PRACTICAL

ELECTRONICS

DECEMBER 1977

45p

Also inside. . . Your **INDEX** *for* **Volume 13**

WATFORD ELECTRONICS

33 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 37774

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/ P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 25p* TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. SEND LARGE S.A.E. FOR OUR FREE LIST.

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POLYESTER CAPACITORS: Axial lead type. (Values are in μF)
400V: 0.001, 0.0015, 0.0022, 0.0033 8p; 0.0047, 0.0068, 0.01, 0.015, 0.018 9p; 0.022, 0.033, 10p; 0.047, 0.068 14p; 0.10 15p; 0.15, 0.22 22p; 0.33, 0.47 39p; 0.68 45p.
160V: 0.039, 0.15, 0.22 13p; 0.33, 0.47 22p; 0.68, 1.0 29p; 1.5 33p; 2.2 38p; 4.7 47p.
DUBILIER: 1000V: 0.01, 0.015 16p; 0.022 18p; 0.047 16p; 0.1 34p; 0.47 43p.

POLYESTER RADIAL LEAD (Values in μF) 250V:
0-01, 0-015 6p; 0-022, 0-027 7p; 0-033, 0-047, 0-068, 0-1 8p; 0-15 12p; 0-22, 0-33 14p; 0-47 16p; 0-68 20p; 1-0 24p; 1-5 27p; 2-2 31p.

FEED THROUGH CAPACITORS
100μF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF)
63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22 9p; 47, 32, 50 12p; 63, 100 27p; 50V: 100 7p; 50, 100, 220 25p; 470 50p; 1000, 2200 68p; 40V: 22, 33 9p; 100 12p; 3300 62p; 4700 64p; 35V: 10, 33 7p; 330, 470 32p; 1000 49p; 25V: 10, 22, 47 6p; 80, 100, 160 8p; 220, 250 13p; 470, 640 25p; 1000 27p; 1500 30p; 2000 34p; 3300 52p; 4700 54p; 16V: 10, 40, 47, 68 7p; 100, 125, 8p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 4, 100 6p; 640 10p; 1000 14p.
TAG-END TYPE: 70V: 2000 98p; 4700 121p; 50V: 3000 75p; 40V: 4000 70p; 2500 65p; 25V: 4700 48p; 2000 37p; 40V: 2000 + 2000 95p; 325V: 200 + 100 + 50 + 100 190p.

TANTALUM BEAD CAPACITORS
35V: 0.1μF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2μF, 3.3, 4.7, 6.8 25V: 1.5, 10 20V: 1.5 16V: 10μF 13p each.
10V: 22μF, 33, 47 6V: 47, 68, 100, 3V: 68, 100μF 20p each

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01μF 5p
0.015, 0.02, 0.04, 0.05, 0.056μF 6p
0.1μF, 0.15, 0.2 7p, 50V: 0.47μF 10p

CERAMIC CAPACITORS: 50V
0.5pF to 10nF 3p each
15nF, 22nF, 33nF, 47nF 4p each
0.1μF 6p

POLYSTYRENE CAPACITORS
10pF to 1nF 6p; 1.5nF to 10nF 10p.

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 9p each
250, 300, 330, 360, 390, 600, 820 16p each
1000, 1800, 2000, 2200 20p each

CERAMIC TRIMMER CAPACITORS
2-7pF, 4-15pF, 6-25pF, 8-30pF 20p

MINIATURE TYPE TRIMMERS
2.5-6pF, 3-10pF, 10-40pF 22p
5-25pF, 5-45pF, 60pF, 88pF 30p

COMPRESSION TRIMMERS
3-40pF, 10-80pF, 25-190pF 25p
100-500pF, 1250pF 38p

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ½W Linear values
1KΩ & 2KΩ (lin only) Single gang 26p
5KΩ-2MΩ single gang 26p
5KΩ-2MΩ single gang D/P switch 55p
5KΩ-2MΩ dual gang stereo 70p

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 80p
Self Stick Graduated Bezels 20p

PRESET POTENTIOMETERS
0-1W 50Ω—5MΩ Miniature
Vertical & Horizontal 8p
0-25W 100Ω—3-3MΩ Horiz larger 10p
0-25W 200Ω—4-7MΩ Vert 10p

RESISTORS — Erie make 5% Carbon Miniature High Stability. Low noise

	RANGE	VAL	1 99	100 +
¼W	2-2Ω-4 7M	E24	1.5p	1p
½W	2-2Ω-4 7M	E12	2p	1.5p
1W	2-2Ω-10M	E12	5p	4p
2% Metal Film 10Ω-1MΩ				6p

100 + price applies to Resistors of each type not mixed values.

FREE STOCK-LIST
We stock thousands more Items. Please send a large SAE for our free list.

OPTO ELECTRONICS★
LEDS - clip
TIL209 Red .125" 13
TIL211 Grn .125" 24
TIL212 Yellow .125" 27
2" Red 17
2" Amber Green Yellow 21
OCP70 40
ORP12 68
2N5777 54
7 Seg Displays
TIL312 C An 3" 125
TIL313 C Cth 3" 125
TIL321 C An 5" 130
TIL322 C Cth 5" 130
DL704 C Cth 99
DL707 CA .3" 99
DL747 CA .6" 180
FND 357 140
DRIVERS
75491; 75492 85

SWITCHES★
TOGGLE 2A 250V
SPST 26p
DPDT 35p
4 pole on/off 58p
SUB-MIN TOGGLE
SP changeover 59p
SPST on/off 54p
DPDT 6 tags 78p
DPDT Centre off 92p
DPDT Biased 115p
SLIDE 250V:
1A DPDT 14p
1A DP c/over 16p
½A DPDT 13p
4 pole c/over 24p
PUSH BUTTON
Spring loaded
SPST on/off 55p
SPDT c/over 65p
DPDT 6 Tag 85p

JACK PLUGS

	Screened chrome	Plastic body
2-5mm	12p	8p
3-5mm	15p	10p
MONO	23p	15p
STEREO	31p	18p

SOCKETS

open metal	moulded with break contacts	in line couplers
8p		11p
8p		12p
13p	20p	18p
15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker 3, 4, 5 Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours / Metal Screened	9p / 12p	5p single / 8p double / 10p 3-way	15p / — / —
BANANA 4mm	10p	12p	—
2mm	10p	10p	—
1mm	8p	8p	—
WANDER 3mm	9p	9p	—

SWITCHES ★ PUSH BUTTON
Miniature Non Locking
Push to Make 15p Push to Break 25p
ROCKER (white) 10A 250V
SP changeover centre off 28p
ROCKER: (black) on/off 10A 250V 23p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 52p
ROTARY: (ADJUSTABLE STOP) 1 pole / 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W 41p
ROTARY: Mains 250V AC, 4 Amp 42p

OIL SOCKETS★ (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 20p; 24 pin 30p; 28 pin 42p; 40 pin 58p.

COLOUR ADAPTOR
FOR YOUR EXISTING BLACK & WHITE
TV GAMES

Complete Kit including UHF/VHF Modulator and the PCBs. £9.89 incl. VAT (45p p&p insured).
Ready Built & Tested £11.39 incl. VAT (45p p&p insured).
Ready Built. Tested and Fitted **£12.75** incl. VAT plus postage.
Colour Encoder with Modulator (no other components) £5.95 incl. VAT (45p p&p insured).

SPECIAL OFFER
The "Olympic" TV Games Kit £25.49 incl. VAT (95p p&p insured).
"Olympic" Kit in Colour £34.85 incl. VAT (95p p&p insured).
"Sure Fire Rifle" Kit for the Olympic £9.50 incl. VAT (40p p&p).
"Sure Fire Rifle" Kit for other TV games £10.25 incl. VAT (40p p&p).
TV Games IC AY-3-8500 **£5.10*** only.

ICs AY-3-8500* £4.50; AY-3-8850* £7.50 only.

STOP PRESS . . . Watford Electronics announce the introduction of their **"ECONOGAME"** the obvious answer to **CHEAP** yet reliable **TV GAMES**. This simple to build Kit comes complete with **AY-3-8500** IC, Fibre Glass PCB, semiconductors and full instructions. All you need to complete the Unit is, two Pots., Switches, Loudspeaker and Control Boxes. The finished board fits our NJSF1 Box **(£1.75*)** to complete an attractive inexpensive TV Games Unit. Price only **£10.45** incl. VAT (35p p&p insured).
TV Games demonstration on at our shop. Send SAE for leaflet.

FERRIC CHLORIDE★
Anhydrous
1lb bag
65p - 30p p&p

DALO ETCH
Resist Pen
Spare Tip **75p★**

COPPER BOARDS★
Fibre Glass
Single Sided
6 x 6" 75p
6 x 12" 130p
SRBP
8 x 10" 65p

VOLTAGE★ REGULATORS
723C 48p
TBA625B 98p
TO3 Can
1A 5V 170p
1A 12V 180p
1A 15V 190p
1A 18V 210p
LM309K 150p
LM323K 625p
1A —5V 220p
1A —12V 220p
Plastic
1A 5V 115p
1A 12V 115p
1A 15V 120p
1A 18V 125p
1A 24V 130p
0-1A 8V 51p

TTL 74★

7400	14	7480	50	74162	116
7401	14	7481	97	74163	116
7402	16	7482	82	74164	121
7403	16	7483	95	74165	130
7404	20	7484	95	74166	141
7405	22	7485	110	74167	198
7406	38	7486	36	74170	240
7407	38	7489	320	74172	625
7408	20	7490	36	74173	175
7409	20	7491	80	74174	113
7410	15	7492	53	74175	90
7411	24	7493	35	74176	120
7412	23	7494	85	74177	116
7413	37	7495	70	74180	142
7414	74	7496	82	74181	299
7416	35	7497	262	74182	127
7417	39	74100	125	74184	225
7420	16	74104	62	74185	146
7421	33	74105	62	74188	650
7422	24	74107	33	74190	140
7423	32	74109	54	74191	140
7425	30	74110	54	74192	140
7426	36	74111	70	74193	140
7427	36	74116	198	74194	140
7428	38	74118	90	74195	95
7430	18	74120	115	74196	118
7432	32	74121	28	74197	118
7433	40	74122	48	74198	248
7437	30	74123	70	75150	110
7438	33	74125	65	75491	75
7440	17	74126	60	75492	80
7441	74	74128	77		
7442	68	74132	73		
7443	115	74136	73		
7444	112	74141	72		
7445	94	74142	280		
7446	94	74143	314		
7447	82	74144	314		
7448	78	74145	85		
7450	17	74147	175		
7451	17	74148	143		
7453	17	74150	118		
7454	17	74151	75		
7460	17	74153	75		
7470	30	74154	140		
7472	28	74155	82		
7473	32	74157	80		
7474	32	74159	225		
7475	42	74160	116		
7476	30	74161	116		

CMOS★

4000	15	4021	99
4001	17	4022	90
4002	17	4023	20
4006	105	4024	76
4007	18	4025	19
4009	58	4026	180
4010	58	4027	55
4011	19	4028	90
4012	18	4029	108
4013	55	4030	58
4015	93	4033	145
4016	52	4034	196
4017	99	4040	105
4018	99	4042	81
4019	60	4043	96
4020	102	4044	95
		4045	145
		4046	130
		4047	99
		4048	58
		4049	52
		4050	52
		4054	120
		4055	134
		4056	134
		4060	115
		4067	380
		4068	22
		4069BE	22
		4070	32
		4072	21
		4075	23
		4076	129
		4077	40
		4078	21
		4081	22
		4082	21
		4502	120
		4507	55
		4510	135
		4511	168
		4512	98
		4516	125
		4518	102
		4519	59
		4520	108
		4528	99
		4532	127
		4539	110
		4585	101

LINEAR IC'S

702	75	MC724★	175
709C 14 pin	35	MC845P	125
710★	46	MC1303L	148
741C★ 8 pin	22	MC1304P	260
74112	90	MC1310P	185
74119	175	MC1312PQ	195
747C	70	MC1458P★	90
748C	36	MC1496	101
753	150	MC1710CG	79
8038CC★	355	MFC6040★	97
AY-1-0212	580	MK50253★	550
AY-1-5051	125	MK50362★	550
AY-1-6721/6	195	MM2101-2	210
AY-3-8500★	510	MM2112-2N★	310
AY-3-8550★	850	NE518A	210
AY-5-1224★	349	NE555★	36
AY-5-1230★	495	NE556DB★	90
AY-5-3500★	510	NE560★	325
AY-5-4007	655	NE561★	410
CA3011★	82	NE562★	410
CA3014★	137	NE565A★	185
CA3018★	82	NE566★	180
CA3020	170	NE567★	187
CA3023	170	RAM2102-2★	210
CA3028A★	95	ROM2513★	700
CA3035	140	SG3402★	255
CA3036	180	SL414A	250
CA3043	190	SN72733N	125
CA3046	80	SN76003N	240
CA3048	200	SN76013N	240
CA3075	175	SN76023N	140
CA3080E	80	SN76033N	230
CA3081	190	SN76115N	215
CA3089E	210	SN76227N	175
CA3090AQ	390	TAA621AXI	228
CA3123E	200	TAA661A	155
CA3130★	94	TAA700	353
CA3140	95	TAA960	300
ICM7205★	1150	TAY-1-1313	660
LM300H	170	TAY-3-8550★	750
LM301A	39	TBA120S	90
LM308	140	TBA540Q	220
LM318	195	TBA550Q	355
LM379	395	TBA641BX11	250
LM380	98	TBA651	180
LM381	170	TBA800	90
LM382	125	TBA810S	105
LM3900	65	TBA820	80
LM3909N	70	TBA920Q	350
M252AA★	750	TDA2020	320
M253AA★	795	ZN414	110
		ZN424	130

TRANSISTORS

	p				
AC117	35	BC168C	12	BF198	18
AC125★	19	BC169C	14	BF200	30
AC126★	15	BC170	13	BF224A	18
AC127★	18	BC171	11	BF256★	50
AC128★	18	BC172	10	BF257★	29
AC141★	24	BC177★	18	BF258★	29
AC141K★	38	BC178★	16	BF259★	30
AC142★	24	BC179★	18	BF394	22
AC142K★	38	BC182	10	BF594	40
AC176★	18	BC182L	13	BF595	38
AC187★	20	BC183	10	BFR39	25
AC188★	20	BC183L	12	BFR40	28
ACY17	35	BC184	11	BFR79	28
ACY18★	40	BC184L	14	BFR80	28
ACY19★	40	BC186	24	BFX29★	28
ACY20★	40	BC187★	28	BFX81★	130
ACY21	35	BC212	11	BFX84★	24
ACY22★	40	BC212L	13	BFX85★	28
ACY28★	40	BC213	11	BFX86★	28
ACY39	78	BC213L	14	BFX87★	23
ACY40★	48	BC214	14	BFX88★	26
ACY44	39	BC214L	15	BFY18	50
AD140	69	BC307B	20	BFY50★	17
AD149★	70	BC328	15	BFY51★	17
AD161★	42	BC338★	15	BFY52★	17
AD162★	42	BC441★	45	BFY71	47
AF114★	20	BC461★	38	BSX20	18
AF115★	20	BC462★	45	BSX20★	18
AF116★	20	BC547	12	BSY65★	30
AF117★	22	BC548	12	BSY95A★	18
AF118★	55	BC549C	13	BU105★	140
AF121★	48	BC558	30	BU205★	190
AF124★	55	BCY30★	57	BU208★	225
AF125★	35	BCY34★	75	E5567	65
AF127★	35	BCY39★	78	MO8001★	158
AF139★	35	BCY40★	75	MJ400★	90
AF178★	70	BCY59★	90	MJ491★	160
AF180★	70	BCY70★	15	MJ2955★	120
AF186★	50	BCY71★	20	MJE340★	45
AF239★	42	BCY72★	15	MJE370★	80
ASY26★	40	BD115★	62	MJE371★	80
ASY27★	45	BD121★	78	MJE520★	65
BC107★	9	BD123	98	MJE521★	74
BC107B★	10	BD124★	115	MJE2955★	115
BC108★	9	BD131★	38	MJE3055★	80
BC108B★	12	BD132★	38	MPF102	36
BC108C★	12	BD133★	43	MPF103	36
BC109★	9	BD135	38	MPF104	36
BC109B★	12	BD136	36	MPF105	36
BC109C★	12	BD137	36	MPF106	50
BC113	17	BD138	50	MPF107	50
BC114	20	BD139	34	MPSA05	32
BC115	20	BD140	36	MPSA06	32
BC116	20	BD142	59	MPSA55	30
BC117	20	BD145★	198	MPSA56	30
BC118	20	BDY17★	195	MPSA70	34
BC119	28	BDY60★	110	MPSU02★	58
BC134	20	BDY61★	165	MPSU05★	50
BC135	20	BF115★	22	MPSU06★	56
BC136	18	BF154★	25	MPSU52★	65
BC137	20	BF156★	29	MPSU55★	55
BC140★	35	BF173★	25	MPSU56★	60
BC142★	28	BF177★	24	MPU131★	39
BC143★	28	BF178★	25	OC25★	120
BC147	7	BF179★	30	OC26★	170
BC148	7	BF180★	30	OC28★	105
BC149	8	BF181★	30	OC29★	160
BC153	27	BF182★	30	OC35★	100
BC154	27	BF183★	30	OC36★	170
BC157	10	BF184★	20	OC41★	48
BC158	11	BF194	10	OC42★	40
BC159	11	BF195	10	OC43★	65
BC160★	42	BF196	12	OC44★	35
BC167A	11	BF197	15	OC45★	35

OC46★	35	ZTX504	25	2N3702	10
OC70★	30	ZTX531	28	2N3703	11
OC71★	30	ZTX550	25	2N3704	10
OC72★	30	2N526★	58	2N3705	11
OC77★	76	2N696★	35	2N3706	10
OC79★	76	2N697★	21	2N3707	10
OC81★	28	2N698★	39	2N3708	11
OC82★	45	2N699★	50	2N3709	11
OC82D★	35	2N706A★	19	2N3710	16
OC83★	48	2N707★	50	2N3711	12
OC84★	44	2N708★	19	2N3715★	250
OC123★	115	2N914★	32	2N3772★	170
OC139★	140	2N916★	27	2N3773★	288
OC140★	125	2N918★	30	2N3819	22
OC141★	157	2N920★	51	2N3820	38
OC170★	40	2N930★	18	2N3823★	65
OC171★	40	2N961★	61	2N3824★	70
OC201★	125	2N1131★	22	2N3866★	90
OC202★	140	2N1132★	22	2N3903	20
OC203★	150	2N1302★	35	2N3904	18
OC204★	150	2N1303★	50	2N3905	18
TIP29	43	2N1304★	50	2N3906	17
TIP29A	44	2N1305★	28	2N4037★	52
TIP29C	60	2N1306★	35	2N4058	17
TIP30	52	2N1307★	50	2N4061	17
TIP30A	52	2N1308★	46	2N4064★	120
TIP30B	64	2N1613★	20	2N4236★	145
TIP30C	70	2N1671★	190	2N4289	20
TIP31★	50	2N1671B★	195	2N4859	65
TIP31A★	50	2N1893★	28	2N5135	42
TIP31B★	58	2N1986	60	2N5136	42
TIP31C★	66	2N2160★	105	2N5138	20
TIP32★	55	2N2217★	48	2N5179★	60
TIP32A★	60	2N2218A★	35	2N5180★	60
TIP32B★	75	2N2219A★	22	2N5191★	65
TIP32C★	77	2N2220A★	26	2N5305★	40
TIP33★	85	2N2221A★	25	2N5457	35
TIP33B★	100	2N2222★	20	2N5458	36
TIP33C★	110	2N2297	45	2N5459	38
TIP34★	95	2N2303★	50	2N5485	38
TIP34A★	95	2N2368	25	2N5777	56
TIP34B★	120	2N2369★	15	2N6027	40
TIP35★	219	2N2476	125	40311★	56
TIP35A	225	2N2483★	28	40313★	125
TIP35C★	270	2N2484★	30	40316★	95
TIP36A★	280	2N2646★	48	40317	52
TIP36C★	325	2N2784	55	40326★	52
TIP41A★	66	2N2846	140	40327★	62
TIP41B★	73	2N2894	30	40347★	99
TIP42A★	72	2N2904A★	22	40348★	116
TIP42B★	82	2N2905A★	20	40360★	43
TIP2955★	65	2N2906★	18	40361★	45
TIP3055★	52	2N2907★	20	40362★	48
TIS43	36	2N2907A★	22	40411★	289
TIS44	45	2N2926G	10	40412★	65
TIS46	45	2N2926O	8	40576★	190
TIS50	47	2N2926R	8	40594★	98
TIS74	47	2N2926Y	8	40603★	113
TIS91	24	2N3011★	30	40636★	165
ZTX107	22	2N3053★	17	40673★	87
ZTX108	20	2N3054★	49		
ZTX109	25	2N3055★	60		
ZTX300	16	2N3108	60		
ZTX301	16	2N3121	40		
ZTX302	25	2N3133	43		
ZTX303	25	2N3135	33		
ZTX304	24	2N3250	30		
ZTX311	17	2N3252	36		
ZTX314	24	2N3302	35		
ZTX341	20	2N3442★	142		
ZTX500	17	2N3563	32		
ZTX501	15	2N3614★	169		
ZTX502	19	2N3615★	135		
ZTX503	19	2N3663	26		

Matched Pair 10p extra

NOISE DIODES
25J 105

DIAC*
ST2 25

DIODES

AAZ15	15	OA90	6
AEY11	60	OA91	6
BA100	10	OA95	8
BY100	24	OA200	9
BY126	14	OA202	8
BY127	14	IN914	4
OA9	60	IN916	5
OA10	20	IN4001/2★	5
OA47	12	IN4003★	6
OA70	12	IN4004/5★	6
OA79	12	IN4006/7★	7
OA81	15	IN4148	4
OA85	12	3A/100V★	18
		3A/400V★	20
		3A/600V★	27
		3A/1000V★	30
		6A/600V	54

ZENERS
Range 3.3V to 33V
400mW 9
1.3w 17

VARICAPS
MVAM2 135
BB104 40
BB105B 40
MVAM115 95

★BRIDGE RECTIFIERS (plastic case

1A50V	20	4A800V	120
1A100V	22	6A100V	73
1A200V	25	6A400V	92
1A400V	29	BY164	56
1A600V	34		
2A50V	35		
2A100V	44		
2A200V	46		
2A400V	53		
4A100V	72		
4A400V	79		

TRIACS★
3A 400V 113
3A 500V 140
6A 400V 140
8A 400V 100
15A 400V 200
40430 99
40528 106
40669 110

THYRISTORS* SCRs
1A50V 38
1A 100V 42
1A 200V 47
1A 400V 52
3A 100V 43
3A 400V 110
5A 400V 120
7A 200V 120
7A 400V 125
8A 400V 150
10A/700V 180
C106D 55
TIC44 25
TIC45 45
2N4444 191

PRACTICAL
ELECTRONICS

VOLUME 14 No. 4 DECEMBER 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our January issue will be on sale Friday, 9 December, 1977
(for contents see page 245)

Random FLASHER UNIT
Wired ready for use Complete with three 100 watt coloured lamps that flash independently at random
£18·95
TWIN BANK 6 LIGHT UNIT
(less lamps)
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ES Fitting
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600 WATTS PER CHANNEL
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INCLUDING CHANNEL OUTPUT PLUGS AND MAINS INPUT SOCKET
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(less lamp)
BC Fitting
£1·95 EACH
ES Fitting
£2·12 EACH
TYPE B 3 BANK UNIT
(Less Lamps)
BC Fitting £6·90
ES Fitting £7·26
TWIN BANK 12 LIGHT UNIT
Length 31¾
(less lamps)
BC Fitting £15·60
ES Fitting £17·00
100 WATT SPOT LAMPS
RED, YELLOW, GREEN BLUE, CLEAR
£1·40 each
3 lamps £4·20
B.C. or E.S. Fitting
ALL PRICES INCLUDE V.A.T. and POST & PACKING
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AND

PACKAGE P.A. SYSTEMS (2 Year Guarantee)

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

100 Watt £145
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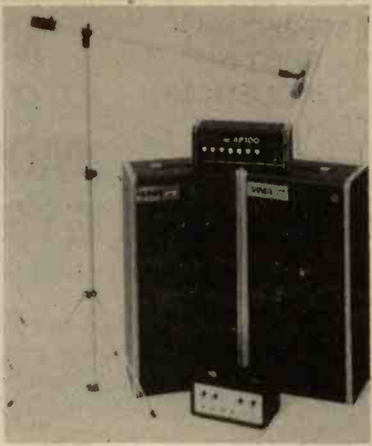
200 Watt £225
Deposit £28.80
12 Months @ £21.38
24 Months @ £12.01

These systems come complete with a Four Channel Amplifier, Leads etc. The 200 Watt system features Twin 100 Watt drive units in each cabinet.



