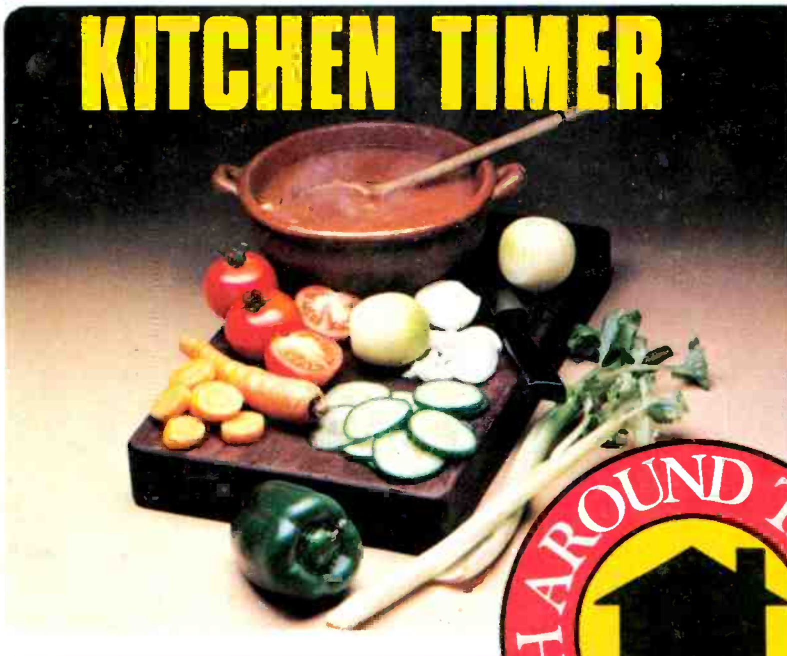
Easy to build projects for everyone

Everyday ELECTRONICS

MARCH 80
50p

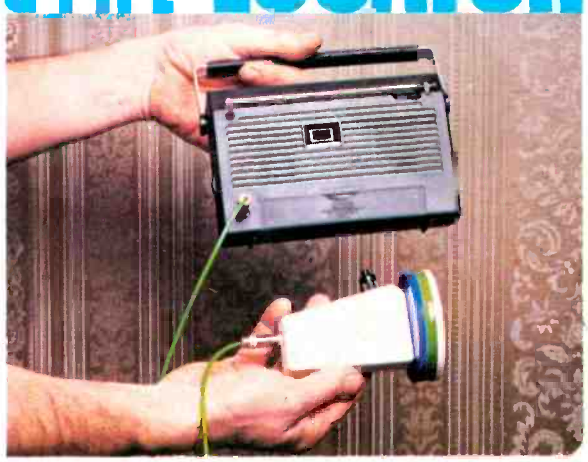
KITCHEN TIMER



AROUND THE HOME PROJECTS

STEREO HEADPHONE AMPLIFIER

CABLE & PIPE LOCATOR



Australia 85c South Africa 85c New Zealand 95c Malaysia $3·50

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

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 30p TO ALL ORDERS UNDER £10·00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.

VAT Export orders no V.A.T. Applicable to U.K. Customers only. Unless stated otherwise all prices are exclusive of V.A.T. Please add 15% to total cost including P & P.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am–6.00 pm. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in μF)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10m, 15n 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p; 150n, 220n, 24p; 330n, 470n 41p; 680n 52p; 1μF 64p; 2μ 82p.
160V: 39μF, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1μF 22p; 1μ5, 2μ2 32p; 4μ7 36p.
1000V: 10nF, 15n, 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1μF 175p.

POLYESTER RADIAL LEAD CAPACITORS (250V)
10nF, 15n, 22n, 27n, 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1μF 22p; 1μ5 30p; 2μ2 34p.

FEED THROUGH CAPACITORS
1000pF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF) 500V: 10 40p; 47 68p; 250V: 100 65p; 63V 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8 10, 15, 22 8p; 47, 32, 50 12p; 63, 100 27p 50V 50, 100, 220 25p; 470 32p; 1000 50p; 40V: 22, 33, 9p; 100 12p; 2200, 3300 85p; 4700 98p; 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 33p; 1500 35p; 2200 45p; 3300 62p; 4700 85p; 16V: 10, 40, 47, 68 7p; 100, 125 8p; 220, 330 14p; 470 16p; 1000, 1500 20p; 2200 34p; 10V: 100 6p; 640 12p; 1000 14p.
TAG-END TYPE: 450V: 100μF 180p; 70V: 4700 165p; 64V: 3300 130p; 2500 98p; 50V: 3300 105p; 2200 99p; 50V: 15,000 399p; 4700 120p; 4000 92p; 3300 93p; 2500 85p; 2200 85p; 2000 + 2000 120p* 30V: 4700 90p* 25V: 15,000 195p 6400 105p* 4700 65p* 3300 80p* 2200 60p.

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 47, 100 40p. 10V: 22μF, 33 20p 6V: 47, 68, 100, 30p 3V: 68, 100μF. 20p

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF 6p
0·015, 0·02, 0·04, 0·05, 0·056μF 7p
0·1μF 8p 0·2 9p 50V: 0·47 12p

MINIATURE TYPE TRIMMERS
2-5·6pF, 3-10pF, 10-40pF 22p
5-25pF, 5-45pF, 60pF, 88pF 30p

COMPRESSION TRIMMERS
3-40pF, 10-80pF 30p; 25-190pF 33p
100 500pF 45p 1250pF 58p.

POLYSTYRENE CAPACITORS
10pF to 1nF 8p; 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, 180 11p each
220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 16p each
1000, 1200, 1800, 2200 26p each

CERAMIC CAPACITORS: 50V
0·5pF to 10nF 4p; 22n to 100n 6p.

EURO BREADBOARD £5·30.

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.
500Ω, 1K & 2K (Lin. only) Single 27p
5K-2 MΩ single gang 27p
5K-2 MΩ single with DP switch 65p
5K-2 MΩ double gang 78p

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
5KΩ-500KΩ single gang 60p
10KΩ-500KΩ dual gang 80p
Self Stick Graduated Bezels 30p

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

RESISTORS: Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

Range	Val.	1–99	100+
¼W 2Ω2–4M7	E24	2p	1p
½W 2Ω2–4M7	E12	2p	1p
1W 2Ω2–10M	E12	5p	4p
2% Metal Film 10Ω–1M		6p	4p
1% Metal Film 51Ω–1M		8p	6p

100+ price applies to Resistors of each value not mixed.

S–Dec 350p T–Dec 400p
U–Dec 'A' 465p U–Dec 'B' 699p

OPTO ELECTRONICS
LEDs plus clips
TIL209 Red 13
TIL211 Grn 17
TIL212 Yellow 18
·2" Red 15
2" Yellow Green 18
Square LED 36
OCP71 120
ORP12 63
ORP61 85
2N5777 45
7 Seg Displays
TIL312 C An 3" 105
TIL313 C Cth 3" 105
TIL321 C An 5" 115
TIL322 C Cth 5" 115
DL704 C Cth 3" 99
DL707 C.A. ·3" 99
DL747 C.A. ·6" 180
FND357 120
MAN3640 175
·3" Green C.A. 180
·6" Green C.A. 225
LCD 3½ Digit 875
TIL32 Inf. Red 58
TIL78 detector 70
Opto Isolators
IL74 48
TIL111 85

VOLTAGE REGULATORS*

1A	TO3	+ve	—ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		—
18V	7818	145p		—
1A	TO220 Plastic Casing			
5V	7805	65p	7905	75p
12V	7812	65p	7912	75p
15V	7815	65p	7915	75p
18V	7818	65p	7918	75p
24V	7824	65p	7924	75p
100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085	95	LM323K	625	TAA550	50
LM300H	170	LM325N	240	TBA625B	95
LM305H	140	LM326N	240	TDA1412	150
LM309K	135	LM327N	270	78H05	595
LM317K	350	LM723	39		

SLIDE 250V:
1A DPDT 14p
1A DP c/off. 15p
½A DPDT 13p
4 pole c/over 24p
PUSH BUTTON
Spring Loaded
SPST on/off 65p
SPDT c/over 70p
DPDT 6 Tag 85p

SWITCHES
TOGGLE 2A 250V
SPST 28p
DPDT 38p
SUB-MIN TOGGLE
SP changeover 59p
SPST on/off 54p
DPDT 6 tags 70p
DPDT c/off 79p
DPDT Biased 115p

SWITCHES Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER: SPST on/off 10A 250V 30p
ROCKER: Illuminated (white)
Lights when on: 3A 240V 70p
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 41p
ROTARY: Mains 250V AC, 4 Amp 45p

DIL SOCKETS (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 16p; 20 pin 22p; 24 pin 25p; 28 pin 39p; 40 pin 50p.

JACKSONS VARIABLE CAPACITORS
Dielectric 100/300pF 175p
500pF 205p
6 1 Ball Drive 4511/DAF 125p
Dial Drive 4103 6 1/36 1 650p
Drum 54mm 40p
0-1·365pF 245p
00 2 365pF 285p
0 2 365pF with slow motion Drive 325p
00 208/176 285p
" " with slow motion drive 325p
C804-5pF 10 15 25 50 pF 185p
100, 150pF 275p
'L' 3 x 310pF 550p
00·3 x 25pF 430p

DENCO COILS
'DP' VALVE TYPE
Range 1 to 5 Bl., Rd., Yl. Wht. 92p
6–7 B.Y.R. 85p
1·5 Green 99p
'T' 1 to 5 Bl., Yl., Rd., Wht. 1·05p
B9A Valve Holder 28p
RDT2 98p
RFC 5 chokes 98p
RFC 7 (19mH) 102p
IFT 13; 14; 15; 16; 17 92p
IFT 18/1·6 104p
IFT 18/465 109p
TOC 1 92p
MW5FR 112p
MW/LW 5FR 120p

VEROBOARD

	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3¾	46p	39p	24p
2½ × 5	55p	50p	31p
3¾ × 3¾	55p	50p	—
3¾ × 5	62p	67p	43p
2½ × 17	169p	135p	92p
3¾ × 17	218p	180p	120p
4¾ × 17	280p	—	183p

Pkt of 35 pins 22p
Spot face cutter 105p
Pin insertion tool 144p

DIODES
AA129 20
BA100 10
BA102 15
BY126 12
BY127 12
CRO33 148
OA9 75
OA47 12
OA70 12
OA79 15
OA81 15
OA85 14
OA90 7
OA91 6
OA95 8
OA200 9
OA202 8
IN914 4
IN916 5
IN4001/2 5
IN4003 6
IN4004/5 6
IN4006/7 7
IN4148 4
IS44 20
3A/100V 18
3A/400V 20
3A/600V 27
3A/1000V 30

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V. 1·3W 15p each

NOISE
Z5J 160

BRIDGE RECTIFIERS
(plastic case)
1A/50V 20
1A/100V 22
1A/200V 25
1A/400V 29
1A/600V 34
2A/50V 35
2A/100V 44
2A/200V 46
2A/400V 53
2A/600V 65
4A/800V 120
6A/100V 73
6A/200V 78
6A/400V 85
BY164 56
VM18 DIL 50

DIAC
ST2 25

SCRs
Thyristors
0·6A/200V 30p
0·8A/100V 30p
0·8A/200A 35p
1A600V 70
5A300V 35
5A600V 43
8A300V 48
8A500V 58
8A600V 85
12A300V 59
12A500V 92
15A/700V 195p
2N4444 140p
2N5062 28
2N5064 35
BT106 150
C106D 38
TIC44 25
TIC45 45

TRIACS
3A100V 48
3A200V 49
3A400V 50
8A100V 54
8A400V 64
8A800V 108
12A100V 60
12A400V 70
12A800V 130p
16A100V 95
16A500V 150
25A800V 295
25A1000V 480p
T28000D 120

TTL 74

7400	11
7401	11
7402	11
7403	12
7404	12
7405	13
7406	23
7407	30
7408	15
7409	15
7410	12
7411	14
7412	18
7413	21
7414	32
7416	23
7417	26
7420	14
7421	25
7422	19
7423	17
7425	16
7426	19
7427	19
7428	19
7430	12
7432	15
7433	20
7437	17
7438	17
7440	11
7441	52
7442	35
7443	50
7444	52
7445	43
7446	45
7447	43
7448	45
7450	15
7451	15
7453	15
7454	15
7460	13
7470	23
7472	23
7473	20
7474	20
7475	23
7476	22
7480	38
7481	69
7482	49
7483	41
7484	80
7485	52
7486	16
7489	120
7490	23
7491	27
7492	28
7493	22
7494	40
7495	30
7496	34
7497	98
74100	75
74104	65
74105	65
74107	30
74109	32
74110	38
74111	50
74112	68
74116	120
74118	56
74119	89
74120	79
74121	25
74122	32
74123	35
74125	33
74126	32
74128	60
74132	41
74136	55
74141	45
74142	160
74143	250
74144	250
74145	50
74147	90
74148	80
74150	50
74151	37
74153	37
74154	59
74155	36
74156	36
74157	36
74159	120
74160	45
74161	45
74162	45
74163	45
74164	50
74165	50
74166	60
74167	110
74170	59
74172	340
74173	65
74174	50
74175	75
74176	50
74177	45
74178	53
74179	53
74180	45
74181	110
74182	35
74184	105
74185	80
74188	175
74190	45
74191	45
74192	45
74193	45
74194	42
74195	40
74196	47
74197	80
74198	150
7150	175
75491	92
75492	92

74LS

74LS00	11
74LS01	11
74LS02	12
74LS03	12
74LS04	12
74LS05	23
74LS08	22
74LS09	22
74LS10	20
74LS11	22
74LS12	23
74LS13	38
74LS14	75
74LS15	30
74LS20	20
74LS21	22
74LS22	22
74LS26	48
74LS27	28
74LS28	48
74LS30	22
74LS32	27
74LS33	39
74LS37	39
74LS38	39
74LS40	28
74LS42	98
74LS47	63
74LS51	24
74LS54	28
74LS55	30
74LS63	150
74LS73	46
74LS74	41
74LS75	48
74LS76	40
74LS78	40
74LS83	115
74LS85	118
74LS86	43
74LS90	38
74LS91	104
74LS92	89
74LS93	89
74LS95	116
74LS96	116
74LS107	44
74LS109	55
74LS112	55
74LS113	50
74LS114	50
74LS123	70
74LS124	180
74LS125	60
74LS126	60
74LS132	95
74LS136	55
74LS138	85
74LS139	85
74LS151	96
74LS153	78
74LS155	96
74LS156	96
74LS157	78
74LS158	96
74LS160	128
74LS161	98
74LS162	138
74LS163	102
74LS164	114
74LS165	75
74LS168	155
74LS169	150
74LS170	288
74LS173	105
74LS174	106
74LS175	110
74LS181	298
74LS183	280
74LS189	430
74LS190	140
74LS191	140
74LS192	132
74LS193	130
74LS194	166
74LS195	138
74LS196	100
74LS197	140
74LS221	96
74LS240	236
74LS241	231
74LS242	232
74LS243	232
74LS244	155
74LS245	270
74LS247	190
74LS251	134
74LS253	142
74LS257	110
74LS258	110
74LS259	160
74LS261	450
74LS266	52
74LS273	244
74LS275	250
74LS279	66
74LS280	250
74LS299	468
74LS323	468
74LS324	240
74LS365	65
74LS366	65
74LS367	65
74LS368	66
74LS373	180
74LS375	160
74LS374	155
74LS378	184
74LS670	248
74LS673	1050
74LS674	1450

CMOS

4000	13
4001	13
4002	15
4006	87
4007	18
4008	82
4009	33
4010	38
4011	18
4012	18
4013	45
4014	80
4015	82
4016	45
4017	82
4018	87
4019	48
4020	99
4021	95
4022	85
4023	22
4024	66
4025	19
4026	180
4027	45
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4029	99
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4033	145
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4035	111
4036	325
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	95
4045	145
4046	128
4047	87
4048	58
4049	48
4050	48
4051	72
4052	72
4053	72
4054	110
4055	123
4056	134
4059	480
4060	115
4061	1425
4062	999
4063	110
4066	58
4067	380
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4073	21
0475	23
4076	85
4077	40
4078	21
4081	20
4082	21
4085	74
4086	73
4089	150
4093	85
4094	190
4095	105
4096	105
4097	372
4098	110
4099	145
4160	109
4161	109
4162	109
4163	109
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4411	958
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	995
4435	825
4440	1275
4450	295
4451	295
490F	695
4490V	525
4501	19
4502	120
4503	69
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4520	108

LINEAR IC's

702	75
709C 14 pin	35
710	67
723	38
733	125
741C 8 pin	17
747C	78
748C	36
753	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500	390
AY-5-1224A	260
AY-5-1230	450
CA3011	110
CA3018	68
CA3020	235
CA3023	170
CA3028A	80
CA3035	235
CA3043	275
CA3046	71
CA3048	214
CA3080E	65
CA3081	190
CA3085	85
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	85
CA3140	48
ICL7106E	795
ICL7107	975
ICM7205	1159
ICM7217A	790
ICM7555	89
LD130	452
LF356	98
LM10	325
LM300H	170
LM301A	23
LM308	70
LM318	205
LM324	45
LM339	70
LM348	90
LM379	375
LM380	80
LM381	145
LM381AN	248
LM382	125
LM1458	40
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
M253AA	795
MC1304P	260
MC1310	149
MC1312P	195
MC1488	85
MC1489	90
MC1495	350
MC1496	92
MC1710	79
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
NE518	210
NE543	210
NE544	185
NE555	20
NE556	55
NE560	325
NE561	395
NE562	410
NE564	425
NE565	120
NE566	160
NE567	170
NE571	420
SN76003	210
SN76013	140
SN76023	140
SN76033	195
SN76477	200
TAA621	250
TBA120F	70
TBA641	250
TBA800	90
TBA810	96
TCA965	120
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TLO61	54
TLO74	140
TLO81	42
TLO83	95
UAA170	150
ZN414	80
ZN424E	130
ZN425E	415
ZN1034	200
ZN1040E	685

TRANSISTORS

				BDY17	195	MJ2955	90	TIP36A	145	2N2905A	22
AC125	35	BC172	11	BDY56	170	MJE340	54	TIP36C	185	2N2906	22
AC126	25	BC173	11	BDY60	110	MJE370	56	TIP41A	50	2N2926G	10
AC127	22	BC177	15	BDY61	185	MJE371	54	TIP41B	55	2N3053	19
AC128	20	BC178	14	BF115	26	MJE2955	99	TIP42A	72	2N3054	55
AC141	27	BC179	15	BF154	25	MJE3055	70	TIP42B	82	2N3055	48
AC142	28	BC181	10	BF156	29	MPF102	66	TIP2955	60	2N3121	40
AC176	25	BC182	10	BF167	30	MPF103	38	TIP3055	48	2N3133	43
AC188	24	BC182L	10	BF173	25	MPF104	36	TIS43	30	2N3135	33
ACY17	60	BC183	10	BF177	24	MPF105	40	TIS44	45	2N3250	30
ACY18	60	BC183L	10	BF178	25	MPF106	40	TIS88A	35	2N3442	140
ACY19	60	BC184	10	BF179	30	MPSA05	15	TIS90	20	2N3663	14
ACY20	53	BC184L	10	BF180	38	MPSA06	16	TIS91	24	2N3702	10
ACY21	35	BC187	22	BF194	10	MPSA12	22	ZTX107	11	2N3703	10
ACY22	60	BC212	9	BF195	11	MPSA55	22	ZTX108	11	2N3704	10
ACY28	60	BC212L	9	BF196	12	MPSA56	22	ZTX109	11	2N3705	10
ACY39	80	BC213	9	BF197	12	MPSU05	50	ZTX300	13	2N3706	10
AD140	70	BC213L	9	BF198	16	MPSU06	56	ZTX301	15	2N3707	10
AD149	75	BC214	10	BF199	18	MPSU56	60	ZTX302	20	2N3708	11
AD161	42	BC214L	10	BF200	29	OC28	120	ZTX303	25	2N3709	11
AD162	42	BC307	12	BF224A	18	OC35	125	ZTX304	17	2N3710	10
AF114	60	BC308	12	BF244B	24	OC36	130	ZTX314	24	2N3711	10
AF115	60	BC327	12	BF244	30	OC41	125	ZTX326	45	2N3713	215
AF118	75	BC328	12	BF256	60	OC42	48	ZTX341	20	2N3771	179
AF139	40	BC338	12	BF256B	45	OC43	55	ZTX500	15	2N3772	195
AF178	75	BC441	27	BF257	30	OC44	55	ZTX501	15	2N3773	283
AF180	70	BC461	27	BF258	28	OC45	30	ZTX502	17	2N3819	20
AF186	50	BC447	35	BF259	28	OC46	28	ZTX503	15	2N3820	45
AF239	42	BC477	35	BF274	38	OC70	35	ZTX504	25	2N3882	130
BC107	11	BC547	10	BF594	30	OC71	28	ZTX531	25	2N3823	70
BC107B	11	BC548	7	BF595	20	OC72	35	ZTX550	25	2N3866	90
BC108	11	BC549C	10	BFR39	25	OC74	50	2N696	36	2N3903	20
BC108B	11	BC557	15	BFR40	28	OC76	45	2N697	25	2N3904	18
BC108C	12	BC558	10	BFR41	24	OC77	76	2N698	40	2N3905	18
BC109	11	BC559C	10	BFR79	24	OC81	36	2N699	30	2N3906	17
BC109B	12	BCY70	14	BFR80	24	OC82	50	2N706	19	2N4037	52
BC109C	12	BCY71	14	BFR81	24	OC83	48	2N708	19	2N4058	17
BC117	20	BCY72	16	BFX29	28	OC84	45	2N918	33	2N4061	17
BC119	23	BD131	42	BFX81	45	OC140	110	2N930	18	2N4859	65
BC137	20	BD132	42	BFX84	26	OC170	85	2N961	61	2N5135	42
BC140	26	BD133	50	BFX85	28	OC171	45	2N1131	22	2N5136	42
BC142	26	BD135	30	BFX86	28	OC202	95	2N1132	24	2N5138	20
BC143	26	BD136	30	BFX87	28	TIP29	31	2N1302	35	2N5179	60
BC147	9	BD137	30	BFX88	28	TIP29C	60	2N1303	50	2N5180	80
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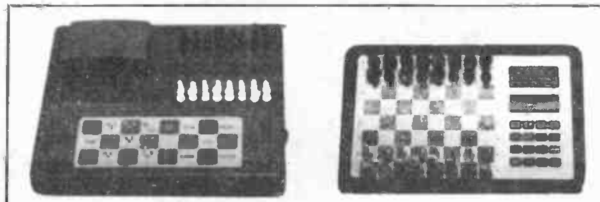

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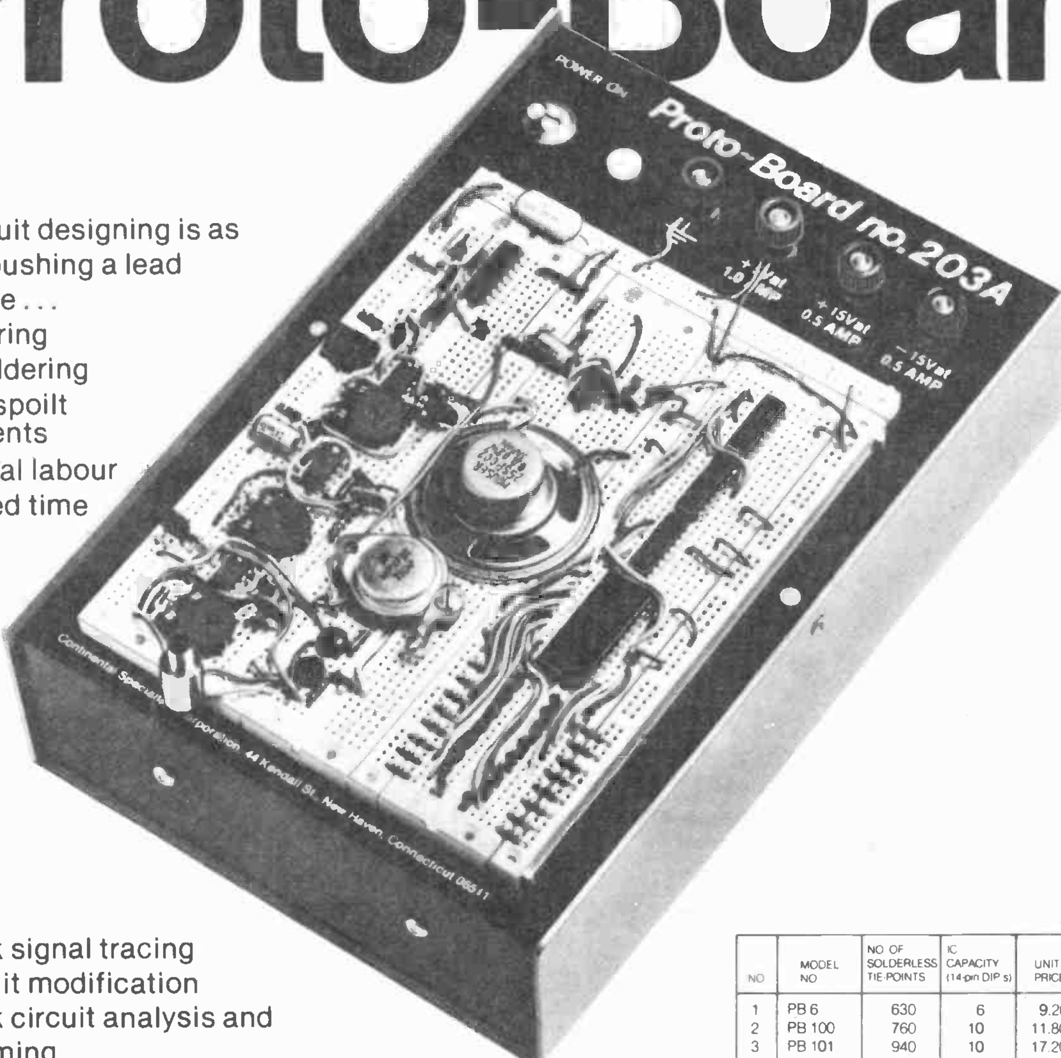

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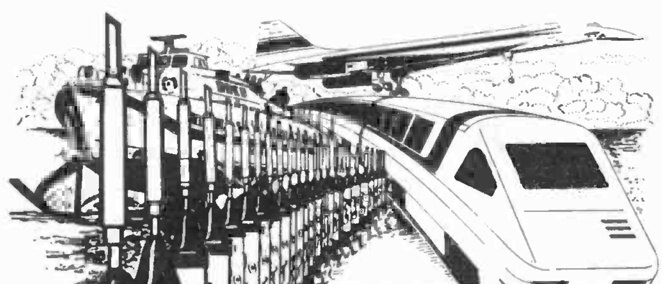

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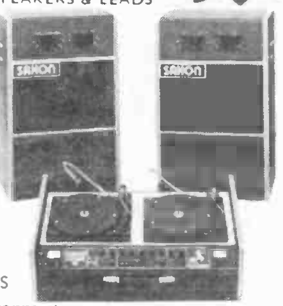

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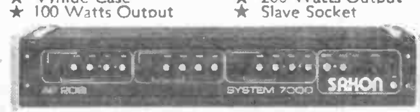

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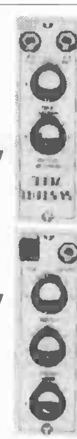

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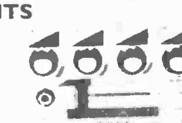

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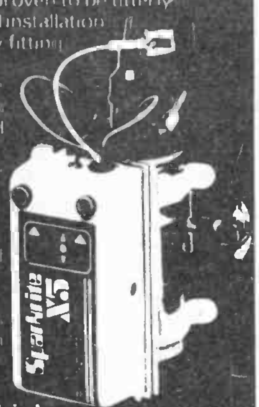

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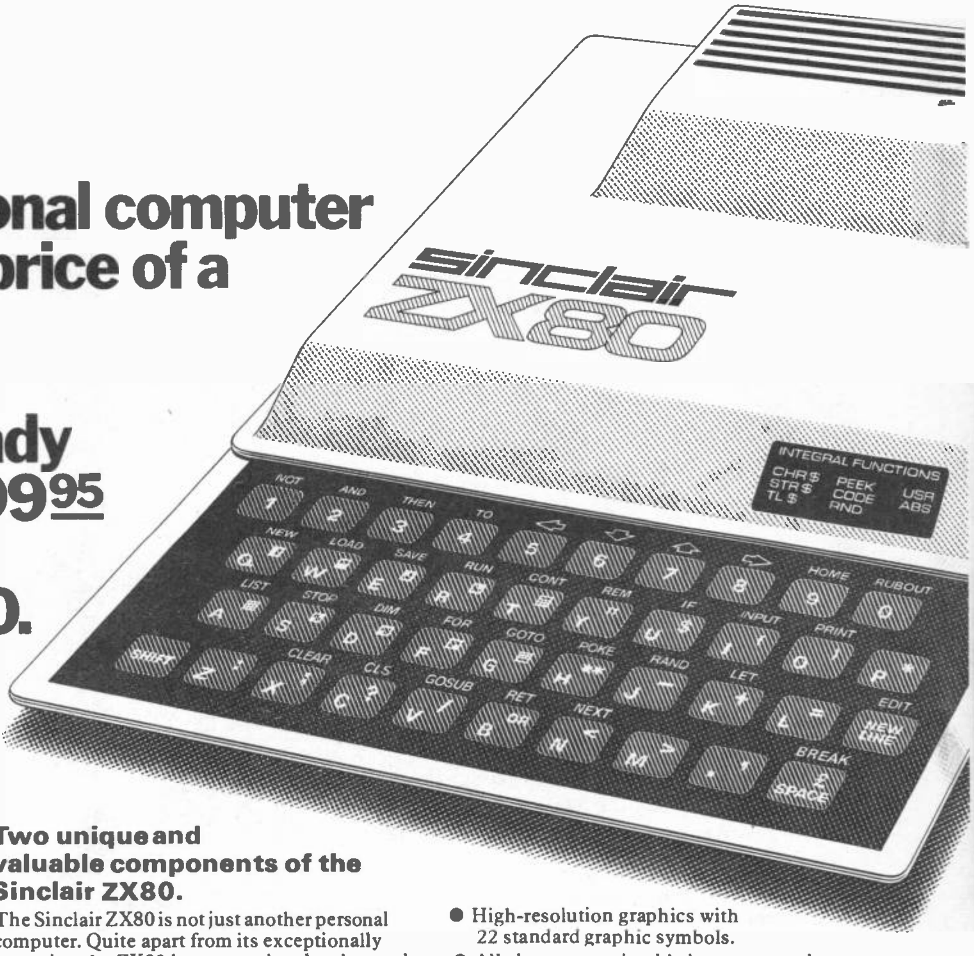

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The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

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- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
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- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
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- High-resolution graphics with 22 standard graphic symbols.
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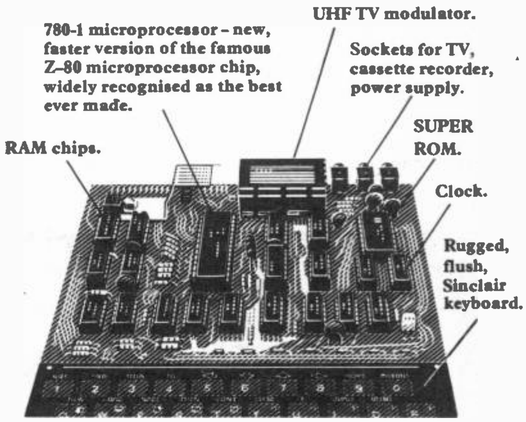
...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you – don't worry. They're all explained in the specially-written 96-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.)



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Projects... Theory...

and Popular Features...

The words home improvement will have an ominous ring about them for many a householder. They conjure up visions of all those jobs that (we are likely to be told) should occupy quite a lot of our spare time.

Home improvement can imply all kinds of jobs from routine redecorating to grandiose schemes involving removal of entire interior walls and other structural changes. Yet they have one thing in common. Any of these operations can bring us up against the problem of buried pipes or mains wiring. For not always is the precise course of these vital service arteries clearly charted. Indeed, in some circumstances there can be a hazard even in the simple and apparently harmless task of knocking a nail or screw into a wall to hang a picture.

The *Cable and Pipe Locator* will therefore be a sensible addition to the handyman's tool kit. Since this tool will be used only occasionally, it has been designed to be used with a small portable radio. In this way the locator unit is kept simple and uses only a few components. Good conservation of resources, please note.

An ever-useful device for the kitchen is an electronic timer. The design presented this month has an extensive range, switchable in 1 minute intervals from a minute to 2 hours. Build this and you won't be accused any more of "wasting your time on that electronics nonsense instead of getting on with the wall-papering." Well, maybe.

Moving on now to other parts of the house, harmony in the home often hangs on disciplined use of the hi-fi by the music fanatic whose choice of music or volume level may not be shared by other members of the family. Listening via headphones is an obvious answer.

Headphones are also convenient for the person living alone, or wherever space limitations do not warrant the outlay on loudspeaker enclosures or a high power amplifier. The *Stereo Headphone Amplifier* will meet requirements such as these very economically.

The projects mentioned so far have well-defined functions to perform in the home. Coming to the *Doorbell Register* the situation is somewhat different. Just how useful this little device will prove to be it is hard to foretell.

Despite its name, its applications obviously are not confined to the front door. It could for example be employed to provide evidence that a room had been entered, or an article disturbed... food for thought at any-rate.

Fred Bennett.

Our April issue will be published on Friday, March 21. See page 175 for details.

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

VOL. 9 NO. 3 MARCH 1980

CONSTRUCTIONAL PROJECTS

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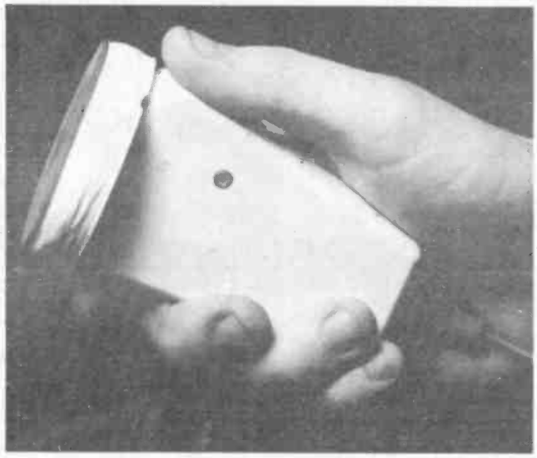
CABLE AND PIPE LOCATOR



By G. Hallam

THIS project arose from the alarming and often dangerous activity of drilling holes in walls in which mains wiring and pipes might be buried.

A simple device was required to give an audible indication of the position of wires and metal conduits with sufficient sensitivity and positional accuracy to avoid striking them. The subsequent device featured in this article has proved invaluable to the author and every handyman ought to benefit from the confidence this device will bring him.

Since copper wire, metal pipes and steel conduits have to be detected, the device is effectively a metal locator and can be used as such in the garden and field and on the beach to find coins and other buried objects of historical interest.

In order to keep construction simple, the cable detector makes use of an ordinary portable transistor radio having a medium or long wave band. The detector generates radio waves, the frequency of which is changed when metal is brought near to the search coil.

These waves interfere with the internally generated intermediate frequencies in the radio to produce an audible tone from the radio. This "beat" frequency varies in tone as metal passes across the search coil.

THE CIRCUIT

The circuit shown in Fig. 1 is a weak radio transmitter and as such needs to be licenced (see licensing address below). The circuit is essentially a Colpitt's oscillator. This consists of a tuned circuit made up of L1, C1 and C2 which forms the collector load of the transistor TR1.

When switched on, the circuit oscillates at a frequency determined by the inductance of L1 and the values of C1 and C2. Because it is necessary to use a portable radio as a detector, r.f. harmonics are not filtered out.

The search coil consists of 100 turns of 33 s.w.g. enamelled copper wire wound on a 65mm diameter former.

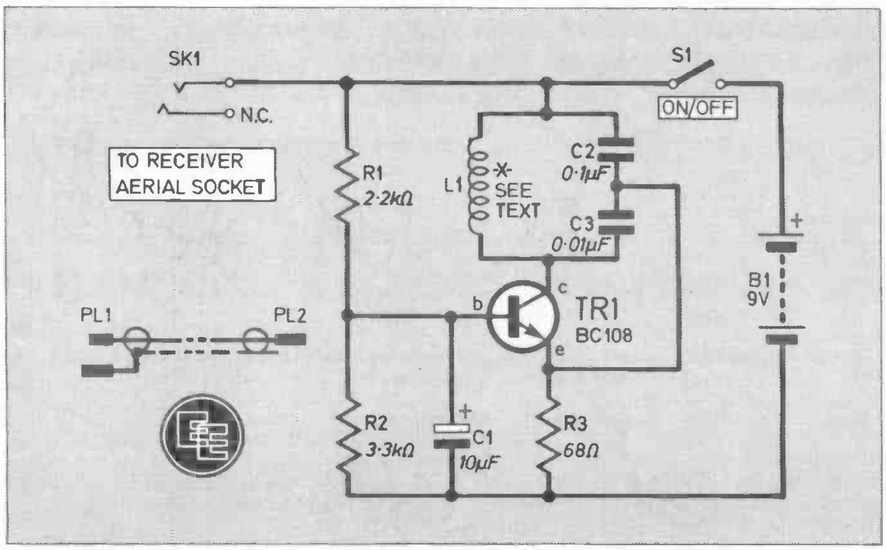
RADIO RECEIVER

Radiations from this circuit pass to a nearby radio receiver and produce the audible beat notes. The effectiveness of the unit is improved if a flying lead is connected between the jack socket of the detector and the aerial socket of the receiver, although just winding this flying lead round the radio may be as effective.

POST OFFICE LICENCE

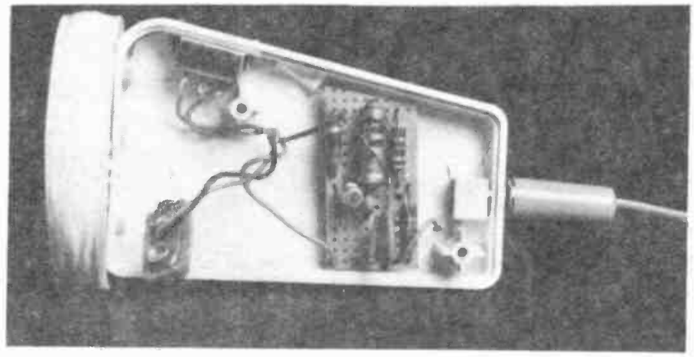
Since this pipe locator actually radiates a radio frequency signal, it requires a Pipe Finder Licence. This can be obtained from the following address: Home Office Radio Regulatory Department, Waterloo Bridge House, Waterloo Road, London, SE1 8UA. At the time of going to press this cost £1·40 for 5 years although readers should check with the Home Office at the above address for the current position.

Fig. 1. Circuit diagram of Cable and Pipe Locator.



