where ambient light and any steady state component of the diode signal are removed by cancellation. The heart pressure wave, represented as the envelope of the remaining signal, is bandpass filtered at 26 and fed to discriminator 28 which triggers on signals which exceed a threshold VR5. The pulsed output is timed at 18 and the heart rate displayed at 30. The lengthy patent contains full details of the techniques used to cancel spurious signals created by ambient noise or finger movement.

Fig. 2





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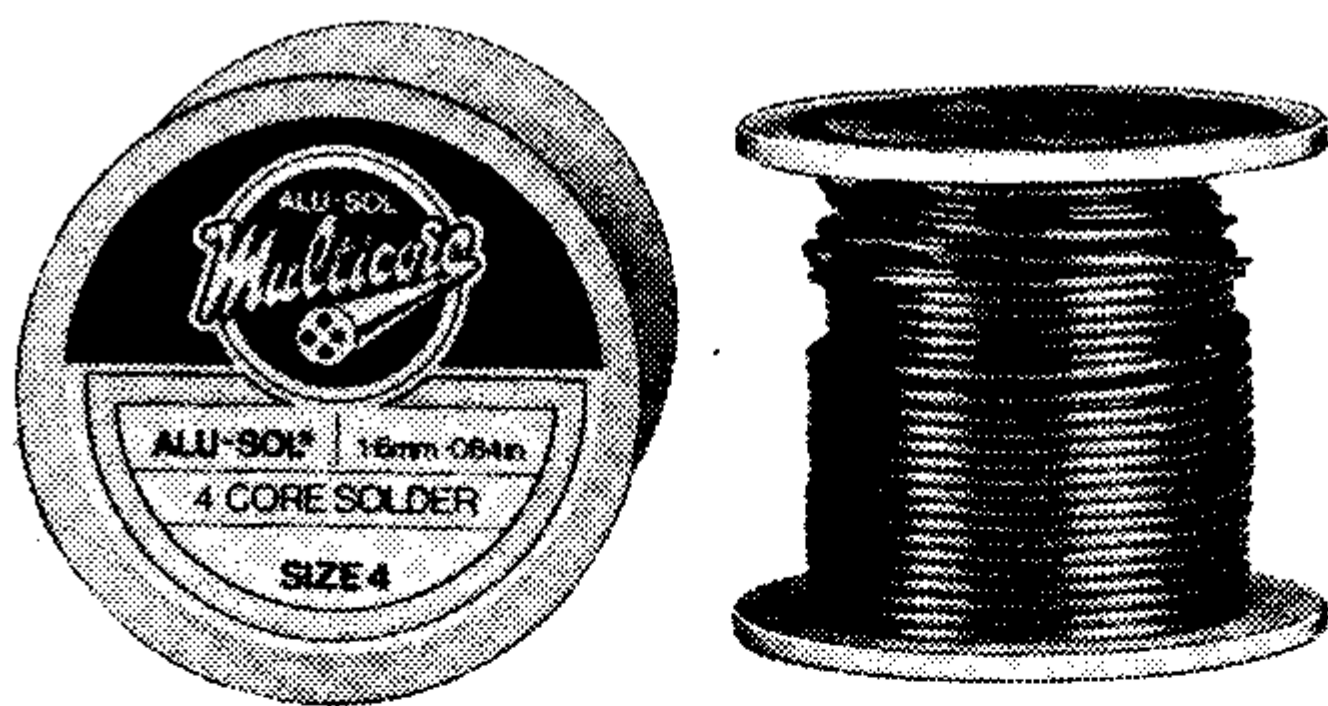


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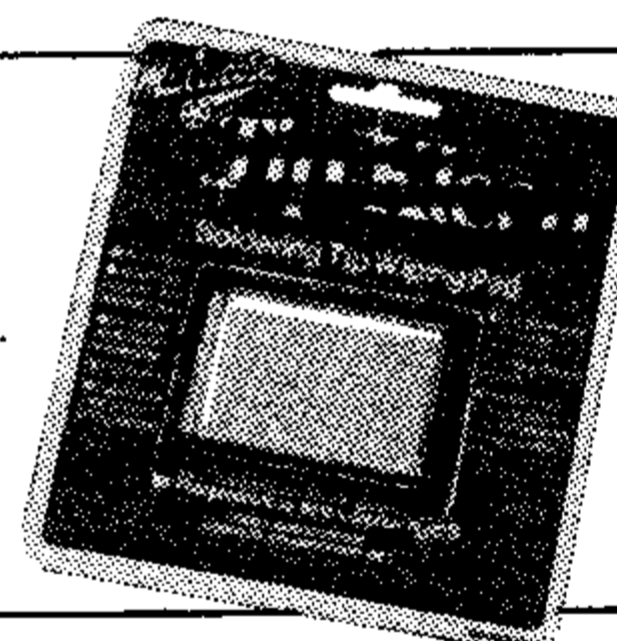
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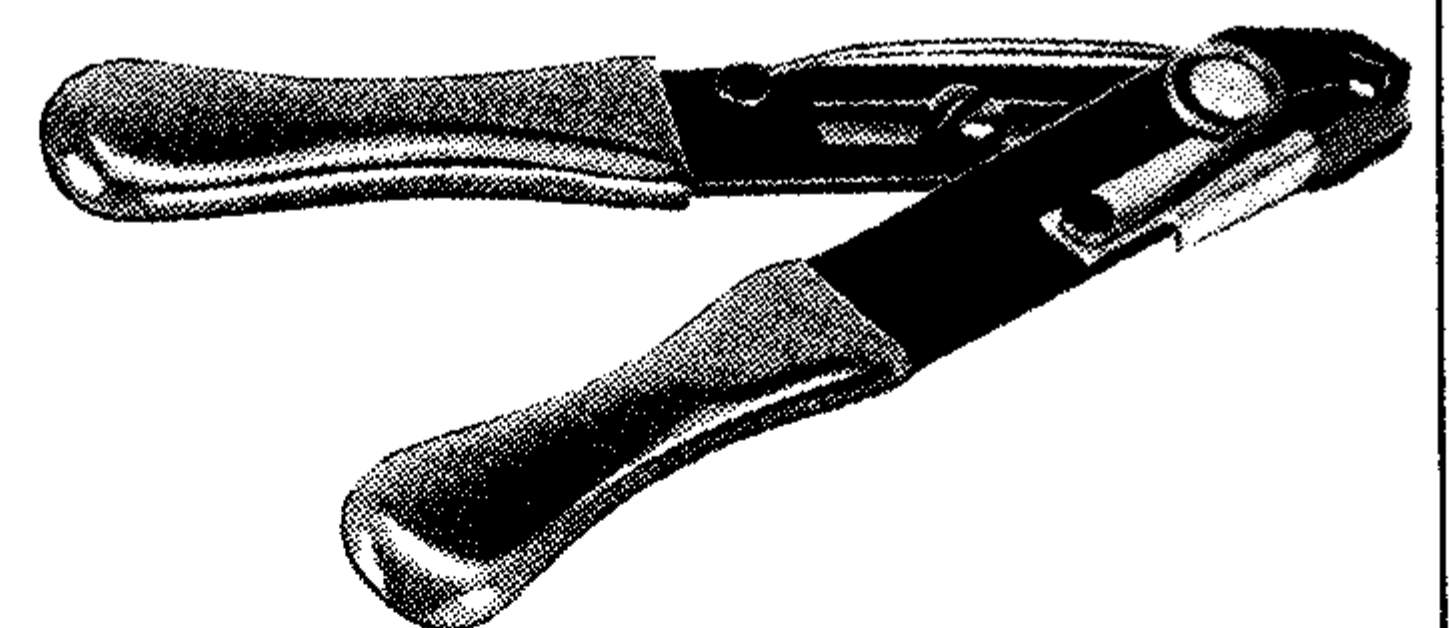
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Bib Hi-Fi Accessories Ltd., (Solder Division), Kelsey House, Wood Lane End, Hemel Hempstead, Hertfordshire HP2 4RQ. Telephone: (0442) 61291.

All recommended retail prices shown are inclusive of VAT. If you have difficulty in obtaining any of these products send direct with 40p for postage and packing. For free colour brochure send S.A.E.

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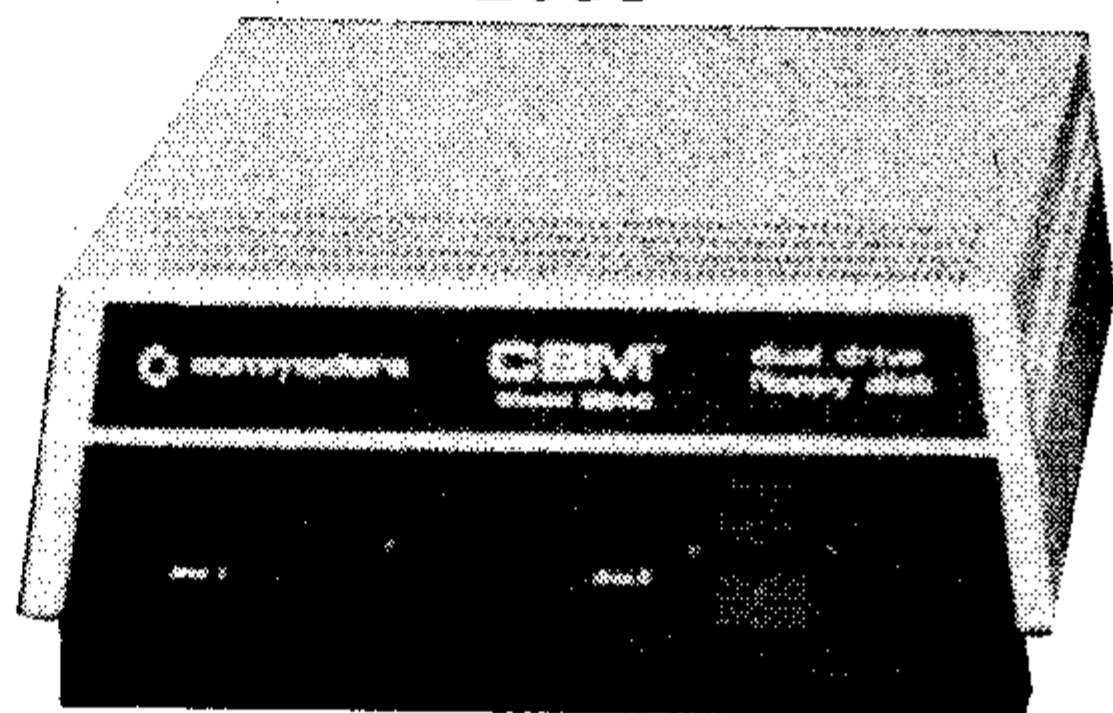
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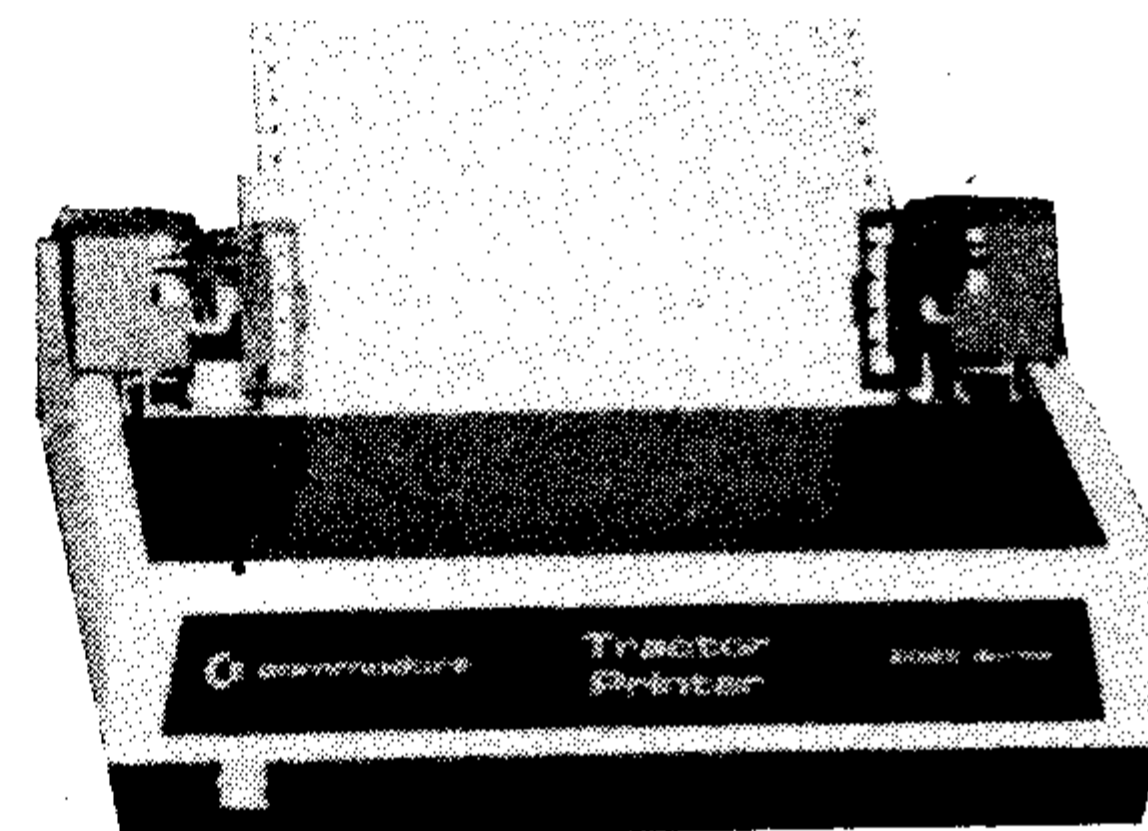
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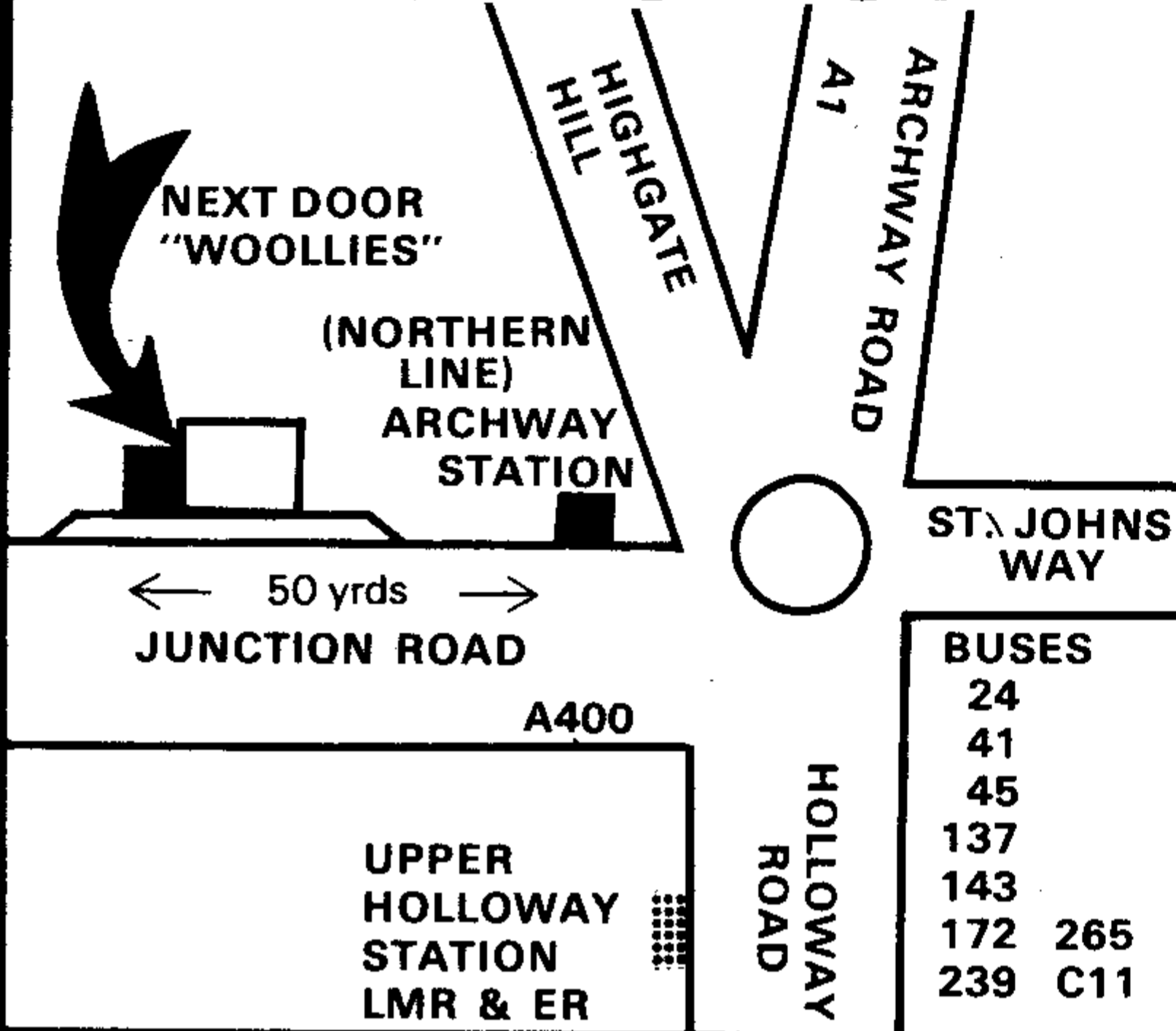