ALSO ILLUSTRATED:
Melos Echo Unit £59.00 Boom Stand £15.50 Electret Mic ECM81 £19.95* Floor Stands £9.90 EM507 Mic* £15.00 Phasers £19.80

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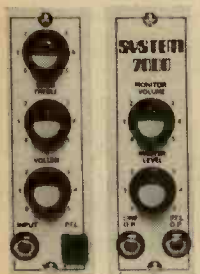

Input Stages Up to 20	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Mixer/Monitor (One only per system)	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Power supply for up to 20 channels		£9.50	Blank panel	£1.00

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7402	16p	7445	123p	7496	83p	CD4002	16p	CD4024	83p	CD4055	140p	CD4088	POA
7403	16p	7446	123p	74100	130p	CD4006	110p	CD4025	20p	CD4056	140p	CD4501	POA
7404	22p	7447	102p	74107	38p	CD4007	20p	CD4026	180p	CD4060	117p	CD4502	130p
7405	22p	7448	130p	74118	125p	CD4008	87p	CD4027	56p	CD4066	70p	CD4507	50p
7406	44p	7454	16p	74121	38p	CD4009	62p	CD4028	88p	CD4067	418p	CD4510	132p
7407	44p	7470	38p	74122	56p	CD4010	62p	CD4029	118p	CD4068	24p	CD4511	172p
7408	23p	7472	28p	74123	103p	CD4011	18p	CD4030	62p	CD4069	22p	CD4516	132p
7409	23p	7473	38p	74144	340p	CD4012	20p	CD4036	130p	CD4070	60p	CD4518	114p
7410	16p	7474	33p	74145	83p	CD4013	50p	CD4041	87p	CD4071	22p	CD4520	114p
7411	24p	7475	46p	74153	82p	CD4015	87p	CD4042	88p	CD4072	23p	CD4522	POA
7412	24p	7476	40p	74154	138p	CD4016	50p	CD4043	98p	CD4076	107p	CD4526	POA
7413	38p	7480	46p	74165	118p	CD4017	98p	CD4044	98p	CD4077	66p	CD4528	POA
7414	41p	7482	91p	74174	132p	CD4018	98p	CD4045	180p	CD4078	24p	CD4572	POA
7416	33p	7483	86p	74175	78p	CD4019	68p	CD4046	131p	CD4081	23p	CD4583	POA
7417	33p	7485	106p	74180	86p	CD4020	118p	CD4047	88p				
7420	16p	7486	38p	74181	296p	CD4021	98p	CD4049	65p				
7425	28p	7489	300p	74190	142p								
7427	28p	7490	57p	74191	131p								
7430	30p	7491	82p	74192	131p								
7432	28p	7492	57p	74193	131p								
7437	28p	7493	57p	74196	130p								
				74198	185p								

D.I.L. Sockets

8	10p	16	14p
14	13p	28	30p

LINEAR I.C.s

CA3028	86p	MC1496	78p
CA3046	90p	NE555	33p
CA3052	152p	NE556	78p
CA3076	138p	NE561	388p
CA3080	57p	NE562	385p
CA3089	236p	NE565	138p
CA3090	327p	NE566	128p
CA3130	113p	NE567	175p
CA3140	74p	SN76003	185p
CA3160	140p	SN76013	185p
LM301	38p	SN76023	180p
LM308	54p	SN76033	250p
LM380	100p	TAA621	257p
LM381	120p	TAA661	175p
LM710	41p	TBA540	236p
LM741	24p	TBA641	281p
LM747	73p	TBA800	102p
LM748	38p	TBA810	113p
LM3900	73p	TBA820	90p
MC1304	282p	μA723	57p
MC1310	197p		
MC1351	78p		
MC1458	78p		

DIODES

BY127	18p
OA47	8p
OA70	9p
OA79	14p
OA81	15p
OA85	14p
OA91	7p
OA95	9p
OA200	8p
OA202	9p
IN914	4p
IN916	6p
IN4001	6p
IN4002	6p
IN4003	6p
IN4004	7p
IN4005	10p
IN4006	10p
IN4007	11p
3 amp 50 P.I.V.	18p
3 amp 100 P.I.V.	18p
3 amp 200 P.I.V.	18p
3 amp 400 P.I.V.	20p
3 amp 600 P.I.V.	25p

10 amp 50 P.I.V.	25p
10 amp 100 P.I.V.	25p
10 amp 200 P.I.V.	28p
10 amp 400 P.I.V.	38p
10 amp 600 P.I.V.	42p
BRIDGE RECS	
1 amp 50 P.I.V.	22p
1 amp 100 P.I.V.	24p
1 amp 200 P.I.V.	27p
1 amp 400 P.I.V.	38p
1 amp 600 P.I.V.	34p
2 amp 50 P.I.V.	34p
2 amp 100 P.I.V.	36p
2 amp 200 P.I.V.	38p
2 amp 400 P.I.V.	40p
2 amp 600 P.I.V.	42p
TRIACS	
2 amp 100 P.I.V.	28p
2 amp 200 P.I.V.	42p
2 amp 400 P.I.V.	71p
6 amp 100 P.I.V.	50p
6 amp 200 P.I.V.	66p
6 amp 400 P.I.V.	81p
10 amp 100 P.I.V.	66p
10 amp 200 P.I.V.	100p
10 amp 400 P.I.V.	113p
10 amp 400 Plastic	130p
15 amp 400 P.I.V.	420p
30 amp 400 P.I.V.	430p

D32 Diac	20p
BR100 Diac	20p
S.C.R.	
1 amp 50 P.I.V.	28p
1 amp 100 P.I.V.	30p
1 amp 200 P.I.V.	38p
1 amp 400 P.I.V.	40p
1 amp 600 P.I.V.	58p
1 amp 800 P.I.V.	68p
3 amp 50 P.I.V.	34p
3 amp 100 P.I.V.	36p
3 amp 200 P.I.V.	38p
3 amp 400 P.I.V.	51p
3 amp 600 P.I.V.	60p
3 amp 800 P.I.V.	90p
5 amp 200 P.I.V.	50p
5 amp 400 P.I.V.	58p
5 amp 600 P.I.V.	75p
7 amp 200 P.I.V.	68p
7 amp 400 P.I.V.	75p
7 amp 600 P.I.V.	123p
10 amp 200 P.I.V.	87p
10 amp 400 P.I.V.	70p
10 amp 600 P.I.V.	83p
ZENERS	
Range 2·2–35 volts	
400m/watts	10p
1·3 watts	20p

TRANSISTORS

AC126	21p	BC148	10p	BC547	14p	BF183	37p	MJ2955	99p	2N1305	21p
AC127	21p	BC149	10p	BC548	14p	BF194	13p	MJE340	64p	2N1306	27p
AC128	21p	BC157	11p	Bc549	27p	BF195	13p	MJE2955	99p	2N1711	21p
AC176	21p	BC158	11p	BC557	14p	BF196	13p	MJE3055	68p	2N2219	21p
AC187	23p	BC159	11p	BCY34	74p	BF197	16p	OC28	108p	2N2904	21p
AC188	23p	BC168	12p	BCY70	17p	BF200	38p	OC35	108p	2N2905	21p
AD149	65p	BC169	12p	BCY71	20p	BF224	16p	OC71	18p	2N2906	17p
AD161	50p	BC171	12p	BCY72	17p	BF257	37p	OC84	48p	2N2926G	9p
AD162	50p	BC172	12p	BD115	58p	BF258	40p	TIP29C	50p	2N2926R	9p
AF114	38p	BC173	12p	BD124	87p	BF259	44p	TIP30	52p	2N2955	130p
AF115	27p	BC177	18p	BD131	47p	BFR39	30p	TIP31A	47p	2N3053	17p
AF116	25p	BC178	18p	BD132	47p	BFX29	34p	TIP32A	61p	2N3054	54p
AF117	23p	BC179	18p	BD135	43p	BFX30	38p	TIP33	90p	2N3055	54p
AF118	38p	BC182L	13p	BD136	50p	BFX84	27p	TIP34	195p	2N3702	10p
AF124	42p	BC183L	11p	BD137	50p	BFX85	34p	TIP35	292p	2N3703	10p
AF125	42p	BC184L	13p	BD138	51p	BFX86	31p	TIP36	389p	2N3704	10p
AF126	25p	BC212L	13p	BD139	61p	BFX87	31p	TIP41A	54p	2N3705	10p
AF139	40p	BC213L	13p	BD140	52p	BFX88	31p	TIP42A	54p	2N3706	10p
AF239	53p	BC214L	14p	BF173	30p	BFY50	17p	TIP2955	126p	2N3708	10p
BC107	9p	BC238	14p	BF179	37p	BFY51	17p	TIP3055	64p	2N3709	10p
BC108	9p	BC303	30p	BF180	37p	BFY52	17p	ZTX108	12p	2N3711	10p
BC109	9p	BC328	15p	BF181	37p	BSX20	21p	ZTX300	13p		
BC147	10p	BC338	15p	BF182	37p	BU105	191p	ZTX500	15p		

SWITCHES

Toggle		
Large	SPST	27p
	DPST	29p
	DPDT	35p
STD	SPST	68p
	SPDT	70p
	DPDT	75p
MIN.	SPST	54p
	SPDT	58p
	DPDT	70p
	DPDT c/off	90p
SUB. MIN.	SPST	48p
	SPDT	52p
	DPDT	60p

ROTARY SWITCHES

1 Pole 12 way	46p
2 Pole 2 way	46p
2 Pole 4 way	46p
2 Pole 6 way	46p
3 Pole 3 way	46p
3 Pole 4 way	46p
4 Pole 2 way	46p
4 Pole 3 way	46p
Mains DPDT	45p
BULGIN Foot Switch	
DPDT	160p
SPST	115p

Push Button SPST Locking	60p
Push Button SPDT Locking	68p
Push Button DPDT Locking	91p
Bias push to make	15p
Bias push to break	20p
Slide DPDT SUB. MIN.	13p
Slide DPDT STD.	13p
Slide DPDT c/off	15p

TRANSFORMERS (Mains, prim. 220-240V)

LT44		60p	6-0-6	1·5A	345p
LT700		60p	9-0-9	1A	280p
6-0-6	100MA	93p	9-0-9	2A	308p
9-0-9	74MA	97p	12-0-12	1A	317p
12-0-12	100MA	99p	15-0-15	1A	350p
0-6-0-6	280MA	140p	20-0-20	2A	544p
0-12-0-12	150MA	150p	25-0-25	2A	585p
6·3V-1·5a		284p	30-0-30	2A	825p

12-15-20-24-30 Tapped 1 amp	455p
12-15-20-24-30 Tapped 2 amp	657p
Pulse TRX 1·1	170p

Potentiometers	
1K—2MΩ Single gang LIN or LOG	27p
5K—2MΩ Single gang D/P switch LOG	55p
5K—2MΩ Dual gang stereo LIN or LOG	70p
SLIDERS	
5K—500K Single Gang LIN or LOG	73p
5K—500K Dual Gang Stero LIN or LOG	88p
Presets sub. min. vert. Horiz. 100Ω—5MΩ	10p
Slider Bezzels 21p Slider Knobs	10p

LOUD SPEAKERS

1½in	8Ω	72p
1¾in	8Ω	72p
2in	8Ω	72p
2¼in	8Ω	64p
2½in	8Ω	64p
2½in	64Ω	72p
2¾in	8Ω	78p
2¾in	80Ω	118p
JACK PLUGS	**Chrome**	**Plastic**
2·5mm	13p	10p
3·5mm	17p	12p
6·3 Mono	26p	17p
6·3 Stereo	35p	21p
RCA Phono	12p	10p
DIN 2, 3, 4, 5, 6, 7 pin		15p
SKT 2, 3, 4, 5, 6, 7 pin		10p

Desoldering Gun	640p
Spare Nozzle	85p
Antex X25 Watt Iron	387p
Antex C/2 15 Watt Iron	387p
Antex CX 15 Watt Iron	387p
PP3 Battery Clips	6p
PP9 Battery Clips	10p
Battery Holder 4 pen Cells	20p
Etching Pen	81p
Ferric Chloride	95p
Etching Kit	245p
Telephone Pick-up Coil	70p
Ear Piece 2·5mm or 3·5mm	16p
Ear Piece Crystal	33p

RESISTORS	
0·33W 10Ω-1MΩ E24	2p
0·5W 10Ω-10MΩ E24	2½p
2·5W 0·22Ω-10Ω w/w	23p
5W 4·7Ω-10kΩ w/w	12p
10W 10Ω-10kΩ w/w	15p
S DEC	218p
T DEC	382p
μ DEC A	417p
μ DEC B	717p
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Black or black/silver Flex	
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BD 103 Alternative unit without arm and lifting device.

The BD 103 Transcription turntable and External Power unit

Connoisseur

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Manufacturers of Connoisseur Sound Equipment, Connoisseur Works, Atlas Mill Road, Brighouse, West Yorkshire HD6 1ES
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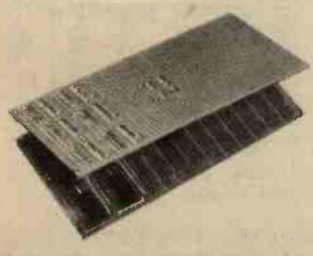

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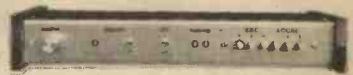

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Volts	No.	Price
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100	THY10A/100	£0·57
200	THY10A/200	£0·62
400	THY10A/400	£0·71
600	THY10A/600	£0·99
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16 AMP TO48 CASE

Volts	No.	Price
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200	THY16A/200	£0·62
400	THY16A/400	£0·77
600	THY16A/600	£0·90
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Volts	No.	Price
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Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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MC3	24	miniature ceramic capacitors, 3 of each value—470pF, 560pF, 680pF, 820pF, 1,000pF, 1,500pF, 2,200pF and 3,300pF	16162	*£0·60
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Set of basic component kits	from £64·25
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The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists.

Set of basic component kits	£83·03
Set of printed circuit boards	£13·20

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists.

Set of basic component kits	£48·18
Set of printed circuit boards	£7·66

GUITAR EFFECTS PEDAL (P.E. July 75)
Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches	£7·59
Alternative component set with panel mounting switches	£4·96
Printed circuit board	£1·43

SOUND BENDER (P.E. May 74)
A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

Component set for above functions (excl. SWs)	£7·84
Printed circuit board	£1·81

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

Component set (incl. PCB)	£2·88

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

Component set (incl. PCB)	£2·87

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

Component set (incl. PCB)	£4·48

SOPHISTICATED PHASING AND VIBRATO UNIT
A slightly modified version of the circuit published in "Elektor", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.

Component set	£17·69
Printed circuit board	£2·33

WAH-WAH UNIT (P.E. Apr. 76)
The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB)	£3·55

AUTOWAH UNIT (P.E. Mar. 77)
Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches	£7·27
Component set and PCB, with panel switches	£4·83

P.E. JOANNA (P.E. May/Sept. 75)
A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.
Main power supply, tone generator, 61 envelope shapers, voicing and pre-amp circuits.

Set of basic component kits for above	£75·29
Set of printed circuit boards for above	£20·35
Power amplifier	£15·97
Printed circuit board for power amp	95p

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5-octave electronic organ with 5 basic voices that can be used individually or together, 5 pitches (2ft, 4ft, 8ft, 16ft, 32ft), variable attack, tremolo, vibrato, phasing, and variable sustain. Details in our list.

ORGAN CONVERSION KIT
Converts the P.E. Joanna electronic piano to also provide most of the facilities offered by the above electronic organ.

Basic component set and PCB	£12·34

SYNTHESISER TUNING INDICATOR (P.E. July 77)
A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.)	£7·45

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77)
A modified and extended version of the circuit published. Details in list.

SEE OTHER PAGE FOR KEYBOARDS, AND OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED

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

Component set (incl. PCB)	£3·72

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)
Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot	£6·86
Component set using dual rotary pot	£6·20
Printed circuit board	£1·62

FUZZ UNIT
Simple Fuzz unit based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·03

TREMOLO UNIT
Based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£3·64

TREBLE BOOST UNIT (P.E. Apr. 76)
Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB)	£2·40

P.E. TUNING FORK (P.E. Nov. 75)
Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike.

Main component set (incl. PCB)	£15·59
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P.E. SYNCHRONOME (P.E. Mar. 76)
An accented-beat electronic metronome, providing duple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.

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Printed circuit board	£2·04

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Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs

Standard tolerance set of components	£2·96
Superior tolerance set of components	£3·78
Regulated power supply (will drive 2 sets)	£4·69

ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)
Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.

Component set (incl. PCB)	£4·66

ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)
This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB)	£6·68

TRANSIENT GENERATOR (P.E. Apr. 77)
An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a "Repeat Effect" enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.

Component set	£4·52
Printed circuit board	£1·82

WAVEFORM CONVERTER
Slightly modified from a circuit published in a German edition of "Elektor". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw's)	£8·19

VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 65-1)	£8·22

RING MODULATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 59-1)	£5·50

NOISE GENERATOR (P.E. Jan. 75)
Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 60-1)	£3·35

SOPHISTICATED POWER SUPPLIES
A wide range of highly stabilised low noise power supply kits is available—details in our lists.

MICROPHONE PRE-AMP (P.E. Apr. 77)

Component set (incl. PCB)	£3·78

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over"—particularly useful for Disco work or for home-movie shows.

Component set (incl. PCB)	£3·97

DYNAMIC RANGE LIMITER (P.E. Apr. 77)
Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4·58

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AND OTHER PROJECTS

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

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

OVERSEAS enquiries for list: Europe—send 20p; other countries—send 40p.

KEYBOARDS AND CONTACTS
Kimber-Allen Keyboards as required for many published circuits, including the P.E. Joanna, P.E. Minisonic, and P.E. Synthesiser. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame.
3 Octave (37 notes) £25·50. 4 Oct (49 notes) £32·25. 5 Oct (61 notes) £39·75.
Contact Assemblies for use with above keyboards: Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally-open make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard. See our list for other contacts.

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BC159	13p
BC182L	12p
BC184	12p
BC187	25p
BC204	14p
BC209C	14p
BC212L	15p
BC213	15p
BC478	29p
BCY71	22p
BD131	44p
BD132	54p
BFY50	22p
BFY51	22p
BFY52	24p
BSY95A	22p
MD8001	172p
OC28	60p
OC71	20p
OC72	25p
OC84	25p
ORP12	70p
ZTX107	12p
ZTX108	9p
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ZTX503	15p
ZTX531	23p
2N706	13p
2N914	22p
2N1304	22p
2N2219	27p
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2N2905A	36p
2N2907	22p
2N3053	18p
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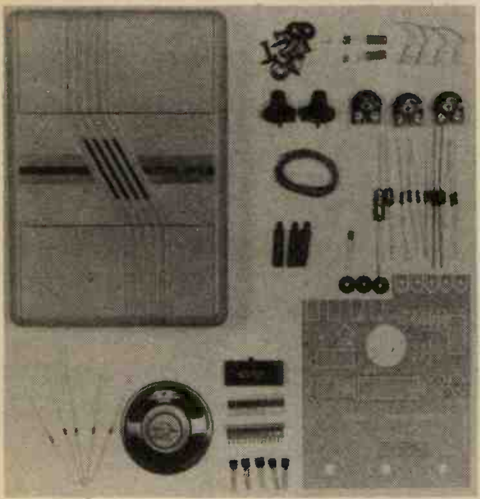

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PE VOLUME 14 No. 4 DECEMBER 1977

THE WAY THINGS GO

As the year approaches its end a little ruminating may not be amiss. Around 1967 PRACTICAL ELECTRONICS was but a few years old and we were all still busily engaged in exploring the uses of the transistor, when the integrated circuit became generally available and started to alter the pattern of circuit design. Today we find ourselves in a somewhat parallel situation to the late 1960s, with the microprocessor now marking the latest revolution in the far from placid history of electronics.

As would be expected, microprocessors have made their initial impact in the industrial and the Service areas, and only just now are these devices beginning to appear in consumer products. Amongst the very first of this kind is a 24-tune door chime. (The designer is in fact a past contributor to this magazine.) To follow, we are promised intelligent toys and combination door locks, according to one speaker at a recent Texas Instruments Seminar. *Hurrah for technology!* Yes, we will not be surprised if some eyebrow-raising greets these disclosures.

We can also make a disclosure. Amateur-inspired combination lock circuits have been an editor's embarrassment ever since TTL chips became cheap and abundant. Like several other popular circuit ideas, they had more worth as design than in any real-life use.

Looking back, it is amusing to recall that P.E. has in the past been accused by a few individuals of encouraging the alleged "frivolous" use of electronics. Evidently, if this is done on a large enough scale and turns into profitable business, the frivolity can be overlooked! The real truth is that, paradoxically, the more advanced the technology the easier it becomes to apply it to what some might consider trivial or frivolous purposes. Thus does electronics perform as a major conditioner of all our affairs.

At this particular moment one certainly gets the impression that microprocessor makers are still groping around for ways to use their latest wonder devices. Large and potentially valuable areas have indeed been marked out for attention. One such is the motor car industry, but to fully implement the use of the latest in electronics in a non-electronic industry is bound to take time.

Various smaller-scale developments are happening of course, often on a modest budget, perhaps in rather unpretentious laboratories. Some examples came to light during the SERT Symposium last September. It became clear that cash constraints and the inability to purchase the very latest in MPUs are no deterrent to enthusiasm among dedicated workers, especially if the goal is something really worthwhile and of likely benefit to mankind, as for example in the medical field.

Serious amateur experimenters are kindred spirits to these professional "loners" and will also have their contributions to make in this latest area of our technology. Here it might be pertinent to say that the biggest memory and the fastest MPU are not necessarily the best for every purpose. The Mini has not been rendered obsolescent by the TR7.

NON-CRYSTAL BALL

From the present, a peep into the future. What will be the next milestone in electronics?

The award of the Nobel Prize for Physics to Sir Nevill Mott (shared with two American physicists) for work on amorphous materials at Cambridge naturally reawakens interest in the use of non-crystalline materials, particularly glass, as the basis for a new generation of semiconductor devices. Low cost is the chief virtue of glass as a semiconductor and one possible application relates to solar cells. It is being suggested that amorphous solar cells could change the whole situation making direct generation of electricity from solar radiation a perfectly economic operation.

SWITCHING OFF

At this point our crystal gazing must stop: quite finally unfortunately, so far as the present writer is concerned. To explain this a change to the first person now seems in order.

After guiding the destiny of PE since its inception I now have reluctantly to relinquish my editorship. This is due to the relocation of our editorial offices to Poole, Dorset. It is especially sad to part at this very time since PE has now become number one in its field in the UK.

These thirteen years have been exciting, stimulating and rewarding. A great number of contacts have been made with members of all sections of the industry, with advertisers, and with contributors. I have been fortunate in that many of these have become more than just business associations; friendships have been made which I greatly value.

There is of course that far larger band of readers with whom I have always felt a strong rapport despite no direct personal contact. To these unseen tens of thousands who have supported PRACTICAL ELECTRONICS throughout the years (including the critics) I am conscious of my indebtedness. For it is in the end the readers who make a magazine. Our task is to try and meet their needs. I can only hope that in the aggregate we have succeeded.

Also leaving PRACTICAL ELECTRONICS will be colleague David Barrington who has worked with me continuously since the pre-launch period in early 1964. He has been a key figure in the compilation of every issue, and his varied feature writing responsibilities included *Market Place*. Dave will join our associate publication EVERYDAY ELECTRONICS which I will continue to edit from our London Offices.

So now, cheerio. FRED BENNETT.

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IF you've ever had to leave your car in a "shady" area of town, and you are only too aware of how little opposition the average car lock presents to a thief, then you probably will have promised yourself a burglar alarm one day. It's not just a question of your car being stolen, but you could come back to find your "in-car" music centre missing, and even a simple system is a good deterrent while there are still other vehicles around without protection.

This automobile burglar alarm is triggered by the door operated courtesy light switches, causing pulsation of the horn and headlights, and features exit and entry time delays with the ON/OFF switch *hidden* somewhere to hand inside the car. The alarm unit itself is fixed in a convenient location somewhere under the bonnet.

CIRCUIT OPERATION

The circuit diagram of the alarm is shown in Fig. 1. With the latch (TR1 and TR2) in the "off" state (TR2 collector low), Timer A is disabled via D2, and the relay is not energised so that the car headlights and horn are off. When the latch is in the "on" state, Timer A is allowed to oscillate, thereby repetitively energising and de-energising the relay, and thus the horn and headlights.

The latch toggles from the "off' to the "on" state when triggered by any of the door switches, except for a short interval after power is applied to the circuit via the hidden switch, when Timer B holds the latch off while the driver vacates the vehicle.

When S1 is closed, C1 begins to charge through R6, at which time the output of Timer B is high, biasing TR2 on, irrespective of the state of all door switches. While TR2 is on, C4 is prevented from charging, and the output of Timer A is high, de-energising the relay. During this interval, the warning light mounted on the dashboard is illuminated to indicate that it is safe to open the car door.

After about 17 seconds ($1{\cdot}1 \times C1 \times R6$), the voltage across C1 reaches the threshold level of Timer B, and the output goes low, releasing the latch and turning off the warning light to indicate that opening the car door will now trigger the alarm.

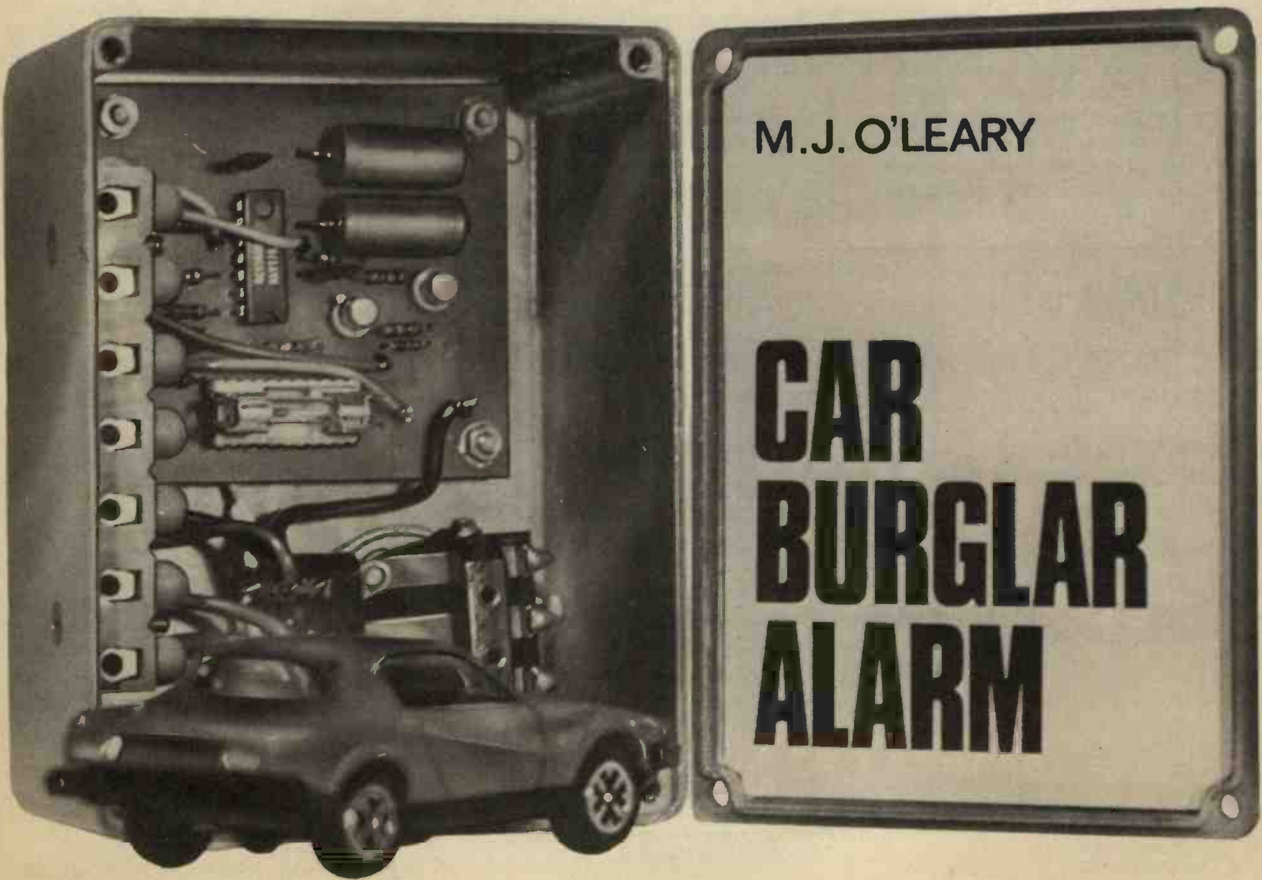
When one of the door switches is operated (closed) by opening the door, even momentarily, the latch toggles from "off" to "on", so that TR2 collector is high. This allows C4 to charge through R7 and R8. After about 18 seconds ($1{\cdot}1C4\,[R7 + R8]$), the voltage across C4 reaches the threshold level of Timer A and the output goes low, energising the relay.

At the same time, C4 begins to discharge through R8 and the timer pin 13. The discharge period lasts for about 11 seconds ($0{\cdot}7 \times C4 \times R8$), until the voltage across C4 falls to the trigger level of Timer A. At this point the timer output goes high, de-energising the relay. Also, the timer discharge pin (pin 13) is now disabled, so that C4 begins to charge once more through R7 and R8.

The charging period this time lasts for about 12 seconds ($0{\cdot}7C4\,[R7 + R8]$) before discharging proceeds as before, so that from now on, the relay is repeatedly energised and de-energised for periods of 11 and 12 seconds respectively.

During the 18 second interval, between the latch being triggered by the door switch and the relay first being energised, the circuit can be de-activated by opening S1. This allows the car owner to enter the vehicle and turn off the power before the horn and headlights operate.

The capacitors C1 and C4 must be low leakage types, otherwise the threshold levels of the timers will not be reached. The remaining components are not critical.



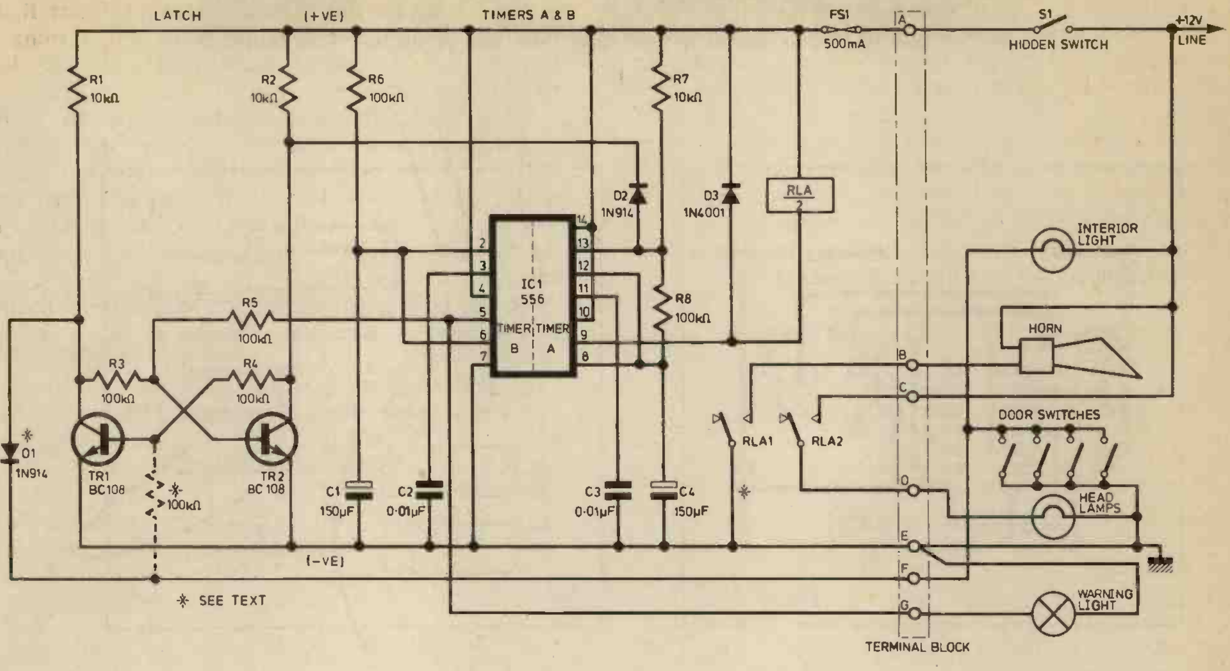


Fig. 1. Burglar Alarm circuit diagram. For positive earth vehicles, D1 is replaced by a 100kΩ resistor which goes to the base of TR1

COMPONENTS . . .

