Easy to build projects for everyone

Everyday ELECTRONICS

FEB. 79
40p

A MICROPROCESSOR AT YOUR DOOR

MICROCHIME

POWER SUPPLY

Simple projects

A.F. MODULATOR

THYRISTOR TESTER

NO LONG WAVE? THEN BUILD OUR

L.W. CONVERTOR

Australia 75c South Africa 70c New Zealand 85c Malaysia $2·75c

Iron out the little problems...

Model TCSU1 Soldering Station

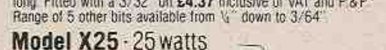
CTC 35 watt –

The TCSU1 soldering station with the XTC 50 watt – 24/26 volt soldering iron or the CTC 35 watt – soldering iron for pin point precision and exceptionally fast recovery time. We have put at least twice as much power into irons which are already well known for good recovery time. The temperature control stops them from over-heating; the "fail-safe" electronic circuit provides protection even if the thermocouple fails. TCSU1 soldering station **£38.10** XTC and CTC irons **£14.85** inclusive of VAT and P.&P.

Model CX 17 watts *(illustrated)*

a miniature iron with the element enclosed first in a ceramic shaft then in a stainless steel. Virtually leak-free. Only 7½" long. Fitted with a 3/32" bit **£4.37** inclusive of VAT and P.&P. Range of 5 other bits available from ¼" down to 3/64".

Model X25 - 25 watts



A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£4.37** inclusive of VAT and P.&P. Range of 4 other bits available.

Model SK3 Kit

Contains both the model CX230 soldering iron and the stand ST3. Priced at **£6.21** inclusive of VAT and P.&P. It makes an excellent present for the radio amateur modelmaker or hobbyist.

Model SK4 Kit

With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home. Priced at **£6.21** inclusive of VAT and P.&P.

Model MLX Kit

The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price **£4.83** inclusive of VAT and P.&P.

Model SK1 Kit

This kit contains a 15 watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet 'How to solder'. Priced at **£6.48** inclusive of VAT and P.&P.

...with Antex

The ANTEX multi purpose range of soldering equipment is fast becoming a must for every home. Built with precision for long life, each iron is fully tested and guaranteed.

ANTEX soldering irons are made in England to strict local and international standards of safety.

Our name for reliability is spreading from all over Europe to U.S.A. to Japan and to many other countries.

Stocked by many wholesalers and retailers or direct from us if you are desperate.

ANTEX

Mayflower House, Armada Way,
Plymouth, Devon.
Tel: 0752 67377/8
Telex: 45296

Please send me the Antex colour brochure ☐ I enclose cheque/P.O./Giro No. 258 1000 ☐

Please send the following

Name

Address

Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 0752 67377

EE 2.79

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. Send 50p (plus 25p p&p) for our catalogue.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked *. To the rest add 12½%.

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:** 0·001, 0·0015, 0·0022, 0·0033 **7p**; 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p**; 0·022, 0·033, **10p**; 0·047, 0·068 **14p**; 0·10 **15p**; 0·15, 0·22 **22p**; 0·33, 0·47 **39p**; 0·68 **45p**. **160V:** 0·039, 0·15, 0·22, **11p**; 0·33, 0·47 **19p**; 0·68, 1·0 **22p**; 1·5 **29p**; 2·2 **32p**; 4·7 **48p**. **DUBILIER: 1000V:** 0·01, 0·015 **20p**; 0·022 **22p**; 0·047 **26p**; 0·1 **38p**; 0·47 **48p**; 1·0 **175p**.

POLYESTER RADIAL LEAD (Values in µF) **250V:** 0·01, 0·015, 0·022, 0·027 **5p**; 0·033, 0·047, 0·068, 0·1 **7p**; 0·15 **11p**; 0·22, 0·33 **13p**; 0·47 **15p**; 0·68 **18p**; 1·0 **24p**; 1·5 **27p**; 2·2 **31p**.

FEED THROUGH CAPACITORS 100µF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in SF) **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 **11p**; 63, 100 **27p** 50; 1·0 **7p**; 50, 100, 220 **25p**; 470 **50p**; 1000; **40V:** 22, 33, **9p**; 100 **11p**; 2200 **68p**; 3300 **62p**; 4700 **84p**; **35V:** 10, 33 **7p**; 330, 470 **32p**; 1000 **49p**; **25V:** 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2200 **41p**; 3300 **52p**; 4700 **54p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 220, 330, 470 **14p**; 1000, 1500 **20p**; 2200 **34p**; **10V:** 100 **6p**; 640 **10p**; 1000 **14p**.
TAG-END TYPE: 70V: 2000 **98p**; 4700 **121p**; **50V:** 10,000 **255p**; **40V:** 2500 **65p**; 3300, 4700 **70p**; 15,000 **450p**; **25V:** 4700 **48p**; 2200 **37p**; **325V:** 200+100+50+100 **190p**.

TANTALUM BEAD CAPACITORS 35V: 0·1µF, 0·22, 0 33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8 **25V:** 1·5, 10 **20V:** 1·5 **16V:** 10µF **13p** each 47, 100 **40p. 10V:** 22µF, 33 **.6V:** 47, 68, 100, **3V:** 68, 100µF. **20p** each

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF **8p**
0·015, 0·02, 0·04, 0·05, 0·056µF **7p**
0·1µF, 0·2 **9p 50V:** 0·47 **11p**

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

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

POLYSTYRENE CAPACITORS
10pF to 1nF **8p**; 1·5nF to 47nF **10p.**

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

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

SOLDERCON PINS*
100 **50p**; 1000 **395p**

POTENTIOMETERS
(AB or EGEN)
Carbon Track. ¼W Log & ¼W Linear values
500Ω. 1K & 2K (lin only) Single **27p**
5KΩ-2MΩ single gang **27p**
5KΩ-2MΩ single gang D/P switch **60p**
5KΩ-2MΩ dual gang stereo **70p**

SLIDER POTENTIOMETER
0·25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **22p**

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

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

	RANGE	VAL	1 99	100
¼W	2·2Ω - 4 7M	E24	1·5p	1p
½W	2·2Ω - 4 7M	E12	2p	1·5p
1W	2·2Ω 10M	E12	5p	4p
2% Metal Film	10Ω-1MΩ		6p	4p
1% Metal Film	51Ω-1M		10p	8p

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

SPECIAL OFFER
NE555 **22p***; 741 **17p***

OPTO ELECTRONICS★
LEDs plus clips
TIL209 Red **13**
TIL211 Grn **18**
TIL212 Yellow **22**
2" Red **15**
2" Yellow Green **19**
Spare Clips **2**
ORP12 **63**
2N5777 **45**
7 Seg Displays
LS400 **255**
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**
FND357 **120**
MAN3640 **175**
LCD 3½ digit **915**
TIL307 **675**

SWITCHES★
TOGGLE 2A 250V
SPST **28p**
DPDT **38p**
4 pole on/off **54p**
SUB-MIN TOGGLE
SP changeover **59p**
SPST on/off **54p**
DPDT 6 tags **70p**
DPDT c/off **79p**
DPDT Biased **115p**
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 **60p**
SPDT c/over **65p**
DPDT 6 Tag **85p**

JACK PLUGS	Screened chrome	Plastic body	SOCKETS open metal	moulded with break contacts
2·5mm	12p	8p	8p	
3·5mm	15p	10p	8p	
MONO	23p	15p	13p	20p
STEREO	31p	18p	15p	24p

S-DEC **325p***
T-DEC **425p***
U-DEC 'A' **450p***
U-DEC 'B' **695p***

	Plugs	Sockets	In Line
DIN 2 PIN Loudspkr.	11p	7p	18p
3 4 5 Pin Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours	9p	5p single 8p double	— 15p
Metal Screened	12p	10p 3-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	7p	7p	—
WANDER 3mm	8p	8p	

SWITCHES ★ Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V
SP changeover centre off **30p**
ROCKER: (black) on/off 10A 250V **23p**
ROCKER: Illuminated (white)
Lights when on: 3A 240V **52p**
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way 2p/2-6W 3p/2-4W 4p/2-3W **41p**
ROTARY: Mains 250V AC, 4 Amp **45p**

DIL SOCKETS ★ (Low Profile – Texas)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 18 pin **20p**; 20 pin **27p**; 24 pin **30p**; 28 pin**42p**; 40 pin **55p**.

JACKSONS VARIABLE CAPACITORS
Dielectric 100/300pF **140p**
500pF **165p**
6 1 Ball Drive 4511/DAF **115p***
Dial Drive 4103 6 1/36 1 **650p***
Drum 54mm **30p***
0-1·365pF **245p**
00 2 365pF **275p**
0 2 365pF with slow motion Drive **325p**
00 208/176 **285p**
,, ,, with slow motion drive **325p**
C804-5pF 10 15 25 50 pF **175p***
100, 150pF **215p***
'L' 3 x 310pF **495p**
00·3 x 25pF **430p**

DENCO COILS
'DP' VALVE TYPE
Range 1 to 5 Bl., Rd., Yl. Wht. **86p**
6-7 B.Y.R. **75p**
1·5 Green **92p**
'T' 1 to 5 Bl., Yl., Rd., Wht. **93p**
B9A Valve Holder **25p**
RDT2 **92p**
RFC 5 chokes **91p**
RFC 7 (19mH) **96p**
1 FT 13; 14; 15; 16; 17 **86p**
1 FT 18/1·6 **99p**
1 FT 18/465 **105p**
TOC 1 **86p**
MW5FR **82p**
MW/LW 5FR **103p**

VEROBOARD ★

	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3¾	41p	33p	22p
2½ × 5	49p	45p	28p
3¾ × 3¾	49p	45p	—
3¾ × 5	58p	60p	39p
2½ × 17	152p	121p	75p
3¾ × 17	195p	163p	107p
4¾ × 17	252p	—	165p

Pkt of 35 pins **30p**
Spot face cutter **85p**
Pin insertion tool **99p**

DIODES
AA119 15
AAZ115 15
BY100 24
BY126 14
BY127 14
CRO 157
OA9 75
OA47 12
OA70 12
OA79 12
OA81 15
OA85 12
OA90 6
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
6A/600V 50

ZENERS
Range 2V7 to 39V 400mW **9p each**
Range 3V3 to 33V, 1·3W **17p each**

NOISE
25J 150

★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,100V 72
4A/200V 75
4A/400V 79
4A/600V 105
4A/800V 120
6A/100V 73
6A/200V 78
6A/400V 85
BY164 56
VM18 DIL 40

SCRs★
Thyristors
1A50V 38
1A100V 42
1A200V 47
1A400V 52
1A600V 70
5A100V 32
5A300V 35
5A600V 43
8A300V 48
8A500V 58
8A600V 85
12A300V 59
12A500V 92
BT106 *50
C106D 38
TIC44 25
TIC45 45

TRIACS★
3A100V 48
3A200V 49
3A400V 50
8A100V 54
8A400V 64
8A800V 108
12A100V 60
12A400V 70
16A100V 95
16A500V 150
25A800V 295
40669 95

DIAC★
ST2 25

TTL 74★

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	36
7480	48
7481	86
7482	69
7483	72
7484	95
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74105	62
74107	29
74109	54
74110	54
74111	68
74112	88
74116	198
74118	83
74119	119
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74136	73
74141	56
74142	269
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74157	67
74159	210
74160	82
74161	92
74162	92
74163	92
74164	105
74165	105
74166	161
74167	198
74170	230
74172	625
74173	170
74174	87
74175	87
74176	75
74177	78
74178	102
74180	85
74181	165
74182	90
74184	135
74185	135
74188	275
74190	115
74191	105
74192	105
74193	105
74194	105
74195	95
74196	99
74197	85
74198	150
75150	110
75491	75
75492	80

CMOS★

4000	15
4001	17
4002	17
4006	105
4007	18
4008	87
4009	50
4010	50
4011	18
4012	18
4013	42
4014	86
4015	89
4016	45
4017	89
4018	89
4019	48
4020	99
4021	91
4022	88
4023	20
4024	66
4025	19
4026	180
4027	45
4028	81
4029	99
4030	50
4031	205
4032	100
4033	145
4034	196
4035	111
4036	325
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	88
4045	145
4046	128
4047	87
4048	58
4049	48
4050	48
4051	72
4052	72
4053	72
4054	110
4055	128
4056	134
4057	2570
4059	480
4060	115
4061	2380
4062	999
4063	110
4066	58
4067	380
4068	22
4069BE	20
4070	32
4071	21
4072	21
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	995
4412F	1650
4415F	795
4415V	795
4419	280
4422	545
4433	1180
4435	825
4440	1275
4450	295
4451	295
4490F	695
4490V	525
4501	17
4502	120
4503	69
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98

LINEAR IC's

702	75
709C 14 pin	35
710★	48
723★	45
733★	99
741C★ 8 pin	22
747C★	70
748C★	36
753	150
810	159
8038CC★	335
AY-1-0212	580
AY-1-1313	660
AY-1-1320	305
AY-1-5050	180
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500★	385
AY-5-1224A★	260
AY-5-1230★	450
CA3011★	82
CA3018★	68
CA3020	170
CA3023	170
CA3028A★	80
CA3035	240
CA3043	190
CA3046	71
CA3048	200
CA3075	175
CA3080E★	70
CA3081	190
CA3089E	210
CA3090AQ	375
CA3123E	200
CA3130★	85
CA3140★	70
ICL7106E★	752
ICM7205★	1150
LD130★	452
LM300H	170
LM301A★	30
LM308	110
LM318★	195
LM324★	79
LM339★	80
LM348★	95
LM379★	375
LM380	95
LM381	145
LM381AN	248
LM382	125
LM1458★	50
LM3900★	60
LM3909N★	70
LM3911★	125
M252AA★	750
M253AA★	795
MC1303	88
MC1304P	260
MC1310	149
MC1312P	195
MC1488★	85
MC1489★	90
MC1495★	395
MC1496	92
MC1710	79
MC3401	69
MC3340P★	150
MC3360P	120
MC724★	175
MFC4000B	85
MFC6040★	97
MK50398★	635
MK50362★	650
MM2102-2★	170
MM2112★	105
MM2112-2★	295
MM57160★	620
NE518A★	210
NE555★	29
NE556DB★	60
NE560★	325
NE561★	385
NE562★	410
NE564★	425
NE565A★	120
NE566★	180
NE567★	170
NE571★	450
RAM2102-2★	170
RC4136D★	120
ROM2513★	595
SFF96364E★	1150
SG3402	295
SN76003N	175
SN76013N	140
SN6023N	140
SN76033N	175
SN76115N	215
SN76227	115
SN76477★	225
TAA621AX1	228
TAA960	300
TBA120S	70
TBA540Q	215
TBA550Q	330
TBA641BX11	250
TBA651	180
TBA800	90
TBA810S	99
TBA820	70
TBA920	260
TCA270	220
TDA1022★	575
TDA2020	320
TL061CP★	76
TL071CP★	76
TL081CP★	48
TL082CP★	84
TL084CP★	130
UAA170	198
ZN414	90
ZN424	130

TRANSISTORS

AC117★	35
AC125★	20
AC126★	20
AC127★	20
AC128★	20
AC141★	24
AC141K★	38
AC142★	24
AC142K★	38
AC176★	18
AC187★	20
AC188★	20
ACY17*	35
ACY18★	40
ACY19★	40
ACY20★	40
ACY21*	35
ACY22★	40
ACY28★	40
ACY39	78
ACY40★	48
ACY44	38
AD140★	70
AD149★	60
AD161★	42
AD162★	42
AF114★	25
AF115★	25
AF116★	25
AF117★	25
AF118★	55
AF121★	48
AF124★	55
AF125★	35
AF127★	35
AF139★	35
AF178★	70
AF180★	70
AF186★	50
AF239★	42
ASY26★	45
ASY27★	45
BC107★	9
BC107B★	10
BC108★	9
BC108B★	12
BC108C★	12
BC109★	9
BC109B★	12
BC109C★	12
BC113	17
BC114	19
BC115	19
BC116	19
BC117	15
BC118	11
BC119★	28
BC134	19
BC135	20
BC136	18
BC137	20
BC140★	28
BC142★	25
BC143★	25
BC147	7
BC148	7
BC149	8
BC153	14
BC154	14
BC157	10
BC158	11
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BC160	27
BC167A	11
BC168C	12
BC169C	10
BC170	17
BC171	11
BC172	10
BC177★	17
BC178★	17
BC179★	17
BC182	9
BC182L	10
BC183	9
BC183L	10
BC184	9
BC184L	10
BC186	21
BC187★	28
BC212	9
BC212L	10
BC213	9
BC213L	11
BC214	9
BC214L	10
BC307B	14
BC308	13
BC328	13
BC338	12
BC441★	30
BC461★	30
BC477★	16
BC547	11
BC548	11
BC549	11
BC557	13
BC558	12
BCY30★	57
BCY34★	63
BCY39★	80
BCY40★	78
BCY43	78
BCY58★	22
BCY59★	22
BCY70★	16
BCY71★	21
BCY72★	21
BCY78★	21
BD115★	62
BD121★	85
BD123★	98
BD124★	115
BD131★	38
BD132★	38
BD133★	43
BD135★	36
BD136★	37
BD137★	36
BD138★	36
BD139★	45
BD140★	36
BD142★	59
BD145★	198
BD222★	60
BD659A★	75
BD696A★	75
BDY17★	195
BDY60★	110
BDY61★	165
BF115★	22
BF154★	25
BF156★	29
BF167	25
BF173★	25
BF177★	24
BF178★	25
BF179★	30
BF180★	30
BF181★	30
BF182★	30
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BF184★	30
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BF195	10
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BF197	10
BF198	18
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BF244	24
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BF257★	29
BF258★	26
BF259★	32
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR79	28
BFR80	28
BFX29★	26
BFX81★	130
BFX84★	24
BFX85★	24
BFX86★	28
BFX87★	25
BFX88★	24
BFY18★	50
BFY50★	20
BFY51★	20
BFY52★	20
BFY71★	26
BSX20★	18
BSY65★	30
BSY95★	25
BSY95A★	25
BU105	140
BU205★	190
BU208★	225
E5567	65
MD8001★	158
ME4102	10
ME6002	14
MJ400★	90
MJ491	160
MJ2955★	95
MJE340★	45
MJE370★	55
MJE371★	60
MJE520★	45
MJE521★	65
MJE2955★	99
MJE3055★	70
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPSA05★	24
MPSA06★	24
MPSA12	42
MPSA55	24
MPSA56	24
MPSA70	34
MPSU02★	58
MPSU05	48
MPSU06	54
MPSU52★	65
MPSU55★	53
MPSU56★	56
MPU131★	39
OC25★	120
OC26★	150
OC28★	99
OC29★	160
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TIP30C	65
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TIP31B★	40
TIP31C★	66
TIP32★	45
TIP32A★	49
TIP32B★	70
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TIP33★	80
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TIP33C★	105
TIP34★	85
TIP34A★	85
TIP34B★	110
TIP34C★	110
TIP35★	219
TIP35A★	225
TIP35C★	270
TIP36A★	265
TIP36C★	325
TIP41A★	63
TIP41B★	73
TIP42A★	64
TIP42B★	82
TIP2955★	63
TIP3055★	65
TIS43	36
TIS44	45
TIS46	45
TIS50	47
TIS60	45
TIS62	45
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX300	13
ZTX301	16
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ZTX311	17
ZTX314	24
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
2N526★	58
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2N706A★	19
2N707★	50
2N708★	19
2N914★	32
2N916★	27
2N918★	30
2N920★	51
2N930★	18
2N961★	61
2N1131★	22
2N1132★	22
2N1302★	35
2N1303★	50
2N1304★	50
2N1305★	28
2N1306★	35
2N1307★	60
2N1308★	46
2N1613★	23
2N1671★	190
2N1671B★	215
2N1893★	28
2N1986★	60
2N2160★	350
2N2217★	48
2N2218A★	31
2N2219A★	22
2N2220A★	26
2N2221★	23
2N2222★	20
2N2297	45
2N2303★	45
2N2368★	21
2N2369★	15
2N2476★	125
2N2483★	28
2N2484★	30
2N2646★	48
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2N2926R	8
2N2926Y	8
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2N3708	10
2N3709	10
2N3710	16
2N3711	10
2N3715★	250
2N3772★	170
2N3773★	288
2N3819	22
2N3820	32
2N3823★	65
2N3824★	70
2N3866★	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037★	52
2N4058	17
2N4061	17
2N4064★	120
2N4236★	145
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2N5485	32
2N5777★	45
2N6027	40
40311★	50
40313★	125
40316★	86
40317★	52
40324*	85
40326★	52
40327★	62
40347★	80
40348★	101
40360★	43
40361★	45
40362★	48
40407★	50
40411★	280
40412★	83
40467*	95
40576★	190
40594★	80

Matched pair add 10p per pair

ROOM THERMOSTAT

Famous Satchwell, elegant design. Intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30 C. Special snip this month **£3·25.**

ROD THERMOSTAT—£3·00.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make **£3·75.**

MICRO SWITCH BARGAINS

Rated at 5 amps 250V. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 (two types) for **£1·25.**

RADIO STETHOSCOPE

Easiest way to fault find, traces, signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set **£3 95.**

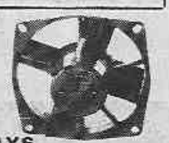
MULTISPEED MOTORS

Six speeds are available 500, 800 and 1,000 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price **£2.**

12V MINIATURE RELAY

dc operated with two sets of change over contacts. The unique feature of this relay is its heavy lead out wires; these provide adequate support and therefore the relay needs no fixing; on the other hand there is a fixing bolt protruding through one side so if you wish you can fix the relay and use its very strong lead outs to secure circuit components—an expensive relay; but we are offering it for only **87p** each. Don't miss this exceptional bargain!

EXTRACTOR FAN



Ex computers—made by Woods of Colchester. Ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5" or 6½" dia. **£5, £6.**

MAINS RELAYS

With triple 10 amp changeover contacts—operating coil wound for 230V a.c. Chassis mounting one screw fixing. Price **£1·25**

BURGLAR ALARM ITEMS

(Circuit free on application)

Trigger mats 24" × 18"	£2·45
13" × 10"	£1·95
Relay 24 volt	85p
9-12 volt	95p
Alarm Bell 24 volt	£7·50
9-12 volt	£2·25
Mains	on application
Reset, Switch, ordinary	45p
Secret type with key	95p
Wire—100 metres	£1·50
24v Power unit mains operated	£5·35

MERCURY BATTERIES

Bank of 7 Mercury cells type 625 which are approx. ⅝in. diameter by ¼in. thick in plastic tube giving a total of 10·7V. Being in a plastic tube it is very easy to break up the battery into separate cells and use these for radio control and similar equipment. Carton of 25 batteries **£1·60.**

PP3/PP9 REPLACEMENT

Japanese made in plastic container with leads size 2in. × 1½in. × 1½in., this is ideal to power a calculator or radio. It has a full wave rectifier and smoothed output of 9V suitable for loading of up to 100mA. **£2·53.**

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in. × 18in. **£2·50.** 13in. × 10in. **£1·95.**

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer, rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **£1·95.**

DRILL CONTROLLER

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

Made up model £1·00 extra

8 POWERFUL BATTERY MOTORS

For models, Meccanos, drills, remote control planes, boats, etc. **£2.**

ROTARY PUMP

Self priming, portable, fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertiliser, chemicals, anything liquid. Hose connectors each end. **£2.**

SHORTWAVE CRYSTAL SET

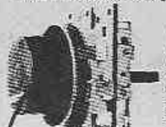
Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

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 and complete with a pair of speakers 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 **£15** including VAT and postage.

HUMIDITY SWITCH

American made by Ranco, their type No J11. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch adjustable by a screw, quite sensitive—breathing on it for instance will switch it on. Micro 3 amp. at 250V a.c. Overall size of the device approx. 3¾ in long, 1 in. wide and 1¾ in. deep **75p.**



DELAY SWITCH

Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact **95p.**

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. **£3·50**

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied Model 1153 500mW, power, output **£1·69**

Model 1172—10 watts power output **£3·94**
Model 1172 1W. power output **£2·25**
Model EP9000 4 watt power output **£2·90**
EP 9001 twin channel or stereo pre-amp **£2·90**

TANGENTIAL HEATER UNIT

3KW MODEL
£5·95
+ £1·50 P & P

A most efficient and quiet running blower-heater by Solatron—same type as is fitted to many famous name heaters—Comprises mains induction motor—long turbo fan—split 2 kw heating element and thermostatic safety trip—simply connect to the mains for immediate heat—mount in a simple wooden or metal case or mount direct onto base of say kitchen unit—price **£4·95** post **£1·50** control switch to give 2kw. 1kw, cold blow or off available **60p** extra.

2 k.w. model made in metal case with control switch **£12·00**

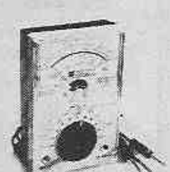
THERMOSTATS

Refrigeration as illustrated with 36" capillary **£1·62.**
Limpet Stat must be mounted in close contact calibrated 90°-190°F 15 amp contacts **£1·62.**
Appliance Stat fix like a volume control—15 amp contact 30°-80°F **85p.**
ditto but for high temps **£1·25.**
Over Stat—with Serson and capillary **85p**
Wall Mounting by Satchwell **£3·00**
Boiler Stat. with control 20°-80°C **£2·16**

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0-1 mA and 0-100 mA
Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only **£6·50 + 50p** post and insurance.

FREE Amps ranges kit enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send **£1·50p.**

TERMS: Cash with order—but orders under **£6** must add **50p** to offset packing, etc.

BULK ENQUIRIES INVITED. PHONE: 01-688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. P.W.), 103 TAMWORTH RD., CROYDON CR9 1SG

IT'S FREE

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

Telephone Ringing Mains Unit Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25 Hz, this frequency gives correct ringing note for GPO bells. These units were made for the GPO so obviously are first class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price **£3·20.**

Telephone Extension Bells in bakelite wall box, these will save you missing calls when you are out in the garden or shed, etc. Price **£3·16.**

Variable Mains Supply A bench mounting unit which contains an isolation transformer for safety and a 2 amp variac for adaptability. With this you will be able to get continuously variable mains supply from zero to full voltage at 2 amps. A real time saving device, price only **£20·75.**

Answering Machines still available as last month's newsletter but supplies are going down rapidly and this may well be your last chance to acquire one of these.