68Ω Blue Gray Black
3.3K Or Or Red
2.2K Red Red Red

CABLE AND PIPE LOCATOR



COMPONENTS

See **Shop Talk** page 167

Resistors
- R1 2·2kΩ
- R2 3·3kΩ
- R3 68Ω

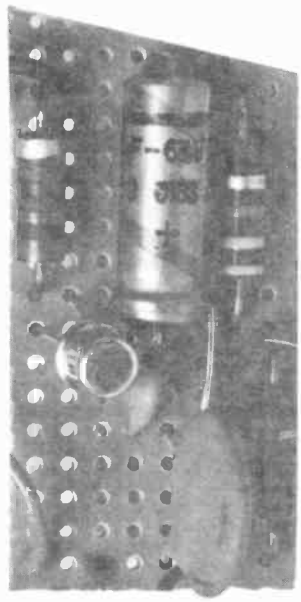
All ¼ W carbon ± 5%

Capacitors
- C1 0·1μF disc ceramic
- C2 0·01μF disc ceramic
- C3 10μF 10V elect.

Semiconductors
- TR1 BC108 *npn* silicon

Miscellaneous
- L1 100 turns of 0·25mm enamelled copper wire on 65mm former (see text)
- S1 s.p.s.t. miniature push button or toggle
- SK1 3·5mm miniature jack socket
- PL1 3·5mm miniature jack plug
- PL2 Plug to suit aerial socket of receiver being used
- B1 9V battery PP3 type

Case: ABS Maplin type 401 or similar; 0·1 inch matrix stripboard, 15 strips × 8 holes; battery connectors; coil former; "Nivea Creme" case or similar 65mm shallow former; interconnecting wire; wire for aerial lead.



(above) The completed unit with one side panel removed showing positioning of the circuit board, on/off switch and jack socket.

(left) The finished component board.

COMPONENTS approximate cost £3·50

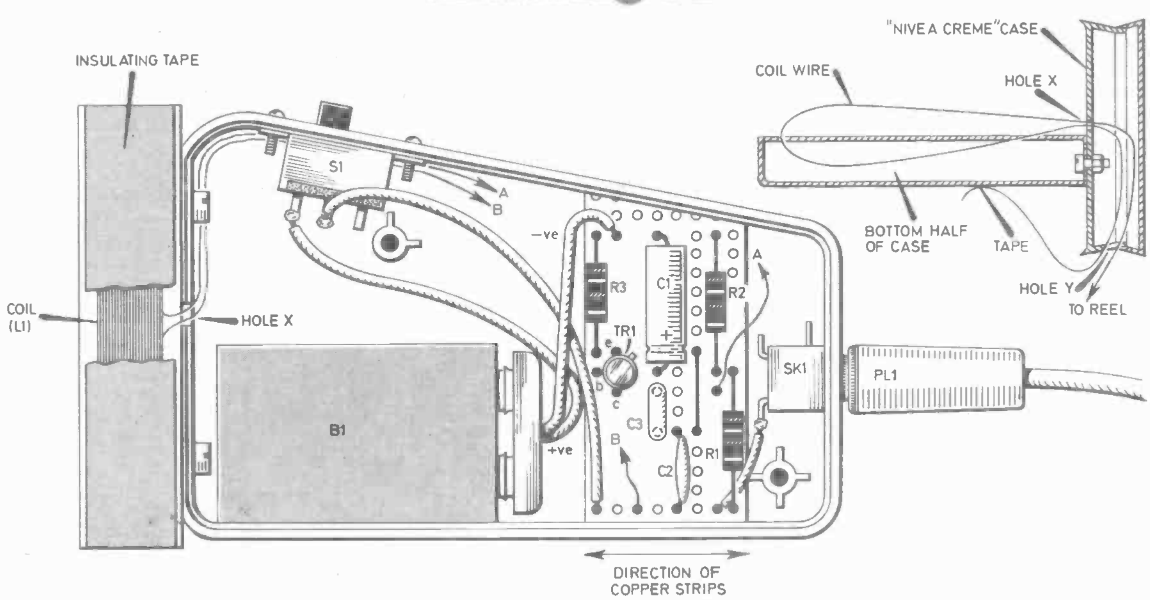
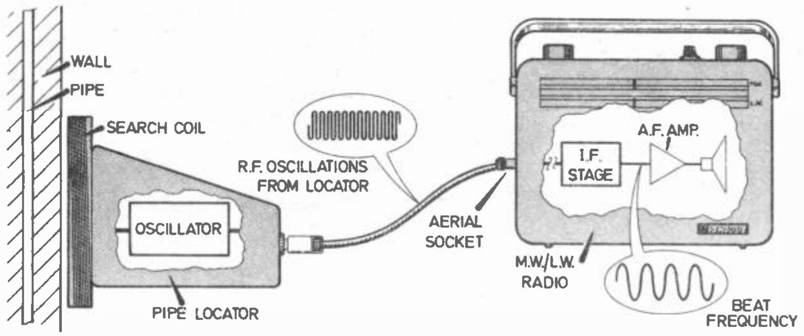


Fig. 2. Interior view of the unit showing component board layout and inter-wiring. Note that there are no breaks in the copper strips on the circuit board. Inset above right shows details of coil construction.

HOW IT WORKS



The search coil forms part of the tuned circuit in the oscillator of the locator. When the coil is brought near a metallic object such as a buried pipe, its inductance changes and so the frequency of oscillation changes. The output from the locator is fed into the aerial socket of a l.w./m.w. receiver. As the oscillator frequency is near to the intermediate frequency of the receiver, a beat note is produced in the loudspeaker. Any change in the oscillator frequency caused for example by the coil being near a pipe will cause the beat frequency to change and so the presence of the pipe will be shown up by the change in the note from the loudspeaker.

CONSTRUCTION starts here

CIRCUIT BOARD

The components are mounted onto a small piece of 0·1 matrix stripboard 15 strips by 8 holes and shaped so that it fits into the case in the position shown in Fig. 2.

The stripboard, PP3 battery B1, jack socket SK1, and switch S1, are housed in a hand-held ABS case with the coil former attached to the wide end as shown in Fig. 2. The holes for the jack socket and switch are made in the bottom half of the case in the positions indicated.

The coil former is made from a 65mm shallow former such as a small size "Nivea Creme" case assembly of which is shown in Fig. 2. The wide end of the case is filed flat and the "Nivea" case fixed to the bottom half with two 6BA nylon screws and nuts so that when the two halves of the ABS case are assembled, the coil former is central.

Two small holes are drilled at points *X* and *Y* (2mm) through which the leads to the coil former are fed.

COIL

The free end of a reel of 0·25mm enamelled copper wire (approximately 20 metres are required) is fed into the case via holes *Y* and *X* in the case of the coil former. A small loop of wire is left inside the case and the end brought out via *X* and *Y* and temporarily attached to the case with Sellotape (see Fig. 2).

The lid of the coil former is glued to its other half with cyanoacrylate or other suitable adhesive ("Superglue") and when this has set 100 turns of copper wire are wound round the coil former. The end of the coil winding is then cut off and soldered to the free end of the wire which was temporarily taped to the case.

The combination is then pulled into the ABS case via holes *Y* and *X* and the coil leads cut to length and soldered to the stripboard. The coil windings can be protected by applying a few turns of PVC tape.

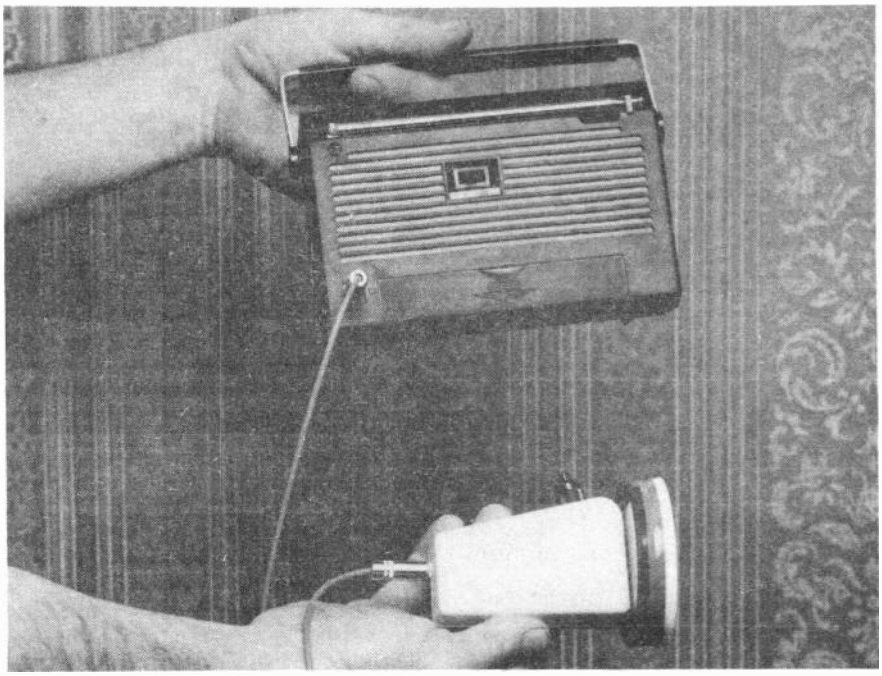
The jack socket SK1 and switch S1 are now mounted in their holes and the circuit connections completed. The detector is now ready for use.

SETTING UP

The detector and the radio receiver are switched on and the tuning dial moved until a whistle is heard as you tune across a station. Select a station where the whistle is loudest and the actual transmission quietest. The note should change in pitch when the coil of the detector is passed over various metallic objects.

Ferrous and non-ferrous objects will be found to cause the note to change in different ways allowing the user to distinguish between copper and iron pipes. This makes the detector an ideal aid to the handyman as it can be used to trace the path of electric cables and conduit buried in walls or for tracing water and heating pipes under floors. ☐

The completed Cable and Pipe Locator plugged in to a radio receiver and ready for use.



By Dave Barrington

Screwdrivers

One of the many problems we encounter in our work is the "fun and games" one experiences trying to fix screws in awkward places when finally putting projects together. Also, we are sometimes asked by beginners "Can you recommend what size screwdriver I will need when I make up my basic tool kit?"

Well, the answer we usually give is: "As many as your pocket will allow making sure they are of varying lengths and tip sizes, including at least two Phillips, two Pozidriv types and one standard blade stubby type".

A good range of tip sizes would be 2·5, 3, 4·8, 5·6mm and possibly the larger 7mm and 9·5mm for heavy duty work. Of course, each individual will have his own ideas and the final choice is yours. Always go for the best quality you can afford.

The reason for suggesting a stubby type is because we have found it a good general purpose screwdriver and invaluable in the workshop for those difficult corners. Its surprising how much leverage you can exert with these types.

Just released on to the market is a new stubby screwdriver from J. Stead & Co. Ltd., and features ratchet operation. Known as the Steadfast Screwmaster it has a 8mm blade and measures only 90mm, including the handle.

The ratchet mechanism is a scaled down adaption of the clutch type and, when in use, as long as the blade has the resistance of the screw to hold it the required operation is gained by rotating a selection ring. This, the makers claim, enables one hand operation.

The price of the Steadfast Screwmaster is £2·25 and details of nearest stockists can be obtained from J. Stead & Co. Ltd., Dept EE, Greenland Road, Sheffield S9 5BW.

Catalogues

Four catalogues have been received this month.

The latest Greenweld 1980 Components catalogue contains 48 pages and is well illustrated throughout. Looking through the pages it is noticeable that many items have actually been reduced in price from last year's catalogue.

The catalogue cost 40p plus 20p postage, but it contains five 12p discount vouchers for use on the first order over £3; thereafter on orders over £2.

Two new catalogues have been issued by Tandy this month. They are the Tandy 79/80 Electronics Catalogue and the Tandy TRS-80 Microcomputer Catalogue.

With the rapid expansion of home computing, Tandy's have found it necessary to produce a 24 page special for their now famous TRS-80 computer. This catalogue lists the hardware and software presently available.

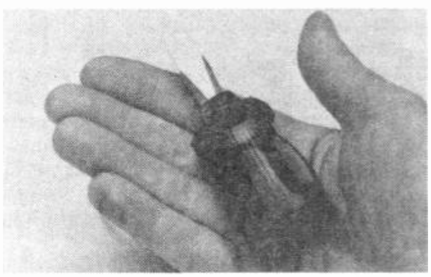
The new 116 page Electronics Catalogue contains many first time items and the components section seems to increase every year and is well worth obtaining.

It is a pleasure to bring to the attention of readers, schools, colleges, universities and even industry the Toolrange 79/80 catalogue.

Making full use of colour, this 104 page catalogue is well presented and contains one of the most comprehensive stocks of workshop tools and complete transportable kits we have come across. For anyone just about to replenish his workshop we strongly recommend they obtain a copy of this catalogue before making their final choice.

The sections on pliers, cutters and screwdrivers will take some beating and the range of soldering irons and soldering equipment is quite impressive.

For more details readers should contact Toolrange Ltd., Upton Road, Reading, RG3 4JA.



Steadfast Screwmaster

Mail Order

Many of our readers will, no doubt, remember the excellent service provided by Doram Electronics Ltd., and will welcome the news of its relaunch under new ownership.

Originally formed by the Electrocomponents Group to distribute RS Components' components by mail order, it ventured into the complete kit and ready-made product market with only mild success and ceased trading as part of a group reorganisation.

The new owners are the Dutch De Boer Group, one of Europe's largest component mail order suppliers, who will administer the Doram mail order business from a UK based distribution centre. The product range, which will include both kits and components, will be based on the current Dutch Components Catalogue.

For further details write to Doram Electronics Ltd., Dept EE, Fitzroy House, Market Place, Swaffham, Norfolk PE37 7QH.

If the service provided by the new company measures up to the old, then readers will be on to another winner.

Change of Address

We have just been informed by Home Radio (Components) Ltd, that due to refusal of planning permission they have had to move to new premises.

The new address for callers is: 269a, Haydons Road, Wimbledon, London, SW19 8TY.

The address for Mail Orders is: PO Box 92, 215 London Road, Mitcham, Surrey, CR4 3HD.

CONSTRUCTIONAL PROJECTS

Radio Control System

Some good news for readers who may be worried about their ability to make up the p.c.b.s for the *EE Radio Control System*. We understand that Proto Design is already producing the receiver and transmitter boards and are planning to produce a complete kit of boards.

Made from fibreglass, the boards are supplied pre-drilled and "roller tinned" (for ease of soldering) and cost £1·47 for the transmitter and 88p for the receiver. A charge of 25p is levied to cover post and packing.

For further information readers should contact Proto Design at 14 Downham Road, Ramsden Heath, Billericay, Essex, CM11 1PU.

Any special items for the Radio Control System are fully covered in the article.

Stereo Headphone Amplifier

The LM301AN called for in the *Stereo Headphone Amplifier* is a low noise plastic dual-in-line version and may prove to be troublesome, but should be available from Marshall's or Watford Electronics and is certainly listed in Electrovalue's catalogue. The LM301AH may be used but being a metal can type the leads will have to be carefully pre-formed. Note that the negative supply, pin 4, is connected to the metal case.

The case used in the prototype was one of the common metal chassis with a base plate fixed to the four corner strengtheners.

Touch Switch

Some difficulty may be experienced with the Darlington transistors called for in the *Uniboard-Touch Switch* project.

The MPSA14 is available from Maplin or Marshall's and alternative devices are the MPSA12, MPSA13, both available from Watford or Marshall's.

Cable and Pipe Locator

The Vero plastics hand-held control box used to house the circuit board for the *Cable and Pipe Locator* is now stocked by a number of our advertisers and should present no problems. Apart from the above the rest of the components should be readily available.

All components for the *Doorbell Register, 5—Range Current Limiter* and the *Kitchen Timer* are fairly common and should not be difficult to obtain.

The loudspeaker called for in the Timer can be any type from 40 to 80 ohms.

Stereo Headphone Amplifier

By R. A. Penfold

WHEN people first try out a pair of stereo headphones they are usually surprised by the high quality of reproduction. Even inexpensive stereo headphones (which usually have ordinary miniature loudspeakers as the transducers) seem to provide quite a high level of fidelity, the main shortcoming being a lack of bass and treble response which is easily compensated for by adjustment of the tone controls. Some of the higher quality types are still very inexpensive by loudspeaker standards, and offer true high fidelity reproduction.

Although headphones are normally considered to be an adjunct to a hi fi system, where low cost is of prime importance there is no reason why they should not be used in place of speakers; indeed, this would seem to be an eminently sensible approach.

There are other advantages to such a system, such as the fact that a system of this type is perfectly well suited to use where the amount of available space is severely restricted. The absence of large and heavy loudspeakers results in ease of portability.

Also, a great advantage of headphones is that even when listening at high volume levels, late at night, there will be no annoyance caused to others.

This article describes a simple and inexpensive amplifier which is specifically intended for use with stereo headphones. The prototype was used in conjunction with a pair of Sennheiser HD400 phones and offers a quality of reproduction that would be difficult to better for the monetary outlay involved.

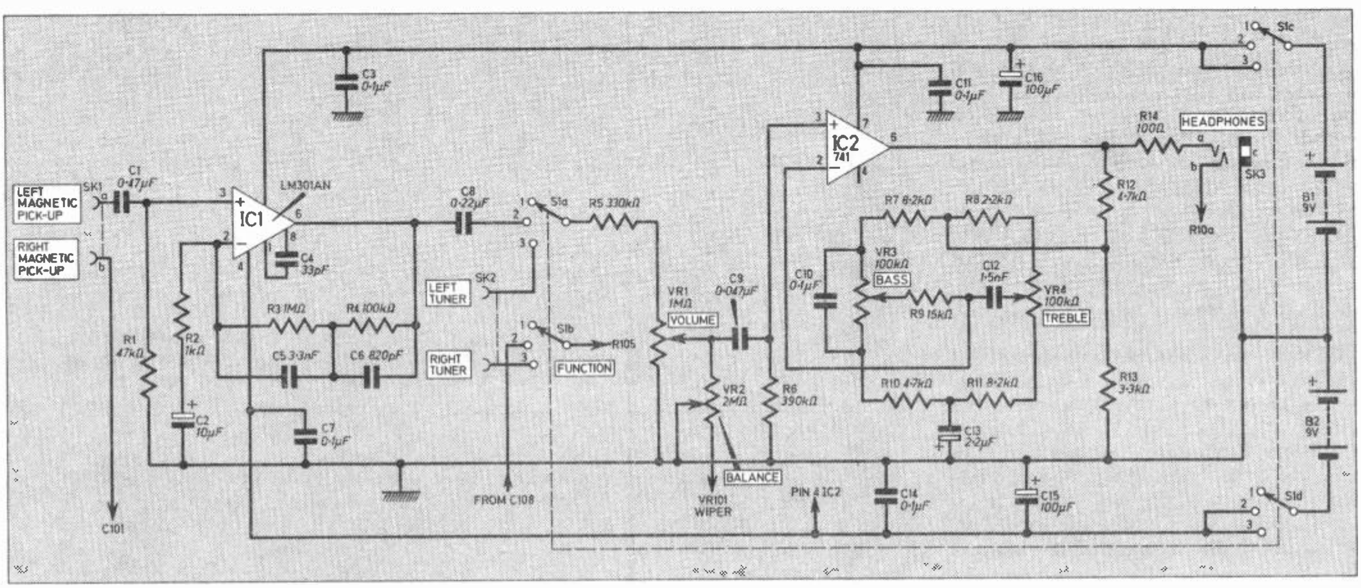
Of course, the unit will operate well with any normal type of stereo 'phone that does not require a high level output (i.e. not a special type that requires direct connection to the loudspeaker output of an amplifier).

The unit can be employed with a magnetic, crystal or ceramic pick-up, tape deck, or tuner. The amplifier is self contained as it is powered from a couple of PP3 9 volt batteries. The total current consumption of the amplifier is about 5mA, equally shared between main and preamp.

CIRCUIT DESCRIPTION

The circuit diagram of the Stereo Headphone Amplifier appears in Fig. 1. This only shows the circuit for one channel of the amplifier, but the other channel is essentially the same. Supply decoupling capacitors, S1, SK3 and balance control VR2 are common to both channels, but the remaining circuitry is duplicated in the other channel. In the constructional drawings and components lists the components in the other channel are given the same identification numbers, but preceeded by "100".

Fig. 1. The circuit diagram of the Stereo Headphone Amplifier.



MAGNET PREAMPLIFIER

The main amplifier requires an input level of about 200mV r.m.s. or more in order to provide a good output volume level. A magnetic cartridge provides a much lower output than this; usually something in the region of 3 to 10mV r.m.s.

The audio signal applied to a record is given a degree of treble boost and bass cut. The treble boost results in an improved signal to noise ratio as it enables a flat frequency response to be obtained at playback with a certain amount of treble cut applied to the signal. The bass cut is needed in order to prevent groove wall collapse at high bass signal levels. A suitable amount of bass boost must be applied at playback in order to compensate for the original bass cut.

Ceramic and crystal cartridges have an output characteristic which automatically provides the necessary equalisation, but this is not the case with magnetic pick-ups. Therefore the preamplifier has to provide both gain and the appropriate equalisation.

The circuit of the magnetic pick-up preamplifier employs an LM301AN operational amplifier which provides low levels of noise and distortion.

Like the main amplifier, this circuit is of the non-inverting type. The input signal is applied to the non-inverting input of IC1 via C1, and R1 biases this input to earth potential. This resistor also sets the input impedance of the circuit at about 47 kilohms, which is the load impedance required by most magnetic cartridges.

RIAA EQUALISATION

Resistors R3 and R4 bias the inverting input from the output of the amplifier, and together with R2, C5 and C6 they form a negative feedback network which sets the gain of the circuit at a suitable level and provides the RIAA equalisation. It is the frequency selective feedback introduced by C5 and C6 which gives the equalisation bass boost and treble cut. At high frequencies the impedance of C6 falls in relation to that of R4, producing the treble cut. At bass frequencies the rising impedance of C5 produces reduced feedback and hence the required bass boost as well.

In a theoretically perfect circuit C2 would not be needed and R2 connected direct to earth. In a practical circuit this would result in the amplifier having a very high d.c. gain, with the quiescent output voltage tending to drift well away from earth potential in consequence. This would result in clipping of the output signal.

Compensation capacitor C4 prevents IC1 from becoming unstable; C3 and C7 are supply decoupling capacitors and are common to both channels. All the other components are duplicated in the other channel.

MAIN AMPLIFIER

The circuit is based on a conventional non-inverting operational amplifier circuit utilising the well known 741C device. This type of amplifier requires dual (positive and negative) balanced supplies with a central 0V earth rail. This is supplied by a couple of PP3 batteries, one to supply the positive rail and the other to supply the negative potential.

A mains power supply could be used, but this would be more complicated and would make it more difficult to obtain a really low background noise level. Background hum and noise tends to be very noticeable when using headphones. Two poles of S1 provide on/off switching.

Resistor R6 biases the non-inverting (+) input of IC2 to earth potential, and the inverting (−) input is biased from the output of IC2 via the negative feedback loop which consists of R12 and R13.

The amount of feedback applied to the circuit determines the voltage gain of the amplifier, minimum feedback corresponding to maximum voltage gain.

COMPONENTS

Resistors

R1,101	47kΩ	R8,108	2·2kΩ
R2,102	1kΩ	R9,109	15kΩ
R3,103	1MΩ	R10,110	4·7kΩ
R4,104	100kΩ	R11,111	8·2kΩ
R5,105	330kΩ	R12,112	4·7kΩ
R6,106	390kΩ	R13,113	3·3kΩ
R7,107	8·2kΩ	R14,114	100Ω

All ¼W carbon ± 5%

Potentiometers

VR1,101	1MΩ log. law carbon dual-gang (1 off)
VR2	2MΩ lin. law carbon
VR3,103	100kΩ lin. law carbon dual-gang (1 off)
VR4,104	100kΩ lin. law carbon dual-gang (1 off)

Capacitors

C1,101	0·047μF polyester type C280
C2,102	10μF 10V elect.
C3,	0·1μF polyester type C280
C4,104	33pF polystyrene
C5,105	3·3nF polystyrene
C6,106	820pF polystyrene
C7	0·1μF polyester type C280
C8,108	0·22μF polyester type C280
C9,109	0·047μF polyester type C280
C10,C110	0·1μF polyester type C280
C11	0·1μF polyester type C280
C12,112	1·5nF ceramic plate
C13,113	2·2μF 10V elect.
C14	0·1μF polyester type C280
C15,16	100μF 10V elect. (2 off)

See **Shop Talk** page 167

Semiconductors

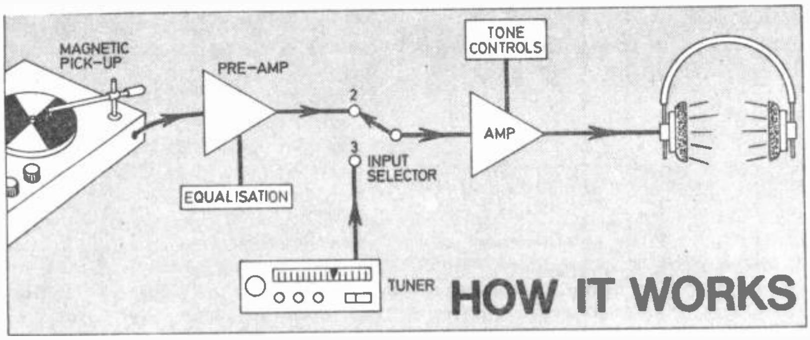
IC1,101	LM301AN low noise op-amp (8-pin d.i.l.)
IC2, 102	741 op-amp 8-pin d.i.l.

Miscellaneous

S1	4-pole 3-way rotary switch
SK1,2	twin phono sockets (2 off)
SK3	standard stereo jack socket
B1,B2	9V type PP3 (2 off)

Stripboard: 0·1 inch matrix sizes 16 strips × 41 holes, 17 strips × 25 holes; battery connectors for B1,B2 (2 pair); control knobs (5 off); 6BA fixings and solder tags; metal case, approximate dimensions 200 × 150 × 60mm—see text.

In the circuit diagram only components for one channel are shown. The components in identical positions in the other channel have "100" added to their circuit reference as can be seen above and in the layout diagrams. Thus two of each value are required except for the potentiometers. The remainder of the components are shared by both channels, and of course only one is required.



Headphones require a driving power of only a few milliwatts to provide realistic volume levels. The unit does not, therefore, incorporate power amplifiers, but drives the phones from low level amplifiers using a single operational amplifier i.c. in each channel. The gain of this circuit is controlled by a negative feedback loop, with the usual bass and treble tone controls are incorporated.

Two sets of input sockets are provided, and a switch selects the desired input. The unit can be used with all normal types of hi fi gear, including magnetic cartridge. This requires extra gain and frequency response shaping (equalisation) which is provided by an optional preamplifier.

TONE CONTROLS

The gain of the circuit is not solely determined by R12 and R13 since a simple tone control network is interposed between their output and the inverting input of the I.C.1. Potentiometer VR4 is the treble control, and when the slider of this potentiometer is at or near the top of its track, C12 will introduce a comparatively large amount of feedback at treble frequencies. This results in treble cut being applied to the circuit.

With VR4 slider towards the other end of its track, C12 will tend to decouple the high frequency feedback causing reduced feedback at these frequencies and a consequent boost in treble response. The treble response will be flat with VR4 slider at roughly the centre of its track.

Potentiometer VR3 is the bass control, and in conjunction with C10 this can increase or decrease the relative amount of feedback at bass frequencies, thus providing bass cut and boost respectively. Resistor R9 minimises interaction between the two tone control networks.

Two sets of input sockets are provided, the desired input being selected by means of S1. From here one pair of input signals is fed to the input of the amplifier through R5, volume control VR1, and input d.c. blocking capacitor C9. The other pair of inputs are fed straight to the magnetic pick-up preamplifier whose output goes to S1 position 2. Potentiometer VR2 forms a conventional balance control in conjunction with R5.

The output to the headphone is obtained by way of series resistor R14. When using 8 ohm impedance headphones this resistor introduces considerable losses, but this is necessary since the output amplitude of the unit will be far too high for this type of headphone; R14 also reduces the loading on the amplifier to an acceptable level when using low impedance headphones.

Many high quality phones have a fairly high impedance, usually in the range 100 to 2,000 ohms; R9 then provides little or no significant attenuation, but this produces good results since higher impedance headphones require higher drive voltages.

CONSTRUCTION starts here

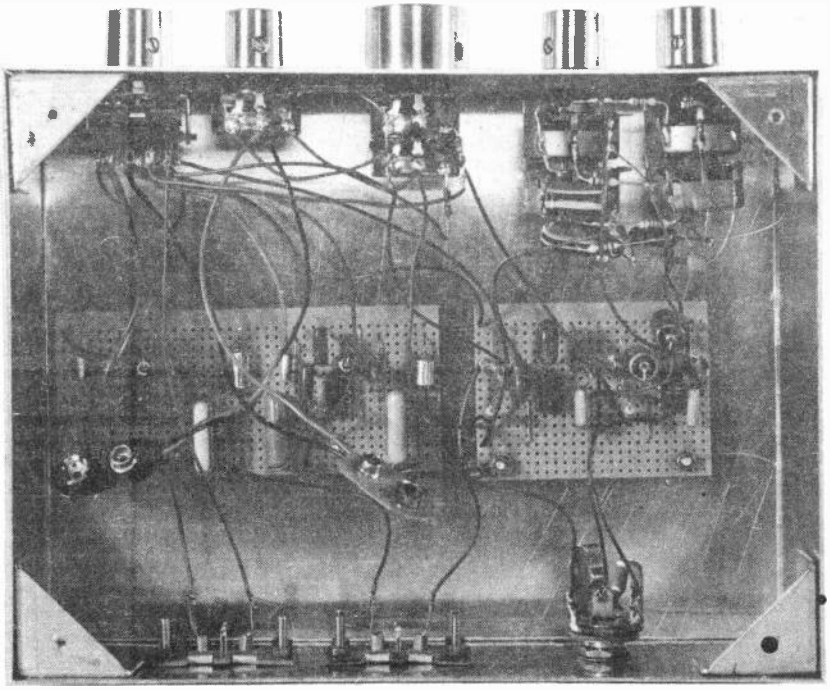
CASE

A suitable housing for the project consists of a 203 x 152 x 63mm aluminium chassis with baseplate. The baseplate is fixed to the corner pieces of the chassis using four 6BA self tapping screws which are not normally supplied with the chassis or baseplate. The mounting holes in the corner pieces are drilled using a No. 42 or similar twist drill, and the holes in the baseplate are made using a No. 31 drill, or an equivalent.

FRONT PANEL

One of the 203 x 63mm sides of the case is used as the front panel, with VR1 centrally on this. The tone controls, VR3 and VR4 are mounted to the right of this with VR2 and S1 mounted symmetrically opposite these on the left (see photographs).

Plan view of the completed prototype amplifier.



Stereo Headphone Amplifier

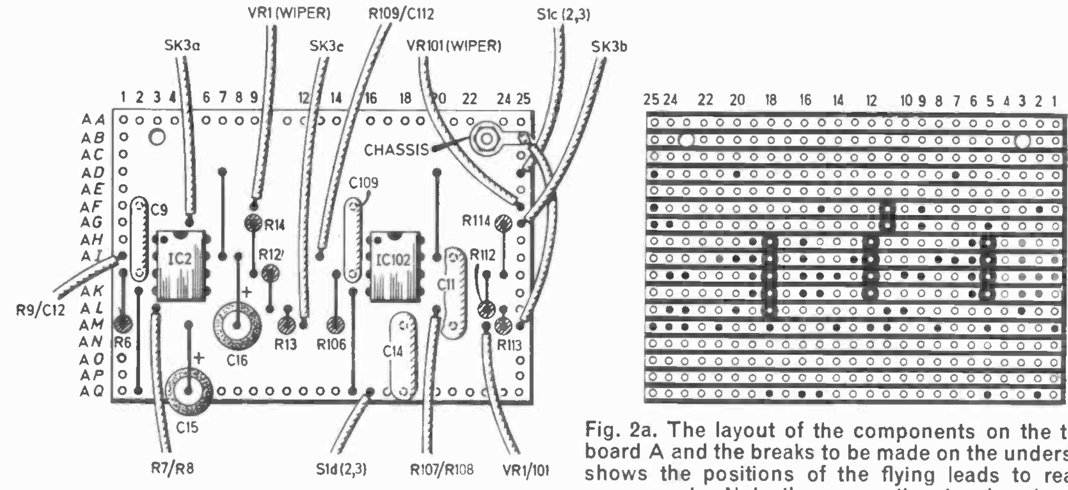
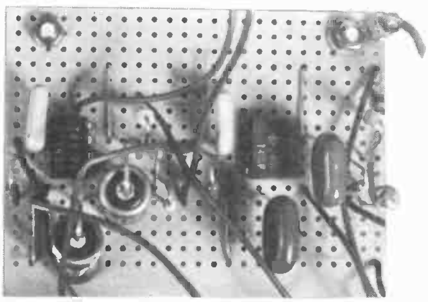
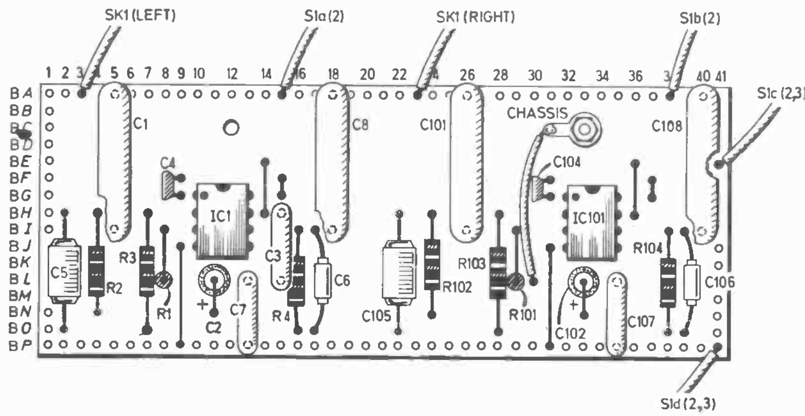


Fig. 2a. The layout of the components on the topside of board A and the breaks to be made on the underside. Also shows the positions of the flying leads to reach other components. Note the connection to chassis via solder tag/mounting bolt.



The completed prototype main amplifier board.



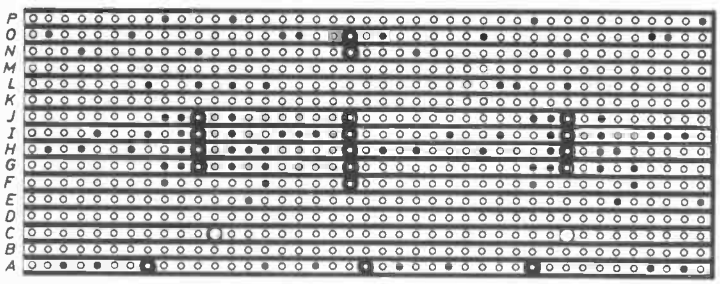
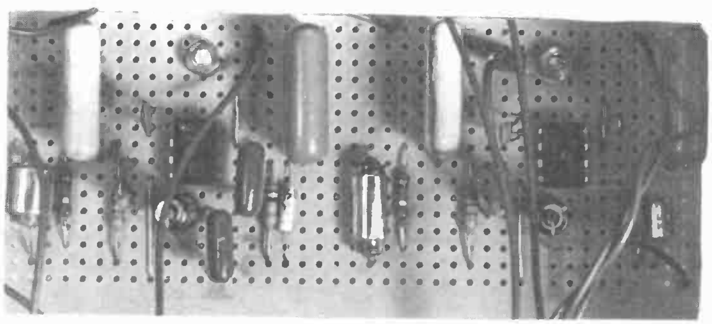


Fig. 2b. The magnetic preamplifier board. Shows the layout of the components on the topside of the board, breaks to be made in the copper strips on the underside, and flying lead connections. A connection to chassis is necessary via solder tag and board mount.

COMPONENTS approximate cost £9 excluding case



The completed prototype preamplifier board.

Stereo Headphone Amplifier

Layout of the controls and suggested labelling on the front panel.

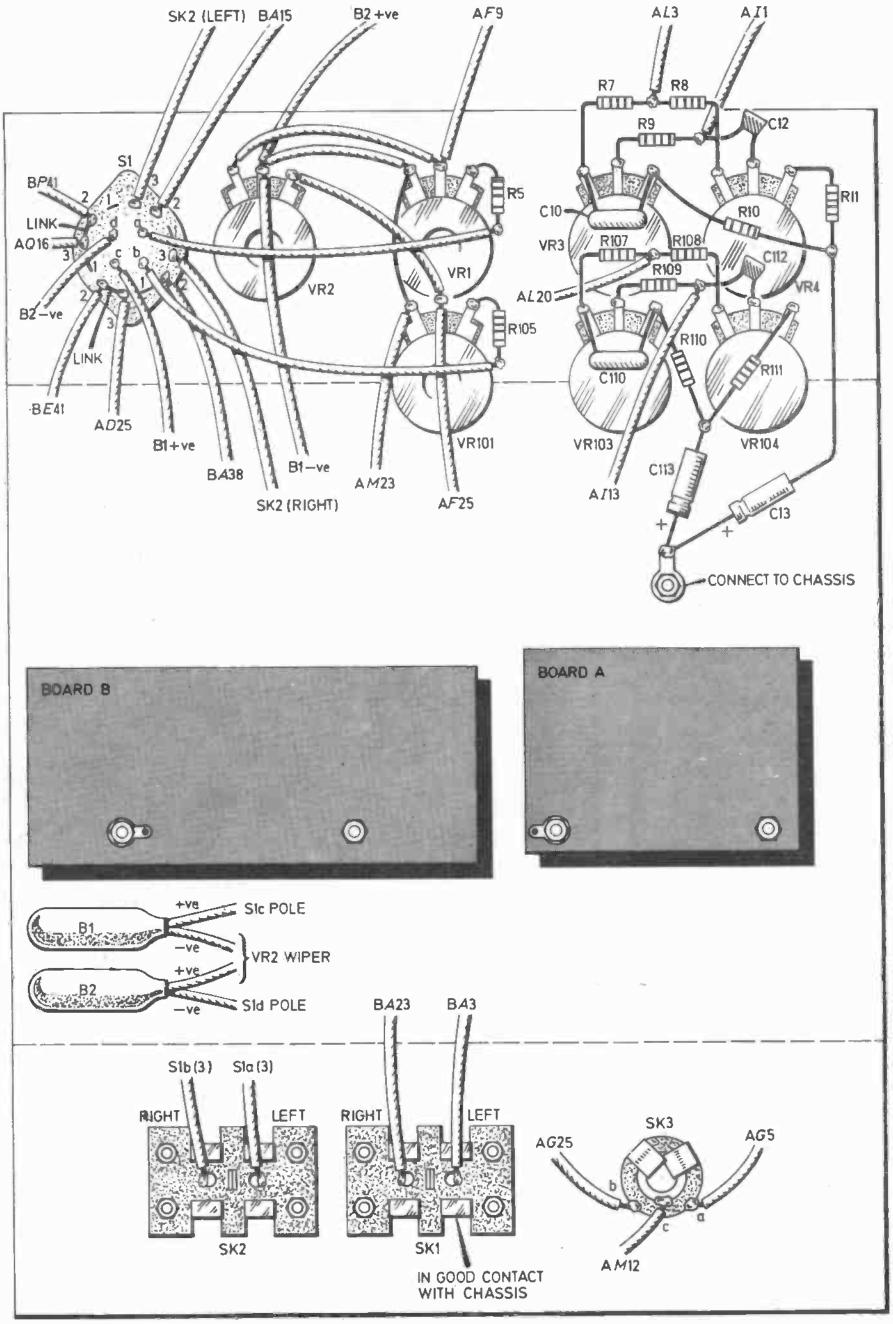
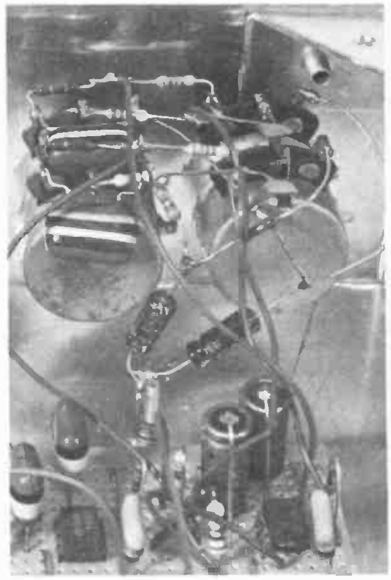
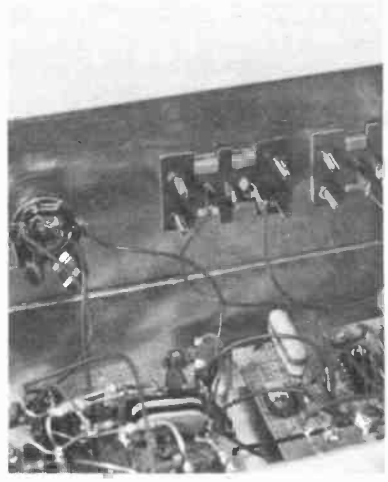


Fig. 3. Complete interwiring details. For clarity the front and rear panels have been laid down. Double-sided adhesive tape can be used to hold the batteries in position.