MEMORY EXPANSION KIT

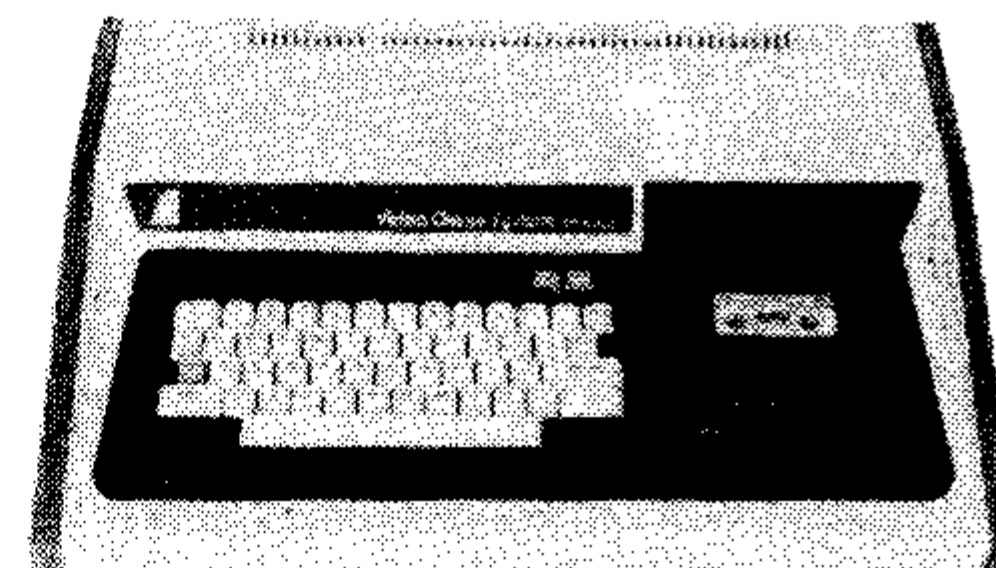
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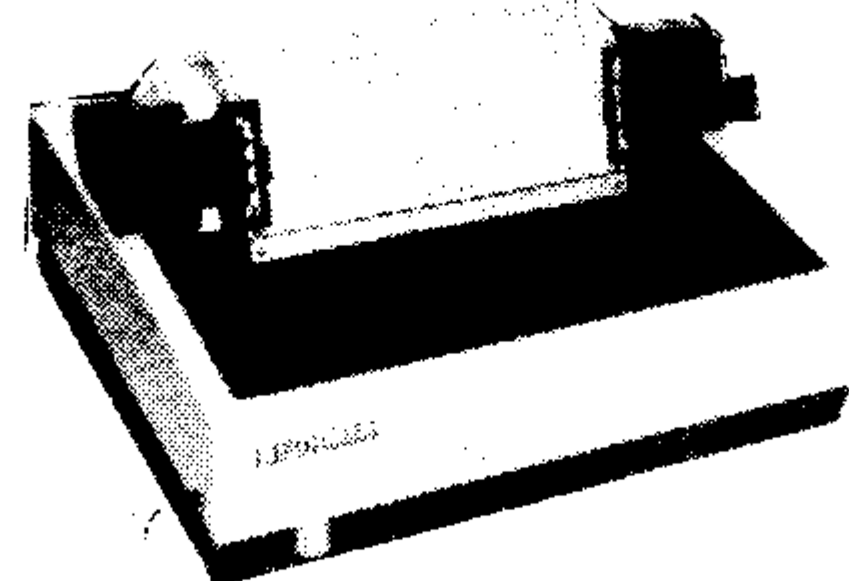
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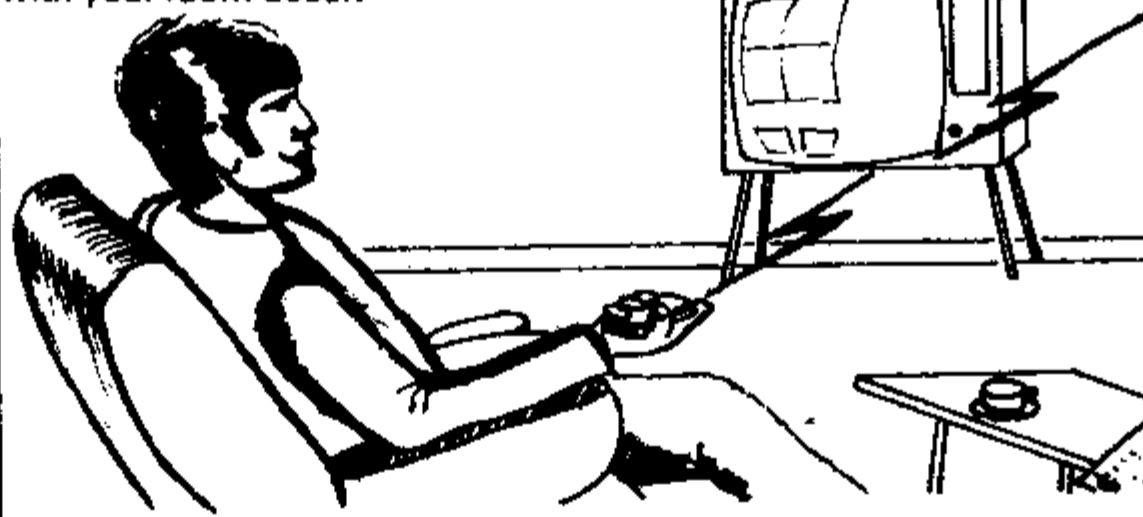
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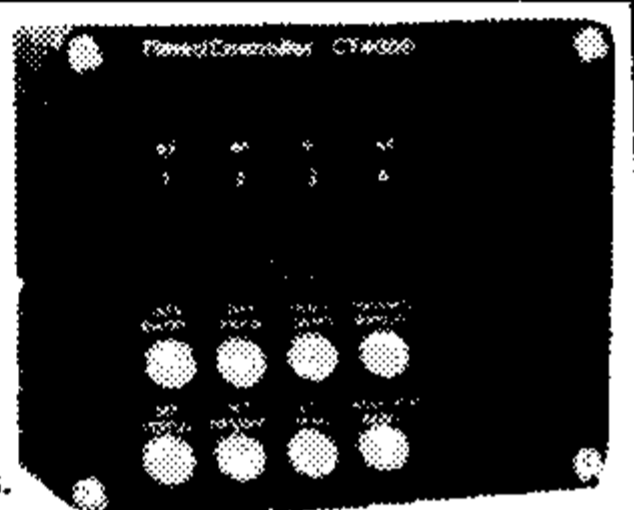
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Colour: Black.

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Understand Digital Electronics

In the years ahead digital electronics will play an increasing part in your life. Calculators and digital watches mushroomed in the 1970's - soon we will have digital car instrumentation, cash cards, TV messages from friends and electronic mail.

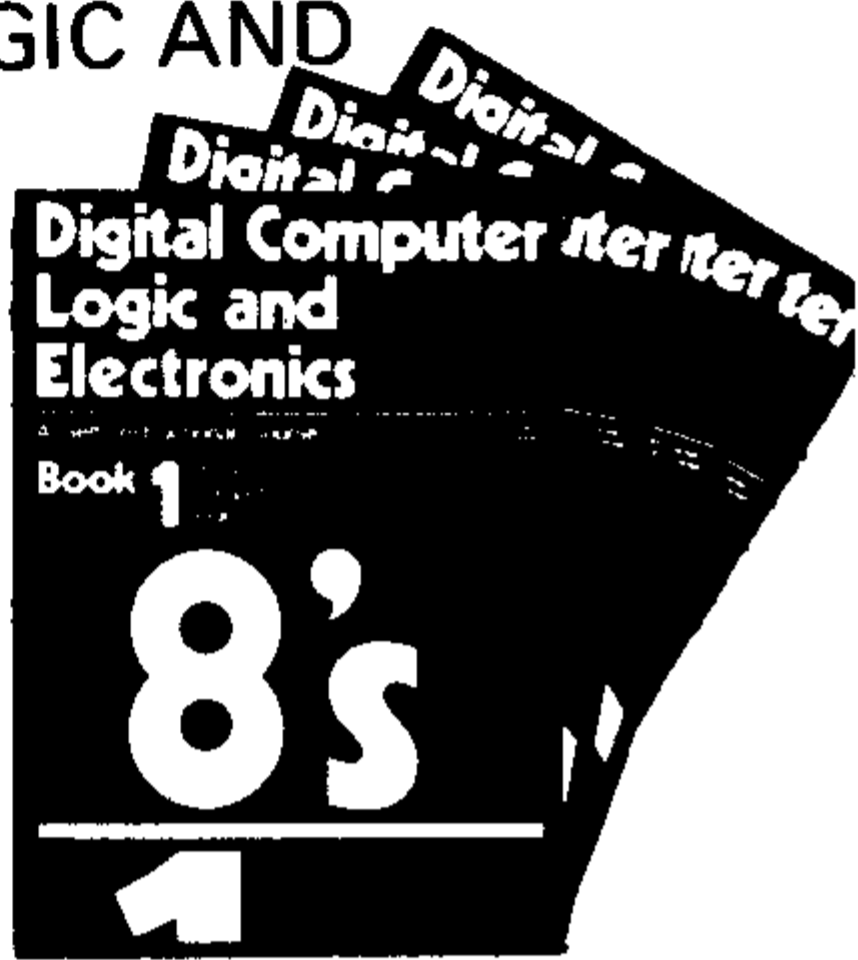
After completing these books you will have broadened your career prospects and increased your knowledge of the fast-changing world around you.

DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.50

This course is designed as an introduction to digital electronics and is written at a pace that suits the raw beginner. No mathematical knowledge is assumed other than the use of simple arithmetic and decimals and no electronic knowledge is expected at all. The course moves painstakingly through all the basic concepts of digital electronics in a simple and concise fashion: questions and answers on every page make sure that the points are understood.

Everyone can learn from it - students, engineers, hobbyists, housewives, scientists. Its four A4 volumes consist of:

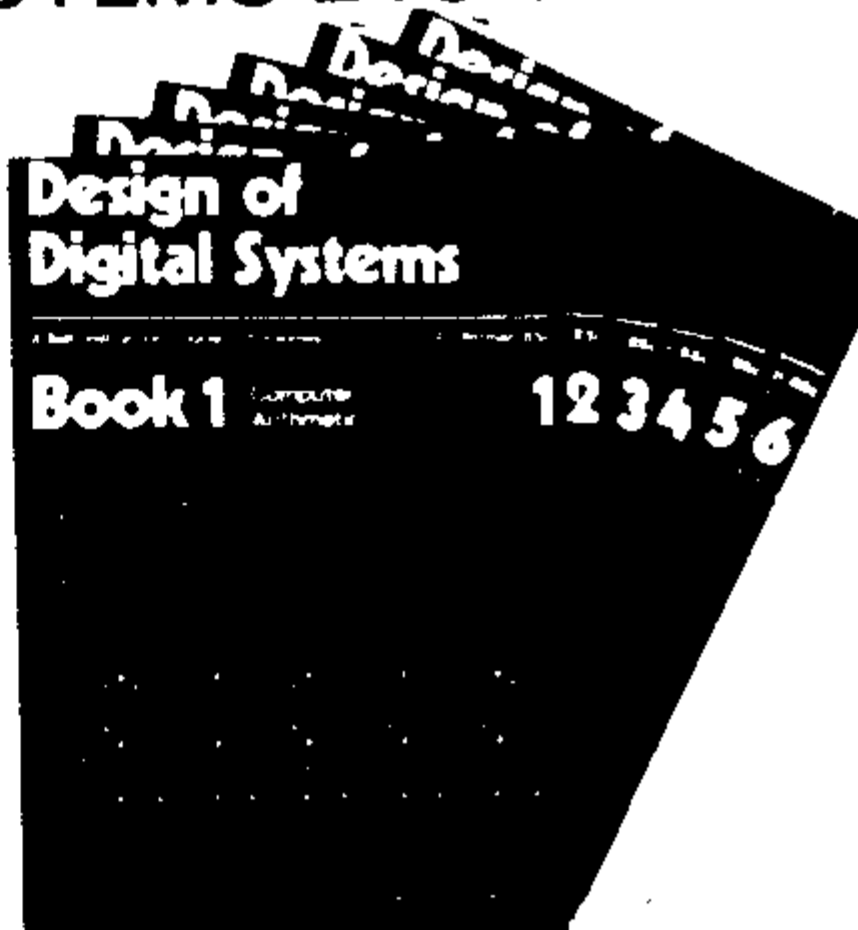
- Book 1** Binary, octal and decimal number systems; conversion between number systems; conversion of fractions; octal-decimal conversion tables.
- Book 2** AND, OR gates; inverters; NOR and NAND gates; truth tables; introduction to Boolean algebra.
- Book 3** Positive ECL; De Morgans Laws; designing logic circuits using NOR gates; dual-input gates.
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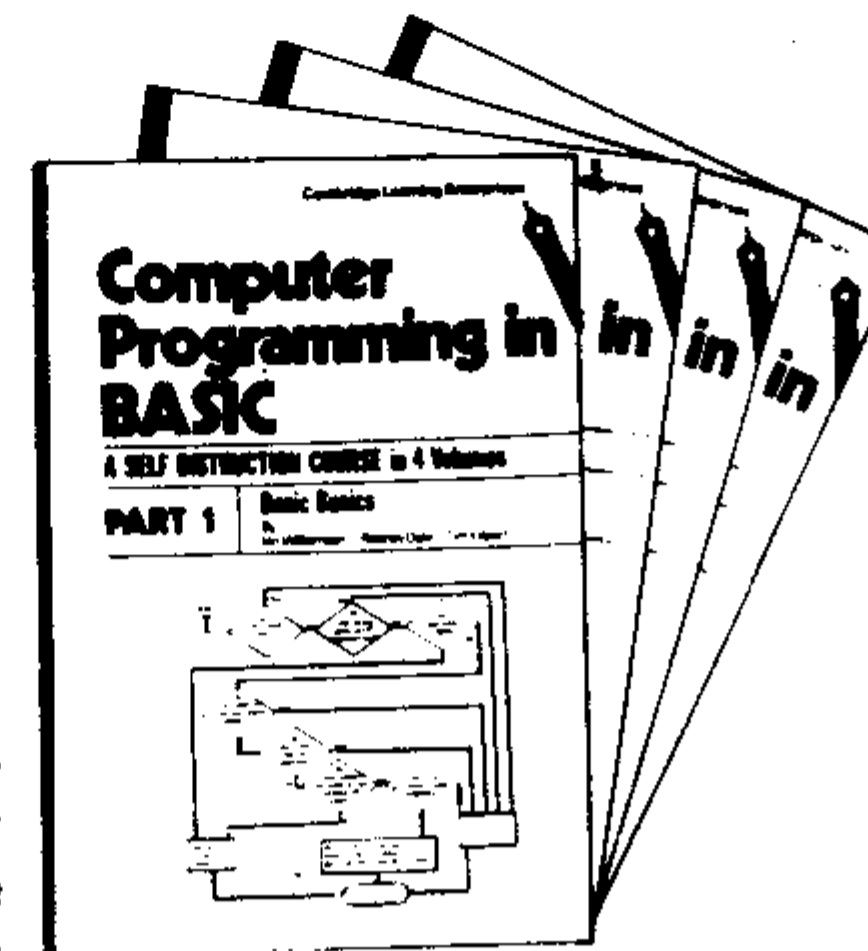
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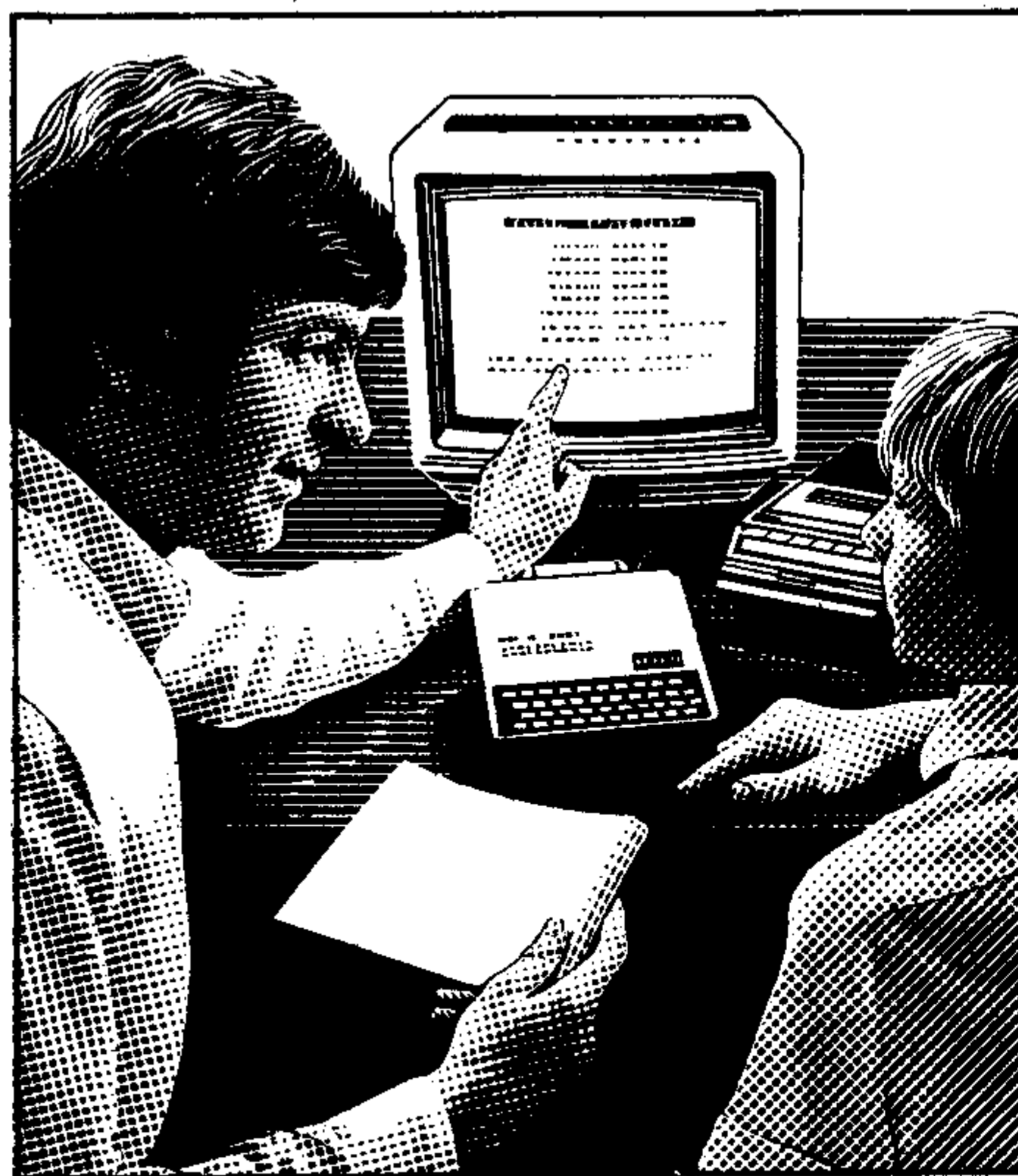