Resistors
R1, R2, R7 — 10kΩ (3 off)
R3, R4, R5, R6, R8 — 100kΩ (5 off)
All resistors ¼W min carbon

Capacitors
C1, C4 — 150µF/15V solid tantalum (2 off)
C2, C3 — 0·01µF ceramic (2 off)
The tant' capacitors must be low leakage (<0·01µA/µFV)

Transistors
TR1, TR2 — BC108 (2 off)

Integrated Circuits
IC1 — 556 Timer

Diodes
D1, D2 — 1N914 (2 off)
D3 — 1N4001

Miscellaneous
Single sided p.c.b. 58 × 66mm
P.c.b. pins
S1 on/off toggle switch
FS1 500mA fuse and 20mm holder
Relay, 12V/110Ω, 2 pole c/o, 10A contacts (Doram)
Diecast box 114 × 55 × 89mm
Terminal block, 7-way
Grommet, 6mm (¼in)
P-clip, size N2
Warning lamp, 12V/2·2W. (An l.e.d. could be used in series with a 680Ω resistor)

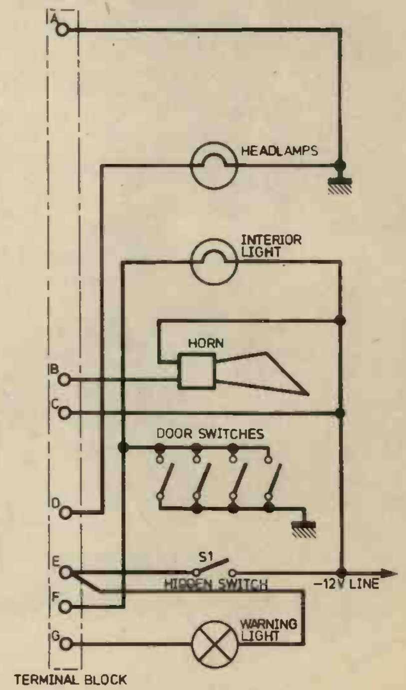


Fig. 2. External wiring arrangement for positive earth vehicles

CAR BURGLAR ALARM

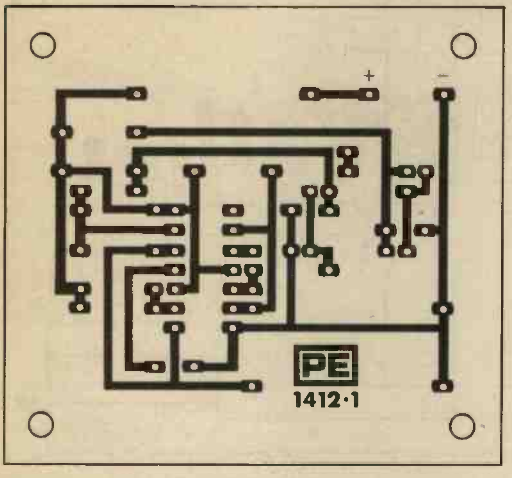


Fig. 3. Printed circuit for Car Burglar Alarm

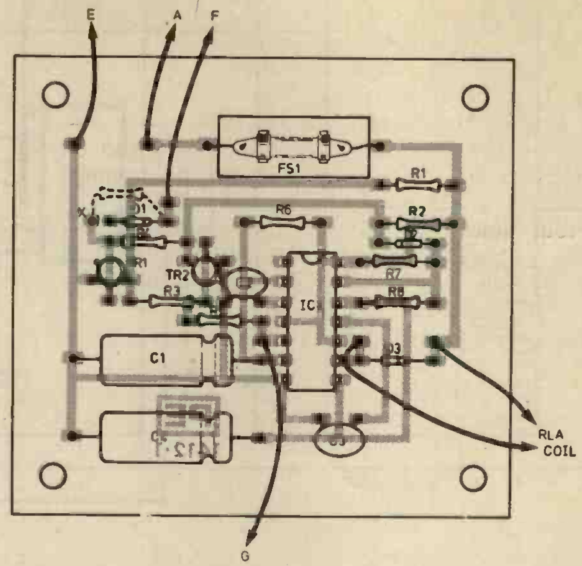
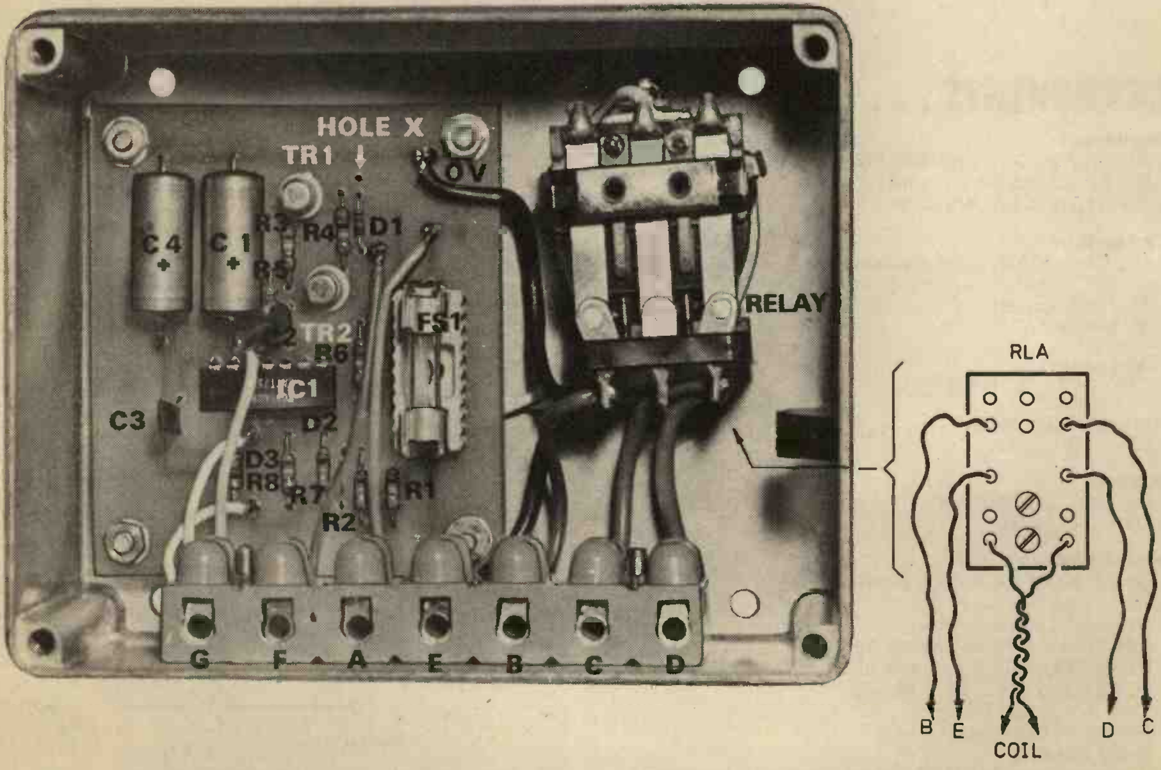


Fig. 4. Component layout of Burglar Alarm board. The spare pad (marked X) is for the "positive earth" modification



The details shown for wiring up RLA are only correct for the Doram type 72-722-0 relay

CONSTRUCTION

The unit comprises a small p.c.b. (which is shown in Fig. 3), a suitable relay, and a seven way terminal block, all housed in a diecast aluminium box which is mounted under the car bonnet. Firstly the p.c.b. should be assembled following the diagram of Fig. 4, and then the metalwork should be carried out.

Four holes are drilled through the base of the box to accommodate the p.c.b. mounting screws. These screws will be independently fastened with nuts to form studs over which the p.c.b. can be placed. They will also act as spacers to separate the board from the base of the box. Fixing holes for the relay should be drilled, and also for the terminal block, and one further hole for the grommet through which the interconnecting leads will enter.

A final four holes are necessary for the self tapping screws which will secure the whole unit to the car. This means that the unit has to be screwed down with the lid off, and the lid subsequently replaced. Make sure that these drillings are situated where there will be plenty of room to introduce a screwdriver once the "bits and pieces" are installed inside the box.

A robust case with tight fitting lid was chosen in preference to a plastics type because the environment inside an engine compartment is pretty hostile. The box will have to stand up to vibration, corrosive elements, and severe heat variations. The unit should be screwed together tightly, using shakeproof washers wherever possible. Good soldering is also necessary.

CONVERSION TO POSITIVE EARTH

The unit as shown in Fig. 1 is designed for negative earth cars, but it can readily be adapted for positive earth vehicles. See Fig. 2.

In this case the positive terminal of the unit (A) is connected directly to earth, instead of S1, and the negative terminal of the unit (E) is now connected to S1, which continues on to −12 volts.

The same p.c.b. and components are used, with the exception that D1 is replaced by a 100kΩ resistor, and an extended pad (marked X in Fig. 4) is provided for this larger component, which goes to the base of TR1 instead of its collector. This is so that the latch can still be triggered by the door switches which are generally connected to earth, and which will give a positive voltage in this case.

The horn and headlight relay contact connections are similar to those for a negative earth system, except that now the horn connection inside the unit (RLA1 pole) is connected to the positive rail instead of the negative one, and the headlights (terminal block C) are connected to negative supply instead of the original +12 volts.

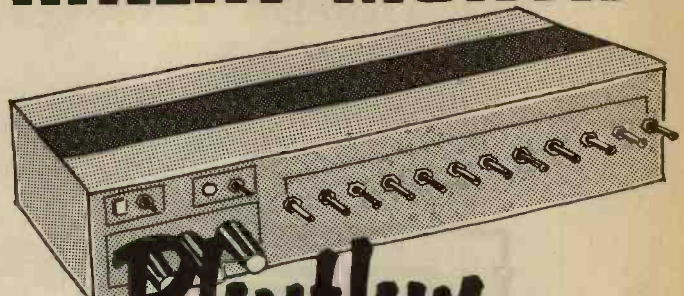
The warning light will still be connected between terminal block points G and E, but since point E is no longer earth, all wiring relating to this lamp will need to be insulated from the car chassis.

POINTS TO CHECK

The wiring details given in this article are based on certain assumptions, but the following points should be verified before wiring up the unit: That the headlamp bulbs, and door switches return directly to the car chassis, irrespective of the polarity of the system; and that the horn returns to "Line" and *not* chassis, i.e. +ve for a negative earth vehicle, or −ve for a positive earth vehicle.

These checks can be made with a simple multimeter, or even a small 12 volt bulb, and the internal relay can be rewired to compensate for any variations encountered. ★

...NEXT MONTH



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PART 2

128 NOTE SEQUENCER

D. G. EVANS

IN this second and final part describing the 128 note sequencer, details will be given for constructing the three sub-assemblies making up the unit together with testing procedures and patching examples for use with a synthesiser.

POWER SUPPLY

The power requirements for the sequencer are positive five volts at about 200mA and five volts negative at a very low current for the 741 op amp. The circuit for this is given in Fig. 7 and provides both regulation and stabilisation for the two lines.

Constructional details for realising this are given in Fig. 8 which shows the majority of components mounted on a 76 × 54mm printed circuit board. When assembled both this and the transformer are mounted on a simple angled aluminium sub-frame. The p.s.u., main and counter display boards should be mounted on the baseboard adjacent to the control panel.

MAIN BOARD

The p.c.b. and component layout for the circuit of Fig. 2 is given in Fig. 8. Here i.c. sockets are used throughout to obviate the possibility of chip damage in assembly. They also facilitate the replacement of i.c.s.

When this board is assembled all i.c.s apart from the RAM should be inserted. This will enable the clock oscillator, counter and D-A converter to be checked for correct functioning.

First the control panel is made up from a piece of 135 × 235mm aluminium. This should be drilled and cleared to suit the components shown annotated in the photograph.

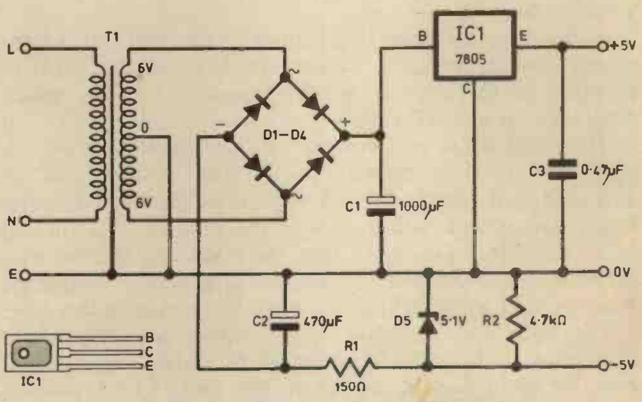


Fig. 7. Circuit of power unit

The Letraset legends were layed on a black paint background and then secured with a clear polyurethane spray.

After this preparation and finishing the control components should be fitted and wired according to Fig. 10 to the main board.

DIGITAL READOUT OF COUNTER

It was found when operating the prototype sequencer that it was often helpful to know what position in the memory had been reached when writing in a tune. It was considered that a full numerical display of the counter state was not necessary, and should greatly increase the cost of the unit. Fig. 9 shows an alternatiye arrangement which was used in the prototype. In this the binary number at the memory address inputs of IC3 is displayed on seven l.e.d.s, driven via buffer transistors.

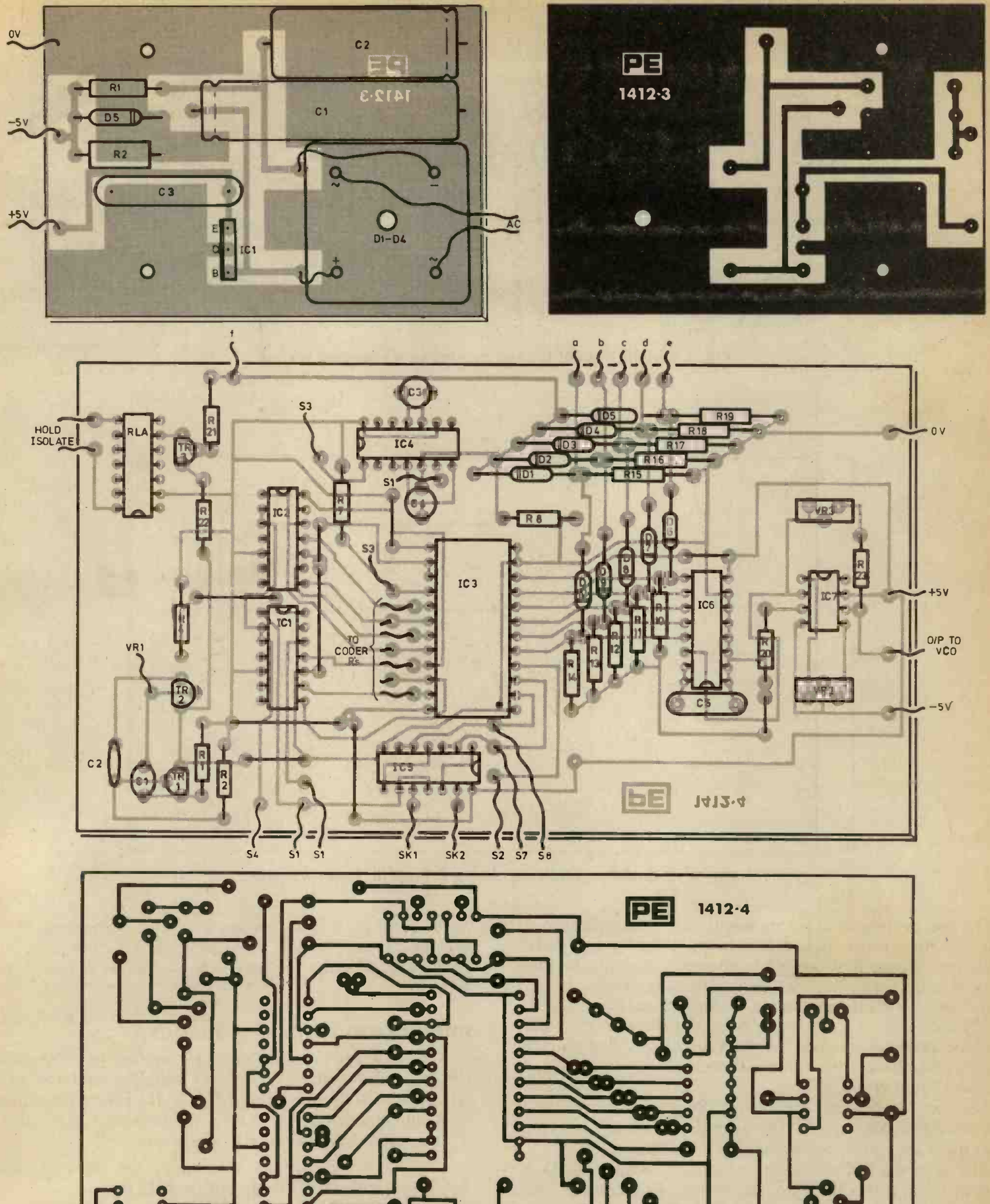


Fig. 8 (top). Showing component layout and p.c.b. for main components of power unit and (below) component board and etching details for the main circuit (Fig. 2)

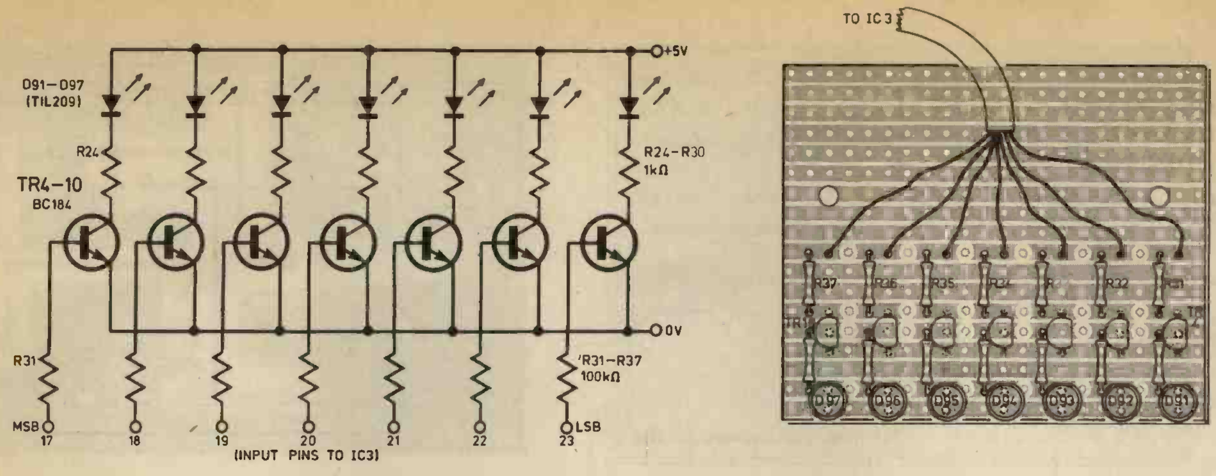


Fig. 9. Circuit of counter and prototype Veroboard layout

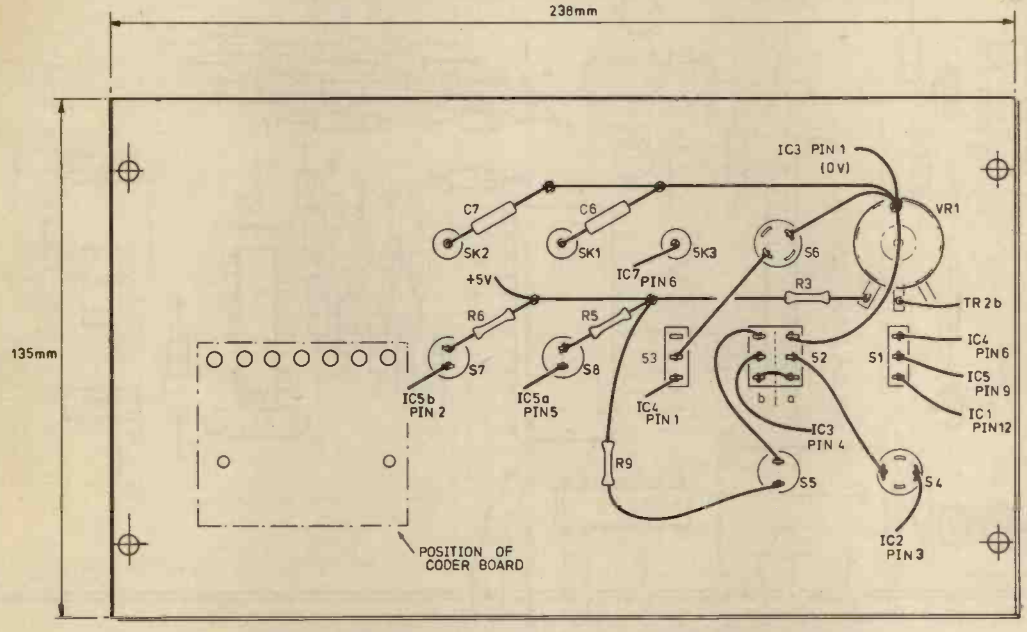


Fig. 10. Interwiring and component layout for control panel

On the prototype unit this circuit was assembled on a 45 × 55mm 0·1in matrix Veroboard (Fig. 9) and fixed with two screws and bushes to the control panel so that all the l.e.d.s are visible via cut-outs from the front.

To check circuit functioning set the "Stop/Run" switch to "Run" and apply power. With a voltmeter or oscilloscope examine whether the clock oscillator is producing pulses and the correct binary count appears at the l.e.d. "Count" display.

Set the "Stop/Run" switch to "Stop" and check that depressing a key causes the counter to step, and also that it causes a pulse to appear at pin 1 of IC4.

Still with the MCM6810 out of circuit, connect the D-A output to a synthesiser v.c.o. Adjust the offset control VR2 (Fig. 2) until the sequencer output is zero with no keys depressed. Now adjust the gain control VR3 so that playing consecutive octaves on the keyboard produces the correct pitch change in the v.c.o. (It may be necessary to adjust the value of the feedback resistor R23 to obtain the correct pitch span.)

If all is correct so far, switch off the power and insert the MCM6810.

On reapplying power, a random series of notes should be sounded by the v.c.o. when the clock is running. Pressing the "Erase" switch while running the clock at a fast speed will clear the memory. The sequencer is now ready for use.

PROGRAMMING THE SEQUENCER

A certain amount of practice is needed to programme the sequencer correctly, the user should familiarise himself fully with the working of the device before attempting to write complicated tunes into the memory.

The operating procedure is as follows:

(1) Clear the memory by running the clock at a fast speed with the "Erase" button held down.

(2) Select "Stop" with the "Stop/Run" switch.

(3) Press the counter "Reset" button.

(4) Set the "Reset Read/Write" switch to "Write".

(5) Write the required notes in by depressing the appropriate keys (go fairly slowly to avoid mistriggering the circuit). If a note is to be held for more than one beat, the key should be pressed more than once.

If the envelope trigger outputs are being used, the trigger button (1 or 2) should be pressed at the same time as a key whenever a trigger pulse is required.

(6) When the last note of the tune has been written in, hold the "Reset Write" button, and press the last key again.

(7) The tune is now ready to be played. Reset the counter, put the "Reset Read/Write" switch to "Read" and select "Run". The tune should now be played through the synthesiser v.c.o.

USING THE SEQUENCER

Even when used with fairly simple synthesisers, the sequencer is capable of producing quite startling results.

Some typical patching arrangements are shown in Fig. 11. The sounds produced by Fig. 11(d) are extremely entertaining if the two v.c.o.s are tuned to a musically related interval.

Fig. 12. Demonstrating a simple tune for the sequencer

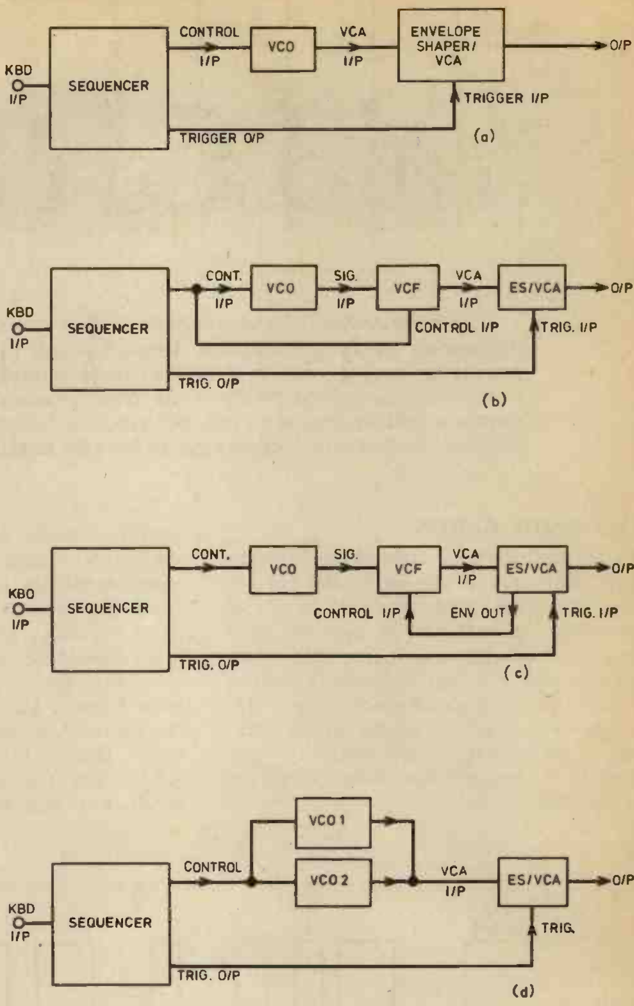


Fig. 11. Some typical patching arrangements with a synthesiser

Fig. 12 demonstrates how a simple tune can be played. Here each bar is divided into 12 beats, a close approximation of the dotted notes is given by using the 1st, 3rd, 4th, 6th, 7th, 9th, 10th and 12th beats only. By writing trigger pulses only on the accented beats the impression is given of a separate bass and melody line being produced by only one oscillator!

It is interesting to note that this tune only uses 25 positions in the memory, less than a fifth of the unit's capacity!

It must be realised that this is a very simple example; the full capabilities of the sequencer are really only limited by the imagination of the user.

EXPANSION

More ambitious constructors should have no difficulty expanding the unit in a number of ways, for example, two or more memories could be connected in series to give longer sequences. Alternatively, two memories could be paralleled to provide more outputs (two tunes could be played at once!).

Even in its basic form, the 128 note sequencer is a very useful addition to a synthesiser, making possible effects and sounds that are very difficult to produce manually. ★

COMPONENTS . . .

P.S.U.

Resistors
R1 150Ω ¼W
R2 4·7kΩ ¼W

Capacitors
C1 1,000μF 25V elect
C2 470μF 25V elect
C3 0·47μF

Semiconductors
D1–D4 Bridge rectifier (2A, 200V) (R.S. Components)
D5 BZX85–5·1 5·1V, 1·3W Zener (R.S. Components)
IC1 7805 5V, 1A regulator (R.S. Components)

Transformer
T1 6–0–6V 250mA mains transformer

L.E.D. COUNTER
(Optional to main board)

Resistors
R24–R30 1kΩ (7 off)
R31–R37 100kΩ (7 off)

Semiconductors
TR4–TR10 BC184 (7 off)
D91–D97 TIL209 (7 off)

KEYBOARD

49 note keyboard C to C
4 s.r.b.p. strips 169 × 51mm for mounting contact blocks
Contact blocks type GB2 (49 off)
(All keyboard items available from Maplin Supplies)

MICRO-BUS

Compiled by DJD.

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

TIME-CODE CLOCK

In the past the only type of clock which did not need to be set to the correct time was the sundial; other clocks are at best only as accurate as the last time they were set. However since 1974 when the National Physical Laboratory started transmitting a high-accuracy time code, it has been possible to design an electronic clock which automatically sets itself to the correct time within a minute of switching it on!

The signal is transmitted from Rugby on M.S.F. 60kHz. A 100-millisecond break in the carrier occurs every second (and on some half-seconds), and each minute the time and date are transmitted in a binary coded decimal format, see Fig. 1. Designs have appeared which used logic gates to read and decode the information but these needed a large number of integrated circuits and much wiring.

An alternative approach presented here is to do all the decoding by software using a circuit based on a microprocessor; in this case the only parts needed, apart from the microprocessor system, are the receiver section and interface as in Fig. 2. This would therefore make an ideal system clock for a microcomputer.

The receiver is built around an NE567 phase-locked loop (PLL) tone decoder whose frequency is set to 60kHz by VR1. When a frequency within about 14 per cent of this is present at its input, it drives the output low. A ferrite-rod aerial tuned to 60kHz feeds a two-stage amplifier which brings the signal up to the 25mV needed to drive the PLL. The aerial should be placed at least 2ft away from the receiver to minimise pick up from the PLL, and the wire connecting them should be screened.

In the prototype the front-end was built from a kit supplied by D. W. R. Higginson Limited, Bristol Road, Sherborne, Dorset, DT9 4EF, for £14·08 (inc. VAT), and this included a pre-aligned aerial (available separately).