A very large purchase this month enables us to offer a range of radio items. You will find the prices well below average:

Cassette Recorder/Player Japanese or Hong Kong made, these have all the normal facilities record, playback, fast rewind, etc., also sockets for stop/start, microphone, earphone and lead for mains as these operate from mains or HP1 batteries. **£12·50.**

Six Transistor Pocket Radios Medium wave only but with Radio 2 and Radio 4 changing places, Medium wave is all the average listener will want in the future. These little radios would make a lovely gift for a child. Modern design and in popular colours, please state preferred colour and give an alternative, price only **£1·50.**

AM/FM Radios There's no doubt that FM does give better reproduction in good areas so a more adult member of the family will be pleased with one of these. The ones we have are in leatherette cases and are battery/mains radios having the mains unit built in and are complete with mains plug. These cover medium wave and VHF with optional AFC. Price **£6·75.**

8 Track to Cassette Adaptors Cartridges are going out of popularity, cassettes on the other hand are being made in increasing numbers and cover practically every field of sound entertainment. Cassettes can be played in 8 track if you have an adaptor. We offer these adaptors complete in carrying case and the price is only **£8·50.**

Soft Toy Radios Not necessarily only for the younger members of the family as these are soft and cute and have universal appeal. Dolls, poodles, elephants and rabbits each with zip compartment at the bottom where the radio fits. Medium wave only, working from PP3 batteries. When ordering please state preference and if possible give an alternative. **£4·50.**

5 Band Portable. A very impressive radio in black imitation crocodile case, size approx. 12in. wide, 7in. high and 4in. deep. This has metal embellished carrying handle and a pullout chrome plated FM aerial, covers the following bands AM 535 to 1605 kHz, FM 88 to 108 MHz weather band 162.5 MHz and it has a logging scale. This battery/mains radio has the built in mains unit also serves as a charger if you use rechargeable batteries. The mains lead with plug tucks away in its own compartment, another feature is a dial indicator which shows state of batteries. A real snip at **£10·50.**

Car Battery Power Unit made for Rank Radio. This unit has been designed to operate 6V battery powered equipment from a 12V car battery, it provides a reliable source of stabilised voltage and gives protection to your equipment in case of accidental reversal of connections also against excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instument being played is not connected to the car chassis. A real bargain at **£2·20.**

Extension Speaker Cabinets A new delivery of these enables us to bring down the price quite a lot. We can now supply the smaller ones (11in. × 8in. × 4½in. approx.) at **£1·95.** Post £1·00 and we have a larger one with a silver finish size approximately 12½in. × 9in. × 5½in. Price of this is **£1·69,** post £1·50. If you can call and collect these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a speacial rate of 25% if you buy four or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

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

Six Digit Counter Mains operated, 1 pulse moves counter through one digit, not resettable but all you have to do is to make note of the numbers before the start of each count. Real bargain at **80p**

Be Prepared For possible blackouts and interruptions in electricity supply this winter! Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12in tubes from 12V car battery and the price is still the same **£3·95** plus 50p post complete with a 21in tube.

Stereo Car Speakers usual type in neat compact enclosures for the rear shelf of the car. 8 ohms 5 Watt **£5·50** per pair.

Bleepers 6/12V battery or transformer operated, ideal for using in many alarm circuits but particularly for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarms. Price **£1·08** + 8p. Large quantities available.

Most Useful Timer Up to 12 on/offs per 24 hours is what you can get from the Venner time switch if you fit our adaptor. The shortest on/or off time is one hour but you can use any combinations of on/off to make up the 24 hours. An obvious use for this is to control immersion heaters. These are real current consumers and even though the thermostats are working properly, economies can be quite considerable if a time switch is used. Our Venners are all capable of 20 amp switching. There are of course many other applications for the time switch, which you will remember in its basic form follows the sun switching on at dusk and off at dawn. Price **£3·24** plus 50p post for switch with adaptor, extra for plastic case **£1·08** or metal case **£2·16** + 16p.

Safe Soilstat For growers who use soil heating on benches, economies can be made by using a thermostat but if mains voltage equipment is used then the thermostat must be enclosed in a waterproof and earthable container. We can now supply this price **£3·78** + 28p. This container will accept the normal immersion heater type thermostat but for soil heating you want one which covers 50 deg. farenheit and upwards, we can supply these at **£3·20.**

Motorised Light Flasher We can offer two motorised units both capable of 2 000W of light. Our ½ second flasher changes every ½ second and the 2 second flasher changes every 2 seconds. Either type **£6·40.**

Frightening Fuel Bills could lose some of their sting if you fit double glazing but even if the fuel bill does not come down much you will have a more comfortable home less draughts, etc. Double glazing frames, movable in the Spring, can be quite easily made using rigid PVC sheetings. We have this, it is as clear as glass and virtually as everlasting. It is easy to fit as you can cut it, bend it, nail it, etc. A recent purchase enables us to offer this at well below current price. It is 600mm (23½in wide) and available in any length (it rolls up like lino). Price 15p per sq ft. Minimum order 20 sq ft for **£1·05** post 50p orders over £6·00 post free, longer lengths price negotiable.

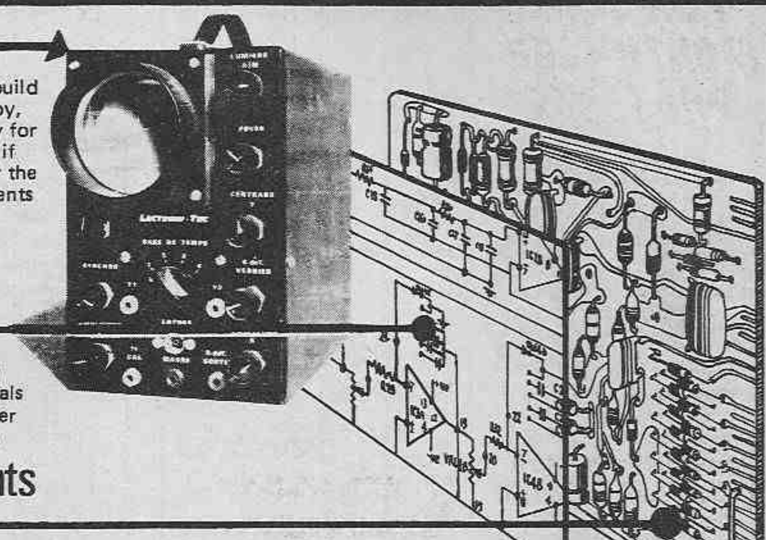
LOOK ! Here's how you master electronics.

.... the practical way.

This new style course will enable anyone to have a real understanding by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.



1. Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

2. Read, draw and understand circuit diagrams.

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

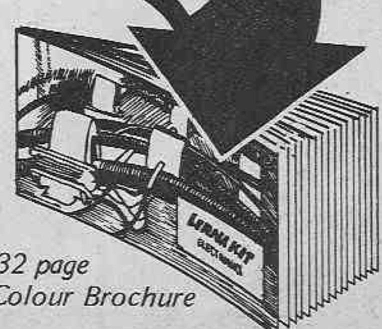
3. Carry out over 40 experiments on basic circuits.

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.

4. Free Gift.

All students enrolling in our courses receive a free circuit board originating from a computer and containing many different components that can be used in experiments and provide an excellent example of current electronic practice.

FREE



32 page Colour Brochure

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P.O. Box 156, Jersey, Channel Islands.

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EEB2/79

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VPS30 Variable Regulated Stabilised Power Supply Module

Incorporating a short circuit protection and current limiting:

Voltage Regulation	2-30V
Regulated Current	0-2A
AC Input Maximum	25V

Eliminates the use of batteries and thus saves £'s-can be used time and time again ONLY **£7.60** + V.A.T.

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ITT 923 Silicon Diodes 200mA 200v.

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Single Sided Fibre Glass Board 12" x 3½" approx. 2 pcs **£0.60**
S143

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No. THY1A/50	1 Amp	50 volt	TO5	18p
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No. THY3A/200	3 Amp	200 volt	TO64	32p
No. THY3A/400	3 Amp	400 volt	TO64	40p
No. THY5A/50	5 Amp	50 volt	TO66	25p
No. THY5A/400	5 Amp	400 volt	TO66	40p
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DIACS

ITT.	V413 equt	12p
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All 3 at SPECIAL PRICE of £1.20*

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All 4 at SPECIAL PRICE of £1.60*

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Order No.		
16213	60¼W.	100 ohm – 820 ohm
16214	60¼W.	1K – 8.2K
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No. MVR7912	μA7912	TO220	75p
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μA723C TO99 **38p** 72723 14 pin Dil **38p**
LM309K TO3 **£1.20**

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Code No's shown below are given as a guide to the type of device. The devices themselves are normally unmarked.

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No. 16133	150 75mA Sil. Fast switching diode like IN4148	40p
No. 16134	50 750mA Sil. top hat Rects.	40p
No. 16135	20 3 amp Sil. stud Rect.	40p
No. 16136	50 400mw Zeners D.O./ case	40p
No. 16137	30 NPN Plastic trans. like BC107/8	40p*
No. 16138	30 PNP Plastic trans. like BC177/8	40p*
No. 16139	25 NPN trans. like 2N697/ 2N1711 TO39	40p
No. 16140	25 PNP trans. like 2N2905 TO39	40p
No. 16141	30 NPN trans. like 2N706 TO18	40p
No. 16143	30 NPN Plastic trans. like 2N3906	40p*
No. 16144	30 PNP Plastic trans like 2N3905	40p*
No. 16145	30 PNP Germ. trans. like OC71	40p
No. 16147	10 NPN to 3 Power trans. like 2N3055	80p

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2 amp 750mW

	VCE	VCB	HFE	
NKT301	40	60	30-100	35p per pair
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NKT303	20	30	30-100	25p per pair
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From U.S.A. *by* DINDY
SCREW CASED
LOW NOISE CASSETTES
C90

Order No. S53 **10 for £3.50***

HEAD-CLEANING CASSETTE **45p** each

AUDIO AMPLIFIER RETURN OF THE AL20A

By popular demand – this useful 5 watt RMS Power Amplifier is offered at the re-introductory price of **£2.75*** – Hook-up data supplied.

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Order No. 1609 **50p each**

UNIJUNCTION TRANSISTORS

UT46 TIS43 **20p**

FET's

2N3819 **15p** 2N5458 **18p**

2 AMP. BRIDGE RECTIFIERS

Metal Stud Mounting

No. S45	50V	(KBS 005)	28p
No. S46	100V	(KBS 01)	30p
No. S47	200V	(KBS 02)	34p

SILICON BRIDGE RECTS.

S99 Mixed Pak 2 – 5 Amp. 50–600v. All coded. 4 for **£1.00***

SILICON RECTS.

SIMILAR IN4000 SERIES

No. S41	25 Like IN4001 (1A 50V)	60p
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SALE T-T-TIME again!

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16168	5 pieces Assorted Ferrite rods	40p
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16177	1 pack Assorted Hardware nuts/bolts etc.	40p
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16180	15 Assorted control knobs	40p
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16188	60 ½W resistors mixed values	40p
16187	30 metres stranded wire assorted colours	40p
S100	120 ½ watt resistors. Pre-formed. 1978 Prod. Our mix	60p*
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S102	250 ⅛ watt resistors. Range 100 ohms – 1.8 meg.	£2.00*
S103	220 ½ watt resistors. Range 100 ohms – 10 meg.	£2.00*
S104	60 Low ohms ⅛ watt resistors. 10 – 100 ohms	60p*
S105	40 Low ohms ½ watt resistors. 12 – 100 ohms	60p*
S106	25 Mixed wirewound resistors	60p*
S107	20 Tantalum bead caps 0.22 – 100mF Our mix	£1.00*
S108	High quality electrolitics 10mF–500mF voltage range 15–50v. Our mix. 40 for	£1.00*
16204	C280 Pak. Contains 50 metal foil caps	£1.00*

POTENTIOMETERS

Slider 40mm TRAVEL

Order No.			
16191	6 x 470 Ohm	LIN Single	40p*
S24	6 x 1 K	LIN Single	40p*
S25	6 x 5 K	LIN Single	40p*
16193	6 x 22 K	LIN Single	40p*
16195	6 x 47 K	LOG Single	40p*
16194	6 x 47 K	LIN Single	40p*
S27	6 x 100 K	LIN Single	40p*
S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*
S32	6 x 50 K	LIN Single	40p*

Slider 60mm TRAVEL

S30	6 x 2.5 K	LOG Single	40p*
S34	4 x 5 K	LOG Dual	40p*
S36	4 x 100 K	LOG Dual	40p*
S37	4 x 1.3 MEG	LOG Dual	40p*
S94	6 x 220 K	LIN Single	40p*
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S98	2N5293 R.C.A. 36w 4 Amps 75Vceo Hfe 30 120. 5 for	£1.00*

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S124 6 x 741P **£1.00**
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S137 20 Assorted Slider Knobs – Chrome/Black **£1.00***

S131	2 x 12v Relays plastic case	£0.70*
S132	2 x 24v Relays plastic case	£0.60*
S133	1 switch bank 5 way incl. silver knob	£0.75*
S134	2 x Magnets suitable for reed switches	£0.10
S135	.1 Veroboard pak 2 pcs 45 sq.ins. approx.	£0.80
S136	.15 Veroboard pak 2 pcs 60 sq. ins. appx.	£1.10
16199	.1 Veroboard pak pcs 30 sq. ins appx.	£0.50
16200	.15 Veroboard pak pcs 30 sq. ins. appx.	£0,50

TOOLS

No. 2011 5"wire cutters **£1.55**
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SUPER DUPER COMPONENT BOX

Min. 3lbs in weight consisting of a fantastic assortment of Electronic Components – Pots, Resistors, Condensers, Switches, Relays, Board – Semiconductors, wire, hardware, Etc., etc..

This is a large box and is sent separate to your order **£2.50** including p & p.
S140

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COMPLETE AUDIO AMPLIFIER KITS:

STA15 15 watts per channel amplifier kit Consists: 2 x AL60–1 x PA100–1 x SPM80 1 x 2034 transformer– 2 x coupling capacitors **£37.70incVAT** + .86p p0p

STA25 25 watts per channel amplifier kit. Consists: 2xAL60–1xPA100–1xSPM120/45 1x2040 Transformer –1xreservoir cap 2xcoupling capacitors **£41.45incVAT** + £1.16p p& p

STA35 35 watts per channel amplifier kit. consists: 2xAL80–1xPA100–1xSPM120. 1x2041 transformer— 1 reservoir capacitor 2xcoupling capacitors **£48.45inc VAT** + £1.16p p & p

STA50 50 watts per channel amplifier kit. Consists: 2xAL120–1xPA200–1xSPM120/65 1x2041 transformer –1xreservoir capacitor 2xcoupling capacitors **£58.20incVAT** + £1.10p p & p

STA125 125 watts per channel amplifier kit. Consists: 2xAL250–1xPA200 –2xSPM120/65 2x2041 transformers– 1xreservoircapacitor 2xcouplingcapacitors **£72.85incVAT** + £1.25p p & p

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TRANSISTORS

BRAND NEW — FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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AC126	14p	BC178	12p	BF195	*9p	TIP32B	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	BC182L	*9p	BF200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	*9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	BC184L	*9p	BFY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
AD161		BC213	*10p	MPSA05	*22p	ZTX107	*6p	2N2369	10p
162MP	80p	BC213L	*10p	MPSA06	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	BC214	*10p	MPSA55	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	BC214L	*10p	MPSA56	*22p	ZTX300	*7p	2N2905	14p
BC107	6p	BC251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
BC108	6p	BCY70	12p	OC45	12p	ZTX302	*9p	2N2906	12p
BC109	6p	BCY71	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
BC118	*10p	BCY72	12p	OC72	12p	ZTX501	*10p	2N2907	12p
BC147	*8p	BD115	*40p	OC75	10p	ZTX502	*12p	2N2907A	13p
BC148	*8p	BD131	*35p	OC81	14p	2N696	10p	2N2926G	*8p
BC149	*8p	BD132	*37p			2N697	10p	2N2926Y	*7p
BC154	*16p	BF115	17p	TIP29A	35p	2N706	7p	2N3053	12p
BC157	*9p	BF167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
BC158	*9p	BF173	20p	TIP29C	38p	2N708	8p	2N3702	*7p
BC159	*9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	*7p
BC169C	*10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	*6p
BC170	*6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	*11p
BC171	*6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	*11p
BC172	*6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	*11p
BC173	*7p	BF185	25p	TIP31C	34p	2N1309	22p	2N3906	*11p

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p					IN5402	12p
BA148	10p	BYZ10	32p	OA47	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA70	5p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA79	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p	OA81	7p	IN4148	4p	IN5408	19p

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LM381	£1.25*	UA741C	£0.20	NE555	£0.22
72709	£0.20	72747	£0.55*	SL414A	£1.80*
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ZN 414 RADIO CHIP 75*

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

For the majority of our fellow countrymen, the big technological discovery of 1978 was the silicon chip. One day last June the Government became aware of the infinite power of this tiny package. Earnest ministerial pronouncements plus feverish activity by the Department of Industry and the setting up of a national microelectronics company alerted the national media. By the autumn silicon chip (alias *silicone)* was the new phrase buzzing up and down the country.

All this was rather amusing to students of electronics. After all, constructors had been living with and making practical use of silicon chips for close on 10 years. What is sometimes referred to as a technological revolution has really been a continuing process, ever since the transistor went into production. But a major breakthrough undoubtedly occurred with the achievement of embodying within a single chip the central part of an electronic computer, which we now know as a microprocessor.

The microprocessor has unleashed electronic computing capability in such a compact and convenient form that any limit to its ultimate application cannot be visualised. Small computers for use in the home and school, as well as for professional people and small businesses, are already available. What is more, minicomputers can be built by constructors. Thus a new growth area for the amateur enthusiast is opening up.

Home or hobby computing will attract those who have a yen for compiling programs and who revel in grappling with the kind of higher intellectual problems that are grist to the computer CPU.

With all that is happening in the field of small computers it is important to realise that microprocessors do not limit their application to these machines. Far from it. For the microprocessor is going to play an ever increasing role in electronics generally. Preprogrammed by the manufacturer to perform one specified routine, the "dedicated" microprocessor chip is a component to be reckoned with, in home constructor circles no less than in industry. We can expect the opportunities for the amateur to widen thanks to this device. Inwardly highly complex but externally simple to build, microprocessor-based projects will be exciting and revealing in the functions they provide.

This month's microprocessor-based *Microchime* musical door bell is an appropriate project to herald in the New Year. A year that is full of promise for the electronics enthusiast, that we are confident.

Fred Bennett

Our March issue will be published on Friday, February 16. See page 91 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.

Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

Component Supplies

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

Everyday ELECTRONICS

VOL. 8 NO. 2 FEBRUARY 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Back issues of EVERYDAY ELECTRONICS June 1977 onwards (October to December 1977, January to March 1978 NOT available) are available world-wide at a cost of 60p per copy inclusive of postage and packing. Orders and remittance should be sent to: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

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BEGINNERS
YOUR INTRO TO ELECTRONICS
SQUARE ONE

LONG WAVE CONVERTOR FOR 4

By F. G. Rayer

If you have a radio in use which does not include long waves, you cannot receive Radio 4 on 200kHz or 1500 metres with it. The single transistor convertor described here overcomes this.

Its purpose is to receive Radio 4 on 200kHz and change this frequency to one falling in the range 490 to 550kHz, so that it can be tuned in near the low frequency end of the medium wave band.

CIRCUIT DESCRIPTION

The circuit diagram of the Long Wave Convertor is shown in Fig. 1.

Coil L1 is the ferrite rod winding, tuned to 200kHz by means of the parallel capacitors C1 and C2. Capacitor C3 couples the signal to the base of TR1, which functions as a self-oscillating mixer, coil L2 being the oscillator coil. Capacitors C5 and C6 determine the oscillator frequency.

In all cases L1 will be tuned to 200kHz, trimmer C2 being adjusted for best reception of Radio 4.

The difference between this frequency, 200kHz, and the frequency of L2 determines the new frequency at which Radio 4 will be found. For example, if L2 is tuned to 700kHz, the difference is 700−200=500, so Radio 4 will be tuned in at 500kHz on the medium wave band. Similarly, if L2 is set at 800kHz, Radio 4 appears at 600kHz.

As trimmer C6 is adjusted, the spot on the medium wave tuning scale of the receiver where Radio 4 is heard will move up or down the scale. It is essential to set C6 so that Radio 4 comes at a position where a normal medium wave station is not heard.

The range obtained with C6 only is 490 to 550kHz, but the signal can be shifted to a frequency higher than 550kHz by slightly unscrewing the core of L2.

OUTPUT LOOP

The signal from the convertor is then coupled to the m.w. radio by means of an output loop, L3.

This is twelve turns of thin insulated wire, 25 to 32mm in diameter. Its ends are about 150mm long, and go to the pins on the board.

The loop is placed under or behind the receiver, or on one side, as found to give a satisfactory signal input to the receiver. It can be secured with adhesive tape if necessary.

Coupling into the receiver depends on the internal layout of the latter. It may be possible to make use of an internal aerial coupling winding and socket. An alternative is a small loop of a few turns under or behind the radio. For specialised or older receivers operating from an external aerial, the loop can be near the aerial lead, or coupling can be by a 22pF capacitor from point *A* on the circuit to the receiver aerial socket.

COMPONENTS approximate cost £3.50 excluding case

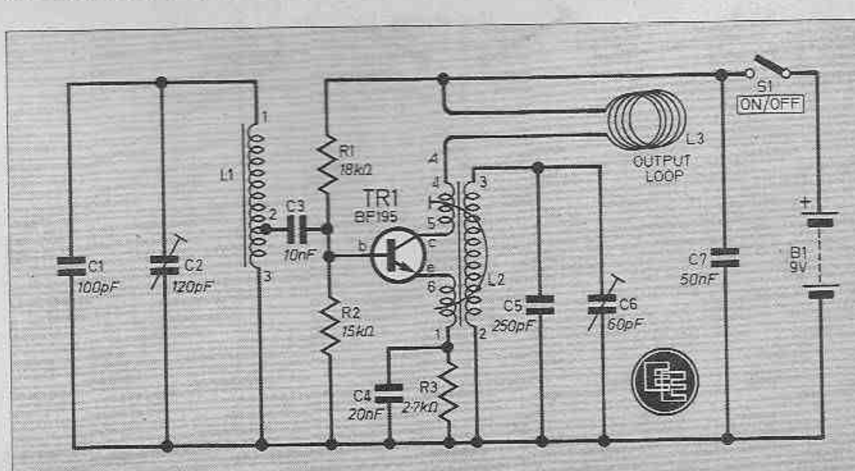
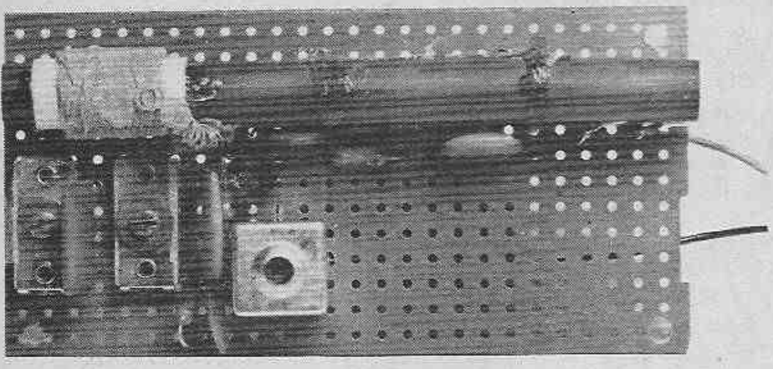


Fig. 1. Complete circuit diagram of the Long Wave Convertor.



LONG WAVE CONVERTOR FOR 4

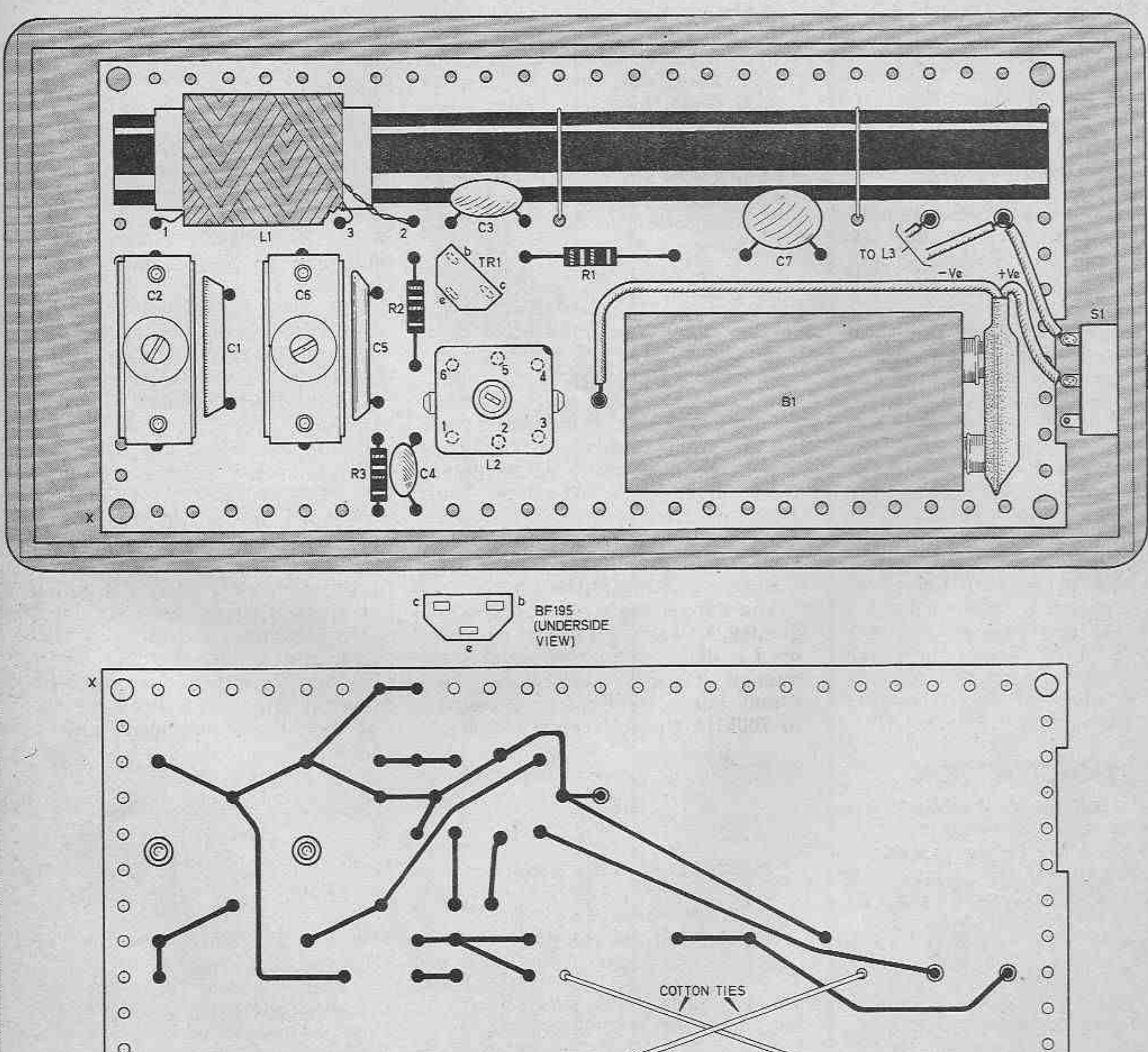


Fig. 2. Wiring details for the unit, showing top and underside. Note how the ferrite rod is held in place using cotton. A small cut-out is required on the matrix board to clear the switch. If a larger case is used then this will not be necessary. The board was not fixed down, being held in place by the battery and lid.