Close-up view of the interwiring of the tone controls.



The wiring to and from the sockets fitted on the back panel.

All these controls require standard 10mm diameter mounting holes. In the prototype a silver card was cut to size and lettered using Letraset, to improve the appearance.

The input and output sockets are mounted on the rear panel, and two twin phono sockets are used as the input sockets on the prototype. However, DIN or any other audio type connectors can be used here if preferred. The output socket is an ordinary open construction type standard stereo jack socket, and requires a 10mm diameter mounting hole.

COMPONENT PANELS

The circuitry is assembled on two boards, one holding the main amplifier and the second the magnetic pick-up preamplifier. The latter may be omitted if not required and the connections from S1 taken to SK1 to form a second identical stereo input.

Some of the components of the main amplifier board, board A, are wired up on a 0·1in matrix stripboard having 17 copper strips by 25 holes see Fig. 2a. Commence construction of this by cutting out a panel of the appropriate size using a hacksaw. Then filed down any rough edges of the board and drill the two mounting holes for 6BA or M3 clearance (about a No. 31 or 3·2mm diameter twist drill). Then the 15 breaks in the copper strips are made using either the special spot face cutter tool or a small hand held twist drill.

Next the components and link wires are soldered into position, the two i.c.s being left until last. The latter are very inexpensive types, and the use of i.c. sockets is probably not justified provided reasonable care not to overheat these components is taken when soldering them.

The completed component panel is mounted on the underside of the top panel of the case just to the rear of VR3 and VR4. Spacers must be used over the mounting bolts to hold the underside of the panel clear of the metal case. The component panel is provided with a chassis connection via a soldertag mounted on one of the mounting bolts for the panel.

Note that the panel cannot be finally bolted into position until it has been wired up to the rest of the unit.

CONTROL WIRING

In order to minimise the amount of interwiring between the component panel and the controls, the tone control components are wired up point-to-point fashion on the tone control potentiometers. This wiring, together with details of the wiring to the other controls, is detailed in Fig. 3.

This is all quite straightforward, and due to the absence of a mains power supply and because the circuitry is screened by the case (*which must be of all metal construction*), it is not necessary for any of the wiring to have screened leads. However, all wiring should be reasonably short and direct.

Capacitors C13 and C113 require a chassis connection, and this is provided by a soldertag bolted to the top panel of the case just to the rear of VR3 and VR4.

PREAMPLIFIER PANEL

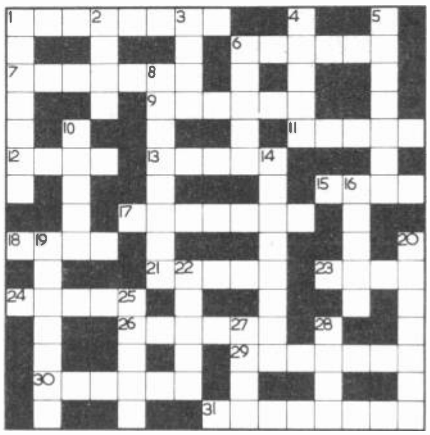
The magnetic pick-up preamplifier is assembled on a 0·1in matrix stripboard panel which measures 16 copper strips by 41 holes. Details of this component panel (board B) are provided in Fig. 2b. This is constructed in much the same way as the main component panel, and when completed under the top panel of the case to the rear of VR1, VR2, and S1. Wiring details are shown in Fig. 3.

IN USE

The completed amplifier requires no adjustment and is ready for immediate use. The amplifier is connected to the other items of equipment by way of twin screened leads terminated in the appropriate type(s) of plug. These input leads must be screened (the outer braiding connecting to the chassis of the amplifier) or there will almost certainly be a significant pick-up of mains hum and other signals in this wiring.

Many people tend to set the volume level rather high when they are using headphones, and it is advisable to avoid doing this as it simply results in increased distortion, and any imperfections on the programme source will become much more noticeable. ⌑

EE CROSSWORD No 25 BY D. P. NEWTON



ACROSS

1 & 31  (8, 8)

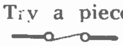
6 Street-like diode characteristic (3, 3)
7 Firmly closed door with a logic circuit (7)

9  (6)

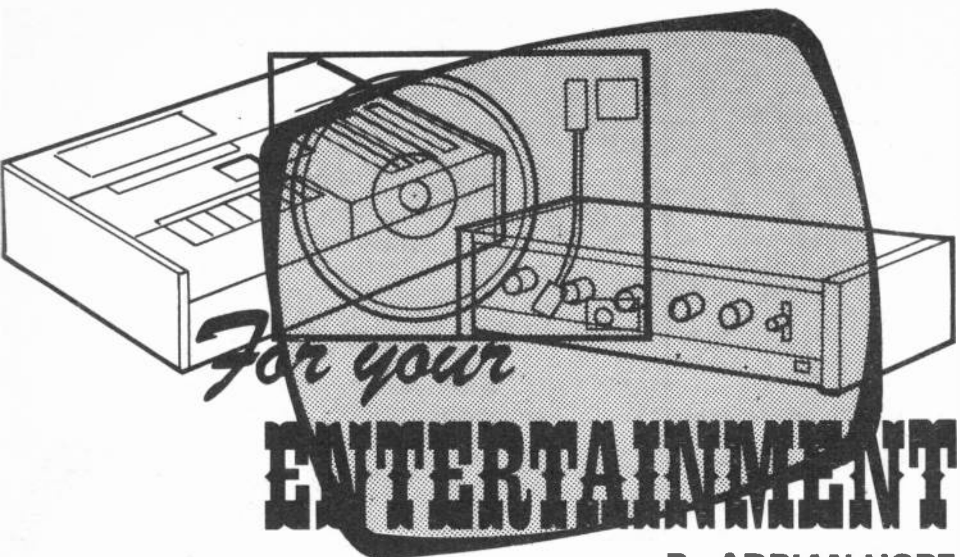
11 Currently a bog (5)
12 Sovereign conductor (4)
13 A circuit operating on the principle of least distance (5)
15 To support a front for the e.m.f. (4)
17 Noise associated with random electrical discharge (7)
18 Trace out an image electronically (4)
21 Musical shorthand (5)
23 Diminutive designation of desk computer (4)
24 Solid follower of semiconducting circuits (5)
26 Severe tension rising initially from each (6)
29 Circuit not resonating (7)
30 Oscillation exponentially dies away (6)

DOWN

1 & 20  (7, 7)

2 Pitch a bit, perhaps caused by 28 down (4)
3 Loud game? (Anag.) (4)
4 Sounds like a result of interference (5)
5 Microphone, full of energy (7)
6 R.F. foe gives in worship (Anag.) (5)
8 Process of electron production (8)
10 Primary designator of amplification (5)
14 Element (8)
16 10 down might result in this, once more (5)
19 Not positive about its connections (7)
22 Giant with a taste for humans (5)
25 Try a piece of prose (5)
27  (4)
28 Devices which rabbit about conversations (4)

Solution on page 184



For your ENTERTAINMENT

By ADRIAN HOPE

A Clever Switch

There are all manner of anti car theft gadgets on the market, but many electronically minded owners simply put a hidden on/off switch in the ignition circuit. The engine then stubbornly refuses to start for anyone but its rightful owner.

Unfortunately thieves, (and for that matter the police, who drive offending cars off to the car pound) are pretty skilled at finding secret switches. So here's a thought for car owning readers to ponder. Try putting not one, but two or even three, on/off switches in the ignition circuit. (Such switches should, of course, always be put in the low voltage supply lead to the coil *not* in the HT leads).

If you put more than one switch in the low voltage line and make one switch much easier to find than the others, you can create a confusing situation for would-be thieves. Try, for instance, leaving the most easy to find switch in the "on" state and a more difficult to find switch in the "off" state.

Anyone trying to start the car and realising that the ignition must be switched off will hunt for a hidden switch. They will then change its state. If the located switch was originally in the "on" state it will now be in the "off" state, so the ignition line will now be broken in even more positions than before.

If the unwelcome visitor to your car then hunts for, and finds, another switch the chances are that he will very soon become very muddled over which switch was in which position to begin with. With a bit If luck he will give up and try and start someone else's car. This is of course the object of the whole anti-theft exercise.

Off the Record

A few month's ago I wondered in this column whether any reader knew about the Tarbel computer system. The question arose because Isao Tomita, the Japanese electronic music composer, had written on the sleeve of his latest record, *Bermuda Triangle,* that the music contained a secret message.

This, he said, was coded in data that could be recovered by interfacing the hi-fi system with a computer "programmed to the Tarbel system". But no one in the UK, even dedicated computer freaks, seems to know what the Tarbel system is.

Well partial relief is finally at hand. Tor-Arne Gisvold of the Norwegian Broadcasting Corporation (the Norwegian equivalent of the BBC) has now written to the monthly sound and music magazine *Sound International* (whose editorial staff were also curious and puzzled over Tarbel) with what seems to be the answer.

Tarbell (Tomita spelled it wrong) is, as we all suspected, a standard for recording digital data streams, not a computer programming system. But it differs from the most common Kansas City standard because it uses phase encoding at a frequency of 1496 bits per second.

Unfortunately no one in the UK seems to have any Tarbell interface gear so we still don't know what Tomita's coded message actually says. It can only now be an anti-climax. But he's certainly got some extra publicity for the record which was presumably one of the objects of the exercise anyway.

Alert and Well

One fast selling electronics item in the USA is the "air ioniser". For around $100 you can buy a small cylinder that plugs into the mains and produces—or at least is claimed to produce—negatively charged air ions which make everyone in the vicinity feel alert and well.

But there are moves to curb the advertisement and sale of such gadgetry because it can constitute a health risk.

The resons for this are quite complex and we need to consider some basic electrochemistry to understand them.

Charged Molecules

Ions are molecules of gas which carry a positive or a negative electric charge. In normal clean air there should be an equal number of negative and positive ions. But in fact, because negative ions tend to be repelled by the earth's surface, even normal air at ground level has a slight surplus of positive ions.

In polluted air the ion concentration drops and there is a greater surplus of positive ions over negative ions. This makes people tired, depressed and irritable. It isn't just polluted air that has an unwelcome imbalance of ions. When the Fohn wind in Germany and the Sharav in the Middle East blows almost everyone in the vicinity starts to feel "under the weather."

In some German cities hospitals cancel all but the most urgent operations when a local "ill wind" blows and causes a positive ion surplus.

What's more a surplus of negative ions does seem to have the opposite effect, making people feel bright, alert and generally pleased with life. Stand by a waterfall, where there tends to be a high concentration of negative ions, and you will feel positively glad to be alive.

A Possible Solution

The obvious solution to ion imbalance, then, is to produce an artificial boost to the negative ion concentration. This is what ion generators are intended to do. A considerable amount of research work on this subject has been carried out in Hungary, to stabilize the ion concentration for instance in a transport driver's cabin.

Hungarian medical workers found that in a large city the air in the driver's cabin of a bus can be massively overloaded with positive ions and clearly it is potentially highly dangerous to have a vehicle driver trapped in an atmosphere that makes him bad tempered. So they designed negative ion generators for use in road vehicles.

Ion Generator

On the face of things it seems an easy task to generate negative ions artificially. You simply push a high negative voltage into an electrode, and produce a corona discharge which negatively charges the air molecules. This is indeed the working principle of most ionisers which are currently sold for use in homes and offices or in cars.

A transformer system winds up the mains or battery supply voltage to levels which will produce a corona discharge from an ionising electrode. But this is where the problems begin. You don't just need a high voltage, you need a *high charge density* on the electrode.

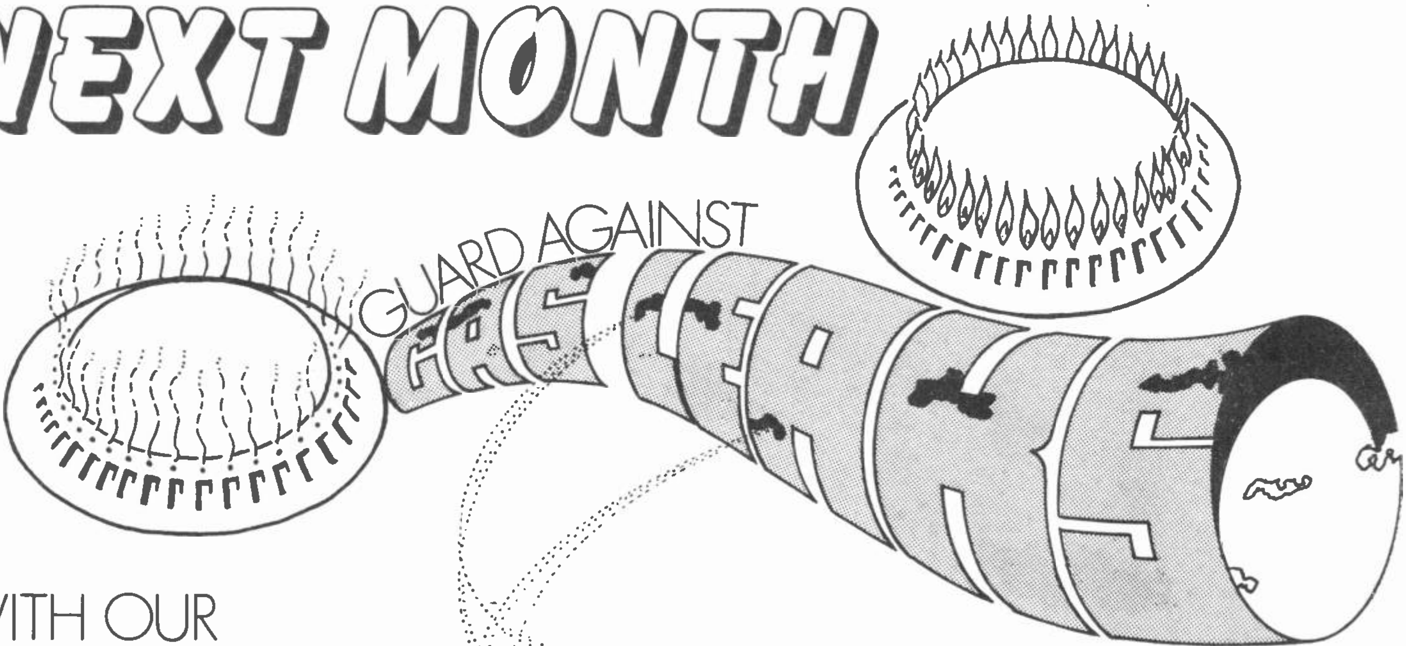
For ionisation a minimum of around 4·5 kilovolts is needed at the tip of a needle electrode. But for safety you need around 10kV because as the electrode is used it will erode, becoming blunter and effectively larger and thus lowering the charge density for the same applied voltage.

Ozone

The real snag is that a low charge density on the electrode, will produce ozone rather than thoroughly ionized air. Ozone is really just partly ionised oxygen and it's a thoroughly unpleasant material. It's harmful to our throat and lungs, it kills plants, it destroys plastics and it may even cause cancer. The only saving grace is that ozone gives its presence away with the characteristic "electric" smell you get near sparking equipment.

It's the generation of ozone by inefficient ion generators which is worrying USA health authorities. So DIY constructors, or anyone owning a cheap ionizer, should be careful not to use anything that produces the characteristic smell of ozone.

NEXT MONTH



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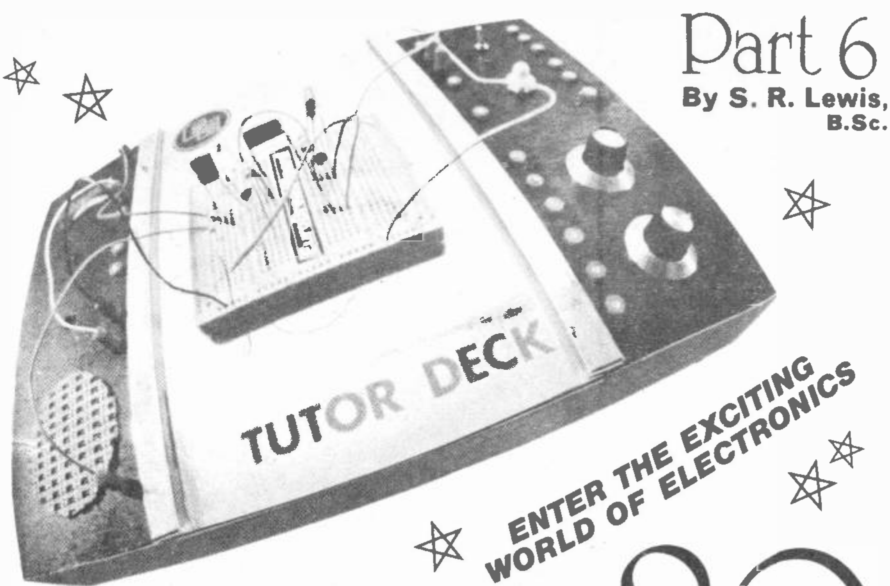


Part 6

By S. R. Lewis, B.Sc.

TEACH-IN 80

SO FAR in this series we have looked at two properties of electronic components: resistance and capacitance. In fact, every circuit element which is **passive**, that is does not have any amplification associated with it, can be defined in terms of only three basic properties: two of them we have already discussed, the third being **inductance** which forms the first subject of this month's part.

When we have understood these three properties we can go on to look at circuits where a combination of the three types of components (resistors, capacitors and **inductors**) may be used to perform useful tasks.

INDUCTANCE

As we saw in the first part of the series, when current flows in a wire it creates a magnetic field similar to that which is produced by a common bar magnet. If a piece of magnetised material is placed in this field then it will tend to be either attracted or repelled depending on the polarity of the two fields.

If we form the wire carrying the current into a loop thus making a coil with a single turn, the magnetic field will be as shown in Fig. 6.1. We can add more turns to the coil to increase the magnitude of the field, but notice that now each coil will now not only be in the field created by itself but also in the field created by nearby coils.

In 1831 Michael Faraday established a physical law which states that a moving **magnet (or,** more generally, a **changing** magnetic field) **will** induce an e.m.f. **in a coil which cuts** that field, and that the e.m.f. will be proportional to the *rate of change* of the magnetic field.

When current in a coil starts to build up from zero it creates an increasing magnetic field around the coil. Now this field is changing and, as we discussed above, this will induce an e.m.f. in the same coil. In actual fact the e.m.f. which is produced is in such a direction as to oppose the e.m.f. which is creating the current in the coil.

When the current in the coil begins to decrease from some previously attained level, the magnetic field will decrease also. Again, the changing field creates an e.m.f. but this e.m.f. tends to maintain the current which is already flowing. Fig. 6.2 shows the rise and decay of current in a coil —or "inductor", as this type of component is usually called.

The property which causes these effects we call **inductance** and the units in which it is measured we call **henries (H)**. To be a bit more precise, we say that a circuit has an inductance (or, more strictly, a **self-inductance**) of one henry if the e.m.f. induced in it is one volt when the current is changing at a rate of one ampere per second.

Henries are sub-divided into **millihenries (mH)** and **microhenries (μH)** for practical use.

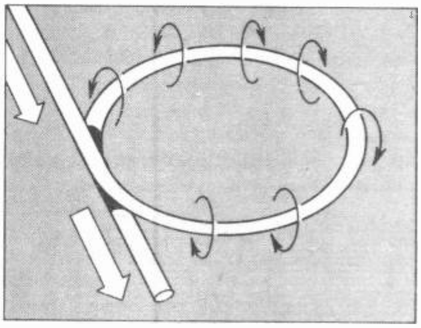


Fig. 6.1 (left). When a wire carrying current is formed into a single turn a magnetic field is produced as shown here.

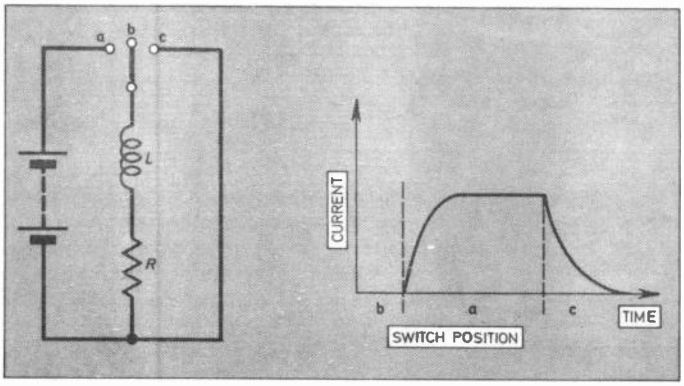


Fig. 6.2 (below left). When a voltage is applied across an inductor it will take a time for the current to attain its final value since the increase of current produces a counter e.m.f. When the voltage is switched off the current is maintained by the e.m.f. produced by the collapsing magnetic field.

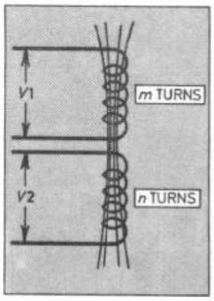


Fig. 6.3 (below right). When two coils are placed close together so that the field produced by one envelops the second (and vice versa) we have what is termed mutual inductance. If the coils have *m* and *n* turns respectively, then the voltage induced in the second will be *n/m* times that in the first.

MUTUAL INDUCTANCE

If two coils are placed next to each other the changing magnetic field from one of them will produce an e.m.f. in the other.

If the two coils were identical and it could be arranged that the field produced by the first totally enveloped the second coil, then the e.m.f. produced in the second coil would be exactly the same as the e.m.f. producing the current in the first coil (see Fig. 6.3).

We call the property which induces a voltage in one coil from another **mutual inductance.** It has the same units as self-inductance, henries. We define mutual inductance by stating that two circuits have a mutual inductance of one henry if the e.m.f. induced in one of them is one volt when the current in the other is changing at one ampere per second.

TRANSFORMERS

If the second coil is totally enveloped by the field of the first but this time has more turns than the first, then the voltage induced in it will be exactly proportional to the number of turns in the second divided by the number of turns in the first. We call a device which takes advantage of this property a **transformer.**

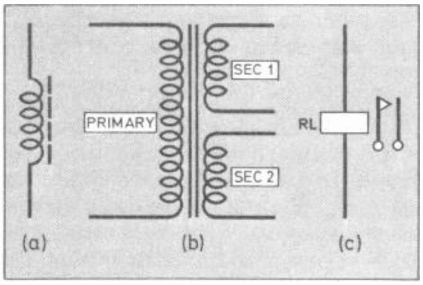


Fig. 6.4. The symbols for three commonly encountered inductors. (a) shows an inductor, (b) transformer and (c) relay with a single pair of normally open contacts. In the case of (a) and (b) the lines next to the coil indicate the type of core.

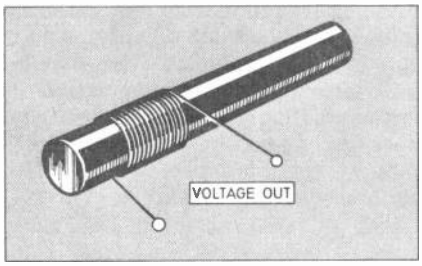


Fig. 6.5 A transistor radio aerial consists of a ferrite rod around which is wound a coil (or several coils). The radio waves induce small e.m.f.s in the coils.

Notice that a transformer requires there to be a *changing* current in one of its coils in order to induce an e.m.f. in the other coil (or coils, for there may be many). We can thus only use the transformer in a.c. circuits.

Of course, the mains electricity supplied to our houses is alternating and we can therefore use a transformer to "step down" the high mains voltage to a more useful low voltage simply by having a large number of turns on the coil connected to the mains and a small number on the side from which we want low voltage.

It is general practice to refer to the winding into which power is fed as the "primary" winding and the windings out of which power is taken as the "secondary" windings.

In transformers we often find that we have secondaries connected together to form what is termed a centre-tapped winding. The transformer used on the Tutor Deck has in fact two separate secondaries but the start of the first coil has been connected to the finish of the second to form a centre-tapped winding.

It is important to connect the coils in the correct sense, otherwise the e.m.f. induced in one of the coils will oppose that induced in the other. Thus if the two "starts" were joined we would get no e.m.f. across the two "finishes".

The thickness of the wire with which the transformer primary and secondary are wound depends on the current which will be flowing through the coils. In a perfect transformer the power put into the primary would exactly equal power drawn from secondaries.

Thus if the transformer was a step-down type (fewer secondary windings than primary) then to maintain the power in-out balance the secondary voltage times the secondary current must equal the primary voltage times the primary current. ($P = V \times I$).

TURNS RATIO

If the turns ratio is n:1 (where n is greater than one) then the primary voltage must be n times the secondary. This implies that the secondary current must be n times the primary.

In general, for a step-down transformer as used in low-voltage power supplies the secondary will be wound with thicker wire than the primary in order to carry the higher current.

Transformers for power supplies are usually specified in terms of their primary voltage and their secondary voltage(s) and current(s). The symbol for a transformer is in Fig. 6.4 (b).

INDUCTORS

Inductors as circuit components are used less and less in modern times. They are avoided because they tend to be bulky for anything other than very small values of inductance; they tend to be sensitive to external magnetic fields and also to create unwanted magnetic fields.

One area where coils are still used extensively is radio circuits, in particular in the aerial circuits. Most transistor radios use a **ferrite rod aerial** which is wound with a number of coils each designed to be particularly sensitive to a given range of radio frequencies.

The ferrite core concentrates the electromagnetic energy of the radio waves so that there is a relatively large changing magnetic field affecting the coil. The radio waves induce tiny e.m.f.s in the coils which are subsequently amplified and decoded into the original audio signal. See Fig. 6.5.

In a radio receiver there are usually, in addition, three or more transformers of a different kind. These are enclosed in metal cans made from a special material which prevents external fields from affecting their operation.

SOLENOIDS

The magnetic field produced by the current flowing in a coil is put to use in a number of **electromechanical** devices. **Solenoids** are simply coils wound round a core which is free to move. When the current is on, the core is pulled into (or pushed from) the coil and this movement can be used to actuate some mechanical device such as a lock.

When the moveable part is used to close or open an electrical switch we have what is termed a **relay.** The symbol for a relay is shown in Fig. 6.4(c).

When we are driving devices with inductance with circuits which are sensitive to high voltages we must be aware of the

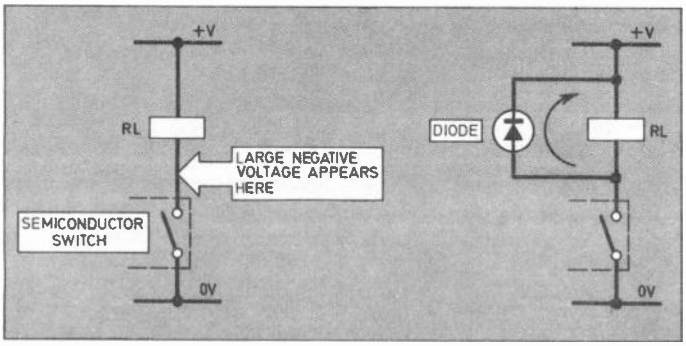


Fig. 6.6. If a voltage sensitive switch (such as a transistor) is used to switch on and off a relay then some protection must be provided against the back e.m.f. produced by the collapsing magnetic field. This is usually in the form of a diode which provides a path for the current produced by the e.m.f. in the coil.

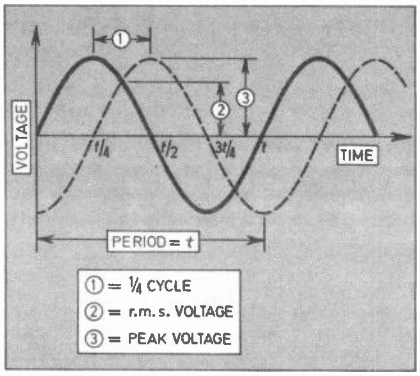


Fig. 6.7 (right). Diagram illustrating the terms period, frequency, amplitude and phase.

high e.m.f. produced by the collapsing magnetic field produced when we switch off the current.

For instance the diagram in Fig. 6.6 shows a switch connected to a relay. After the switch has been on for a long time a constant current will be established in the coil. When the switch is turned off the magnetic field will collapse producing an e.m.f. which tends to maintain the current in the coil.

The voltage at the top end of the coil is prevented from altering since it is connected to the power supply rail, but the bottom end will go to a very high negative voltage. If the switch is some sort of semiconductor device then it will inevitably be destroyed.

A number of remedies are possible, the simplest of which is to connect a diode across the coil with the cathode to the positive supply (Fig. 6.6(b)). The diode now provides a path for the current when the field collapses.

Because the voltage across the coil is now clamped to the forward voltage drop of the diode the energy stored in the inductance takes longer to be dissipated. This is the penalty we must pay, but in most cases the slowing up is irrelevant.

Like capacitors, inductors are stores of energy. But whereas capacitors store the energy in the form of electric fields, inductors store energy in magnetic fields.

A.C. CIRCUITS

Now that we have looked at the three basic elements which go to make up every real circuit component, we must see how the three elements interact in real circuits.

When we are analysing circuits with repetitive waveforms we make use of the fact that any real repetitive function can be thought of as composed of a number of pure sinewaves of varying amplitude and phase added together.

The terms **frequency, amplitude** and **phase** need to be defined and to do this we refer to Fig. 6.7.

The figure shows a sinewave starting at time zero. After a time t the waveform begins again and repeats exactly the shape of the first "cycle". The time between two identical points on a waveform we call the **period.**

The number of cycles in one second we call the "frequency". The frequency is the reciprocal of the period.

$$f = 1/t$$

Frequency is measured in **hertz (Hz)** where 1 Hz = 1 cycle per second.

AMPLITUDE

The amplitude of the waveform can be defined in a number of ways. We can simply define the peak amplitude as the voltage at the top of the waveform. The more usual way of specifying the amplitude is to quote the **root mean square** (or **r.m.s.**) value. This is defined as the value of the d.c. voltage which would produce the same heating effect as the a.c. waveform.

For a sinewave there is a simple relationship between the peak value and the r.m.s. value (r.m.s. amplitude = 0·707 × peak amplitude) but for anything other than this the relationship is more complex.

The waveform shown dotted in the diagram has exactly the same amplitude and frequency as the solid waveform but it is displaced in time. As we move from left to right along the time axis we move on in time hence the dotted waveform is "lagging" the solid one.

Each complete cycle can be divided into 360 degrees just like one complete revolution around a circle. We can specify by how much the dotted waveform is lagging the solid by using degrees as our unit. In the case of the diagram, the dotted waveform is lagging the solid waveform by a quarter of a cycle or 90 degrees.

Using all these terms we can now look at how inductors, capacitors and resistors affect a.c. waveforms which are applied to them.

CAPACITOR PLUS RESISTOR

The diagram in Fig. 6.8(a) shows a sinusoidal waveform applied to a simple network consisting of a resistor and capacitor; we wish to discover how the output waveform differs from the input.

When we were discussing capacitors we noted that the current through the capacitor was equal to the capacitance times the rate of change of voltage across that capacitor. Now the total voltage across the capacitor plus the voltage across the resistor must at any particular instant equal the input voltage.

The voltage across the resistor and that across the capacitor are shown in Fig. 6.8(b) and many interesting points can be noticed.

First, the total voltage across the two components (the driving voltage) has a phase which is between that of the capacitor and resistor. Also, the maximum voltage is not the sum of the two separate peak voltages because these do not occur at the same time. However, it is larger than either of the two components.

Though a solution to the problem has been presented, the way in which it was derived has not. It is clear that deriving the voltages in any circuit containing capacitance (and indeed inductance) is not possible using simple arithmetic as was possible with circuits containing only resistance.

In fact when this subject is studied in more detail it will be found that there are two main methods of circuit analysis: one is a method using geometry (called the vector method) and the other using a special type of mathematical operator (called the "j-operator"). Neither of these methods will be described here, only the results obtained will be presented.

INDUCTANCE PLUS RESISTANCE

In a circuit containing resistance and inductance we again have a complex situation as the voltage across an inductor is proportional to the rate of change of current through that inductor. We can imagine the capacitor as being a store of voltage and the inductor as being a store of current.

If we apply an a.c. voltage to the inductance-resistance network then the voltages and currents which are produced are shown in Fig. 6.9.

Notice that the current now lags the phase of the voltage.

PART 6 QUESTIONS

6.1. What is the inductance of a coil which has 6mV across it when the current is changing at 3mA per second:
a) 0·5mH
b) 2H
c) 2μH
d) 5H

6.2. A transformer has 250 primary turns and 25 secondary turns. What will be the secondary voltage when 250V are applied to the primary:
a) 100V
b) 10V
c) 25V
d) 2·5V

6.3. For the transformer described in 6.2, a current of 2A is drawn from the secondary. What is the primary current:
a) 1A
b) 0·1A
c) 0·2A
d) 20A

6.4. What is the resonant frequency of a 200pF capacitor in parallel with a 10μH inductor:
a) 20MHz
b) 3·56MHz
c) 35·6MHz
d) 200kHz

6·5 When a 200pF tuning capacitor is set to 63·3pF a radio is tuned to 200kHz. What is the parallel inductance:
a) 10mH
b) 63·3mH
c) 200mH
d) 10μH

PART 5 ANSWERS

5.1. a) 5.2. a) 5.3. b) 5.4. a) 5.5. a)

THE TUNED CIRCUIT

When inductance and capacitance are combined together in a circuit we have what is termed a **tuned circuit**. We are all familiar with the process of "tuning in" a radio station: we simply turn a control until the station that we want to hear is at its clearest; either side of this setting the reception is poorer.

The tuned circuit has a response which varies in a similar way as the frequency of the driving signal is altered.

There are two ways of connecting the capacitor and inductor: in series and in parallel.

We said earlier that the capacitor could be regarded as a store of voltage and the inductor as a store of current. When the two elements are connected there is a transfer of energy between the two. At a particular frequency, called the **resonant frequency**, the two storage elements act together in a special way.

When the capacitor and inductor are connected in parallel we know that the voltage across the two elements must be the same. Now the current through the capacitor leads the voltage while the current through the inductor lags the voltage. At the resonant frequency these two currents cancel each other out and the capacitor-inductor combination effectively acts as a barrier to currents of the frequency to which it is tuned.

Of course, this assumes perfect components: inductors without resistance or capacitance, and capacitors without resistance or inductance. Real components will have a little of each, although the most significant "unwanted" component is the resistance of the coil used to make the inductor. The effect of this is that the capacitor and inductor are not exactly out of

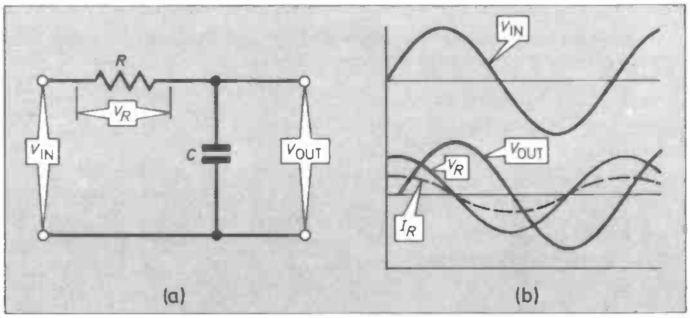


Fig. 6.8. When the capacitor-resistor network at (a) is fed with the alternating voltage, the voltages and currents are as at (b) the current leading the voltage by 90 degrees.

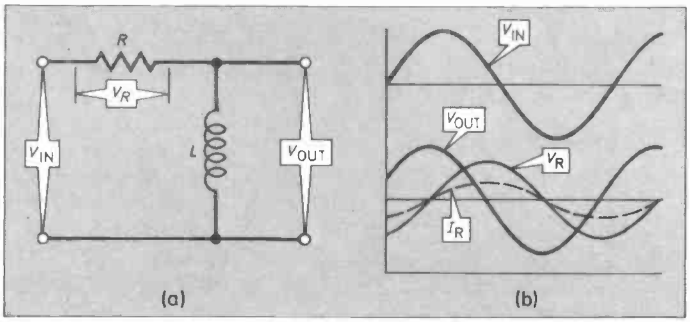


Fig. 6.9. When the inductor-resistor network at (a) is driven with an alternating voltage, the voltages and currents produced are as at (b) the current lagging the voltage by 90 degrees.

EXPERIMENT 6.1: MUTUAL INDUCTANCE

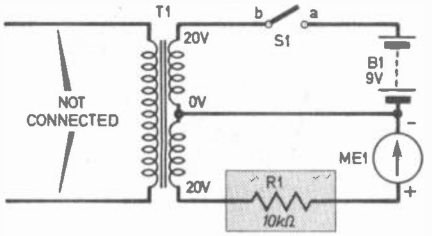
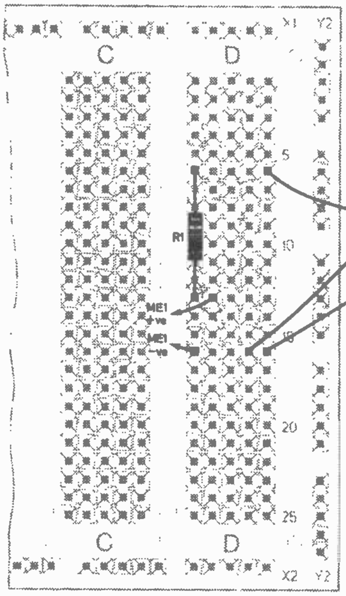


Fig. 6.12. The circuit of Experiment 6.1 with the layout of the components shown at (b).