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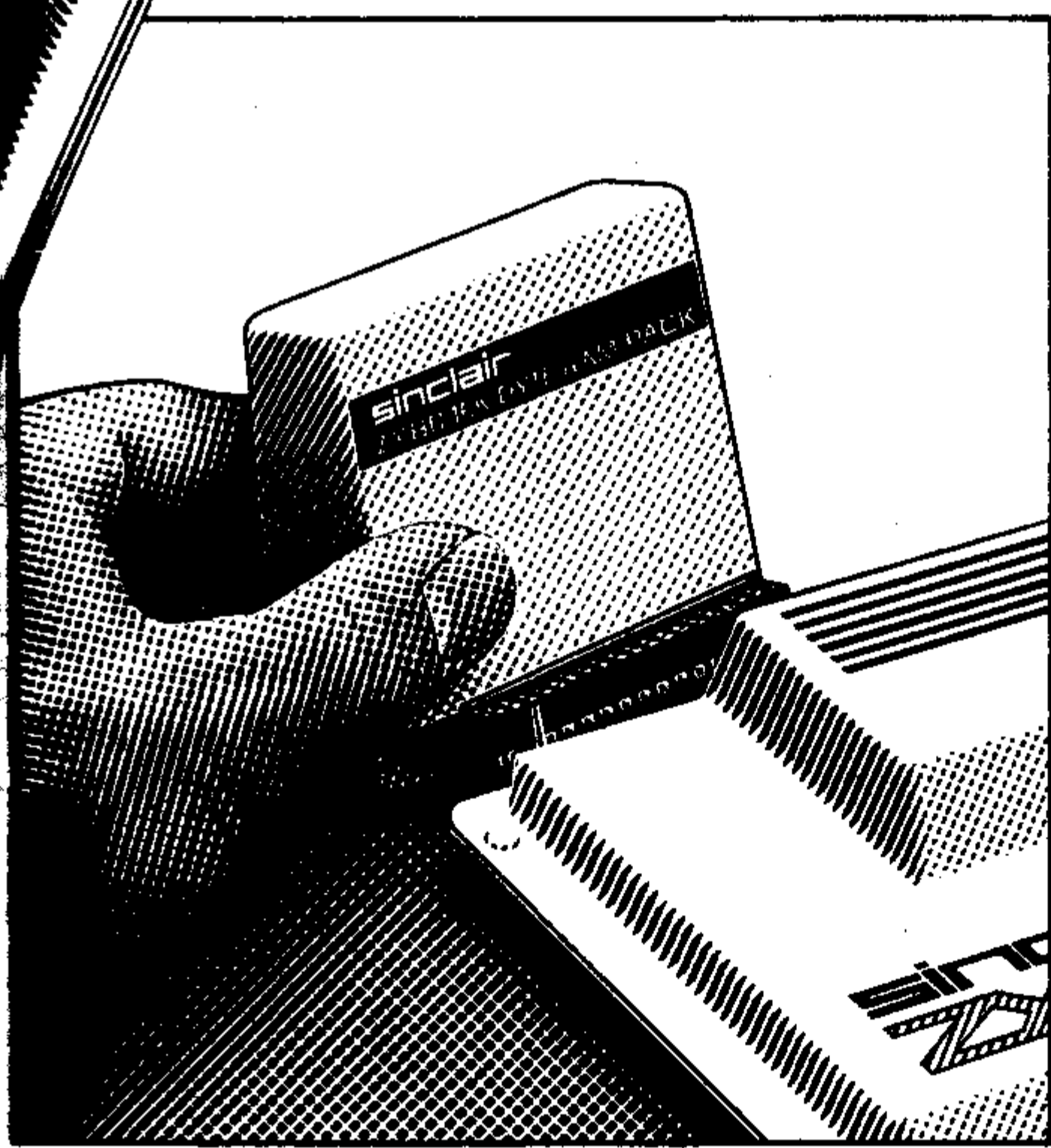
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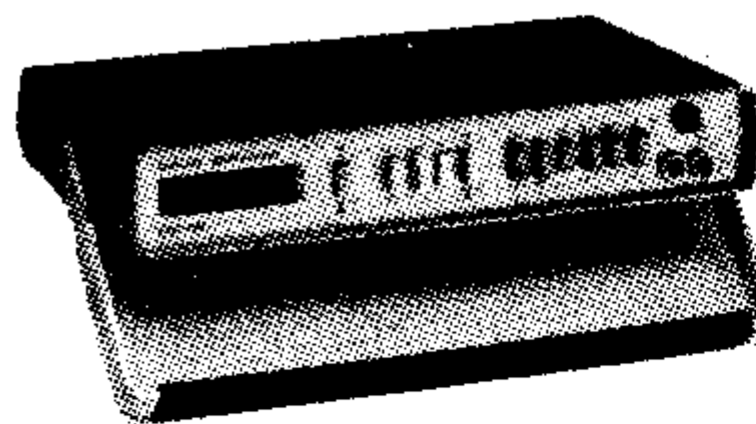
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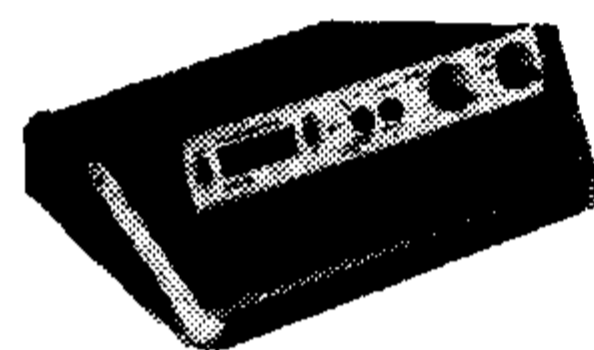
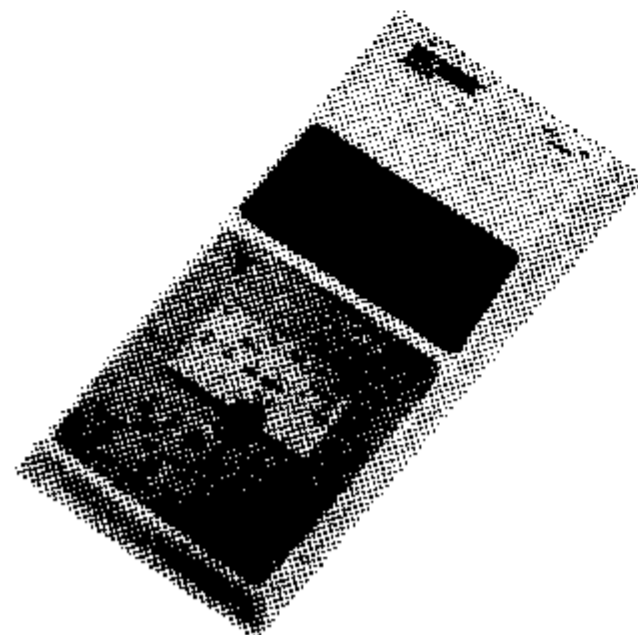
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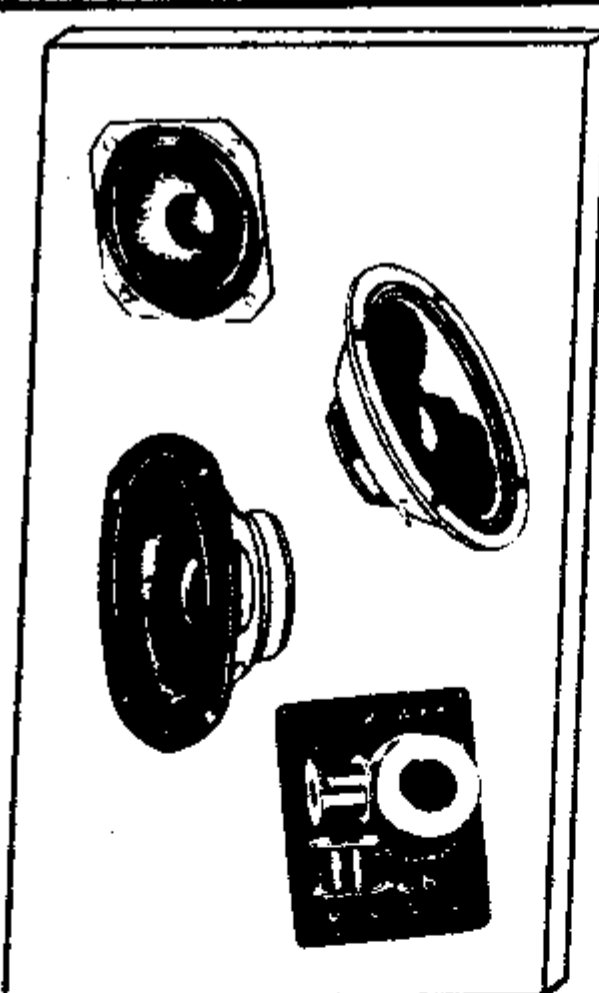
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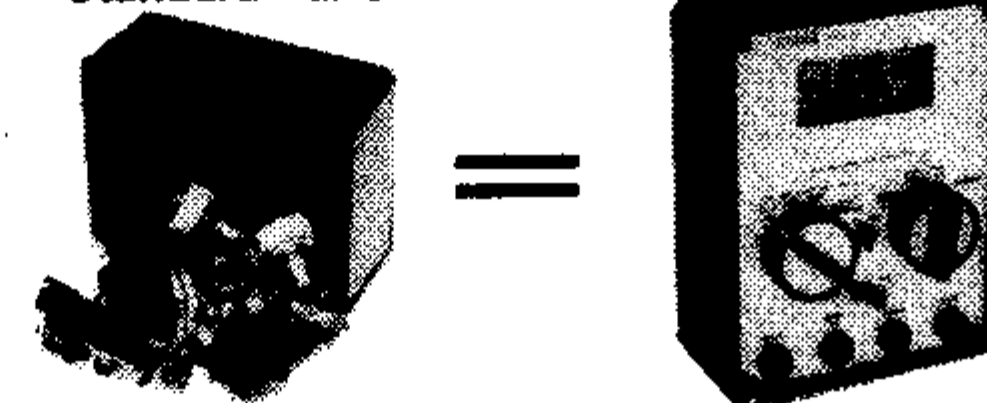
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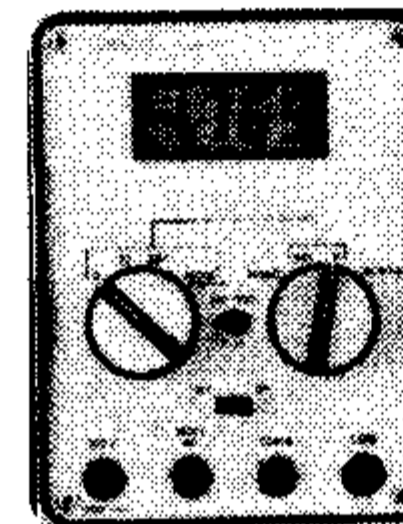
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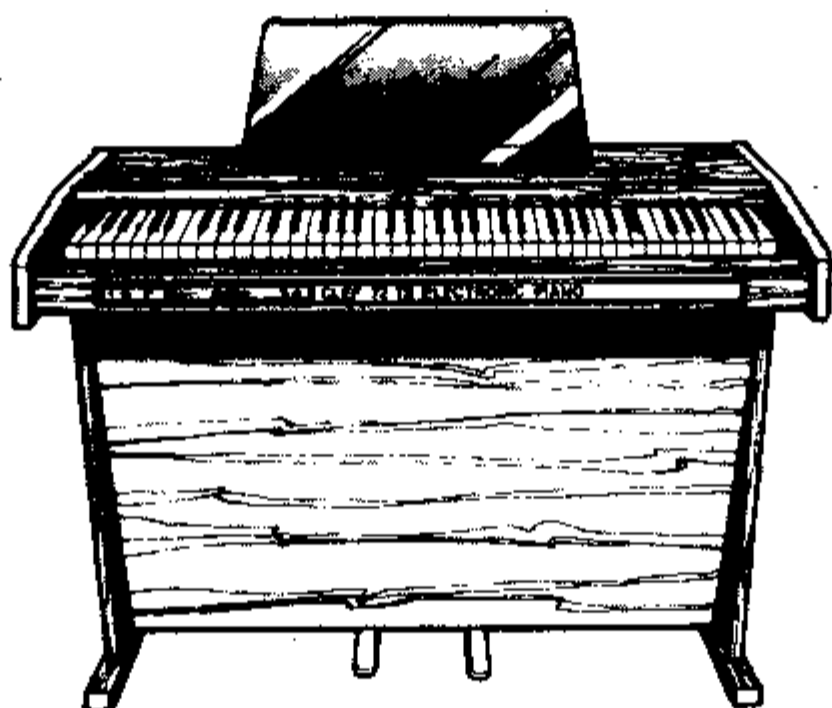
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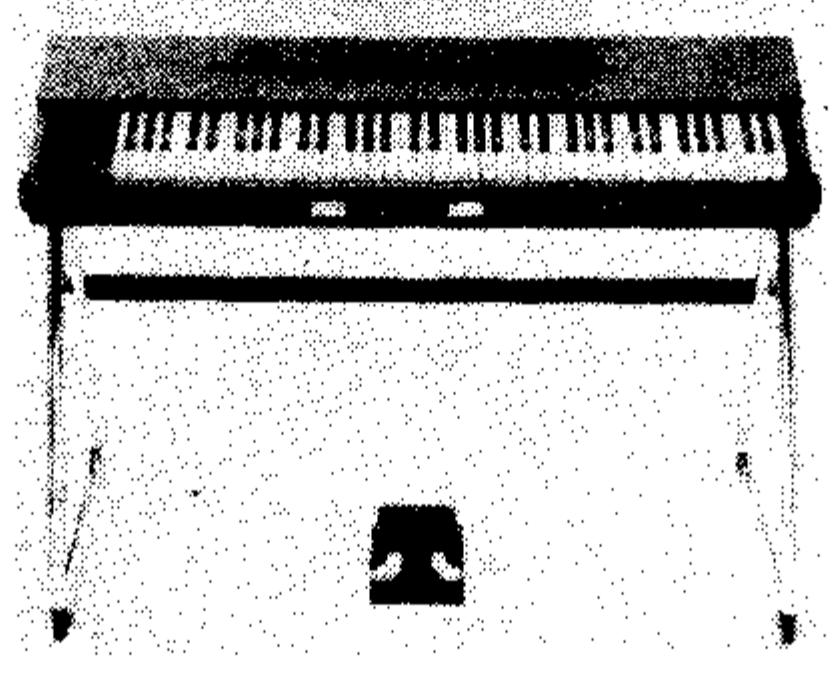
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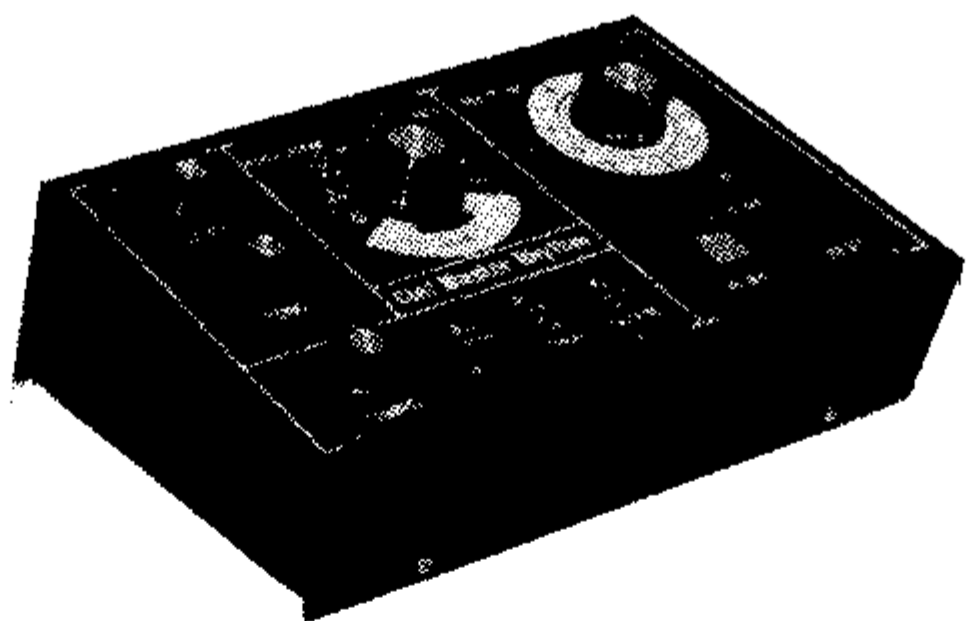
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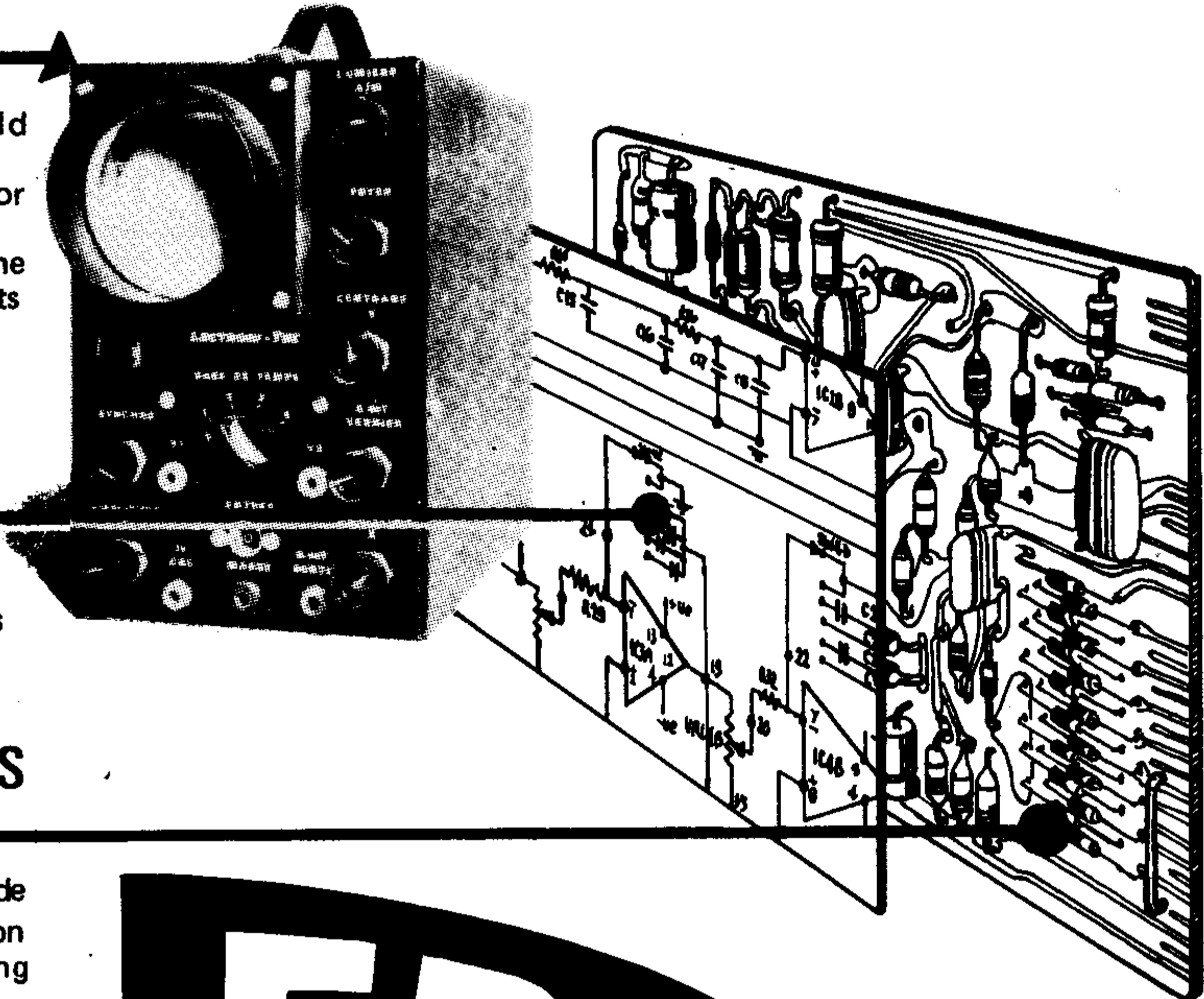
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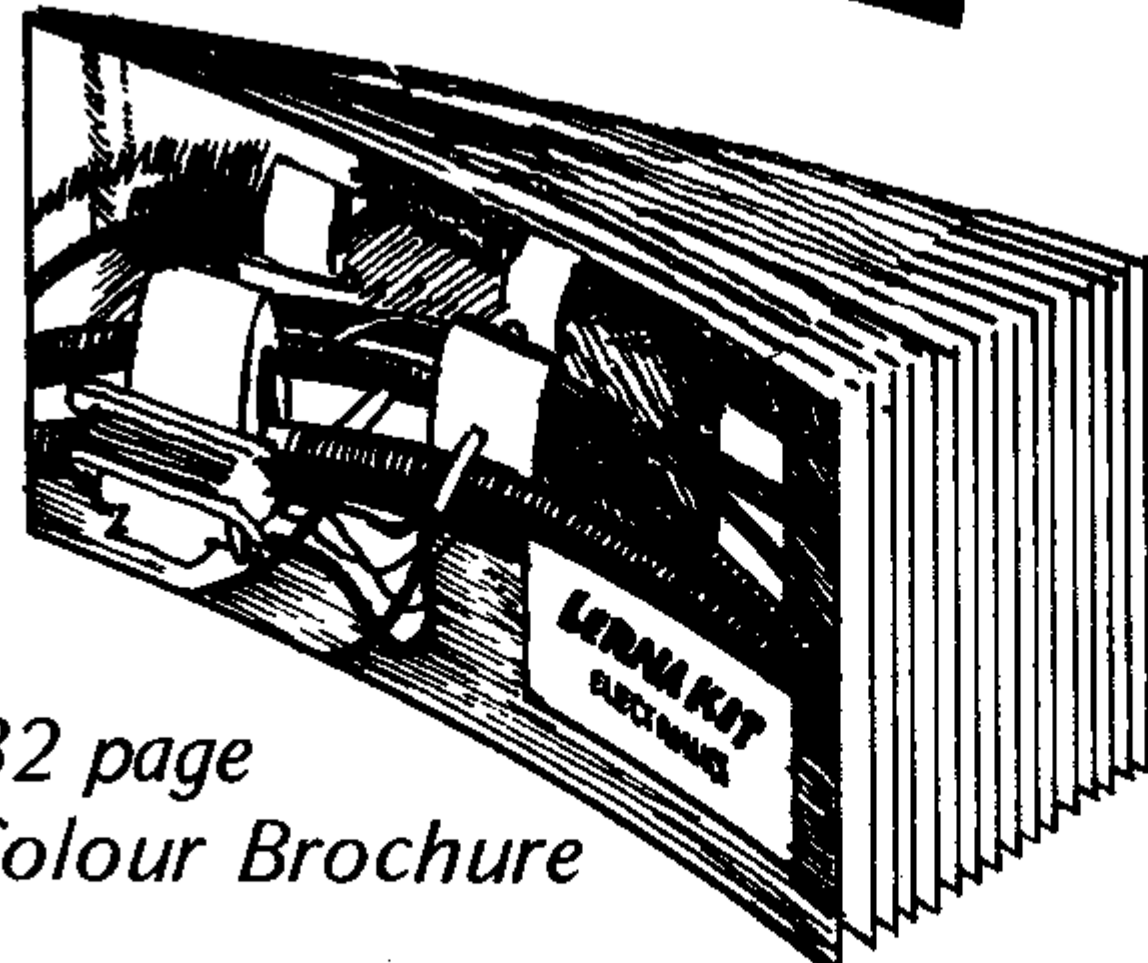
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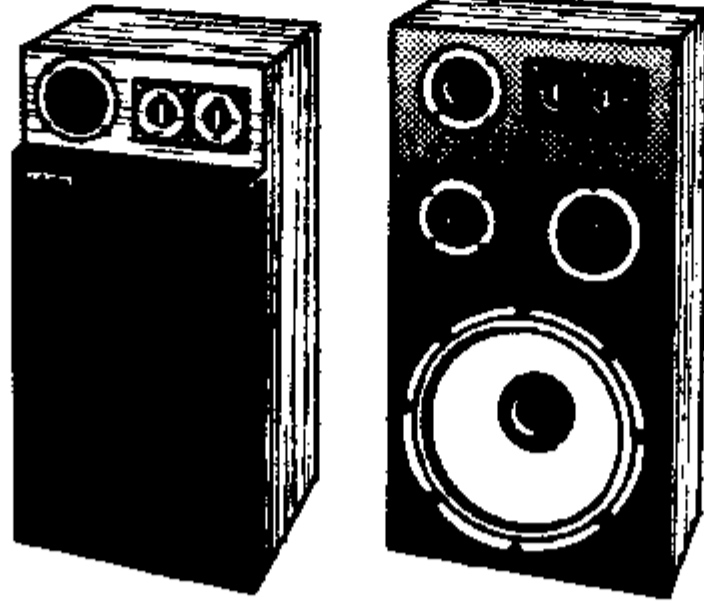