CONSTRUCTION starts here

Complete wiring details for the convertor is shown in Fig. 2. When mounting coil L2, note that pins 1 and 2 are closer together than pins 2 and 3, and must be mounted this way. It is necessary to enlarge the holes in the board to accommodate the tags and fixing lugs.

A piece of wood about 6mm thick is placed under the ferrite rod, which is held with adhesive and cotton through the board. Coil L1 is the long wave section of an easily obtained aerial with the medium wave section removed. Take care to identify the outer ends 1 and 3, and the tap, lead 2 correctly.

ADJUSTMENTS

No results will be obtained until L1 is tuned to 200kHz, and L2 is set to a frequency to suit the receiver.

Initially place L1 about 5/16 in from the end of the rod, and screw C2 nearly fully down. Once Radio 4 has been received. set C2 for best volume. If necessary, slightly move L1 on the rod, and secure it with adhesive when it is found that C2 allows correct tuning. They should then be left set for best volume.

Rotate the core of L2 until it is about 1/16 in below the top of the coil. Tune the medium wave receiver to somewhere in the range 490 to 550kHz, and rotate C6 slowly until Radio 4 is heard. Small adjustments of C6 will move Radio 4 as found on the m.w. radio, so C6 must be set so that Radio 4 appears at a spot where m.w. signals are not heard. This will generally be easy during daylight hours, but must be checked after dark when more signals are present. Leave L1 and C2 as they are, but adjust C6 *very slightly* and re-tune the receiver as necessary. If it is wished to tune above 550kHz, unscrew the core of L2 slightly, as required.

IN USE

To change from ordinary m.w. reception to radio 4, switch on the convertor and tune to the position on the scale that you have arranged shall be used. No further trimming is needed, as tuning is with the m.w. radio in the usual manner.

COMPONENTS

See Shop Talk page 92

Resistors
- R1 18kΩ
- R2 15kΩ
- R3 2·7kΩ
- All ¼W carbon ±5%

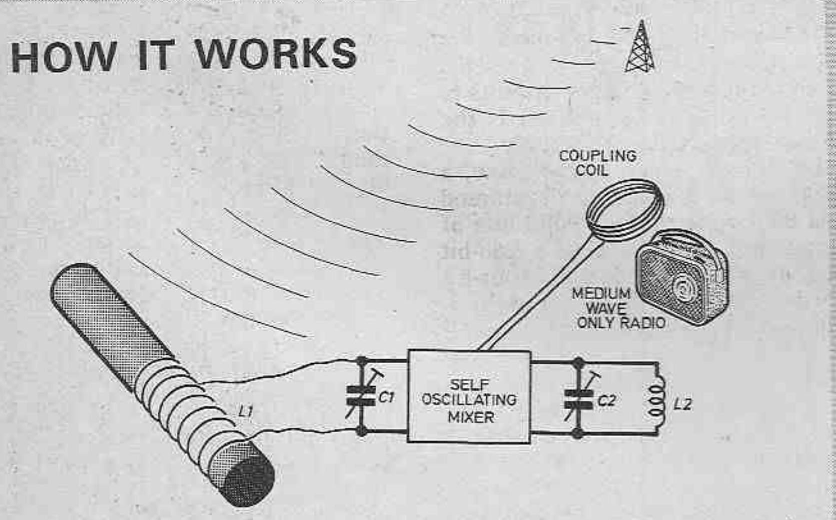
Capacitors
- C1 100pF 5% silver mica
- C2 120pF compression trimmer
- C3 10nF ceramic
- C4 20nF ceramic
- C5 250pF 5% silver mica
- C6 60pF compression trimmer
- C7 50nF ceramic

Semiconductors
- TR1 BF195 *npn* silicon

Miscellaneous
- L1 Ferrite rod aerial, type MW/LW 5FR
- L2 TOC 1 oscillator coil
- L3 coupling loop (see text)
- S1 miniature single pole slide switch
- B1 9V PP3 battery

Matrix board 0·15 inch, 26 × 13 holes; battery connector; small plastic case 127 × 60 × 38mm or similar; cotton thread; small piece of wood; connecting wire.

HOW IT WORKS



The ferrite aerial, *L1* together with the trimmer capacitor *C1* are precisely adjusted to resonate at a frequency of 200kHz, this is the frequency of Radio 4 on long waves. The second coil, *L2* and trimmer *C2* are so adjusted that the mixing of the 200kHz signal, and the frequency of the oscillator will produce a difference frequency which can be received on an ordinary medium wave radio.

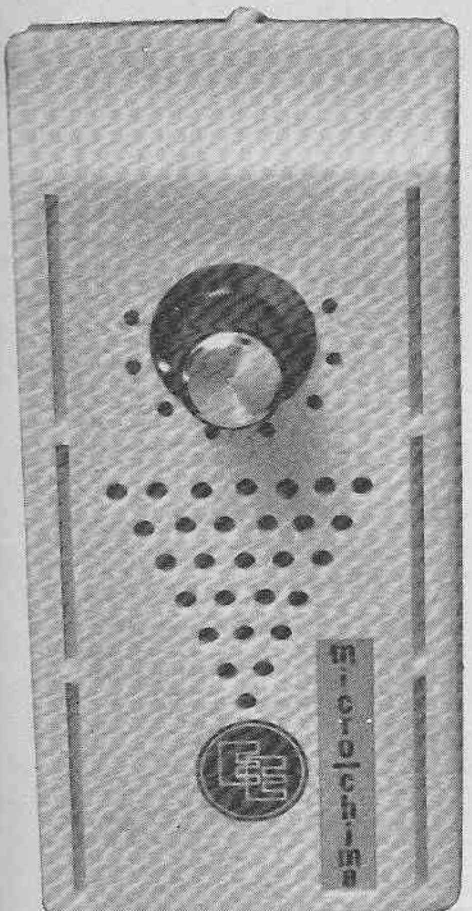
The difference frequency can be adjusted over a fairly wide range so that the Radio 4 signals can be heard in a quite section of the medium wave. With this unit no modification is required to the m.w. radio.

Remember it is essential to bring Radio 4 up at a spot on your tuning dial where m.w. transmissions are absent. It is also helpful to arrange coupling from the loop so that Radio 4 is strongly received with the volume control on the receiver only turned up a little.

Although essentially the convertor is an outboard unit, intended to be used with one of many different radios, there is no reason why it cannot be used as a "dedicated" device.

To do this, the component board can be made smaller if necessary to fit inside the radio, the ferrite aerial being mounted in any convenient position within the case. The ON/OFF switch can be mounted as required in a convenient position. Alternatively it may be possible to use switches already in the radio to perform this function.

Whatever method is chosen, however, the convertor will allow you not to miss your favourite Radio 4 programmes, whatever the "Beeb" do with the frequencies from now on! ⌑



A microprocessor at your door

By R. D. Palmer, B.Sc.

MICROCHIME

COOKHOUSE DOOR
SOLDIERS CHORUS (FAUST)
WILLIAM TELL OVERTURE
RED FLAG/MARYLAND/TANNENBAUM
THE STARS & STRIPES
BEETHOVENS ODE TO JOY (9th)
TWINKLE TWINKLE LITTLE STAR
GREAT GATE OF KIEV

Music playing computers have been about for quite a few years. Man has been devising machines which will perform music automatically for well over 600 years! Of course until the development of electronics all such automata were entirely mechanical. Some were highly successful, remember the Pianolla and the Barrel Organ?

In the 1950's there were some of the valved, killowatt gobbling monsters of the age programmed to do tuneful party pieces. Until comparatively recently only a few people had used this technique for any practical purposes, principly due to the extravagant cost and size of "mainframe" computers.

ECONOMICAL REALITY

Now, with the advent of the microprocessor and the further advance of being able to integrate on a single chip both the processor and the necessary ROM, RAM and I/O input output interface circuitry to make a one-chip computer, the use of this trick becomes an economic reality.

SINGLE CHIP MICROCOMPUTER

The first single chip microcomputer to go into really large scale production (several million units to date and still going strong) is the Texas Instruments TMS1000.

This device has a four-bit ALU, a 1024 word masked programmed ROM 8-bit wide making 8192 bits of permanent storage and a 256-bit RAM organised as 4 x 16 four-bit words. There are four input lines and two lots of outputs totalling 19 lines.

The control circuitry is driven from an on-chip clock oscillator. The frequency of this is set by means of an external resistor and capacitor. These components set the speed at which the system executes each instruction. When the oscillator is running at 400kHz each instruction takes 15μS to perform. There are 43 different instructions in the chip's repertoire altogether.

Now outwardly, this chip would seem a bright little beastie! But unfortunately it's not. Compared with most 8-bit microprocessors such as the 8080 or 6800 etc., it's very dim. However, this silicon dunce really scores high when you look at its relative cost compared to its much more accomplished cousins.

In a system for a dedicated function (that is, specifically programmed to do one set of tasks only, like the Microchime) the costs may be only one tenth. This is mainly due to the fact that nearly everything is on the same chip and you only need a few external components to make it work.

PROGRAM DEVELOPMENT

The instructions provided by the TMS1000 are fairly rudimentary, which means the programmer has

COMPONENTS approximate cost £10.50

to work overtime to execute trivial routines. The program development work must be done on a much bigger minicomputer since it is virtually impossible to write machine code and try it out on the device itself. The power of the minicomputer or mainframe gives the designer many resources to overcome the apparent shortcomings of the microcomputer.

Once all the development work has been completed the programmer's source program is put through a cross assembler. This is a special program which converts the original source which is a fairly ledgible form, to pure binary "object" for the TMS1000's ROM.

At this point in the development work can be checked by simulation on a big machine pretending to be a TMS1000. This can be somewhat labourious as it means going over literally yards of print out.

A MORE PRACTICAL METHOD

A more practical and usual method is to use the binary object program directly, either by feeding in a punched tape version of it into a TTL model of the TMS1000 called an HE-1 or alternatively "blowing" the program into a PROM. The PROM can then be used with a special version of the chip called the SE-1 which has no internal ROM. Thus a nearly perfect model of the final hardware can be checked in the proposed circuit of the eventual product. This must be thorough since even a tiny modification to the object code once it is committed to a mask is both an expensive and time consuming operation.

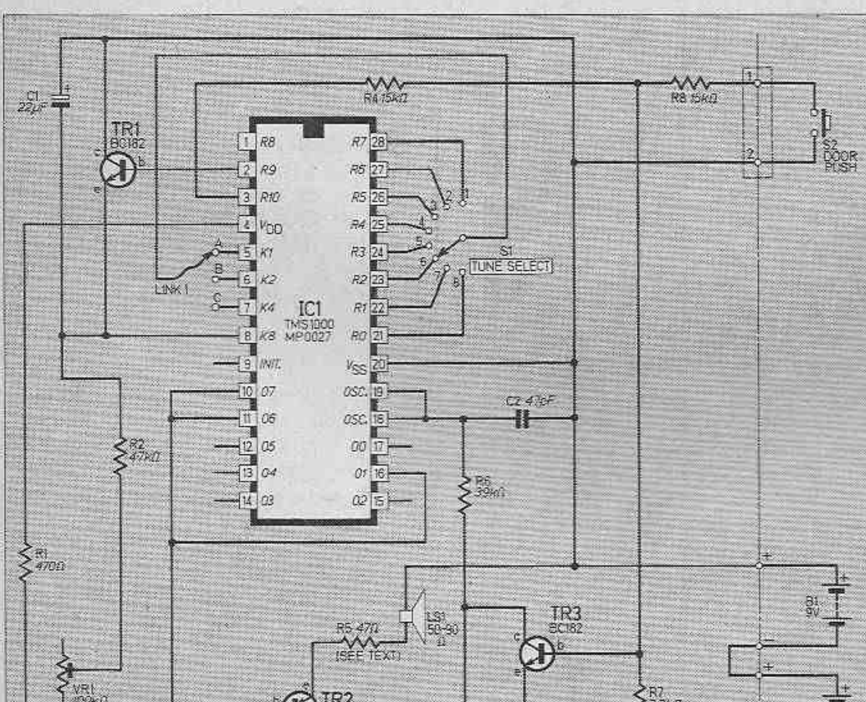
A copy of the final binary object in the form of a punched tape is sent off to the chip manufacturer together with a cheque for the equivalent of an arm and a leg! The tape is processed by yet another computer to produce an output to a digitally controlled mask cutting plotter.

Unlike a fully custom chip, the microcomputer only needs one mask to customize the internal ROM pattern. The large scale mask is then reduced in scale by the usual precision photographic step-and-repeat processes down to chip size. This mask forms one of the set used to manufacture the chips.

Once a few trial sample devices have been made using the custom mask, these can be tested in the product circuit. Provided they are proven 100 per cent, then large scale production may begin.

This is how Chromatronics of Harlow, Essex developed its processor for the World's first microcomputerised Door Chime after over two years work. The first model, the "Chroma-Chime" made use of the full capability of the chip to play 24 tunes with variable volume, tempo and timbre. The EE Microchime uses the same chip but with a simplified circuit to keep down the number of external components. The full type number for this dedicated chip is TMS1000N—MP0027A.

Fig. 1. Circuit diagram of the Microchime.



TUNE GENERATION

Basically all the tunes in the chip repertoire have been encoded into a digital binary form for storage in the ROM. For example, in a tune the note C=0001, D=0010, E=0011; similarly the length of each note is enclosed for example, semiquaver = 0001, quaver = 0010, crotchet = 0100, and so on.

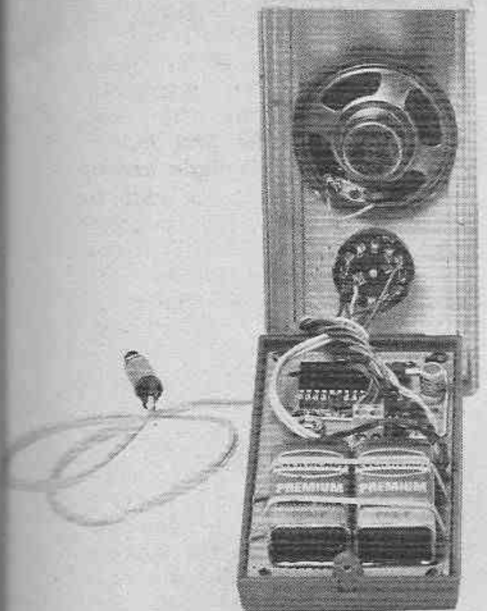
Approximately 700 of the ROMs "words" are used for music storage, the remainder are used for the operating program to select, decode and play the tunes.

The frequency of each note is determined by a timeline loop which counts a precise number (according to the note in the tune) of the machine cycles from the master clock oscillator. Each time the loop is completed an output from the chip is toggled to produce a square wave voltage. Since each note synthesised as a predetermined number of machine cycles, they cannot go out of tune with one another whatever absolute frequency the clock is running at.

The overall pitch of all the notes is then set by the clock, so it must remain stable throughout the execution of all the tunes. The timing for the duration, each note is set by an external time constant *(RC)* connected to an input pin. This is used to interrupt the synthesis loop routine to move one to a new note in the tune.

CIRCUIT DESCRIPTION

The microchime circuit (Fig. 1) is powered by two 9 volt batteries B1, B2, connected in series, giving 18 volt total output. Being standard P-MOS technology the chip IC1 needs a fairly high voltage to operate, but it can work at below 14 volts, allowing for battery run



down. Since the internal MOS f.e.t. transistors are negative in polarity (i.e. their sources connected to the positive rail, $+V_{ss}$) it is a good idea to regard the positive rail from the battery as *common*.

In the quiescent state there is no bias to the base of TR3, hence it is off. The function of this transistor is to turn the power to the chip on and off in order to save wasting power when the system is not playing a tune.

When the door push S2 is closed, the base of TR3 is biased via R8 and it turns on (saturated). Power is then applied to pin 4 (V_{dd}) via R1 to drop the voltage slightly; pin 20 (V_{ss}) is connected directly to the positive line. The clock timed by C2 and R6 starts immediately at about 400kHz. At this point the program starts, and after clearing all its resistors ready for action turns on its R10 output at pin 3. This holds on TR3 via R4, so that it does not matter if the door push is released in the middle of a tune.

TUNE SELECTION

Next, the program turns on in succession each of the outputs *R0* to *R7* to test the position of the Tune Select switch S1. The 24 tunes are arranged to be in three banks of eight. Thus, the position of the link (A, B or C) sets which bank is to be played. The connection between one of the *R0 to R7* outputs and one of the *K1* to *K4* inputs is detected by the program. (If there is no connection it will simply do nothing but scan *R0-R7* until there is).

This input data is used to address the correct tune in the ROM.

EXECUTION PHASE

The tune playing algorithm now comes into operation and the first note synthesised. Outputs *06* and *07* drive R3 with a square wave at a frequency between 550Hz and 200Hz. This is current amplified by emitter follower TR2 which feeds the loudspeaker LS1. R5 limits the current so as to not overdrive the speaker. If the speaker impedance is below 50 ohm, R5 must be increased to 100 ohms. The value of R5 can be increased anyway if the volume needs to be reduced. For example, to 220 or even 470 ohms.

As the note is played, C1 charges up via R2 plus VR1 the Tempo control. When the voltage reaches about −3 volts (ref. $+V_{ss}$), input *K4* senses and the program turns on R9 (pin 2) for a short period. TR1 saturates, discharging C1. This cycle repeats a number of times (between 2 and 16) depending on the length of note being played.

Then the program selects the next note and so on.

When the end of the tune is encountered by the program it turns off the output *R10*, turning off TR3 and shutting down the system.

CONSTRUCTION starts here

There are no special restrictions concerning arrangement of components on the circuit stripboard. However, the use of a socket or soldercon socket strips is recommended for IC1, as the chip is sensitive to damage by static electricity. The chip should be handled by the body only—without touching the pins—and only be inserted in its socket after all the soldering has been completed on the board. Incidentally, no damage would be done should the i.c. be inserted backwards—it just would not work.

For convenience, the Microchime is built into a small two-tone ventilated Verobox. This provides a very neat unit, but is a little restricting regarding the component layout and loudspeaker size. An alternative would be a hand-crafted, genuine tree wood, polished cabinet if you're good at that sort of thing. (Chromatronics can supply not only the chip but a purpose-designed, plastic case and p.c.b., etc., if you really would like to make construction easy.)

A hole must be drilled in the top of the Verobox for the switch S1, and also a number of small holes, closely grouped, to provide an aperture for the loudspeaker.

COMPONENTS

See **Shop Talk** page 92

Resistors

R1 470Ω
R2 4·7kΩ
R3 4·7kΩ
R4 15kΩ
R5 47Ω ½W (see text)
R6 39kΩ
R7 2·2kΩ
R8 15kΩ
All ¼W carbon, except where otherwise stated.

Potentiometer

VR1 100kΩ miniature skeleton preset

Capacitors

C1 22μF 25V (or higher) elect.
C2 47pF 5% ceramic or polystyrene

Semiconductors

TR1 BC182, BC172, or BC108
TR2 BC327, BFR61, or ZTX550
TR3 BC182, BC172, or BC108
IC1 TMS1000N-MP0027A—CS107-01 microcomputer (Available from Chromatronics, River Way, Harlow, Essex. £4·95 inclus.)

Miscellaneous

LS1 50-90 ohm speaker 57mm (2¼inch) diameter
S1 1-pole 8-position rotary switch
S2 Push-to-make 1-pole switch

Two-way terminal block, p.c.b. mounting type. Stripboard Veroboard 0·1 matrix 25 strips × 49 holes. Terminal pins. Verobox 65-2525F. Two 14-way soldercon socket strips (for IC1). Knob to suit S1. Two PP3 battery connectors. Two PP3 batteries.

MICROCHIME

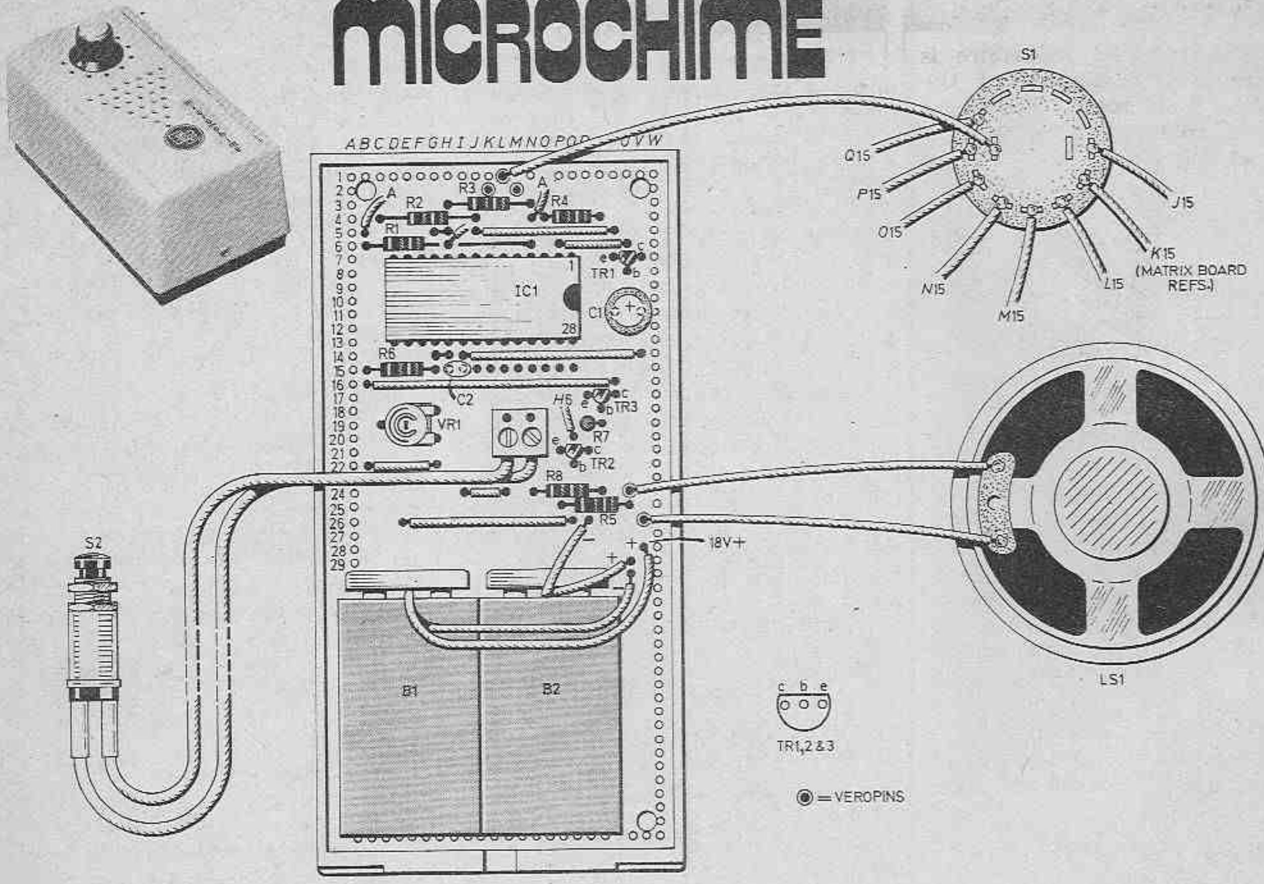


Fig. 2. Top view of circuit board with all components fitted and showing connections to Tune Select switch S1 and loudspeaker **LS1**.

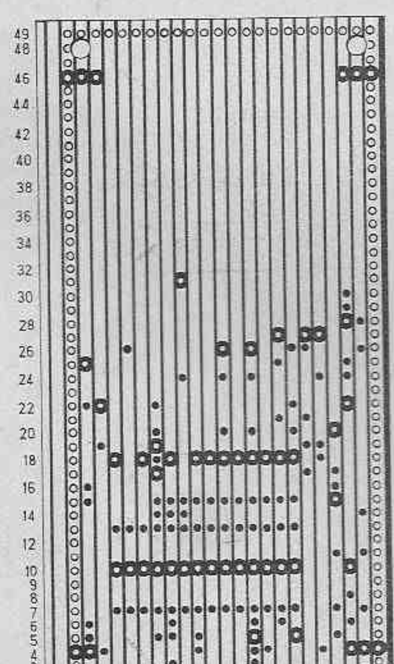
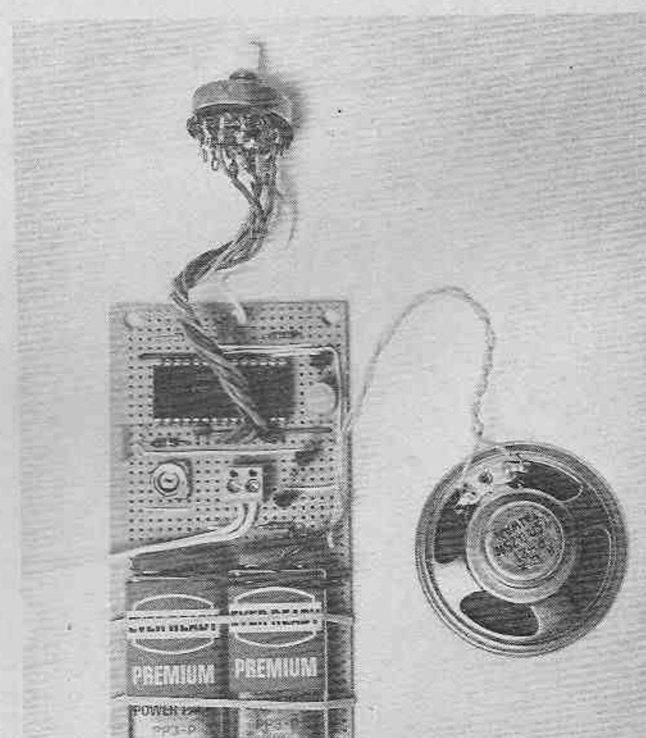


Fig. 3. Underside of stripboard showing all breaks in copper tracks and soldered connections.