The circuit diagram for the experiment is shown in Fig. 6.12a and the layout on the Tutor Deck in Fig.6.12b. **Note that the transformer is not plugged into the mains**—we are only using the two secondary windings to show how the change in current in one produces an e.m.f. in the other.

When the switch S1 is open no current can flow in the first winding but as it is closed current builds up. The time it takes to reach the final value and the magnitude will depend on the resistance and inductance of the coil, but these actual values are not important.



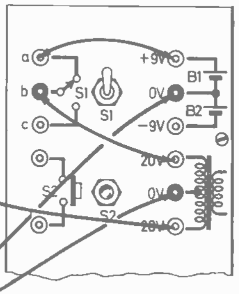


Fig. 6.12b

The changing current in the first coil produces a changing magnetic field which, in turn, produces an e.m.f. in the second coil.

The meter needle will be deflected, the current being limited by the series resistor R1.

When the switch is opened the magnetic field collapses as the current previously established falls to zero. This changing field again induces an e.m.f. in the other winding but note that this time the deflection of the meter, and hence the e.m.f., is in the opposite direction.

EXPERIMENT 6.2: SIMPLE POWER SUPPLY

Components needed: 1N4148 diodes (2 off), 5·1V Zener diode, 470µF 25V capacitor, 1kΩ ¼W resistor, 680Ω resistors (2 off).

Using the principles so far covered in this series one can combine components to form a simple power supply which can be used to drive any circuits requiring 5V at a few milliamps.

The circuit for the power supply and the layout on the Tutor Deck are shown in Fig.6.13a and Fig.6.13b.

The diodes D1 and D2 are used to form a full-wave rectifier. This produces pulsating d.c. and to smooth it we use a high value electrolytic capacitor C1. The capacitor charges up to the peak voltage produced by the diode bridge. As the voltage from the rectifier starts to fall the voltage stored on the capacitor reverse biases the diodes so that the only path for the current is into the circuit to the right of the capacitor.

The capacitor is followed by a 340 ohm resistor in series with a 5·1V Zener diode D3. This resistor is actually two 680 ohm resistors connected in parallel (R2, R3). The value is chosen so as to pass sufficient current into the diode to keep it on its constant voltage operating characteristic yet allow enough current to pass into the load, this being connected across the Zener diode.

With values shown the circuit can deliver approximately 10mA at 5·1V. If a load which demands more current than this is connected across the output, then the voltage across the resistor will increase and the Zener diode will no longer receive enough current to keep it in its constant voltage, mode, hence the output voltage will drop.

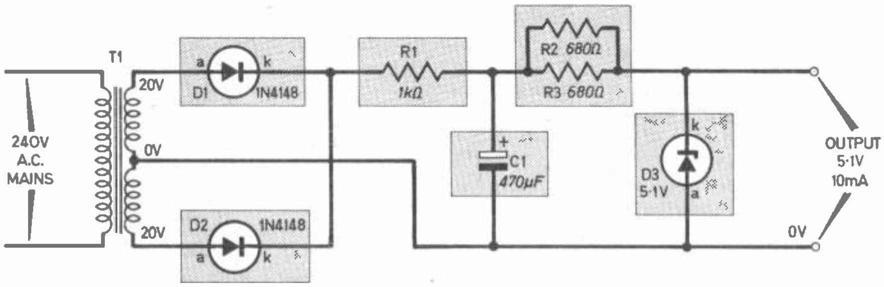


Fig. 6.13. Circuit of the simple power supply which is the subject of Experiment 6.2. The layout of the components on the Tutor Deck is shown at (b).

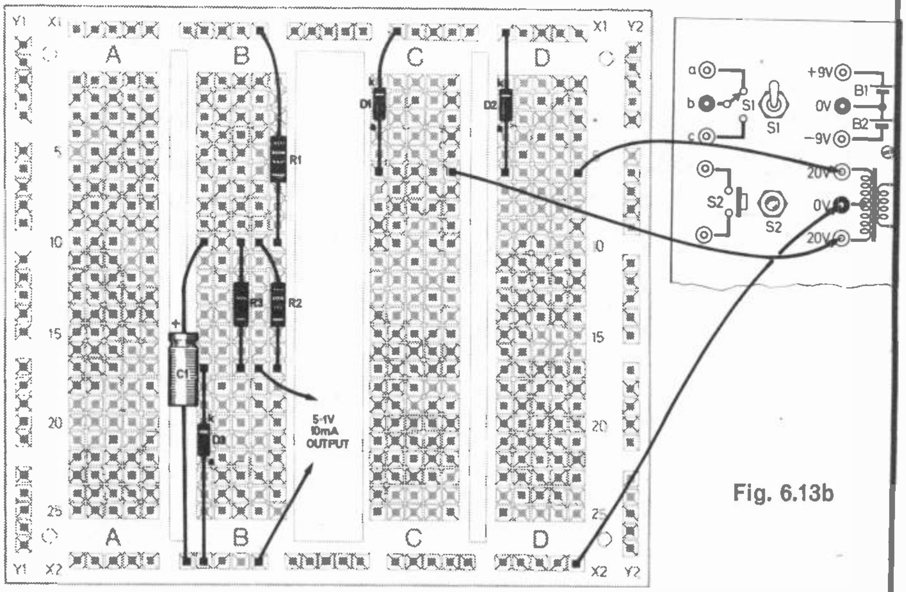


Fig. 6.13b

phase, and so a small current flows even at resonance.

The plot of current against voltage for varying frequencies in a parallel tuned circuit is shown in Fig. 6.10. The actual relationship between the values of the capacitance and inductance and the resonant frequency are

$$fr = \frac{1}{2 \times \pi \times \sqrt{L \times C}}$$

In a series tuned circuit as shown in Fig. 6.11 we have the situation that the current through the capacitor and the inductor are the same. At the resonant frequency two equal and opposite voltages are produced across the capacitor and inductor and these tend to cancel so maximum current flows through the network. The effect is that the total network appears like a short circuit.

Again the above description assumes perfect components; in practice even at resonance there will be some resistance in the circuit.

The variation of the current flow through the series network is shown in Fig. 6.11(b). The relationship between the resonant frequency and the component values is exactly the same as the parallel circuit.

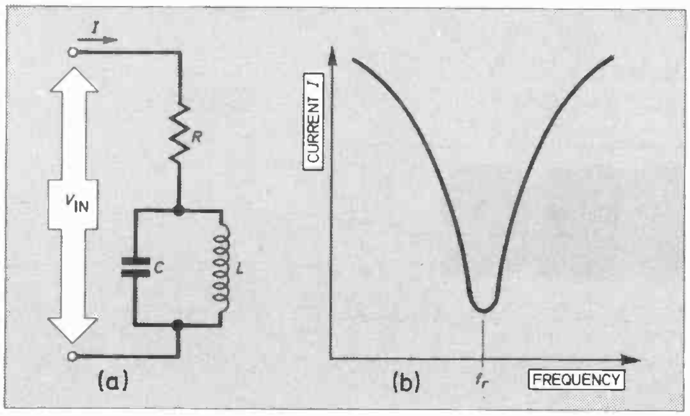


Fig. 6.10. A parallel resonant circuit is shown at (a) and the relationship between frequency and current at (b).

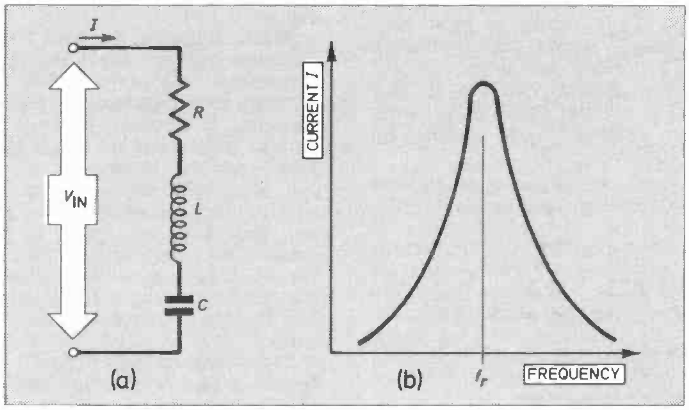


Fig. 6.11. A series resonant circuit is shown at (a) and the relationship between frequency and current at (b).

USES OF TUNED CIRCUITS

Tuned circuits find use most often in radio circuits where their characteristics make them ideal for selecting the particular radio frequency in which we are interested. One of the components (usually the capacitor, but in higher frequency systems the inductor) is made variable so that the resonant frequency of the network can be varied at will.

The other use of tuned circuits is in oscillators and we will see how these operate in a later part of this series.

Next month we will meet that very important semiconductor device, the transistor.

SQUARE one FOR BEGINNERS

As one becomes more experienced and ambitious, the need for a special workbench or workshop area will probably arise. For one thing, there will be a few test instruments and a power supply unit to make provision for, in due course, as well as an increasing stock of electronic components. But until this stage is reached, the newcomer can enjoy himself no end using the minimum amount of equipment and making use of the table top.

TABLE TOP OPERATIONS

ONE of the great attractions of electronics construction is that one does not need special or elaborate workshop facilities in order to get started in this hobby. A table or any flat surface is all that is needed, essentially, for assembly and wiring-up electronic circuits.

There are of course some objections to working directly on the table top. Possible damage to the surface is naturally one; another is the inconvenience of having to gather up all one's bits and pieces when the table is needed for other purposes. A simple solution is to obtain a sheet of hardboard, say 2ft by 3ft and fix wooden battens around three edges to retain the tools and components.

The hardboard work top can be very quickly removed from the table, without any disturbance to any partly completed job in hand. The board may also be found suitable for working in an armchair. There's luxury for you!

One possible hazard to be guarded against is damage caused by a hot soldering iron.

Always have a suitable metal receptacle at hand and place the iron in this when not in use. Some soldering irons have their own "stand", but it is still advisable to have a metal tray or suchlike over which the iron should be held when wiping or tinning the bit.

A small piece of expanded foam, a thin sponge pad, or a duster folded several times, makes a suitable mat for the circuit board during component assembly and soldering operations.

The purpose of a mat is twofold. It provides a suitable grip for the board, so preventing it moving at a critical moment during soldering operations. It cushions the components from the working surface—thereby preventing damage to the components themselves while also protecting the working surface from scratches.

The metal tray has a further use. When component leads have to be cut (cropped) perform this operation over the tray. At the end of a building session, it is a simple operation to empty the tray into the dust bin. Adopt this procedure and there should never be complaints of solder globules or tiny bits of wire embedded in the carpet.

When building a project some light engineering or mechanical work is sometimes involved. For example, cutting and bending a piece of aluminium, or drilling holes in metal or s.r.b.p. This kind of work should certainly not be attempted on the table top. Here one should of course resort to the normal procedures and carry out this kind of work in the shed, garage or room specifically allocated for workshop activities. In any event, a mechanics vice is likely to be essential for this "more physical" kind of work.

Thus the major part of project building can be carried out in agreeable surroundings, without damage to property or hindrance to other occupants of the room.

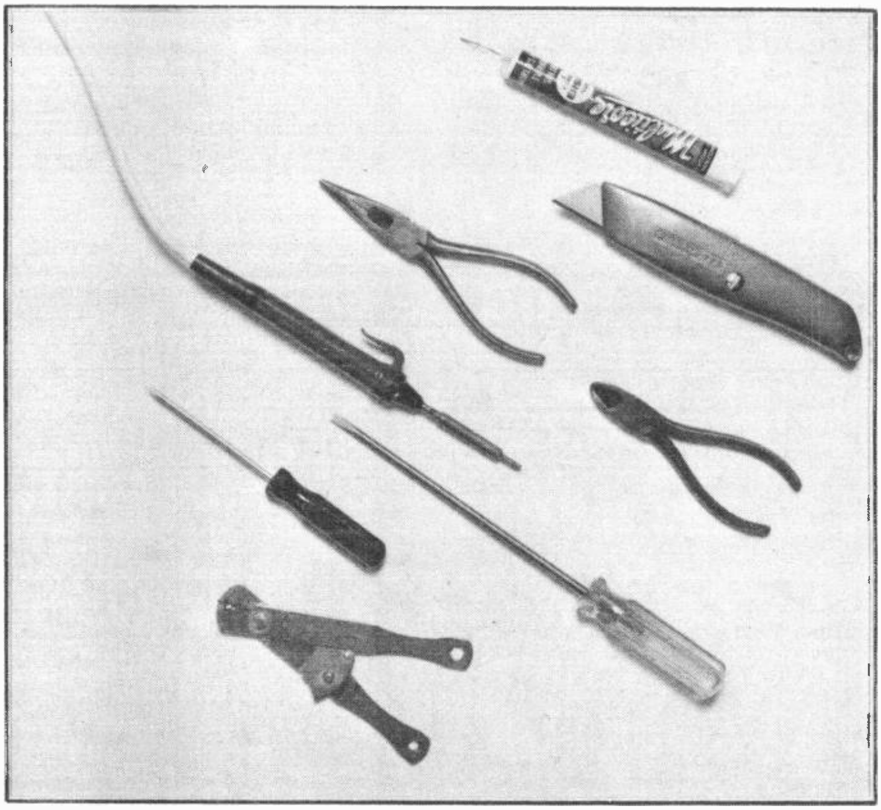
BASIC TOOLS

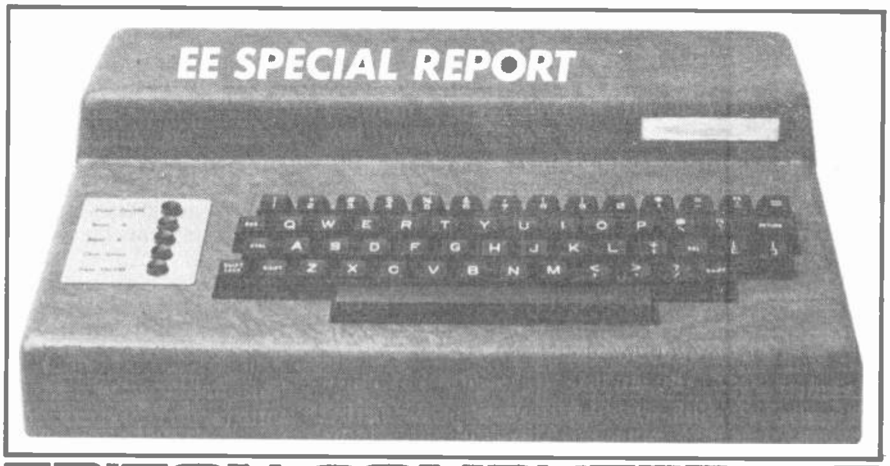
Listed here are minimum requirements in the way of tools and equipment for electronic construction.

Screwdriver 2mm (1/8in) blade
Screwdriver 4mm (3/16in) blade
Miniature side-cutters
Miniature insulated long-nose pliers
Side-action wire strippers
Utility knife
Miniature soldering iron, 15–25 watt
  2 bits: 2·3 and 4mm (approx.)
Cored Solder (60% tin, 40% lead) 22s.w.g.
Small Multimeter:
Ranges (minimum specification)*
  D.C. 10, 50, 250, 1,000 volts
  A.C. 10, 50, 250, 1,000 volts
  D.C. 1mA, 100mA
  Resistance 0–150 kilohms

**for example* Type FL60Q (Maplin Electronic Supplies Limited)

Next month a suggested list of circuit components for the newcomer to purchase will be given in Square One.





TRITON COMPUTER KIT

Less than five years ago, the thought of owning one's own digital computer would for most people have seemed pretty remote. Actually building such an intricate and powerful machine would hardly have been contemplated by the private individual due to the complexity and sheer volume of construction involved with the components available at the time—and the cost.

With the advent of the microprocessor all this has been changed. Tens of thousands of digital computers are privately owned in the UK alone and sales are accelerating.

The majority of these have been purchased ready built and tested but a large number have been built from a microcomputer kit. One such kit is for the TRITON, designed and marketed by a British firm called Transam. Since its launch in November 1978 more than 2,000 kits have been purchased.

It is not necessary to understand the internal workings of a computer to be able to use it to maximum advantage. But for those who do want this knowledge, we believe one of the best ways is to actually put a system together in conjunction with the theory of the system as provided in this package. It often helps to understand more fully the working of devices if you know what they look like and how they are physically interconnected to others. Besides this, great satisfaction is obtained from "doing it yourself".

SINGLE BOARD

Nearly all the components in the Triton are mounted on a ready drilled (double-sided fibre-glass tinned) printed circuit board with plated through holes, as can be seen in the photograph. The board is guaranteed free from design errors.

By far the most important requirement for anybody thinking of building this system, as any other electronic project, is the ability to solder. There is no danger however of i.c.s being damaged by the soldering iron since all i.c.s are mounted in sockets. The fitting of these sockets forms a major part of the construction on this board and requires no special tools, only a good miniature soldering iron. Construction appears to be straightforward and explained in detail in the 116 page manual.

One criticism we have regarding the presentation of the constructional information, is the lack of constructional and interwiring diagrams that readers of EE can take for granted. Only one drawing is provided which is rather cramped. It shows the total component layout of the p.c.b. overlayed on the printed circuit pattern. With such a project it would be desirable to have more interwiring diagrams. There are none for the keyboard, power supply or control switches. A stage-by-stage assembly diagram would be most helpful.

KIT OF PARTS

The Triton kit comes complete with power supply and a full 56 station ASCII keyboard to be mounted in a pre-drilled and formed aluminium case (not shown) which has a large flat horizontal top panel on which the TV can stand (VDU). The photograph shows the alternative vacuum formed rugged plastic case available.

For those on a limited budget, the basic kit has been broken down into 16 individual packs available separately enabling the system to be purchased over a period as funds permit. Also the constructor has the option of using components he may already have in stock. Needless to say, the total cost of the individual packs exceeds the total kit price.

The Triton uses the well tried and tested Intel 8080 microprocessor. Total on-board memory is 8K of which 3K is user RAM. The memory can be easily increased via an external motherboard system up to the full 64K, in blocks of 8K pluggable RAM cards and/or 8K EPROM cards. Both are available in kit form.

The system has been designed to plug directly into the aerial socket on a standard UK TV, channel 36. A cassette interface is included allowing programs/data to be rapidly loaded in and out of the computer using a standard cassette tape recorder.

FIRMWARE

All of the firmware is resident in UV erasable EPROMS. There are six Basic firmware options to choose from to suit most needs: L4.1 (1K monitor 2K Tiny Basic having seven monitor functions); L5.1 (1·5K monitor 2·5K Tiny Basic with 14 monitor functions); L6.1 (2K monitor 7K Basic with 25 monitor functions) this is a scientific package with full floating point arithmetic; L7.1 (8K Extended Basic). Also available are L4.2 and L5.2, higher clock frequency (18 MHz) versions of L4.1 and L5.1. In addition a Pascal firmware pack L8.1 has recently become available.

The basic Triton L4.2 kit (£286 + VAT) is an excellent introduction to the fascinating world of computers and can be easily adapted to suit requirements and expanded up to a 64K system with full Basic or Pascal by the addition of the motherboard and plug in RAM/ROM cards.

Firmware L9.1 has recently become available to allow the Triton to be interfaced with a floppy disc system and there is more to follow, as 50 per cent of Transam's investment is dedicated to developing new soft/firmware.

An after sales service exists for constructors who have experienced difficulties in getting the completed system operational. Also for those people not sufficiently skilled in the art of soldering or construction, the microcomputer may be purchased ready assembled at an extra cost of about £60.

If you require further information we suggest that you contact Transam Components Ltd; Dept. EE, 12 Chapel Street, London NW1.

BOOK REVIEWS

SYMBOLS AND ABBREVIATIONS FOR ELECTRICAL AND ELECTRONIC ENGINEERING

Editor IEE Editorial Panel
Price £0·75
Size 210 × 148mm 16 pages
Publisher Institution of Electrical Engineers
ISBN 0 85296 197 7

THIS is a fully revised edition of a similarly entitled booklet previously published in 1968 and 1971.

It contains the IEE recommended usage for students and staff in educational establishments. Also it is intended as a handy reference for authors of papers and books on technical subjects, and for draughtsmen and designers in industry. It takes into account the latest relevant British, Military and International Standards.

Rules governing the formation of abbreviations for words and phrases are explained with examples. The International System (SI), derived units, mathematical symbols, subscripts and conversion factors are included. Two pages are devoted in circuit symbols.

SINGLE I.C. PROJECTS

Author R. A. Penfold
Price £1·50
Size 180 × 108mm 127 pages
Publisher Bernard Babani
ISBN 0 9001 6285 6

LIKE the curate's egg, one is tempted to say "good in parts". With the advent of specialised i.c.s construction of even quite complex devices has been made that much simpler and the 20 projects presented here reflect this trend.

As the title suggests, each circuit incorporates just one i.c. and provided a modicum of care is exercised, even a relatively inexperienced constructor should be able to produce a range of useful gadgets.

That is he would be able to if he had the patience to sift through the text, find the right diagram for the right design, work out which component list is which and so on.

The layout and organisation of the text and diagrams is somewhat haphazard to say the least and even the contents list does not reveal all the projects that are in the book.

Regular readers of EE will no doubt be familiar with the author's name and it is a great pity that the presentation does not do his designs justice. S.E.D.

FROM TELEVISION TO HOME COMPUTER

Editor Angus Robertson
Price £8·95
Size 223 × 140mm 323 pages
Publsiher Blanford Press
ISBN 0 7137 0973 I

THE first two-thirds of this book merit its title. The final 100 pages are shared between a miscellany of electronic products: watches, calculators, home protection and security devices, amateur and CB radio hi-fi, and in-car entertainment. These brief surveys, the work of individual contributors, have been added, it must be supposed, to a predominately TV or video survey in an attempt to justify the sub-title "The Future of Consumer Electronics". But it falls short here, by at least one glaring omission—the microwave oven.

As a review of technical progress to date and a forecast of future developments in television and video in all its various forms this book is certainly a timely and useful work. Video recording, for example, is going to make its impact upon the domestic scene and now is the time for an appraisal of techniques involved. The chapters on video cassette recorders (Angus Robertson) and video discs (Adrian Hope) will help clear many misconceptions. Teletext and Viewdata are described and the future of these information services is predicted. Television games get good coverage, but home computers receive but cursory treatment in mere nine pages.

LETTERS

Thanks for the Memory

I found Mr. Young's recollections of early radio, see *Counter Intelligence* January issue, very interesting but slightly erroneous.

Children often misjudge measurements which is evidensed when they return to childhood houses in later years and find them much smaller.

Grid bias batteries were certainly not a yard long about 9 inches I think. Also H.T. batteries could hardly have weighed half a hundredweight. I was no Samson and had to bring them home very frequently—they did not last long.

Accumulators were not that big either. My brother made a living re-charging them for radio owners and they were quite portable.

I certainly remember Leonard Henry and many others. There was the "Roosters Concert Party" which I found superb. They must have been the pioneers of sound effects, and reproduced marching and other forms of transport to perfection. They started in the first world war and my elders did not find them as good as I did—probably because of war-time memories. After a while they disappeared and I have not since found a concert party to equal them.

I won't bore you any further with my reminiscences but thank you for recalling such a happy aspect of my youth.

C. L. Engbert
Pinner

Peg-A-Hole

When constructing your project *Peg-A Hole* game, I used the thyristor THY1A400. When using this I found that R1, a 2·2kΩ resistor was too large because it did not allow enough current to the gate terminal. I found a 220Ω the most suitable replacement.

Paul Snape (Age 11)
East Gomeldon

Crossword No. 25—Solution

DOOR BELL REGISTER

By A. P. Donleavy

IT CAN be useful to know whether someone has called when one is out of the house. The simple device described here will provide such an indication. It has other uses as well, and could be used as a general event recorder.

CIRCUIT

The circuit (see Fig. 1) is built around a CMOS i.c., type CD4013. This is a dual flip-flop, only one half of which is used in this project.

Operation is as follows: A positive clock pulse applied to pin 3 causes the output at pin 2 to go from low to high and turn on the light emitting diode D1. The output stays high when further pulses are applied, until a positive pulse to pin 6 via S1 resets the output to low.

Components R1, R2 and C1 are included to give protection to the i.c. from the high voltages which can be generated from coils in the door bell.

Being a CMOS chip the CD4013 only consumes about a micro amp when the l.e.d. in the off state, and about 7mA in the on state.

CONSTRUCTION

The prototype was built in a Vero box measuring about 45 x 100 x 25mm. The components, with the exception of S1 and S2, are all mounted on a piece of 0·1 matrix stripboard measuring 1·75 inches x 1·25 inches approximately (12 strips by 16 holes). Component arrangement and breaks in copper strips are shown in the diagram Fig. 2.

The lid of the box is drilled such that the l.e.d. protrudes through it when the lid is placed in position. S1 and S2 are mounted on either side of the battery. The layout is not at all critical and can be altered to suit the constructor.

The input leads from the bell are brought in via a hole drilled in the back of the case. The other end of these leads should be attached to the bell terminals.

The component board is secured to the box with one 6BA screw using a brass tapped-bush incorporated in the box.

When soldering the i.c. be sure to use a well earthed soldering iron, and never solder or insert the i.c. into the circuit with the power on.

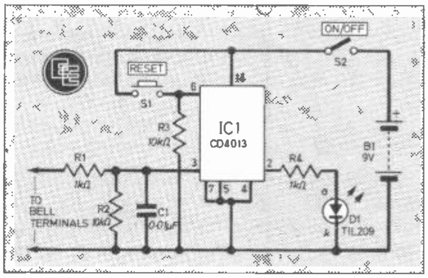


Fig. 1. Circuit of the Doorbell Register.

The 9V battery sits securely in the lid, being a tight fit between the pair of tapped bushes.

When the instrument is first switched on the l.e.d. may light; press the S1 to reset it. If the l.e.d. does not light at all, it is probably wired in with its terminals reversed.

COMPONENTS

S1 is a miniature push-to-make type switch. S2 is a miniature on/off switch. Any small l.e.d. can be used, but be careful to get the right polarities when assembling.

The device will work on any voltage from 3V—15V. A PP3 is a convenient size of battery. If a lower voltage is used, for example 3 volts, reduce R1 to 270 ohms.

COMPONENTS

Resistors
R1 1kΩ, 4 R2 10kΩ, 3
All ¼W carbon

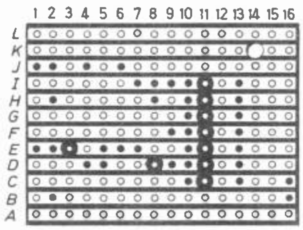
Capacitors
C1 0·01µF polyester

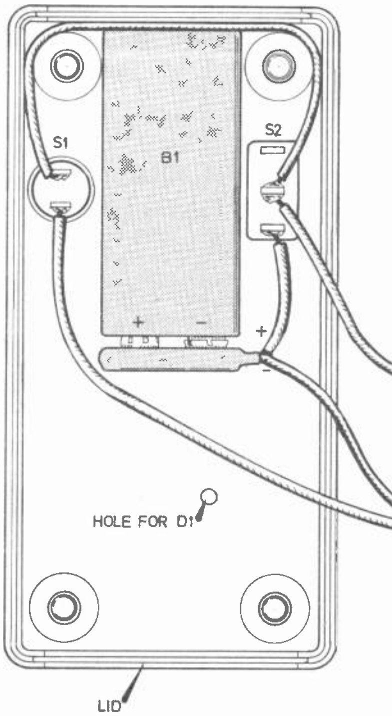
Semiconductors
D1 TIL 209 light-emitting diode
IC1 CD4013 CMOS dual flip-flop

Switches
S1 miniature push-to-make
S2 miniature toggle on/off

Battery
B1 9V PP3

Miscellaneous
Vero box 100 × 45 × 25mm. Stripboard 0·1in matrix 12 strips × 16 holes. Battery connector.





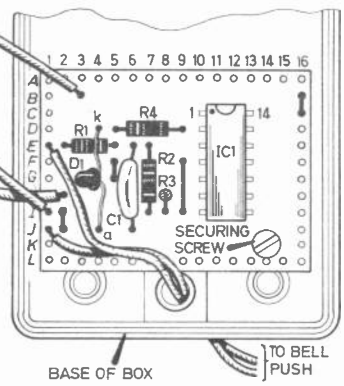


Fig. 2. Interior view of box showing assembly of parts and wiring between lid and base of box. *Top right:* underside view of stripboard.

5 RANGE CURRENT LIMITER

By F. G. Rayar

THIS type of "electronic fuse" protects d.c. power supplies against short circuits or excess loads, as well as limiting the current which can flow in equipment operated from the supply. There are five ranges, selected by a switch. These allow limiting at 50mA, 100mA, 250mA, 500mA and 1 ampere.

CIRCUIT DESCRIPTION

The complete circuit diagram of the current limiter is shown in Fig. 1. Transistor TR1 is a d.c. amplifier, TR2 the series control transistor, and TR3 the limiting circuit transistor. Switch S1 selects the wanted range, and the limiting action depends on the values of the resistors R2 to R9. By employing resistors in parallel, standard values of ¼W resistors can be used throughout, which is an advantage when obtaining the components.

Actual values for the five ranges are 12 ohm (R2) for 50mA, 6 ohm (R2 and R3 in parallel) for 100mA, 2·2 ohm (R2 and R4 in parallel) for 250mA, 1·32 ohm (R2, R5 and R6 in parallel) for 500mA, and 0·69 ohm (R2, R7, R8 and R9 in parallel) for 1A.

CURRENT LIMITING

With current under the set limiting value, TR1 base is supplied by R1 and TR2 base from TR1 emitter. Transistor TR3 is not operating since the emitter-base potential depends on the particular resistance value present between these two points, for example 12 ohm for 50mA. Current is thus available through TR2 for the equipment.

COMPONENTS approximate cost £3·50

Should current increase due to a heavy load or short circuit, the voltage drop across R2 rises to 0·6V for 50mA, so TR3 switches on. The excess load or short circuit across the output terminals means that TR3 emitter is

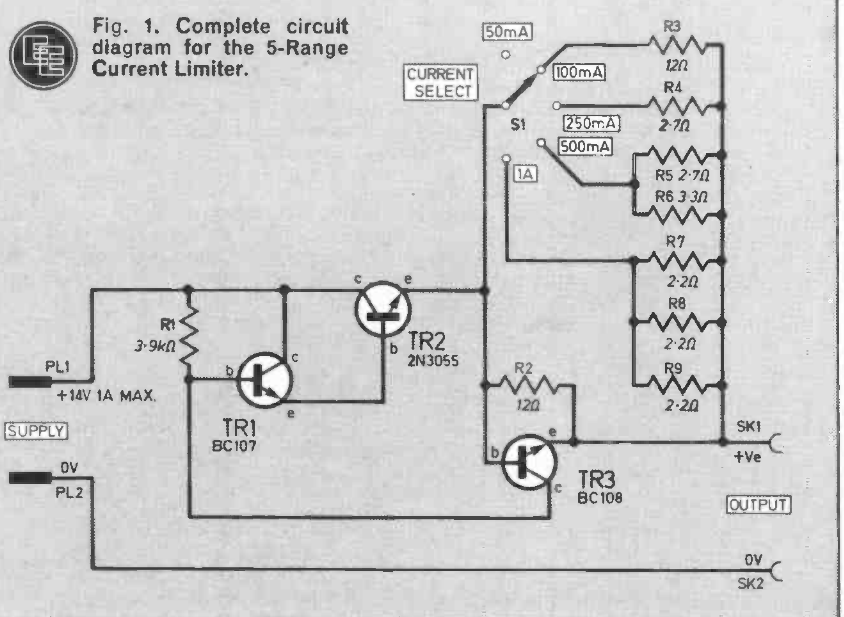


Fig. 1. Complete circuit diagram for the 5-Range Current Limiter.

COMPONENTS

Resistors
R1 3·9kΩ
R2 12Ω
R3 12Ω
R4 2·7Ω
R5 2·7Ω
R6 3·3Ω
R7 2·2Ω
R8 2·2Ω
R9 2·2Ω
All ¼ watt carbon ± 5%

See Shop Talk page 167

Semiconductors
TR1 BC107 *npn* silicon
TR2 2N3055 *npn* silicon
TR3 BC108 *npn* silicon

Miscellaneous
S1 2-pole, 6-way switch (see fig.2.)
SK1, SK2 4mm sockets (one red, one black)
PL1, PL2 4mm plugs (one red, one black)
Metal box 165 × 65 × 40mm; five-way tag strip; mica washer, insulating bushes and mounting nuts and bolts for TR2; control knob; solder tag; two lengths of p.v.c. covered 16/0·2mm connecting wire (one red, one black).

negative, so conduction in TR3 moves TR1 base negative, and TR1 emitter follows this, shutting off TR2.

For heavier currents, R3 or other resistors will be in parallel with R2, as described. The current level at which TR3 operates is thus increased.

The completed unit showing the front panel lettering and mounting of the power transistor.

CONSTRUCTION starts here

ASSEMBLY

A metal box 165 x 65 x 40mm is used to house the unit. Transistor TR2 is mounted on the side of the box itself using insulating bushes and mica washers and the remainder of the components are wired between a five-way tag strip and S1 as shown in Fig. 2.

The input to the unit from an external power supply is taken via red and black flexible leads terminated by plugs PL1 and PL2, the output is taken from sockets SK1 and SK2.

Resistor R2 is in circuit for all ranges, so no connection is made to the 50mA position tag on S1. The unit could simply be placed in the positive supply line, but it was found more convenient generally to have negative run to the second socket.

TESTING THE LIMITER

After assembly, the unit can be checked by placing a meter in series with the supply. Set the instrument to the 1A or larger current range, or to an appropriate lower current range for the lower current positions of S1. With a deliberate overload or short circuit at the sockets of the unit, current will be limited to about the values shown for the various switch positions.

USING THE LIMITER

The unit is intended for power supplies of up to 24V. In the worst operating conditions, that is a complete short circuit of output on the 1A range with 24 volts, dissipation in TR2 is about 24 watts. This is not immediately too important because the panel and box are a heat sink for TR2, but the short or overload should of course be removed.

At lower currents and voltages, the heating of TR2 will be proportionally less. Switch S1 is set to that current range which comes most nearly above the normal current demand of the equipment, model, or other apparatus being powered. ⌑

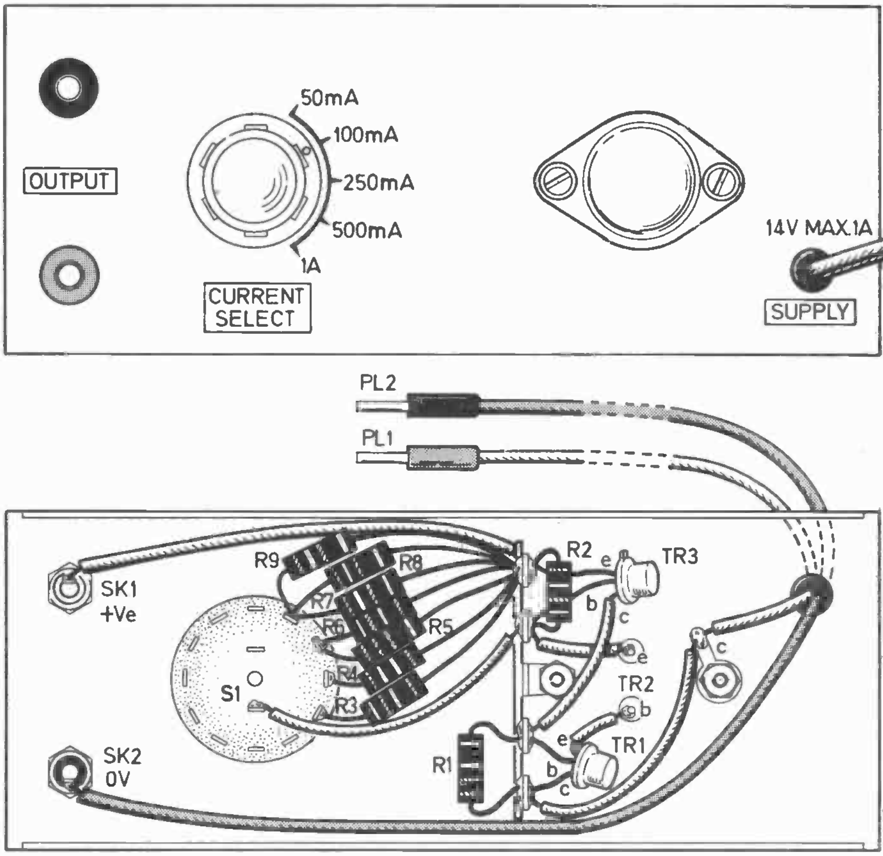
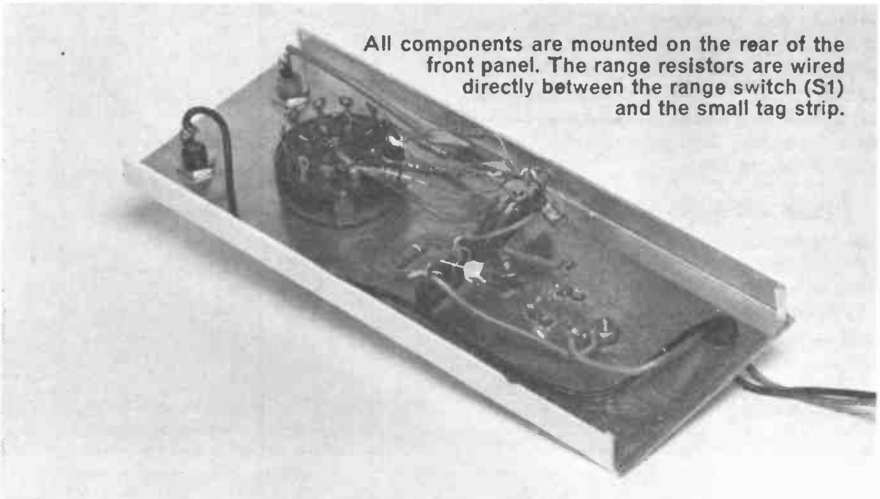
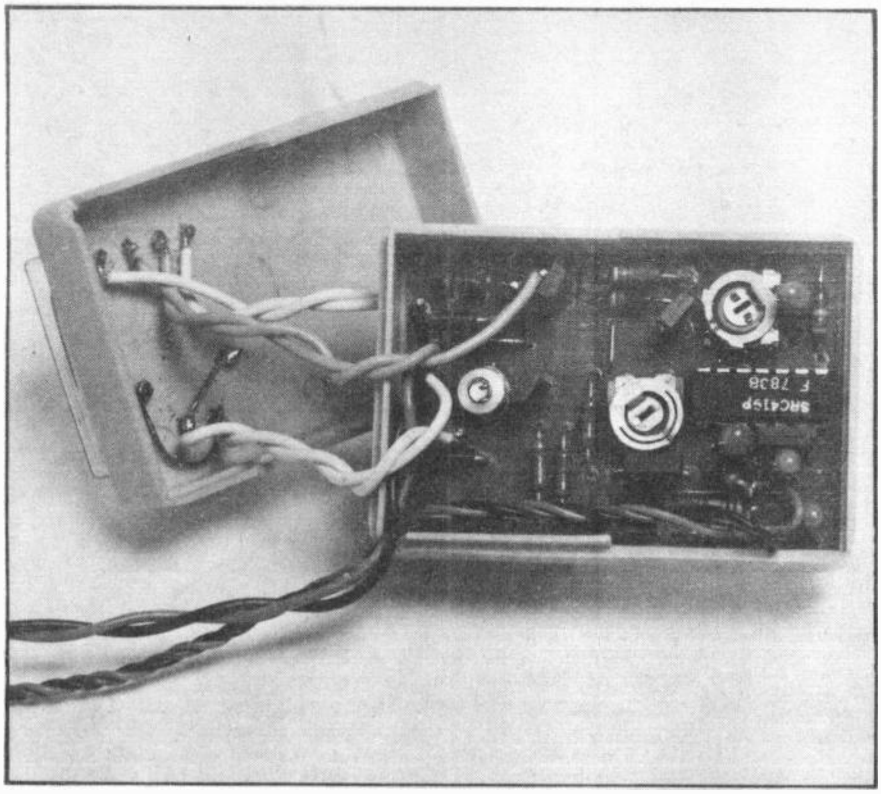


Fig. 2. Layout of components, interwiring and front panel details. Note that S1 consists of one section of a 2 pole-6 way rotary switch with two positions unused.