The output from the PLL drives an l.e.d. which should flash at 1Hz when a signal is being received, and the two inputs to the MC6820 Peripheral Interface Adapter (PIA) in the microprocessor system. One input is a conventional input and the other is a latched control unit.

The clock was tested on a Motorola D2 kit, which uses a 6800 MPU, and the complete program is shown in Fig. 3. This could easily be modified for use

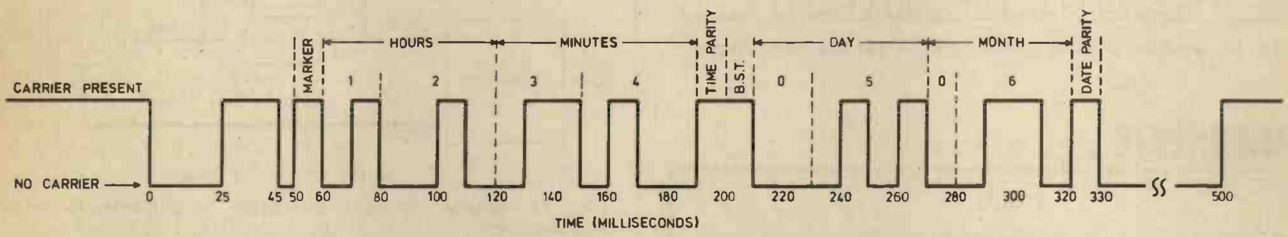


Fig. 1. Format of the encoded time and date information transmitted at the start of each minute

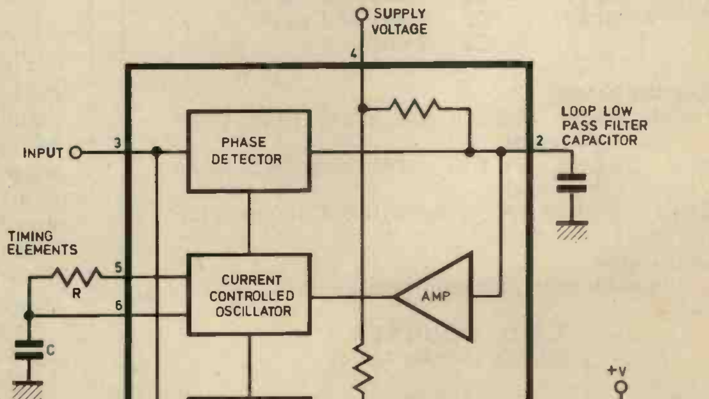
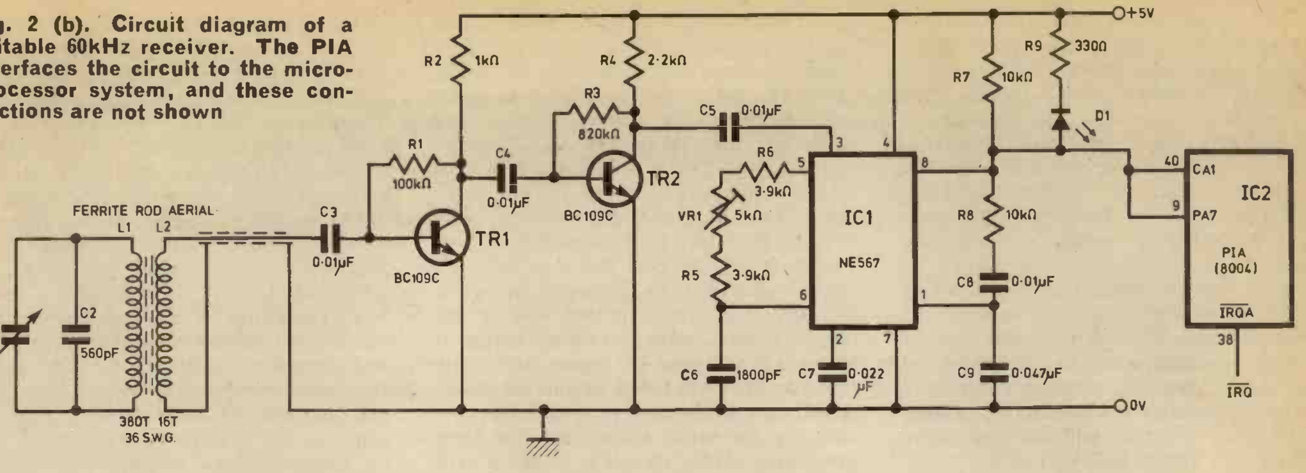


Fig. 2. (a) Block diagram of the NE567 phase locked loop tone-decoder integrated circuit used in the receiver

Fig. 2 (b). Circuit diagram of a suitable 60kHz receiver. The PIA interfaces the circuit to the microprocessor system, and these connections are not shown




```
                  NAM    CLOCK
           *** RUGBY TIME CLOCK ***
           *
     8004  PIA    EQU    $8004
     E0FE  OUTDS  EQU    $E0FE     IN JBUG
     A000  IRQ    EQU    $A000
           *
0000 0002  XTEMP  RMB    2
0002 0001  DATA   RMB    1          HOURS
0003 0001         RMB    1          MINUTES
0004 0001         RMB    1          TIME PARITY BIT
0005 0001         RMB    1          B.S.T. BIT
0006 0001         RMB    1          DAY
0007 0001         RMB    1          MONTH
0008 0001         RMB    1          DATE PARITY BIT
0009 06    BITS   FCB    6,7,1,1,6,5,1
000A 07
000B 01
000C 01
000D 06
000E 05
000F 01

           *** MAIN PROGRAM ***
           *
0010 86 07   BEGIN  LDA A  £%00000111
0012 B7 8005        STA A  PIA+1     CONTROL WORD
0015 CE 0022        LDX    £ISR
0018 FF A000        STX    IRQ       INTERRUPT VECTOR
001B B6 8004        LDA A  PIA       CLEAR INTERRUPTS
001E 0E             CLI
001F 7E E0FE        JMP    OUTDS     OR MAIN PROGRAM

           *** INTERRUPT SERVICE ROUTINE ***
           *
0022 CE 0903 ISR    LDX    £30000/13   (30 MSEC.)
0025 8D 39          BSR    DELAY
0027 B6 8004        LDA A  PIA
002A 2B 33          BMI    RETURN   NOT MINUTE PULSE
002C CE 0A84 MINUTE LDX    £35000/13   (35 MSEC.)
002F 8D 2F          BSR    DELAY
0031 CE 0002        LDX    £DATA
0034 DF 00   NDIGIT STX    XTEMP
0036 E6 07          LDA B  7,X
0038 6F 00          CLR    0,X
003A B6 8004 NEXTIN LDA A  PIA
003D 43             COM A
003E 49             ROL A
003F 69 00          ROL    0,X
0041 CE 0301        LOX    £10000/13   (10 MSEC.)
0044 8D 1A          BSR    DELAY
0046 DE 00          LDX    XTEMP
0048 5A             DEC B
0049 26 EF          BNE    NEXTIN
004B 08             INX
004C BC 0009        CPX    £DATA+7    ALL IN?
004F 26 E3          BNE    NDIGIT     YES
             ** SUMMERTIME CORRECTION **
0051 96 02          LDA A  DATA       HOURS
0053 9B 05          ADD A  DATA+3     B.S.T.
0055 19             DAA
0056 81 24          CMP A  £$24
0058 26 01          BNE    FINE
005A 4F             CLR A             CHANGE 24 TO 00
005B 97 02   FINE   STA A  DATA
             ** DISPLAY DATA **
005D 8D 05          BSR    UPDATE
005F 3B      RETURN RTI

             **** DELAY APPROX. X*13 USEC. ****
             *
0060 09      DELAY  DEX
0061 26 FD          BNE    DELAY
0063 39             RTS

             **** UPDATE DISPLAY BUFFER ****
             *     (FOR D2 KIT ONLY)
     E0C4    CLRDS  EQU    $E0C4
     E31C    DIS01  EQU    $E31C
     E327    DIS23  EQU    $E327
             *
0064 BD E0C4 UPDATE JSR    CLRDS
0067 96 02          LDA A  DATA
0069 BD E31C        JSR    DIS01
006C 96 03          LDA A  DATA+1
006E BD E327        JSR    DIS23
0071 39             RTS
```

Fig. 3 Program for the 6800 which reads and decodes the time and date information from the receiver section, and displays the time on the displays in the D2 kit

with other micros. As it stands the program uses the display routine in the D2 kit JBUG monitor to display the time; when executed the program first causes an arbitrary number to be displayed (and this flickers at one-second intervals due to the time taken by the interrupt service routine), and then each minute the display is updated to the new correct time as the time code is received.

The program is entered at BEGIN, and this first section initialises the PIA, making CA1 an interrupt input, and puts the address of the interrupt-service routine ISR into the pseudo interrupt-vector at A000; on interrupts this is picked up by the monitor and used as a jump address.

The interrupt mask is then cleared, and control transferred to the main program; in this case OUTDS, the display routine which refreshes the 7-segment displays in the D2 kit.

On the rising edge of every pulse from the receiver an interrupt is generated and the routine ISR is called. This routine is only concerned with minute pulses, so it reads the input line after 30 milliseconds and returns to the main program if it is still high. Otherwise the ISR updates the seven locations at DATA with the decoded information, and it does this as follows:

The program delays a further 35 milliseconds to the centre of the first data bit and then reads bits at 10 millisecond intervals into the correct location at DATA. The number of bits to be shifted into each location is different (see Fig. 1) and is given by the number in the corresponding element of the array BITS. All the delays are generated by the subroutine DELAY which counts down the index register X, and in systems with different clock rates the delay parameters will have to be altered accordingly.

To convert from G.M.T. to the more familiar B.S.T. the program adds the summertime bit to the number of hours. Finally, for testing purposes, the routine UPDATE uses subroutines in JBUG to clear the displays and load the new hour and minute counts into the display buffer. Note that although the date and parity information are not displayed they are available in the array.

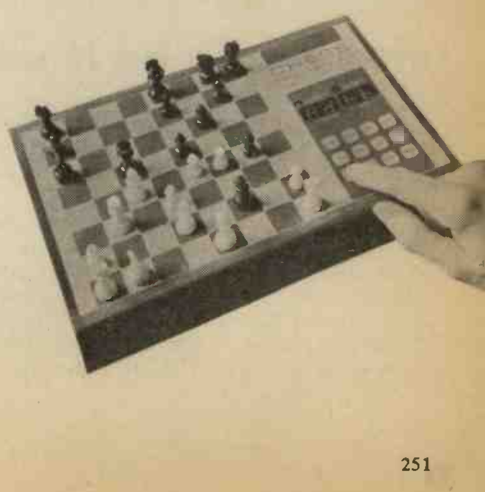
DATA

As well as making an ideal source of the time and date in an existing microcomputer system, a time-code clock could be constructed using a dedicated microprocessor with the program stored in ROM. It would be a simple matter to extend the program to give date display, error-checking (using the parity bits), seconds, an alarm, and time-controlled switching of circuits. All things considered, the sundial does not have much going for it any longer!

MICRO PLAYS CHESS

The "Chess Challenger" pictured below is a new microprocessor-based game that is being imported from the States, and it is currently on sale here for about £150. It is a remarkable example of how micros have crept up on us, and most people who have played against it are amazed that such a serene-looking wooden case contains a machine that can produce strong opposition to their moves.

The Chess Challenger microprocessor-based chess playing game



The player enters his move at a keyboard to the right of the chess-board, and the machine gives its reply on a four-digit seven-segment display. The moves are entered as the co-ordinates of the two squares involved (in what is unfortunately the opposite of standard algebraic notation): *e.g.* FROM 4b TO 4d. The "EN" key then enters the move and the machine replies in about two seconds.

It is worth noting that the machine performs no move checking, so any piece may be moved to any square that is either unoccupied or else occupied by an enemy piece; it is up to you not to cheat! This has the side-effect of making it possible to set up mid-game positions, albeit in a rather tedious way.

AN EXCELLENT PARTNER

The special moves of castling and en-passant captures are dealt with by means of the "DM" double-move key. This prevents the machine from replying to the next move entered, so it enables you to move more than one piece in one turn. The machine will castle at the first opportunity and it sometimes castles through check; in this event it is necessary to move its king and rook back and ask it to move again, and it will not attempt another castling. It does not capture en-passant. If a player's pawn reaches the back line it is promoted into a queen and you cannot ask for an under-promotion. However, it neglects to promote its own pawns, and in one game played against it where it could have forced a victory it left its pawn unpromoted on the last line.

The machine announces "check" by an l.e.d., and when mated says "I lose" with an other. A useful additional feature is the possibility of interrogating for the current board position piece by piece to verify that the pieces are set up correctly.

At first sight the machine plays a good game, and it certainly never misses a trick if one is immediately possible. However, it only performs a static evaluation of the current position and does not look ahead at all. In other words it will fail to spot a mate in two, unless it happens to choose the key move for other reasons. Despite this the algorithm it uses to choose what it considers to be the best move is well designed so that nine times out of ten it actually does come up with one of the better moves. When for some reason it gives a bad move its opponent usually remarks that "it failed to see what was going on"; it cannot spot long-term plans and, by the same token, does not form long-term plans. This is a common failing of all but the most sophisticated of chess programs.

Out of a number of games played against it by players of ordinary to club standard it won about one-third. The shortest mates are spectacular if unrepresentative, but they illustrate the machine's blind spots and two are given below:

Pete Christian White	*Chess Challenger* Black
1. 5b–5d	5g–5e
2. 4a–8e	7g–7e
3. 7a–6c	8g–8f
4. 6cN5e (xP)	7h–6f
5. 8e–6g (xP)	I LOSE

Geoff Walker White	*Chess Challenger* Black
1. 5b–5d	5g–5e
2. 2a–3c	2g–2f
3. 6b–6d	5e–6d (xP)
4. 4b–4d	3h–2g
5. 4b–4d	7g–7e
6. 6a–3d	6h–5g
7. 6c–5e	6g–6f (??)
8. 4a–8e (ch)	5h–6h
9. 8e–6g	I LOSE

The game is based on the 8080A micro, the Intel-designed 8-bit device descended from their 8008 and currently the most widely used microprocessor. The program and keyboard/display interface routines are stored in a 2K byte ROM, and for the board position and other variables there are ½K bytes of RAM. As the photograph shows, it forms a very compact unit, this being made possible by supplying the transformer as a separate unit.

This machine is an excellent partner for average players who want some rapid and accurate opposition to help them improve their game, and it will certainly get one past the stage of leaving pieces unprotected. Unfortunately, while you are improving, the machine stays at the same level making the same mistakes. Perhaps with this in mind the makers offer to upgrade the game for an additional £50 by replacing the program chip. The upgraded game can be set to play at one of three strengths, and at level 3 it searches to a greater depth and takes up to 30 seconds per move. For those who do not play chess the makers say that a "Backgammon Challenger" is in the pipeline, and who can guess what else may be on the way?

FERRANTI D/A CONVERTER

The ZN425E is the cheapest monolithic 8-bit D/A converter currently available despite its excellent specifications, and as an added bonus it contains an 8-bit binary counter so that it can be used as the basis of a simple A/D converter. It was specified for the digital waveform generator in the previous *Micro-Bus*, and can be obtained from S.D.S. Components Ltd., Hilsea Industrial Estate, Gunstore Road, Portsmouth for £3·78 (inc. VAT) plus 65p postage.

A few tapes of the program for a "Bulls and Cows" game are still available from P.E. (see October issue).

NEWS BRIEFS

Program Cassettes for Home TV Terminal

GENERAL Instrument Microelectronics Ltd and EMI Tape Ltd have jointly developed an inexpensive method of storing computer data for home use, using conventional audio cassette tapes and a standard audio cassette mechanism or deck.

The technique, for which patents have been obtained, permits the storage of 1·6 million bits of data on each side of a conventional C-60, 30-minute per side cassette and offers one hundredfold increase in storage capacity in comparison with ROM microcircuit cartridges, at one quarter of the price. Moreover the technique allows voice and digital data to be stored on the same cassette.

The widespread availability of inexpensive hardware for the storage and playback of computer programs is seen as a key requirement in the development of the domestic television receiver into a computer system for use by all the family as a TV games centre and programmed learning and information terminal.

The possible range of programs is unlimited. By plugging a suitable cassette program into the cassette deck contained in the TV Game, the linked television could be transformed into a scientific or business calculator display in which every stage of calculation is displayed on the TV screen. Alternatively, language tapes could be made available combining on-screen text with the spoken word.

General Instrument Microelectronics have in an advanced state of development a set of compatible MOS microcircuits for interfacing the television to its CP1600 microprocessor family. Modular in concept, these interface circuits can be used by the manufacturer to offer a wide range of optional extras on the standard TV, culminating in a complete home computer system. These interface circuits allow the reception of the Viewdata and Teletext services.

FRANK W. HYDE

SAILS IN THE SUNSET

The now rejected system of photon propulsion for the spacecraft which will be used to rendezvous with Halley's comet has caused some people difficulty. In fact the same principles apply to this system, which uses photon wind for the propulsive medium, as to the normal sailing dinghy. The incident radiation would be reflected by the sail and the resultant energy would urge the vehicle in the same manner as the wind on Earth. It is, of course, necessary to take into account the action of gravitational and centrifugal forces.

However, it could be intriguing to plot a course with its necessary tacking when moving towards the sun. It might not be so facetious if it was suggested that the variations in the medium and the strength of the radiation might lead to the use of the planets as buoys.

SPACE SHUTTLE

Now that the space shuttle has entered both the vocabulary of the public at large and the world as a whole, it is to be hoped that a new look will appear on the space scene. Since there will be much that other countries can aim for at a much lower budget, it is foreseeable that many more missions will be required than envisaged in the first plans.

The rate at which mission time has already been taken up, it would seem that the second and third shuttles are already justified. Indeed, the natural reaction to the September disaster for the second *Voyager* may accelerate this.

It must be very apparent now that the way to economic stability in the space programmes is via a maximum use of these new methods. The horizons are so wide that the accusation of "money wasted on wrong things" can be easily disposed.

The implications for industry and further employment is very considerable particularly in light metal raw materials. These are to be thought of in terms of millions of tons. So much indeed is required that every country in the world can benefit where process industries are working.

CHEAP SOLAR CELLS

One of the greatest needs of solar development is the requirement of cheap solar cells. It would not require any more money spent on development to increase efficiency for the quantities needed would be so great that a very rapid lowering of price would result.

While the last little fraction of efficiency is required for space missions, this does not apply to earth based equipment. The difference in cost for a low grade cell is very great and other alternatives of basic materials could now be investigated.

The same reasoning applies to space projects where the shuttle is used. The weight that can be raised to orbit is so great in comparison to a single launch, that larger quantities of solar cells can be used. Here again the economic law applies. It is better and cheaper to use a large number of less efficient units which will in the end exceed the installed equivalent power.

THERMOELECTRIC DEVICES

So far as earth based units are concerned, attention might also be given to thermoelectric devices. Used in cylindrical reflectors the area of activity is of sufficient extent for continuous lines of such devices to be used without overheating.

For example, a two metre by one metre sheet of aluminium will give a very high concentration of heat over a plane of 500 centimetres. For the "do it yourself" enthusiast it may be extended cheaply using simple angles instead of a parabola-cum-cylinder arrangement. A simple corner reflector will serve very well if slightly modified. Two sheets of aluminium, two metres by one metre, set longways will provide one square metre of concentration with a gain of four to one. In fact a complete unit such as this, with preheating from the distributed "lost heat", can make a very efficient garden unit to supplement the household heating.

The last few sentences may be thought to be far removed from space, but is it really so? Does not the new space age offer such spin-off facilities? The same techniques can be moved from one discipline to another to make the maximum use of resources. Many years ago it was suggested that a large reflector arranged in orbit could not only supplement the heating of the Earth but that also it could be arranged to act as a second moon. Such a project is well within the compass of present technology.

The moving of the large gravity pulled structures and the associated equipment into space would reduce many costs and enable many devices on Earth to be reduced considerably in dimensions. Is it so fanciful to see the Earth controlled from its outer environs?

Certainly, if all nations took part in such a future programme there would be automatic control of attitudes. There would be so much for everyone to do that common interest could lead to common citizenship. Such a situation would indeed make horizons boundless. Not least of the benefits would be a wrist telephone which put everyone in touch with everyone else. Perhaps it is better to leave the subject there for the moment.

JUPITER

There seems to be a number of people who have been somewhat dismayed by the interpretation of Prof. McNally's report about the Jovian planet. Within the last several weeks there have been many questions as to whether Jupiter is to be a second Sun. It is unfortunate that when these ideas take hold of public imagination a whole crop of pseudo science appears.

It has been known for a very long time that Jupiter gives out more heat than it receives. This in no way justifies a statement that it will grow hotter and hotter to reach a state of concentrated gravity condition to raise temperatures to fission level. Indeed, application of the inverse square law will settle any fears of a new "Sun" within the lifetime of the one already sustaining the Earth and its people.

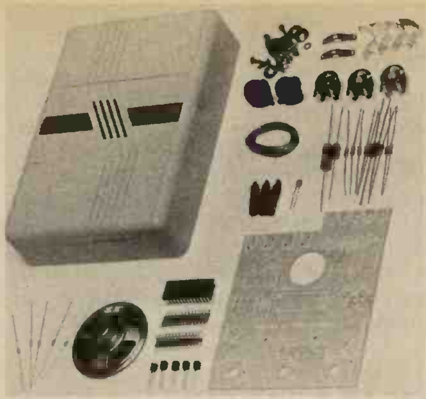
At the distance of Jupiter from the Sun, nearly 500 million miles, a much smaller fraction of the Sun's heat per square mile of the planet is received than that received on the Earth.

The *Pioneer* results, in any case, have established the reigning temperature very definitely. A great deal of heating up would be required to bring it to a hospitable level. The projected mission into the atmosphere of the planet will bring forward much needed data to enable assessments to be made in these matters.

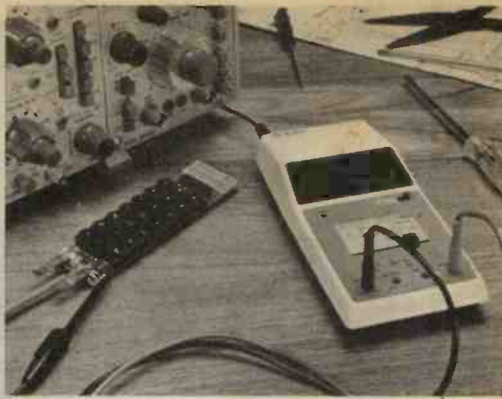
That Jupiter is a remnant of the original nova is gaining ground now. This would seem to be a logical explanation of Jupiter's size and effect in the solar system. Its effect on the Sun is considerable because the centre of rotation of the Sun and Jupiter is some 30,000 miles outside the photosphere. The inevitable result is a disturbance of the atmosphere of the Sun.

MARKET PLACE

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



Chroma-Chime kit from Chromatronics



Sinclair PDM35 digital multimeter

POCKET MULTIMETER

A new, high accuracy, personal digital multimeter from **Sinclair Radionics** is now available in the UK at £29·95 plus VAT.

Claimed to be less than one-third the price of existing 3½ digit meters, the PDM35 fits easily into a coat pocket, brief case or tool kit.

Using an adaption of the old Oxford calculator cases (to save cost), the PDM35 will measure a.c. and d.c. voltage to an accuracy of 1 per cent of reading. Also d.c. current can be measured to the same accuracy. The resistance range is up to 20 megohms. Range selection is by a slide switch as against the usual rotary type.

There is no provision for a.c. current measurement as Sinclair claim their investigations show little demand for this facility.

A brief technical specification is as follows: D.C. Volts (4 ranges) 1mV to 1,000V at 1 per cent ±1 count, 10MΩ input impedance; A.C. Volts (40Hz–5kHz) 1V to 500V at 1 per cent ±2 count, mean reading r.m.s. (calibrated); D.C. Current (6 ranges) 1nA to 200mA at 1 per cent ±1 count, maximum resolution 0·1nA; Resistance (5 ranges) 1Ω to 20MΩ at 1·5 per cent ±1 count, also provides 5 junction-test ranges.

Additional extras include an a.c. adaptor for 117V 60Hz or 220/240V 50Hz, carry case and a 30kV probe.

For addresses of nearest stockists of the PDM35 digital multimeter readers should write to **Sinclair Radionics Ltd., Dept P.E., London Road, St. Ives, Huntingdon, Cambs, PE17 4HJ,** although most good component shops and some stores will have stocks.

MUSICAL DOORBELL

No doubt most readers will have already heard of the Chroma-Chime, claimed to be the world's first microprocessor controlled electronic doorbell manufactured by **Chromatronics.**

This product is now available in kit form for the enthusiasts who want to build their own units. The kit comes complete with all parts including the microprocessor chip, printed circuit board and a comprehensive assembly manual.

At £18 inclusive of VAT and postage the Chroma-Chime will certainly make a novel gift to add to the Christmas shopping list. Further details and kits can be obtained from **Chromatronics, Dept P.E., Coachworks House, River Way, Harlow, Essex.**

We hope to give a more in-depth report on the Chroma-Chime kit in the near future.

TAPE/RECORD CARE

With the price of tapes and records on the increase each month, it would seem that **BASF** have taken the ideal opportunity to launch their Checkpoint record and tape care accessories.

Being their first venture into record accessories, they have produced special gift packs containing such items as cleaning fluid, record cleaning arm and strobe speed check discs. For the cassette recorder there's a cassette tape head cleaner and even an inspection mirror.

Apart from complete record and tape care kits all Checkpoint accessories are available separately in special bubble packs.

Prices of the BASF Checkpoint accessories vary from £7·94 for a complete record and cassette case kit to 30p for a record cleaning cloth. All units are available from most audio shops and some big stores.

DIFFICULT COMPONENTS

Readers who are experiencing difficulty in obtaining the Radiospares switches for the "Digital Multimeter", published in our October issue, will be pleased to know that **Sparks Developments** are able to meet their requirements.

They are also able to offer a low cost alternative to the 1 per cent high stability resistors required for the input divider chain. By using two resistors for each of R20–R26 allows the use of preferred resistance values from the E12 range. Also, by utilising the spread in values of a sample of components, a pair of resistors can be selected by measurement to obtain a final value very close to the ideal value.

They are prepared to supply a complete set of resistors R20–R27 to make up the input divider chain to an accuracy of 1 per cent. In addition they will supply printed circuit boards for the project with the necessary modifications to accommodate the extra resistors.

All enquiries should be addressed to **Sparks Developments, Dept P.E., 53 North Street, Melbourne, Derbys, DE7 1FZ.** A stamped addressed envelope should be enclosed with any enquiry.

GOOD-BYE

This is a very sad occasion for me to have to say goodbye to all readers of P.E., having been responsible for "Market Place" since the first issue.

This is due to a management decision that the magazine would benefit by a move to Poole, Dorset. Even though the Editor and myself, who first started Practical Electronics way back in 1964, feel that this is a bad move for the magazine.

Not being able to make this move West the Editor, Fred Bennett, and myself are having to relinquish our positions on Practical Electronics at a time when the efforts of all the P.E. Team have now made it No. 1 in its field in the U.K.

For myself it is particularly sad as I am the sole Editorial staff member of the Practical Group of magazines who worked with and was trained by the late F. J. Camm, the originator of the "Practicals".

I should like to take this opportunity to thank all my friends at our Printers, my colleagues on P.E. (particularly Dave Tilleard and Peter Mew of Advertising), our Advertisers and my close friend Gordon Godbold for an exciting and rewarding 13 years.

Finally, I hope that all readers of P.E. will continue to give the magazine the support it deserves.

Dave Barrington

INDUSTRY NOTEBOOK

By Nexus

MAIL BAG

The most distressing feature of being a columnist in 1977 is the occasional mail which arrives from young people seeking an entry into the electronics industry. The writers are generally out of work or in some dead-end job. Can I help? Would I please supply names and addresses of firms who have vacancies, give introductions. They are sad letters to receive, reflecting the high level of unemployment in our society, especially among school leavers.

Regretfully, I have to point out that while sympathising with the plight of my correspondents, it is no function of PE to act as an employment agency although, of course, we are always glad to receive letters from readers and give what advice we can.

It seems to me that career expectations are much higher today than they used to be. Young people are encouraged to believe that jobs will be found for them, whereas, we of an older generation were brought up to help ourselves and be far more self-reliant. We had to be prepared to work long hours for very little pay if this meant getting experience and a foot-hold on the bottom rung of the ladder.

Any sort of job would do to get a start and provide a chance to prove yourself. But if you fell down on the job, then it was a week's notice and out you went. My first job in electronics was as a junior service engineer at a local radio dealer for which I got £1·25 for a 48-hour week and no extra pay for overtime. It was a start on the road to becoming a qualified engineer.

Those were the bad old days of hire and fire, long hours and low wages, but those days offered the opportunity of getting a start, however humble. Today there are so many rules and regulations that employers are much more reluctant to take on any but the obviously best youngsters. Greater job security would seem to have limited the job opportunities.