CHOICE OF REPERTOIRE

Selection of tune repertoire is made by the positioning of the lead from S1 rotor. This lead should be soldered to pin M2, L1 or K2 as desired.

The tunes available are:

LINK A (pin M2)

1. *Oh Come All Ye Faithful*
2. *Oranges and Lemons*
3. *Westminster Chimes*
4. *Sailor's Hornpipe*
5. *Land of Hope and Glory*
6. *Rule Britannia*
7. *God Save The Queen*
8. *Greensleeves*

LINK B (pin L1)

1. *Soldiers Chorus (Faust)*
2. *Twinkle Twinkle Little Star*
3. *Great Gate of Kiev*
4. *Red Flag/Maryland/Tannenbaum*
5. *William Tell Overture*
6. *Beethoven's Ode to Joy (9th)*
7. *The Stars & Stripes*
8. *Cook House Door*

LINK C (pin K2)

1. *Mozart*
2. *Colonel Bogie*
3. *Wedding March (Mendelssohn)*
4. *The Lorelei*
5. *Toccata in D Minor (Bach)*
6. *Deutschland Uber Alles*
7. *The Marseillaise*
8. *Beethoven's "Fate Knocking"*

FAULT FINDING

1. No sound whatsoever

(a) Check the supply paths via TR3. When the pushbutton is pressed, the voltage from *c* to *e* of TR3 should go from nearly full battery volts to less than 0·5V (saturated condition).

(b) Check the chip supply current (4·5 to 8·5mA) by measuring the voltage across R1. This should be between 2 and 3 volts. If it is higher, but below 4 volts, then substitute a lower value for R1, for example 270 ohms.

(c) If the chip current is correct, check the output drive circuitry TR2, R3, R5 and the loudspeaker.

(d) Check the clock timing components R6 and C2. If you have an oscilloscope the waveform at pins 18 & 19 is triangular and at a frequency of 300 to 400kHz. If the frequency is too high, the chip will not operate properly and an additional capacitor of 10pF must be added in parallel across C2.

(e) If the connection between the *R0* and *R7* pins and *K1* to *K3* input pin via the selector switch S1 is not made, the chip will draw a continuous current and not play any tune.

2. Makes only a click sound

(a) Check C2 and R6 (see 1(d)).

(b) Check connections at pin 10 and 11.

(c) Is IC1 the right way round in its socket? (unlikely to damage it, but not recommended).

3. Plays seemingly random notes

(a) Is the voltage across the chip between 14 and 17·5 volts? (measured whilst the push-button contact is held closed). If not, check batteries, TR3 and see 1(a).

(b) See 1(d).

4. Plays a continuous note

(a) Is C1 the right way round, or short circuited?

(b) Check TR1 and R1, VR1.

One of the screw lugs on the bottom should be removed, leaving a slot to accommodate the door push lead when the top of the box is in position.

CIRCUIT BOARD

First prepare the underside of the stripboard by making the breaks as indicated in Fig. 3. Four screw-fixing holes should be made at the corners of the board, to align with the bushes incorporated in the bottom panel of the case.

Referring to Fig. 2, proceed to mount the components.

Mount the soldercon sockets (two 14-way strips), solder each individual socket to the stripboard. *Do not remove the connecting strip from the top of the sockets at this stage.*

Mount the two-way terminal block, and then the potentiometer VR1 (note one end of the track goes to an "isolated" hole in the stripboard). Mount the transistors, resistors (note vertical arrangement of R7) and capacitors (note polarity). Fit all link wires as shown in Fig. 2, using insulated wire.

Fit the five terminal pins (at K2, L1 and M2; and at U24 and V26. Wire up the switch S1 to the stripboard using 8 leads, each 6 inches in length (preferably different colours to aid tracing).

Solder two 6 inch leads to the loudspeaker, and solder the other ends to terminal pins at U24 and V26.

Wire up the two PP3 battery connectors to the stripboard: B1+ to U27, B1− to U30, B2+ to U29, and B2− to R26. The two batteries are secured to the board by a pair of rubber bands.

Fit the loudspeaker and the switch S1 to the case. The loudspeaker can be secured by a small amount of glue applied to its rim, at point of contact with case.

Connect the leads from the door push S2 to the terminal block.

MICROCOMPUTER CHIP

The microcomputer chip IC1 may now be taken from its protective packing. Do not handle this device unnecessarily, and then by the body only. Check that the "pins" are true and straight. If not, they may be carefully bent with long-nosed pliers. The two rows of pins are usually splayed out very slightly wider than the mounting holes in the i.c. socket. If this is so, gently push the i.c. down edgeways on the flat of the pins on to a hard surface, such as a wood or Formica work top.

Fit the microcomputer chip IC1 into its socket, right way round as shown in Fig. 2. Carefully align all the pins over the sockets, then push firmly down into position. The socket connecting strips can now be removed. This is done by gripping between a pair of pliers and easing gently to and fro until the strip parts company from the socket.

Fit the circuit board into the bottom part of the case, and secure with four screws. ⌑

DOING IT DIGITALLY

PART 5

Last month we saw how flip-flops can be cascaded to act as digital dividers. This month we begin with a close look at the 7490 i.c. which contains four flip-flops, three permanently wired in series.

COUNTER/DIVIDER IC

The 7490 i.c. contains a ready-connected series of flip-flops and associated control gates and connections, see Fig. 5.1. There are actually two dividers (or counters) in this i.c.

(1) Flip-flop *A:* Clock input at pin 14; $\overline{Q}$ output at pin 12 (*Note:* there is no Q *output)*. This single stage divides input frequencies by two.

(2) Flip-flops *B, C* and *D:* Clock input to *B* at pin 1; *Q* outputs at pins 9, 8 and 11. This divides input frequencies by five.

Inspection of Fig. 5.1 shows that the method of connecting the three flip-flops is different from that suggested previously. Can you work out how it operates? If not, do not worry—just accept for the moment that it does operate.

Flip-flop *D* is of slightly different type, a SET-RESET flip-flop. If when the clock goes low, its set (*S*) input is high, *Q* goes high; here the *S* input is fed from an AND gate. If the reset (*R*) input is high, *Q* goes low at the next falling clock pulse.

The flip-flops can be reset to zero by applying high input to *both* of pins 2 and 3, and low input to one or both of pins 5 and 6. A high input to both of pins 5 and 6 sets the outputs to read "9" on the binary scale (1001). If one or both of pins 1 and 2 *and* one or both of pins 6 and 7 are low normal division (or counting) occurs.

TEST-BED

Insert a 7490 i.c. in a socket on the Test-Bed patchboard, and make the connections indicated by Fig. 5.2. The four outputs are taken to the four in-built l.e.d.s which we shall designate *D, C, B* and *A* from *left to right*. Joining the output of flip-flop *A* (pin 12) to the input of flip-flop *B* (pin 1) connects all four flip-flops in series, giving a divide-by-10 circuit.

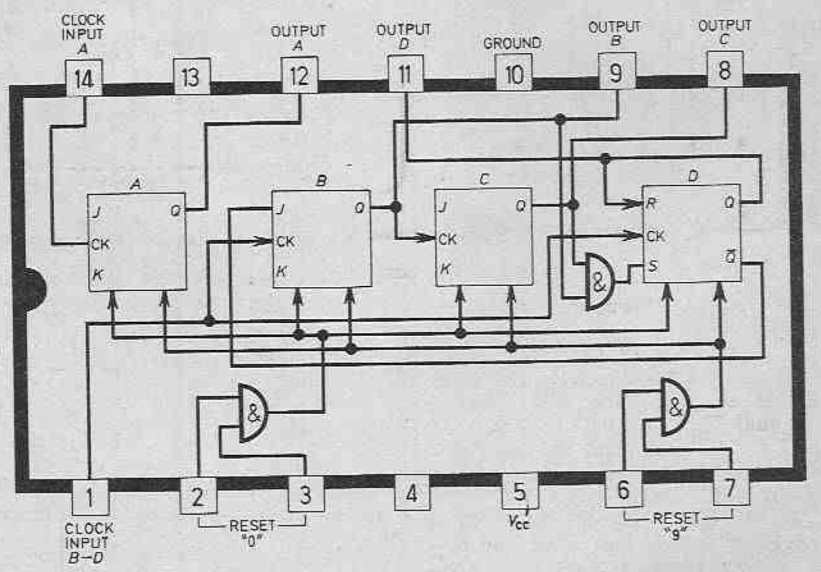


Fig. 5.1. Pinning details for the 7490 integrated circuit showing a series of flip-flops and control gates. Note the supply connections of pins 5 and 10. Also shown below is the counting sequence table.

Alternatively we can consider it as a 10-stage counter, counting from zero (0000) up to nine (1001) see Table 5.1. You can now observe the counting sequence and the effects of various inputs to the reset circuits, as outlined above. When conducting this experiment set the clock to its lowest frequency.

You can also disconnect pins 1 and 12, and use the dividers separately.

Problem: Fig. 5.3 shows that there are *two* ways of connecting the two dividers. Both of these arrangements divide by 10, but what is the difference in their action? Try it and see (answer (1)).

LOGIC LEVELS

The inputs and outputs of TTL circuits can assume either one of two levels, "high" or "low". They do not operate with "in-betweens". In *logical* operations performed with these circuits, "high" usually corresponds to "true" and "low" correpsonds to "false". In *mathematical* operations, "high" corresponds to "1" and "low" to "0". Of course, there is no basic difference between logic and mathematics—mathematics is a logical process, and we can represent familiar mathematical operations by logical statements.

For example, one row of the multiplication table can be stated as follows:

statement A: $x=5$
statement B: $y=7$
statement C: $xy=35$ (x times y)

Table 5.1. counting sequence table for the 7490

Count	Output D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

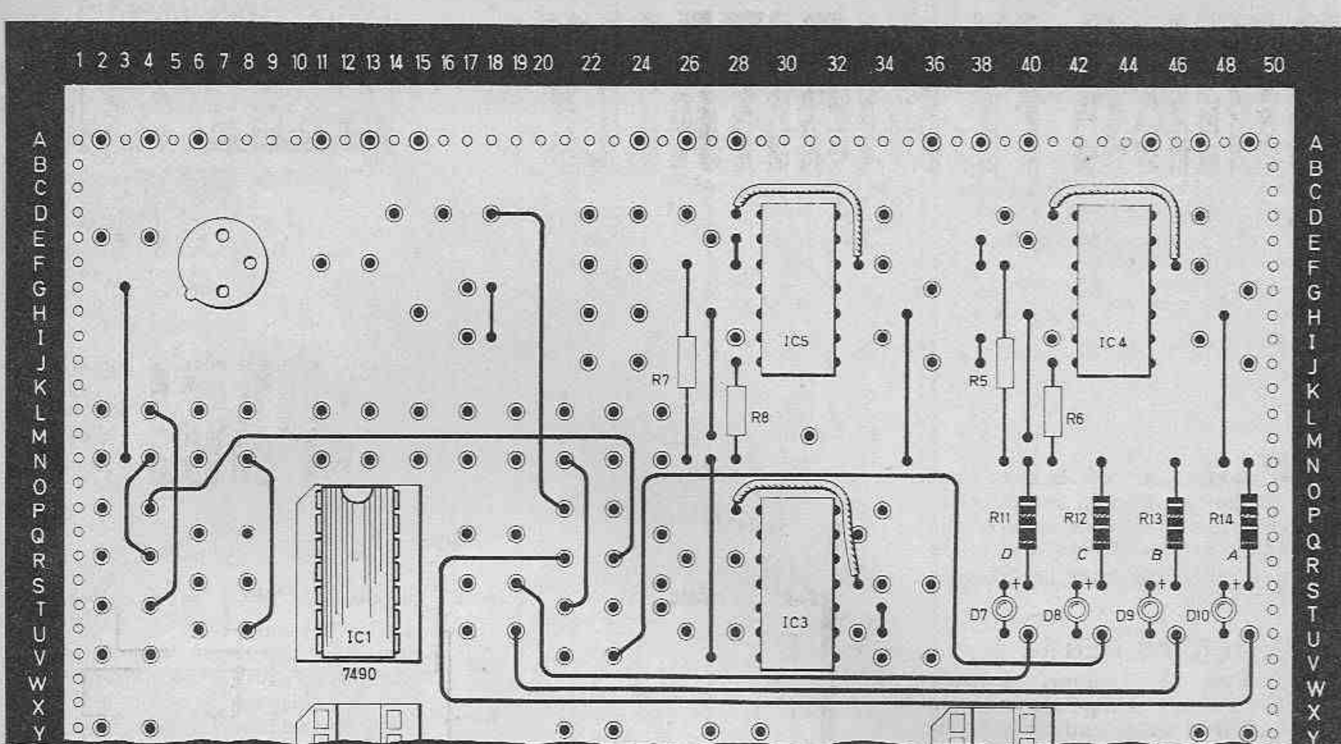


Fig. 5.2. Wiring connections on the Test-bed for investigating the action of the 7490.

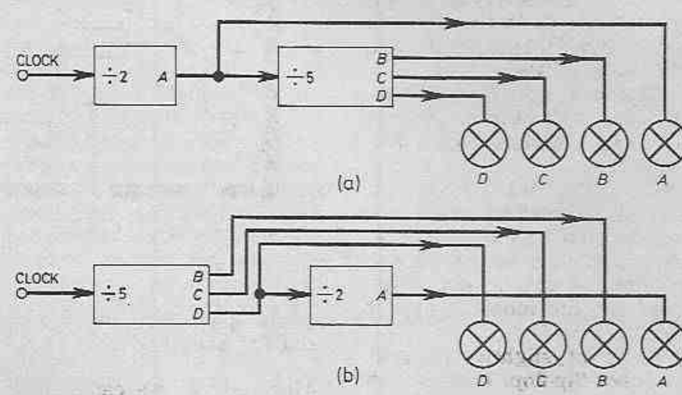


Fig. 5.3. Two ways of connecting the elements of a 7490 to produce a divide by-ten stage.

The logical statement connecting these is:

If *A* AND *B*, then *C*.

The AND truth table tells you when *xy* does equal 35 and when it does not equal 35, given various values of *x* and *y*. Later we shall see how logic gates can be used to perform arithmetical operations.

The advantage of designing gates to work with only two input and output voltage levels is that they need relatively few components to give a reliable and rapidly acting gate. The operation of the gates is unaffected by small voltage fluctuations or by the small voltage pulses or spikes that inevitably find their way into circuits. In short, they are reasonably immune to *noise* in the system.

The "high-low" idea presents no problems for logical statements; any statement is either true or false. But for mathematical work we are limited to only two values, 0 and 1. This means that we are forced into using a counting system that employs only these two numbers.

In everyday life we are accustomed to using the *decimal* system, which has ten numbers, 0 to 9. From this we use the "hundreds, tens and units" convention to write a row of digits with which we can represent quantities far larger than 9.

For example, if we write the digits 4869, we mean:

4 × 1000 =	4000	(1000 is 10^3)
plus 8 × 100 =	800	(100 is 10^2)
plus 6 × 10 =	60	(10 is 10^1)
plus 9 × 1 =	9	(1 is 10^0)
Total =	4869	

Reading from *right to left*, each digit in the number is the multiplier of a power of 10, beginning with 10^0, and increasing the value of the index figure by 1 at each step.

With TTL we have only 0 and 1 to use, so are limited to the *binary* system. For example, if we write 1001100000101, we mean:

1 × 4096 =	4096	(4096 is 2^{12})
plus 0 × 2048 =	0	(2048 is 2^{11})
plus 0 × 1024 =	0	(1024 is 2^{10})
plus 1 × 512 =	512	(512 is 2^9)
plus 1 × 256 =	256	(256 is 2^8)
plus 0 × 128 =	0	(128 is 2^7)
plus 0 × 64 =	0	(64 is 2^6)
plus 0 × 32 =	0	(32 is 2^5)
plus 0 × 16 =	0	(16 is 2^4)
plus 0 × 8 =	0	(8 is 2^3)
plus 1 × 4 =	4	(4 is 2^2)
plus 0 × 2 =	0	(2 is 2^1)
plus 1 × 1 =	1	(1 is 2^0)
Total =	4869	

In the table the calculations are in the decimal system, but if you read the right hand column of figures from top to bottom, you have the binary number that is being converted to decimal. If you read down the right-hand column of figures, you can see that the binary number is based on successive powers of 2.

Calculators and computers work in the binary system, but people work in the decimal system. If we want to do a calculation using the number 4869, it would be tedious to have to convert it to 1001100000101 before entering in the calculator. Errors would be common. Yet the calculator's arithmetical circuits can not work on a number in decimal form as it stands. We need a *coder* to convert numbers of the decimal system, as entered on a calculator keyboard, into the binary system, so that they can be handled by the arithmetical circuits. Later we

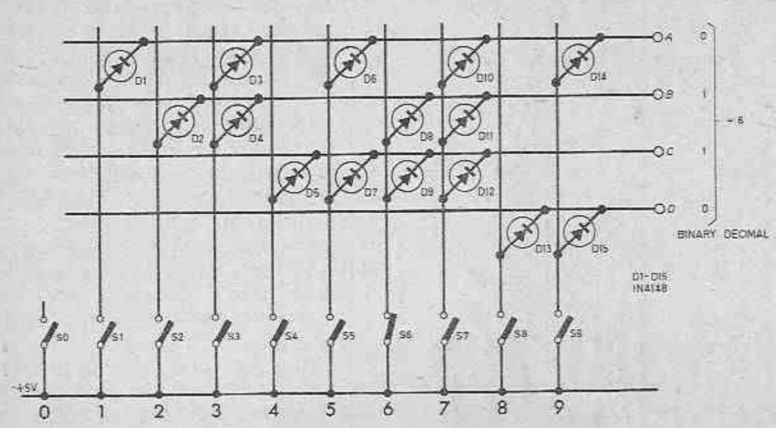
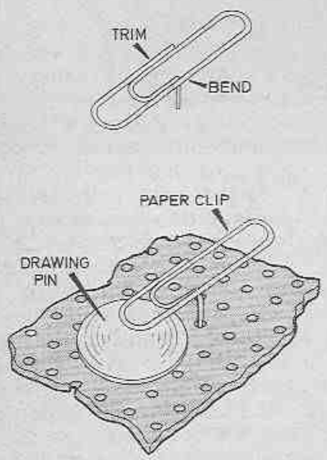


Fig. 5.4. A diode matrix arranged to produce a binary output for numbers up to nine.



shall need a *decoder* to convert the final answer back to decimal system again, ready for it to be displayed and read by the human operator.

KEYBOARD CODING

A convenient method of coding is to use a network of conductors, linked by diodes, Fig. 5.4. The switches S0 to S9 are the push-button keys. In Fig. 5.4, S6 is shown depressed, giving the output 0110 from the four output terminals *DCBA* (taken in that order). It is possible to buy ready-made keyboards and sliding or rotary switches which are constructed to give binary output according to which key is pressed, or which position the switch is set to, but it is more instructive to make up one of your own, as in Fig. 5.5. The keys are made from wire paper-clips and drawing-pins. Ten of these are for coding the numbers 0 to 9. The other four keys are "function" keys that we shall use later when operating a simple calculator circuit.

Construction of the keyboard presents no problems, once the correct position for bending the paper-clip has been found by trial. It is advisable to use a heat-sink when soldering in the diodes. To use the keyboard, connect its terminals to V_{cc} and to the four inbuilt on the test-bed. Press the keys *one at a time* and read the figure "1" for a glowing l.e.d. and "0" for a dark l.e.d., from left to right, in numerical order.

Answers

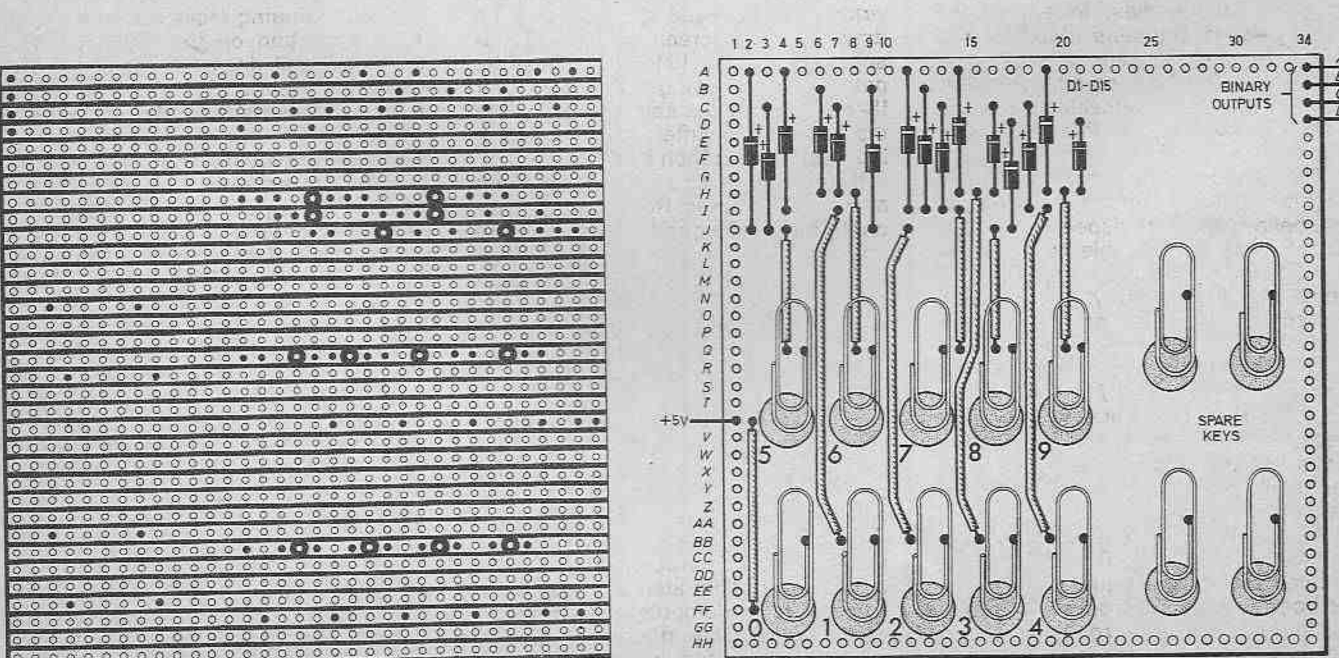
(1) (a) The sequence is 0000, 0001, 0010, 0011, 0100, 0101, 0110, 0111, 1000, 1001 and then back to 0000, etc. This represents the binary form of numbers 0 to 9; the output is suitable for counting.

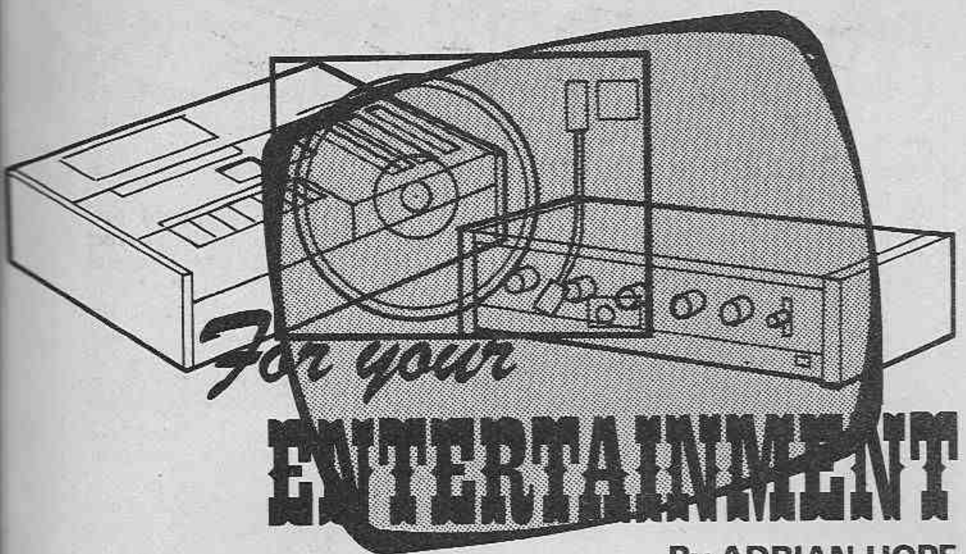
(b) The sequence is 0000, 0001, 0010, 0011, 0100, 1000, 1001, 1010, 1011, 1100 and then back to 0000, etc. This gives the binary form of numbers 0 to 4 followed by 8 to 11. This is not suitable as a counting sequence.

In this sequence the *D* output (figure on extreme left) is low for five counts and high for five counts, giving a symmetrical waveform. But in (a) the *D* output is low for eight counts and high for only two, an unsymmetrical waveform. This circuit is therefore the better one for frequency division.

To be continued

Fig. 5.5 (above and below). The home made binary keyboard constructed from drawing pins and paper clips.





For your ENTERTAINMENT

By ADRIAN HOPE

Computer Sound

The American loudspeaker firm Acoustic Research has recently devoted a great deal of time, energy and expense into programming a computer to research the behaviour of loudspeakers in a room. It's easy to overlook the fact that just about the worst place you can listen to a loudspeaker is in a room, because the sound from the speaker is reflected off the walls, floor and ceiling to create a complex of boosts and cuts at some frequencies of the reproduced sound.

The crucial point to remember is that if two sound waves of the same frequency mix, for instance one coming direct from a loudspeaker and the other reflecting off the wall, they will cancel when out of phase and add together when in phase. This is what produces the boosts and cuts at some frequencies. In each case exactly what happens depends on where the loudspeaker is positioned and where the listener sits, because waves will be cancelling at one listening position in the room and boosting at another.