All components are mounted on the rear of the front panel. The range resistors are wired directly between the range switch (S1) and the small tag strip.



By L. ARMSTRONG ● H. DICKINSON ● W. WILKINSON

PART FIVE

EE RADIO CONTROL SYSTEM

PROPORTIONAL SPEED CONTROLLER

THE conversion of electric signals into mechanical action is the main purpose of radio control systems. This month we deal with a speed controller as applicable to model boats and cars.

PROPORTIONAL SPEED CONTROLLER

A proportional speed controller is a variation of a servo, in this case without the gearbox and with the position feedback potentiometer removed. Once again the ZN419CE integrated circuit is used. As well as these two physical differences there are two other changes, this time in characteristics of operation.

LARGER DEADBAND

As mentioned in the servo section Fig. 4.3 showed the relationship of error to pulse expansion, which in the case of the servo was a narrow deadband and a very steep pulse expansion slope.

If Fig. 5.1 is now referred to the characteristics for the speed controller can be seen. Here a larger deadband is used together with a drastic reduction in the pulse expansion slope to the extent of full drive output being reached very close to full stick-movement (maximum error) which will be equivalent to maximum revolutions on an electric motor.

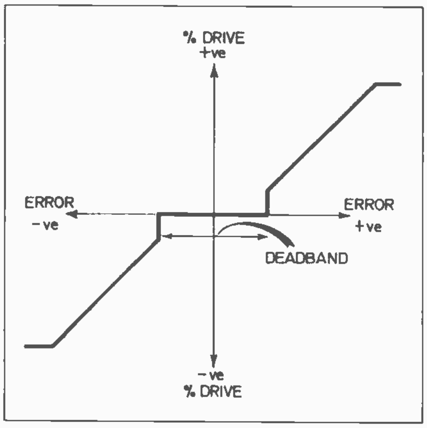


Fig. 5.1. Proportional speed controller error and output drive relationship.

PULSE EXPANSION RELATIONSHIP

Fig. 5.2 clearly shows the pulse expansion relationship for four different input pulse widths.

Case *A* is when the input pulse is at its minimum value of 1ms. The error between this and the fixed internally generated pulse (1·5ms) is 0·5ms which produces an output drive pulse of 20ms (full drive).

Case *B* has an error of 0·25ms which produces an output pulse of 10 ms (half-drive).

These two cases are for the input pulse widths less than the internal pulse, producing "positive" drive output pulses. As the error approaches zero so the output pulse will reduce in a linear fashion.

For cases *D* and *C* this is where the error is "positive", that means input pulse larger than internal 1·5ms, which will produce a "negative" drive output. (The terms "positive" and "negative" refer to the direction of rotation of the motor.)

It can therefore be seen that with the transmitter stick at neutral (producing a control pulse width of 1·5 ms) there will be no error pulse and so the motor will remain stationary. Any change of stick position will produce a pulse width error in the speed controller causing an output drive pulse to be produced and the motor to turn. The larger the stick movement the greater the error and the faster the motor will turn.

TWO IMPROVEMENTS

This is the theory of operation of a basic speed controller. The design incorporated in the EE Radio Control System has two improvements over such a basic system.

A relay is used to reverse the direction of rotation of the motor to avoid too many expensive power transistors when using larger motors.

The power gain stage between the servo amplifier and the motor enables external batteries to be used so that the normal receiving batteries are not "flattened" by the motor.

CIRCUIT DESCRIPTION

Fig. 5.3 shows the full circuit diagram of the speed controller. The deadband is set by the capacitor C3. As can be seen this capacitor is much larger than that on the normal servo amplifier. C4, R7 and VR2 combine to produce the desired expansion characteristics, VR2 enables the expansion to be adjusted to produce the optimum performance.

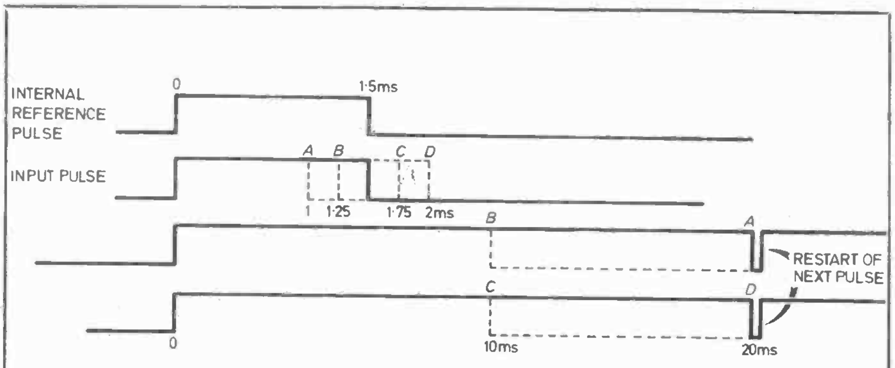


Fig. 5.2. Proportional speed controller pulse expansion relationship.

The positive and negative drive pulses are combined via R6, R5, TR3, and TR4 to produce a common drive pulse.

TR6, TR7 and R10 from a power stage to give the speed controller the ability to drive larger motors.

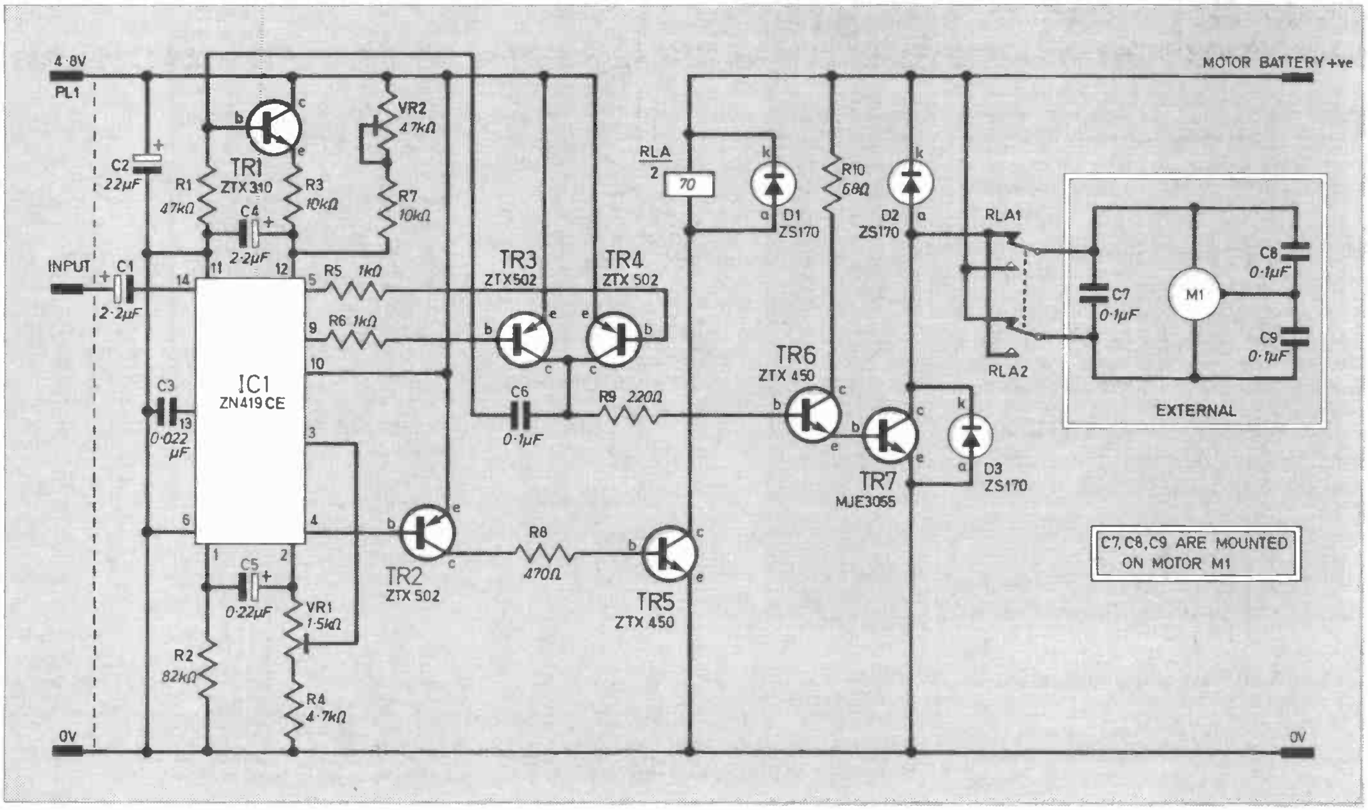
FLIP FLOP AND RELAY

The desigh of the ZN419CE i.c. includes a flip flop output on pin 4. This is high when the output drive is in one direction and low when in the other. This signal is used to drive the relay RLA which controls the direction of rotation of the motor. TR2, R8 and TR5 are the associated discrete components.

The combination C6, R1, TR1, R3 is designed to ensure that the minimum output pulse width is close to zero other than 2ms as in the normal servo. This ensures that there is a smooth take-off of the motor at low speeds.

The remaining components R2, C5, VR1 and R4 are associated with the internal monostable, in IC1.

Fig. 5.3. Circuit of the EE Radio Control System Proportional Speed Controller. Motor M1 and associated capacitors are external to speed controller.



PROPORTIONAL SPEED CONTROLLER

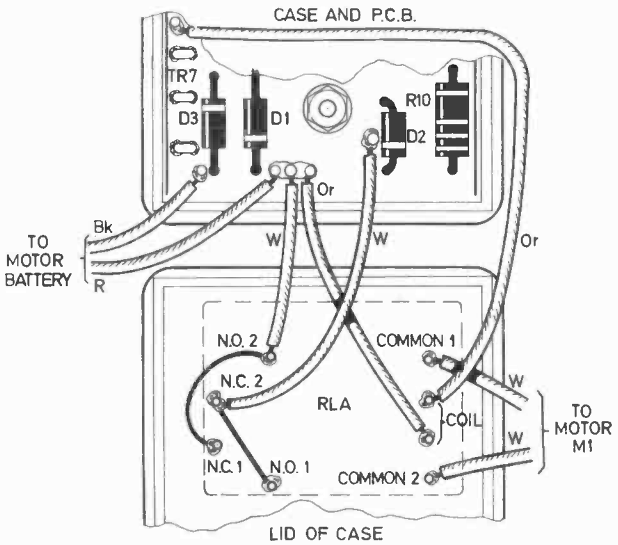
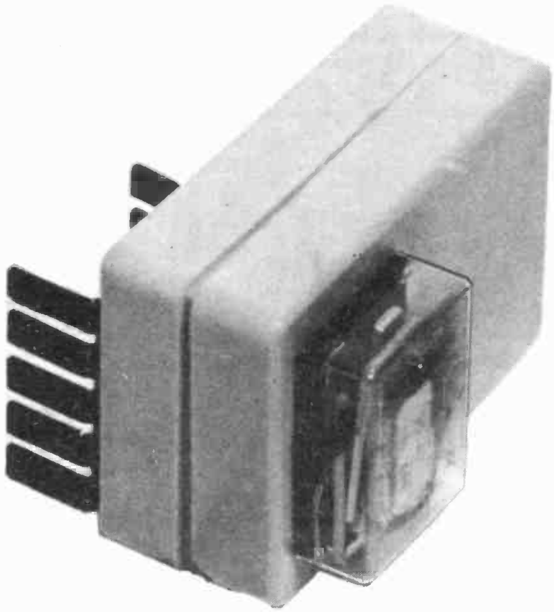


Fig. 5.6. Connections between the p.c.b. and TR7 and RLA, which are mounted on the bottom and top of the case, respectively, see photo (right.)



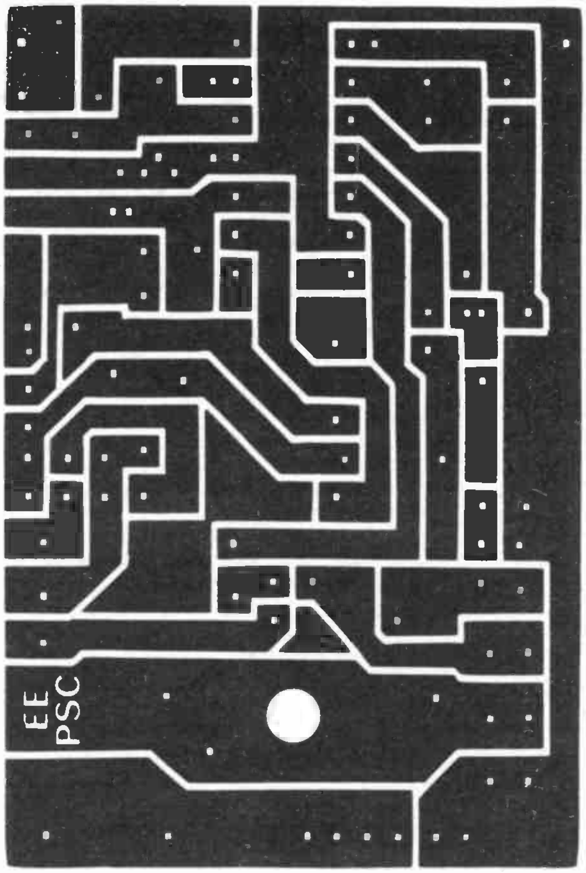


Fig. 5.4. Printed circuit board for the EE Radio Control Proportional Speed Controller. Note this is twice actual size.

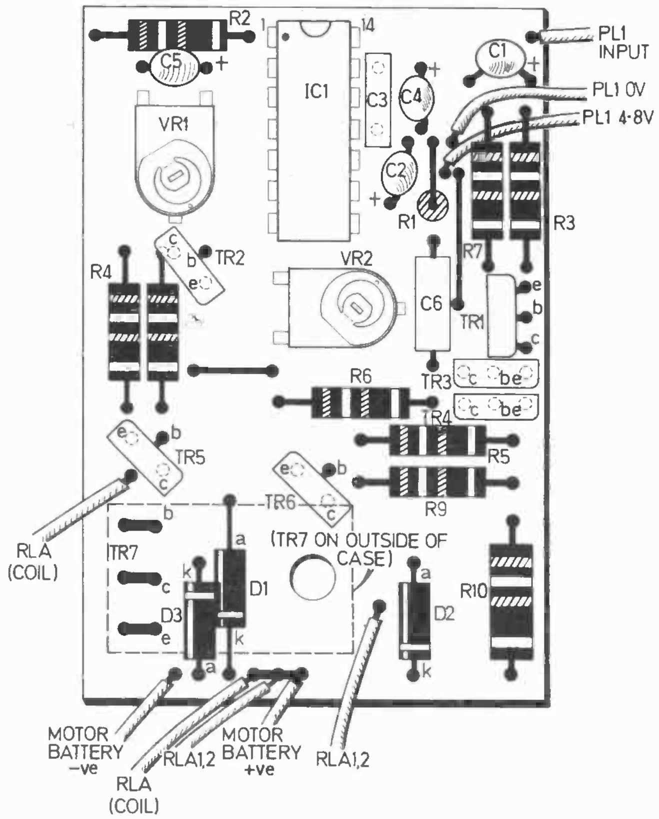


Fig. 5.5. Top view of the p.c.b. with all components in situ.

CONSTRUCTION starts here

The speed controller is housed in a plastics case of same size as that used for the receiver. The p.c.b. also is comparable in size to the receiver p.c.b. Thus the construction should not prove any more difficult than the receiver—and certainly less "tricky" than the servo.

The power transistor and its heat sink are mounted externally on the bottom of the case. The relay is also mounted outside but on the top of the case.

CIRCUIT BOARD

The p.c.b. pattern is shown in Fig. 5.4. The top side with components in position appears in Fig. 5.5.

Ensure that the i.c., diodes, transistors and polarised capacitors are inserted the correct way round.

The only difficult part is the power transistor TR7. This is mounted outside the case on a heat sink with the leads bent to go through the case and the board. Here they are soldered to the three pins shown. The bolt for the transistor also holds the p.c.b. in place inside the plastic case.

Before fixing the power transistor in position it is wise to check and double check all soldered joints ensuring that no solder bridges adjacent tracks on the p.c.b.

The relay RLA is mounted to the top of the case, Fig. 5.6.

COMPONENTS

SPEED CONTROLLER

Resistors

R1	47kΩ	R6	1kΩ
R2	82kΩ	R7	10kΩ
R3	10kΩ	R8	470Ω
R4	4·7kΩ	R9	220Ω
R5	1kΩ	R10	68Ω 1W

All ¼W carbon ± 5%, except R10

Potentiometers

VR1 1·5kΩ horizontal mounting miniature skeleton preset
VR2 47kΩ horizontal mounting miniature skeleton preset

Capacitors

C1 2·2μF tantalum bead 10V
C2 22μF tantalum bead 6·3V
C3 0·022μF ceramic
C4 2·2μF tantalum bead 10V
C5 0·22μF tantalum bead 35V
C6 0·1μF ceramic disc
C7 0·1μF ceramic disc
C8 0·1μF ceramic disc
C9 0·1μF ceramic disc

Semiconductors

TR1 ZTX310 *npn* silicon
TR2 ZTX502 *pnp* silicon
TR3 ZTX502 *pnp* silicon
TR4 ZTX502 *pnp* silicon
TR5 ZTX450 *npn* silicon
TR6 ZTX450 *npn* silicon
TR7 MJE3055 *npn* silicon (plastic)
D1-3 ZS170 1A diode 100V working (3 off)
IC1 ZN419CE (SRC419)

Miscellaneous

PL1 3-pin plug (SLM)
RLA 6V d.c. 70Ω coil, 2 pole c.o. contacts 2A. (RS 349–181)
Case, 60 × 40 × 22mm approx. (SLM); Printed circuit board; Small plastic power transistor heatsink; ½ inch × 4BA bolt and nut; Wire for leads; Heat shrinkable plastic sleeving.

EXTERNAL LEADS

External leads should be soldered to the p.c.b. before it is secured within the case:

(a) The three input leads (approximiately 8 inches in length) should be twisted together and soldered to a 3 pin SLM plug, as shown in Fig. 5.5.

(b) A pair of leads for the motor battery (black and red).

Inter-connections between the p.c.b. and the top half of the case can now be made. A pair of leads must be provided to go to the drive motor (see Fig. 5.6).

When and only when you are satisfied that the speed controller is correctly constructed then you can proceed to the next step, that of setting it up.

SETTING UP PROCEDURE

Before plugging in to the receiver, and with the motor disconnected, set VR2 fully anticlockwise and VR1 to approximately the centre position.

Plug in to the receiver output and connect the external 6V motor supply (check correct polarity).

With the transmitter and receiver switched on and all sticks in neutral, movement of VR1 should cause the relay RLA to pull in at one end and drop out at the other end. The correct setting is where the relay is "just" off.

Now connect up the motor.

With the transmitter stick in the neutral position the motor should not turn. Move the stick in any direction the motor should start to turn slowly at first and faster for more movement of the stick.

With the stick in its maximum position adjust VR2 slowly until no further increase in speed is noticed. This is the correct position.

Now check that when the stick is moved in the opposite direction the relay changes over and the motor turns the other way.

It is suggested that when using the speed controller in a boat or car the control stick used is in place of the elevator (see Fig. 2.7 in Part 2).

If, when the system is installed, the motor turns the opposite way to that you require, reverse the connections to the motor or change over the stick plug in the transmitter. DO NOT change round the drive battery.

INSTALLATION

Typical arrangements of equipment including the servo and the speed controller inside a model boat and a model car are shown in Fig. 5.7.

Next Month: Battery charger and fault finding chart.

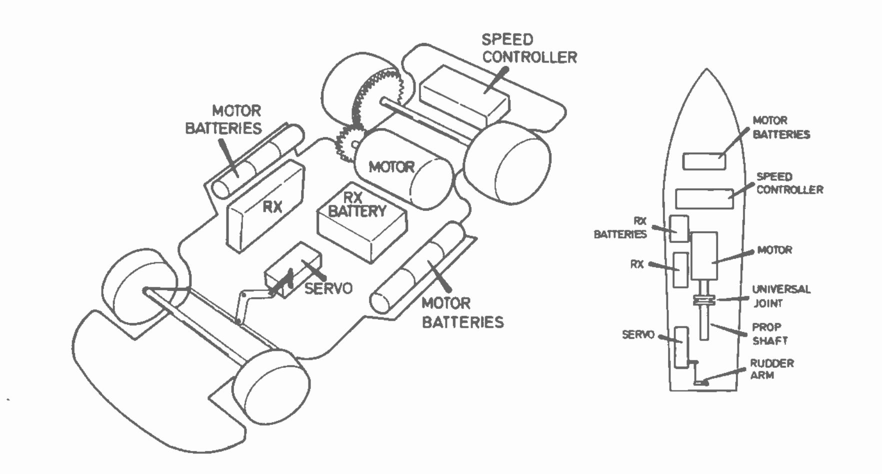
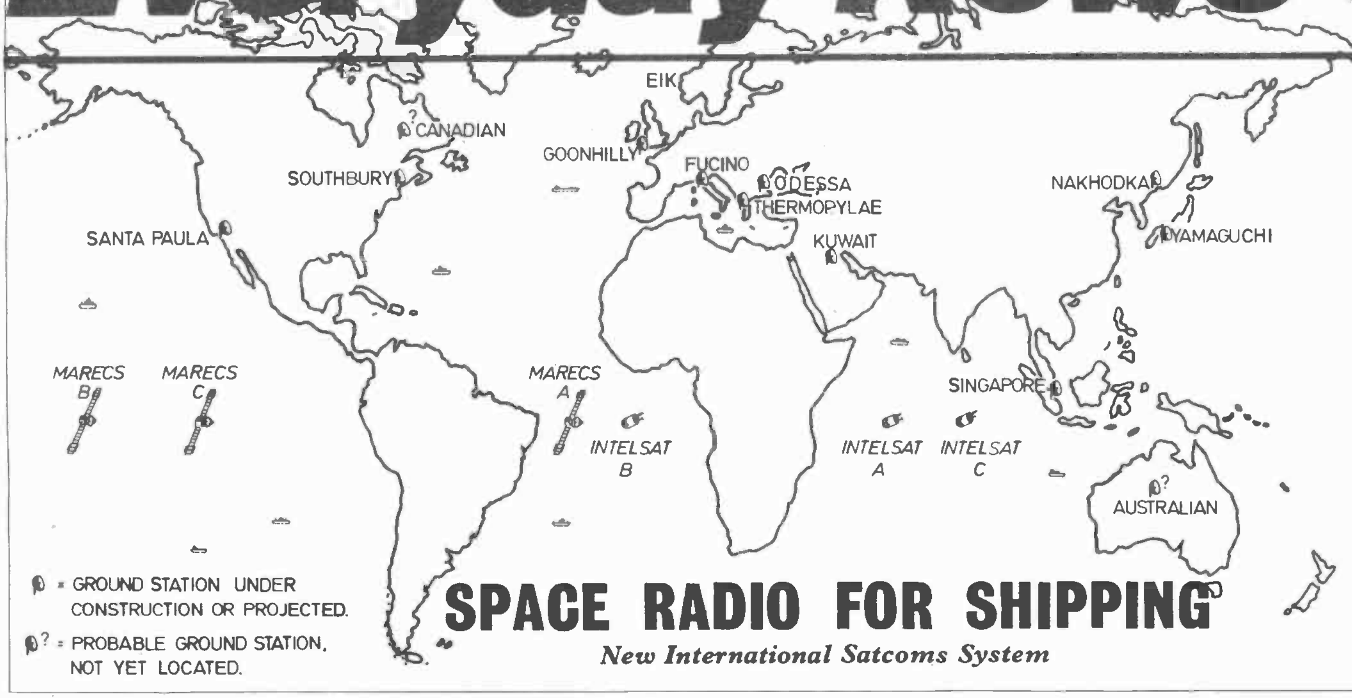


Fig. 5.7. Typical installations of equipment in a model racing car and a model boat.

Everyday News



SPACE RADIO FOR SHIPPING

New International Satcoms System

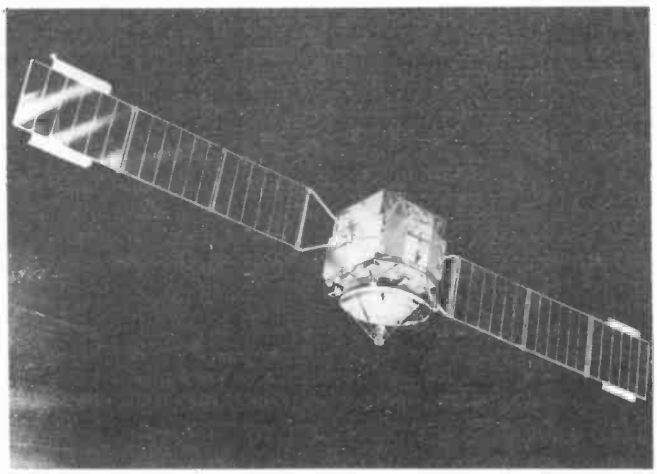
This new decade will see a revolution in radio communication for ships at sea with the formation of INMARSAT, the International Maritime Satellite Organisation, whose first director general, Mr. Olof Lundberg from Sweden's maritime telecommunications organisation Televerket, set up INMARSAT's London headquarters recently. INMARSAT is a consortium of twenty-nine maritime countries in which Britain with 9·95 per cent of the shareholding has the third largest stake, exceeded only by the USA with 23·5 per cent and the USSR with 14·17 per cent.

The consortium plans to put up six satellites with pairs placed in geostationary orbit 22,300 miles up above each of the ocean zones Atlantic, Pacific and Indian to provide ample channel capacity for telex, telephony, facsimile and data and recorded information communications for a satcoms-equipped ship population expected to reach at least 2,000 by 1990; channels will also be available for distress and safety traffic.

This 3 plus 3 configuration will comprise three *MARECS* satellites supplied by the European Space Agency plus special maritime transponders on three *INTELSAT* satellites of the International Telecommunications Satellite Organisation. The first satellite, *MARECS A*, is scheduled for launching into orbit over the Atlantic before the end of this year, from Kourou in French Guiana, on an *Ariane LO4* rocket.

The first of the *INTELSAT* trio is expected to be put into position over the Indian Ocean by late 1981 and though no dates have been set for further launchings these should then follow in fairly quick succession to complete the space segment with the Atlantic zone covered by *MARECS A* and *INTELSAT B*, the Pacific by *MARECS B* and *C*, and the Indian Ocean by *INTELSAT A* and *C*.

The European Space Agency's MARECS satellite, a maritime version of the European Communications Satellite (ECS). MARECS will provide direct telephone and telex links between ships in distant oceans and shore stations.



Ground Stations

At least a dozen ground stations, and probably several more, will work the six satellites. Britain's will be at Goonhilly where a new 13m diameter dish antenna will beam on the Atlantic, and the Nordic countries will have their terminal, working to the Indian Ocean, at Eik in Norway.

Russia plans to build one at Odessa on the Black Sea and another at Nakhodka near Vladivostok. The station for Greece will probably be at Thermopylae, Italy is thinking of Fucino as a site, Kuwait and Singapore are both planning to have their own, and Australia and Canada will also build ground stations at sites not yet determined.

It is expected that other member countries of INMARSAT, notably in South America, Africa, the Indian sub-continent and China, will also set up ground stations. The existing terminals of the US Navy's MARISAT satcoms system, at Southbury in Connecticut, Santa Paula in California, and Yamaguchi in Japan will switch over to INMARSAT as MARISAT is phased out over the next two or three years.

With a wide geographical spread of numerous ground stations and double the number of satellites, exclusively dedicated to commercial traffic, INMARSAT will offer a fast high-quality service when it gets off the ground, literally as well as metaphorically.

The British Post Offices Prestel Viewdata system has been purchased by Hong Kong with the service expected to start late in 1980.

. . . from the World of Electronics

LOOKING BACK

In March 1930, Baird's much heralded "Televisor" was finally on sale, and the experimental 30-line transmissions from the BBC Brookmans Park station were for the first time accompanied by sound.

Television broadcasting, in fact, had arrived, and the fiftieth anniversary of this milestone is being marked by a special exhibition, entitled *The Great Optical Illusion*, at the Science Museum on March 27 for six months.

—ANALYSIS

THE LASER COMES OF AGE

Twenty years ago Dr. T. H. Maiman, a scientist working for Hughes Aircraft Corporation in California achieved light amplification by stimulated emission of radiation which, from its initial letters, generated a new word in the vocabulary of physics—the laser.

Here was an entirely new form of light of great spectral purity, all on one wavelength and with all the waves in a beam in phase with each other. It was coherent light, unlike the light we ordinarily see from the sun or from a tungsten filament which is scattered in a direction and of random wavelengths and energies.

The special characteristic of laser light is that it can contain very concentrated energy and can be in a very fine needle-beam which is so nearly parallel that even at a distance as great as that from the earth to the moon it would still only have a diameter of a couple of miles. In 1960 the laser was rightly hailed as a great invention.

In practice, oscillation is more important than amplification but then the acronym would have become 'loser' and that would hardly do. Nonetheless, in a sense the early lasers were losers. Although recognised as a wonderful technological breakthrough, nobody quite knew what to do with them. The laser was dubbed an invention in search of an application.

Within months of Dr. Maiman's achievement with his ruby laser, another scientist at the Bell Telephone Laboratories had produced a gas laser and later there came along the semiconductor laser. Today we have a whole range of types each with characteristics which might include exceptional power, or continuous beam or exceptionally directional or particularly coherent. And there are different wavelengths, not all in the visible region, and some offer a choice of colours.

The applications were not long in coming. By 1965 the fine beam of a laser was being used in eye surgery, one of the more significant early applications. Today the laser is found as well in industry, in communications, in research, in measurement, in navigation (the laser gyroscope), in entertainment electronics and particularly in defence.

In 1968 the gas dynamic laser gave a great increase of power which led to speculation on the development of the death-ray of science fiction. The direct-beam laser weapon remains a possibility using newer chemical or electric discharge types. The idea of vaporizing an incoming ballistic missile with its nuclear warhead almost as soon as detected is certainly attractive, and nothing is as fast as a laser beam to make the intercept, travelling at the speed of light. But this is a long way off yet. At present the laser in military use is confined to a secondary role such as range-finding, target marking and weapon guidance, and communications.

Meanwhile more peaceful applications continue to proliferate and it is quite conceivable that at least the semiconductor laser may soon find its place alongside other devices in the electronic hobbyist's kit.

Brian G. Peck

Writing Typewriter

An electronic typewriter that writes the characters with a stylus instead of impacting from a pre-formed metal character has been developed by Centronics Data Corporation.

It can "write" up to 20 characters per second and can be programmed for different styles of script and in different sizes. And because it writes instead of types it is silent in operation.

Named the Quietwriter it is expected to be available early in 1981.

Mobile telephone users in the London area will be able to use direct dialling from their cars instead of being connected by operator. New equipment supplied by Pye and worth £1·75 million will enable 15,000 mobile users to dial direct.

Farnborough '80

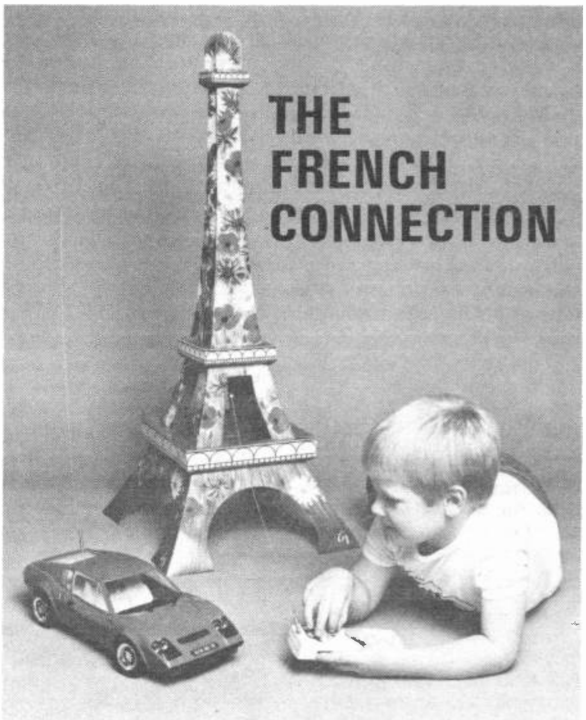
This year's Farnborough Air Show (September 1-7), a major electronics as well as aerospace event, will be 30 per cent larger than the last show in 1978.

A Datatext micro-chip based word processing system will be used to process the 100,000 or so admission tickets for invited guests from 100 countries.

Solar Power Down Under

Australia's first high-temperature solar power station is to be located at Whitecliffs, New South Wales.

Designed by the Australian National University it uses paraboloidal mirrors to concentrate the solar energy to generate super-heated steam to drive a turbo electric



An order for over 500,000 remote control chips has been awarded to Plessey Semiconductors for use in the French toy manufacturers Joustra's radio control models.

The integrated circuits used are the SL490 transmitter and the ML928 receiver and can also be used for ultrasonic, infra-red or cable transmission.

Originally developed for TV applications, Plessey is designing the i.c.s into toys, TV games and domestic appliances.

RADIO WORLD

By Pat Hawker, G3VA

Those so puzzling echoes

More than 50 years ago radio engineers and scientists began to investigate a most puzzling and curious phenomenon —the occasional appearance on some h.f. (short wave) transmissions of distinct and quite audible echoes where the second signal was sometimes many seconds or even minutes after the first. Now a radio signal that goes right round the world (as of course happens quite regularly on h.f.) will do so in under a second, while even a signal reflected from the moon will be safely back on earth within about two seconds.

So what could happen to a signal travelling at 300,000km per second that could delay it by several seconds? In other words what path could it take to account for such "long delay echoes" (LDEs).

In 1927 and 1928 a special series of transmissions from Eindhoven, Holland yielded many instances of delays of from 3 to 15 seconds, and even instances of echoes delayed by 3 or 4 minutes. Since then, many investigations have been made and many theories put forward. Yet none has been entirely satisfactory or widely accepted. And there has been a curious change in the reporting of LDEs.

Up to about 1939, there is good evidence that many apparently genuine LDEs were heard and even, in a few but reliable cases, such echoes were recorded photographically or on undulator machines used for machine-telegraphy (this was before the days of the ubiquitous tape recorder). But since 1946 the LDE has become extremely rare.

Some five years ago, Peter Duffett-Smith, G3XJE at the Cavendish Laboratory devised a complex correlation technique to search automatically for LDEs in a noisy background; yet half-a-million transmissions did not yield a single positive result and he concluded that "the phenomenon of LDEs should be treated with reserve".

Certainly it has been shown that some reports were due to deliberate hoaxes, some people feel the echo is often an odd quirk of the brain, and other people have linked them with UFOs. There are also reports that turn out to be due to the practice of overseas relays of h.f. broadcasting stations playing tapes sent out from base slightly out of sync with the home transmission.

Yet those early reports remain convincing, though in many years of listening of h.f., I cannot claim to have heard an LDE. In 1974, a Danish amateur heard a 4·6-second echo on his "moonbounce" signals on the unusually high frequency of 1296MHz: he believes his signals were being reflected from an ionized cloud near the sun.

Now a Canadian scientist, D. B. Muldrew, has published a long and detailed paper surveying the whole history of LDEs and has advanced some theories of his own, including the possibility that one of the basic mechanisms is non-linearity in the ionosphere (the old "Luxembourg" effect). This seems to tie several loose ends together.

I have always had the feeling that the key to the puzzle must be in the difference between the pre-1939 and post-1947 conditions. And remember that it was in those years that a vast number of high-power radar, television and megawatt broadcasting stations began to appear.

It is known that powerful signals raise significantly the electron-temperature of the ionized layers and so bring about non-linearity. Exactly why that should affect the non-appearance of LDEs I have no idea—but (at least to me) it seems as plausible a theory as many of the others!

On the amateur bands

Much that is reported about amateur radio operating seems to place undue emphasis on the unusual contacts: those often fleeting and perfunctory "contacts" with DXpeditions, rare-country or rare-prefix stations or in the all-too-numerous "contests". While undoubtedly all these have an established place within the large framework of amateur radio, personally it has always seemed to me that as equally an interesting and as varied a side is represented by the longer, more leisurely contacts with old friends or the random new ones that come from looking around the bands and responding to CQ calls.

In this way one is likely to find oneself in contact with all those mysterious-sounding Russian towns, from Kirov to Kharkov, from Krasnodar to Gorky, from Baku to Tomsk or with the many Scandinavians spread out from the Lofoten Islands to Stockholm, Oslo to Pitea and then, as the "skip" lengthens, with friendly amateurs down in Rio or in remote Anchorage, Alaska or busy New York. Even with a simple transmitter one can take advantage of those powerful American 1kW, "6-element Yagi, up 70ft" stations spread right across the United States, or perhaps look into Europe through the ears and fingers of the small 3-watt morse transceivers of the Heathkit HW7/HW8 class used by so many of the QRP (low power) enthusiasts.

Or you come across the chap who keeps an accurate cross-index to his log and can immediately tell you he last "worked" you in August 1947 or the amateur who recalls his visit to London or his hopes of coming soon. Perhaps he is particularly proud of his "homebrew" equipment, or that he has been licensed for just three weeks—or perhaps 50 years.

The other day Nick Carter, G2NJ, an old-timer, recalled to me the early 1920s and his memories of the days when amateurs in the UK were allowed to operate on 440 metres and had their own "signature tunes" (for many years amateur stations were permitted to play one gramophone record for "test" purposes) such as the Skater's Waltz (G2UV still an active amateur) and "A pair of sparkling eyes" (G2MO).

There are all those names in the log—Vlad, Igor, Jirka, Adam, Gerard, Zoli, Bengt, Czeslaw, Leif—and the pleasure when one suddenly comes across a callsign that strikes a distant chord and turns out to be old Stan in Swansea with whom one remembers sharing Hut 4 in 1942 but has not met for over 35 years.