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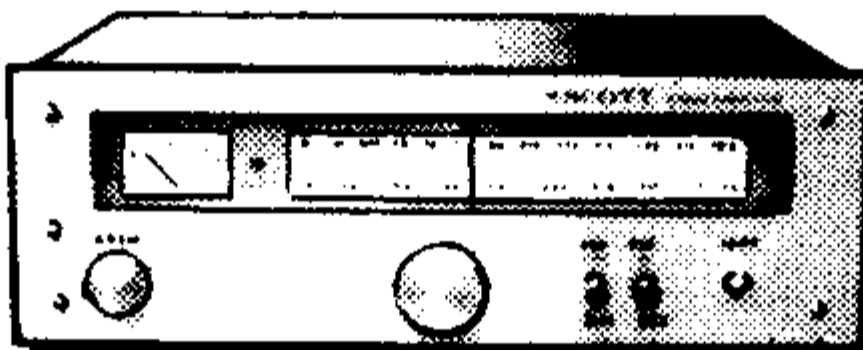
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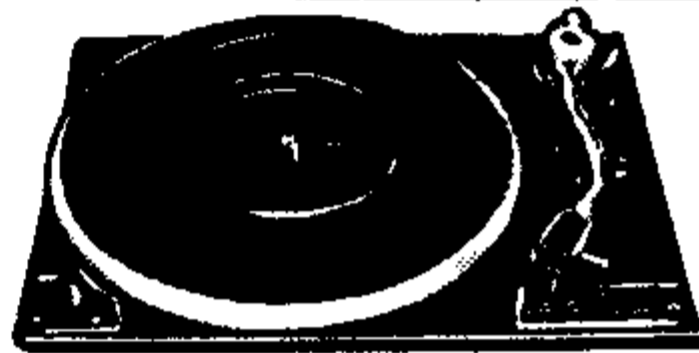
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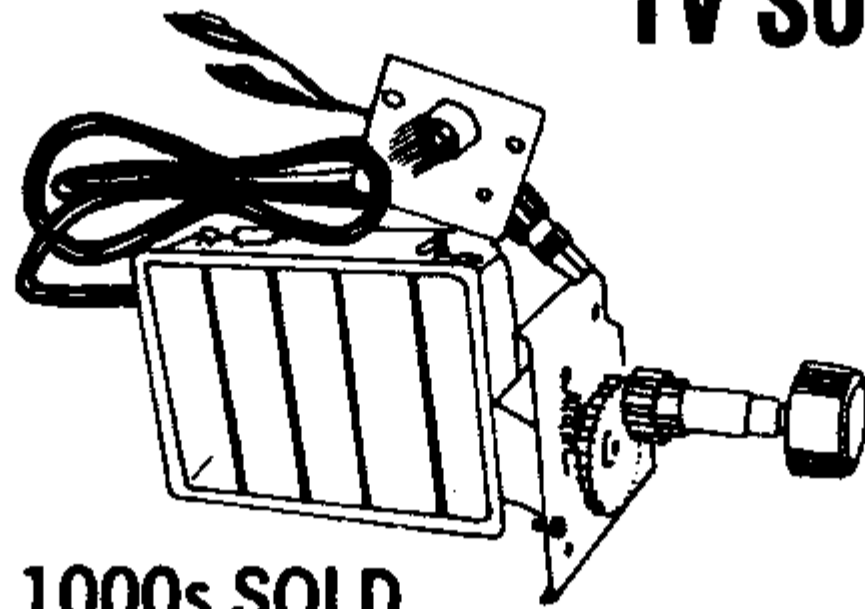