The Acoustic Research computer program was intended to analyse the behaviour of loudspeakers in just about every conceivable room situation. Some fascinating results have come out of this study. For instance it turns out that not only is a room just about the worst place to listen to a loudspeaker (we would all do better to live in a field) but the centre of a room is the worst place of all because it is half way between all the walls and thus the position where all the wall reflections will meet and cancel or boost.

Also, although there is great enthusiasm in the hi fi world at the moment for using equalisers to cut or boost the sound from an amplifier to "tune it" to the room, this can be expensively dangerous. If room cancellations are eliminating a bass frequency at the listening position, boosting the amplifier at that frequency won't help—it will simply push more power into the loudspeaker, which will still be lost in the room, and the loudspeaker coils may well burn out.

Home Computers

Acoustic Research have now transferred some of their laboratory computer programs onto compact cassette tape for use with portable computers which their engineers are taking round the world for "audio clinics", usually at hi fi shows. The portable computers used to go under the trade name Apple (computer words are called "bytes", get it?).

An ordinary TV set is used as the computer display and a room of virtually any shape or size can be drawn on the screen, with the loudspeakers and listening position patched in accordingly. The computer then reads out the acoustic problems the listener will suffer. Another listening position can then be tried.

If you are visiting an audio exhibition at which Acoustic Research is demonstrating, it is a good idea to measure your room before you go as you may have a chance to punch your room dimensions into the computer. When you think of the man-years needed to write such a program, you can understand why AR guard those tapes more than a little carefully.

The Apple computer is remarkably cheap, between one and two thousand pounds, and must be regarded as one of the advance guard of the new generation of cheap home microprocessor computers.

An interesting problem arose when AR first demonstrated it in England. Because the computer is designed as an essentially domestic gadget, with programs fed in from cassette tapes through domestic cassette machines, it was thrown into confusion when Acoustic Research fed in their tape program using a sophisticated hi fi tape deck.

The computer program is stored on tape as a stream of pulses which are equivalent to audio square waves. The hi fi machine first used by Acoustic Research reproduced the square waves with too much fidelity, and caused ringing in the input circuits of the computer which failed to program. But as soon as a cheaper cassette machine, less able to reproduce square waves with fidelity, was used it was all systems go.

Incidentally, one of the programs on tape was for fun only. A *Star Wars* game with the operator able to pit his wits against a computer program to shoot down space fighters as in the last reel of the film.

Computer Language

Thanks, no doubt, to the grand old British tradition of incompetence at other peoples languages, English is now becoming a world standard. It is already the international language used by airline pilots.

I've noticed over and over again when visiting firms in foreign lands that it's assumed right from the start that if there is even one English speaking visitor present, that language will be spoken throughout; irrespective of what other nationalities are present. I have several times, for instance, been shown round German electronics factories alongside Italian and French journalists who have had to make notes in their own language from explanations given to them in English by a German engineer.—Heaven knows how it finally looks in print.

The continuing move towards world standardisation on the English language is well instanced by current computer trends. The new breed of microprocessors and home computers receive their instructions through a typewriter keyboard with the instructing words entered in "basic" language. This is perhaps best described as mid-Atlantic pidgin English.

So what is happening on the Continent, I wondered? When, as we are promised, microcomputers become an every day part of family life, will for instance German hausfrauen need also to learn pidgin English to put their central heating, larder stock and overdraft under computer control?

I went to the horse's mouth, checking with Advanced Micro Computer GmbH, a subsidiary of the German giant Siemens AG. The answer is *yes*. There is no translation for "basic" expressions. So in future English-American will become the Continental standard for domestic computers.

In this respect, at least, Britannia still rules the electronics world.

MINI~MODULES

By George Hylton

Handy "Beginner" projects based on simple circuits and featuring a variety of building methods.

5 AUDIO MODULATOR

MODULATORS are devices which allow one signal to control another. In audio work they are often used to produce special effects such as tremolo and the intermodulation of voice and music.

A modulator can be "balanced" or "unbalanced". A balanced modulator is one which has no output at the input frequency but produces only new frequencies. An unbalanced modulator allows some of the input frequency to pass through unchanged. If the modulator is balanced for one input but not for the other it is "single balanced"; if for both signal and control frequencies it is "double balanced".

The two audio modulators in this Mini-Module are strictly speaking unbalanced types. However, they work in such a way that very little of the control frequency reaches the output, so for most purposes they can be considered to be single-balanced.

PRINCIPLE

The operating principle is very simple (Fig. 1). The modulator is a voltage divider formed by R_1 and R_2. If R_2 is fixed the circuit is merely an attenuator. But if R_2 is varied at a fast rate any audio signals which enter at the "IN" terminals are subjected to a rapidly fluctuating attenuation. This is all that modulation means in the present case.

To make a rapidly-varying R_2, a transistor is substituted for the resistor (Fig. 2). The transistor can be turned on and off as rapidly as necessary by applying a control voltage to its base. Note that no power supply is needed.

To form an effective attenuator the transistor must have a low resistance to any voltages applied to its collector, i.e. to the input signals as opposed to the control. The collector resistance of a transistor is normally high but falls to a few tens or hundreds of ohms when the collector voltage is very low, or zero as here.

The collector resistance is only low, of course, if the transistor is switched *on* at its base. If switched *off* it is very high. When driven hard by its control frequency the transistor alternates between a very low resistance state and a very high resistance state.

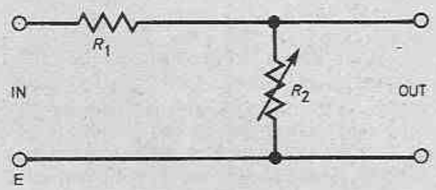


Fig. 1. Modulator principle.

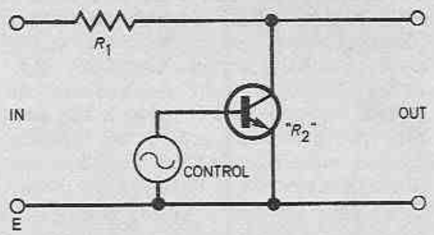


Fig. 2. Using a transistor as the variable resistance.

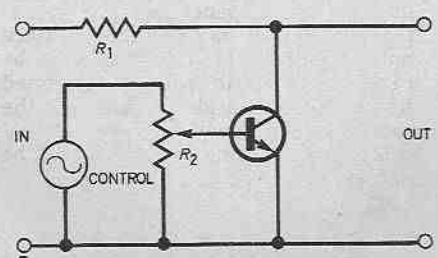


Fig. 3. Fade-in by varying the control voltage.

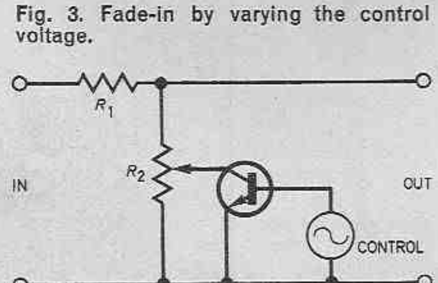


Fig. 4. Fade-in by sliding the transistor into circuit.

The effect is to "chop" the input signals by alternately attenuating them and letting them pass. The amount of attenuation depends on the size of R_1 compared with the "on" resistance of the transistor. If R_1 is 10kΩ and the "on" resistance is 100Ω then the input signal is attenuated about 100-fold.

There is often no need to build R_1 into the modulator circuit. The source impedance of the input signal is often about the right size to act as R_1. This means that the circuit can still act as a modulator even when the input is applied to the output terminals instead of the input terminals.

This can be very useful when modulation has to be added to some existing audio circuit because all that then needs to be done is to run two leads ("OUT" and "E") into the existing circuit. All the rest can be outside it.

Note however that the modulator must be connected to a point where the signal level is not less than about 100mV. It is also necessary to avoid connecting it to a circuit with negative feedback as the feedback will try to prevent modulation from taking place. In many cases a blocking capacitor will be needed to prevent d.c. from entering the input terminal.

CONTROL OPTIONS

There are also two ways of effecting control. It is usually desirable to be able to fade the modulation in and out at will.

One way is to provide an adjustment for the control input (Fig. 3). Modulation does not begin until the voltage at the base of the transistor reaches about 500mV. If a few volts of control signal are available a variable potentiometer (of the kind used for volume control) enables the amount of modulation to be increased from zero to virtually 100 per cent.

The other option is to apply plenty of control signal all the time and use a potentiometer to slide the transistor into circuit (Fig. 4). There is not much to choose between the two control methods and in the prototype module one of each kind is included.

Although we have been talking about using a control *voltage*, in practice it is better to use a *current*. In the actual module the voltage is turned into a current by inserting a high resistance in series with the base.

CONSTRUCTION

The final circuits (Fig. 5 and Fig. 6) are as discussed, with the addition of a blocking capacitor at the control input. No blocking capacitor has been included at the signal input but one can easily be added if required. A value of 10 to 100μF should be suitable but the polarity and working voltage will have to be selected with reference to the circuit to which the modulator is to be connected.

Input impedance is about 10kΩ to both signal and control inputs.

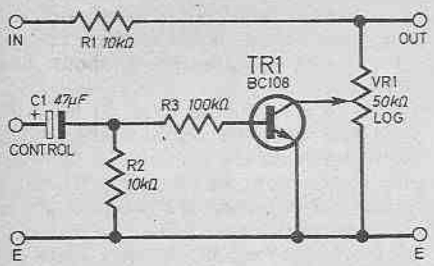


Fig. 5. Modulator 1 practical circuit (derived from Fig. 4)

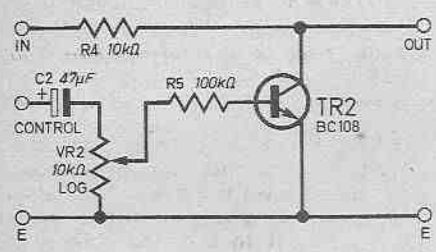


Fig. 6. Modulator 2 practical circuit (derived from Fig. 3)

COMPONENTS

Resistors
R1 10kΩ
R2 10kΩ
R3 100kΩ
R4 10kΩ
R5 100kΩ
All carbon, 5% tol. ¼W

Potentiometers
VR1 50kΩ carbon track log
VR2 10kΩ carbon track log

Capacitors
C1 47μF 25V elect.
C2 47μF 25V elect.

Semiconductors
TR1, TR2 BC108 npn transistor (2 off)

Miscellaneous
Electrical double-switch box.
Plastic-surfaced hardboard.
¾in. coppered hardboard pins.
Two knobs.

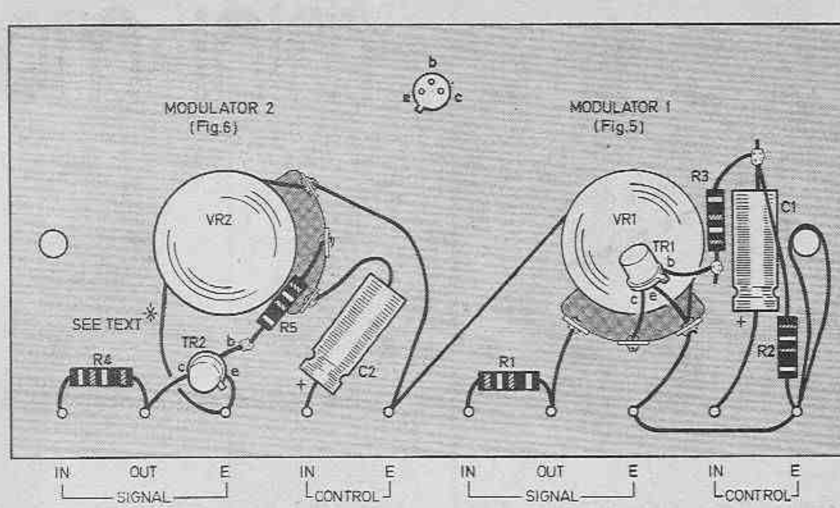


Fig. 7. All components are assembled on the hardboard panel (as shown above). Note the earthing wires which should be clamped between the metal case of each potentiometer and the panel, and the loop made over one panel screw hole to effect bonding to the metal case when the fixing screw is fitted.

Since few components are needed there is no difficulty in circuit building. They can be mounted on a tag strip or supported in the wiring.

The prototype was housed in a box whose bottom and sides were provided by a standard electrician's item. This was a 1½-inch metal double-switch box and its normal use is to be buried in the wall to hold a pair of flush mains switches.

The overall size is about 130 x 70 x 35mm deep. No lid is provided because the switches form one, but their fixing holes can be used to secure a home-made lid or panel.

PANEL AND TERMINALS

For the prototype a panel was made from plastic-surfaced hardboard, cut to fit tight inside the box. Using a non-conducting panel like this means that screening is incomplete since only the rest of the box can be earthed (an earth point is provided by the makers inside the box). At the correct signal level of above 100mV complete screening is unlikely to be necessary.

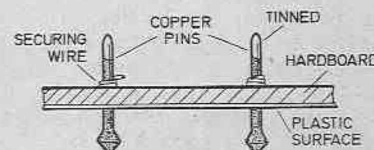
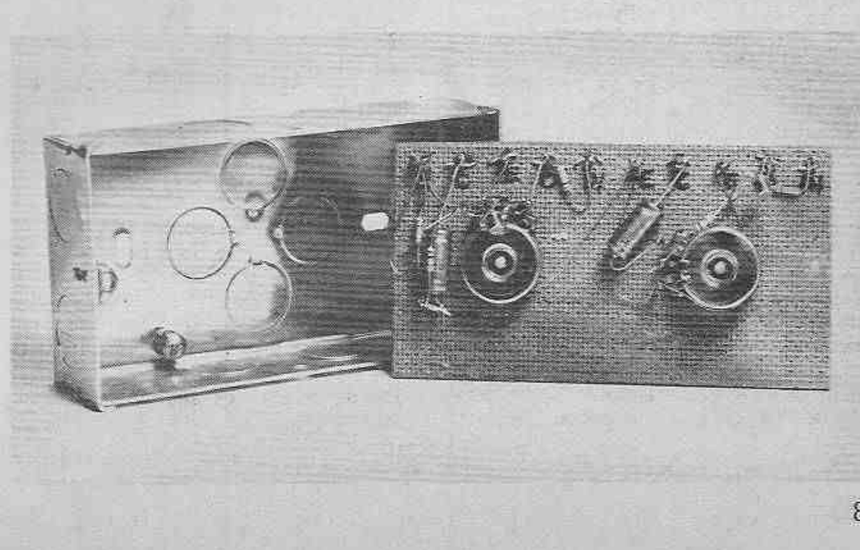


Fig. 8. Feed-through terminals made from coppered hardboard pins.

A non-conducting panel is easy to equip with feed-through terminals. Those in the prototype are the cheapest imaginable: ¾-inch coppered hardboard pins. To prevent them from pulling out or being pushed into the box wrap a few turns of bare wire round the shanks where they enter or emerge from the hardboard and solder onto the pins to form locking rings. Naturally any other sort of terminal may be used as an alternative.

When wiring up it is useful to anchor some of the components to the panel with a spot of glue. (But if you use a metal panel don't attach the transistors; the "can" of the BC108 is "live" (connected to the collector).

Next Month: Versatile Power Supply



SQUARE ONE FOR BEGINNERS

LAST month resistors and capacitors were discussed. So far as the latter are concerned, we only covered non-polarised capacitors. Now we continue with a look at that important variety of capacitor, the electrolytic.

POLARISED CAPACITORS

The electrolytic capacitor is a polarised type of component. Its two leads or terminals are clearly marked positive (+) and negative (−). It is essential that these capacitors are fitted correct way round into the circuit.

Circuit diagrams emphasise the special nature of electrolytics by showing one "plate" in open outline, this being the positive side; the other plate is blacked in (as for non-polarised capacitors) and is the negative side.

Always carefully examine electrolytic capacitors and be sure the leads or tags are properly recognised before connecting up.

VOLTAGE RATING

Next of importance is the voltage rating. This must be as specified in the components list, and will have been selected because it closely matches the actual voltage that will be experienced in the particular circuit.

It is safe to use an electrolytic capacitor with a voltage rating slightly higher than specified. But on no account should an electrolytic capacitor with a lower voltage rating be used. Breakdown of the capacitor is possible under such circumstances. Since "breakdown" usually means a dead short through the capacitor, the consequences may be serious.

Electrolytic capacitors are widely used in the power supply sections of electronic circuits, where the normal operating voltages are equal to or in excess of the a.c. mains supply. Thus observation of this point is most important.

LARGE VALUES

The great feature of electrolytic capacitors is the very large values of capacitance they provide in comparatively small physical volume. Values

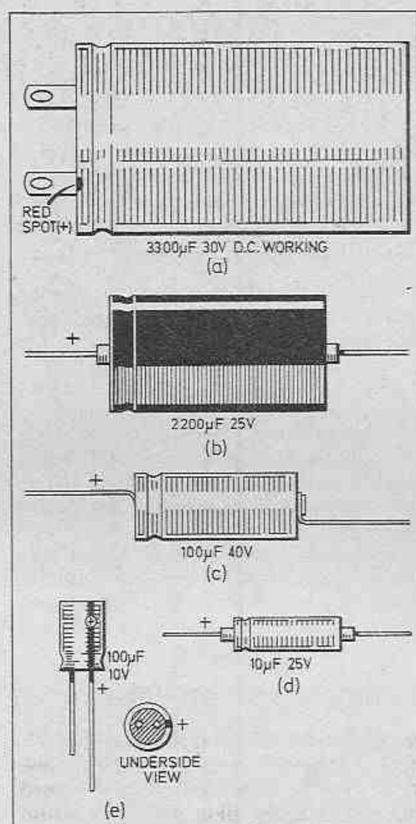


Fig. 1. Aluminium foil electrolytic capacitors. The can is usually negative, but not always. Can sometimes enclosed with plastic sleeve. (a) single-ended, tags. (b)-(d) double-ended, axial lead-out wires. (e) Single-ended, p.c.b. type, radial lead-out wires. (e) Single-ended, p.c.b. type, radial lead-out wires, for direct mounting on printed circuit board.

such as 8µF, 32µF, 100µF, 2,200µF and 4,700µF, and even higher, are normal.

Electrolytic capacitors do not offer a perfect barrier to direct current (d.c.), but a very small "leakage current" normally flows through this type.

The electrolytic capacitor also offers some "resistance" to the passage of a.c. That is why a small value non-electrolytic capacitor is sometimes seen connected directly across an electrolytic capacitor whose value is probably several thousand times greater. This non-polarised capacitor provides a low reactance (resistance) path to alternating voltages, such as audio and radio frequency signals.

THIN OXIDE FILM

These two "defects" of the electrolytic capacitor are due to the nature of its construction and its "chemical action". However such defects are greatly outweighed by the advantages of the very large capacitance values possible.

The secret of a large capacitance lies in the formation upon an aluminium foil of an extremely thin insulating film. This film takes the place of the conventional dielectric material (mica, paper, ceramic or plastic) in non-polarised capacitors.

The electrolytic capacitor is actually an electrolytic cell containing a chemical solution. The aluminium foil is the "anode" or positive side of this cell. The oxide film is produced through chemical action during manufacture caused by the application of a voltage. When in use the capacitor requires a similar voltage to be applied across its terminals in order to maintain the essential film and thus its function as a capacitor.

It will now be appreciated why electrolytic capacitors have a "shelf life," and have to be treated with rather more respect than the non-polarised variety.

TANTALUM CAPACITORS

Most electrolytic capacitors are of the aluminium foil variety, as described above. There is however another type of electrolytic capacitor which uses the metal tantalum.

Tantalum (although more costly) has many advantages over aluminium resulting in extremely small electrolytic capacitors with improved performance, especially at high and low temperatures. Generally they do not operate at voltages in excess of 35V.

Tantalum capacitors are commonly available in the form of small "beads". Typical values are 0·1µF, 0·47µF, 6·8µF, 68µF and 100µF.

Whenever these type of polarised capacitors are specified, it can be assumed there is a very good reason for this, and other kind of capacitors should not be used as substitutes.

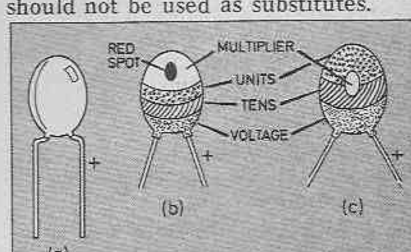


Fig. 2. Solid tantalum bead electrolytic capacitors. (a) value, voltage and polarity printed on body. (b) and (c) two styles of colour coding. Positive lead is always on the right when capacitor is viewed as shown, i.e. with lettering or multiplier spot towards one.

Breadboard '78 Review

By Terry Johnson

BREADBOARD '78 sounds a rather misleading name for an exhibition, brings to mind a crowd of Bakers showing how to make bread. Something like "Aladdin's cave", or "Pandora's Box" would be a more apt title considering the amount of "goodies" on sale.

On a more serious note, Breadboard '78 which took place between the 21st and 24th November, has been described as "An exhibition showing the many and varied aspects of home constructing". And this was the impression one obtained.

From simple prototyping boards to a sophisticated sound to light display to a mini home computer, all showed what could be accomplished by the home constructor.

Undoubtedly a few of the exhibitors were mainly interested in selling odds and ends, which probably gave the casual visitor the impression that the show was just one large "junk" sale. However it was not until one wandered through and delved deeper that this impression was revealed as being far from the truth. And you really *did* need to go deeper to appreciate the significance of the exhibition.

CROWDS AND DECIBELS

We went along on what we thought would be a quiet day—Thursday in fact. However from the time we arrived to the time we left, the crowd was remarkably like that at Euston Station during the rush hour. It gave the visitor an idea what it would be like to be a sardine in a can!

On a first casual wander round we saw many of our regular, and perhaps a few soon-to-be, advertisers, all apparently enjoying the wealth of such a vast crowd. There were a few of what we could term "commercial" companies: that is those who do not aim their sales at the hobbyist, but rather to the wholesaler.

In this context we noted a lack of famous household names, Philips, Sony etc, but there again the show was aimed at the home constructor rather than the consumer.

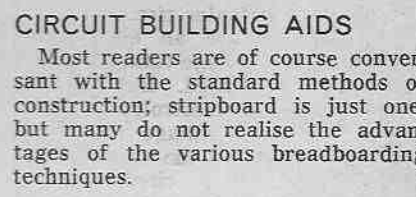
One aspect about the exhibition that would be noticed by visitors, especially those with sensitive hearing, was the extreme level of noise, ranging from weird space age sounds to loud pop music.

It was certainly a lively show.

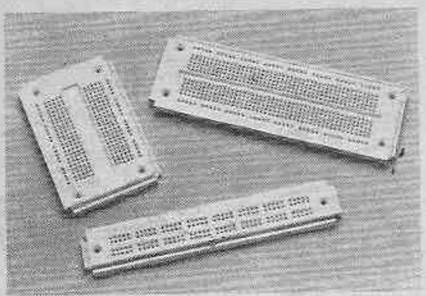
As the exhibition was intended mainly to show the varying constructional methods available to the home constructor, we decided to concentrate our attentions in this area. Consequently we never had time to go round all the stands, and regretfully a few had to be left out of our inquisitive wanderings.

CIRCUIT BUILDING AIDS

Most readers are of course conversant with the standard methods of construction; stripboard is just one, but many do not realise the advantages of the various breadboarding techniques.



Examples of Euroboard.



Experimenter breadboards from CSC.

Many examples were on show, notably Wonderboard which was described in our November issue. The examples on show were certainly complex, containing many i.c.s, and so rather put our Combination Lock to shame!

Although Wonderboard is intended for the more permanent circuit, there are many occasions where a great deal of prototyping needs to be done. Following this concept there are many companies who have obviously seen the light, not to mention the money, and have taken the plunge into producing prototyping systems.

Those actually exhibiting, although there must be many more, included; Continental Specialities who demonstrated their range of Proto-Boards, similar in appearance to the widely acclaimed S-Decs but far more flexible; AP Products Inc. who showed a completely new-to-the-UK range of ACE (all circuit evaluator) breadboarding kits; Boss Industrial Mouldings Ltd, displaying their range of Bimboards, as well as many cases and other hardware. And last but not least, O.K. Machine and Tool Ltd who had a very wide range of systems. Many used a system known as wire wrapping—perhaps a new idea to many home constructors, but equally at home under the one name of "Breadboarding".

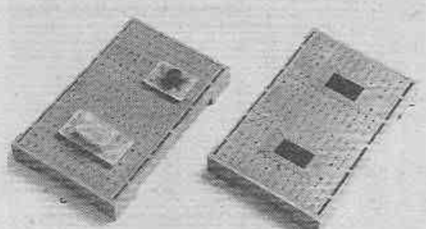
So you've proved your circuit, how about a printed circuit board? In the past the home constructor had great difficulty in producing a first class board, but from Mega Electronics comes a complete kit for making printed circuit boards and front panels easily and cheaply.

The kit is complete in every detail, and being reasonably priced will make a worthwhile addition to the hobbyist's workshop.

Circuit board finished? How about housing your pride and joy? Here again Breadboard comes to the rescue by bringing the constructor right up to date with the many ways of housing your project.

HI TECHNIQUES

Advanced technology was featured prominently in the form of microprocessors, minicomputers, electronic musical instruments and TV games. Judging by the great interest shown in minicomputers it seems the home constructor is now on the verge of giving up transistors and moving into the complex world of Bytes, Buses and Basic!



Two examples of S-Decs.

An innovation from the Nearbear Computing Store, "Bearbugs", enables the novice to learn how computers work by actually building a minicomputer in easy stages. This is always a far easier way of learning than wading through a great pile of literature.

The "bags" are based on the popular 6800 CPU, and come complete in every detail. Although they are self-contained, they are to some extent dependent on others, so unless one has a deep pocket this is not for you.

TV games were in abundance, the range of different games available being almost unlimited—a far cry from the original ping-pong concept. Many were of the self-contained ready to use type, others were kits you build yourself. In a similar vein were the many light shows being demonstrated. Some were commercial, but the vast majority were examples of what the home constructor could achieve. Especially noteworthy was the Chromascope demonstrated by Chromatronics. It creates wonderful "wallpaper" patterns on your colour TV.