The other great change is in the electronics industry itself. It is still a great growth industry but not in the numbers of people employed. If we look back to the first generation of electronic computers we find that the original ENIAC computer developed in the United States and completed just over 30 years ago used 18,000 valves and consumed 100kW of power.

It seems laughable today but just think of the employment it provided. All those valves, valveholders, resistors, capacitors, the millions of interconnections all wired by hand and laboriously soldered, joint by joint. Even when they got it going it needed an army of trouble-shooters to keep it on stream.

The fact is that today an unskilled operator pushes an l.s.i. module in to a printed circuit board and passes it to a flow-soldering machine and in less than a minute has wired up as many as 5,000 components and the board works first time and keeps on working. And today, the chances are that even the testing of the board after assembly will be done on automatic test equipment by a semi-skilled operator.

This hard fact was brought home forcibly to me when I was looking over the last set of GEC accounts. This year's record profits and turnover were achieved with less people employed. The UK work-force in 1976 was 166,000 people. Today it is 10,000 less.

By no means is this reduction entirely due to things like l.s.i. but it does show the trend resulting from mechanisation and automation and modernisation.

If we look at Racal Electronics Group we find turnover in 1975 of £50 million generated by 4,187 people. 1976 saw a huge leap forward to £79 million generated by 5,028 people. This year's turnover was £122 million with 5,373 people. Note that turnover has more than doubled with only a 25 per cent increase in employment in the past two years. In the past year alone, turnover was up 53 per cent and yet the Group employed only just over 300 more people.

All is not lost however for the bright young person. Technology-based companies are hungry for talent. Last year GEC spent £150 million on R and D. So my advice to keen youngsters is to get qualifications as quickly as they can. An ONC or HNC won't guarantee a job but it will impress an employer that the applicant is career-minded and not just a job-hunter.

PRICE BREAKTHROUGH

After the National Enterprise Board took a big stake in Sinclair Radionics everything seemed to go quiet, unusual for such a publicity-conscious concern. Then there was that sudden spate of press advertising for Sinclair calculators and now the big breakthrough in instruments.

To market a digital multimeter with a price tag of under £30 was a bold move. But such a price is only possible if the instrument can be produced in great volume. The DM2 had done well with over 25,000 units sold but the new smaller and cheaper PDM35 will do even better as it started off with firm orders for 20,000 from the USA alone.

Among the cost-cutting economies to get price down without sacrificing performance were the use of an adaptation of the Oxford calculator case as a housing, thus saving on tooling costs, and a precision resistor network on a single thick film circuit.

The designer of the DM2, John T. Nicholls, has also designed the PDM35. As head of Sinclair's Instrument Division he is already looking ahead to a range of instruments to be introduced to the international market in 1978. I understand that an up-market model will be an auto-ranging 4½ digit instrument but it is also hinted that there will be some down-market instruments as well. Sinclair Radionics is aiming to be the world's largest manufacturer of digital multimeters, at least in volume of instruments, by mid-1978.

Meantime, I can reveal that production of Sinclair's tiny t.v. set is rapidly expanding and although the bulk of production is ear-marked for the United States market it is expected to be available in the UK by Christmas.

SIGNS OF THE TIMES

Selling information can be just as profitable and far less risky than selling products. But while some people talk, others get out and sell. Oil-rich Libya has just given Marconi Communcations Systems Ltd its biggest ever single order, worth £9 million, for updating the radio facilities at Benghazi and Tripoli airports.

The capacitor manufacturers, Advance Filmcap, has changed its name to Gould Components Ltd., reflecting its change of ownership to the US Gould Corporation. I think it unlikely that the Advance name will be dropped from instruments but one never knows.

The Co-op has signed up for another £4 million worth of ICL mainframe computers. This is the biggest single commercial order that ICL has ever taken and raises Co-op purchases from ICL in the past 18 months to £6 million.

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400	0·40	0·60	0·50	0·45	0·87	0·84	0·89	1·40
600	0·85	0·85	0·70	—	1·09	1·18	1·26	1·60

BT106 £1·00, BT107 £1·60, BT108 £1·60, BT109 £1·00, BT116 £1·00, 2N3525 £0·50

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	4A (a)	4A (b)	6·5A (a)	6·5A (b)	8·5A (a)	8·5A (b)	10A (a)	10A (b)	15A (a)	15A (b)
100V	0·60	0·60	0·70	0·70	0·78	0·78	0·83	0·83	1·01	1·01
200V	0·64	0·64	0·75	0·75	0·87	0·87	0·97	1·01	1·17	1·17
400V	0·77	0·78	0·80	0·83	0·97	1·01	1·13	1·19	1·70	1·74
600V	0·96	0·99	1·01	1·10	1·21	1·26	1·42	1·50	2·11	2·17

N.B. Column (a) without internal trigger; (b) with internal trigger.

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7405	0·18	7491AN	0·65
7408	0·18	7492	0·57
7409	0·18	7493	0·45
7410	0·16	7494	0·85
7412	0·25	7495	0·67
7413	0·40	7496	0·82
7414	0·72	74100	1·07
7417	0·43	74107	0·35
7420	0·16	74121	0·34
7425	0·30	74122	0·47
7427	0·30	74123	0·65
7430	0·16	74141	0·78
7432	0·28	74145	0·68
7437	0·30	74154	1·30
7441AN	0·76	74164	0·93
7442	0·65	74165	0·93
7445	0·90	74174	1·40
7447AN	0·81	74175	0·94
7448	0·81	74180	1·06
7470	0·32	74181	2·70
7472	0·26	74191	1·33
7473	0·30	74192	1·20
7474	0·32	74193	1·35
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7476	0·36	74196	1·64

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CA3130	0·90
MC1304P	1·60*
MC1307P	0·85*
MC1310P	1·60*
MC1351P	1·20*
MC1352P	0·75*
MC1353P	0·75
MC1458P	0·77
MC1496L	0·82*
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SAS570	2·25
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TAA310A	1·38
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THE HOME COMPUTER FORUM

Our Seminar will be held on 26th November at the Wembley Conference Centre 10 a.m.-5 p.m. We hope to have five speakers from various backgrounds but all specialists in the micro-computing/software field. The NASCOM I micro-computer will be launched at the seminar. Tickets at £3·50 each are now available together with a newsheet on the seminar. Please write or telephone for details. Only 40p seats are available and 115 have been sold at press time.

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NPN TO-3 POWER TRANSISTORS. Fully tested but unmarked. Similar to 2N3055 except BVCEO = 50. HFE (gain) = 20 + at 3A. VCE SAT < 1·3V at 3A. 5 pcs £1; 25 pcs £4; 50 pcs £7·50; 100 pcs £13.

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AC128	0·16	BC125	0·18*	BC302	0·40	BDY60	1·70	BFY50	0·20	OC84	0·40	2N2906	0·18
AC128K	0·25	BC126	0·20*	BC303	0·46	BDY61	1·65	BFY51	0·18	OC139	1·30	2N2925	0·14*
AC141	0·22	BC140	0·32	BCY30	0·55	BDY62	1·15	BFY52	0·19	OC140	1·30	2N2926O	0·09*
AC141K	0·34	BC141	0·28	BCY31	0·55	BDY95	2·14	BFY53	0·25	OC170	0·23	2N2926R	0·10*
AC142	0·18	BC142	0·23	BCY32	0·60	BF121	0·50	BFY64	0·35	TIP29A	0·44*	2N2926Y	0·09*
AC142K	0·32	BC143	0·23	BCY33	0·55	BF123	0·50	BFY90	0·90	TIP30A	0·52*	2N2926G	0·10*
AC176	0·16	BC144	0·30	BCY34	0·55	BF179	0·30	BSX19	0·16	TIP31A	0·54	2N3053	0·20
AC176K	0·32	BC147	0·09*	BCY38	0·50	BF180	0·30	BSX20	0·18	TIP32A	0·64	2N3055	0·50
AC187	0·18	BC148	0·09*	BCY39	1·15	BF181	0·30	BSX21	0·20	TIP41A	0·68	2N3137	1·10
AC187K	0·36	BC149	0·09*	BCY40	0·75	BF182	0·30	BSY52	0·28	TIP42A	0·72	2N3440	0·56
AC188	0·18	BC152	0·25*	BCY42	0·30	BF183	0·30	BSY53	0·39	2N404	0·40	2N3442	1·20
AC188K	0·32	BC153	0·18*	BCY54	1·60	BF184	0·20	BSY54	0·33	2N696	0·20	2N3570	3·60
AD149	0·80	BC157	0·09*	BCY70	0·12	BF185	0·20	BSY55	0·74	2N697	0·20	2N3702	0·10*
AD161	0·35	BC158	0·09*	BCY71	0·18	BF194	0·10*	BSY65	0·30	2N706	0·15	2N3703	0·10*
AD162	0·35	BC159	0·09*	BCY72	0·12	BF196	0·12*	BSY95A	0·16	2N718	0·22	2N3704	0·10*
AF114	0·20	BC160	0·32	BD115	0·55	BF197	0·12*	BU105	1·80*	2N929	0·16	2N3705	0·10*
AF115	0·20	BC161	0·38	BD131	0·36	BF224J	0·18*	BU105/02	1·90*	2N1131	0·15	2N3706	0·10*
AF116	0·20	BC168	0·09*	BD132	0·40	BF244	0·17*	BU108	3·00*	2N1132	0·16	2N3707	0·10*
AF117	0·20	BC169	0·12*	BD135	0·36*	BF257	0·30	BU109	2·50*	2N1302	0·40	2N3708	0·09*
AF118	0·50	BC169C	0·14*	BD136	0·39*	BF258	0·35	BU126	1·60*	2N1303	0·40	2N3709	0·09*
AF124	0·25	BC182	0·11*	BD137	0·40*	BF259	0·48	BU133	1·60*	2N1304	0·45	2N3710	0·10*
AF125	0·25	BC182L	0·12*	BD138	0·48*	BF336	0·35*	BU204	1·60*	2N1305	0·45	2N3711	0·10*
AF126	0·25	BC183	0·10*	BD139	0·58*	BF337	0·32*	BU205	1·90*	2N1306	0·50	2N3715	1·70
AF139	0·35	BC183L	0·10*	BD144	2·20	BF338	0·45*	BU206	2·40*	2N1307	0·50	2N3716	1·80
AF239	0·37	BC184	0·11*	BD157	0·60	BFW30	1·25	BU208	2·60*	2N1308	0·60	2N3771	1·60
AL102	1·45	BC184L	0·12*	BD181	0·86	BFW59	0·30	MJ480	0·80	2N1309	0·60	2N3772	1·90
AL103	1·30	BC186	0·20*	BD182	0·92	BFW60	0·36	MJ481	1·05	2N1711	0·24	2N3773	2·10
AU107	3·30*	BC187	0·24*	BD183	0·97	BFX29	0·26	MJ490	0·90	2N2102	0·44	2N3819	0·28*
AU110	1·75*	BC207B	0·12*	BD184	1·20	BFX30	0·30	MJ491	1·15	2N2217	0·30	2N4347	1·10
AU113	1·60*	BC212	0·11*	BD232	0·60	BFX84	0·23	MJE340	0·40*	2N2369	0·14	2N4348	1·20
BC107	0·09	BC212L	0·12*	BD233	0·48	BFX85	0·25	MJE520	0·45	2N2369A	0·14	2N4870	0·35*
BC107B	0·12	BC213	0·12*	BD237	0·55	BFX86	0·25	MJE521	0·55	2N2483	0·20	2N4871	0·35*
BC108	0·12	BC213L	0·14*	BD238	0·60	BFX87	0·20	OC43	0·95	2N2484	0·16	2N4918	0·60*
BC108B	0·12	BC214	0·14*	BD410	0·60	BFX88	0·20	OC44	0·32	2N2646	0·50	2N4919	0·70*
BC109	0·12	BC214L	0·15*	BDX32	2·30	BFX89	0·90	OC45	0·32	2N2711	0·20	2N4920	0·50*
BC109B	0·12	BC237	0·16*	BDY10	1·50	BFY11	1·10	OC46	0·20	2N2712	0·15	2N4922	0·58*
BC109C	0·15	BC238	0·16*	BDY11	2·00	BFY18	0·50	OC70	0·30	2N2904A	0·20	2N4923	0·46*

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4012BE	0·20
4013BE	0·50
4014BE	1·00
4015BE	0·95
4016BE	0·54
4017BE	1·00
4018BE	1·10
4019BE	0·50
4020BE	1·12
4021BE	1·03
4022BE	0·95
4023BE	0·20
4024BE	0·86
4025BE	0·20
4026BE	1·55
4027BE	0·62
4028BE	0·91
4029BE	1·10
4030BE	0·55
4041BE	0·80
4042BE	0·83
4043BE	1·00
4044BE	0·94
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4050BE	0·54
4069BE	0·30
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TV GAMES IN FULL COLOUR

At last it's here! The new Swanley colour encoder kit £7.50. Adds different colours to the frome, boll, bots ond bockground of the AY-3-8500 TV gomes.
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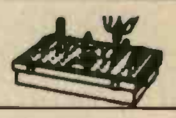

S-DeC £1.94. T-DeC £3.61.
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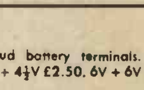
JC12, JC20, JC40 AMPLIFIERS



JC12 6W IC audio amp with free data and printed circuit £1.95. Also new JC40 20W model with pcb £3.95. Sensational new JC20, 10W integrated circuit amp with pcb £2.95. Send s.a.e. for free leaflet or all 3 models and associated power supply and pre-amp kits.

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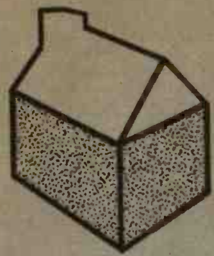
Post 30p. Prices include VAT. Official orders welcome. Overseas customers deduct 7% on items marked * and 11% on others.



Home Entertainment Show

M. Abbott

THE balconies remained empty in the Grand Hall of Olympia for what used to be called the Audio Fair, where just under ninety stands barely filled the main floor.

The exhibition ran from September 12 to 18, and giving lectures during that period at the *Wireless World* stand was John Logie Baird himself! This lifesize model of the inventor, with his blank wax face animated by a sound synchronised movie projector, was chillingly convincing, as he (it?) told of his early experiments in television.

Although numerous big names in hi-fi were present at the exhibition, their interest rating seemed "pushed over" in favour of such things as calculators, alternative uses for television, digital watches and clocks, including an *l.e.d.* clock radio from SI Electronic (UK) for under £20. The show was of no real interest to organ or synthesiser fans.

INTELLIGENT TURNTABLE

There was a chance to see and operate the new ADC Accutrac +6 Turntable, and this gave a good example of the subservient microprocessor's ability to please, because this deck, which is expected to retail at around £150 inclusive of cordless remote control, can play up to six l.p.s using touch-switch activated "hands off" servo mechanisms which *really do* treat the records with loving care. There can be no mishaps, and the records are not dropped brutally on to the platter.

What is more, the system can be instructed to play any combination of tracks *in any order*. The microprocessor stroboscopically controls the turntable speed, and seeks out the selected recordings with an infra-red "eye" mounted in the cartridge, which counts the smooth unmodulated gaps between tracks. ADC are keen to point out that this is a *true* hi-fi class deck, and not a mere gimmick. The circuit blueprint for the Accutrac +6 measures nearly 5m by 6m, most of which is on a 2·5mm MOS chip!

CORDLESS HEADPHONES

Listening to recordings with headphones is generally accepted as being more satisying than using loudspeakers, but nobody likes tripping over wires. For this reason Beyer Dynamic developed their infra-red cordless system. The ISS 76 Stereo Transmitter (there is also a mono version), along with the DT444S headphones incorporating infra-red receiver, will set you back about £190, but if you have your own headphones, you can buy a discrete plug-in type receiver for about £30.

The transmitter can take an audio signal from any source, and the infra-red output is semi-directional, therefore needing some walls around to "bounce" the signal.

INFORMATION BY TV

Much activity was centred on television, providing an opportunity to try out the CEEFAX and ORACLE teletext systems for one's self, but by far the most impressive t.v. data service to use was that of Viewdata, both from simplicity of operation and the potential usefulness point of view.

Unlike other systems, the PO's Viewdata communicates via telephone lines and is completely user interactive. If the required page number is not known, you simply call up the general index, and select a suitable heading by entering its number. A more appropriate index will then appear, and further selection through this "family tree" of pages will bring you to anything from a Which Report on a particular freezer to an airline ticket booking facility. You could find the nearest golf course to your Summer holiday location, complete with fees and opening hours.

The services possible are endless; it simply depends upon which organisations feed their information into the system. For example, a motoring organisation could provide a diagnostic service. If your car will not start on a cold morning, by answering "yes/no" type questions, the most likely fault would be displayed.

As yet there is only a pilot service, and a full public service is not envisaged until the early 1980s. Because of this, there are no conversion modules which will instantly give your t.v. Viewdata capability, and a set designed for this additional facility would probably cost an extra £80

MARKSMANSHIP BY TV

Anyone expecting to hear the roar of tank battles and dog fights at the t.v. games stands would have been disappointed, for with the odd uninspiring exception, only the "blipping" of the usual ball games could be heard.

Along with these games, Interton Electronic were showing the rifle range option of their Video 3001 multi-games (colour) unit, with which, for an extra £20 on top of a basic £52, you can plug in the V300 Rifle and aim at a spot of light bouncing around the screen, or call for the target to fly past in clay pigeon style. No scores appear on the screen (for obvious reasons) and the plastics "shooting iron" gets flooded by daylight, so the game has to be played in a darkened room.

OTHER INTERESTS

The show was by no means all about hardware, and among the other activities were live music performances at the theatre, with an open invitation to make private recordings, and which included a demonstration by the BBC Radiophonic Workshop. There were lectures by various hi-fi experts too!

A cinema showed films of all kinds, one of which, produced by the BBC, gave an insight to local radio behind the scenes. The London Broadcasting Company (LBC), local radio, were indeed present, and transmitting live from Olympia throughout the show, whilst a few stands away, the BBC were busily receiving experimental transmissions of Proms concert music for live demonstration in Matrix H Quadrophony.

The new base of this exhibition may not please the hi-fi buff, but will undoubtedly provide greater scope for imagination in the future.

Beyer ISS 76 infra-red stereo transmitter and DT 444S stereophone.

The ADC Accutrac +6 turntable.

NEWS BRIEFS

SERT MICROPROCESSOR SYSTEMS and SOFTWARE SYMPOSIUM

More than 140 delegates attended the Society of Electronic and Radio Technicians three-day symposium held at the University of Kent last September. Twenty papers were delivered during the five sessions of this wide ranging programme. Overall the Symposium embraced a broad spectrum of user experience with contributions from active participants in this new technology from universities, technical colleges, semiconductor makers, industry, the Health Service, the Post Office and the National Institute of Agricultural Engineering.

The opening session covered introductory and basic matters. Software is a subject that makes many strong electronics men blanche, whereas the hardware side of the business is reasonably easy to digest. Papers dealing with machine codes and structure and language in software specification and design must have cleared points of doubt or confusion among those without much experience in program compiling.

SOFTWARE SENSE

A point stressed during the fourth paper was the importance of consulting fully with the user at the initial planning stage and defining precisely the problem to be solved before attempting to construct a flow chart. Subsequent alteration or additions to the software can only be made at considerable expense and trouble. Whereas hardware costs have fallen dramatically, software tends to become more expensive and is the major cost factor in current computer systems. All this indicates a need to organise a method for examining programmes in detail at different steps. Here a leaf could be taken from the hardware engineer's book, for something analogous to circuit fault finding is the obvious answer.

THINGS TO COME

Looking ahead, the same speaker ventured the view that soon microprocessor will speak to microprocessor—and that might spell doom for the human programmer. Software could be available on the shelf in the form of standard modules to be selected and plugged in just like hardware units.

In the meanwhile, however, the electronics designer has to face reality and get to grips with development systems, programmers, languages, editors, and compilers—subjects which received attention during Session 2 entitled Programming and System Design.

LOW COST MICROPROCESSOR APPLICATIONS

The Third Session included papers dealing with Low Cost Storage on Audio Cassettes, an MPU System for the Enthusiast or Small Laboratory, and Microprocessors in Education. The presenter of the last paper enthused over US minicomputers, which are available in this country either as complete machines or in kit form, recommending these for students and hobbyists alike.

COMMERCIAL APPLICATIONS

Session 4 was devoted to commercial applications; these included a microprocessor system which has replaced a conventional pneumatic logic control system in a factory air conditioning plant with a claimed 70 per cent energy saving; a system for monitoring and controlling commercial greenhouse environments; and a microprocessor control system for telephone coin boxes. The latter has been developed by Post Office Research to replace existing relay logic systems. The tremendous scaling-down of hardware (and of the circuit diagrams) was demonstrated with illustrations of the existing relay equipment and its probable successor. It is of interest to learn that the Post Office started on this project in 1972 before the first commercial microprocessor had become available.

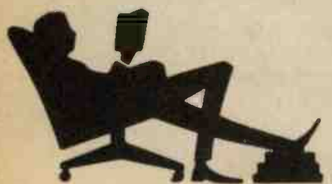
SOPHISTICATED SYSTEMS

Session 5 was devoted to advanced and unusual uses of microprocessors and included two papers relating to medical applications. Assuredly there is an exciting and socially important role for microprocessors in the Health Services. One example is a microprocessor-based foetal monitoring system devised to overcome the disadvantages of the normal chart recording bedside monitor which has been in use for many years. The system described has been used successfully for monitoring patients in the labour ward of a maternity hospital, and has been well received by medical staff.

The second medical application provided an example of computer assisted learning, a technique which has become well established for education and training in a wide range of subjects. The project described is a training equipment for patients undergoing haemodialysis treatment with artificial kidney machines. The haemodialysis Simulator/Trainer incorporates an Intel 4040 together with an alphanumeric display unit.

SYMPOSIUM PAPERS

Reprints of all the papers presented at this symposium are available in a single volume comprising some 200 pages. This publication is available to Practical Electronics readers at the specially reduced price of £7.00 which is inclusive of postage and packing. Orders, with remittance, should be sent to the Secretary, 1977 MPU Symposium (Dept P.E.), S.E.R.T. 8-10 Charing Cross Road, London WC2H 0HP.



BOOK REVIEWS

ELECTRONIC INVENTIONS 1745–1976
By G. W. A. Dummer
Published by Pergamon Press
158 pages, 190 × 275mm. Price £5.50

This is an unusual, if not unique, book. A source of reference for serious student work, but also an enticing volume for browsers, perhaps even a bedside book for electronics enthusiasts to dip into.

Brief descriptions of inventions with source reference are given in chronological order. Ample cross reference is provided through separate listings of subjects and inventors, plus an index.

The concept is excellent. The subject is so immense, the task therefore colossal. So the courage of the compiler is to be admired. This kind of reference book courts trouble—since spot the omissions is a game all can play!

This reviewer for example was disappointed to find no mention of Messrs. Colpitts, Hartley, Cockcroft or Walton, Foster or Seely, or Wien in the List of Inventors. Truly an unfortunate slight to these gentlemen and their contributions to classic circuitry.

Under Transistors and Semiconductor Devices we find Esaki and the tunnel diode, also Ovshinsky and the amorphous semiconductor. But absent is Dr. Carl Zener.

What is an electronic invention? The author himself discusses this tricky definition in the Preface. One could also enquire exactly what is entitled to be referred to as "electronic". Surely not the Phonograph or Gramophone? Yet this invention of Mr. Edison's in 1877 is given a place. There are further examples of equipment or devices which taken on their own have no claim to be considered electronic, yet they are commonly accepted as so nowadays because in their modern form they are an integral part of some electronic amplifying or control system.

These points of criticism are in fact a kind of compliment to this book, for they demonstrate the fascinating nature of its contents and the thoughts they set going in the reader. The author invites additional data, for possible inclusion in a further edition. It is to be hoped that this work undergoes further research and expansion for it could be the basis of a badly needed central reference source in the field of electronics. But it will require revising and expanding at least once a year!

F.E.B

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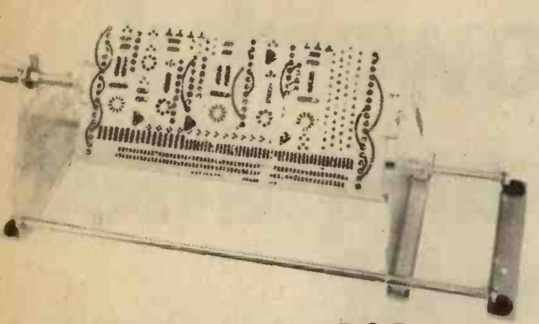

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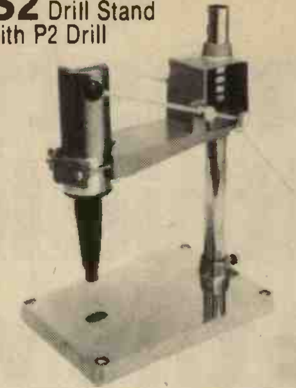

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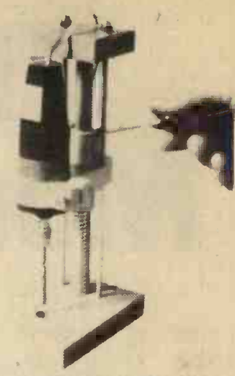

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4·7	04½p	05p	05½p	06p
6·8	05p	05½p	06p	07p
10	05p	06p	07p	09p
22	06p	07p	09p	13p
33	07p	08½p	10p	15p
47	08p	10p	12p	19p
100	10p	13p	18p	26p
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BC142	.25	BCY70	.17	MJE2955	.92	TIP30B	.55
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BC147	.09	BCY72	.15	MPF102	.38	TIP31B	.55
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2N3055	.42
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CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

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BOOK REVIEWS

EDISON THE MAN WHO MADE THE FUTURE

By Ronald W. Clark
Published by Macdonald and Jane's
256 pages, 240 × 165mm. Price £6.95

THE Edison story is perhaps the most romantic of all in the realm of invention. From his earliest years Thomas Alva Edison had an enquiring mind that could be satisfied only by intense experimentation. Throughout his life a relentless physical drive coupled to a great creative mind bore a prolific crop of inventions such as no one else has equalled, as evidenced by the vast number of patents in his name.

The talking machine (phonograph), the electric light bulb, and electricity generation and distribution are his most memorable achievements, but there were many others. Not a scientist, but essentially a practical experimenter and innovator, Edison nevertheless was an instigator of research and development, his Menlo Park "invention factory" being the forerunner of the modern R and D Department.

Edison, the man who made the future is the latest addition to a long list of published biographies. Published this October no doubt to coincide with the centenary of the gramophone, Ronald Clark's book is a good introduction to the great man. There are obvious difficulties in treating adequately this subject within a mere 250 pages; however Edison's life, his inventions and the (often tempestuous) commercial affairs that formed a large part of the Edison story are described in sufficient detail for this purpose. Another feature that will ensure this book's popularity is the historically interesting photographic record presented in 48 pages of sepia prints. This colour, used also for the text, intensifies the sense of history, and plays its part in making this an attractive volume. F.E.B.

PROBLEMS AND SOLUTIONS IN LOGIC DESIGN

By D. Zissos
Published by Oxford University Press
146 pages, 155 × 230mm. Price £1.75 Paperback; £3.50 Hardback

MOST elementary books on logic design show how, using Boolean algebra, a minimal logic circuit can be derived from the truth-table. However in practice theoretically correct circuits may not work, due to race-hazards (spikes caused by gate delays), or may need modification to allow for fan-in restrictions (the maximum number of inputs available on each gate).

Previously these aspects of the design had to be worked out empirically, but in this book Professor Zissos shows how these factors can be taken into account in the design stages by using some elegant methods derived by him. Furthermore he shows how sequential logic circuits too can be systematically designed, using his sequential equations which give the new states of the circuit in terms of its previous states.

Most of the book is taken up with, as its title suggests, worked problems illustrating the various techniques. These fifty-one problems fall under four headings:

Unclocked sequential circuits; *e.g.* traffic lights, pump controller, panel game, electronic dice.

Clocked sequential circuits, using flip/flops; *e.g.* word scanner, paper-tape reader, parity circuit.

Counters; *e.g.* programmable counter, self-locking counter, 24-hour clock.

Combinational circuits; *e.g.* seven-segment display, binary-to-gray converter.

As can be seen from the above examples the problems chosen are practical and entertaining, and where the techniques are not explained in quite enough detail the problems provide the necessary supplement. The book assumes no specialist knowledge and should provide anyone with the necessary tools for designing practical digital circuits.

D.J.D.