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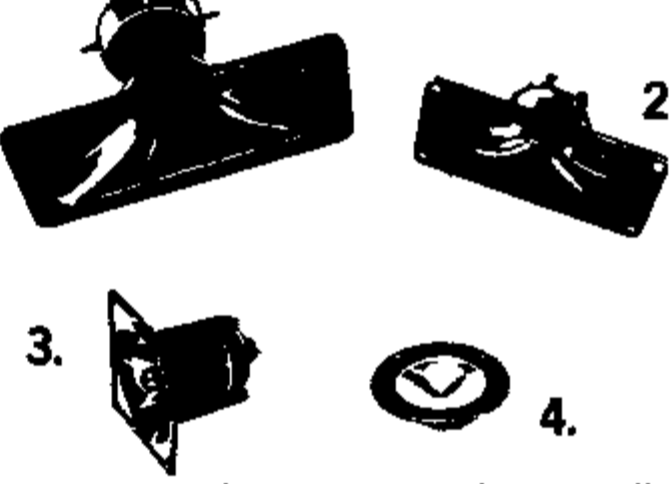
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104	2	4.0	7.88
105	3	6.0	9.42
106	4	8.0	12.82
107	6	12.0	16.37
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12V	15	40.41
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10	8.36	1.31
12	12.10	1.31
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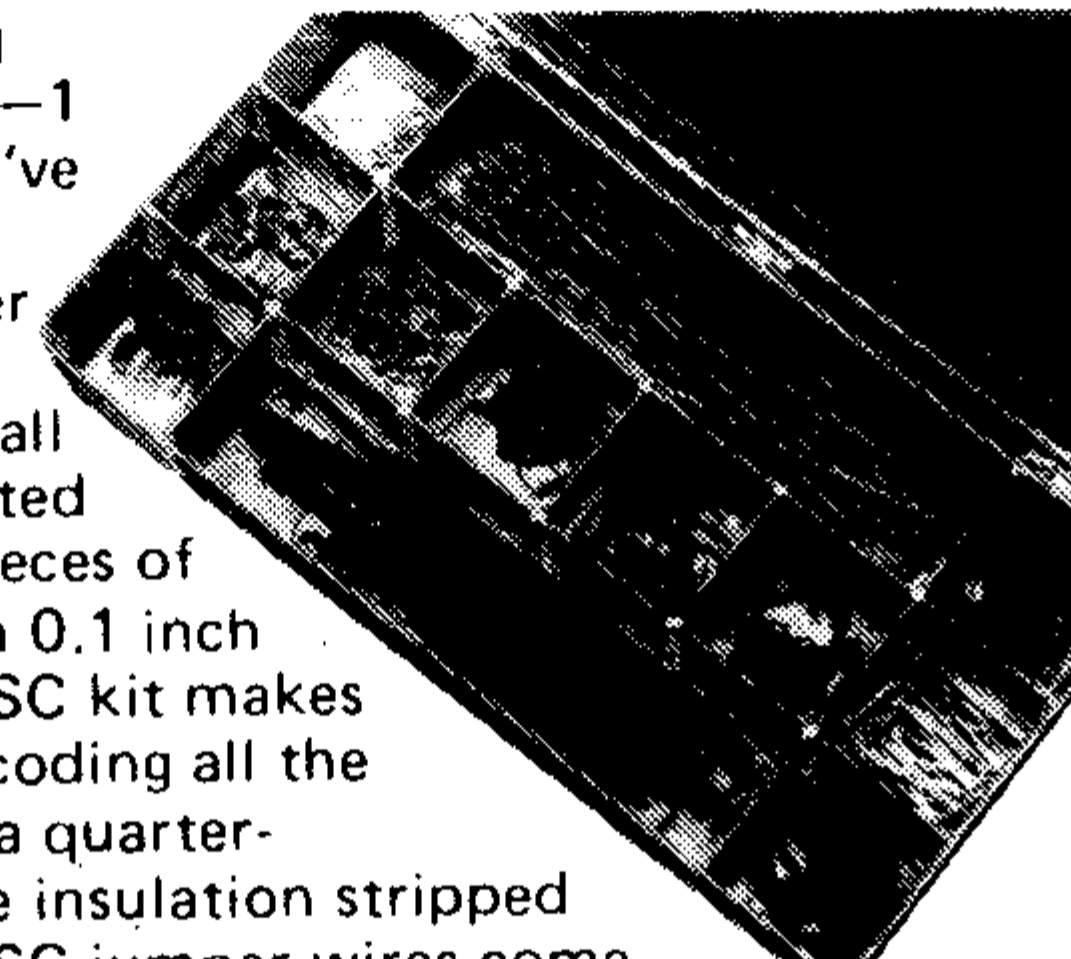
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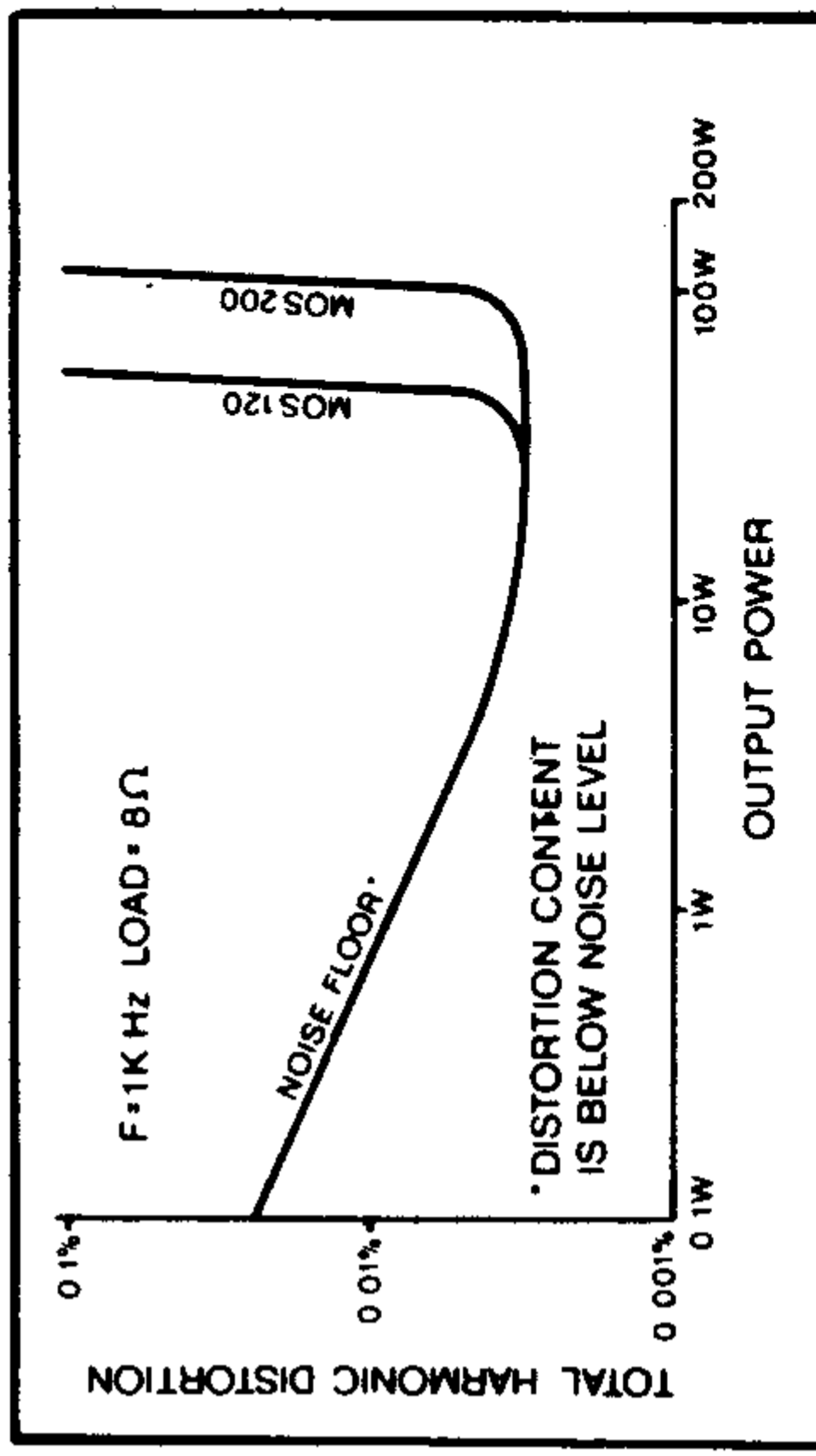
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

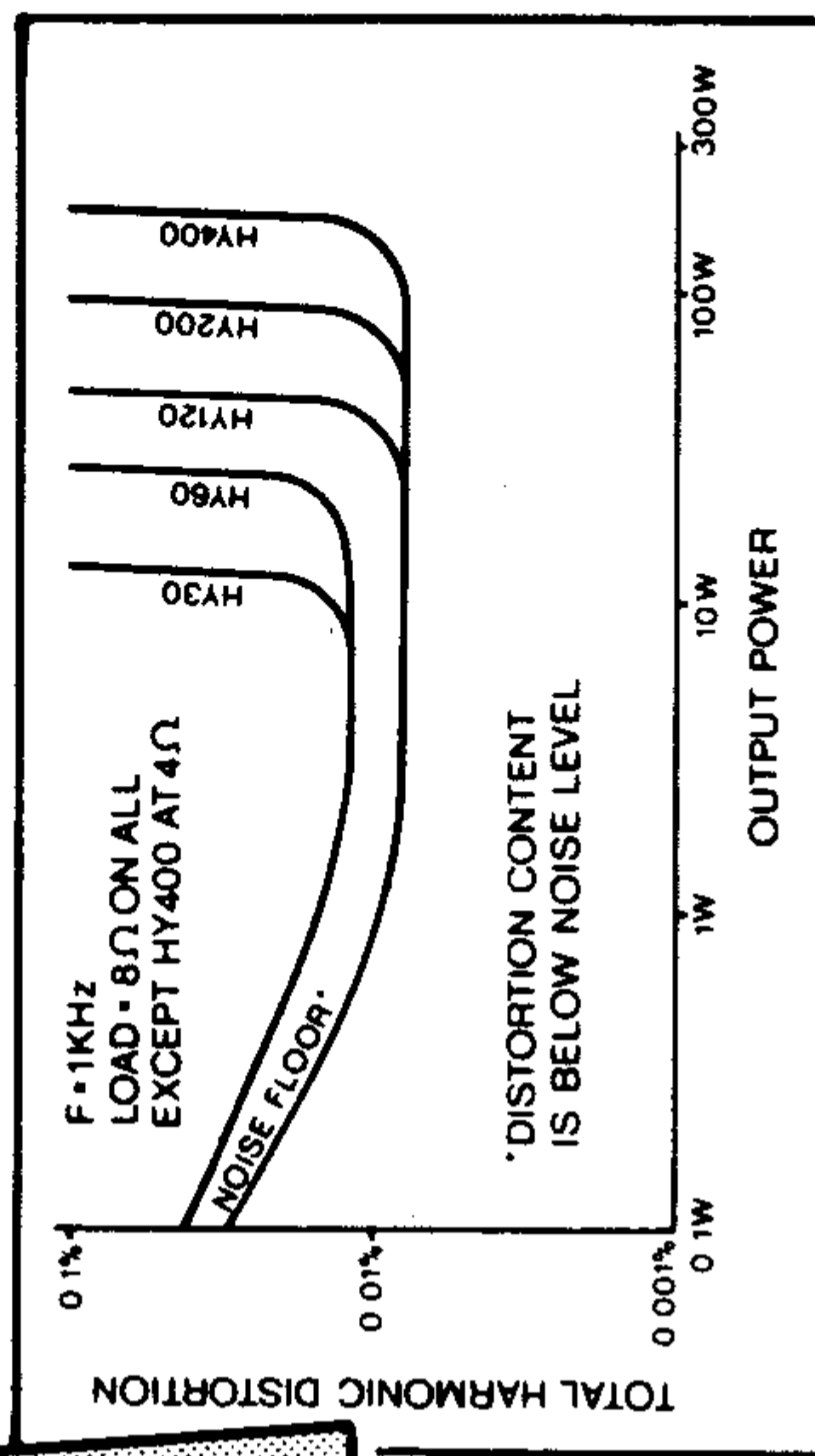
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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
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HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77