MAGAZINES SHOW PROJECTS

Many of the magazines devoted to the home constructor interest were in attendance, exhibiting past, present, and future projects. Again, in keeping within the theme of the show, many were showing examples of constructional techniques, as well as demonstrating the apparent ease by which projects could be made to look professional.

The Roulette game, the Combination Lock (disguised as a safe!) and the Hot Line on the EVERYDAY ELECTRONICS stand gave many a visitor a frustrating time. We had several winners who cracked the combination, representing great odds in actually doing so. We hope those who were successful will enjoy their one year FREE subscription to EE.

BARGAINS GALORE

For those who went to the exhibition just to be on the lookout for a bargain, they were certainly rewarded; l.e.d.s selling for less than 10p, and packs of resistors for less than 50p were something not to be missed.

As well as the recognised "junk" on sale, including surplus equipment, new components of every description could either be bought or ordered to be delivered at a later date. Some had a special "Exhibition Only" price tag, representing a considerable saving. The bookworm was not overlooked, Bi-Pak doing quite a nice range in beginners and advanced technical books.

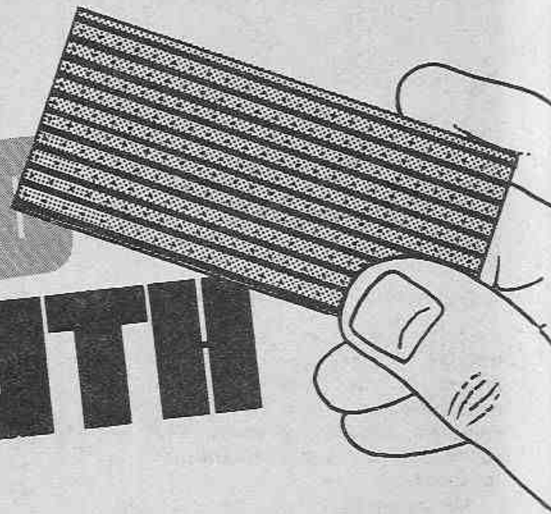
In such a short space we could not hope to cover all the products on the stands, the following is just a small example of what was there—and what could be at next year's show: aerials, amplifiers, boxes, breadboards, computer kits, floppy discs, high power audio systems, knobs, oscilloscopes, soldering equipment, tuners, v.d.u.s, video games, synthesisers and light shows, *ad infinitum*.

BIGGER AND BETTER

Over 10,000 enthusiasts and dealers visited the show. The organisers are to be congratulated on putting on such a good exhibition. Let us hope that next year's will be even bigger and better. So we'll let the organiser's, Trident Exhibitions, have the final word: "In view of its success, Breadboard '79 will have to be moved to a bigger venue next year." ⌑

Proto-Board and the Design Mate 2 function generator.

FREE VEROBOARD NEXT MONTH



A portable "instant" electronic workshop with tools, power supplies and test equipment for design work in logic (TTL and CMOS), audio, r.f. etc.

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MARCH

ISSUE ON SALE FRIDAY, FEBRUARY 16

By Dave Barrington

For those readers who do not feel capable of making their own printed circuit boards for the *EE2020 Tuner Amplifier* we understand that Proto Design are offering a complete set of boards for the sum of £10·95, including post and packing.

Apart from the guide lines given in part one there should be no component problems with this months article.

Power Supply Unit

A good source of power is a prime requisite in any workshop and the *General Purpose Power Supply* should prove very popular.

The only problems we can foresee are the transformer and meter availability. The transformer specified should be available from our advertisers, however if another type is used make sure if it will fit inside the case.

The meters used in this project were the Japanese SEW types but these may prove difficult to obtain. Provided the meter ratings and similar dimensions are available any other type may be used (see Watford Electronics LSQ range).

The aerial, oscillator coil and trimmers for the *Long Wave Convertor* should be available from most of our advertisers. These components are certainly listed in the Home Radio, Watford Electronics and Greenweld catalogues. Of course, you can always write direct to Denco for details of nearest stockists.

The *Thyristor Tester* and the *Mini Module* use commonly available components and constructors should not experience any difficulty purchasing components.

The "add-on" *Treasure Hunter Sound Adaptor* is the result of requests from readers for some form of audio indication of buried objects for the original project published in our October 1978 issue.

There should be no problems in obtaining components for this project.

Microchime

Just a few pointers regarding the construction of the *Microchime*.

The same rules apply to microprocessors as those often mentioned in past pages about the care when handling integrated circuits, i.e. extreme care should be exercised when handling and avoid touching the pins as the device is susceptible to damage by static electricity. The microprocessor should only be inserted after all soldering has been completed.

The Verobox specified in the article was specially chosen to take the circuit board, batteries and speaker with very little room for adjustment for other components. However, there is no reason why a different case could not be used as wiring is not critical.

For those readers who do not wish to shop around, a complete kit of parts, including case, printed circuit board and microprocessor chip, can be obtained from Chromatronics, Dept EE, River Way, Harlow, Essex.

I MENTIONED in one of my recent articles that the villains are not all on my side of the counter, but I was reminded the other day that all our sheep are not snow white. I suffer slightly from hypertension. Do not bother to spray your copy with disinfectant, it is not catching and probably 99 per cent of my colleagues are similarly afflicted. It is a hazard of the trade. It simply means high blood pressure. Naturally most of us are interested in any means of lowering it without drugs. Now someone made the remarkable discovery that it can be controlled by thought. The only difficulty being, that unless you have a simple means of continuously checking it you cannot direct your thoughts into the channels that will achieve these results.

It was then discovered that the resistance of the skin gives an indication of this ailment and a firm, probably of foreign origin, who shall be nameless, put on the market a little gadget that would do this. Two small electrodes attached to the body control the pitch of an audio oscillator, the patient fixes them in place, turns the machine on and then lies down and listens to a high pitched squeak. He then tries to think of something pleasant and as his pressure drops the oscillation will go down in pitch until it is a series of clicks.

Quite a shock

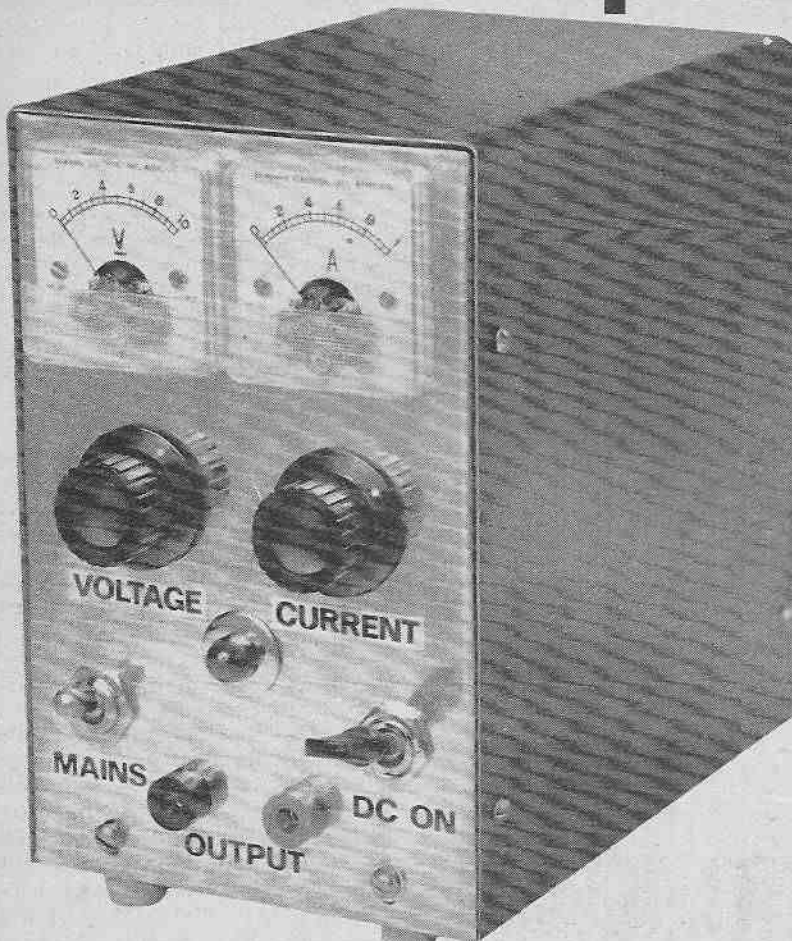
I was told that users of the machine, after several hours practice, can control blood pressure and heart rate, even without the apparatus.

I sent for one, which cost about £15 and the first thing I did was to take off the back to look at the works. When the back was removed the electronics were hidden by a piece of thick fibre board stuck into place with Araldite and written across it in large letters the warning "Removal of this protective cover may cause damage to the unit". Detective Young having decided that the only damage that might be caused by removing this cover, was the shattering of his illusions, immediately prized off the cover. As I suspected the total value of the parts to make one of these, would come to about three or four pounds ! Nuff said!!

Those of us who were fortunate enough to be present at a recent Radio Industries Club Luncheon were also treated to a facinating lecture by James Burke. Fixed to the bottom of everyone's coffee cup was a tiny chip of silicon five millimeters square. James Burke told us that it contained 5,000 transistors. The mind boggles, but from what I read this is only the beginning and they are already talking of accommodating far larger numbers on a similar sized chip.

No wonder one of my colleagues, barely half my age said to me, the progress of electronics is too fast for me, it has already left me behind! There is no need to be despondent about it, it is obviously going to develop into a specialists world and we can only hope that the outcome of these marvels will bring some lasting tangible benefit to mankind.

General Purpose



POWER SUPPLY

By F. G. Rayer

THIS power supply will provide up to 20 volts at one amp, so will operate most of the items likely to be used by the electronics enthusiast. These will possibly include radio receivers, amplifiers, and all sorts of experimental and other electronic projects. The power supply can also be used to run model motors or trains within its rating, or for the trickle charging of accumulators, model lighting, or booster charging of dry cells. It can thus be expected to pay for itself in due course.

The same circuit can be adopted with various mains transformers and meters, as will be explained later, and this may allow items to hand, to be brought into service, thereby reducing expense.

The supply is fully adjustable, has excellent regulation, and is automatically protected against overloads or short circuits.

CIRCUIT DESCRIPTION

The full circuit diagram of the Power Supply is shown in Fig. 1. Transformer T1 has a low voltage secondary, and rectification is by the four diodes, D1 to D4. Output from these passes to the reservoir and smoothing capacitor C1. Direct current for the later parts of the circuit is obtained from C1.

Switch S1 is the mains switch, and the neon, LP1 is to show when mains power is on. The transformer fitted is an easily obtained multi-output component, and the rectifiers are connected to the 0V and 19V taps, to give a final output of up to about 20V.

If other transformers are used, the voltage across C1, after rectification, should not exceed 30V. Lower secondary voltages, such as 12V, will naturally reduce the maximum output voltage, but will often be adequate for most equipment. A transformer with two or three 6·3V windings would provide 12·6V or 18·9V with the windings connected in series in correct phase.

The secondary current rating must at least equal the maximum current required, and the circuit is designed for 1A.

REGULATOR

Integrated circuit ICI forms the regulating part of the circuit and is a positive voltage regulator. Negative or inverting feedback is provided by VR1.

COMPONENTS approximate cost £15 excluding meters

Suppose for a moment that the power supply is set to give an output of, say, 10 volts. In this state the series pass transistor, TR1, is biased sufficiently on for this voltage to appear at the output.

This is accomplished by means of the potential divide network consisting of R2, VR1 and R3, the wiper of the voltage control being fed back to the inverting input of ICI (pin 6).

If a load is now connected across the output, the immediate action is for the voltage on VR1 wiper to reduce. This decrease in

SPECIFICATION

Voltage: Fully variable from 0 to 20 volts.

Current: Fully variable and current limited. Up to one amp maximum.

Meters: Two front panel meters indicating voltage and current supplied to the load.

Fully protected against inadvertent short circuits and overloads for an indefinite time.

voltage causes ICI to increase its output to TR1 causing it to conduct more heavily, and restore the potential at VR1 wiper to its original value to maintain a 10 volt output at the emitter of TR1.

When the load is removed, the voltage fed back to pin 6 increases. In turn the i.c. output reduces causing TR1 to conduct less until the voltage on VR1 wiper is restored.

In practice this "pulling" and "pushing" happens very fast, faster than it does to explain it, with the result that the final output maintains a very stable level—the "ripple", the variation between the "pull" and "push", being within a few millivolts.

CURRENT LIMITING

Current limiting is achieved by VR2 which can limit the current from a maximum of one amp to as low as 50mA. Thus even a short circuit on the output can cause no damage to the power supply.

The output is finally taken to the output terminals via S2, which allows complete isolation of the load from the supply. Capacitor C4 filters any noise induced on the supply lines.

Although not shown on the circuit, a series combination of a resistor and light emitting diode can be connected across the output to give an indication that the d.c. supply is on.

The power supply is fully metered, ME1 measuring the d.c. voltage at the output, and ME2 the current taken by the load. Those used were SEW type MR38P which are seldom seen nowadays in suppliers catalogues, but should be available from old stock. It should be noted that the metal work for the power supply was dimensioned using these types of meters, if other types, either smaller or larger are used then the sizes must be varied accordingly.

METERS

Ideally the meters should read 0 to 20 volts f.s.d. for ME1, and 0 to 1 amp for ME2. These can be purchased correctly scaled, but it is more likely that constructors will already have meters to hand, and these can be used instead. The voltmeter, MEI could be a milliameter with a series resistor, R4.

This resistor can have a value of one kilohm per volt for a 1mA meter, which means a resistance of 20 kilohms for the meter to read 20 volts, or 200 ohms per volt for a 5mA meter, which is four kilohms to read 20 volts. The formula for calculating this "multiplier" resistor is simply:

$$R_{MULTIPLIER} = \frac{\text{Voltage to be measured}}{\text{Current rating of meter}} \text{ (Kilohms)}$$

For the current meter ME2, a direct reading meter can be used. If however a meter of greater sensitivity than one amp f.s.d. is used it can be shunted with resistance wire.

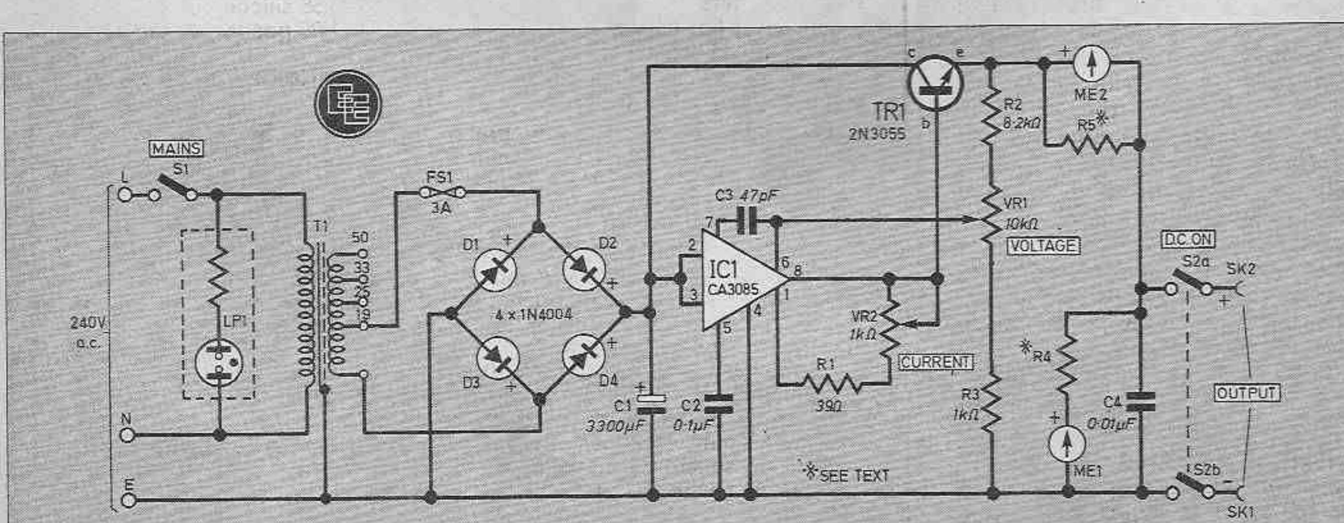
The value of this resistor is calculated from the following equation:

$$R_{SHUNT} = \frac{I_m}{I - I_m} \times R_m \text{ (Ohms)}$$

Where I_m=Current rating of meter, I=Maximum current to be measured, and R_m=Resistance of meter.

As the value of the shunt may be rather small, and quite possibly will be difficult to measure an alternative is to find the shunt by trial and error. To do this connect a 500mA load, such as a six watt 12 volt bulb and a test meter set to read one amp in series across the output. Solder a short length of resistance wire across the meter terminals.

Fig. 1. Complete circuit diagram of the General Purpose Power Supply.



Adjust VR1 from a low voltage until the test meter reads 500mA. If ME2 reads too high, shorten the resistance wire. If it reads too low, lengthen the wire to increase the resistance. With a few trials ME2 can be made to read correctly.

Switch off the mains each time the shunt is being changed.

CONSTRUCTION starts here

CASE DETAILS

An attractive and inexpensive case can be made from three 152 × 100mm flanged Universal Chassis members for the front, bottom and back. These are held together with 4BA mounting hardware as supplied with these parts.

A cover is necessary to protect the user and power supply. This can be made from a piece of sheet metal of 22 s.w.g. or similar. The overall size is 408 × 152mm and is finally bent into a "U" shape. This is relatively easy if the metal is not too stout and if gripped firmly when bending. It is fixed to the main chassis using self tapping screws which screw into the flanges on the Universal Chassis members.

CIRCUIT BOARD

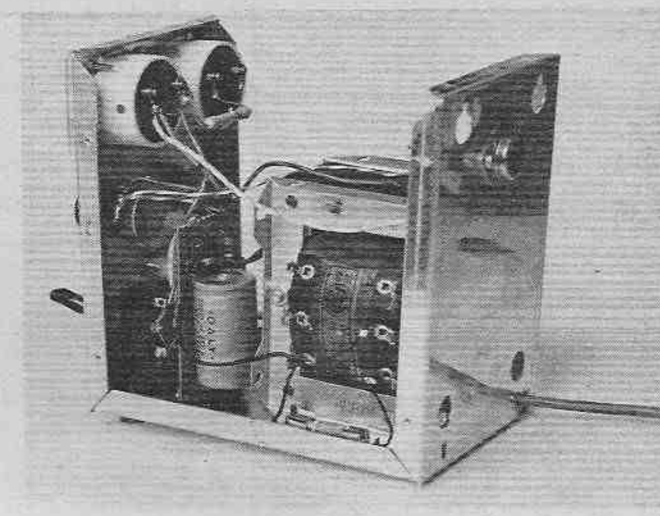
The diagram in Fig.2 shows the stripboard layout for the rectifier part and regulator part of the circuit. Make all the breaks shown not forgetting those which isolate the metal mounting bracket and then wire the diodes followed by the resistor and capacitors. The i.c. is left to last. Be extra careful with the i.c. as many of the leads are splayed out more than normal, and if forced can break away from the body. A socket cannot be used here for this reason.

The flying leads can be wired either direct or by the use of Veropins. Colour coding of the wires will be an advantage at this stage if for instance, at a later date fault finding is necessary.

FRONT PANEL

Next to be wired can be the front panel. Drilling details for this is shown in Fig.3. Note that the hole sizes depend on whatever type of meter you have. If other larger types are used then obviously a larger front panel, hence a larger overall case needs to be used. It is best therefore to obtain the meters first and make the case accordinly.

It will be easier to dismantle the three sections of the chassis when wiring up the front panel, remembering to leave connecting wires long enough to reach the rest of the circuit. Wiring details for the front panel is shown in the overall diagram of Fig.4.



The main chassis frame members. The power transistor TR1 is seen mounted on the rear panel. The circuit board is mounted vertically close to the output switch S2. It would be a good idea to insert a piece of plastic or polythene sheet between S2 and the circuit board to avoid any possibilities of "short circuits . The cover for the unit is simply a "U" shape which is fitted over and fixed with self tapping screws.

BOTTOM AND REAR

Whatever type of transformer you have chosen needs to be fixed as near to the back as possible so as to clear the front panel components. The completed circuit board can also be mounted on the bottom panel using the small bracket as detailed in Fig.2. The fuse holder is also mounted at this stage.

The rear panel has only one component mounted on it and this is the power transistor TR1. This needs to be isolated from the chassis, and is accomplished using

COMPONENTS

Resistors
- R1 39Ω
- R2 8·2kΩ
- R3 1kΩ
- R4 Meter multiplier (see text)
- R5 Meter shunt (see text)
- All ½W carbon ± 5%

Capacitors
- C1 3300μF 25V elect.
- C2 0·1μF polyester
- C3 47pF polystyrene
- C4 0·01μF polyester

Potentiometers
- VR1 10kΩ lin. carbon
- VR2 1kΩ lin. carbon

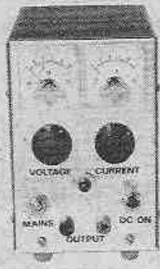
Semiconductors
- TR1 2N3055 silicon *npn*
- IC1 CA3085 positive voltage regulator
- D1 to D4 1N4004 silicon rectifier

Miscellaneous
- LP1 240V mains neon with integral resistor
- ME1 0 to 20 volt meter, 60 × 48mm front (see text)
- ME2 0 to 1 amp meter, 60 × 48mm front (see text)
- S1 s.p.s.t. toggle switch
- S2 d.p.d.t. toggle switch
- SK1, 2 4mm sockets (1 off red, 1 off black)
- FS1 3 amp fuse with chassis mounting holder
- T1 240 volt mains transformer, secondary as required rated at 1 amp. Type MT104AT (Home Radio) was used in prototype which had a 19V secondary. (See text)

Stripboard 0·15 inch matrix 10 strips by 20 holes; aluminium 20 × 20mm; Universal Chassis flanged members 152 × 100mm (3 off); 22 s.w.g. sheet metal for cover, bent into a "U" shape, overall dimensions 408 × 152mm; 4BA and 6BA hardware as required; insulating kit for TR1; two small round knobs; four rubber feet; length of mains cable; connecting wire.

See Shop Talk page 92

General Purpose POWER SUPPLY



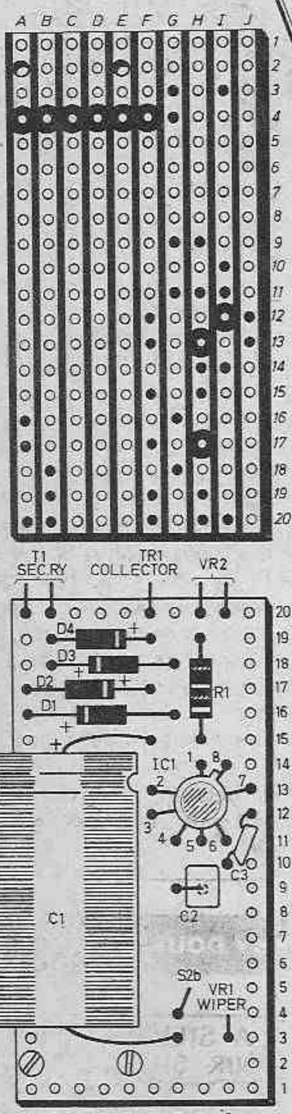


Fig. 2. Wiring details for the component board showing the breaks to make.

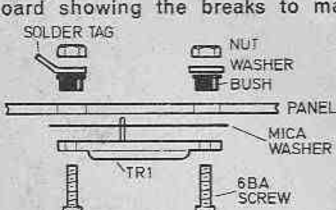


Fig. 5. Mounting the power transistor using a mica insulation kit.

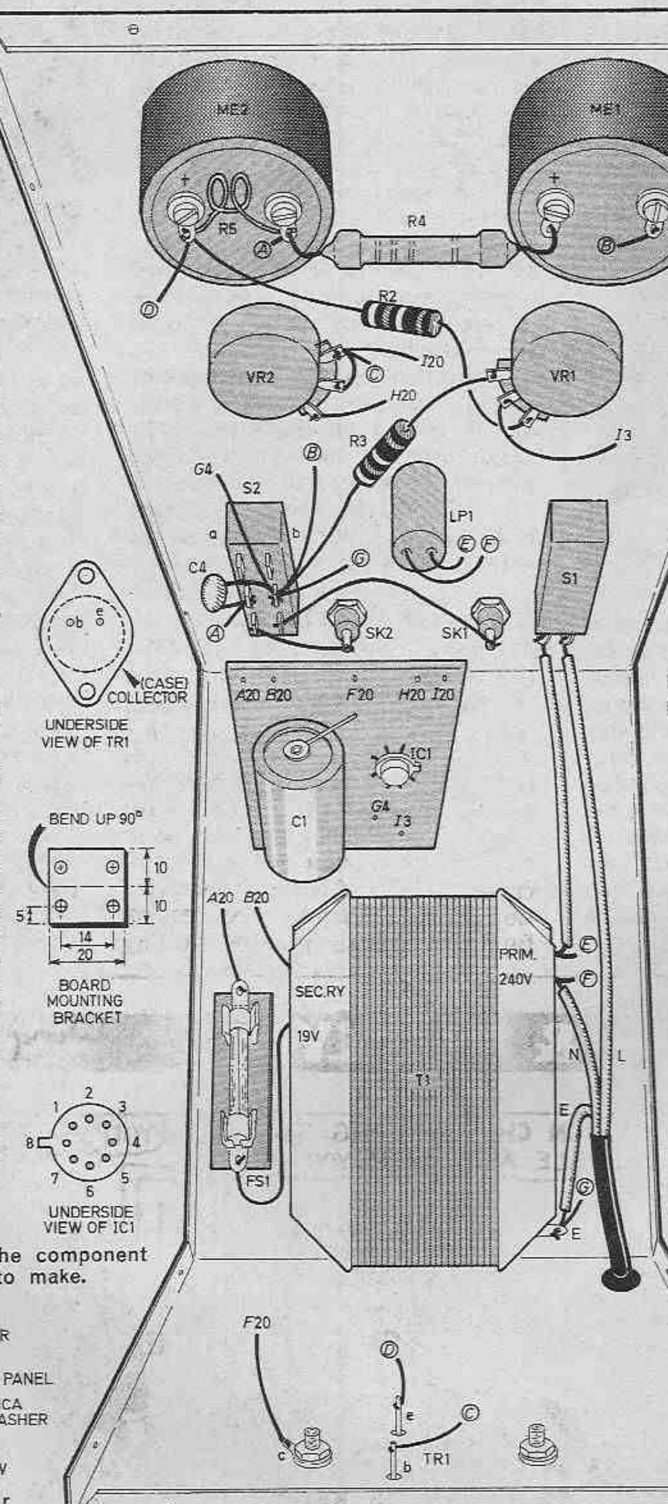
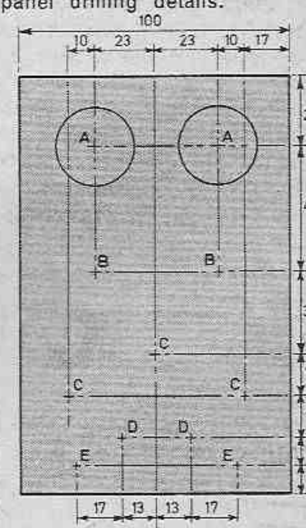


Fig. 4 (Left). Main wiring details for the unit. With the transformer specified there is not a great deal of room on the base, hence the component board should be mounted as near to the front panel as possible without touching the mains switch.