AN INTRODUCTION TO MICROCOMPUTERS: VOLUME 1—BASIC CONCEPTS

By Adam Osborne

THIS is an expanded version of the chapters forming the first half of an earlier edition of *An Introduction to Microcomputers* which sold 30,000 copies in the USA. The book deals with microcomputers on two levels. Firstly it contains a very clear description of the fundamental concepts of computing—binary arithmetic and boolean algebra—and explains how a typical microprocessor operates. It comes into its own, however, in the later chapters which cover such subjects as input/output and memory addressing, and provide answers to questions like "what is the difference between cycle stealing and simultaneous DMA?" and "why do few microprocessors provide indirect memory addressing?". In dealing with the internal logic of the microprocessor the chip slice is explained, and the book concludes with the compilation and discussion of a hypothetical instruction set.

The book is well illustrated with diagrams clearly drawn and in a uniform style (not just extracted from manufacturers' data as is unfortunately sometimes seen), and a novel technique of dividing the text into sections of boldface type, for fundamental facts, and lightface, for explanations in greater depth, makes the book useful as a reference source. All in all it provides well written, authoritative, and very readable explanations of most aspects of microcomputer design.

D.J.D.

A PRACTICAL INTRODUCTION TO ELECTRONIC CIRCUITS

By M. H. Jones
Published by Cambridge University Press
237 pages, 175 × 255mm. Price £9.50 Hardcover
£3.95 Paperback

AN excellent up-to-date text book practically orientated and using well-known circuit devices as illustrations throughout. Explanations are clear and to the point, uncluttered by unnecessary delving into non-essentials. There is no excessive recourse to mathematics. Component values and pin connections are given in the circuit diagrams so that the readers can follow out the author's recommendation to prove by practise. For Dr. Jones is, as he tells us in the Preface, a staunch believer in learning by constructing and experimenting.

One chapter is devoted to thermionic valves and the cathode ray tube otherwise the book concentrates on solid state devices. The function of bi-polar, field-effect, power and other discrete devices is explained and such devices are then shown in typical applications. Integrated circuits received full attention. The 741 is the most frequently used linear example. One chapter on logic, counters and timers introduces digital i.c.s—TTL, the 555 timer and alternative forms of logic such as MOS and CMOS.

All the well-known circuit building blocks seem to be covered including one of fairly recent introduction, the bucket brigade. This makes the book a good work of reference apart from its main purpose as a textbook for those who have already some knowledge of simple circuits and who wish to progress with a serious study of the subject. *A Practical Introduction to Electronic Circuits* deserves to become a standard work for the hobbyist and student. F.E.B.

STARTING AND RUNNING A SMALL BUSINESS

By Alan Sproxton
Published by United Writers
130 pages, 210 × 130mm. Price £3.95

THE component retailing business offers plenty of examples of "The Small Business". It is appropriate therefore that a book on this subject should come from the pen of one who has established his own highly successful component business, well-known in the constructor field. Mr. Sproxton's experiences as an entrepreneur have not been limited to electronic components but he has in the past been involved in several different business ventures.

Drawing freely upon all of this wide background the author has written a book that is enjoyable to read and imparts helpful information to the would-be proprietor. The author explains the problems every small owner faces and from personal experience offers sound and valuable advice, interlacing the hard facts of business life with amusing anecdotes and humorous asides. In this free and entertaining approach he has been aided and abetted by Jack Pountney, Art Editor Practical Electronics, who has provided this book with amusing illustrations. F.E.B.

PE CHAMP

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PART FOUR

Now that we have examined the circuitry of the CHAMP main board, and the details of its interface with the control panel and keyboard, we are in a position to move into the construction phase. This month we will consider the assembly of the main board, the design and construction of the power supply module, and the assembly of the plinth which supports the main board, and houses the power supply module.

STRIPBOARD LAYOUT

The CHAMP main board consists of a piece of 0·1in matrix Veroboard measuring 304·6 × 165mm (12 × 6·5in). This is an unusually large size for Veroboard, and if you intend to build CHAMP PROG it may be wise to buy two sheets at the same time, because of course CHAMP PROG uses the same type of board.

The board layout and the required track breaks are shown in Fig. 4.1 and Table 4.1. Before working on the board we would recommend chamfering the edges where they slide into the self adhesive card guides, because these guides grip very firmly and this can hamper board removal later.

As far as possible, the Veroboard component geography is similar to the circuit layout of Fig. 2.3, and although there are some differences, constructors should have no difficulty in finding their way around. Notice in particular that the program memory data and address buses, and the four bit m.p.u. bus are each represented by parallel runs of Veroboard copper track. This arrangement is costly in board space, but is more than made up for by the added convenience when wiring up and trouble shooting, and it provides a layout which can be related to the circuit diagram very easily.

SOCKETS

On the prototype board all i.c.s were mounted using Soldercon socket strips. This technique is strongly recommended for three reasons:

(a) Sockets are essential in MOS systems because of the damage which can occur if an LSI chip ever has to be removed.

(b) Soldercon pins are the cheapest way of providing sockets.

(c) Soldercon pins have the advantage that wiring up can take place *between* the i.c. pins instead of *just outside* the i.c. pins, as would be necessary with "raft" type sockets. This is a big help when using 0·6in wide chips, and allows maximum use of available board space.

The *disadvantage* of Soldercon pins is that they are not much good when repeated insertions or withdrawals of the chip is necessary.

This is not a problem with the CHAMP integrated circuits, but the interfacing sockets (SK1–8) certainly will get well used, and consequently conventional low profile 16-way d.i.l. sockets should be used in these positions. It is also possible that constructors of CHAMP PROG will find themselves regularly swopping 4702A chips around on the CHAMP board, and in this case 24-way low profile sockets could be substituted in the IC18 and IC19 positions, although this has not yet been found necessary on the prototype.

You may have noticed that the prototype board sports an extra 28-way Soldercon i.c. socket in the top right-hand corner. This was installed in the prototype to allow

TABLE 4.1.

Track cut positions to be made on CHAMP Veroboard

Row	Positions
5	BN–BF, BB–AV, AR–AJ, T
6	AD–W
9	BN–BE, BB–AU, AR–AJ, T, R–H
11	AD–W
14	BN–BF, BB–AV, AR–AJ
15	V–H
18	BN–AS, AE–AB, D, E
19	AR–AJ, AA–X
20	W
23	V–H
24	BP–AT
29	BP–BD, V–H
31	BA–AT, Y
35	P–H
36	BC–AT
38	P–H
39	BC
40	BB–AT, BD
41	BC
43	R–H
45	BD–AT, AH, AF
46	V, T
48	R–H
49	BA–AT
53	R–H
55	BE–AT
57	X–H
61	BE–AT
66	X–H
67	BE–AT
69	AA–U, R–H
72	AA–H
73	BD–AT
76	AA–H, AB
78	BD–AT
81	R–H
82	AA–T
83	BD–AT
86	AA–T, R–H
87	S
88	BD–AT
91	AA–U, S–H
93	BD–AT
94	F, E, D
95	AA–L
96	K, J, H
98	BD–AT
100	H, D,
101	AA–L, E
103	BD–AT
105	H, D,
108	BD–AT, E
109	AA, U
111	BP–BF, T–N
112	AB–U, M–D
115	BN–BF, AS–AJ
116	BP, AB–U, N–D

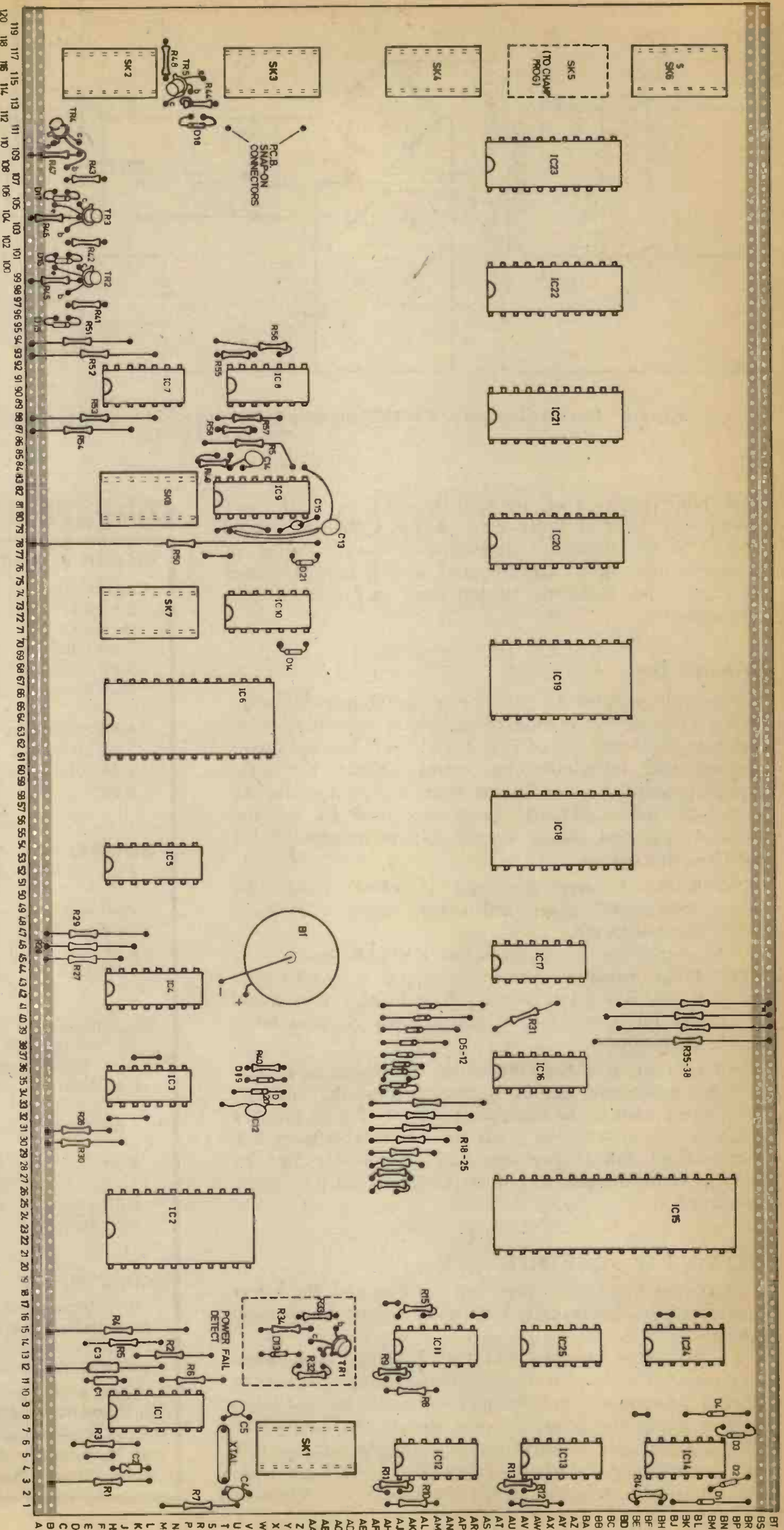


Fig. 4.1. Basic CHAMP board layout. Wiring details of CHAMP complexity cannot be superimposed on this diagram and so for full assembly of this board reference to Fig. 2.3 should be made

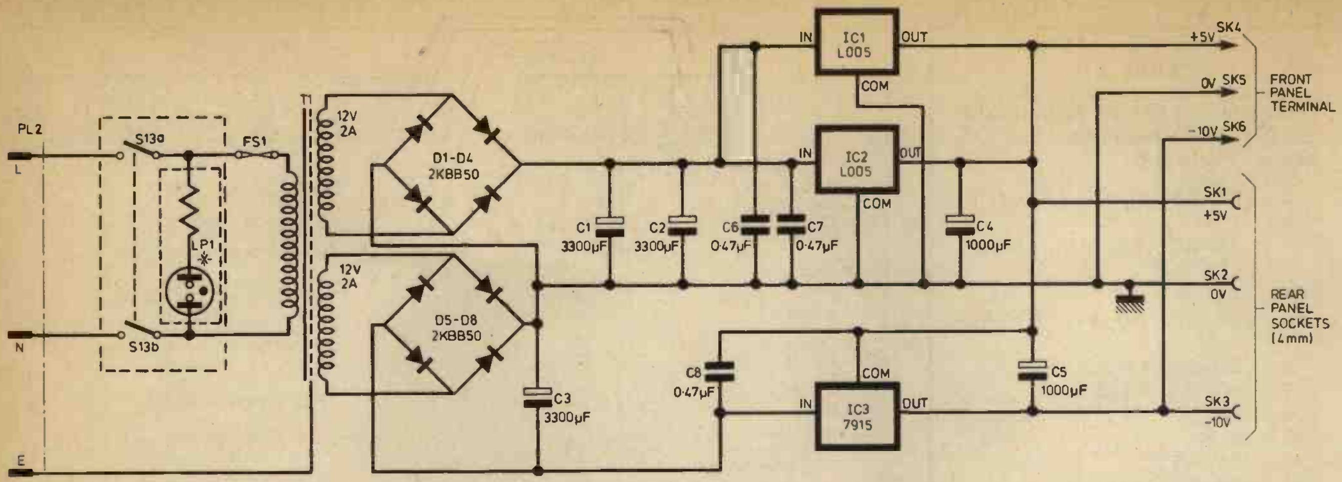


Fig. 4.2. Circuit diagram of CHAMP power supply. Fuse FS1 is only essential if a fused mains plug is not used and should be 2A

the future addition of an 8251 USART or 8253 programmable interval timer chip to the CHAMP board, should it be desirable. With hindsight we consider it unlikely that most constructors would require these facilities, and therefore suggest that this area is left uncommitted.

WIRING UP

It is not possible to produce a comprehensive interwiring diagram for Veroboard circuits of this complexity, but with combined use of Fig. 2.3, Fig. 4.1, and the board photographs, interconnection wiring should be fairly straightforward for the experienced constructor. In the prototype yellow KYNAR wire was used for all the logic wiring, and this is very highly recommended for the following reasons:

(a) Kynar is very fine and therefore avoids the "Spaghetti" effect which can occur with p.v.c. insulated wire.
(b) Despite its small diameter, KYNAR has a very tough insulation which is nevertheless easy to strip.
(c) KYNAR is silver plated which helps you to avoid dry joints and assures you of high integrity interconnections.

The *disadvantage* of KYNAR is that it seems to be difficult to find in amateur suppliers' catalogues at the moment. It is widely used in the electronics industry for its primary purpose of wire-wrapped joints and *is* available from R.S. Components, but if you are unable to secure any, be sure to substitute the very finest single strand p.v.c. wire you can find.

GETTING IT TOGETHER

Once the board has been cut to size and the edges chamfered, track breaks can be made, which conform to Table 4.1.

The Soldercon pins and d.i.l. sockets should be soldered in position first, to provide a reference framework for the discrete components and the interwiring, but the bandolier strip to which the Soldercon pins are attached should be left in place until construction is complete, as this will help prevent any distortion or loss of pins during soldering. The exact order in which the discrete components

COMPONENTS . . .

CHAMP POWER SUPPLY & MAINFRAME

Capacitors

2 off 0·1µF	30V ceramic disc	C9, C10
3 off 0·47µF	Ceramic disc	C6, C7, C8
2 off 100µF	35V tant bead	C11, C12
2 off 1,000µF	25V electrolytic	C4, C5
3 off 3,300µF	25V electrolytic	C1, C2, C3

Semiconductors

2 off L005	Regulator	IC1, IC2
1 off 7915	Regulator (Technomatic)	IC3
2 off	Bridge rectifier 2 Amp (I.R. 2KBB50)	B1, B2

Switches

4 off s.p.d.t.	Doram type sub min	S1, S2, S11, S12
4 off c/o	Doram type min push	S5, S6–S8
2 off n.c.	Doram type min push	S3, S4
2 off n.o.	Doram type min push	S9, S10
1 off d.p.s.t.	Doram type illuminating rocker switch	S13

Miscellaneous

T1 0–12 0–12V, 25VA winding
PL2 Mains chassis mounting plug

3 off 4mm	Socket/terminal post	SK4, SK5, SK6
1 off 16-pin	d.i.l. socket (or other connector)	SK7
1 off	Experimenter 300 Breadboard	
8 off 2mm	Sockets	SK8–SK15
3 off 4mm	Sockets	SK1, SK2, SK3

CONSTRUCTOR'S NOTE

The large sheets of Veroboard can be obtained from **A. Marshall (London) Ltd.** A suitable transformer for T1 can be obtained from **Doram**, order code: 66–150–6, or **RS Components**, order code: 207–251.

Card guides for the CHAMP main board may also be obtained from Doram, order code: 68-337-1.

The breadboard (EXP300) is available from **Continental Specialties Corporation (UK) Ltd.**, Spur Road, North Feltham Trading Estate, TW14 0TJ.

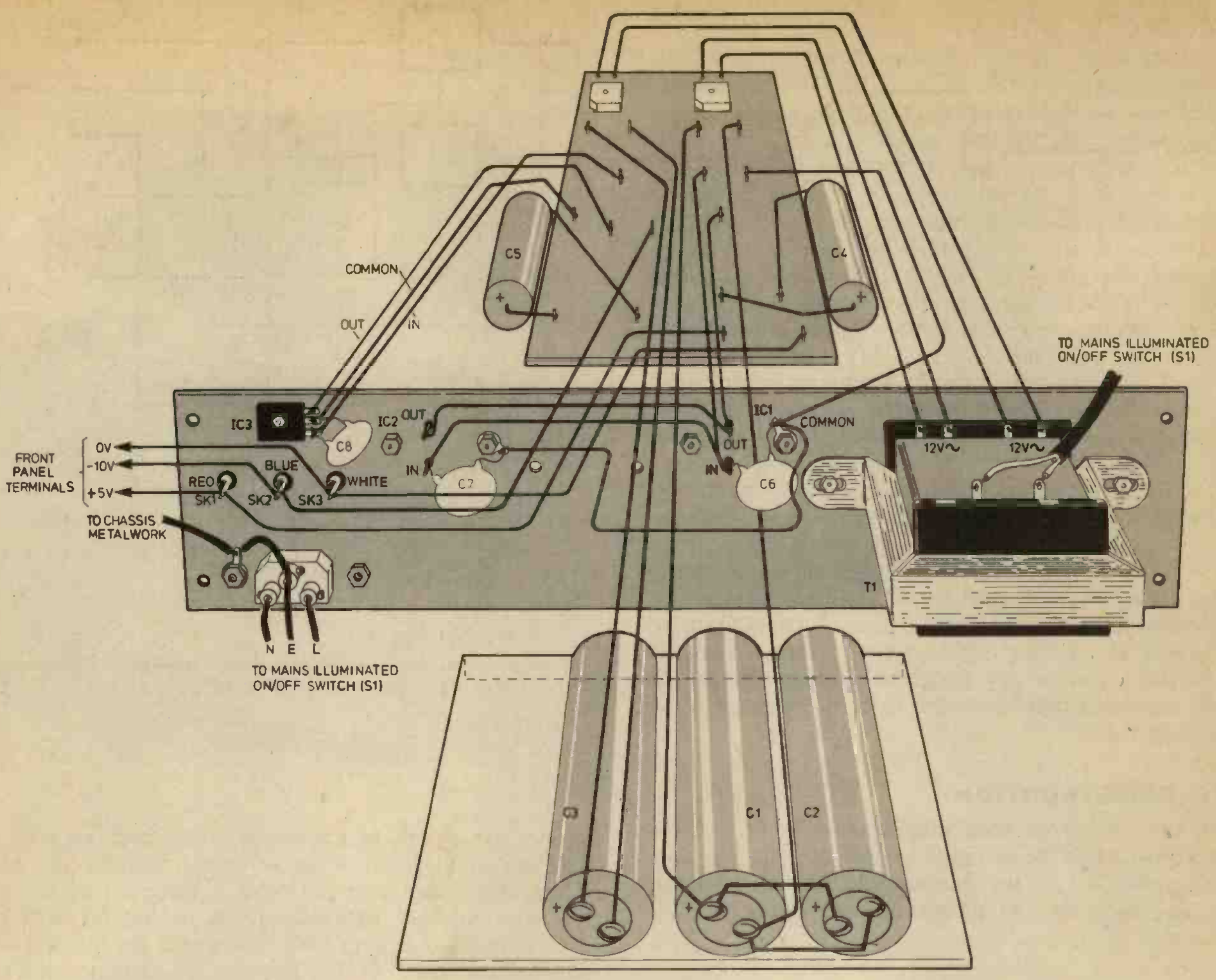


Fig. 4.3. Exploded view and wiring layout of CHAMP power supply. The p.c.b. and the large electrolytic support plate are both mounted on the CHAMP back-plate

and the interwiring are added, is best left to individual preference, but of course, the MOS chips should *not* be plugged into their places until construction is complete, to prevent accidental damage. The last component to be mounted should be the DEAC stack, and in fact it might be wise to add this only after the circuit has been checked with power applied.

The power connections to the board are made via three wander plug terminated flying leads, and these are made with p.v.c. insulated flexible wire soldered to terminal pins inserted in the CHAMP board power bus tracks. Terminal pins are also used to provide the keyboard power, and two are situated adjacent to SK3 for this purpose, wired to +5V and 0V respectively.

The 16-way interconnection jumpers from SK7 to SK8, and from SK1 to the front panel socket can ideally be made up using ribbon cable, and 16-way plugs of the penetrating "no solder" variety such as those made by T & B Ansley, which was the method used in the prototype. The main problem with these components is availability; putting them together was found to be easy even without the special tools made for the purpose, and much more convenient than making soldered connections. An alternative to the ribbon cable system is to use d.i.l. "header plugs" with soldered multiway cable, a more tedious but perfectly sound solution.

POWER SUPPLY CIRCUIT

The CHAMP power supply is designed to provide sufficient current to power the main board, the CHAMP-PROG board, and any reasonable combination of interface circuitry on the breadboard socket. The specification therefore calls for a +5V supply at 1A, and a −10V supply at 750mA. In practice these current specifications have been comfortably exceeded.

The circuit of the power supply module is shown in Fig. 4.2, and as can be seen, the design is fairly conventional, using fixed voltage regulators to set the output potential and provide the necessary high quality regulation. The positive supply uses two L005 devices in parallel to meet the current requirement, but there is no reason why LM309Ks should not be substituted directly if available. The LM309K will also provide a higher current capability if this should be necessary, although to take full advantage of this, the bridge rectifier would have to be changed to a 4 amp unit to prevent overheating.

A negative regulator from the 79' series i.c.s is used to provide −10V but since −10V units are not available, a 15V device (the 7915), is used with its common terminal referenced not to zero volts, but to the +5V output from the L005s.

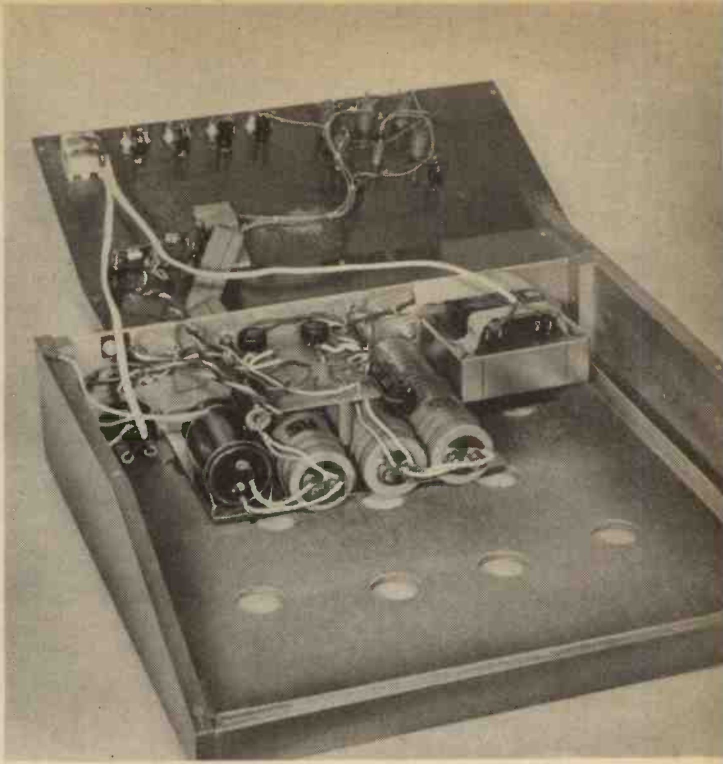
This configuration works well with no compromise of the short circuit protection provided in the regulator.

POWER SUPPLY LAYOUT

The power supply is built as a module which can be tested independently of the other CHAMP components, and which can be removed easily from the plinth as and when necessary. The module uses the aluminium back panel of the plinth as its main structural component and also as a heat sink for the regulators and transformer. The large electrolytic smoothing capacitors are supported by an aluminium tray which rests on the bottom panel of the plinth for stability, and for the sake of neatness, some of the circuit interconnections are provided by a printed circuit board which mounts on a bracket also attached to the back panel.

Figure 4.3 shows the overall arrangement and the connections required, and this should be compared with the photograph of the unit assembled in the plinth. The printed circuit board layout is shown in Fig. 4.4, although 0·15in matrix Veroboard or even pin-board could be used instead if p.c.b. making is not your area of interest.

The only thing to remember when wiring up the unit, is that wire of sufficient diameter to handle the currents involved should be used, and that all terminals conducting mains voltage should be properly insulated. It is of course *essential* that all exterior metalwork be connected to the mains earth to prevent any danger of electric shock, and CHAMP should always be used with a 13 amp plug fitted with a 2 amp fuse.



PLINTH CONSTRUCTION

The plinth design has been simplified as far as possible so that construction is straightforward, but as you can see, the appearance of the finished unit is very pleasing to the eye. Materials and dimensions are given in Figs. 4.5 and 4.6.

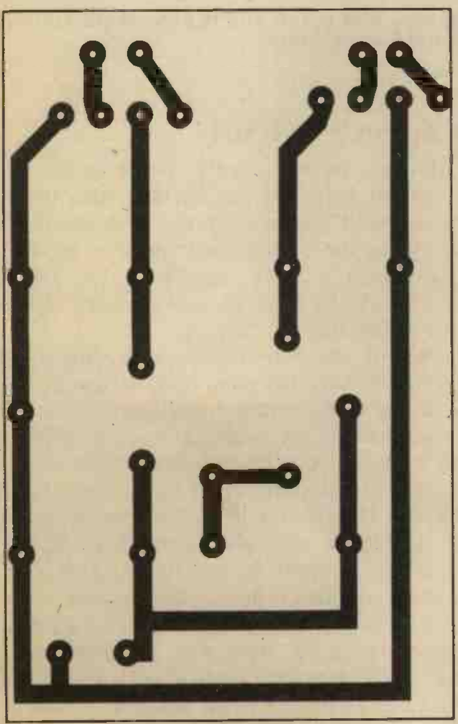
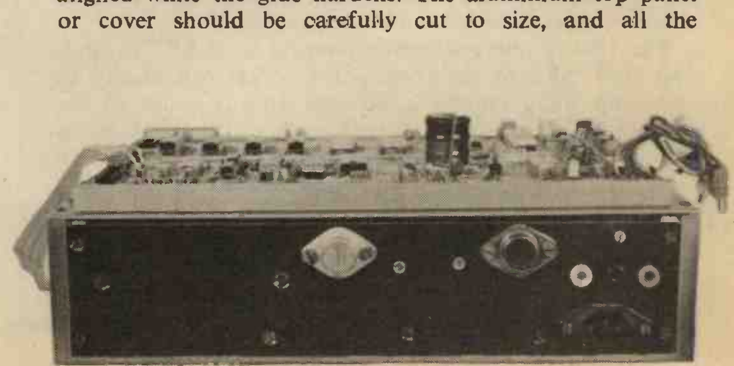


Fig. 4.4. Printed circuit layout of CHAMP power supply, p.c.b.

The first step is to cut the plywood parts to size, and it is important at this stage to ensure that the two plinth side members are identical. This is achieved by clamping the sides together with G clamps, or binding with tape before finally trimming both to size. On the inside bottom edge of the sides, mark a line equivalent to the thickness of the bottom panel, and similarly on the inside rear edge, mark a line equivalent to the thickness of the back panel, and finally, on the front edge draw a line equivalent to the thickness of the front edging strip.

The plywood runners should be cut to fit inside these marks, and then pinned and glued in position with a woodworking adhesive such as Evostick Resin W. If a large illuminated mains on/off rocker switch like the one in the prototype is used, it will probably be necessary to truncate the left-hand plywood runner to provide the necessary clearance for the switch body. The bottom panel, when cut to size, should have a number of air holes drilled in it to allow for convection cooling of the power supply module, whereupon it can be primed and glued to the sides and the front edging strip.