This type of amateur activity has changed remarkably little over the years. Of course, modern equipment is easier, far easier, to operate with its voice or key operated changeover switching, its vastly improved stability, its more penetrating s.s.b. than the old a.m. equipment. But the pleasure to be derived from such contacts has changed so very little.

In the UK, amateur radio has been growing rapidly in numbers, with some 26,981 licences current at the end of 1979 and with 3155 new licences issued by the Home Office during the year.

Droitwich to move?

One of the lesser noticed changes that will stem from the World Administrative Radio Conference at Geneva last year is a small frequency shift made to the longwave broadcasting band. So small that it will hardly be noticed by the average listener when it occurs some time around 1986–90. But for many enthusiasts this change poses a particular problem.

The very high stability of the BBC Droitwich station, on exactly 200kHz, has for long made it an ideal "frequency standard" particularly when all modulation is stripped off by passing the carrier through a crystal filter and then generating harmonics right up to h.f./v.h.f. as calibration markers. Far better and more reliable (except when the Christmas gales damaged the aerial) than the WWV-type of h.f. standard frequency transmissions (5, 10, 15MHz etc).

But it looks as though Droitwich will have to move to 198kHz, an exact multiple of the 9kHz channel spacing. Of course, with modern digital techniques one can divide by any integral—but, well, how can one get enthusiastic about the number 198 compared with that nice conveniently rounded 200! So make the best use of Droitwich while you can.

CB in the States

At a time when CB appears to have been postponed indefinitely in the UK, it is interesting to learn that the Federal Communications Commission are proposing to relax still further some of the current CB rules in the United States. On December 19, 1979 at an open meeting of the FCC, preliminary steps were taken to consider allocating more channels to s.s.b. and to explore ways of making it legal for CB stations to work over longer distances and to use variable frequency oscillators.

However, the FCC is apparently considering a suggestion that before such relaxation of the rules, operators would have to demonstrate their knowledge of FCC rules which are seldom obeyed by some CB operators.

CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
4017	47p	4046	90p	4520	60p
4018	55p	4049	25p	4528	60p

FULL DETAILS IN CATALOGUE!

TTL

		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

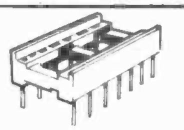
OPTO

LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

SKTS



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8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
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Soldercon pins: 100:50p 1000:370p

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2.5 x 5	54p	54p	Pin insertion
3.75 x 5	64p	64p	tool 108p
3.75 x 17	205p	185p	
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709	35p	LM339	45p	SN76477	230p
741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

TRANSISTORS

				ZTX500	16p
				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
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	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

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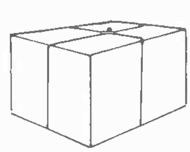

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Resistance	0 – 600K (7K ohms centre)

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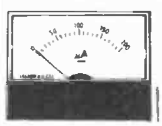

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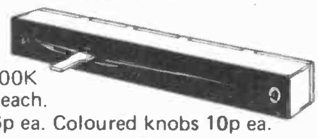

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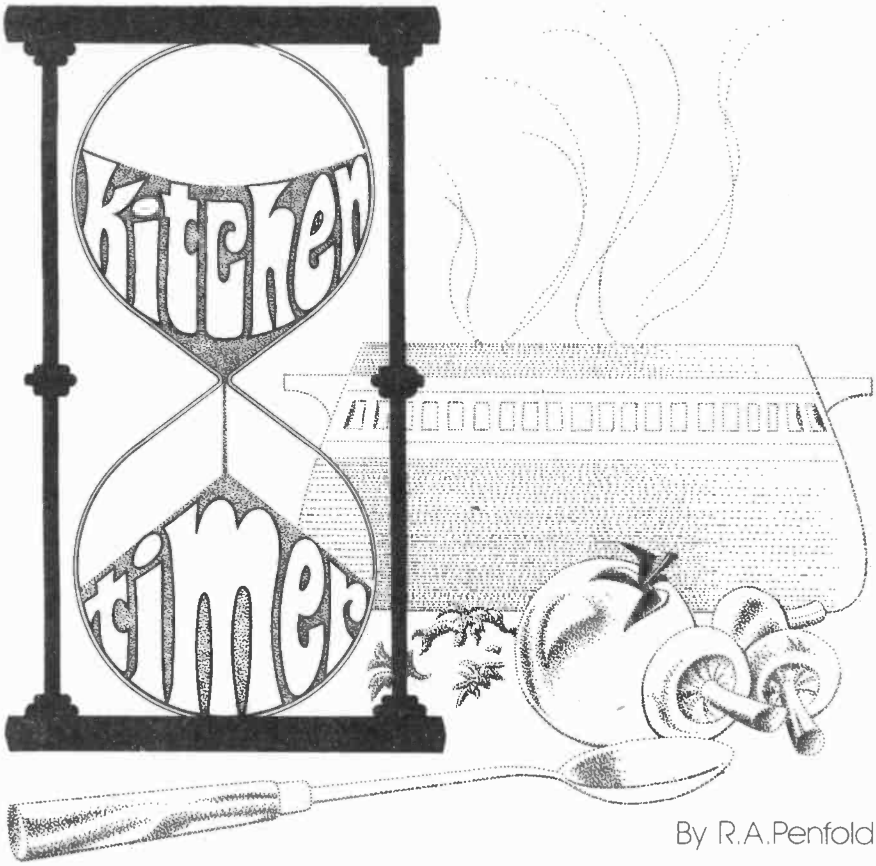
Kitchen Timer



By R.A.Penfold

THIS unit is primarily intended for use as a kitchen timer, but it could, no doubt, be employed in other timing applications. The timer sounds an audio alarm at some predetermined time after the unit is switched on, and the times available range from 1 minute to 2 hours in 1 minute steps.

The required time is selected by adjusting two switches, and once the alarm has sounded the unit is silenced simply by switching off using the on/off switch. In order to start another timing run it is only necessary to switch the unit on again, having readjusted the time setting if necessary.

METHOD OF OPERATION

Most electronic timers are of the *CR* type where a capacitor is charged via a resistor. The voltage across the capacitor rises until a certain trigger level is achieved, and then the circuit switches on an alarm of some kind.

Such timers can be very accurate where only fairly short times are required, say no more than a few minutes, but they tend to be unreliable where longer times are called for. This is because in a practical circuit the length of the timing period is usually calculated from the formula:

$$t = CR$$

where t is time (seconds)
C is capacitance (farads)
R is resistance (ohms)

For a one second delay this would mean values of 1 microfarad for C and 1 megohm for R.

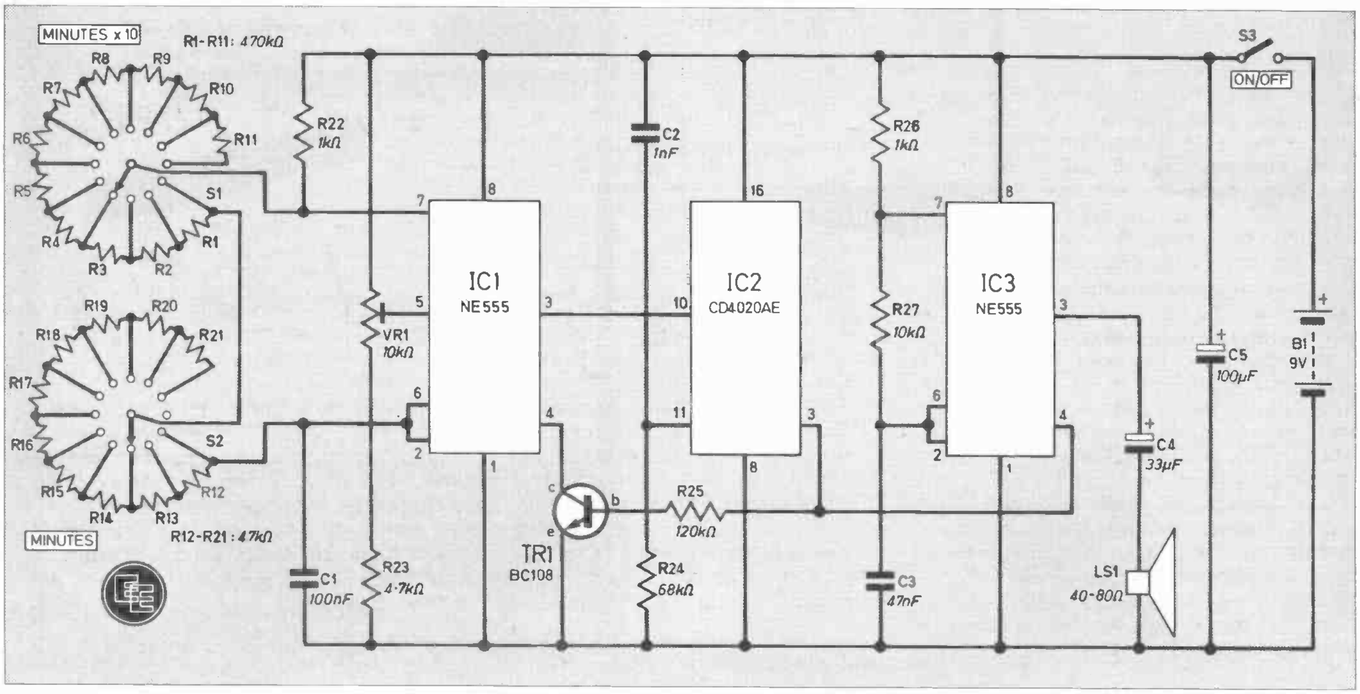
In order to obtain a delay of a couple of hours (7,200 seconds) timing component values of something like 1,000 microfarad and 7·2 megohm would be required (1,000 x 7·2 = 7,200).

Values of this order are readily available, but it would be necessary to use an electrolytic timing capacitor due to the high value needed, and such capacitors tend to have high leakage levels.

This would result in a significant amount of the charge current leaking away during the charge period, extending the charge time and possibly preventing the trigger voltage being reached at all.

A more sophisticated form of circuit is needed in order to give good

Fig. 1. Complete Circuit of the Kitchen Timer.



predictability of the timing period plus consistent and reliable performance.

THE CIRCUIT

The usual form of precision long timer circuit has a *CR* oscillator and a counter circuit. When the counter has received a certain number of input pulses from the oscillator it operates the alarm.

The counter circuit usually has a high division rate (1,000 or more) so that the oscillator can operate at a comparatively high frequency and still provide long timing periods. This enables quite low value timing components to be used in the oscillator. Consequently there is no need for the timing capacitor to be an electrolytic component and good results can therefore be produced.

CLOCK OSCILLATOR

The circuit diagram of the Kitchen Timer unit is shown in Fig. 1, and this is of the type outlined above. The well known 555 timer i.c. is used here in the astable mode to provide the oscillator section of the timer (IC1). This type of circuit is normally termed the "clock oscillator" or just the "clock".

This part of the circuit operates with C1 first charging up to two-thirds of the supply voltage via R22 and the resistance between pins 6 and 7 of IC1 and then discharging through the resistance between pins 6 and 7 and an internal transistor inside IC1 until it has a charge equal to one-third of the supply potential. It then commences charging to two-thirds of the supply voltage again, and the circuit continuously oscillates in this manner.

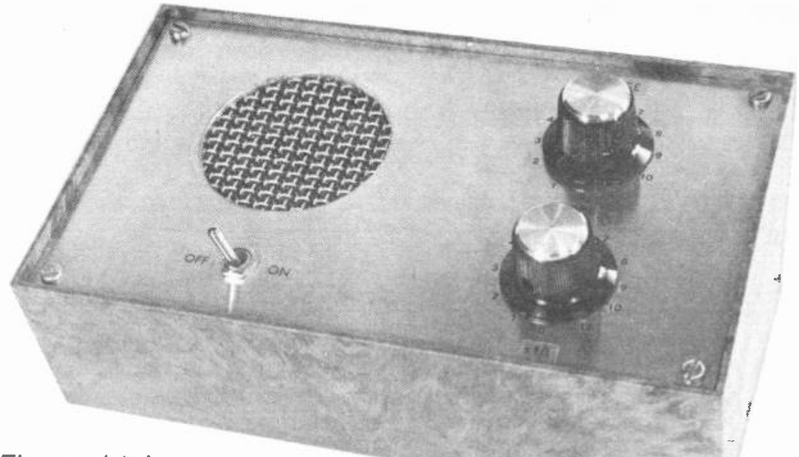
TIMER RANGE

The value of one timing element must be made variable in order to give a range of times, and the resistance between pins 6 and 7 of IC1 has been made the variable element.

Times of 0 to 10 minutes can be provided by S2 and R12 to R21. With S2 adjusted so that only one resistor is connected into circuit, the oscillator will run at a frequency that gives a one minute delay.

Switching two resistors into circuit will give double the timing resistance, half the previous frequency, and hence double the time delay. Three resistors will give three times the delay and so on.

The switch S1 can be used to switch further timing resistors into circuit (R1 to R11), and as these have ten times the value of the other timing resistors they will each increase the delay by ten minutes when switched into circuit.



The completed Kitchen Timer showing front panel layout.

It has been assumed here that the delay is proportional to the resistance between pins 6 and 7 of IC1 but actually the resistance of R22 must also be taken into account. However, since R22 is only effective while C1 is charging, and its resistance is always low in comparison to the main timing resistance, any inaccuracies this introduces will be negligible.

TIME PERIOD ADJUSTMENT

Resistors VR1 and R23 shunt the internal potential divider of IC1 that sets the discharge threshold for C1, and VR1 can be used to trim the clock to the correct frequency range so that the appropriate delay times are produced.

Component tolerances and similar considerations would otherwise give a relatively low level of performance. Raising the discharge threshold voltage of C1 reduces the clock speed since it will obviously take longer for C1 to charge to this level. Reducing the discharge threshold voltage has the opposite effect.

COUNTER

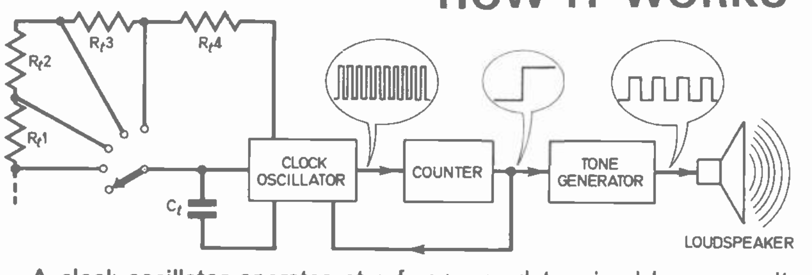
The CMOS chip IC2 is the basis of the counter circuit and this has 14 divide-by-2 stages connected in series giving a total division rate of 16,384. Components C2 and R24 provide a positive pulse to the reset terminal of IC2 at switch on so that it is automatically reset to zero and the output pin 3 assumes a low voltage.

If allowed to continuously cycle, after 8,192 input pulses the output would go from a low voltage to virtually the full positive supply voltage. After another 8,192 input pulses it would return to a low voltage, and so on, with 16,384 input pulses producing one complete output cycle.

This does not occur here because when after the first 8,192 input pulses the output goes high, TR1 will be switched on by the base current it receives through R25; TR1 then ties IC1 pin 4 to the negative supply and this disables the clock oscillator.

The circuit therefore latches with the output of IC2 in the high state until the power is switched off.

HOW IT WORKS



A clock oscillator operates at a frequency determined by a capacitor C_t and a network of switched resistors R_t1, R_t2, R_t3 R_t4 . . . (providing a wide range of frequencies and times). The output of the counter circuit is normally at a low voltage, but after it has received 8192 pulses from the clock oscillator its output goes high. This switches on a tone generator oscillator which drives a loudspeaker and provides an audible alarm. The counter's high output is also used to disenable the clock oscillator, thus preventing further pulses being applied to the counter (which would cause its output to go low again after a further 8192 clock pulses).

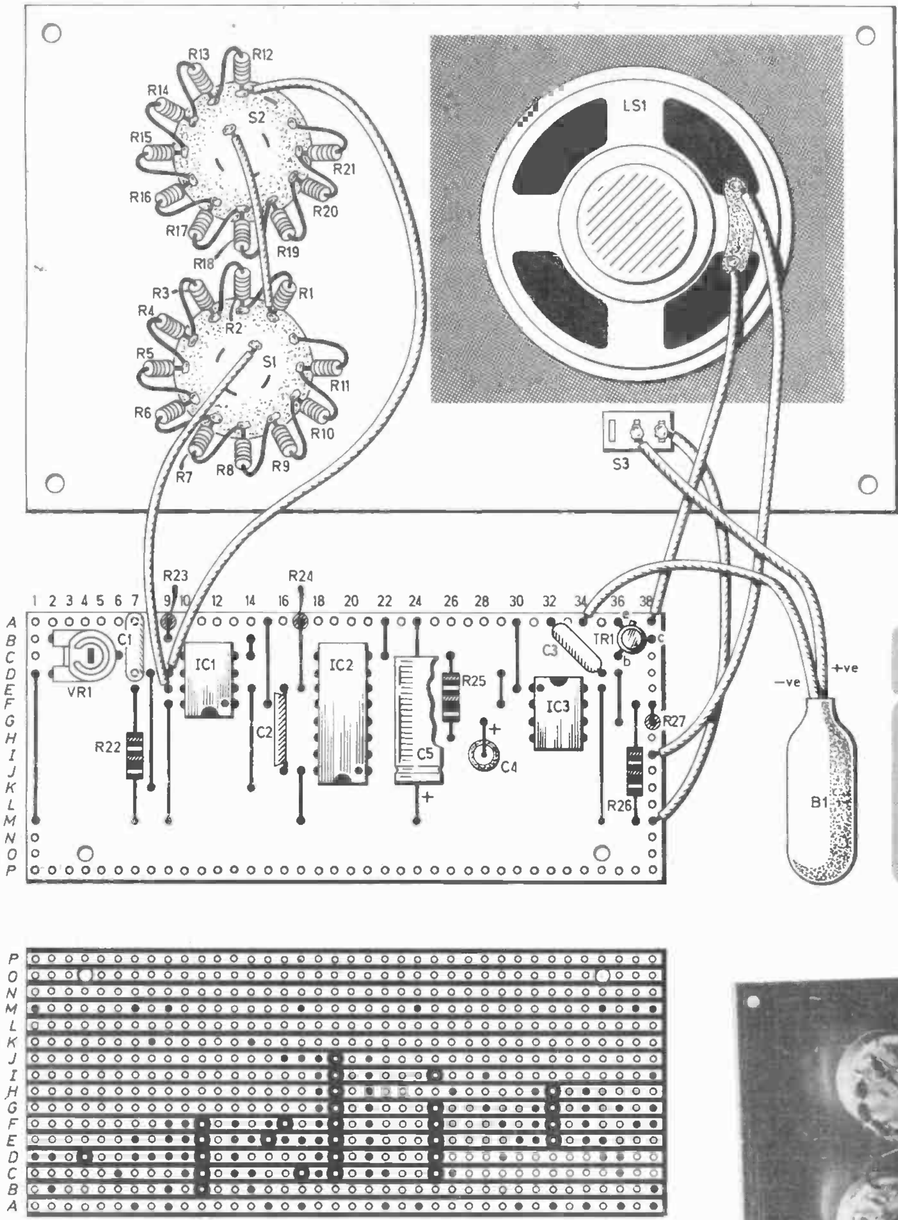
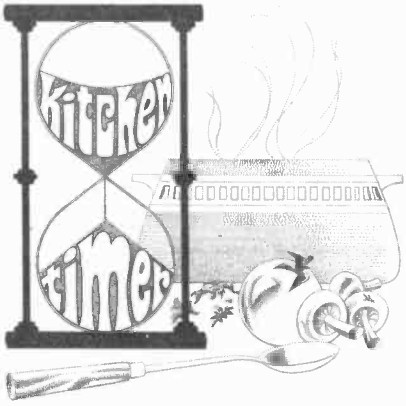
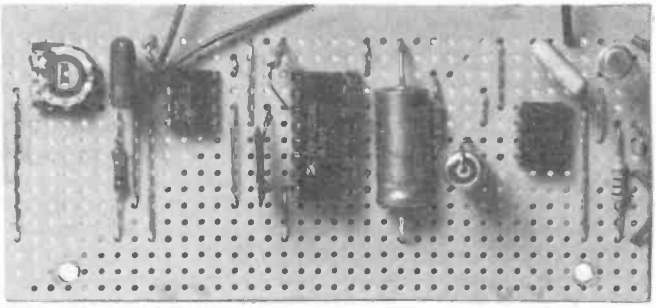


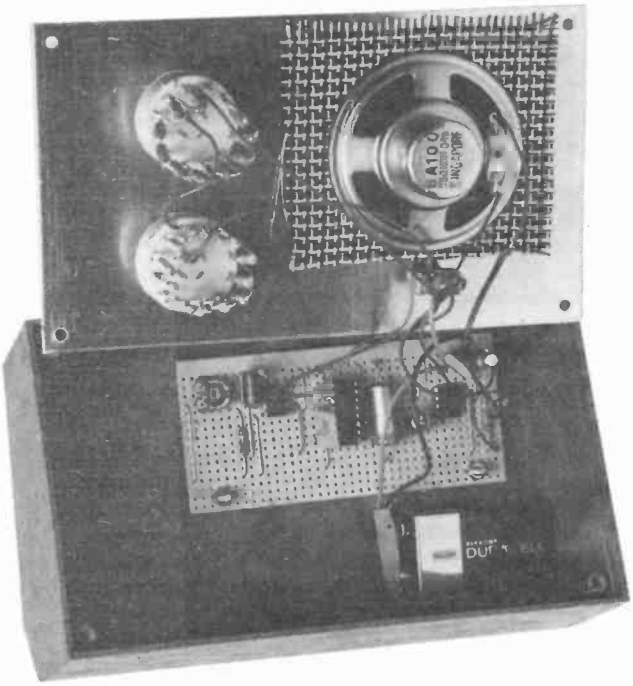
Fig. 2. Circuit board component layout and rear view of front panel showing interwiring details. Also shown is circuit board underside and breaks in the copper strips.



COMPONENTS approximate cost £10



Components mounted on the finished circuit board. Take particular care to ensure all link wires are correctly positioned.



The completed timer with front panel displaced showing positioning of circuit board. The range resistors are mounted directly on the selector switches.

TONE GENERATOR

Another 555 timer chip IC3 again connected in the astable model is used as the basis of the alarm generator. Timing components R26, R27 and C3 produce an operating frequency of about 1kHz, and the output from pin 3 is supplied to a high impedance speaker via d.c. blocking capacitor C4.

Pin 4 of IC3 is normally held at a low voltage by the output of IC2, but this is taken high at the end of the timing period, enabling IC3 to function properly and causing the audio alarm to be generated.

Capacitor C5 is a supply decoupling component. The operating frequency of a 555 astable circuit is not significantly affected by variations in supply voltage, and so a non-stabilised 9 volt battery supply can be used.

The current consumption of the unit is about 15mA under quiescent conditions, and about 50mA or so when the alarm is operating. This gives many hours of operation from a PP6 battery.

COMPONENTS

Resistors

R1-R11	470kΩ 2% tolerance (11 off)	R24	68kΩ
R12-R21	47kΩ 2% tolerance (10 off)	R25	120kΩ
R22	1kΩ	R26	1kΩ
R23	4·7kΩ	R27	10kΩ

All $\frac{1}{4}$W carbon ± 5% unless otherwise stated

Potentiometer

VR1	10kΩ subminiature horizontal preset

Capacitors

C1	100nF polyester	C4	47nF polyester
C2	1nF ceramic	C5	100μF 10V elect.
C3	33μF 16V elect.		

Semiconductors

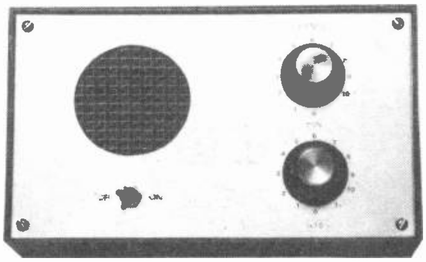
IC1, IC3	NE555 timer i.c. (2 off)
IC2	CD4020AE CMOS 14-bit binary counter
TR1	BC108 *npn* silicon

See Shop Talk page 167

Miscellaneous

S1	1-pole, 12-way rotary switch
S2	1-pole, 11-way rotary switch (12 way with adjustable end stop)
S3	miniature s.p.s.t. toggle
LS1	miniature loudspeaker, impedance 40-80 ohms
B1	9V PP6 type

Sloping front box 162 × 97 × 68mm, or similar; 0·1 inch matrix stripboard 38 holes × 16 strips; two control knobs; battery connector; 16 pin d.i.l. socket or soldercon pins; speaker covering; mounting nuts and bolts for circuit board; interconnecting wire.



CONSTRUCTION starts here

CIRCUIT BOARD

Most of the circuit is constructed on a piece of 0·1 inch matrix stripboard, 16 strips by 38 holes, using the layout illustrated in Fig. 2. Drill the two mounting holes and make the 27 breaks in the copper strips before soldering the components and link wires into position. Note that IC3 has the opposite orientation to IC2 and IC1.

As IC2 is a CMOS device, it can therefore be damaged by high static voltages. It is therefore recommended that a socket should be used for this component and that it should not be plugged into position until the unit is otherwise complete.

This device will probably be supplied in some form of protective packaging and it should not be removed from this packaging until it is to be plugged into circuit.

CASE

A sloping front case having approximate dimensions of 162 x 97 x 62mm (maximum height) makes a good case for this project, but any case of about the same size should be equally satisfactory.

The switches S1 and S2 are mounted one above the other on the right hand side of the front panel, and the loudspeaker plus S3 are situated opposite these on the left hand side.

A cut out about 45mm in diameter must be made for the loudspeaker and some speaker cloth or fret is glued in place behind this. Very few miniature loudspeakers have provision for screw fixing and it will almost certainly be necessary to glue the speaker in place, taking care not to smear adhesive onto its diaphragm.

FINAL ASSEMBLY

The component panel is mounted on the base panel of the cabinet on the left hand side and well towards the front, leaving a space for the battery behind the component panel. However, before finally mounting the component board it is necessary to complete the remaining wiring which is shown in Fig. 2.

This mainly consists of wiring the timing resistors to S1 and S2. These resistors should not be allowed to project too far back from the range switches or they will prevent the front panel assembly from being slotted into the rest of the case.

ADJUSTMENT

Initially VR1 is adjusted so that its wiper is at roughly the centre of its track. With both S1 and S2 set fully anticlockwise so that none of the timing resistors are connected into circuit, the alarm should be activated within about one second of the unit being switched on. If it is not, switch the unit off at once and check for wiring errors.

With S2 advanced one position there should be a delay of very approximately one minute between switch on and the alarm sounding. There will almost certainly be a significant error though, and this must be minimised by trial and error adjustment of VR1. Clockwise adjustment of VR1 will increase the delay and anticlockwise adjustment has the opposite effect.

When the one minute delay is approximately correct, set the range switches for a somewhat longer delay and make the final fine adjustments to VR1 to obtain a suitable level of accuracy, again using trial and error.

UNIBOARDS

SIMPLE TRANSISTOR DESIGNS 4

By A.R. Winstanley

TOUCH SWITCH

A touch operated switch is a useful and popular example of the application of electronics and this article describes the construction of such a device.

In brief, a relay is made to switch on or off by simply touching the appropriate touch pads on the front panel of the Touch Switch unit. The circuit detects the resistance of the skin across the pads and then operates accordingly.

Any load, mains or otherwise, may be switched provided that the electrical specifications of the relay contacts are adhered to. The unit to be described here was designed to be powered from the *9 Volt Power Power* project described last month.

CIRCUIT DESCRIPTION

The circuit diagram of the Touch Switch appears in Fig. 1. Transistors TR1 and TR2 are special types of transistors called "Darlington transistors". They have the usual three terminals but internally they actually incorporate two individual transistors as the circuit symbol illustrates. The major advantage of the Darlington is the superior gain parameter obtained from the use of two transistors: gains of 5,000 to 25,000 are not uncommon. A "normal" bipolar transistor may have a gain of several hundred only.

The circuit operates as follows. When the ON contacts are bridged with a finger, the base of TR2 is connected to the positive supply line through R3, R4 and the resistance of the skin. Base current (although very small) therefore flows and TR2 conducts, causing RLA to energise (relay contacts close) and D1 to illuminate.

Without TR3, if the finger is removed from the ON pads then TR2 would switch off and the relay contacts open; TR3 has been incorporated to act as a latching transistor. When TR2 is conductive, TR3 is also biased into operation. Current therefore flows through R7 and supplies base current to TR2, thereby keeping this device switched on.

If the finger is removed from the ON contacts therefore, TR3 and TR2 will remain conductive, latching the circuit and ensuring that the relay remains energised (contacts closed).

If the OFF pads are now touched, base current for TR1 flows through the skin and R1. This switches TR1 fully on. The base current for TR2 is therefore diverted to ground. This cuts off both TR2 and TR3, and so the relay switches off. If the finger is removed from the OFF touch contacts then TR1 will cease to conduct with the relay remaining in the OFF state.

The circuit is so sensitive that even a resistor of 30 megohms placed across the pads will operate the circuit. (This implies a base current of less than one microamp!).

Any a.c. signal which the human body may present to the very sensitive base circuits when the pads are touched is removed by C1 and C2. They also remove the possibility of relay chatter if the pads are touched only very lightly. Capacitors C3 and C4 serve to decouple the power supply.

The reverse-connected diode D2 shorts away any back e.m.f. generated when the relay coil switches out quickly, which might otherwise damage TR2.

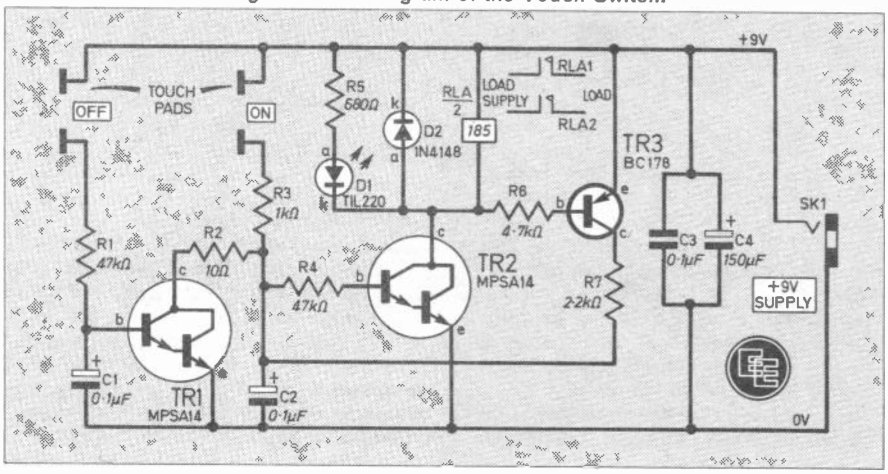
The desired load is controlled through both sets of relay contacts, RLA1 and RLA2. The circuit diagram supposes that a mains load will be driven. The relay chosen should have contacts suitable to comfortably handle the load connected.

Finally, the *9 Volt Power Supply* is connected to the Touch Switch unit via SK1. The power supply requirements are 9 to 15V d.c. at approximately 50mA. As a suggested application, the touch switch could therefore be wired to operate successfully in the car as well as in the home.

CONSTRUCTION starts here

The complete Touch Switch is constructed on a piece of 0·1 inch matrix stripboard, 10 strips × 24 holes, as depicted in Figure 2. Two 6BA clearance holes are drilled in the locations shown. These holes will permit the support of the completed stripboard with the appropriate mounting hardware. Eleven breaks are required in the copper strips, and these can be

Fig. 1. Circuit diagram of the Touch Switch.



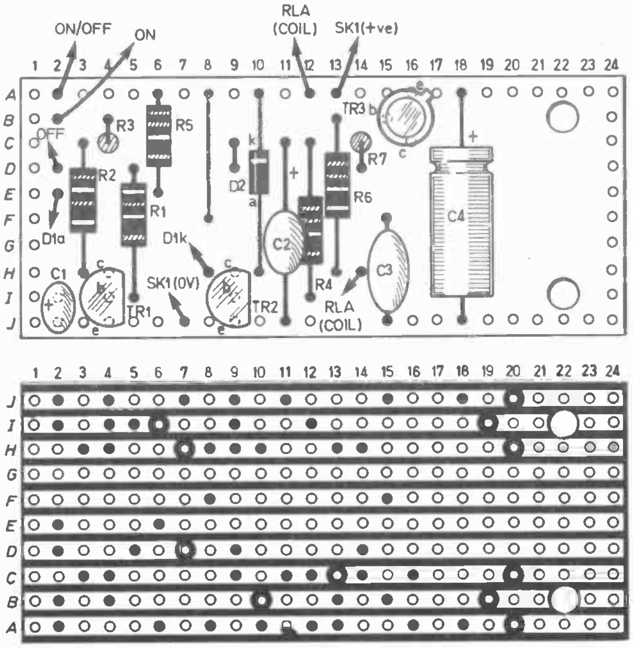
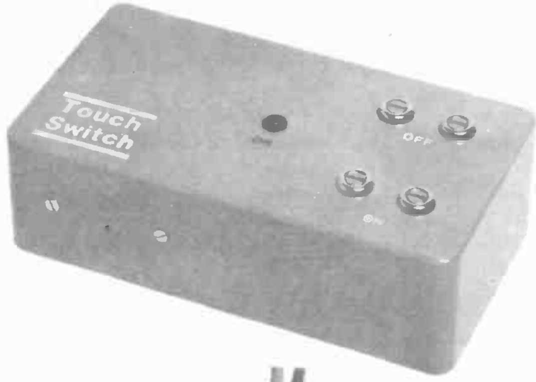
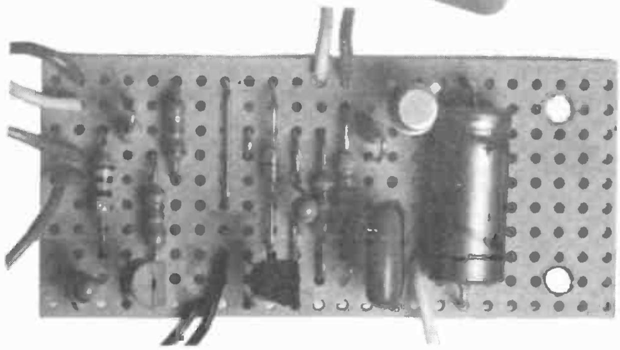


Fig. 2. Layout of the components on the topside of the board, showing wiring connections, and breaks necessary on the underside of the board





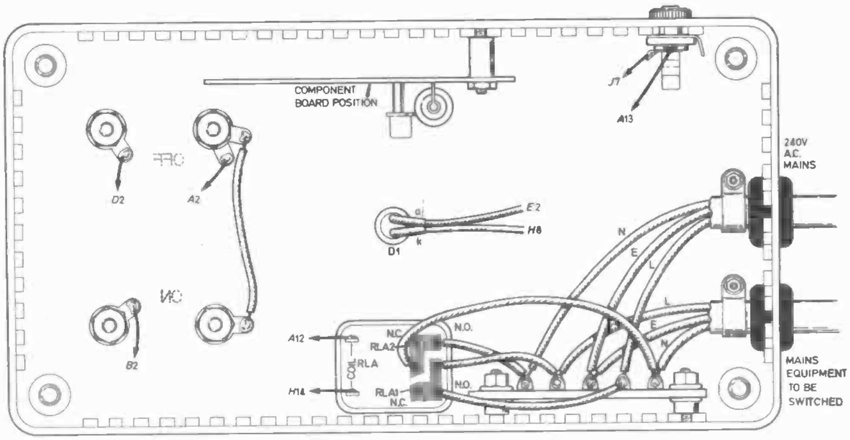
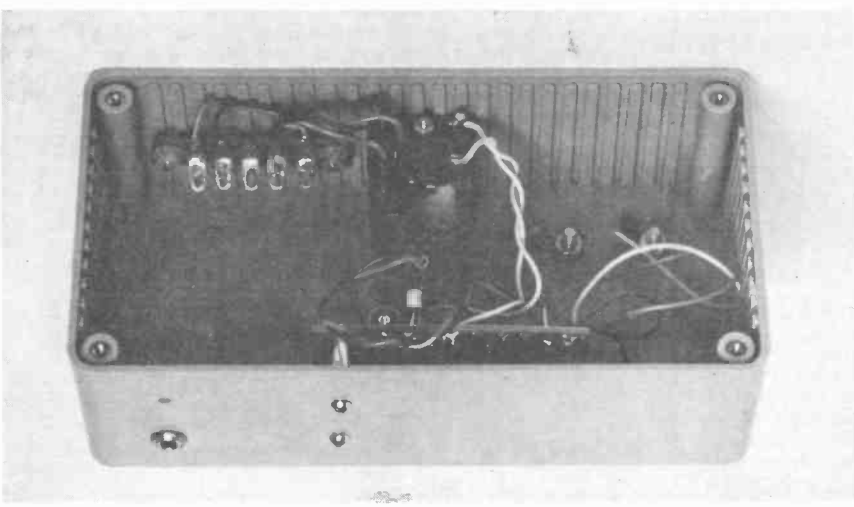


Fig. 3. Complete interwiring details between component board and case mounted components.



COMPONENTS

See **Shop Talk** page 167

Resistors
- R1 47kΩ
- R2 10Ω
- R3 1kΩ
- R4 47kΩ
- R5 680Ω
- R6 4·7kΩ
- R7 2·2kΩ

All ¼W carbon ± 5%

Capacitors
- C1,2 0·1μF 35V tantalum (2 off)
- C3 0·1μF polyester type C280
- C4 150μF 25 V elect.

Semiconductors
- TR1, 2 MPSA14 Darlington silicon *npn* (2 off)
- TR3 BC178 silicon *npn*
- D1 TIL220 red light emitting diode
- D2 1N4148 silicon small signal diode

Miscellaneous
- RLA 185 ohm 12V coil and at least two sets of normally open contacts rated to suit applied load
- SK1 3·5mm jack socket

Stripboard: 0·1 inch matrix size 10 strips × 24 holes; plastic case type BIM 2005/15 or similar (150 × 80 × 50mm); countersunk 4BA bolts/nuts/solder tags/cups for touch pads; 6BA mounting hardware, nuts/bolts/spacers; mounting clip for D1; mains cable rated to suit application; rubber grommets to suit mains cable; 5-way tag strip; cable grips for mains cable.

Approx. cost Guidance only
£6.00 excluding case

made with a "spot face cutter" or a hand-held twist drill.

It is important that miniature components are used in this design, for it will be seen that the component arrangement on the circuit board is very compact. In this respect, ¼watt resistors must be employed, and tantalum bead capacitors have been selected for C1 and C2 because of their small size.

Provided that the diagram is followed carefully there should be no problems, but, as usual, care should be exercised regarding the soldering of the semiconductors. In particular, the tantalum capacitors must be soldered in the right way, as must the diode D2. Note the orientation of the transistors.

ASSEMBLY

The prototype unit was housed in a grey Bimbox type 2005/15, measuring 150×80×50mm. In this instance it is necessary that a plastic or other non-conducting housing is chosen to encase the Touch Switch. The touch pads are mounted on the case and it is of course essential that these are insulated from each other.

The construction of the actual touch pads on the prototype consisted of a 4BA countersunk screw with a screw cup placed under the head to give a neater appearance. Connection to the touch contact is by means of a solder tag under the mounting nut.