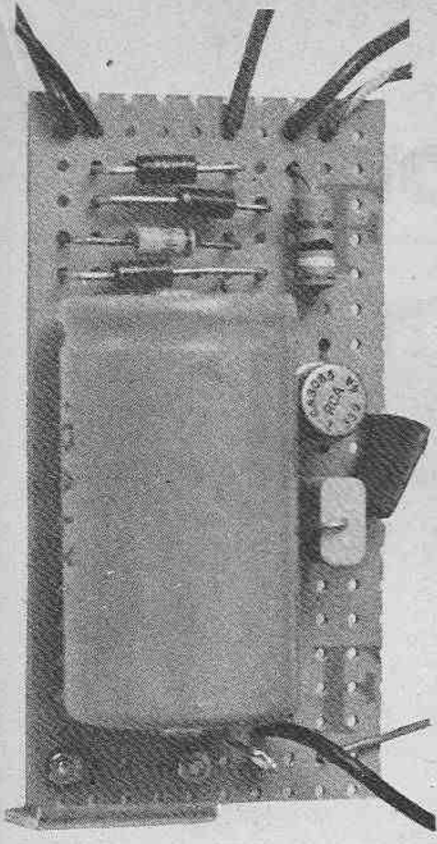
Fig. 3 (Below). Typical front panel drilling details.



FRONT PANEL DRILLING DETAILS

ALL DIMENSIONS IN mm

HOLE SIZES
A = TO SUIT METERS B = 12
C = 16 D = 10 E = 4BA



The completed circuit board. Note the small L-shaped mounting bracket.

a mica insulating kit as shown in Fig.5. When mounting the transistor be sure to position it so that it will clear the mains transformer, otherwise a short circuit may occur and cause a great deal of damage.

Four holes each 15mm in diameter are also drilled in the rear panel, two near the top above the transformer, and two at the bottom. The three separate sections can then be bolted together before testing.

IN USE

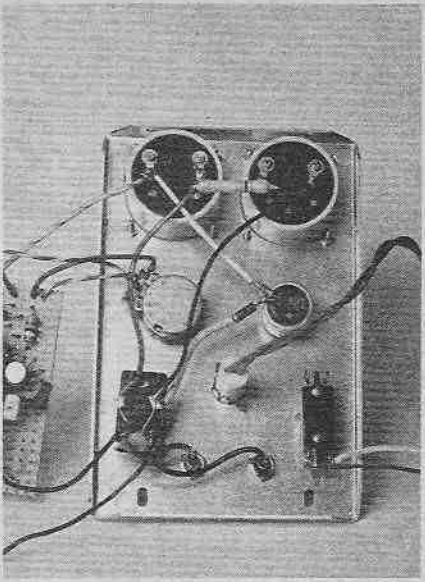
Before switching on, the usual checks should be made to ensure that no errors have crept in. Be extra cautious with this design to look out for short circuits, particularly around the rectifier part of the circuit board and transistor. An ohmeter set to its low resistance range should show no indication at all when connected between the chassis and the case of the transistor. Take time over this test as mistakes at this stage can be very expensive!

If all seems well the mains lead can be plugged in, fit a one amp fuse in the plug, and switch on. The neon should at once light, and depending where the controls are set an indication may be seen on the voltmeter.

Adjusting the VOLTAGE control, VR1 should allow the wanted voltage to be set on the meter. The range obtained on the prototype was just over zero to just over 20 volts. Depending on the transformer used the voltage can be lower or higher.

CURRENT CONTROL

Set the required voltage on the meter and connect the power supply to a load, turn the CURRENT control fully anticlockwise and switch on S2. The voltmeter will still show an indication but the current meter will show zero. Slowly turn the CURRENT control clockwise and note the reading increases also. When further rotation of the control produces no further increase in the reading turn the control back to the point where the reading stopped.



Rear of the front panel showing interwiring between components.

The CURRENT control is now set so that no further increase in the current will take place. The load and power supply in this state are now fully protected. For example if the load goes short circuit the power supply will limit the current thus protecting the load as well as the supply. Under fault conditions such as this the voltage reading will remain the same, but the current will fall to almost zero. There is a slight leakage current on a full short circuit but this can normally be ignored.

Once practice has been gained at using the controls the power supply will become a most useful instrument in the constructors workshop. ⌑

JACK PLUG & FAMILY...

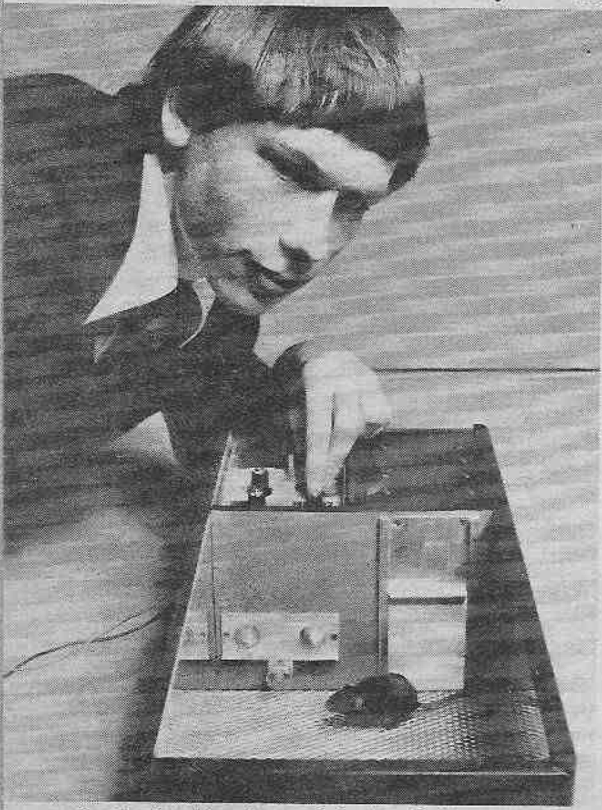
BY DOUG BAKER

Everyday News

BRITAIN'S DESIGNERS OF TOMORROW

Electronics feature in three of six prize winning ideas in national competition for schoolchildren

But Minister says—Overall response a little disappointing



David Crosbie, from Dulwich College with the Skinner Box.

The printed circuit board assembly jig designed by Leslie Brookes, Shaun Gallagher, Dennis Oliver, Raymond Pearce and Ian Sperry from the Drayton School, Banbury.

The 1978 winners of the Design Council GEC Schools Design Prize were announced at the Royal Institution London on November 21. This is the second year of the annual award scheme, which is open to secondary schools and aimed at encouraging pupils to turn their bright ideas to practical use. It is sponsored by The General Electric Company Limited.

In his introductory speech before the official prize giving ceremony Mr. L. Huckfield M.P., Parliamentary Under Secretary of State, Department of Industry, emphasised the need for closer interface between industry and schools. Quality of design is all important in the drive to sell abroad, and we must encourage the generation of ideas by schoolchildren. Their contributions can be most valuable. While complimenting the winners of this year's competition, the Minister also said the response was a little disappointing: more than 6,000 secondary schools were initially contacted; 200 schools showed interest, and only 50 finally participated.

Two prize-winning designs involve the use of electronic circuitry, and one other is an aid for p.c.b. assembly. Brief details of these three designs follow.

Improved "Skinner Box"

To help the biology department at Dulwich College in their work in establishing a conditioned reflex in a mouse, David Bruce Crosbie (aged 16) devised an adapted "Skinner Box". He designed an electronic system to provide the mouse with its reward when it made a correct response. The animal must learn the correct response to the two lights in the box and touch a narrow ledge when either of the lights come on in order to release its reward.

P.C.B. Assembly Jig

A printed circuit board jig that will make the soldering of components an easier and cheaper operation for small firms has been designed by a team of five pupils (aged under 16) from Drayton School, Drayton Road, Banbury, Oxon. The novel feature is a foam-filled lid which holds the components securely in place when the frame is reversed for soldering operations. (For speed of production in industry, component leads are pre-cut to suitable length and pushed through the p.c.b. holes without any final bending to lock components in position).

Sunshine Recorder

By using a two-cell system, with one cell monitoring direct sunlight the other monitoring ambient or scattered sunlight, Neil Duncan Hunt (aged 16) of Brentwood School, Essex, was able to record the hours of sunshine more accurately than with a traditional Campbell-Stokes recorder.

Neil designed the electronic sunshine recorder entirely in his own time. He hopes it can be developed for use in researching the possibilities of harnessing solar energy.

● The other three prizewinning designs were for animated roadsigns, music calculators for teaching musical theory; and geometric dominoes for blind children.

Neil Hunt, from Brentwood School with the Sunshine Recorder.

ANALYSIS

In the old days (in electronics this can be as recently as ten or fifteen years ago) semiconductor manufacturers were able to hand-test transistors as they trickled off the production line. Then, as production methods improved and the trickle became a torrent, so the unit cost of production lessened until there came a time when the cost of testing them first became equal to, and then exceeded, the cost of producing them.

This crazy situation was soon remedied by the development of automatic test equipment. Then came the integrated circuit which, because of its additional complexity, again put test cost ahead of production cost. So it was back to the drawing board to design more advanced test gear which could do more tests faster. I.C.s in computers were now controlling test sequences for testing i.c.s. Chips testing chips.

Today we have LSI in the form of memories and MPUs of such complexity that it is impossible to test them other than with automatic high speed testers. Impossible? Yes! If you sat down with a multimeter and other appropriate test gear, measuring each possible parameter and writing it down on a test sheet, working eight hours a day, you could spend your whole life on a single chip and still not have tested it fully.

In fact so complex are today's advanced chips that even using the most sophisticated automatic testers it is only possible on a commercial scale to test up to a certain "confidence factor" which indicates that the chip should function properly in most applications.

What can be done for testing semiconductors can also be done for other circuits. So, in the past decade a new ATE (Automatic Test Equipment) sector of industry has been born making testers not only for i.c.s but also for printed circuit board assemblies, cableforms, complete equipments, and missiles and other weapons systems. ATE has grown in importance so that it now has its own literature (and jargon!), its own trade exhibitions, and its own specialist breed of ATE engineers working in companies solely devoted to designing and manufacturing ATE of various types.

Early ATEs were based on large computers. Then came the mini and now the MPU is taking over. Even when it is possible to test an assembly or an equipment in the old-fashioned way it is generally quicker and cheaper to use ATE with unskilled or semiskilled operators. With diagnostics, if something is wrong the ATE prints out how to put the fault right.

You're right if you say this is another example of soulless automation. But without chips testing chips some things would be impossible, others far more expensive to buy.

Brian G. Peck

GRANTED

The Science Research Council is granting £316,000 to Edinburgh University to rebuild and up-date the University's silicon diffusion plant used for research and instruction.

The plant was recently renamed the Wolfson Microelectronics Institute and enjoys an income of £200,000 a year from industry and government research projects.

Miscalculation

There are now only a handful of pocket calculator manufacturers still in business compared with 50 or so five years ago. Peak sales in the UK were 5 million units in 1976-77. Estimates for 1979-80 are 3·5 million unit sales worth £35 million, a drop of £20 million on the peak year according to John Sivyer, marketing manager of Commodore.

MPU COMPETITION

The manufacturer of Prestige kitchenware is offering prizes for designs for the microprocessor in the kitchen.

Ideas should be for a piece of kitchen equipment making maximum use of a MPU either in storage, preparation, cooking or serving food, or with information processing such as storage and retrieval of cooking recipes.

Double Viewing

The UK's largest maker of colour TVs, Thorn Consumer Electronics, is to double its investment in automated processing in its factories. The plan is to invest £13 million in an attempt to equal or surpass the techniques used by Japanese competitors who hold some 10 per cent of the UK market.

Market analysts Mackintosh Consultants forecast that the total West European market for electronics will be a record £25 billion in 1979 and £31 billion by 1982 at constant 1977 prices. Largest market is Germany, followed by France.

WRITER OF THE YEAR

In recognition of his contributions in the audio/video field, the 1978 Audio Writer Award has been won by Barry Fox.

Better known to our readers as Adrian Hope, *he is one of the most prolific freelance writers on audio, video and patents. Paying particular attention to detail and research, he writes for the majority of audio and video publications and is the author of two books, one on Inventions and the other on Audio.*

Sponsored by BASF United Kingdom, the award, a silver tuning fork and £300, was presented by Charles Mackerras, the international conductor.

On Fire

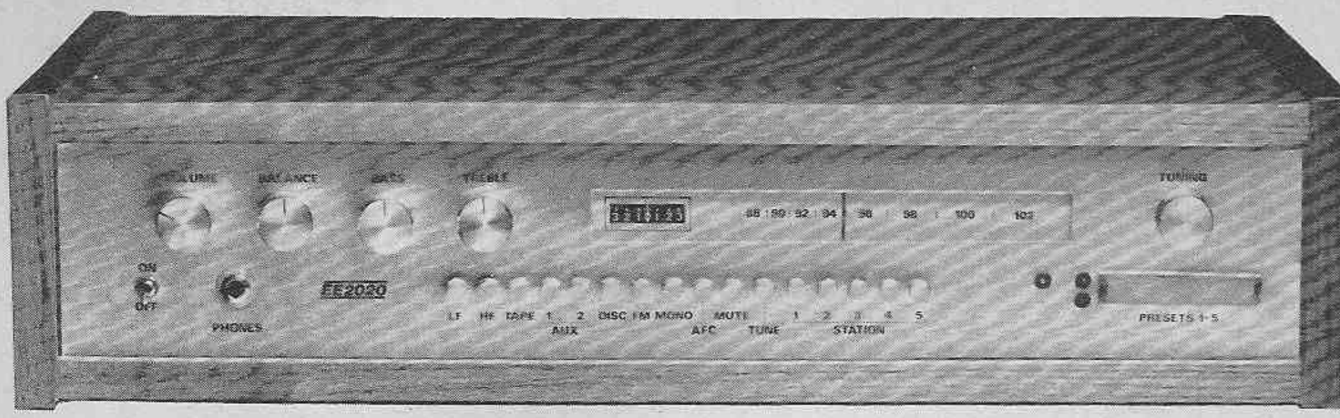
Fairchild's 9440 Microflame 16-bit 10MHz microprocessor has made its European debut. It is claimed as bringing full minicomputer capability on a single microprocessor chip. Software support system is Fire (Fairchild Integrated Real-time Executive).

Microflame II, a second-generation system, is already in development and should hit the market in mid-1979. Other "hot" names in Microflame are Spark, Firebug and Blaze, all being configurations of the system.

The 1979 All-Electronics Show to be held in London's Grosvenor House Hotel opening on February 27 is fully sold out with over 200 stands taken by exhibitors.

SAILING

Operation Drake, the two-year voyage for young people commemorating Sir Francis Drake's circumnavigation of the globe 400 years ago, will use three Racal v.h.f. manpacks and four pocket two-way radios to keep the young explorers in touch during land-based exploration trips.



EE2020 TUNER AMPLIFIER PART 3

HI-FI SERIES

BY E. A. RULE

THIS month the remaining two printed circuit boards are covered. These are board B—Control Unit and board D—Power Amplifier.

Full component lists and full-size p.c.b. patterns are included.

It is strongly recommended that only Grade 1 Fibreglass be used for the p.c.b.s.

Drilling details:

(*a*) normal component holes 1mm.
(*b*) pushbutton switches, preset potentiometers, and terminal pins 1·2mm.
(*c*) board fixing 4mm.

The procedure given last month should be followed when assembling components on these boards. The eight pushbutton switches must be fitted to board B before other parts are mounted. Full details appeared last month, see Fig. 2·7.

TRANSISTORS

Transistors type BC182L, BC212L and BC384L are encapsulated in TO 92 epoxy packages, with the three leads "in line", see Fig. 3.5b.

For use in the 2020 Tuner Amplifier, a special version of these transistors with the suffix "TO 5" is recommended. Devices so coded are supplied with their leads "cranked" to give the standard TO 5 configuration, see Fig. 3.5a. They are suitable for direct fitting in the appropriate holes in the p.c.b.s.

If devices without the TO 5 suffix are obtained it will be necessary to "form" the leads to conform to the TO 5 arrangement before assembling on the boards.

COMPONENTS

BOARD D

See Shop Talk page 92

Resistors

R82a,b	4·7kΩ	R92a,b	4·7kΩ
R83a,b	180kΩ	R93a,b	5·6kΩ
R84a,b	100kΩ	R94a,b	120kΩ
R85a,b	100kΩ	R95a,b	10kΩ
R86a,b	15kΩ	R96a,b	100kΩ
R87a,b	3·9kΩ	R97a,b	1kΩ
R88a,b	15kΩ	R98a,b	1kΩ
R89a,b	820Ω	R99a,b	0·22Ω 2·5W wirewound 10%
R90a,b	100kΩ	R100a,b	0·22Ω 2·5W wirewound 10%
R91a,b	82kΩ	R101a,b	1kΩ 1W

All $\frac{1}{4}$W $\pm$5% high-stability carbon film, except where otherwise stated (2 off throughout)

Potentiometers

VR15a,b	47kΩ horizontal mounting miniature skeleton preset RS type 184/5 (2 off)
VR16a,b	2·2kΩ horizontal mounting miniature skeleton preset RS type 184/5 (2 off)

Capacitors

C46a,b	100pF polystyrene	C52a,b	47μF 63V elect. double-ended
C47a,b	4·7μF 63V elect.	C53a,b	0·1μF polyester
C48a,b	10μF 63V elect.	C54a,b	15pF polystyrene
C49a,b	47μF 63V elect.	*C55a,b	2,200μF 63V elect. single-ended
C50a,b	220μF 63V elect.	C56a,b	0·22μF polyester
C51a,b	100pF polystyrene		

Unless otherwise stated, all electrolytics (elect.) are the small single-ended p.c.b. type. (2 off throughout)
**Mounted on main chassis*

Semiconductors

TR14a,b	BC182L/TO5 *npn* silicon
TR15a,b	BC182L/TO5 *npn* silicon
TR16a,b	BC212L/TO5 *pnp* silicon
TR17a,b	BC182L/TO5 *npn* silicon
TR18a,b	BC182L/TO5 *npn* silicon
TR19a,b	BC212L/TO5 *pnp* silicon
*TR20a,b	TIP33A *npn* silicon
TR21a,b	BC182L/TO5 *npn* silicon
*TR22a,b	TIP34A *pnp* silicon

(2 off throughout)
**Mounted on rear panel*

Socket

*SK9 *Phones* 3-pole chassis jack socket Maplin type HF92A
**Mounted on front panel*

Printed Circuit Board

D 114 × 114mm (see Fig. 3.1)

BOARD D

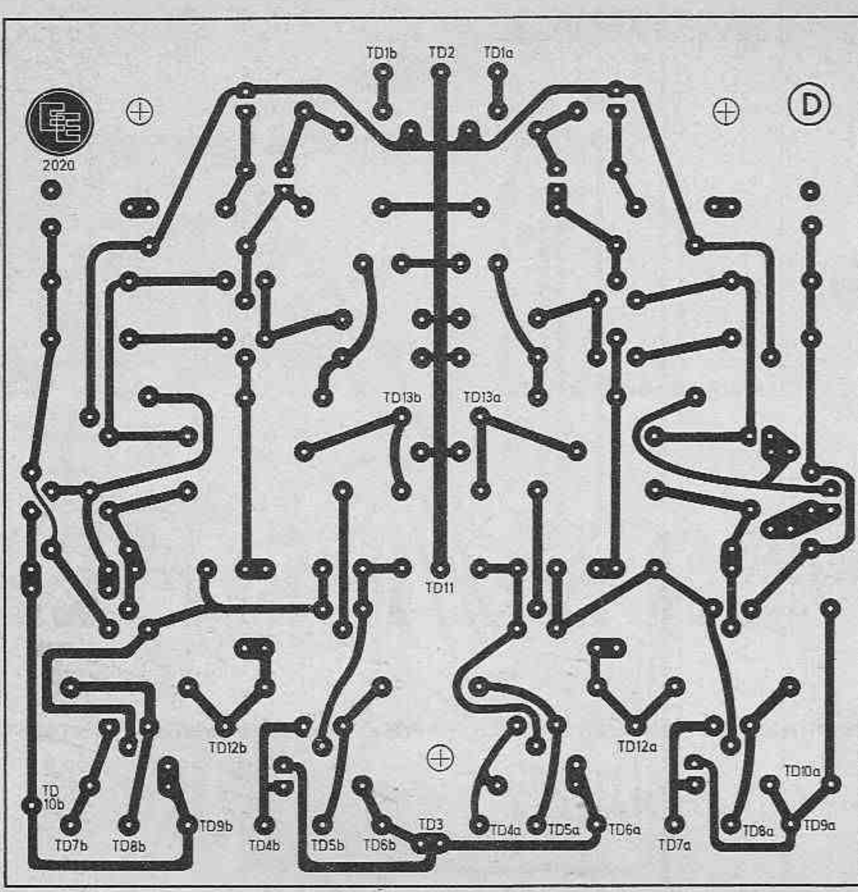
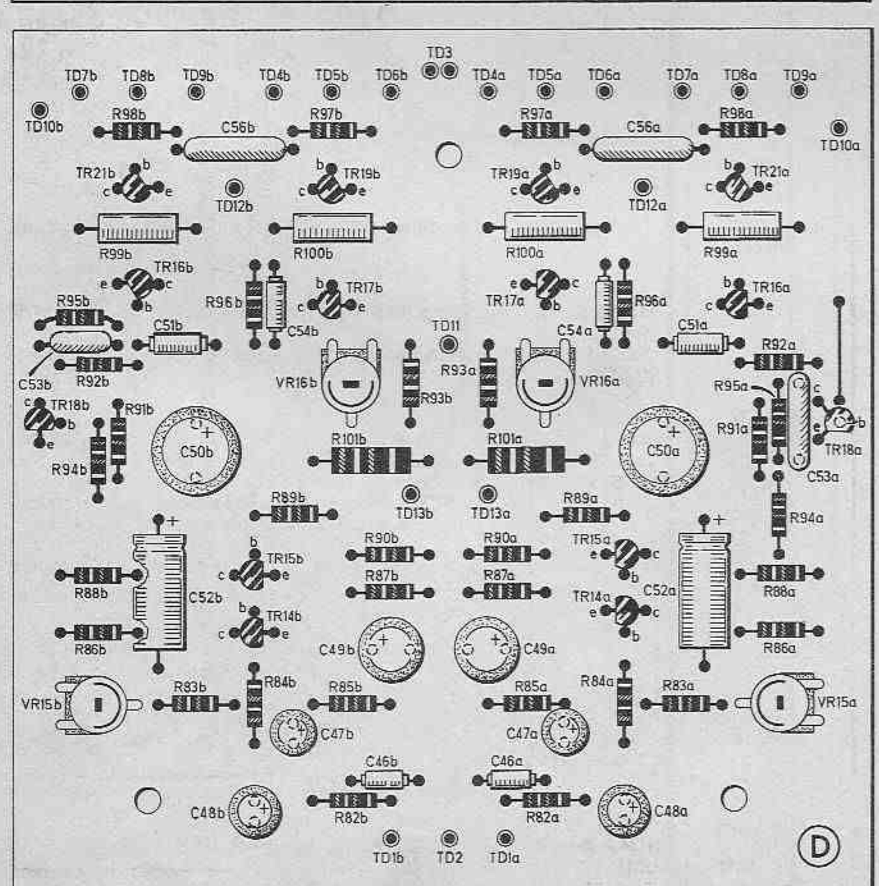


Fig. 3.1 (left). Board D of the 2020 Tuner Amplifier: underside view showing printed circuit (full size).



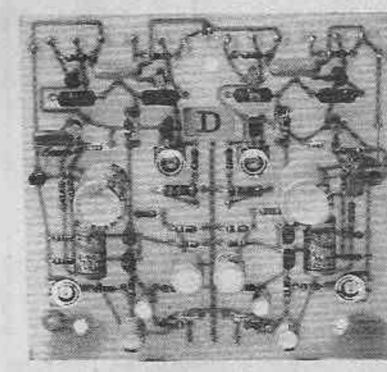


Fig. 3.2 (left). Board D of the 2020 Tuner Amplifier: top view showing components in position. NOTE: one side of R101a, b goes to TD2, *not* to TD3 as shown in the circuit diagram Fig. 1.2b.

EE2020

COMPONENTS

BOARD B

Resistors

R41a,b	1MΩ
R42a,b	330kΩ
R43a,b	100kΩ
R44a,b	1kΩ
R45a,b	1kΩ
R46a,b	1·5kΩ
R47a,b	4·7kΩ
R48a,b	47kΩ
R49a,b	18kΩ
R50a,b	39kΩ
R51a,b	27kΩ
R52a,b	47kΩ
R53a,b	330kΩ
R54a,b	330kΩ
R55a,b	100kΩ
R56a,b	1kΩ
R57a,b	1kΩ
R58a,b	270Ω
R59a,b	8·2kΩ
R60a,b	39kΩ
R61a,b	5·6kΩ
R62a,b	2·7kΩ
R63a,b	8·2kΩ
R64a,b	470kΩ
R65a,b	27kΩ
R66a,b	10kΩ
R67a,b	2·7kΩ
R68	100Ω
R69a,b	15kΩ
R112a,b	330kΩ

All $\frac{1}{4}$W ±5% high-stability carbon film (2 off throughout, except R68)

See Shop Talk page 92

Potentiometers

*VR11	*Bass* 100kΩ dual gang, linear
*VR12	*Treble* 100kΩ dual gang, linear
*VR13	*Balance* 100kΩ single gang linear
*VR14	*Volume* 100kΩ dual gang, log.