It is a good idea to temporarily attach the aluminium back panel at this stage, so that the plinth is properly aligned while the glue hardens. The aluminium top panel or cover should be carefully cut to size, and all the



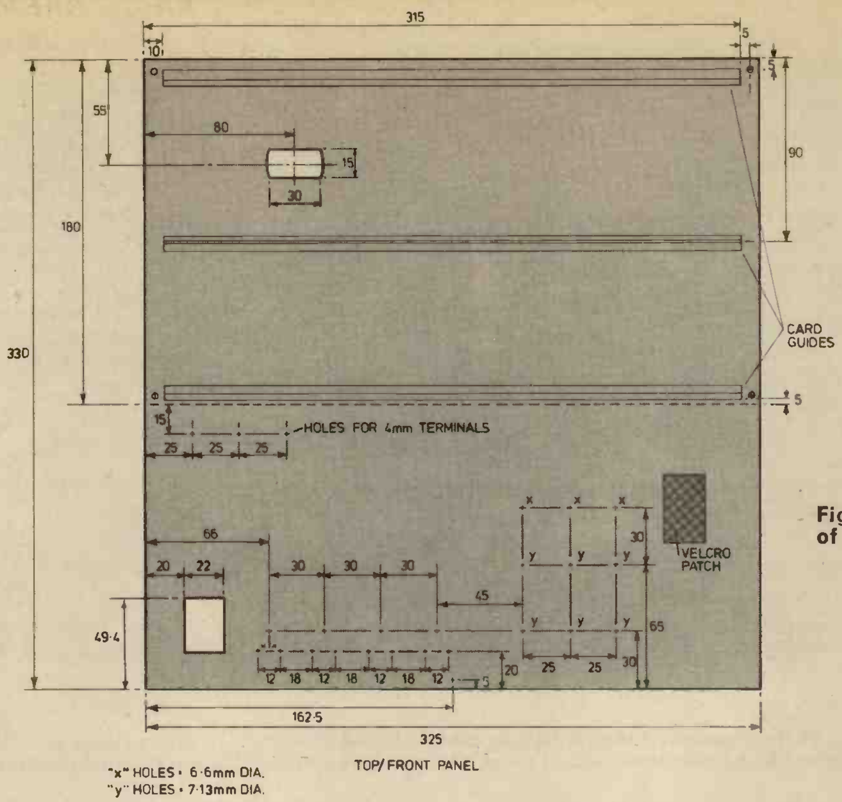


Fig. 4.5. Top/front panel of CHAMP unit

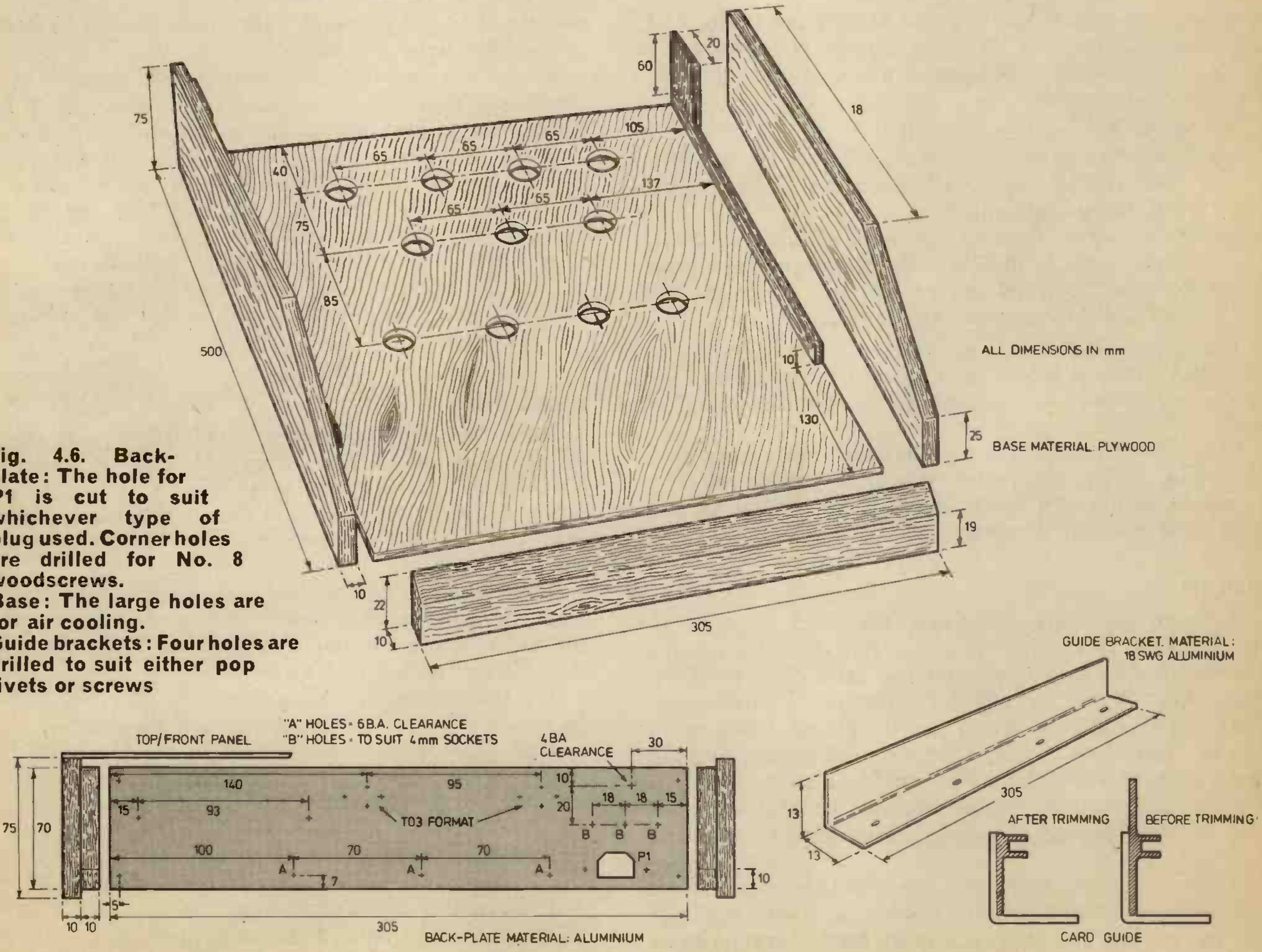


Fig. 4.6. Back-plate: The hole for P1 is cut to suit whichever type of plug used. Corner holes are drilled for No. 8 woodscrews.
Base: The large holes are for air cooling.
Guide brackets: Four holes are drilled to suit either pop rivets or screws

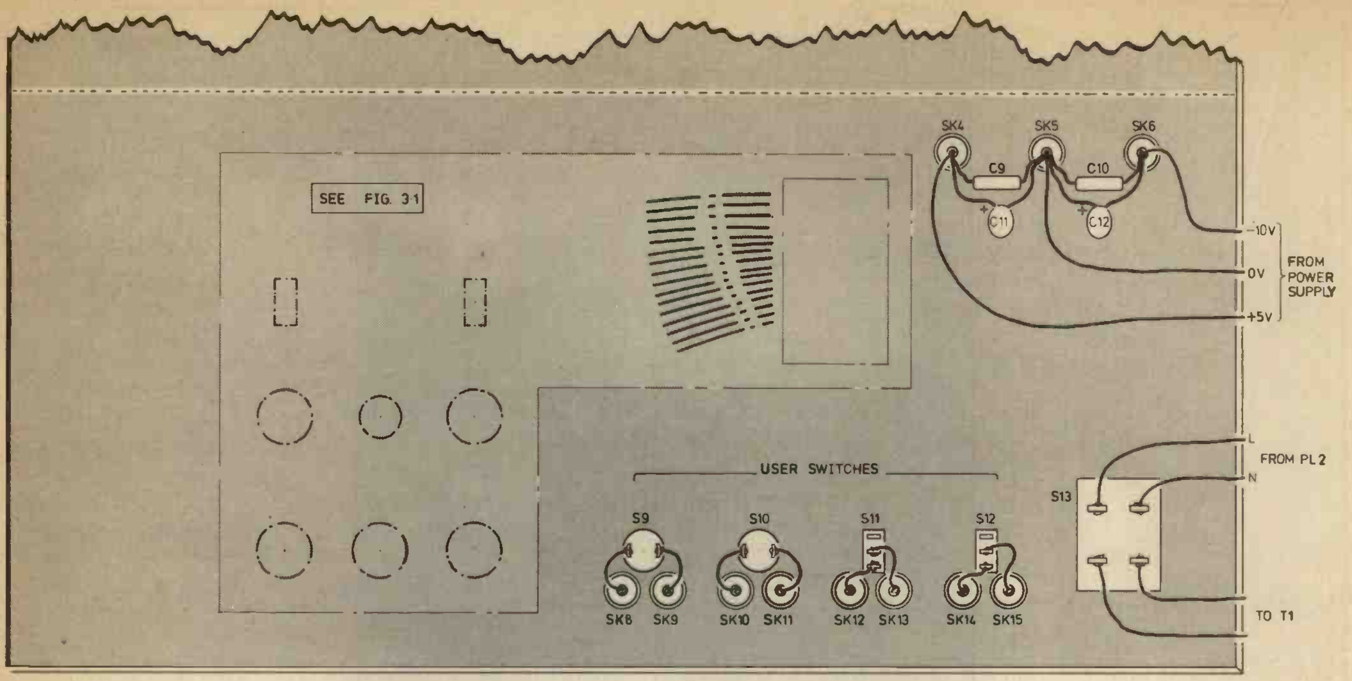


Fig. 4.7. Rear view of front panel wiring. A 16-way connector (d.i.l. socket in the prototype) enables all leads from the CHAMP board to be disconnected at once. Details given match Doram type pushbutton switches

necessary component locating and fixing holes drilled and deburred. The bend in the cover can be produced fairly easily, even without a bending machine, if the following procedure is followed:

(i) Mark the bend line in pencil.

(ii) Clamp the panel to a workbench with the aid of a stout straight edge, with the pencil mark aligned with the straight edge.

(iii) With another stout straight edge press evenly down on the panel, bending it only a few degrees at a time.

(iv) Remove the panel often and check it against the plinth until the desired angle is obtained.

The cover should now be screwed to the plinth and the edges trimmed before the L shaped brackets and card guides are bolted (or pop-riveted) into position (see Fig. 4.6).

It is a good idea to use the CHAMP main board as a jig while finally positioning the card guides prior to fixing, to ensure that the board is not too loose or too tight when assembly is complete.

FINISH

A lot of care was taken over the finish imparted to the CHAMP prototype, and we feel that the results achieved, justify the small amount of extra effort involved. When the "fit" of the plinth components is satisfactory, the cover should be removed and the plywood base given two or three coats of aerosol primer. Allow the primer to dry and sand down to a fine surface between coats. A top coat of a suitable colour can then be applied; in the case of the prototype, a metallic cellulose paint was used, with attractive results.

The cover should be rubbed down all over with wet and dry paper or fine Emery to provide a good "key" for the primer which is applied, and as before, apply two or three coats. A contrasting metallic finish was chosen as the top coat, and several light coats should be applied until a good finish is achieved.

Before the outlines and lettering are applied to the cover, the paint should be allowed at least two days to harden off to prevent damage to the finish. The outlines are first pencilled in with the aid of a soft pencil, then inked over with either drawing ink or a spirit based felt tipped pen. (Do not use a water based ink, or the lines will run when varnish is applied.)

All necessary lettering is applied with Letraset, or a similar dry transfer technique, before the application of a coat of clear polyurethane varnish to give a durable protective finish.

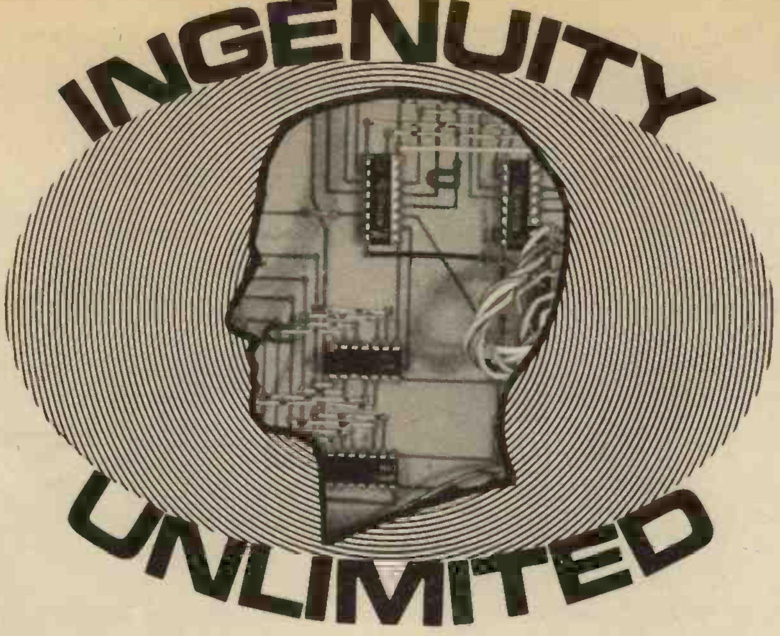
ASSEMBLY

When the plinth is complete, the front panel components can be fitted and wired up as in Fig. 4.7. The use of a 16-pin d.i.l. socket as a termination adds to the modularity of the design, but is not strictly necessary. Terminal pins and soldered connections could be used instead if desired.

The ribbon cable, or loom, from the front panel is taken through the large hole in the cover to appear under the main board, so that it can be unobtrusively mated with the appropriate d.i.l. socket.

The power supply module should be thoroughly tested in isolation before the main board is plugged in, and it is wise to do comprehensive voltage checks on the main board *before* any chips are plugged in. It will not be possible to get CHAMP to run properly at this stage because the keyboard has not been described, and the CHAMP firmware will not be available, but if desired, the clock chip can be plugged in and the clock and reset waveforms checked with an oscilloscope, as can the SYNC pulses emanating from the 4040 CPU chip.

NEXT MONTH: Keyboard design and construction



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

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

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

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

CAR LIGHTS ALARM

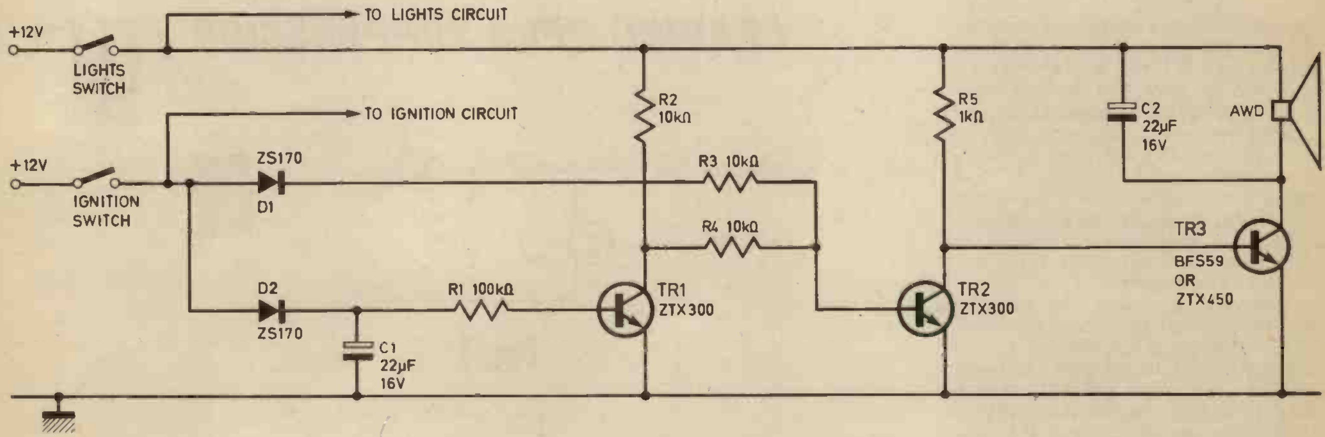


Fig. 1

THE alarm circuit shown in Fig. 1 can save the embarrassment of a flat battery due to forgetting to turn off the side lights. The alarm will sound for about five seconds after the ignition is switched off, so if the lights are needed for parking the alarm is eventually silent. This circuit is designed for negative earth cars. For positive earth vehicles, p.n.p. transistors would have to be used, and the capacitors and ZS170 diodes reversed.

The circuit can be built on a piece of stripboard. It is then connected to the car earth, and to the lighting and ignition switches as indicated in Fig. 1.

If the RS Components type audio alarm is used, which has an average current of 60mA and peaks of 1A, then a high current transistor should be used for TR3.

When both lights and ignition are on, TR2 is on, which holds TR3 off. Also TR1 is on because C1 is charged up. When the ignition is turned off, TR2 turns off, and is temporarily kept off by TR1 being on for five seconds by the charge on C1. When this charge decays, TR1 goes off and TR2 switches back on, thus inhibiting the alarm.

The circuit works very well, and gives a short sharp reminder to turn off the lights.

A. J. Buxton,
Stockport,
Cheshire.

LAMP FAILURE INDICATOR

THE circuit in Fig. 1 was intended as a rear light bulb failure indicator for cars, but could be used for any light source monitoring. Numerous designs for this purpose have appeared over the years, but this is probably the simplest method possible (and should therefore be the most reliable!), having only three components.

The l.d.r. (R2) is mounted in a convenient position within the lamp housing, with the active face directed towards the filament. When the bulb is illuminated, R2 has a low resistance thereby short circuiting the l.e.d. which consequently remains off. If, however, the bulb blows, the resistance of the l.d.r. rises causing the voltage across D1 to increase sufficiently for it to light up.

The circuit as shown, is for a 12V negative earth system. For positive earth vehicles, reverse the l.e.d., and for 6V systems reduce R1 to 470Ω. In any case, the warning circuit should be wired on the correct side of the on/off switch to ensure that no current consumption takes place while the lights are turned off.

If there is insufficient room within the lamp housing for the l.d.r., a small hole can be drilled through the reflector, angled towards the filament, and the l.d.r. mounted behind it.

G. H. Lucas,
Leicester.

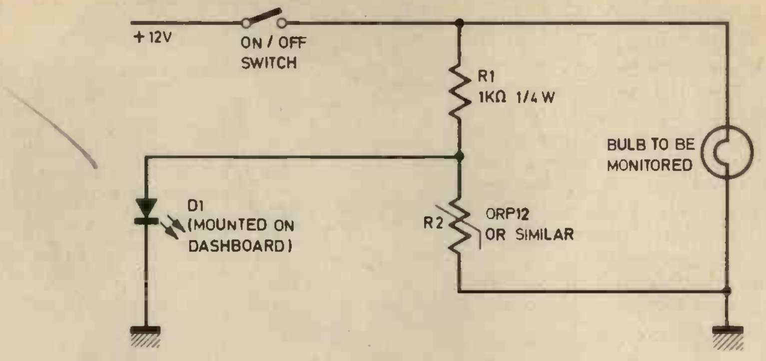


Fig. 1

LEADING ZERO SUPPRESSION

ALTHOUGH this circuit was designed for the six digit common anode display of a CT7001 digital clock i.c. it could be modified for use with other types of seven segment display.

Zero blanking in the tens-of-hours digit is normally achieved by using the circuit shown in Fig. 1. The count here is either 1 or 2, depending upon whether a 12 or 24 hour display is used. At segment *f* it is possible to detect the presence of a zero, and suppress the display.

However, to blank the zeros in tens-of-minutes and tens-of-seconds where the count climbs to 5, two segments have to be used, and segments *c* and *e* are selected, as it is only in a zero format that both of these segments are active at the same time.

In Fig. 2, a 7432 OR gate is used to detect a zero. The output of the gate connected to the digit driver will only be low when the inputs connected to segments *c* and *e* are both low. As this only happens when a zero is present, all other figures from 1 to 5 will be displayed, while a zero which requires both segments, will be inhibited.

Only one gate is required, as the output is fed via diodes to the tens-of-minutes and tens-of-seconds digit drivers.

G. Ballantyne,
Clydebank,
Dunbartonshire.

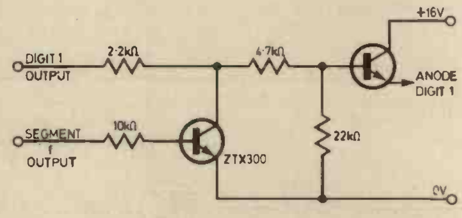


Fig. 1

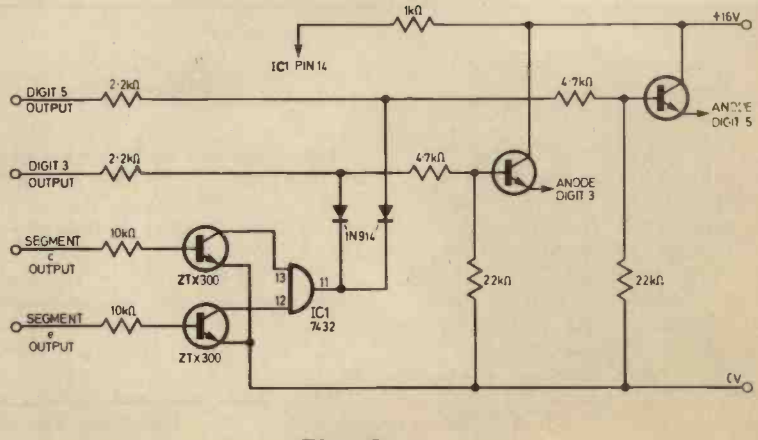


Fig 2.

POLARITY PROTECTOR

THE home experimenter can all too easily destroy expensive components at the anxious moment of trying out a circuit, by hastily applying reversed polarity to the supply input.

Time and money can be saved by simply fitting a bridge rectifier to the circuit, as shown in Fig. 1. Polarity of the applied power is now unimportant. The sacrifice made for the benefit of this precaution is that a volt or more will be lost across the rectifying diodes, but more often than not, this voltage loss will be inconsequential.

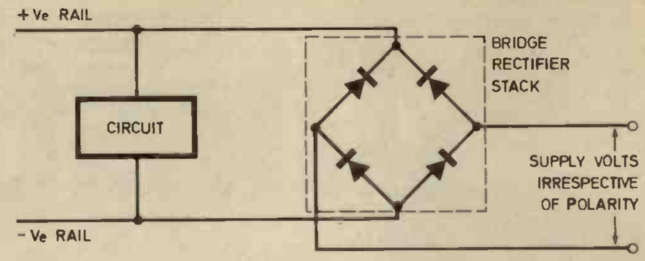


Fig. 1

This idea is particularly suitable for car radios and cassette players, where the vehicle may have a positive or negative earth electrical system.

P. M. Freeman,
Nottingham.

LOGIC PROBE

HAVING seen many different types of TTL logic probes advertised in magazines varying in price from £5–£25, I was prompted to design this circuit which has many of the features of a probe in the £9–£12 range, yet it only costs about £1 to build.

The circuit (Fig. 1) was built onto an old "fat" ball point pen tube, which had flying leads for +5V and 0V connections.

When A is at 0 the output of IC1a is at 1, so l.e.d. D3 is on, indicating the "low" state.

When A is at 1, because of the inverter, IC1 pin 5 is at 0, so the output of IC1b is at 1 and D4 is on, indicating a "high" state.

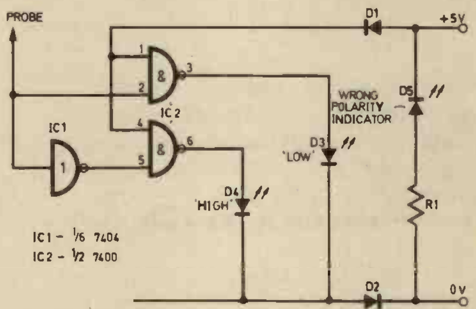


Fig. 1

D1 and D2 are included to protect the circuit against wrong polarity R1 is chosen to give correct operating current for D5.

J. Scott Patterson,
East Lothian.

BATTERY CONDITION INDICATOR

THIS circuit was built to replace an expensive meter in a radio control transmitter.

The NiCad battery used is nominally 12 volts, with a maximum of nearly 14V when fully charged. When discharged, the cell voltage should not fall below 1 volt; that is, 10 volts for the battery.

The circuit of Fig. 1 is a Schmitt trigger operating an l.e.d. indicator. The reference voltage is provided by the 5·6V Zener diode, and hysteresis is set by the ratio of R4 and R5 to about 1 volt. The trip voltage is set by the ratio of the potential divider resistors, R2 and R3. For accurate setting, R3 could be replaced by a variable resistor. When the battery falls to 10 volts the output of IC1 goes low and turns off the l.e.d., which remains off until the battery rises to at least 12 volts again. The total cost is very much less than the cheapest meter.

A. Langton,
Aberdeen.

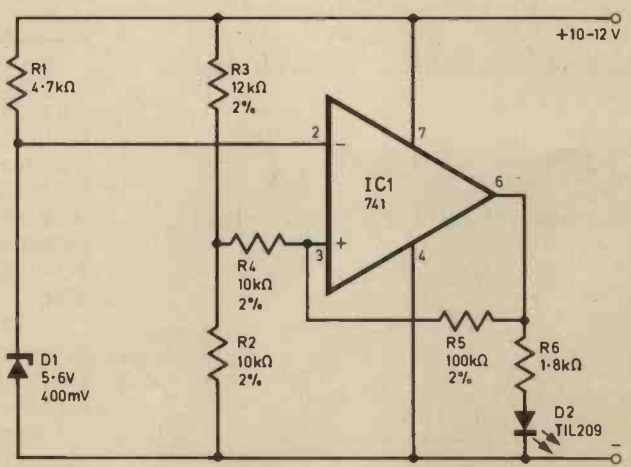
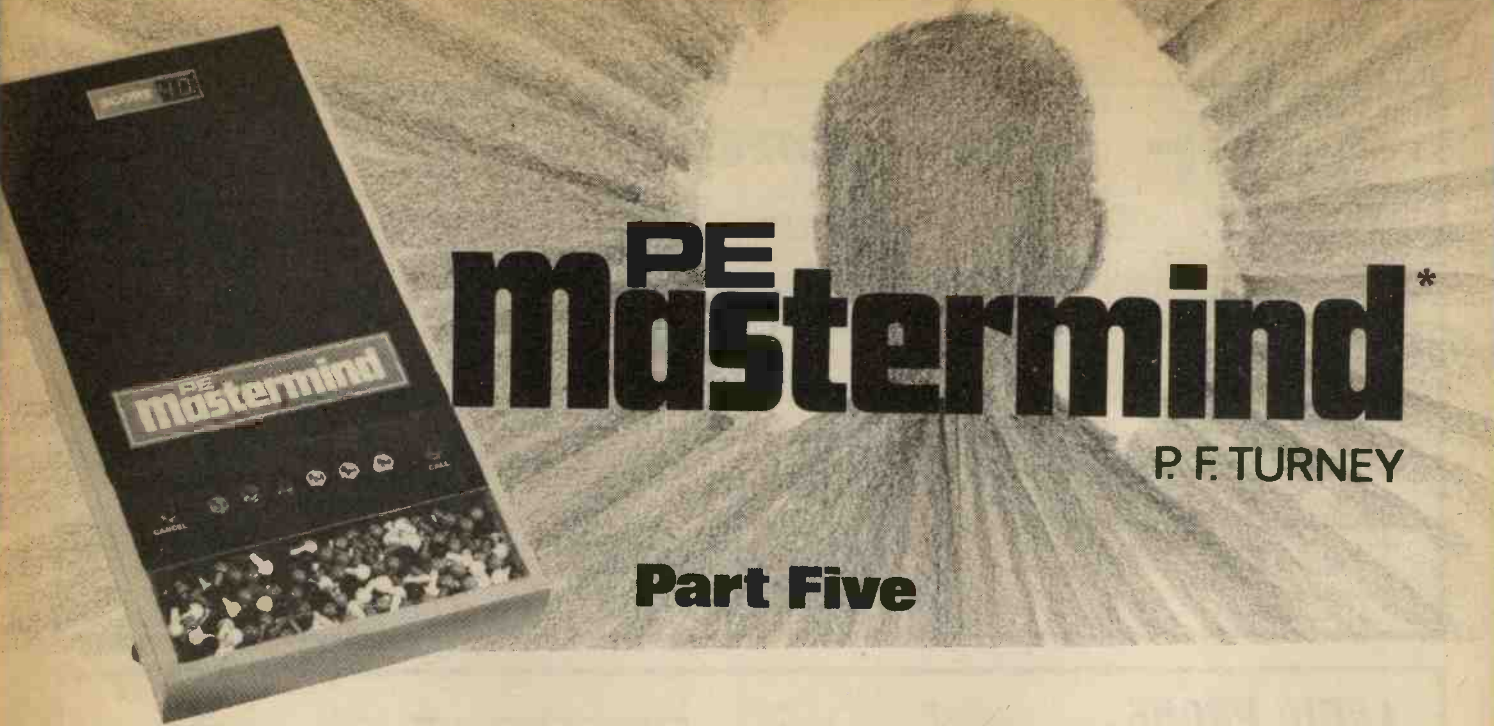


Fig. 1



PE Mastermind*

P. F. TURNEY

Part Five

LAST month it was seen how the position indicator signal handled the situation of repeated internal colours with both "P" and "I" correct entries. The final section of the scoring logic, dealing with the cases where there are repeated internal colours with only "I" correct entries, is to be considered this month, together with the display logic.

THE RESET LOGIC

The existence of this logic was mentioned last month and rather than to now undertake a full operational description the approach will be to illustrate its action with a series of actual examples.