WIRING-UP

The complete interwiring is shown in Fig. 3. Stranded lightweight interconnecting wire can be used throughout, with the exception that wiring at mains voltages should be suitably rated (3A minimum). All soldered joints which are at mains voltage must be of a good quality.

The mains (or other) supply enters and leaves the case via holes fitted with grommets in the case end. The cables should be fitted with grippers for safety reasons. A 5-way tag-strip was found to be a convenient interface between the cable and relay contact tags.

The l.e.d. can be mounted on the front panel using the special plastic clip normally provided with it; the relay can be stuck down with double-sided adhesive foam strip.

With construction complete, connect up the *9 Volt Power Supply*, or other suitable supply (9 volt to 15 volt) and then switch on. Touch the ON pads: the relay should be heard to click into operation and the l.e.d. should illuminate. Touching the OFF pads should cancel the relay and extinguish the l.e.d.

The Touch Switch is then complete and ready for use.

Next Month: Audio Tone Generator

BOOK REVIEWS

IBA TECHNICAL REVIEW NUMBER 12—TECHNIQUES FOR DIGITAL TV
Editor C. W. B. Reis
Price £1·50
Size 225 × 195mm 72 pages
Publisher Independent Broadcasting Authority
ISBN 0 308 423 X

As the title suggests, this is a review of current practices and future trends in digital TV techniques within the IBA and as such requires a high level of understanding by the reader if he is going to be able to get anything out of the material presented. Chapter headings such as "Digital Sub-Nyquist Filters" and "A Low Bit-Rate System for Digital Video" give a good idea of the standard of knowledge assumed.

This publication is effectively intended for engineers and students directly involved in the field of broadcasting and as such is likely to have only limited appeal although presentation is clear and precise with a larger number of line drawings and photographs. S.E.D.

NEWNES BOOK OF AUDIO
Editor K. G. Jackson
Price £4·95 Limp
Size 250 × 185mm 144 pages
Publisher Newnes Technical Books
ISBN 0 408 00429 0

SEVEN well-known specialists have contributed articles to this highly readable, well illustrated survey of techniques and equipments currently in vogue in sound reproduction systems. The names of the contributors will be familiar to all hi-fi magazine devotees; this fact should provide sufficient recommendation to others, especially those seeking to acquire their first hi-fi set-up or wishing to up-date an existing system. For them this book will prove a most valuable technical reference, and help them explore the jungle of the market place.

As the title suggests, the contents are not restricted to "hi-fi" as generally understood. Recording techniques are explained at length, aided and abetted by another section on microphones. The increasing importance of audio in the car is recognised by a section which helps the motorist to get the best from in-car entertainment equipment.

MECHANICAL WORLD ELECTRICAL YEAR BOOK 1979/80
Editor R. Warring
Price £3·95 Paperback
Size 155 × 105mm 383 pages
Publisher Argus Books
ISBN 0 85242 679 8

THE composition of this book reveals just how interwoven these two branches of engineering have become.

The purely electronic information is pretty well as comprehensive as you could wish for in a pocket book: colour codes, semiconductor theory, lists of current discrete and integrated devices, circuit theory and formulae, soldering, wire gauges—these are random samples.

The "electrical" information includes resistivities of metals, properties of plastics, insulating materials, electric lighting installation, cables, fuses, motors, thermostats, electroplating, metric/English threads, SI Units and much more.

In brief, a wealth of information clearly laid out in text, tables and diagrams, and always conveniently at hand.

PLEASE TAKE NOTE

One Armed Bandit October 1979

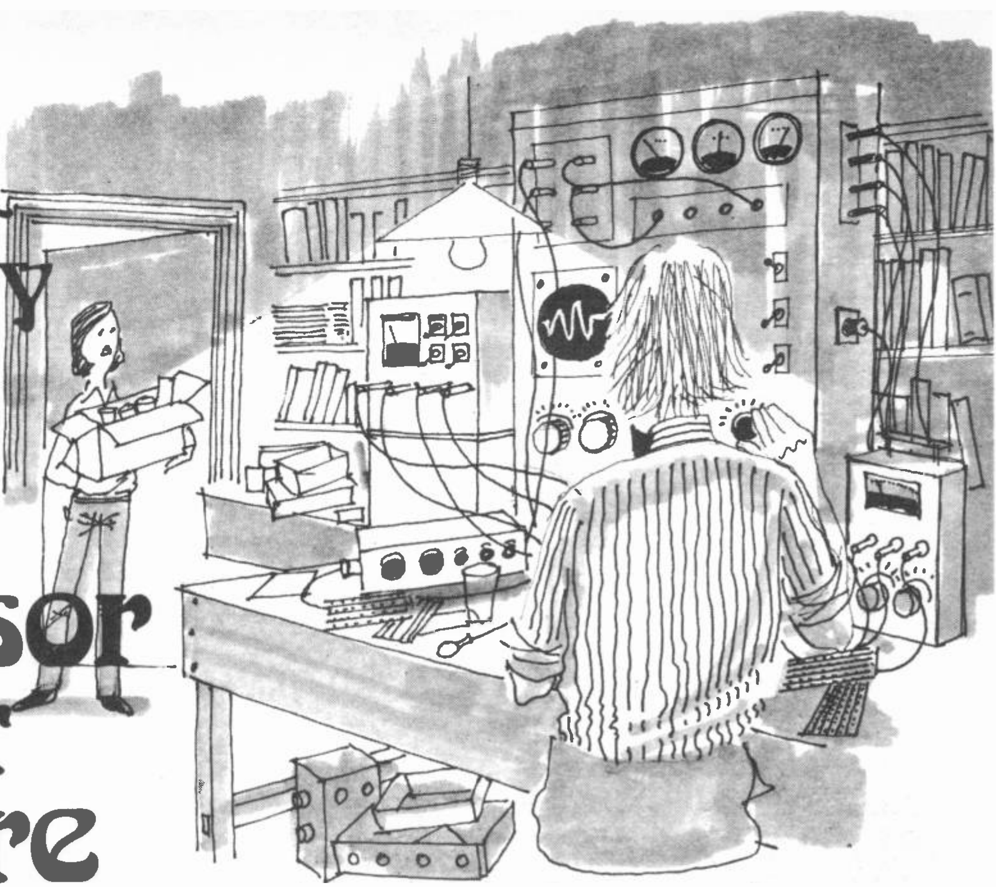
We offer our apologies for three mistakes that appeared in the layout diagrams of the One Armed Bandit project.

In Fig. 2, underside view, a break is shown at location *O35*. This is not required and should be bridged with a short piece of wire.

Also in Fig. 2, the end of R14 located at *O29* should be removed and connected to *A26*.

In Fig. 3 the two connections *P64* and *E64* from the diode "reels" should be transposed and annotations "D6-D12 and D20-D26" transposed to agree with the circuit diagram.

The Extra-ordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

THE Prof. is discussing Guitar Fuzz Boxes with Bob, whose friends Tom and Maurice have brought a couple of faulty ones for his attention.

DIODES

"In this circuit (Fig. 1) the signal is amplified before being clipped by means of two germanium diodes (D1, D2). Instead of using a variable resistor in series with the diodes to control the fuzz depth, as in the 'Simple I.C. Fuzz Box' (Fig. 7 last month), the potentiometer VR1 is used as a volume control to determine how much signal is presented to the diodes after amplification by the input stages, and this determines the proportion of the signal which is clipped away.

"Another way in which small signal diodes can be used to produce fuzz effects is by placing them in the feedback loop of an amplifier. Non-linear elements such as diodes, when placed in the feedback loop of an amplifier will result in non-linear amplification and this is often used in fuzz box circuits."

FOOT SWITCHES

"Prof., most fuzz boxes have a footswitch which the guitarist presses to change from 'normal' sound to 'fuzz' sound and back, but I notice the diagrams you have shown do not include the footswitch as part of the diagram. Why is this?"

"This is because there are various types of footswitch available and in many instances the footswitch arrangements are interchangeable between the various fuzz circuits.

"The simplest footswitch arrangement in common use uses a single-pole changeover switch (Fig. 2). Here the footswitch connects the output of the fuzz box either to the input or the output of the fuzz circuit, which could be satisfactory in many instances. However, in the 'straight through' or normal sound position of the footswitch the input of the amplifier is still connected to the signal path and this has a slight effect on the sound of the guitar.

"Most guitarists prefer a slightly more complicated arrangement using a double-pole footswitch (Fig. 3) and here for 'normal' sound the guitar really is connected 'straight through' the fuzz boxes so that the electronic circuitry for producing fuzz sounds should not affect the sound until 'Fuzz' is selected by operating the switch."

BATTERY SAVER

"In some fuzz boxes the footswitch is arranged to switch the battery supply 'off' for normal playing and 'on' for fuzz. This is a good idea as it means that during normal playing

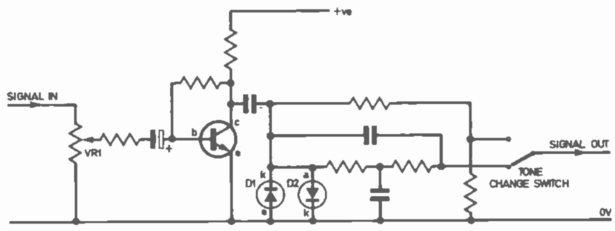


Fig. 1. Diode clipping Fuzz circuit.

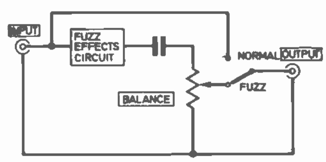


Fig. 2. Single pole Fuzz select switch.

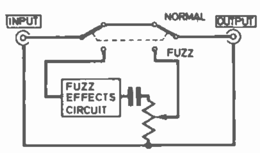


Fig. 3. Double pole Fuzz select switch.

the circuit does not drain the battery and consequently lasts much longer.

"However, this type of circuit must be carefully designed and built, in order to avoid a loud 'click' when the footswitch is pressed, and possibly a delay between pressing the switch and the appearance of a fuzz effect."

MODERN TREND

"Although this type of problem might be solved with a more complicated switching arrangement, the trend in modern electronics is to replace the moving mechanical parts with electronic circuitry wherever possible, and this could be applied to fuzz boxes with considerable benefits.

"The mechanical changeover switch could be replaced with a simple single-pole on/off switch which would send a control signal to a logic circuit. The logic circuit could then control a more complex switching arrangement using static electronic switches, with no moving parts to jam, break or become covered in dust or corrosion, and which would route the signal through various effects as required by the player.

"Low-cost CMOS analogue switches such as type 4016 are available at low cost and would be suitable for this purpose. For a little more expense electronic attenuator i.c.s will do even better, especially for the professional user."

SCHMITT TRIGGER FUZZ

"Prof., wouldn't it be possible to use a bistable circuit such as a Schmitt trigger to produce fuzz effects?" enquired Bob, "By feeding the guitar signal through such a circuit it would become totally squared and should give a very intense fuzz effect."

"That is a good idea, Bob, and it has been tried with some success. However, it also produces another effect which, although it is rather novel and interesting may in practice be inconvenient.

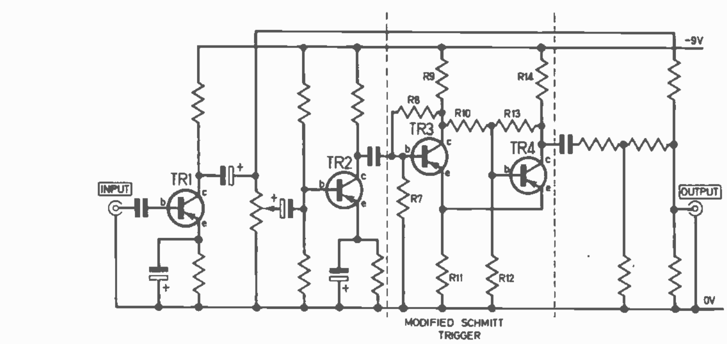


Fig. 4. Schmitt trigger Fuzz circuit.

"The Schmitt trigger circuit responds not only to the fundamental frequency of any note played, but also to many of its harmonics, usually one at a time in rapid succession. The resulting output from the Schmitt trigger is a series of notes harmonically related to the guitar note being played, in addition to the note itself, and because it is difficult to control is not usually considered to be musically valid.

"By modifying the circuit of the Schmitt trigger this problem can be overcome and an example of this is shown in Fig. 4. Here, TR3 and TR4 form a modified Schmitt trigger circuit, with additional 100 kilohm resistors (R8, R13) from the collector to base of each transistor.

"This moves the two trigger-points of the Schmitt circuit much closer together, so reducing its hysteresis very greatly. As a result, although the output is still a square wave, it is more closely related to the actual note being played and does not show rapid jumps from one harmonic to another.

"In this circuit there is no bias supply to the first transistor, however, like Fig. 1 last month, the circuit does actually work and derives its bias from transistor leakage."

"Prof., I have seen Schmitt trigger circuits which have a 'hysteresis control' for moving the two trigger points closer together or further apart," remarked Bob. "Now I wonder what happens if the hysteresis control is moved to the point where the trigger points coincide ('zero hysteresis') then taken even further, what happens to the trigger points? Do they simply move past one another or annihilate one another? What happens?"

"An interesting question, Bob. As the hysteresis points are two very definite points of action of the circuit, one might expect by extrapolation that they would continue to exist even when the control is moved past the point of zero hysteresis, on the other hand one might also logically deduct that as one is a point of action in a positive direction, and the other in a negative direction, they might annihilate each other on contact!

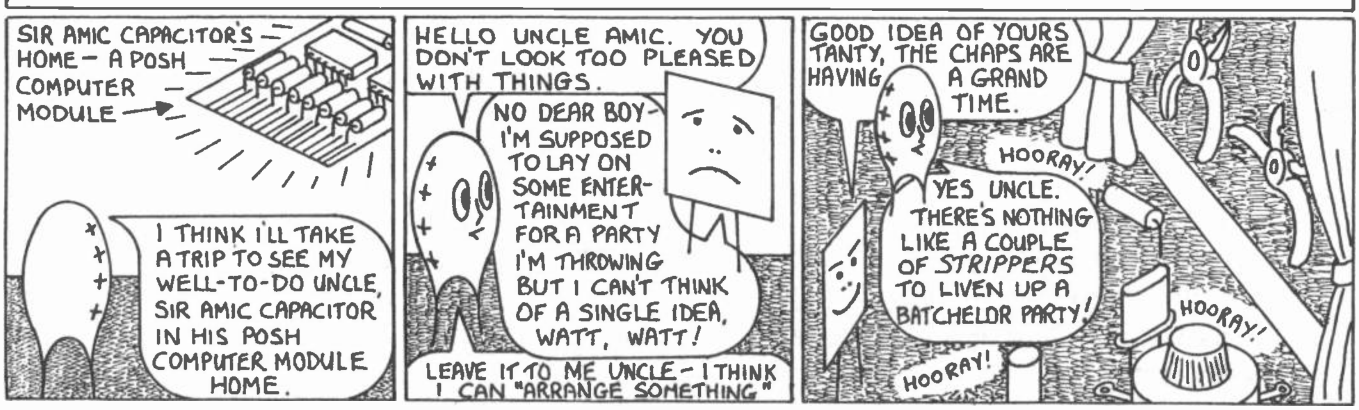
"One could try to find the answer by actually experimenting practically with a Schmitt trigger circuit or by extrapolation and deductive means as a mental exercise!"

Although the Prof. could tell them the answers, he is content to let them find out for themselves whilst he casts a critical eye over the faulty Fuzz boxes—and finds that they use yet more different circuitry for generation of fuzz effects.

To be continued

The Adventures of Tanty Bead

By Matthew Reed



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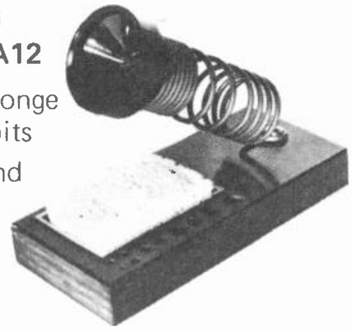

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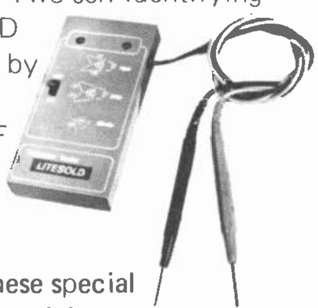

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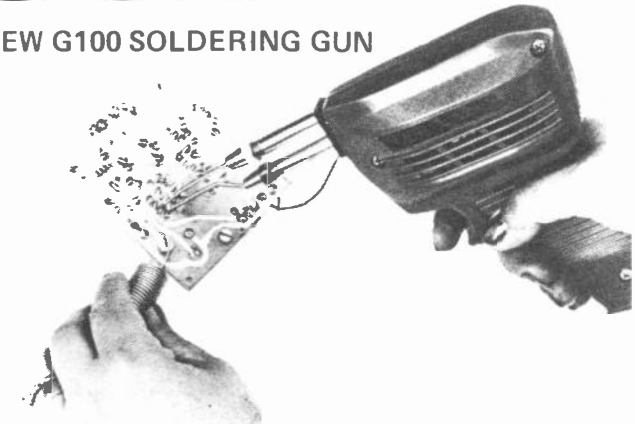

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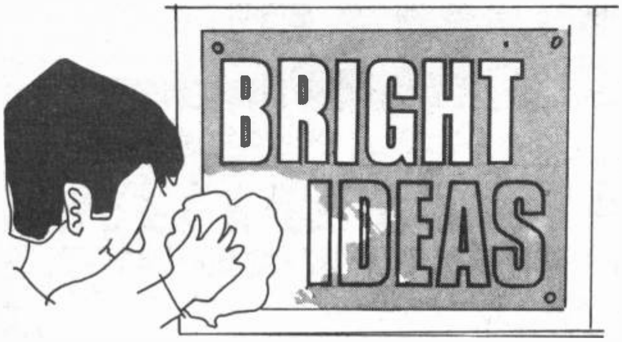


Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

RESIST REMOVER

After etching a home made p.c.b. the constructor is faced with the small problem of removing the etch resist ink from the copper tracks. An inexpensive way of doing this is to give the board a quick squirt with cigarette lighter fluid available in "bubble sachets" for a few pence. The ink can then be wiped off with a cloth. The board requires only a quick rub with a cleaner before soldering.

Mr. M. Stansfield,
Mirfield, W. Yorks.

RING PADS FOR P.C.B.

While using etch resist transfers I found that I had run out of pads. As a substitute I used some Reinforcement Rings intended for file paper, available from W. H. Smiths. I stuck these onto the copper side of the board so that the hole for the component lead was in the centre of the ring. Then I filled in the space in the middle with etch resist ink and removed the ring leaving a spot of etch resist ink.

I found that this worked quite well in circuits where the components don't have to be spaced close together like power supply boards and other projects where i.c.s are not used.

Mr. R. Jonasar,
Aylesbury, Bucks.

SHOCK ABSORBER

The normal method of attaching a p.c.b. (or other circuit board) to the project case is by nuts, bolts and spacers. This has the disadvantage that if the boxed project is dropped or jolted, the impact force is transmitted to the p.c.b. components and wiring possibly damaging them. I overcame this by using no spacers, but instead a thin layer of foam plastic between the p.c.b. underside. This then acts as a shock absorber/spacer.

P. Haddad,
Penketh, Cheshire.

PLUG STAND

It is often difficult to solder small audio plugs because both hands usually have to be free to do the work. If the plug is held in one hand it doesn't take long for the plug being soldered to get too hot to hold.

I use a small block of wood with different holes drilled in to solve this problem. The size of the hole(s) to be drilled is the same as the plug pin(s).

Loudspeaker DIN plug holes are made with a 3/64 inch (0·1mm) drill bit and the flat contact is made with three of these holes drilled close to each other and the wood in between chiselled out.

P. Humphrey (aged 14),
Mealbank, Cumbria.

SCRATCH RESIST

To aid the drilling of chassis panels ordinary white sticky backed plastic (Fablon) may be employed. The construction lines and drilling points necessary are drawn onto the plastic in pen or pencil and the sheet then applied to the panel. This makes scribing marks unnecessary and at the same time helps to prevent accidental damage during drilling.

J. Winter,
Forfar, Angus.

COMPONENT BASE

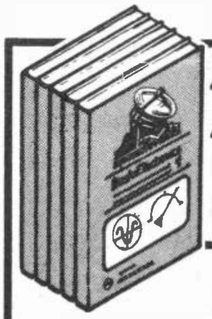
When building a project I usually take out all the components I need and put them on the table. But many times I forget where I put them, or on other occasions something falls on the floor and I waste time looking for it. By pressing a piece of plasticine on the table and inserting the components into this, the components are prevented from rolling around on the table and falling to the floor.

P. Mallia,
Santa Lucia, Malta.

GROMMET FEET

We have found that small grommets make ideal non-slip feet for calculators and the like, which are prone to slide around when in use on smooth surfaces. The grommets are cut through the central grove, providing two feet which can be stuck onto the base of the unit.

K. R. Nash & A. M. Williams, Swansea.



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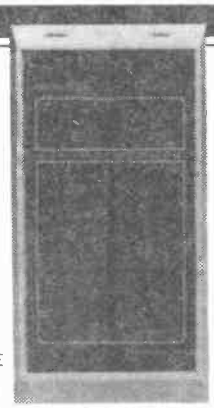

Counts frequencies from 100 Hz to over 45 MHz with 100 mS gate time. Accuracy is 3 ppm at 25°C or less then ± 30 Mkz on 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Req. 9V battery. **22-351.** REG. PRICE

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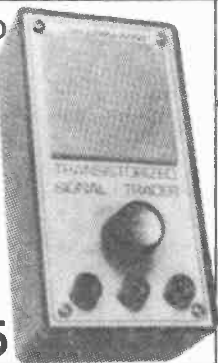

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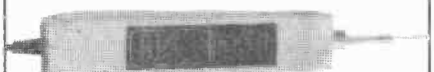

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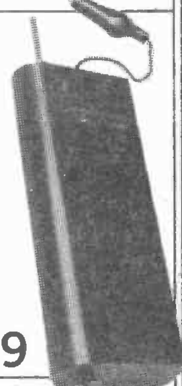

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VARIABLE POWER SUPPLY

Power project boards. IC's, other low-voltage DC equipment. Load regulation: less than 450mV at 1 amp at 24V DC. Ripple: less then 25mV. Maximum output current: 1.25 amps. Switchable colour-coded meter reads 0-25V. DC and 0-1.25 amps. Three-way binding posts take wires, banana plugs or dual banana plugs with 0.75" centres. For 220/240V AC. **22-9123**

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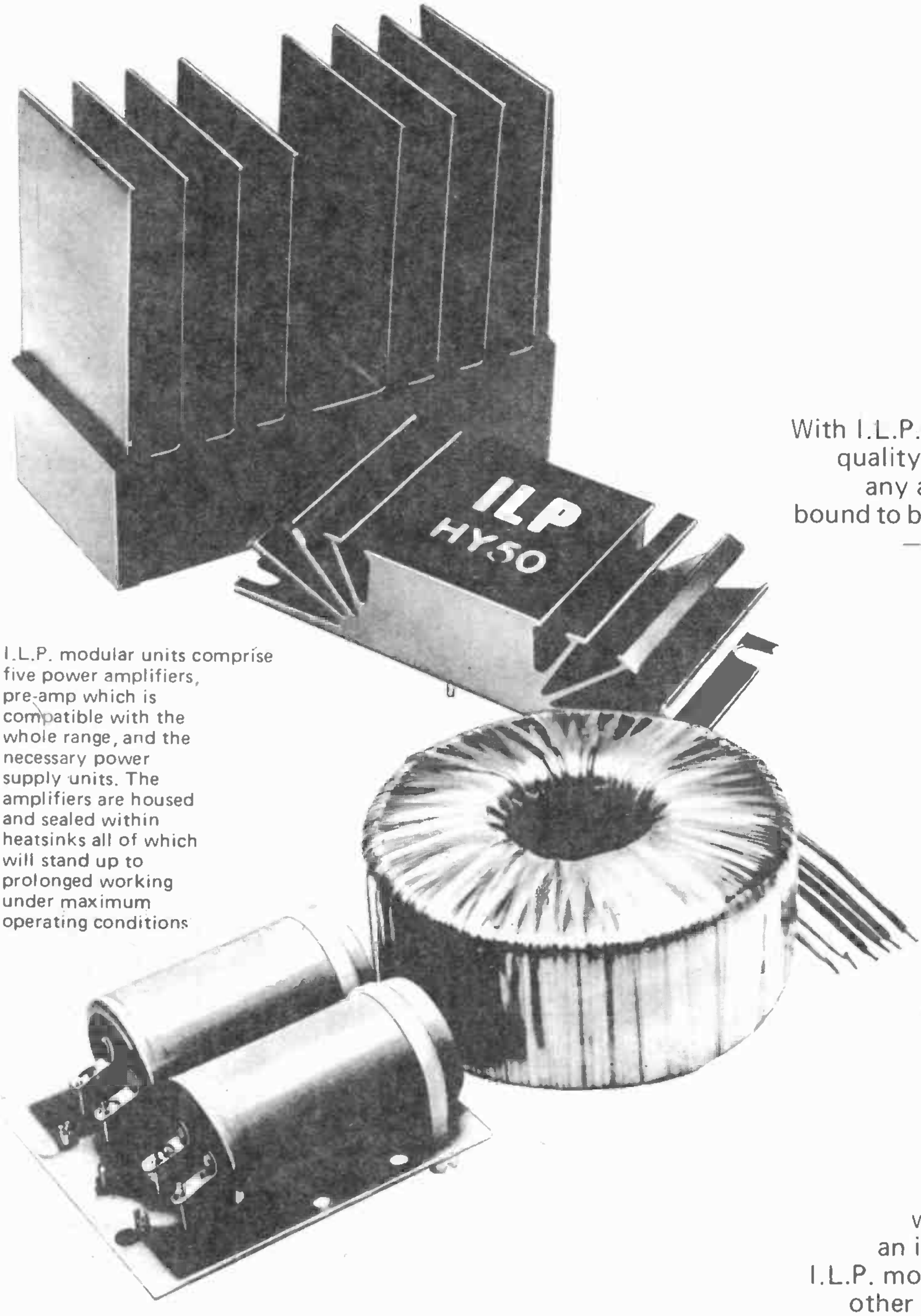
ILP'S NEW GENERATION OF HIGH



I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance – and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain – the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

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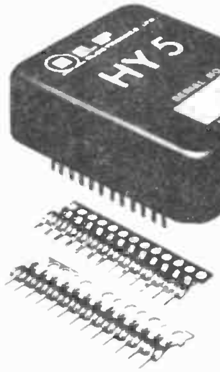
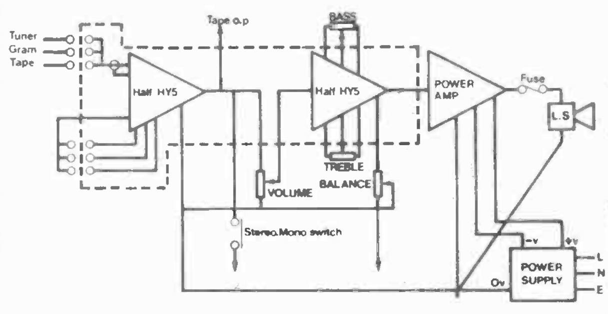
PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER



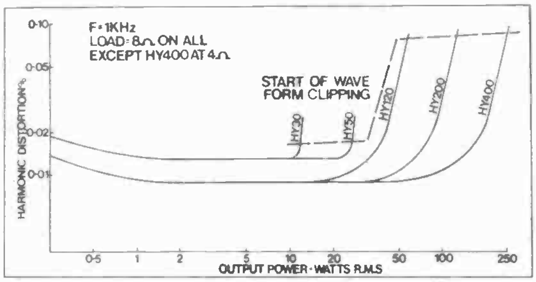


VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume — 10K Ω log.
Bass/Treble — 100K Ω linear. Balance — 5K Ω linear.

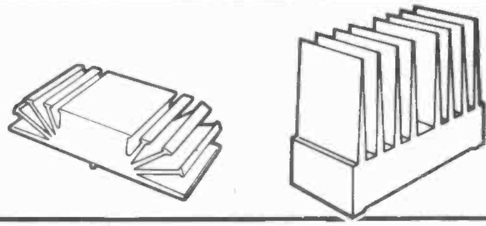
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

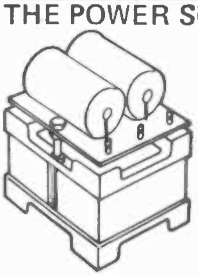


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15



Load impedance — all models 4 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 100K Ω
Frequency response — all models 10Hz - 45Hz - 3dB

THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms — one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

PSU 30	±15V at 100ma to drive up to five HY5 pre-amps	**£4.50** + £0.68 VAT
PSU 36	for 1 or 2 HY30's	**£8.10** + £1.22 VAT
PSU 50	for 1 or 2 HY50's	**£8.10** + £1.22 VAT
PSU 70	with toroidal transformer for 1 or 2 HY120's	**£13.61** + £2.04 VAT
PSU 90	with toroidal transformer for 1 HY200	**£13.61** + £2.04 VAT
PSU180	with toroidal transformer for 1 HY400 or 2 x HY200	**£23.02** + £3.45 VAT

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3 ohm. 6 × 4in. £1·50. 7 × 4in £1·50. 8 × 5in. £2·50. 6½in. £1·80. 8in. £2·60. 10in. £3. 12in. £4.
8 ohm. 2¾in. £1·50. 3in. £1·50. 5in. £1·50. 10in. £3. 12in. £4.
16 ohm. 6 × 4in. £1·50. 7 × 4in. £1·50. 5in. £1·50. 8in. £2·60. 10in. £3. 12in. £4. 10 × 6in. £3·50.

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500mF 12V 15p; 25V 20p; 50V 30p; 1200mF/76V 80p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p;
2000mF 6V 25p; 25V 42p; 420mF/500V £1·30.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
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HIGH VOLTAGE ELECTROLYTICS

8/350V 22p	8+8/450V 50p	50+ 50/300V 50p
16/350V 30p	8+16/450V 50p	32+32/450V 75p
32/500V 75p	16+16/450V 50p	100+100/275V 65p
50/350V 80p	32+32/350V 50p	150+200/275V 70p

MANY OTHER ELECTROLYTICS IN STOCK

SHORT WAVE 100pf air spaced gangable tuner, 95p.
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PAPER 350V-0.1 7p; 0·5 13p; 1mF 150V 20p; 2mF 150V 20p 400V–0·001 to 0·05 5p; 0·1 15p; 0·25 25p; 0·47 35p.
MICRO SWITCH SINGLE POLE CHANGEOVER 20p.
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TWIN GANG, 385 + 385pF 80p; 500pF slow motion 75p. 365 + 365 + 25 + 25pF. Slow motion drive 85p.
120pF **TWIN GANG,** 50p; 365pF **TWIN GANG,** 75p.
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NEON PANEL INDICATORS 250V. Amber or red 30p.
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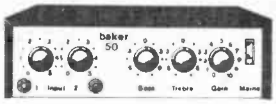
BAKER 50 WATT AMPLIFIER £65 Post £1



Superior quality ideal for Halls/PA systems. Disco's and Groups. Two inputs with Mixer Volume Controls. Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). Blue wording on black cabinet.

BAKER 150 Watt AMPLIFIER 4 inputs £85.

DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Controls up to 480 watts AC mains. Post 35p **£3·25**

STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high medium or low gain per channel, with volume control and P.C. Board. Can be ganged to make multi-way stereo mixers. Post 35p **£2·95**

R.C.S. SOUND TO LIGHT DISPLAY MK 2

Complete kit of parts with R.C.S. printed circuit. Three channels. Up to 1,000 watts each. Will operate from 200MV to 100 watts signal source. Suitable for home Hi-Fi and all Disco Amplifiers. Cabinet extra £4·50. Post 50p **£18** Post 50p

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw 75p each or 6 for £4. Or 12 for £7·50. Post 30p per order.

MAINS TRANSFORMERS Post 75p

250-0-250V 70mA, 6·5V, 2A .... £3·45
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300-0-300V 120mA, 2 × 6·3V 2A C.T.; 5V 2A .... £10·00
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GENERAL PURPOSE LOW VOLTAGE. Tapped outputs
2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V ...... £6·00
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3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 .... £12·50
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12V, 100mA .... £1·30	12V, 3 amp .... £3·50
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30V, 5 amp and 17V-0-17V, 2 amp .. £4·00	20V, 1 amp .... £3·00
0, 5, 8, 10, 16V, ½ amp .. £2·50	20V-0-20V, 1 amp .... £3·50
9V, 3 amp .... £3·50	30V-0-30V, 2 amp .... £8·00
20-0-20V 3 amp ...... £7·00	2 of 18V, 6 amp, each £11·00
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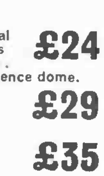
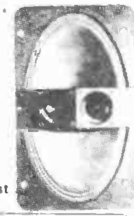
30V, 1½ amp .... £3·30	9V, ¼ amp .... £1·50
20V, 40V, 60V, 1 amp .. £4·00	28V, 1 amp+28V 1 amp £5·00
	32-0-32V 6·5A .... £11·00

BAKER SPEAKERS "STAR SOUND" Post £1 ea.



GROUP 45–12 12in. 45 watt 4, 8 or 16 ohms. **£15**
GROUP 75–12 12in. 75W professional model. 4, 8 or 16 ohms Response 30 – 16,000. With aluminium presence dome. **£24**
GROUP 100/12 12 in 100W model 8 or 16 ohm **£29**
GROUP 100–15 15in. 100 watt 8 or 16 ohms. **£35**
Send for leaflets on Disco, P.A. and Group Gear.

E.M.I. 13½ × 8in SPEAKER SALE!



With tweeter. And crossover. 10W. State 3 or 8 ohm. **£9·95** *Illustrated* Post 75p
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GOODMANS 20 Watt Woofer Size 12 × 10in. 4 ohms. Rubber cone surround. Hi-Fi Bass unit. **£9·95** Post £1·60
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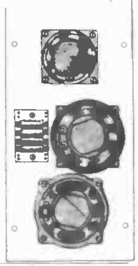
R.C.S. MINI MODULE HI-FI KIT 15 × 8½in 3-way Loudspeaker System, EMI 5in, Bass 5in, Middle 3in. Tweeter with 3-way Crossover and Ready Cut Baffle. Full assembly instructions supplied. Response = 60 to 20,000 cps 12 watt RMS. 8 ohm. £10·95 per kit. Two kits £20. Postage £1. One or two kits.



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DISPLAY LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto-isolated audio input.

DL1000K

This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.60**

DLZ1000K

A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**
Optional Opto Input DLA1 **60p**

INTEGRATED CIRCUITS

555 Timer	21p
741 Op. Amp	19p
AY-5-1224 Clock	£2.80
AY-5-1230/2 Clock/Timer	£4.20
AY-3-1270 Thermometer	£8.20
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual low noise preamp	£1.00
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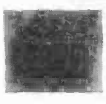
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
TBA800 5W Audio Amp	58p
TBA810AS 7W Audio Amp	85p
TDA1024 Zero Voltage Switch	£1.00
TDA2020 20W Audio Amp	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data & circuits. Data sheets only 5p

DIGITAL VOLTMETER/THERMOMETER KIT



Based on the ICL7106. This Kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply. (PP3 battery) **£20.75**

LEDs

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	
Rectangular Red	20p
Rectangular Green	25p

DISPLAYS

DL304 Red 0.3" c.c. pin compatible with DL704 **70p**
DL307 Red 0.3" c.a. pin comp. DL707 **70p**
DL847 Red 0.8" (pin comp. DL747) c.a. **£1.80**
DL850 Red 0.8" c.c. (pin comp. DL750) **£1.60**
DL727 Dual 0.5" c.a. Red **£1.50**

MINI TRANSFORMERS

Standard mains primaries 240V a.c. 100mA secondaries

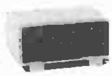
6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p

Soldercon Pins 50p/100

24 HOUR CLOCK/APPLIANCE TIMER KIT



Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit **£14.90**
CT1000KB with white box (56/131 x 71mm) **£17.40**
Ready Built **£22.50**

CAPACITORS

Polyester 250V

0.01	6p	0.22	12p
0.022	6p	0.33	12p
0.033	7p	0.47	15p
0.047	7p	0.68	18p
0.068	7p	1.0	24p
0.1	7p	1.5	27p
0.15	11p	2.2	31p

Electrolytics A=Axial R=Radial

63V	1.0	R	3p	16V	10	R	3p
	2.2	R	3p		22	R	3p
	4.7	R	4p		33	R	3p
	10	R	5p		47	R	4p
	47	R	8p		100	R	5p
25V	22		6p		220	R	6p
	47	A	6p		470	R	9p
	100	A			1000	R	15p
	220	A	9p	10V	47	A	6p
	470	A	16p		100	A	6p
	1000	A	20p		220	A	6p

Tantalum (bead)

35V	0.1	7p	10V	22	12p
	0.22	7p	6.3V	33	12p
	0.47	7p		47	14p
	1.0	7p	3V	100	14p
25V	2.2	8p			
	4.7	9p			
	10	12p			

VOLTAGE REGULATORS

Available in 5V, 12V & 15V versions.
78L series 100mA pos. **26p**
79L series 100mA neg. **60p**
78 series 1A pos. **52p**
LM317T adjustable 1.2V-37V 1.5A **£1.80**

MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

TEMPERATURE CONTROLLER/THERMOSTAT

Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. PCB (4 cm.sq.) potentiometer, plus all other components included with instructions.
500W **£3.20** 1KW **£3.50**

SOLID STATE RELAY

Ideal for switching motors, lights, heaters etc. from logic. Opto isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

BAR/DOT DISPLAY

Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indictors etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER

Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0·5°C.
1·5KW **£5·25** 3KW **£5·55**

BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black or white.
PB2 95x71x35mm **65p**
PB3 115x95x37mm **78p**

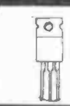
ZENER DIODES

400mW 3.3V-30V **8p**
1.3W 7.5-30V **15p**

RESISTORS

¼W 22ohm-10M Pack of 10 (one value) **10p**
10 packs (10 values) **80p**

TRIACS



400V Plastic Case (Texas)

3A	49p	16A	90p
8A	58p	20A	165p
12A	70p	25A	190p
6A with trigger			80p
8A isolated tab			82p
Diac			18p

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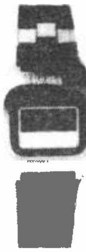
Access

QUARTZ LCD 5 Function



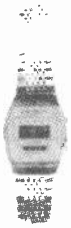
Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function



Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.,
Split and lap modes.
Back-light, auto calendar.
Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£9.55 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs,. month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£9.55

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags.
22 functions.
Constant display of hours and mins., plus optional seconds or date display.
AM/PM indication, month, date.
Continuous display of day.
Stop-watch to 12 hours 59·9 secs., in 1/10 second steps.
Split and lap timing modes.
Dual time zones.
Only 8mm thick.
Back-light. Fully adjustable open bracelet.