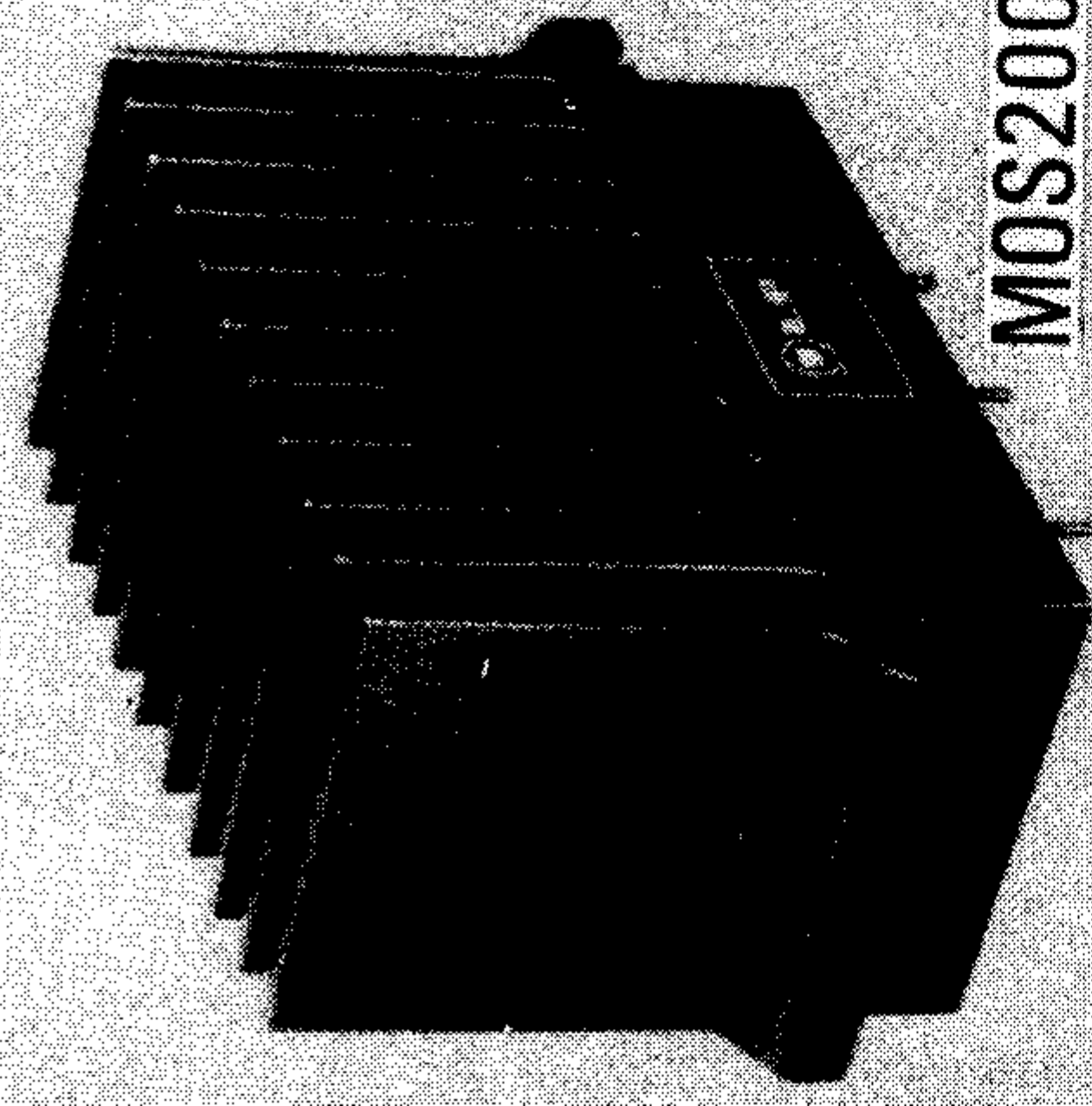
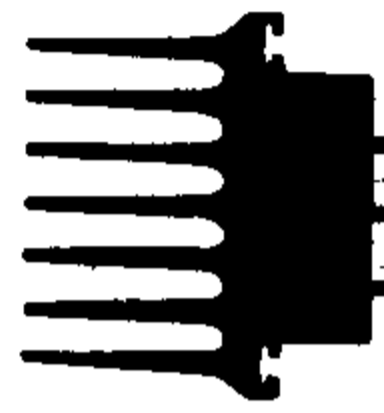
Load impedance both models 4Ω - ∞ Input impedance both models 100KΩ
 Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω - ∞ Input impedance all models 100KΩ
 Input sensitivity all models 500mV Frequency response all models 15Hz-50KHz - 3dB

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MOS200



HY60

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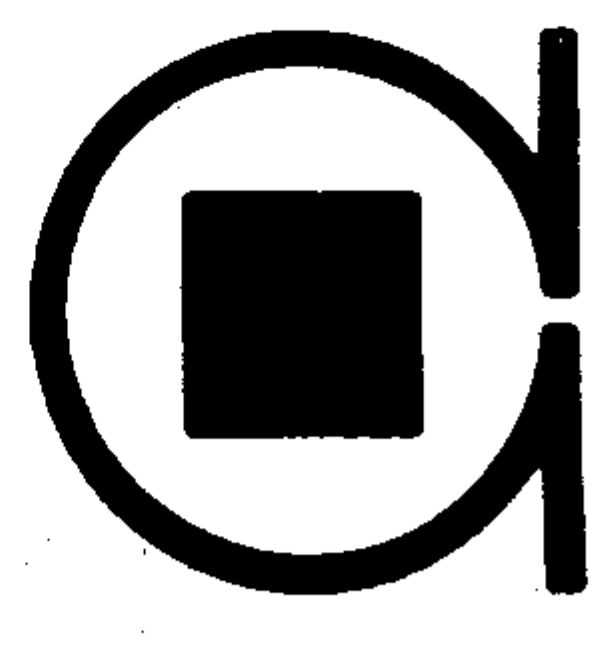
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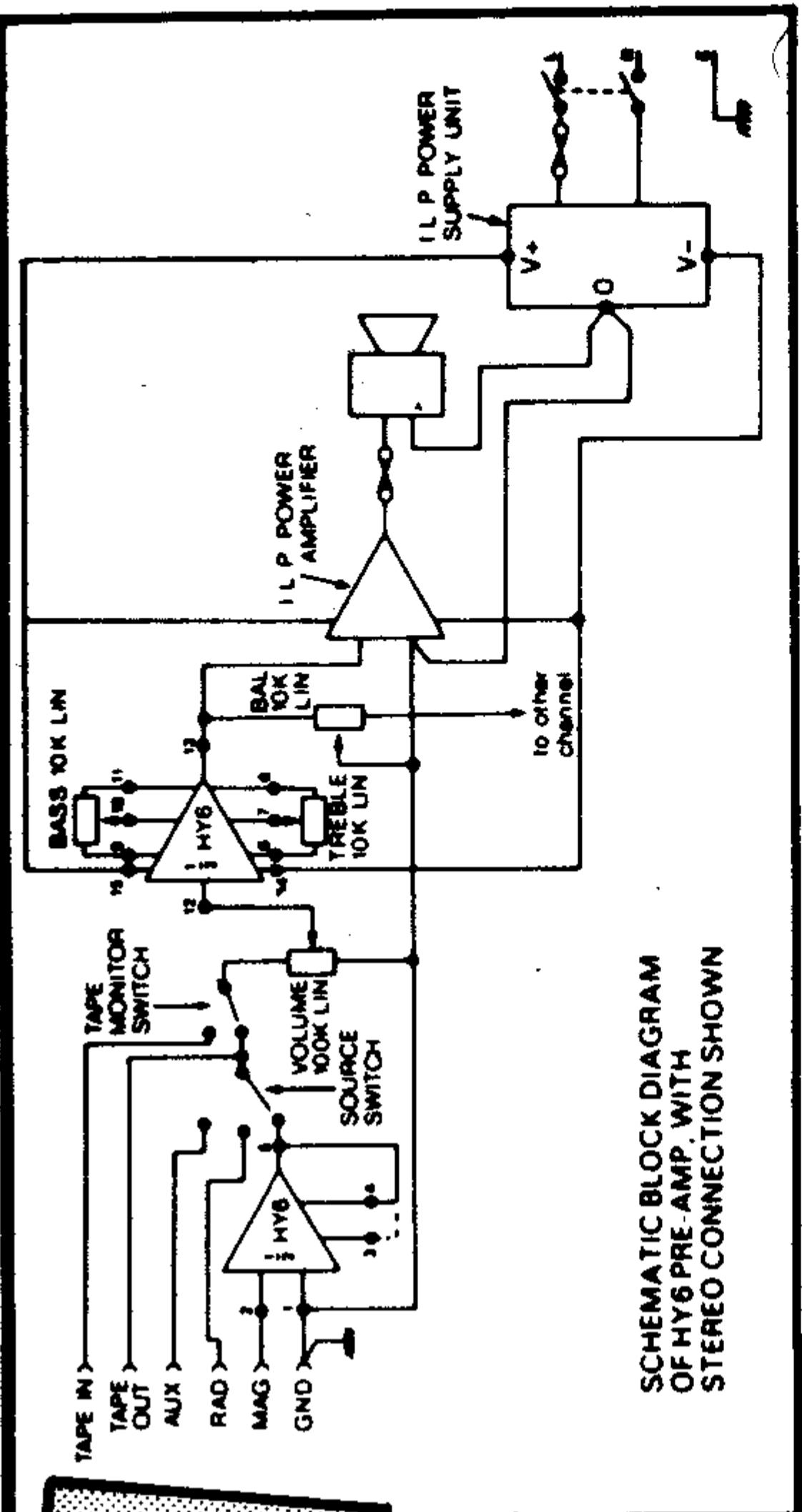
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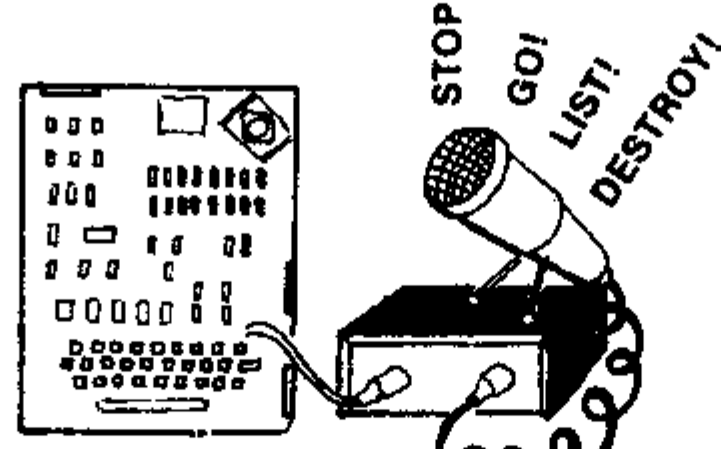
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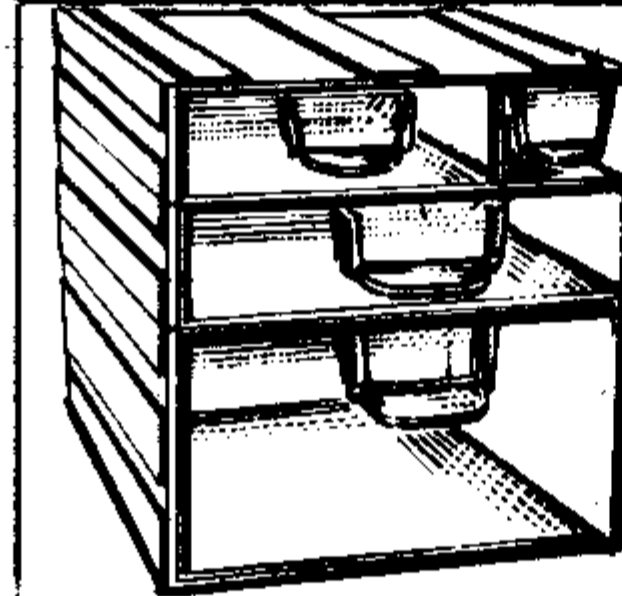
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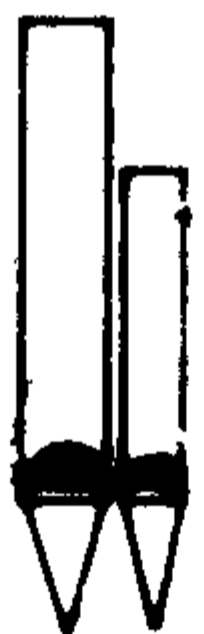
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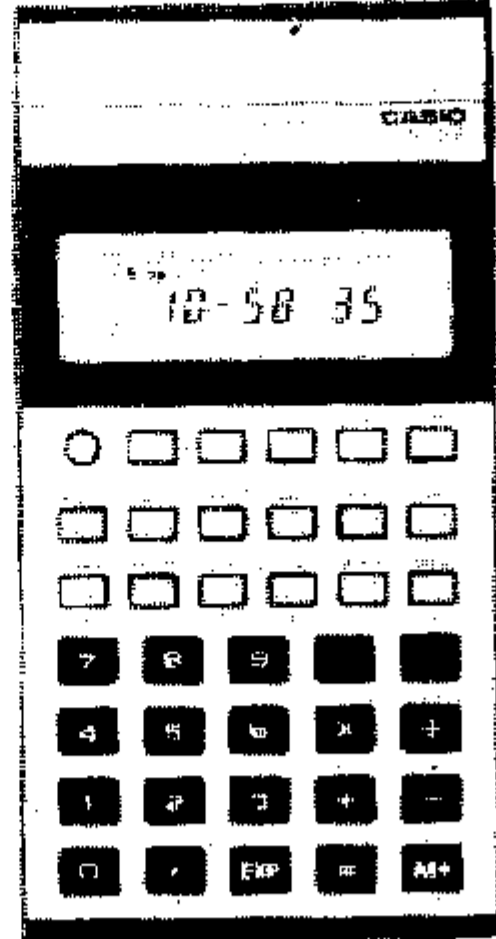
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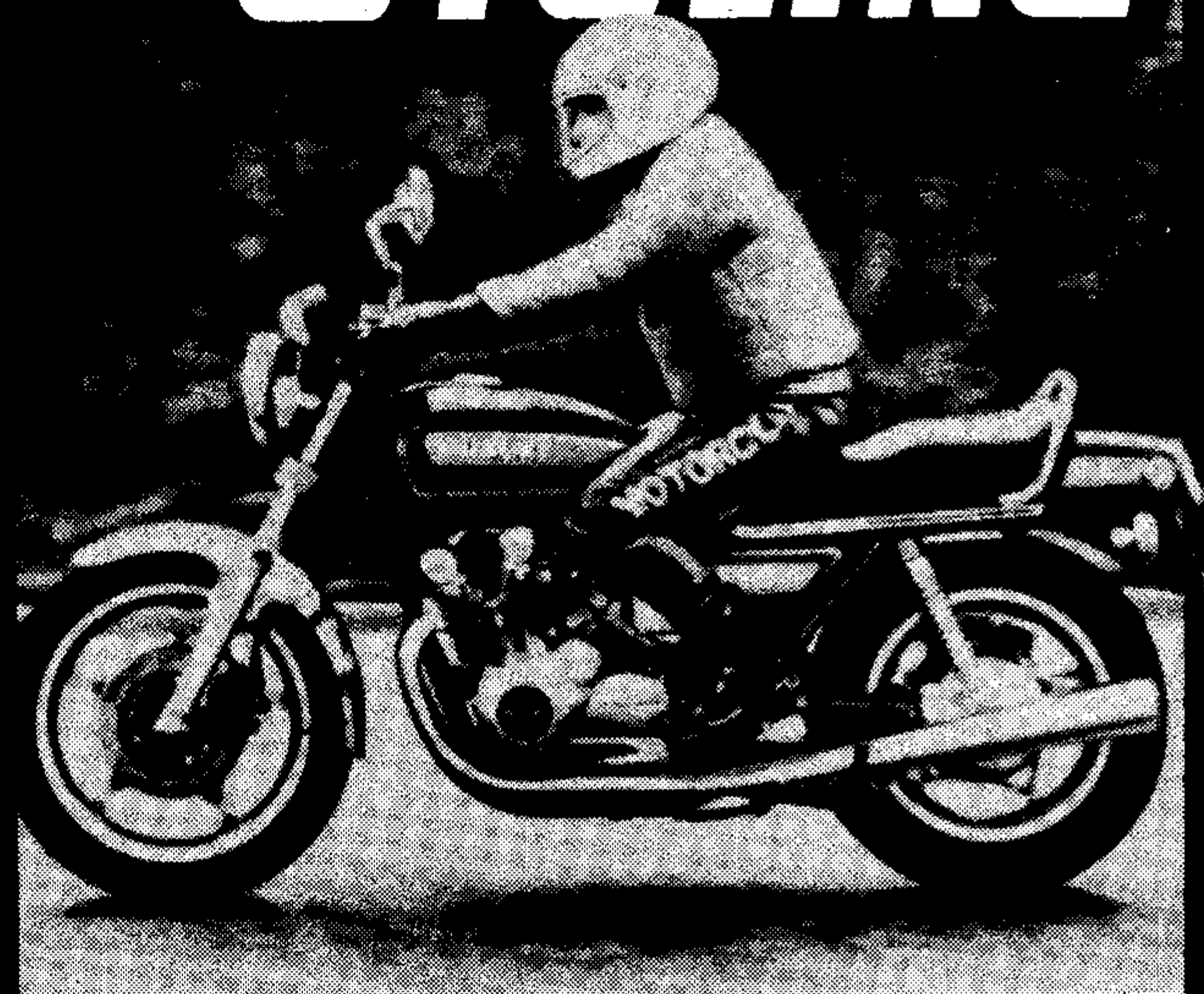
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INDEX TO ADVERTISERS