The basic function of this logic is highlighted by the example shown in Fig. 5.1. Below is shown a sequence of events executed by the machine in response to the colours of this example.

(1) Enter First Red — $K = 1$

$C_1\bar{C}$	$E = 0$	$I_1, S_1, P_1 = 0$
$C_2\bar{C}$	$E = 1$	$I_2, S_2 = 1$
$C_3\bar{C}$	$E = 1$	$I_3, S_3 = 1$
$C_4\bar{C}$	$E = 1$	$I_4, S_4 = 1$

(2)–(4) no further change of status (except for clearing of "S"s).

Fig. 5.1. Example showing the need for the reset logic

		X CODE B	R	R	R
ENTRIES	R	0	1	1	1
	W	0	0	0	0
	W	0	0	0	0
	W	0	0	0	0

Table 5.1
TRUTH TABLE FOR THE RESET LOGIC

Slave Status				Reset functions				A Flip Flop I/P's	
S_1	S_2	S_3	S_4	R_1	R_2	R_3	R_4	J_{A3}	J_{A4}
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	1
0	1	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	1	0	K
0	1	1	0	0	0	1	0	K	0
0	1	1	1	0	0	1	1	1	0
1	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	1	0	0
1	0	1	0	0	0	1	0	0	0
1	0	1	1	0	0	1	1	0	0
1	1	0	0	0	1	0	0	0	0
1	1	0	1	0	1	0	1	0	0
1	1	1	0	0	1	1	0	0	0
1	1	1	1	Don't care condition					

It is seen that I_2, I_3 and I_4 are all set, giving an incorrect score of three white key pegs. It is the function of the reset logic to reset two of these flip flops and produce the correct score of one white key peg. By convention I_3 and I_4 are reset with I_2 retained. The truth table for this and all other examples of reset logic operation is shown in Table 5.1. The final two columns of this table will be discussed a little later.

In the example just considered "S" flip flops S_2, S_3 and S_4 were all set by a single entry, corresponding to a slave status of 0111 in the truth table, which shows that I_3 and I_4 are to be reset to logical zero ($R_3 = R_4 = 1$).

These resets are enabled by clock pulse $C_5\bar{C}$ from the comparison counter, and there are two reasons why this must be so. Firstly, by the time $C_5\bar{C}$ appears all flip flops will have been clocked and given time to set, and secondly,

* Mastermind is the registered trade mark of Invicta Plastics Ltd

had a "P" correct entry been made the PI signal would have gated clears to any "I" and "S" flip flops also set by the entry, prior to the appearance of $C_5\overline{C}$. If more than one "S" flip flop has remained set by the time $C_5\overline{C}$ appears, it is known that only "I" correct entries have been made and the reset logic can therefore be enabled.

The slave status 1111 can never occur, since in this situation one entry would be "P" correct (1111 means that the entry is correct for colour with all internal colours and so must be correct for position with one of them), and all slaves would be cleared prior to $C_5\overline{C}$.

IC48 and 49, shown in Fig. 5.2, are used to implement these reset functions.

THE "A" FLIP FLOPS

The example of Fig. 5.3 will be used to demonstrate the requirement for two more flip flops. The sequence of events is summarised below.

(1) Enter Red — K high
$C_2\overline{C} - C_4\overline{C}$ — I_2, S_2; I_3, S_3 and I_4, S_4 set
$C_5\overline{C}$ — I_3 and I_4 reset by reset logic

(2) Enter Red — L high
C_0 — Slaves cleared
$C_2\overline{C}$ — P_2 sets – I_2, S_2 therefore cleared and inhibited via gate 2 of reset level 1. PI goes high
$C_3\overline{C} - C_4\overline{C}$ — S_3, I_3 and S_4, I_4 set and promptly cleared by PI
$C_5\overline{C}$ — No action (no slaves remaining set)

(3)–(4) No change

Only P_2 remains set and an incorrect score would be indicated. What has happened is that P_2 in (2) clears I_2 which was retained in (1) by the reset logic, reducing the score by one white key peg. Had the reset logic been organised to clear I_2 and I_3 and retain I_4 instead there would still be input combinations that would be wrongly scored.

The solution to this dilemma is to use conditional deletions or clears, and the "A" flip flops are used to indicate whether or not a clear is conditional. No detailed description of these flip flops is to be given and their operation is illustrated by way of example, see Fig. 5.3 and the sequence of events below.

(1) Enter Red — K high
$C_2\overline{C} - C_4\overline{C}$ — S_2, I_2; S_3, I_3 and S_4, I_4 set
$C_5\overline{C}$ — I_3 and I_4 reset by reset logic. A_3 set to indicate that I_3 was conditionally reset

(2) Enter Red — L high
C_0 — Slaves cleared
$C_2\overline{C}$ — P_2 sets and clears and inhibits I_2 and S_2. PI high
$C_3\overline{C}$ — S_3, I_3 set. PI line is inhibited from clearing S_3 and I_3 by $\overline{A}_3 = 0$ at input to gate 3 of reset level 2 (see Fig 4.1)
$C_4\overline{C}$ — I_4, S_4 set and promptly cleared by PI
$C_5\overline{C}$ — No action (only S_3 set)

(3)–(4) No change

The score is now the correct score of one black and one white key peg. Flip flop A_4 serves for I_4 in a similar fashion, no example is to be given for this case.

The set conditions for the "A" flip flops are shown in the last two columns of Table 5.1. The entries of K (from the entry counter) in these columns indicate that only if the corresponding slave status arises in response to a first entry is a conditional reset necessary. Note that the status 0101, for example, can arise only if an entry is made in position 1 or in position 3 (otherwise it would be "P" correct), and only in position 1 is the retained "I" flip flop I_2 subject to a possible reset by the occurrence of a "P" correct entry in position two.

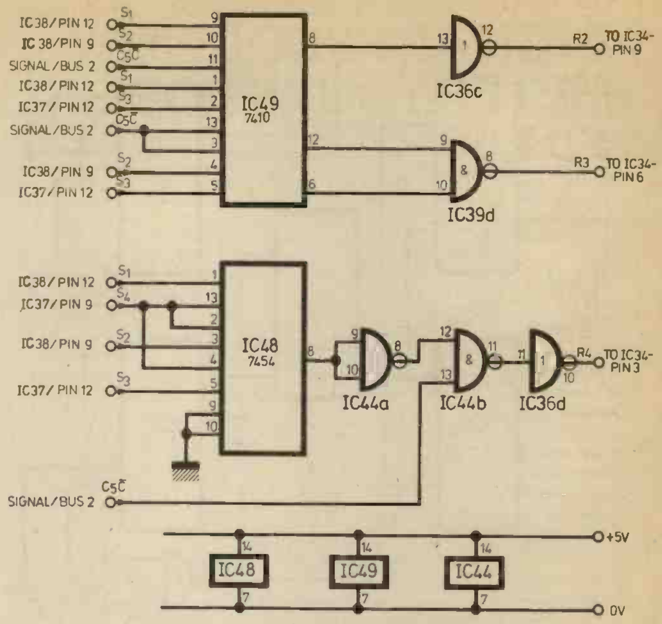


Fig. 5.2. The reset logic circuitry

0111 GATE

This is a two input NAND gate (IC39c) that acts to inhibit the PI line from resetting I_4 when the 0111 status arises, which can only be in response to a first entry. A full discussion of its role is somewhat involved and is for this reason not included here.

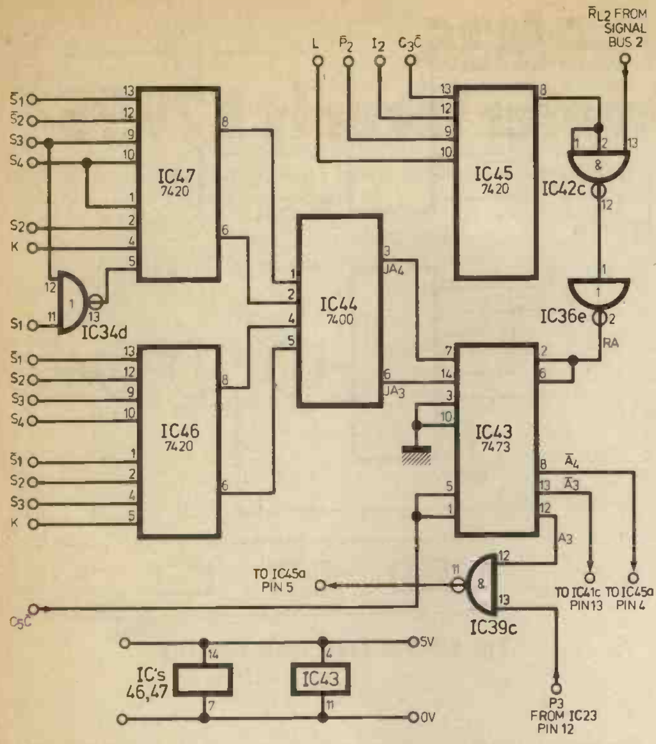
Fig. 5.3. Example illustrating three reset modes of the scoring logic

X CODE

ENTRIES	B	R	R	R
R	0	I_B	I_A	I_A
R	0	P	I_C	I_C
W	0	0	0	0
W	0	0	0	0

The reset modes are as follows:—(a) I_A—cleared by "reset logic"; (b) I_B—cleared by P_2 (clear and inhibit function); (c) I_C—cleared by PI enabling "Reset Level 2".

As explained in the text, the score given here is incorrect, and so necessitating the use of the "A" flip flops.



S_1 from IC38/pin 12
$\bar{S}_1$ from IC38/pin 13
S_2 from IC38/pin 9
$\bar{S}_2$ from IC3/pin 8
S_3 from IC37/pin 12
S_4 from IC37/pin 9
$C_5\bar{C}$ from Signal Bus 2
K from Signal Bus 1

L from Signal Bus 1
$\bar{P}_2$ from IC22/pin 8
I_2 from IC31/pin 9
$C_3\bar{C}$ from Signal Bus 2

Fig. 5.4. The "A" flip flop and associated logic. Locations for i.c. pin outs are also listed

CLEARING THE "A" FLIP FLOPS

Both these flip flops are cleared by the reset signal R_{L2}, but A_3 is additionally cleared via IC45. The reason for this is that unless A_3 is cleared as soon as it has served its purpose it can in certain circumstances incorrectly inhibit the PI line from clearing I_3.

A type SN7473N dual JK flip flop is used for A_3 and A_4, shown in Fig. 5.4 together with the set and reset logic, ICs 43; 44, 46 and 47; and 45b respectively.

DISPLAY LOGIC

Conventional display logic is employed using two SN7447N seven segment decoder drivers coupled to a type DL727 dual seven segment l.e.d. display (see Fig. 5.5). This display must only be enabled when the final results are available from the scoring logic. For this reason signal N from IC20, the entry counter, is taken to the BI/RBO (Blanking input/Ripple blanking output) of both drivers, so that these are only enabled following the fourth entry made, and until such time as a subsequent deduction is commenced. Signal N is buffered by IC19 and 27 before being taken from board one to board two.

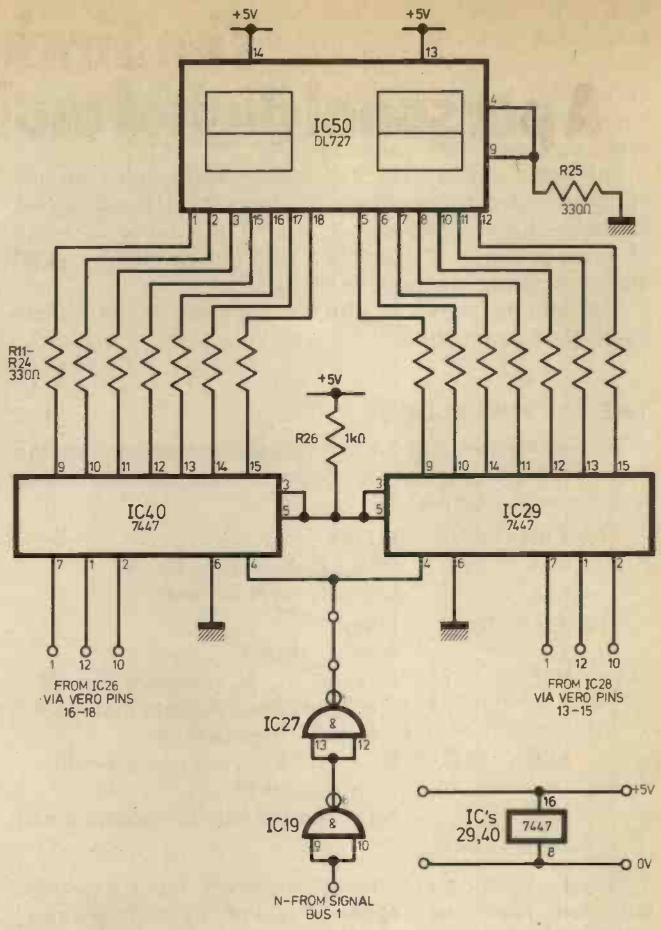


Fig. 5.5. Circuitry for the display logic

Strictly the BI/RBO should be used in conjunction with an open collector gate, but in this application the internal output is disabled by ensuring that the RBI never assumes the value of logical zero.

Limiter resistors are necessary between the decoder and the displays. Do not use values of resistance below approximately 180 ohms in an effort to achieve greater brightness from the displays. (A value of 330 ohms, as given in the list of components, was used for these resistors in the prototype).

CONSTRUCTION

The remaining section of the scoring logic is wired on the main board (Board 1), with i.c. positions as shown in Fig. 5.6. As usual, all wiring is carried out using single cored wire on the top side of the board, reference being made to the circuit diagrams of Fig. 5.2 and 5.4 as appropriate.

Remember that an i.c. should be carefully positioned and orientated on the board before any of the copper tracks are broken and any connections made.

The display circuits are wired onto Board 2. The details of this board are given in Fig. 5.6. One important point to remember here is that the DL727 display is viewed through the cut-out on the peg board. It is therefore a very wise precaution to check that the final position of this display on Board 2 lines up exactly with this cut-out when the board is mounted in the casing. The display itself should be mounted using, for example, solder-con pins.

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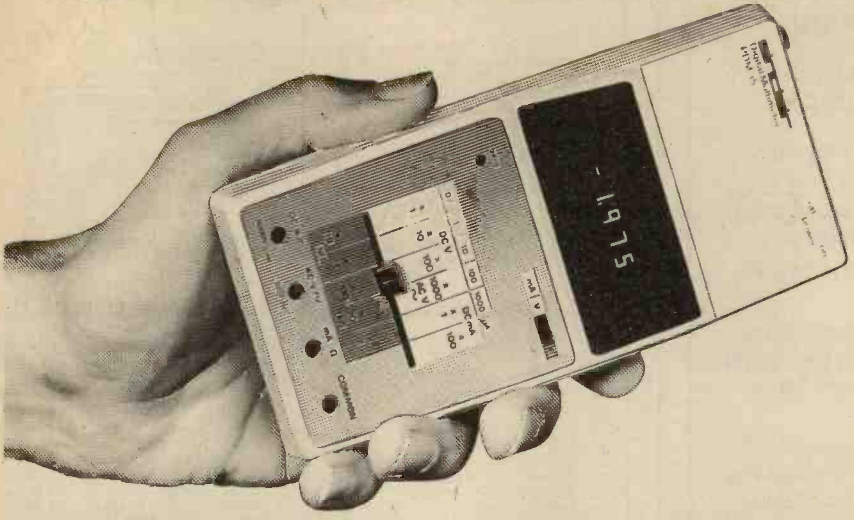

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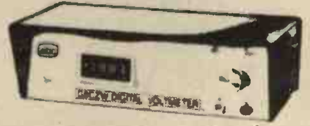

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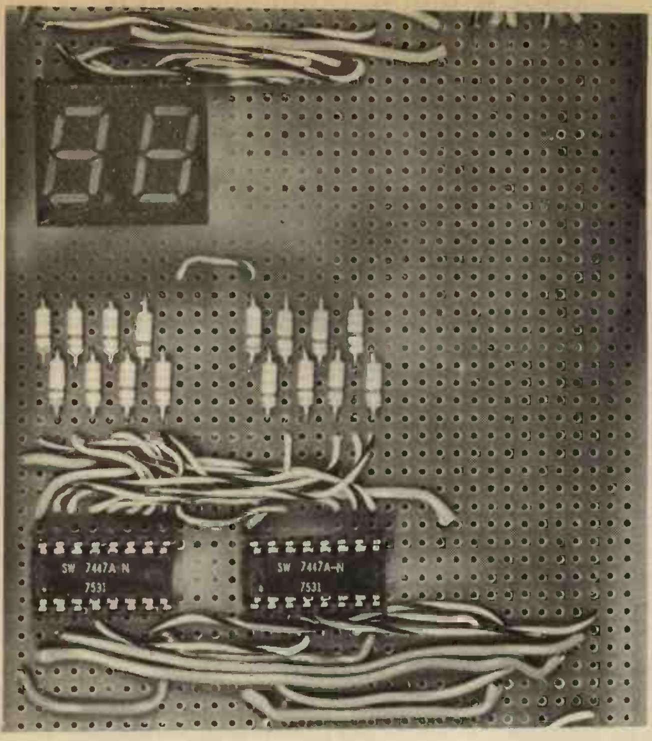

In the test schedule last month it was suggested that temporary connections be made between pins 9, 6 and 3 of IC34 and 0V in order to perform worthwhile testing. Do remember to remove any such connections before proceeding with this month's construction!

FINAL TESTING

The ultimate test of any piece of equipment is to connect it up and try it! The scoring may be checked by monitoring the internal X codes and comparing the achieved scores with those expected from appropriately chosen combinations of inputs. Advantage may be taken of any occurrences of repeated X codes to verify that the reset logic and "A" flip flops are performing correctly.

Remember that fault tracing may be expedited by slowing down the internal clock as described in part three. To help those who do meet with problems a list of likely oversights is given below.

(a) Check i.c. power connections—these are easily missed!

(b) Make sure that you have not forgotten to solder in any i.c. pins.

(c) Check for shorting Veroboard tracks.

(d) Forgotten any Veroboard breaks?

Finally, it may be mentioned that there is a golden rule with non-operative TTL built systems: Always suspect your wiring first and the IC last! ★

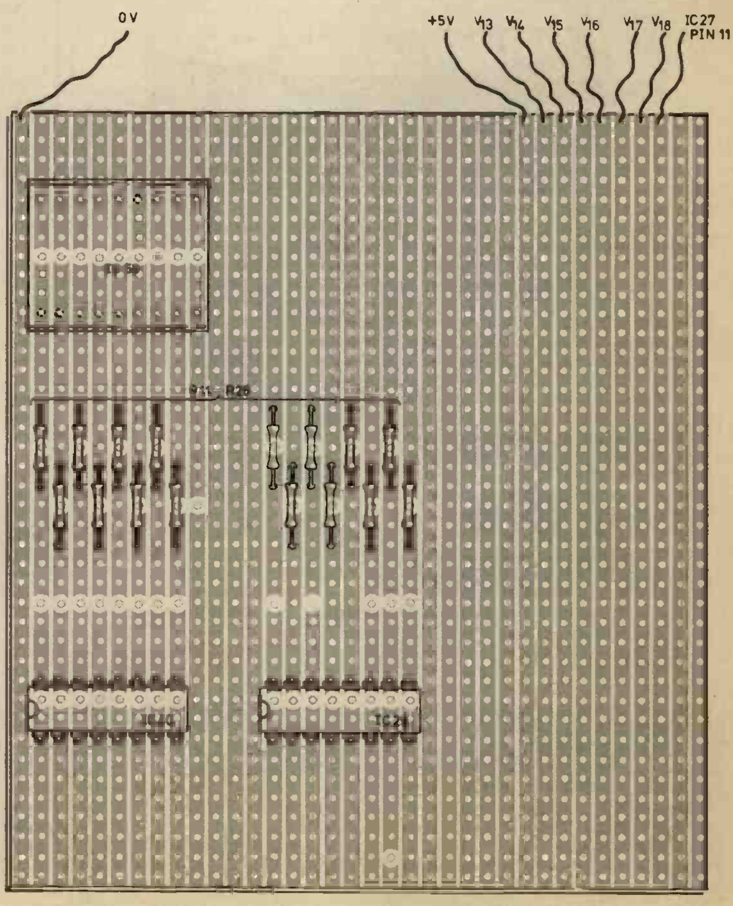

Fig. 5.6. Component layout for the display logic. A photo of the prototype is shown above. For assembly details Fig. 5.3 should be referred to

COMPONENTS . . .

Semiconductors

IC43	SN7473N
IC44	7400
IC46–47	7420 (2 off)
IC48	7454
IC49	7410
IC40–29	7447 (2 off)
IC50	DL727 l.e.d. display (Litronix)

Resistors

R11 – R25	330Ω
R26	1kΩ

Miscellaneous

Veroboard 0·1in matrix coppered size 3¾in by 4in (Board 2)

NEWS BRIEFS

Sound Transmission by Infra-red Light

A NEW multi-channel infra-red sound transmission system has recently been demonstrated in this country. The Sennheiser Intraport System designed and manufactured in West Germany by Sennheiser is a large-scale development from the cordless headphones system for domestic hi-fi equipment first introduced at the Berlin Audio Fair 1975. Equipment is available for up to nine channel operation.

The demonstration was arranged by Hayden Laboratories Limited, of Chalfont St. Peter, Bucks, the U.K. distributors, and took place at Shepperton Film Studios. The whole of one stage area was saturated at high intensity from a number of strategically placed i.r. radiators (aerials). Each infra-red power radiator contains a bank of diodes and the power stage electronics. An automatic level setting amplifier ensures a low distortion radiation at maximum power.

The transmitter contains the exciter circuits of the multi-channel unit and the power supply for up to eight power radiators. A high frequency carrier is frequency-modulated by the audio signal. The transmitter output feeds the active radiators, where the emitted infra-red light is amplitude-modulated by the carrier. A special connection cable contains a coaxial lead for the r.f. signal and two d.c. supply leads for the power radiators.

The receiver is incorporated in the headset. This is fitted with a channel selector switch and houses standard batteries. Mounted on the headset, facing forward, is the infra-red receiving diode.

Reception is not entirely dependent upon direct line-of-sight with the radiators, since the i.r. radiation is reflected from light-coloured walls and objects, and so a strong field can be built-up within the room or hall. The number of radiators required depends upon the area to be covered and the reflection nature of the surrounding surfaces. The system's only limitation is that it cannot function in bright environments (over 300ft candles).

Using the standard headset PE's representative found that excellent reception was obtainable anywhere within the stage area, a fall-off in signal and increase in background noise being experienced when the wearer closely approached the dull-coloured distant walls, but a sheet of polystyrene of about 1 metre square was sufficient to restore the reception to normal.

The system is stated to be ideal for conference halls, factories and other large, moderately well-lit areas. Since solid surfaces are opaque to infra-red no radiation "leaks" out of the enclosed area, thus the infra-red system has great possibilities for "security sensitive" applications.

No licence is required for this type of wire-less communication.

POINTS ARISING

DIGITAL REACTION TIMER *(November 1977)*
The p.c.b. conductor layout in Fig. 2 does not show the necessary copper cladding extension around the fixing holes, which allow the stiff copper wire p.c.b. anchors to be soldered. This omission should be catered for. Also, the fixing holes themselves need not be as large as indicated in Fig. 3.

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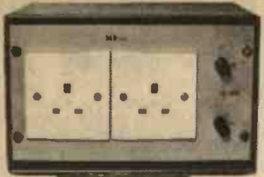

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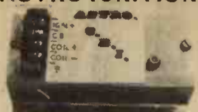

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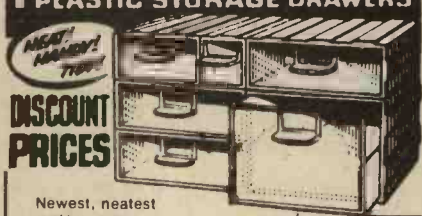

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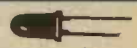

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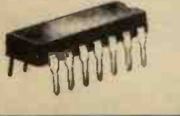

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CD4001	0·24	CD4019	0·70	CD4042	0·96	CD4060	1·27	CD4082	0·25	74LS04	0·27	74LS151	1·13
CD4002	0·24	CD4020	1·27	CD4043	1·15	CD4063	1·25	CD4085	0·81	74LS08	0·24	74LS157	1·17
CD4006	1·34	CD4021	1·15	CD4044	1·06	CD4066	0·80	CD4086	0·81	74LS10	0·24	74LS160	1·40
CD4007	0·24	CD4022	1·10	CD4045	1·59	CD4067	4·25	CD4089	1·77	74LS13	0·65	74LS161	1·50
CD4008	1·10	CD4023	0·24	CD4046	1·52	CD4068	0·25	CD4093	0·91	74LS32	0·25	74LS162	1·50
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CD4010	0·64	CD4025	0·24	CD4049	0·64	CD4070	0·66	CD4095	1·19	74LS74	0·48	74LS163	1·50
CD4011	0·24	CD4027	0·64	CD4050	0·64	CD4071	0·25	CD4096	1·19	74LS75	0·60	74LS164	1·52
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74C20	0·26	74C157	2·35
74C30	0·26	74C160	1·18
74C32	0·26	74C161	1·18
74C42	0·92	74C162	1·18
74C48	2·30	74C163	1·18
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74C74	0·59	74C173	0·95
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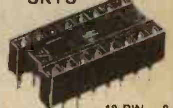

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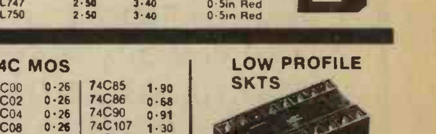

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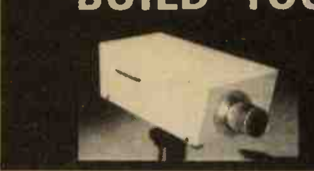

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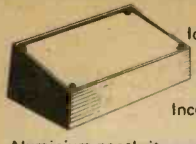
MINI CONSOLES



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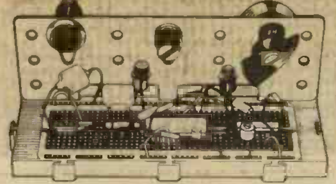

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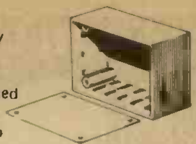

Easily drilled or punched, orange, blue, black and grey ABS. Incorporate slots for holding 1.5mm thick pcb's. Aluminium panel sits recessed into front of the box and held by screws running into integral brass bushes.

SC 85 x 56 x 35mm	80p	(1-9)	77p	(10+)
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150mm leads, held in 6.4mm hole by nut

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240 VOLTS MINI HAND DRILLS

Ideal for drilling pcb's, chassis etc as well as model making. Supplied with 3 collets that accept tools and drills with 1mm, 2mm and 1/8" dia shanks.
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Held in 8mm hole by plastic bezel
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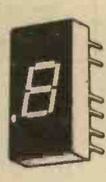
Green 28p each

SEVEN SEGMENT DISPLAYS



Economy Quality
Common Anode – 0.3" – Left Decimal
Red, Yellow and Green @ 45p each

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Red @ 98p each
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Quantity quotations on request

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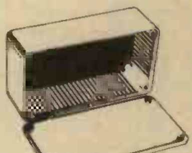

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RC 100 x 50 x 25mm	51p	(1-9)	49p	(10+)
RC 112 x 62 x 31mm	59p	(1-9)	52p	(10+)
RC 120 x 65 x 40mm	68p	(1-9)	62p	(10+)
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RC 190 x 110 x 60mm	£1.33	(1-9)	£1.30	(10+)

Polystyrene version
in grey only with no slots, no integral brass bushes

RC(P) 112 x 61 x 31mm	35p	(1-9)	32p	(10+)

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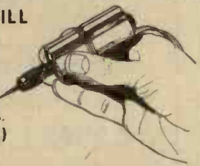
12 VOLTS MINI HAND DRILL



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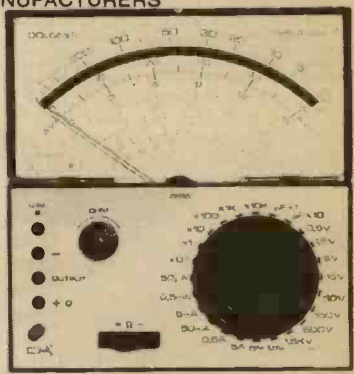

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This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s. Input 100M.V. high imp. Size $9\frac{3}{4} \times 3 \times 2$in. A/C mains operated.

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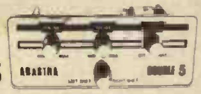
10 Transistor Push-Pull Ready built with volume, treble and bass controls. 240V operated.



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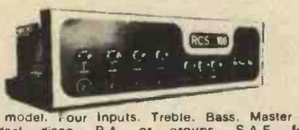

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