£19.95

Guaranteed same day dispatch

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags.
22 functions.
Solar panel with battery back-up.
6 basic functions.
Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps.
Split and lap timing modes.
Dual time zones.
Alarm. 9mm thick. Back-light.
Fully adjustable bracelet.

£17.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£24.55

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up.
6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.
Split and lap modes.
Back-light, auto calendar. Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£11.55
Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch

Only 25 × 20mm and 6mm thick.
Hours, minutes, seconds, day, date, backlight and auto calendar.
Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists.
State colour preference.

£7.55
Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour.
Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists.
State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch

Highly functional watch which also suits those special occasions.
Beautifully designed with a very thin bracelet which retains strength as well as elegance.
Hours, mins, secs, day, date, backlight and autocalendar.
Bracelet fully adjustable to suit slim wrists.
State gold or silver finish.

£15.55

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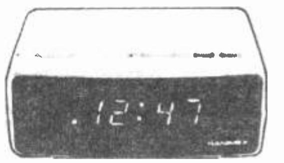
M18

HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on off control. Display flashing for power loss indication. Repeatable 9 minute snooze. Display bright dim modes control. Size 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm)
Weight 1.43 lbs (0.65 kg) AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

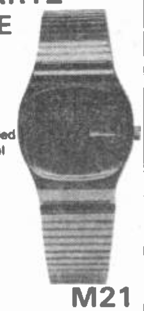
EXECUTIVE ALARM WATCH

6 Functions plus Alarm:
Conference signal,
5 minute snooze alarm.
Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel.
Snooze sounds 5 mins., after main alarm and is always preceeded by the conference signal.

£12.55

M60

MACY QUARTZ ANALOGUE



Automatic Calendar
Day and Date
infinite bracelet.
This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£13.55

OUTSTANDING FEATURES

- **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- **CALENDAR FUNCTIONS** include the date and day in each time zone.
- **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch.

M16

HOW TO ORDER
Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

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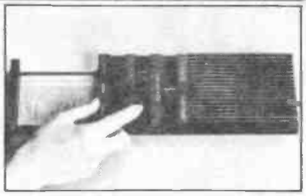
24 TUNE DOOR CHIMES



DOOR TUNES £17 13 + VAT.
Waddington's Videomaster announce a doorbell that doesn't go Brrringgg, Ding-Dong or Bzzzzz. Instead it plays 24 different classical and popular tunes. It will play the tune you select for your mood, the season or the visitor you are expecting to call. Door tunes is not only great fun and a wonderful ice breaker, but is also very functionally and beautifully designed to enhance your home. There is something for Christmas, something for your continental visitors or your relations from the states, and even something for the Queen. Door tunes is easy to install and has separate controls for volume, tone and tempo.

T.V. GAMES

PROGRAMMABLE £29·50 + VAT.
COLOUR CARTRIDGE T.V. GAME.

The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug-in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase of additional cartridges as new games are developed. Each cartridge contains up to ten different action games and the first cartridge containing ten sports games is included free with the console. Other cartridges are currently available to enable you to play such games as Grand Prix Motor Racing, Super Wipeout and Stunt Rider. Further cartridges are to be released later this year, including Tank Battle, Hunt the Sub and Target. The console comes complete with two removable joystick player controls to enable you to move in all four directions (up/down/right/left) and built into these joystick controls are ball serve and target fire buttons. Other features include several difficulty option switches, automatic on screen digital scoring and colour coding on scores and balls. Lifelike sounds are transmitted through the TV's speaker, simulating the actual game being played.
Manufactured by Waddington's Videomaster and guaranteed for one year.

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Grand Prix motor racing with gear changes, crash noises
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STAR CHESS – £55·09 + VAT.
PLAY CHESS AGAINST YOUR PARTNER.
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CHESS CHALLENGER 7 – £85·65 + VAT.
PLAY CHESS AGAINST THE COMPUTER.
The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including "Mate in two" and "Chess by mail". The computer will only make responses which obey international chess rules. Castling, en passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computor memory recall button.
Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.

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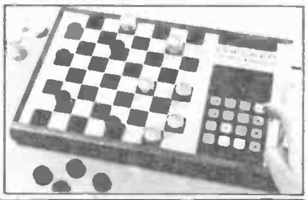
PLAY DRAUGHTS/CHECKERS AGAINST THE COMPUTER



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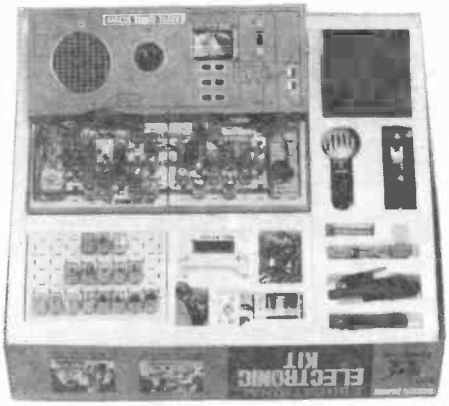

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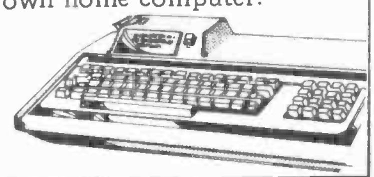

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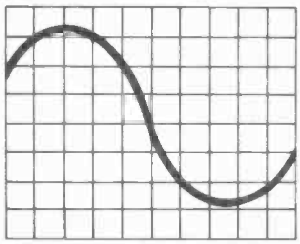

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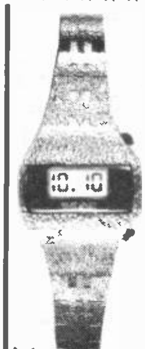

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L5
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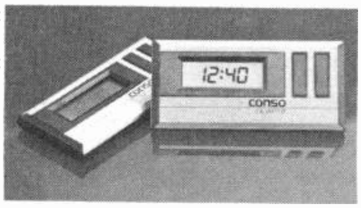

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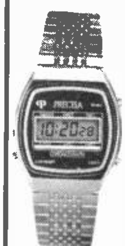

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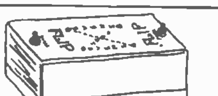

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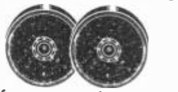

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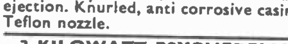

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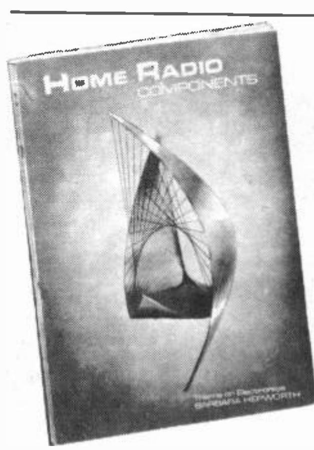

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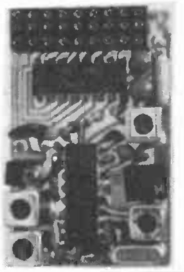
IT'S HAPPENNED* AGAIN !

THE PART THREE CATALOGUE IS PUBLISHED & WE HAVE MOVED TO BIGGER PREMISES.

Yes, it's here at last - the all new Part Three Catalogue. Fun for all the family, and the usual update on all that is new, worthwhile and exciting in the world of Radio and Communications. A big section on frequency synthesis techniques covering broadcast tuners, to communication quality transmitter systems. More new products than ever - RADIO CONTROL parts, crystal filters, ceramic filters for 455kHz and the new range of TOKO CFSH low temperature coefficient types for 10.7MHz. Details on new radio ICs, including the new HA11225, the CA3189E lookalike with 84dB signal to noise, and adjustable muting threshold. Radio control ICs - and an updated version of the RCM&E 8 channel FM receiver - now with an Ambit designed screened front end, with 27MHz ceramic bandpass filter. LCD panel clock/timer modules - the neatest and best LCD panel DVM yet (only £19.45 each + VAT), the new 5 decade resolution DFM3 for LW/HF/VHF with LCD readout. The DFM6 with fluorescent display to 10kHz resolution on VHF, 1kHz on SW. A 1kHz HF synthesiser with five ICs - the list is endless. Get your copy of the catalogue now. Post publication price is 60p (inc PP etc). The previous two sections are also required for a complete picture: Parts 1 & 2 £1 the pair. All 3 £1.50. And don't miss our spot the gibbon contest, together with a quiz to see if you can spot the differences between a neolithic cave drawing and a circuit diagram of one of our competitor's tuners. (* Yes, we still haven't learnt how to spell.)

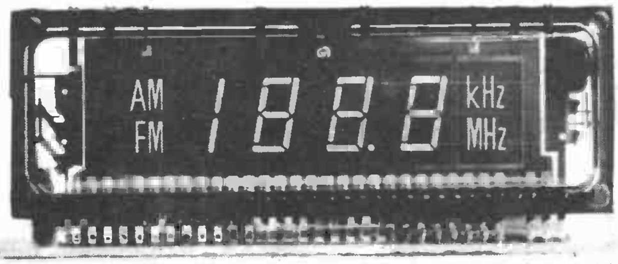
FM radio control RX kit



8 Channel RC receiver (FM)
- Single IC RF/IF/Detector
- Single IC decoder
- 27MHz ceramic filter input
- FET RF stage with double tuned bandpass filter
- Dual ceramic filter IF
- Best quality SLM servo connector block
- ONLY £16.10 inc VAT (kit) (includes new SLM case)

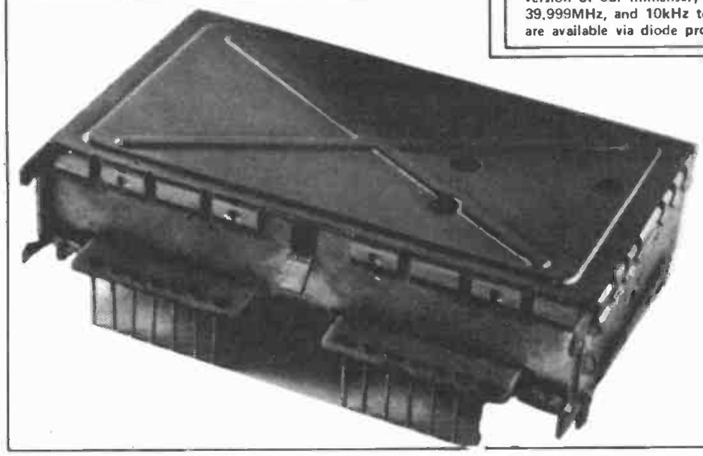
DOES YOUR ONE GLOW GREEN IN THE DARK ??

Our DFM4 does, since it uses a vacuum fluorescent display for direct readout of MW/LW/FM. Basically the same as the DFM2, (LCD Version). £24.45 kit (inc VAT) Transformer with all necessary windings for DFM4 - £2.50 inc VAT.



Not illustrated here - but also now available is the DFM6. This is a vacuum fluorescent display version of our immensely popular DFM3 (LCD). Resolution is 100Hz to 3.9999MHz, 1kHz to 39.999MHz, and 10kHz to 200.00MHz+; all standard IF offsets (inc. 10.7MHz on shortwave) are available via diode programming.

New series of radio modules in fully screened cans:



UM1181 VHF band 2 VARICAP TUNERHEAD
5 tuned circuit, with image/spurii better than −80dB, buffered LO output, MOSFET RF stage, FET IF preamp; tunes with only 1½ to 8v, −9dBm 3rd order intercept. 1off price £12.00 inc VAT. (100off/ OA)

911225 FM IF strip with all mod cons for the HiFi tuner:
All types use 80+dB S/N Hitachi IC, with muting, AFC, AGC, meter outputs for signal level and centre zero. IF preamp stage.
'A' Dual linear phase ceramic filters, with MOSFET (AGC'd) IF preamp and a 3rd narrow filter with DC filter selection. Dual tuned FM detector stage. £23.95 inc VAT (built)
'B' Dual ceramic filters, single tuned detector stage £14.95 inc VAT
(All 'A' series units are set up with a spectrum analyzer for best THD)

91072 AM RADIO TUNER MODULES · DC TUNED and DC SWITCHED Available February '80
All include buffered LO output, mechanical IF filter (TOKO CFMQ) 1·10v tuning bias, switching by a single pole to earth
A MW/LW (150 to 350kHz LW range) with ferrite rod antenna
B As 'A' but also including SW1 or SW2 (specify.)
SW1 = 1.8 to 4MHz SW2 = 5 to 10MHz
C With both SW ranges
Prices -one off INC VAT
'A' £14.43 'B' £15.90 'C' £17.50 (Custom types OA).

There is a danger - when advertizing in some magazines - that because we do not find space to list everything we sell in every ad., that some readers forget about half the ranges we stock. So to summarize the general ranges:

TOKO	Chokes, coils for AM/FM/SW/MPX, Audio filters etc Filters: Ceramic for AM/FM, LC for FM, MPX etc. Polyvaricons ICs for radio, clock LSI, radio control, MPX decoders etc
Micrometals	Dust iron cores for toroids for resonant and EMI filters Toroid mounts
Hitachi	Radio/audio/mpx linear ICs 100W MOSFETs, small signal FETs, MOSFETs and bipolar

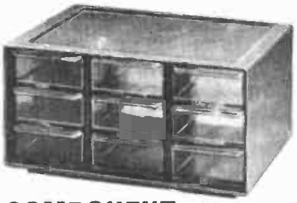
And the following groups of products from a broad range of sources:
Semiconductors —specializing in radio devices, Plessey SL1600, EUROPE's best selection of AM/FM and communications devices. Power MOSFETs, WORLD's LOWEST NOISE AUDIO small signal transistors, BAR graph LED drivers for linear and log.
CD4000 series CMOS, TTL/LPSNTTL, standard linears (741, 301, 3080 etc). MPUs, memories. Small signal transistors from AEG BC237/8/9 families etc. (1000 off BC239C : 5.2p ea)
LEDs: AEG 3mm/5mm round, 2.5x5mm flat, red, greem, orange, yellow. The best prices you will find for quality products.
MOSFETs for RF signal processing, including the BF960 UHF device, and 3SK51 for VHF. Varicap diodes for 17:1 capacity ratio tuning
FREQUENCY READOUT LSI from OKI with a one-chip answer to most digital frequency display needs (and various modules).
Crystal and ceramic ladder filters from leading manufacturers, ferrite rods, various ferrite beads and a range of crystals for 'standard' frequencies and both AM and FM radio control at 27MHz. Trimmer capacitors.
METERS - a new range of linear movement types, plus many 'indicator' types for VU, all types of tuning indicators etc.
SOCKETS - a new range that are better quality than Texas low profile, yet better priced.
Modules for AM/FM/STEREO, complete kits for tuners, audio amplifiers from Larsholt.
SWITCHES - complete low cost DIY systems for push button arrays, keyboard switches.
DOUBLE BALANCED MIXERS - MCL SBL1, replacement for MD108 etc. And cheaper.

OUR LATEST MOVING EXPERIENCE :: At last, we have moved to the address below. There is car parking for customers approaching via North Service Road (an extension of North Road Avenue, entrance opposite the Brentwood Fire Station.) Pedestrian access from the High Street (alongside 117 High Street). The new building is six times bigger than our Gresham Road offices, and we will be installing a much expanded sales counter in the fullness of time. NEW TELEPHONE NUMBER (0277) 230909, TELEX NUMBER (as before) 995194 AMBIT G. See you there !

200 North Service Road, Brentwood, Essex.

GREENWELD

443D MILLBROOK ROAD, SOUTHAMPTON SO1 0HX
All prices include VAT–just add 40p post. Tel (0703) 772501



COMPONENT CABINET IDEAL FOR THE NEWCOMER TO ELECTRONICS

Contains hundreds of brand new resistors, capacitors, transistors diodes and I.C.'s. All useful values, carefully chosen to help the new constructor pursue his hobby without finding himself short of some vital parts!

All parts contained in clearly marked bags in a plastic storage cabinet 232 × 121 × 165mm with 9 drawers into which all parts can be neatly located.

If bought individually parts plus case would cost over £47 but we are offering this for ONLY £31·95 + £1 p & p. Simply send a cheque or P/O for £32·95 for immediate despatch.

CONTENTS:
200 ¼ watt resistors
20 Wire wound resistors
70 Ceramic Capacitors
70 Mylar Capacitors
50 Polyester Capacitors
56 Electrolytic Capacitors
61 Transistors
12 I.C.'s
20 L.E.D.'s
55 Diodes and rectifiers

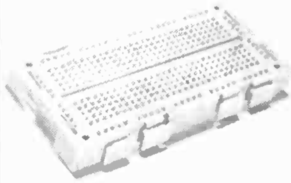
Altogether 614 components.

Price includes current catalogue and Greenweld pen for reordering supplies. Plus FREE surprise gift.

PC ETCHING KIT MK III
Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. £4·95

KITS OF BITS FOR EE PROJECTS

We supply parts for nearly all EE projects—for a detailed components list of this month's, and previous articles, please send SAE.



VEROBLOC BREADBOARD
New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs and be joined together. Bus strips on X & Y axis–total 360 connexion points for just £3·70.

VU METERS
V002 Twin type. 2 meters 40 × 40mm and driver board, supplied with circuit and connexion data, £3·50.
V003 New type, just in. Twin type moulded in one piece. 80 × 40mm (no driver board but suitable circuit supplied). £2·50.

THE NEW 1980 GREENWELD CATALOGUE

FEATURES INCLUDE:
- 60p Discount Vouchers
- Quantity prices for bulk buyers
- Bargain List Supplement
- Reply Paid Envelope
- Priority Order Form
- VAT inclusive prices

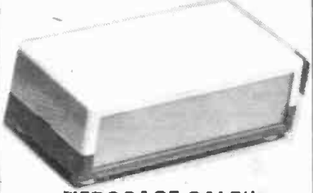
PRICE 40p + 20p POST

WIRE & FLEX
Solid core—ideal for breadboards etc. 50 × 2m lengths many assorted colours, total 100m for £1·30.
Flex packs—5 × 5m lengths of multi-strand thin flex, ideal for wiring up circuits. Only 35p

EX-COMPUTER PANELS
Z528 Pack of boards containing 100's R's, C's diodes, including at least 50 transistors. Only £1·30.
Z529 TTL pack—Panels with 74 series on, together with code sheet. From simple gates to complex counters. 20 IC's £1; 100 IC's £4.

COMPONENT TRAY
Attractive yellow tray 285 × 165 × 42mm with clear hinged lid and movable compartments. Up to 15 can be made from dividers supplied. As an added bonus, a selection of new surplus components are included, all for the special low price of £3·95.

INVERTER
Prepare for the Power Cuts! Ready built Inverter, 24V DC 290 × 55 × 37mm in, will power 6 × 8W fluorescent tubes. Circuit supplied. Only £2·90.



VEROCASE SALE!!
3 popular sizes of Verocase at drastically reduced prices—these were part of their standard range (75-1411 etc.) but are in GREEN and have been discontinued by Vero. We have purchased their entire stock and offer them as below:

Type No	Size	Price
21050	205 × 140 × 75mm	£2·70
21051	180 × 120 × 65mm	£2·30
21052	154 × 85 × 60mm	£1·75
21053	125 × 65 × 40mm	£1·45

1A 400V RECTIFIERS
Plastic, like 1N4004, type 388F these diodes have preformed leads for horizontal mntg (15mm FC). Supersaver price—100 for £2·30; 500/£10 1000/£18

BUZZERS & MOTORS & RELAYS
Z401 Powerful 6V DC Buzzer all metal construction 50mm dia × 20mm 70p.
Z402 Miniature type Buzzer 6, 9 or 12V, only 22×15×16mm. Very neat 53p.
Z450 Miniature 6V DC motor, high quality type 32mm dia × 25mm high, with 12mm spindle. Only £1.
Z459 115/230V ac high torque motor with geared reduction down to 60 rpm. Sturdy construction, 70mm dia × 20mm. Spindle 6mm dia × 20mm long. Only £2·00.
W892 Heavy duty 12V relay, ideal for car use—single 15A make contact. Coil 25R. 85p.
W890 DIL reed relay—SPCO 2·4V-10V 200R coil. Only £2·20.
W847 Low profile PC mntg 10 × 33 × 20 mm 6V coil, SPCO 3A contacts. 93p.

TEACH IN 80

We are again supplying all parts required for this major series which started in October. The price for all the Tutor Deck parts is £19·50. Also supplied *without* breadboard for £13·50. The price for the additional components required for Parts 1-6 is £2·00. All prices include VAT and Postage. Reprints of parts 30p per month

TECHNICAL TRAINING IN ELECTRONICS AND TELECOMMUNICATIONS

ICS can provide the technical knowledge that is so essential to your success: knowledge that will enable you to take advantage of the many opportunities open to you. Study in your own home, in your own time and at your own pace and if you are studying for an examination ICS guarantee coaching until you are successful.

City and Guilds Certificates:
Telecommunications Technicians
Radio, TV, Electronics Technicians
Technical Communications
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MPT Radio Communications Certificate

Diploma Courses:
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Computer Engineering and Programming
Radio, TV, Audio Engineering and Servicing
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ICS To: International Correspondence Schools

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Subject of Interest ....
Name ....
Address ....
.... Tel: .... Age: ......

OHIO SCIENTIFIC Superboard 2 assembled 50Hz model, 8K basic 4K ram with free psu and modulator kit £188 + 15% vat post free.

SINCLAIR PRODUCTS New 10MHz scope £145. pfm200 £51·95, case £3·40, adaptor £4·03, connector kit £11·27. Microvision tv £91, adaptor £6·88. pdm35 £34·23, adaptor £4·03, case £3·40. dm350 £76·70, dm450 £102·17, dm235 £55·55, rechargeable batts £7·99, adaptor £4·03, case £9. Enterprise prog. calculator + accessories £19·95.

COMPUTER GAMES Chess champion 6 £49·95. Chess challenger 7 £84. Phillips G7000 home computer £149. Videopaks £12·95. Atari videocomputer £147. Cartridges £14·85.

COMPONENTS 1N4148 0·9p. 1N4002 3·1p. 741 18p. bc182, bc184, bc212, bc214, bc548 5·5p. Resistors ¼W 5% E12 10R to 10M 1p, 0·8p for 50+ of one value. 16V electrolytics ·5, 1, 2, 5, 10, 22mf 5p, 100mf 6p, 1000mf 10p. 1 lb FeC1 £1·30. Dalo pen 84p. 40 sq ins pcb 45p. Polystyrene capacitors E12 63V 10 to 1000pf 3p, 1n2 to 10n 4p. Ceramic capacitors 50V E6 22pf to 47n 2p. Zeners 400mW E24 2v7 to 33v 7p.

TV GAMES AY-3-8500 + kit £7·26. Rifle kit £5·27. AY-3-8600 + kit £17·28. Stunt cycle chip + kit £18·66. AY-3-8603 chip £13·63.

TRANSFORMERS 6-0-6V, 1½a £2·60. 9-0-9V 75ma 76p, 1a £2·22, 2a £3·94. 12-0-12V 100ma 92p, 1a £2·80.

IC AUDIO AMPS with pcb. JC12 6W £2·08. JC20 10W £3·14.

BATTERY ELIMINATORS 3-way type 6/7½/9v 300ma £3·14. 100ma radio type with press-studs 9v £3·57. 9 + 9v £4·79. Car convertor 12v input, output 4½/6/7½/9v 800ma £2·66.

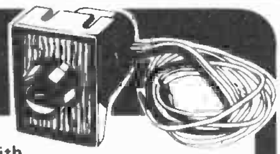
BATTERY ELIMINATOR KITS 100ma radio types with press-studs 4½v £1·49, 6v £1·49, 9v £1·49, 4½ + 4½v £1·92, 6 + 6v £1·92, 9 + 9v £1·92. Stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma £2·50, 1 Amp £5·30. Stabilized power kits 2-18v 100ma £2·98, 1-30v 1A £6·20, 1-30v 2A £11·24. 12v Car convertor 6/7½/9v 1A £1·35.

T-DEC AND CSC BREADBOARDS s-dec £3·79, t-dec £4·59, u-deca £4·69, u-decb £7·16, exp4b £2·64, exp300 £6·61, exp350 £3·62, exp325 £1·84.

BI-PAK AUDIO MODULES s450 £25·06. AL60 £5·06. pa100 £17·33. spm80 £4·74. bmt80 £6·08. Stereo 30 £21·57. AL30A £4·08. pal2 £8·38. psl12 £1·58. ma60 £38·27

SWANLEY ELECTRONICS
Dept. EE, 32 Goldsel Rd., Swanley, Kent.
Post 30p extra. Prices include VAT unless stated. Official and overseas orders welcome. Lists 24p post free. Mail order only.

VARI WIPE



WIPER DELAY CONTROL

The Vari Wipe provides intermittent operation of the windscreen wipers with adjustable control to delay each wipe between 3 and 60 seconds. Set the control to suit the conditions to clear light drizzle, fog, snow, sleet or spray. Easily fitted to British, Continental & Japanese cars with 12 volt self park wipers. Complete kit contains all components, including timer chip, PCB, case, mounting panel, wire, etc., with full instructions.

VARI WIPE KIT £6.75 inc. P & P
ASSEMBLED £9.25 inc. P & P

or send large s.a.e. for details

Card Holders Phone 0253 27244

Spimin DEVELOPMENTS Dept **EE1**

FREEPOST Thornton Cleveleys, Blackpool FY5 2BR

SPECIAL NOTES: The "+" sign after the amount shows the amount of V.A.T. The postage is based upon the amount the article costs to send if the same article forms part of a larger parcel. Would your order be less than £6·00 however, you must send an additional 50p to offset packing and other expenses.

INTERCOM, complete with 50ft plug ended interconnecting leads. Master station and sub-station can call each other. In neat cream cases, suitable for office or home or as a baby alarm etc. These are new stock but may need attention. Offered at half regular price, only £3·00 + 45p per pair.

CAR STARTER KIT
Has no doubt helped many motorists out of trouble but supplies are getting short. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage whichever suits you best. Price £9·00 + £1·35 + postage £2·00.

TANGENTIAL HEATERS
Good stocks of these super heater units which require only a simple case or could be fitted into the bottom of a kitchen unit or bookcase. Both 2K and 3K models are in stock. £5·20 + 78p for 2K and £6·05 + 90p for 3K, post £1·50 per heater. Heater control switch enabling full heat, half heat or cold blow and data. 75p + 12p.

DESOLDERING PUMP
Ideal for removing components from computer boards as well as for service work generally. Price £5·45 + 88p.

ELECTRONIC MEGGER
250v ohmmeter, made for GPO so obviously a first class instrument, size approx. 9" cube, with carrying handle gives clear readings of resistance from 1 ohm right up to 100 megs, then to inf. A beautiful instrument which must have cost at least £100 to make, it is battery operated and has a separate meter to give battery voltage and setting up indications. 250v is the testing voltage for most electrical and telephone installations. Brand new. Price £22·50 + £3·38 + post £2.

500 WATT HEAT AND LIGHT LAMP
Philips Mullard, tubular for high speed drying, or for general use, especially where quick localised heating is required in workshops or warehouses where heating is impossible costwise. Supplied complete with holder and mounting clips. £2·50 + 38p, post and special packing £1·25p.

275 WATT HEAT AND LIGHT LAMP
Useful in the bathroom or loo to prevent cisterns, etc., freezing. B.C. so fits any lampholder. Price £2·50 + 37p, post 80p.

MAKING A CONVECTOR HEATER?
We can offer a bank of four 1KW metal clad elements all mounted on a 3" square iron plate. By comparatively simple switching 8 heat outputs ranging from approximately 250 watts to 4000 watts can be achieved. The elements, which are in the form of loops with push on tag connectors, extend to a length of approximately 17" from the mounted plate, so a relatively compact simple convector heater could be made using this. Price £2·50 + 37p, post £1·50.

G.P.O. HIGH GAIN AMP/SIGNAL TRACER
A massive bulk purchase enables us to offer this useful piece of equipment at a fraction of its original cost. Housed in a weatherproof case measuring only 5½" × 3½" × 1½" is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. We have tried it successfully with a radio and it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1·62 + 26p. Suitable 80 ohm earpiece 60p + 9p.

TELESCOPIC AERIAL
5 sections, 21" when extended. Nickel plated superior make, one nut fixing, folds over for FM. Price 95p + 15p.

CASSETTE BARGAIN
Cassette player/recorder units, not secondhand but for some reason, a small defect prevented their being sold at the recommended retail price of £19·50. Our price £9·95 including post and VAT. Don't miss this bargain.

6 Transistor Radios again new but slightly faulty, 10 for £10 + £1·50, post £1.

BLEEPER
Makes a sound very similar to the Black & Decker smoke alarm. 6-12 dc or 12-24v ac. Ideal for fire and smoke alarm, anti-mugging device, car or motor anti-theft. American made, compact. Price 75p + 12p.

MOST USEFUL POWER SUPPLY
240v mains input, switched outputs of 6, 9 & 12 volts d.c. at max of 1 amp. Ingenious circuitry limits the voltage differential between off load and full load. Illuminated voltmeter on front panel shows output voltage. Completely encased, size 165 × 82 × 63mm. Price £14·50 + £2·18.

CHARGE-DISCHARGE PANEL METER
made for military so of good quality. Fitted with shunt this reads 50-0-50 amp, hole size 2" dia. with flange for flush panel mounting. Price £2·50 + 38p.

THIS MONTH'S TRANSFORMER BARGAIN is a 12v 1½ amp varnish impregnated, dead quiet so suitable for audio amps or anything else. This could be said to be treble insulated as the secondary is wound on a separate former, also there is plenty of room to add or subtract a few turns if you want an odd voltage. Special price this month £1·30 + 19p + 30p postage. Sorry no discount but 10 or more post free (cash orders).

0-10V DC MOVING COIL PANEL METER
Another military model flanged for flush panel mounting through round hole size 2" dia. Range easily extended by adding a series resistor. Price £2·00 + 30p.

WAFER SWITCH BARGAIN
18 pole 2-way on three glazed ceramic wafers, 5 amp silver plated contacts. This switch is okay for mains or even higher voltages, it's made to P.O. specification and would cost at least £5 from makers. Our price only £1·50 + 22p.

MESSAGE TAPES
250' on 3" spool—3 for £1 inclusive.

CASSETTES
C.90 in screwed together type cases so you can get tape out for joining, etc., 3 for £1 inclusive.

POWER SUPPLY UNITS
Save the cost of batteries, we can still supply the **Sinclair** 9v 100mA at £2·50 + 38p. The **Adaptable 300mA** gives 6v-7·5v or 9v by switch setting and has a plug-in reversible lead and four pronged output which fits practically every radio-cassette, calculator, etc. Price £3·05 + 45p. The **Smooth Flow** 12v-750mA in neat plastic case with mains lead and screw down terminals for output. Price £4·00 + 60p. Finally the **Rank Car P.U.** to operate 6v equipment from 12v car battery, negative earth, also positive earth equipment if this does not have to connect to car. Price £2·50 + 38p.

12V 4 AMP TRANSFORMER
Normal mains primary, impregnated and varnished with fuse holder attached. Price £2·85 + 42p, post 40p.

BREAKDOWN UNIT 1B
Mounted on useful board size 4" × 5" are 14 axial ended caps all easy to remove, with good length wire ends. 12 are polystyrene 1% types: 4 × 74 nf 160v, 4 × 60 nf 125v, 2 × 15 nf 350v, 2 × 5 nf 400v. Lastly there are 2 × ·1 uf 250v 10% polycarbonate. In addition to this on flexible leads are two encased units which we believe to be transducers. This is a real bargain at £1·00 + 15p.

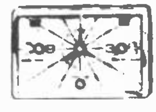
MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16 including VAT and postage.

FREE GIFT—Buy this month and you will receive a pair of Goodman's elliptical 8" × 5" speakers to match this amplifier.

25A ELECTRIC PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours independent 60 minute memory jogger. A beautiful unit. £5·50



HUMIDITY SWITCH

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

MAINS BLOWER

The Torrin—quiet but powerful outlet size 2½ × 1½ for cooling equipment etc. will extract if outlet is blowing outwards. Price £6·50.
Other models from £4·00.

INDUCTION MOTORS

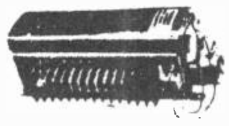
One illustrated is our reference MM11 made for ITT ½ stack 1½ spindle £2·25. ½ stack model £1·75. 1 stack £2·75. 1½ stack £3·25.

DRILL CONTROLLER

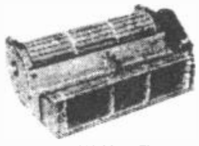
Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·45
Made up model £2·00 extra

MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi adjustable switches are rated at 10 amps. This would provide a magnificent display. For mains operating. 8 switch model £6·25. 10 switch model £6·75. 12 switch model £7·25.



TANGENTIAL HEATER UNIT



3KW MODEL
£6·95
+ £1·50 P & P

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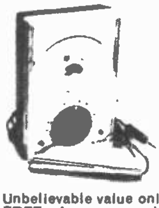

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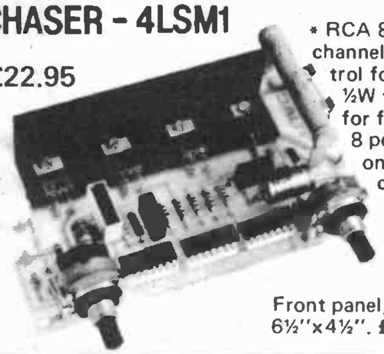

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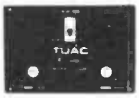

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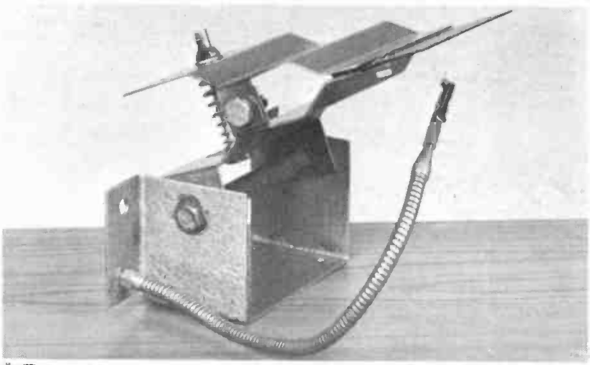

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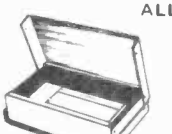

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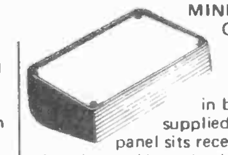
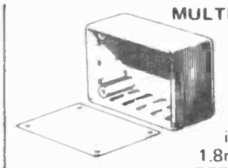


Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

BIM 1005 (161 x 96 x 58mm) £2.48
BIM 1006 (215 x 130 x 75mm) £3.48

MULTI PURPOSE BIMBOXES



Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

BIM 4003 (85x56x28.5mm) £1.34
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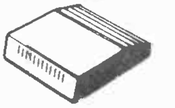
Colour Code	Top Panel	Base
A	Off White	Blue
B	Sand	Green
C	Satin Black	Gold



15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£11.36
BIM7152 (165x140x51[28] mm)	BIM7302 (165x140x76[28] mm)	£12.28
BIM7153 (165x216x51[28] mm)	BIM7303 (165x183x102[28] mm)	£13.43
BIM7154 (165x211x76[33] mm)	BIM7304 (254x140x76[28] mm)	£14.83
BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£16.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£17.71
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£18.83
BIM7158 (356x287x76[33] mm)	BIM7308 (356x259x102[28] mm)	£19.92

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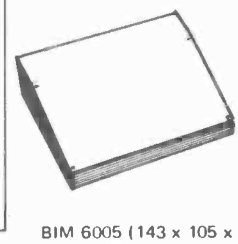
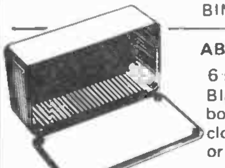


Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.76
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.58
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.83

ABS & DIECAST BIMBOXES



6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x50x25mm)	N/A		BIM5001/11	£1.54	£1.23
(100x50x25mm)	BIM2002/12	£1.09	BIM5002/12	£1.66	£1.32
(112x62x31mm)	BIM2003/13	£1.27	BIM5003/13	£2.24	£1.70
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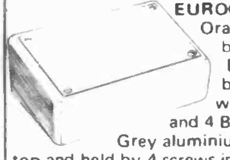
(150x80x50mm)	BIM2005/15	£1.72	BIM5005/15	£3.19	£2.72
(190x110x60mm)	BIM2006/16	£2.69	BIM5006/16	£4.94	£3.96

Also available in Grey Polystyrene with no slots and self-tapping screws
BIM 2007/17 (112x61x31mm) £1.06

EUROCARD BIMCONSOLES



Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

BIM 8005 (169x127x70[45] mm) £4.71
BIM 8007 (243x187x103[66] mm) £6.70

BIMTOOLS + BIMACCESSORIES

MAINS BIMDRILLS

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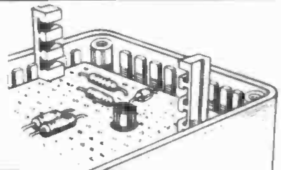
Mains Kit 2 includes Mains BIMDRILL as above, 20 assorted drills, mops, burrs, grinding wheels and mounted points, 1mm, 2mm, 2.4mm and .125" collets. Complete in transparent case measuring 230x130x58mm £23.57

BIMDAPTORS



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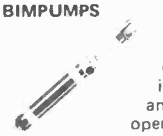
Accessory Kits 1 have appropriate drills and collets as above plus 20 assorted tools. Mini Kit 1 – £16.10, Major Kit 1 – £20.70. Accessory Kits 2 have appropriate drills, collets plus 40 tools and mains-12V dc adaptor. Mini Kit 2 – £36.22, Major Kit 2 – £41.97. Accessory Kits 3 as appropriate Kits 2 plus stand/lathe unit. Mini Kit 3 – £48.30, Major Kit 3 – £54.05.

BIMPUMPS



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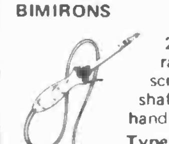

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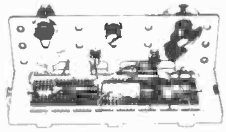
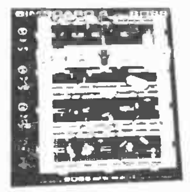
BIMBOARDS



DIL COMPATIBLE BIMBOARDS



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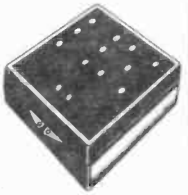
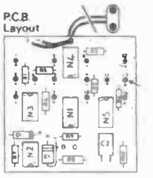

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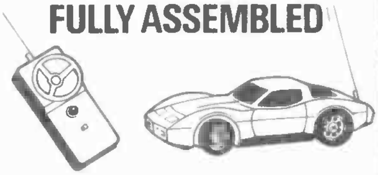

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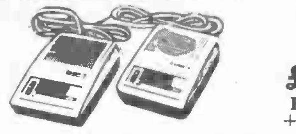

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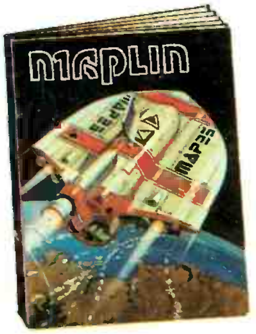

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