Aitken Bros	74
Audio Electronics	13, 78
Aura	47
Barrie Electronics	79
Bib Hi-Fi Accessories	67
Bi-Pak	11
Bolster Instruments Co	84
Boss Industrial Mouldings	10
Bradmet	85
British National Radio & Electronics School	77
Cambridge Kits	84
Cambridge Learning	71
Centurion Alarms	82
Chromasonic Electronics	68, 69
Clef Products	76
Codespeed	84
Computer Components (Teleplay)	Cover II
Continental Spec.	3, 79
Crofton Electronics	65
C.U.A.	51
Davian	78
Doram	74
E.D.A.	10
Electronic Brokers	4
Electrovalue	79
Feltglow	51
Flairline Supplies	84
G J D Electronics	84
Hall, Adam	84
Hiykon Limited	84
Home Radio	85
I.C.S. Intertext	7, 82
I.L.P. Electronics	80, 81, 86
Jayen Developments	75
Keelmoor	69
L & B Electronics	4
Litesold	40
Maclin-Zand	70
Maplin Electronics	Cover IV
Marshall A.	75
Micro Circuits	5
Microsystems '81	51
Modern Book	87
Parndon	40
Phonosonics	6, 7
PKG Electronics	84
Progressive Radio	40
Proto Design	82
Radio Component Specialists	87
Radio & T.V. Components	14
Rapid Electronics	78
Sandwell Plant	83
Saxon Entertainments	12, 75
Science of Cambridge	72, 73
Scientific Wire Co	83
Sentinel Supply	85
Service Trading	Cover III
Swanley Electronics	12
Tandy	8, 9
Technomatic	88
Tempus	85
T.K. Electronics	70
Time Data Ltd	82
Titan	12
Videotone	23
Watford Electronics	2, 3
Williamson Amplification	83
William-Stuart Systems (Video music)	84
William-Stuart Systems (Big Ears)	83
Wilmslow Audio	40
Yale Products	84

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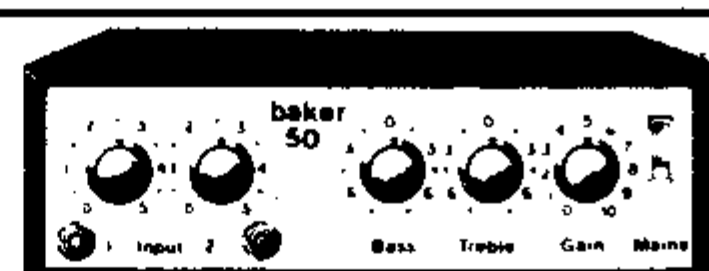
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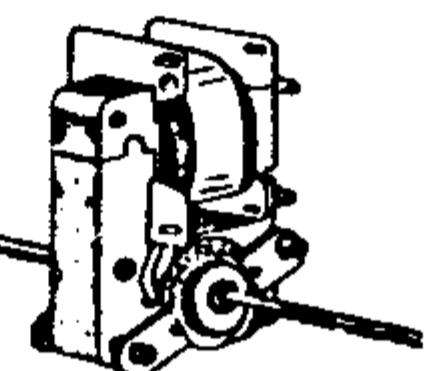
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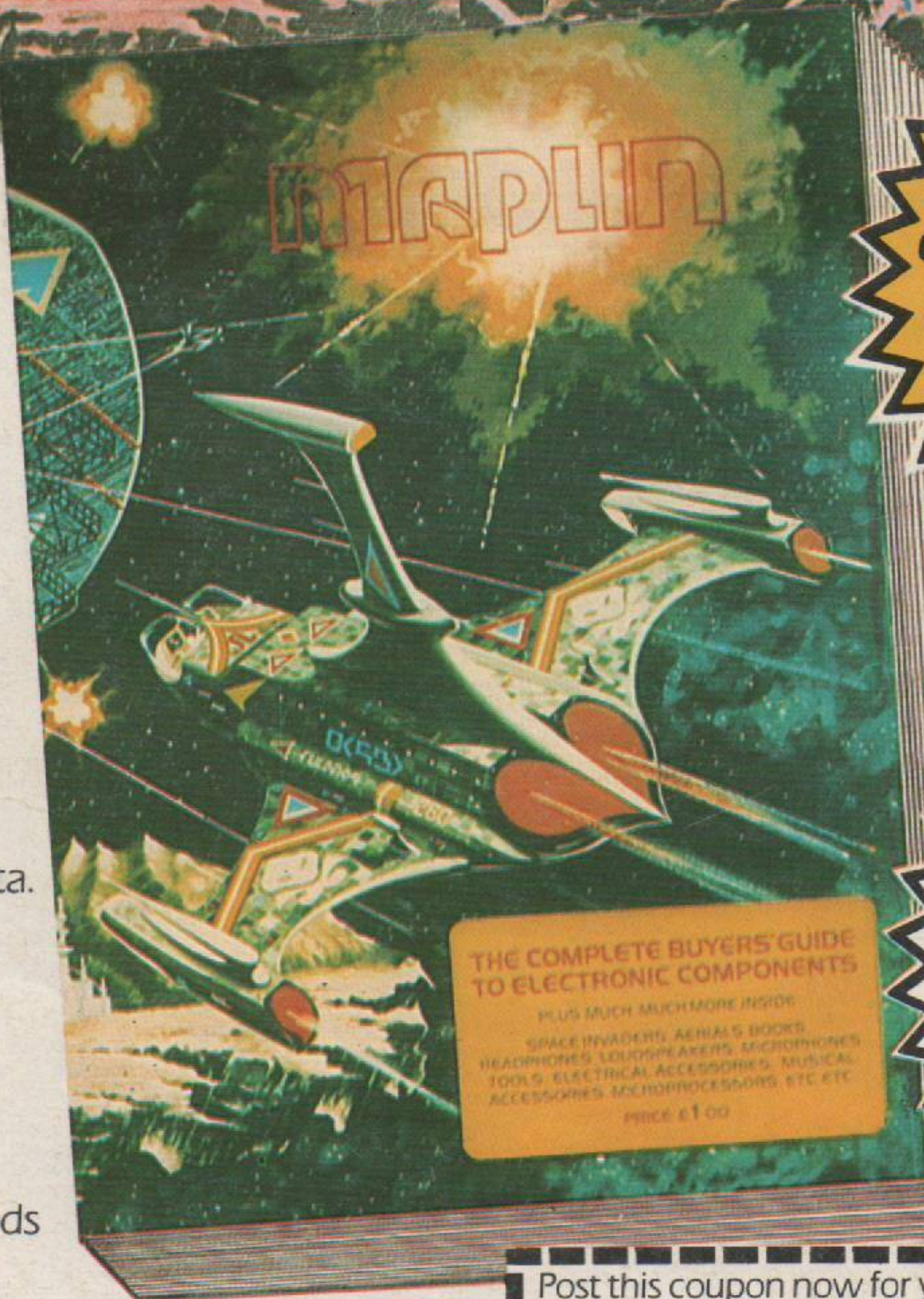
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