**Mounted on front panel*

Capacitors

C23a,b	2·2μF 63V elect.
C24a,b	2·2μF 63V elect.
C25a,b	10μF 63V elect.
C26a,b	0·22μF polyester
C27a,b	0·22μF polyester
C28a,b	470pF polystyrene
C29a,b	470pF polystyrene
C30a,b	2·2μF 63V elect.
C31a,b	2·2μF 63V elect.
C32a,b	68pF polystyrene
C33a,b	2·2μF 63V elect.
C34a,b	0·047μF polyester
C35a,b	0·047pF polyester
C36a,b	3300pF polystyrene
C37a,b	10μF 63V elect.
C38a,b	22pF polystyrene 5% *or* sub-miniature plate ceramic
C39a,b	10μF 63V elect.
C66	47μF 63V elect.

Unless otherwise stated, all electrolytics (elect.) are the small single-ended p.c.b. type (2 off throughout, except C66).

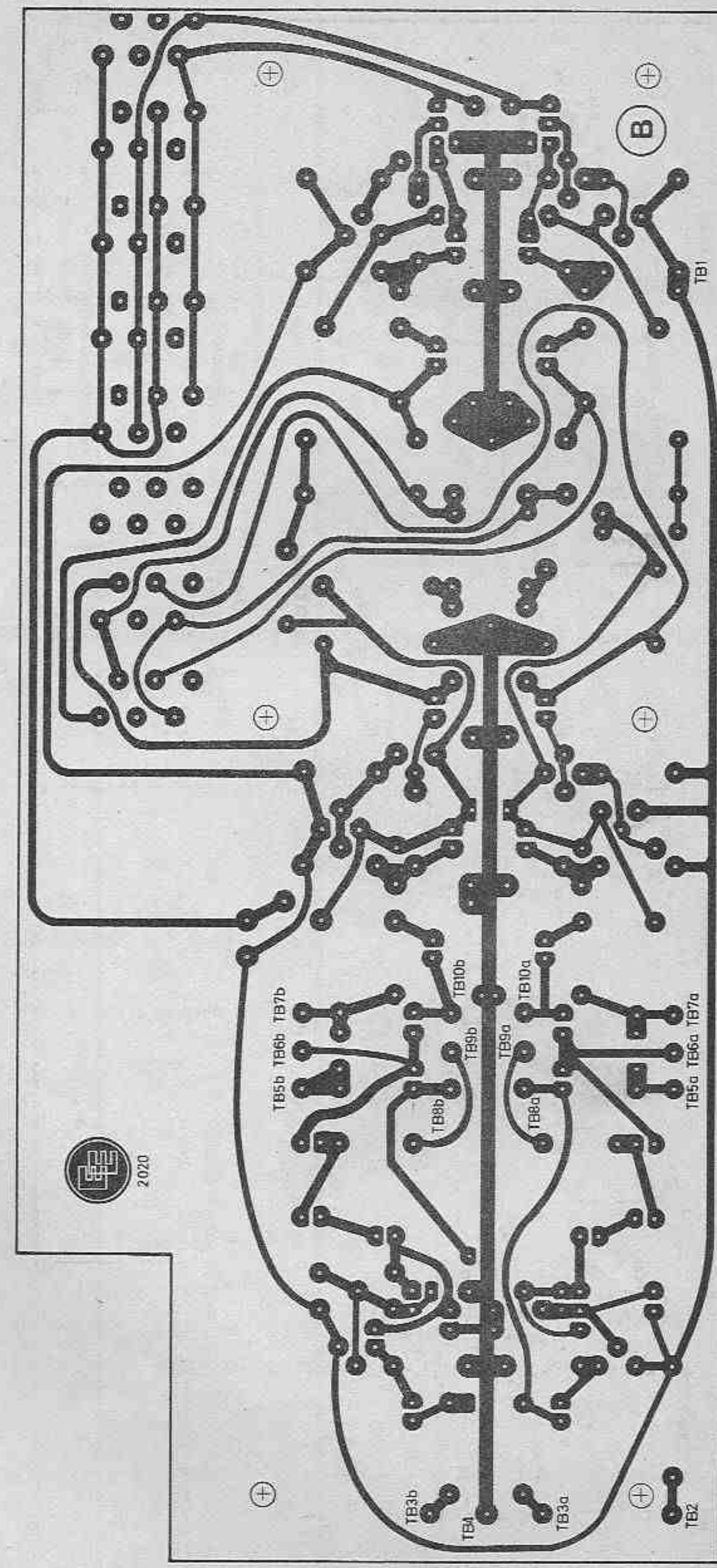


Fig. 3.3. Board B of the 2020 Tuner Amplifier: underside view showing printed circuit (full size).

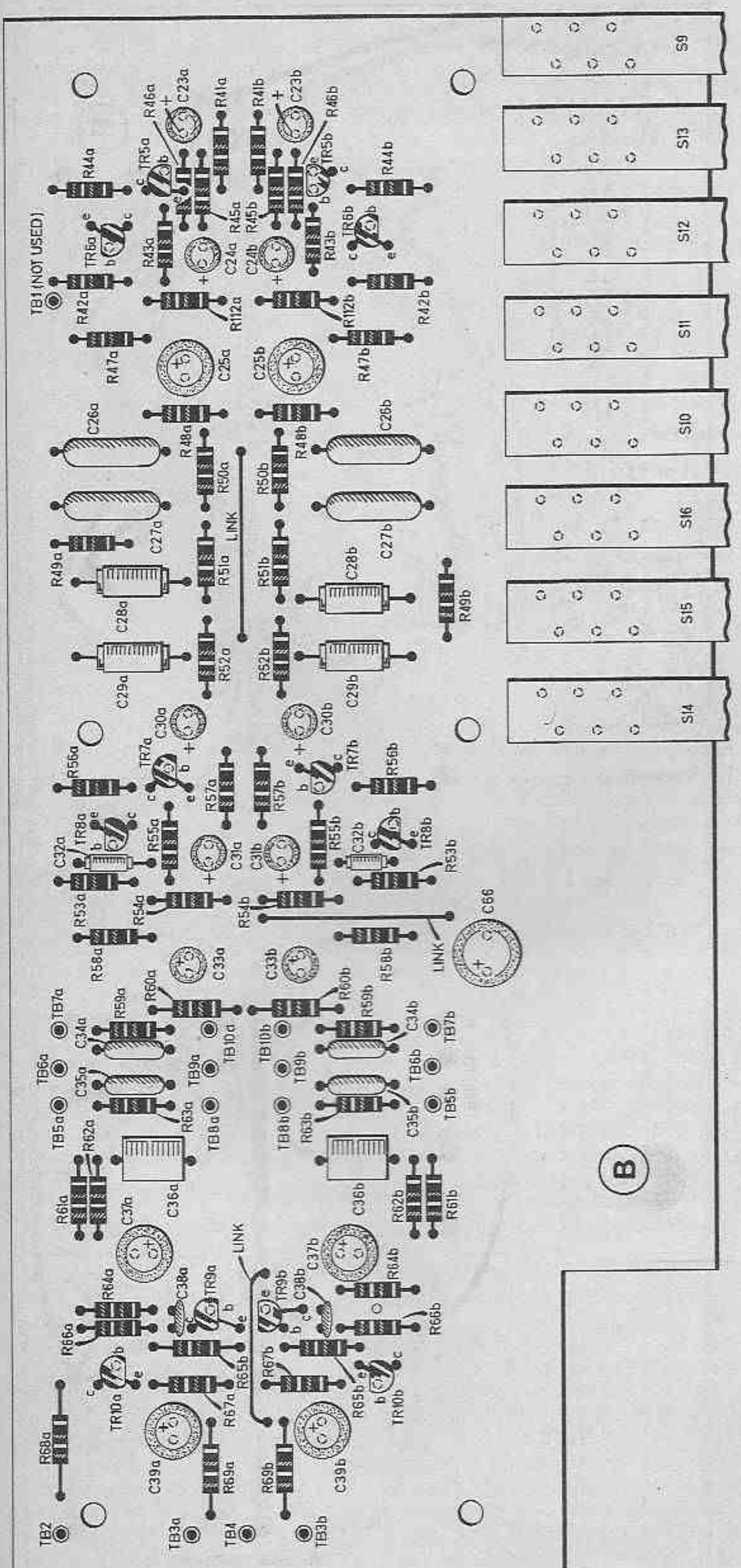


Fig. 3.4. Board B of the 2020 Tuner Amplifier: top view showing components in position.

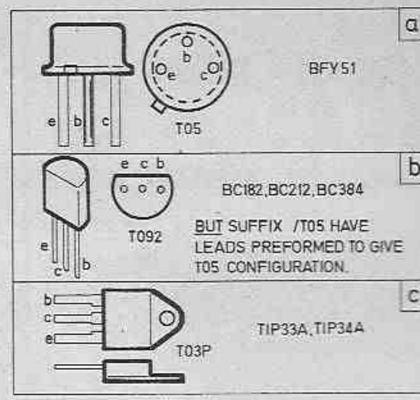


Fig. 3.5. Lead-out details for all transistor types used in the 2020 Tuner Amplifier.

Pushbutton Switches
(Manufactured by Jean Renaud)

S9	*Mono*	2-Pole changeover RS type 338-434; ITT type 44012R (8 off)
S10	*Aux 1*	
S11	*Aux 2*	
S12	*Disc*	
S13	*F.M.*	
S14	*L.F. filter*	
S15	*H.F. filter*	
S16	*Tape*	

One 4-switch latching assembly (for S10—S13) RS type 338-254; ITT type 44019F

Sockets

SK2a,b	*Aux 1*	phono socket single-hole chassis mounting RS type 477-848 (12 off in all)
SK3a,b	*Aux 2*	
SK5a,b	*Tape Out*	
SK6a,b	*Tape In*	
SK7a,b	*Amplifier Out*	
SK8a,b	*Amplifier In*	

Semiconductors

TR5a,b	BC384L/TO5 *npn* silicon
TR6a,b	BC212L/TO5 *pnp* silicon
TR7a,b	BC384L/TO5 *npn* silicon
TR8a,b	BC212L/TO5 *pnp* silicon
TR9a,b	BC384L/TO5 *npn* silicon
TR10a,b	BC384L/TO5 *npn* silicon

(2 off throughout)

Printed Circuit Board

B 210 × 96mm (see Fig. 3.3)

NOTE: Correction to Part 2, page 38.

A 242 × 96mm (see Fig. 2.1)
E 115 × 57mm (see Fig. 2.5)

See Bulk Components list (page 878) and individual components lists for full designation of all transistors. Connection details are given in Fig. 3.5.

OFF-BOARD COMPONENTS

Components marked with an asterisk are mounted on the main chassis assembly. Full details of all metalwork will be given next month.

To be continued

RADIO WORLD

By Pat Hawker, G3VA

Clarity and Air Traffic Control

THE relatively poor clarity of some civil aircraft radio systems (at least to the outsider) is becoming a matter of concern to some communications engineers. An American, Richard G. Davaney, has on several occasions recently tried to raise this life-and-death issue publicly and asks "Why is this state of affairs tolerated and never mentioned or cited as a problem?"

He claims that tapes from the 1978 San Diego air disaster were completely unintelligible to the average listener, adding that when they were used on television "it was necessary not only to have someone repeat the conversations, but also to print an overlay of sub-titles . . . I cannot believe these scarcely understandable communications are not at least partly responsible for accidents and near-misses."

Certainly mis-understood radio messages appear to have played a tragic part in the world's worst air-disaster in the Canary Islands in 1977, apparently brought about by a mis-understanding or mis-hearing of the instructions from the control tower.

Broadcast Receivers

In contemplating the change of BBC Radio 4 to 200kHz (1500m) in this column last October, I suggested that interference might prove a more serious problem than had been anticipated, due to such questions as radiation from television receivers. This indeed seems to have happened plus a further problem that few foresaw: "image" (second-channel) spurious responses on a considerable number of receivers to the 1152kHz Independent Local Radio stations and particularly LBC in London.

It is a simple matter of mathematics: if you have a receiver with an intermediate frequency of around 475kHz then, if the set is tuned to 200kHz there will tend to be a response to any station on $200 + (2 \times 475)$ or 1150kHz, resulting in an audible beat with 1152kHz, or if very near to the ILR station, breakthrough of the programme material. Curiously, this should have similarly resulted in interference from the old frequency of 1151kHz to Radio 2, yet apparently there were few complaints. May be all former Radio 2 listeners had receivers with either better pre-mixer selectivity or with intermediate frequencies safely below about 470kHz. One answer, of course, is to re-align the i.f. of receivers suffering interference.

Better Receivers

One result of the reshuffle of the frequencies is that many people have suddenly become aware of the relatively poor design of the front-ends of many m.f./l.f. broadcast receivers. It was not always so. At one time many ingenious designs with band-pass circuits providing pre-mixer selectivity of a high standard, variable i.f. bandwidth, push-button and motorised tuning were all part of the broadcast receiver scene.

As others have pointed out, it is a fallacy to believe that medium-wave a.m. reception is inherently second-class, much inferior to v.h.f./f.m. reception. Apart from some limitation of dynamic range, the present deficiencies are largely man-made, often stemming from the megawatt approach to external broadcasting on m.f.

There are a number of ways in which we could significantly improve the ability of receivers to reject interference. One such system would be the use of binaural synchronous detection which exploits the coherent nature of the two sidebands as compared with the non-coherent interference. Less complex would be the practical development of homodyne, direct - conversion broadcast receivers.

Satisfactory (although complex) techniques for synchronous detection for a.m. signals were put forward over 20 years ago by J. P. Costas and still turns up from time to time, most recently in "IEEE Transactions on Consumer Electronics" (August 1978) by Hudson, Castle and Krauss. This design uses two type 561 integrated circuit phase-lock-loops but unfortunately also requires some close-tolerance phase-shifting components.

One suspects that synchronous demodulation for broadcast receivers will never become popular until someone produces an integrated circuit chip that does the whole thing and makes it as simple as the common diode demodulator. But more the pity!

Hair-pins and HF Radio

A name that has long been associated with a high standard of short-wave receivers and components is Eddystone. But few of those who have used the firm's equipment know that it all started when women began to cut their hair short in the period following the end of World War I.

The Eton crop, the bob and the shingle meant a falling demand for those now almost forgotten wire hair-pins. This was a disturbing trend for the Birmingham costume-jewellery firm of Jarrett, Rainsford and Loughton who had a factory geared up to turning out six tons of hair pins each week. It was in fact G. Stratton Loughton who in 1922 took this part of the firm into the radio business as one of the companies associated with the old British Broadcasting Company.

The competition was intense and some five or six years later Harold Cox and Arthur Edwards changed the emphasis from medium to high frequencies. This soon resulted in such sets as the Eddystone All-World Four which in its "ant-proof" aluminium die-cast case brought pleasure to many tea and rubber planters—and in doing so helped to pioneer the concept of "tropicalisation" of radio equipment.

Later Eddystone helped pioneer police v.h.f. radio providing an emergency communications network for the London police just a few weeks before the outbreak of war in 1939. The company suffered severely in the blitz and were forced to move into the old West Heath Lido or "The Bath Tub" where it became perhaps the first radio company ever to operate from a swimming pool.

Much later, in the mid-sixties, Eddystone became and has remained a fully-owned subsidiary of The Marconi Company on its long trek from hair-pins to high-grade h.f. receivers.

Sunspots and Weather

Many short-wave listeners and radio amateurs have long compared the daily variations of the ionosphere, due to sun spot activity, with the ever-changing British weather. But is there really a link? During the past century more than 1000 articles have been published which either claim or refute correlations between solar activity and some feature of terrestrial weather or climate.

But it is only relatively recently that investigations do appear to reveal at least some definite sun-weather signals: for example the 22-year solar magnetic cycle does appear to be linked with a regional drought cycle; while the mini-ice age of the Maunder Minimum (1645 to 1715AD) linked a long cold period with a period of remarkably low sunspot activity.

BRIGHT IDEAS

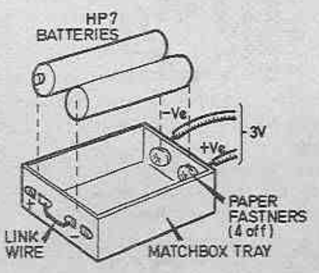
PCB ALTERNATIVE

I have formulated a method which combines the versatility of stripboard with the neatness of printed circuit boards. The idea is to drill holes in a Blob Board according to the p.c.b. diagrams given.

All one has to do then, is to wire the components to the nearest "pad" and where they do not exist wire links can be used. In my opinion this produces a neat looking board. A further advantage is the tracks on Blob Board are already pretinned, making soldering far easier.

R. Reid, Northants

SPACER AND HOLDER



When cartridge fuses of the ceramic type have "blown", and the metal caps removed a very cheap stand off, insulated pillar, or spacer is the net result.

A small battery holder for two penlight, HP7 batteries can be made from a matchbox. Four brass paper stud fasteners are used. The two at one end are joined together, and the other two then form the positive and negative terminals. The cover is then slid on, to provide a neat inexpensive battery box.

C. Sear, Cardiff, S. Glamorgan.

TRACK CLEANER

When cleaning up the flux and solder threads from 0·1 inch stripboard, I have always used a fine toothed junior hacksaw blade. The set of teeth just fit the space between the tracks, and it is a very simple matter to draw the blade gently along, leaving behind completely clean recesses between tracks.

Rev. J. H. Hart, Liverpool.

PLEASE TAKE NOTE

SOLID STATE ROULETTE (January 1979)

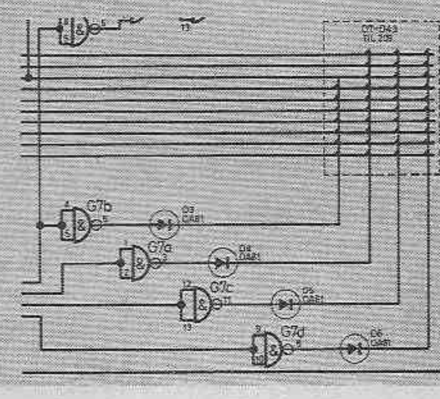
We would like to apologise to readers for some errors that have appeared on the circuit diagram (Fig. 1) for the Solid State Roulette.

The value of resistor R4 should be 10 ohm and not as shown.

The pin numbering of gates G7c and G7d of IC7 should be transposed. The diode matrix or "wheel" (D7-D43) is shown incorrectly.

The correct circuit layout for G7c, G7d and diode matrix (D7-D43) is shown below.

The wiring diagrams Figs. 2 to 4 are shown correctly.



EE CROSSWORD No 12 BY D.P.NEWTON

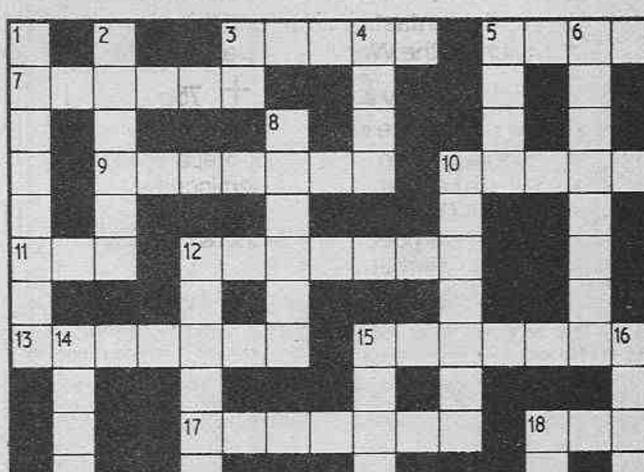
ACROSS

3 Aerial network.
5 Not very hard-wearing?
7 Hi-fi characteristic achieved by Dolby (2,4).
9 Original places of supply.
10 Large pile.
11 Chaotic material.
12 The means of circuit adjustment, generally.
13 Technique for the growth of transistor crystals, partly in a taxi.
15 As far as circuit boards are concerned, this is no picture.
17 Sub-atomic particle.
18 Projectile emitter but usually of electrons in our business.
19 His pace is slow.
21 Appertaining to heat.
22 A catching ring, in part.
23 Periphery.
24 Not on top.

DOWN

1 A computer type.
2 Frequent relationships between waves.
3 Doping part of eleven across.
4 Line about which a body rotates.
5 Amorphous form of a resistive conductor.
6 Reaction with a fact to give a fragment.
8 Barely but more than observing in a regular, repetitive way.
10 A waxy base for a chip.
12 River-bed station?
14 Registered invention.
15 Partly learned and well-deserved.
16 Upset green-tea for electrical creation (Anag.).
18 Naturally occurring crystal with semiconducting properties.
20 To tick over lazily.
21 Pipe with picture properties.
22 Short wave to begin with.

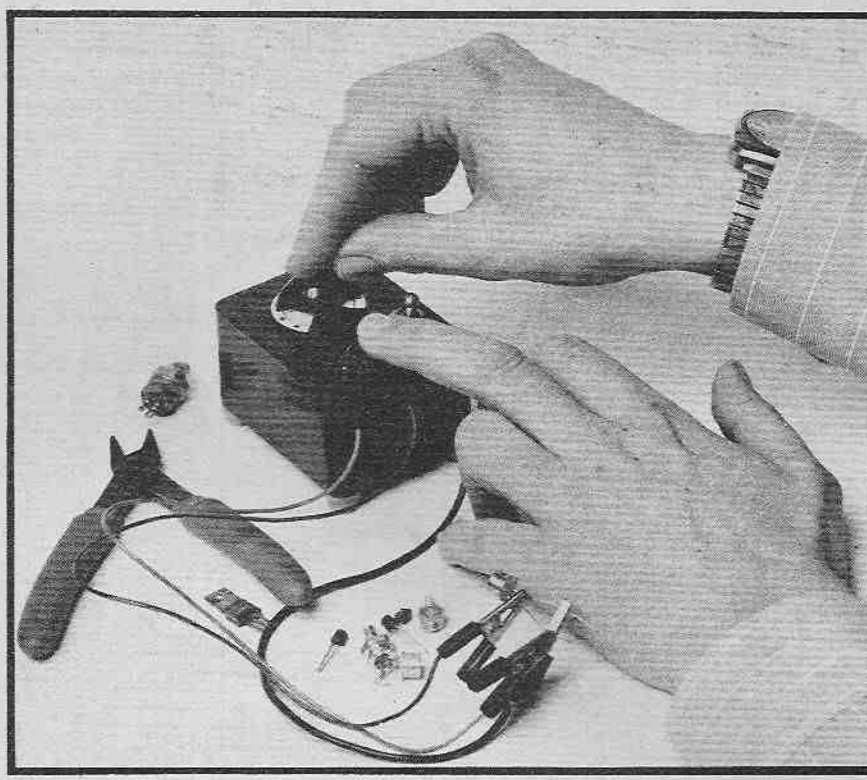
Solution on page 117



THYRISTOR TESTER

By P. C. O'Neil

AN INDISPENSABLE TESTER FOR QUICK GO—NO GO TESTS ON A VARIETY OF THYRISTORS



THYRISTORS, or to give them their proper name, controlled silicon rectifiers, c.s.r. for short, are becoming more and more popular in circuits and are being used in many instances to replace relays.

The thyristor works on the principle of acting like an infinite resistance between the anode and cathode in both directions. Yet when a small trigger current is applied to the gate terminal, it behaves like a rectifier, allowing current to flow easily in one direction, but acting like a high resistance to reverse current.

The purpose of this unit is to test the amount of gate current needed for it to become conducting and also to indicate if it is either short circuit or open circuit.

FUNCTION

The unit is very simple to operate. A suspect thyristor is connected to the unit via the three test leads, noting the correct connections. The only controls are S2, the ON/OFF switch, S1 the SHORT CIRCUIT test, and VR2 the gate or trigger current control. Preset VR1 is used to correct tolerance errors on VR2.

Power is applied to the unit, and S1 depressed. If the light emitting diode illuminates, the diode is short circuit and should be discarded. If the l.e.d. does not come on, VR2 is rotated slowly, until a point is reached where it does illuminate. The amount of gate current needed to switch or trigger that particular thyristor can then be read off the scale.

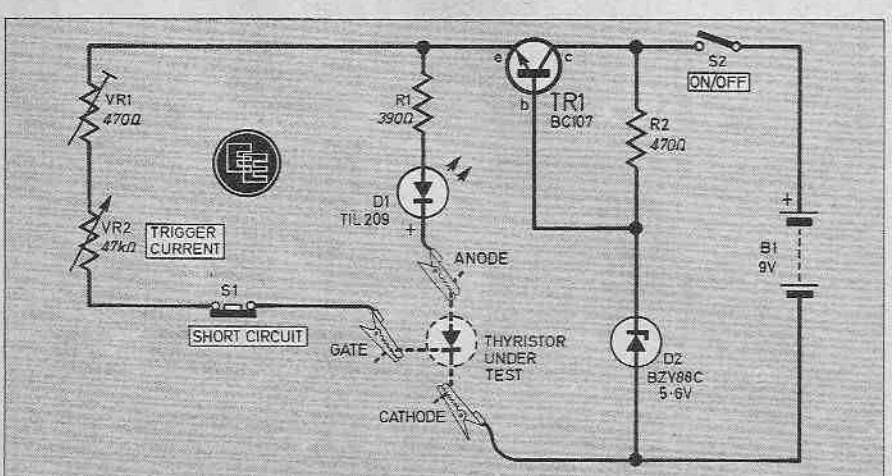


Fig. 1. Circuit diagram of the Thyristor Tester. The thyristor under test is shown dotted.

CIRCUIT DESCRIPTION

The circuit diagram of the Thyristor Tester is shown in Fig. 1. The first part of the circuit is a simple voltage regulator comprising TR1, R2 and Zener diode D2. These together produce 5 volts at the emitter of TR1. This regulator was thought necessary in the event of an ageing battery. The 5V output will remain stable, whereas an ageing battery will produce a lower voltage thus altering the calibration marks on the scale.

The second part of the tester actually tests the thyristor. Using the value specified for VR2, the gate current can be altered from 20 milliamps to 100 microamps. It thus covers all the likely currents needed.

Push switch S1 is a push to break type. When this is depressed, it

THYRISTOR TESTER

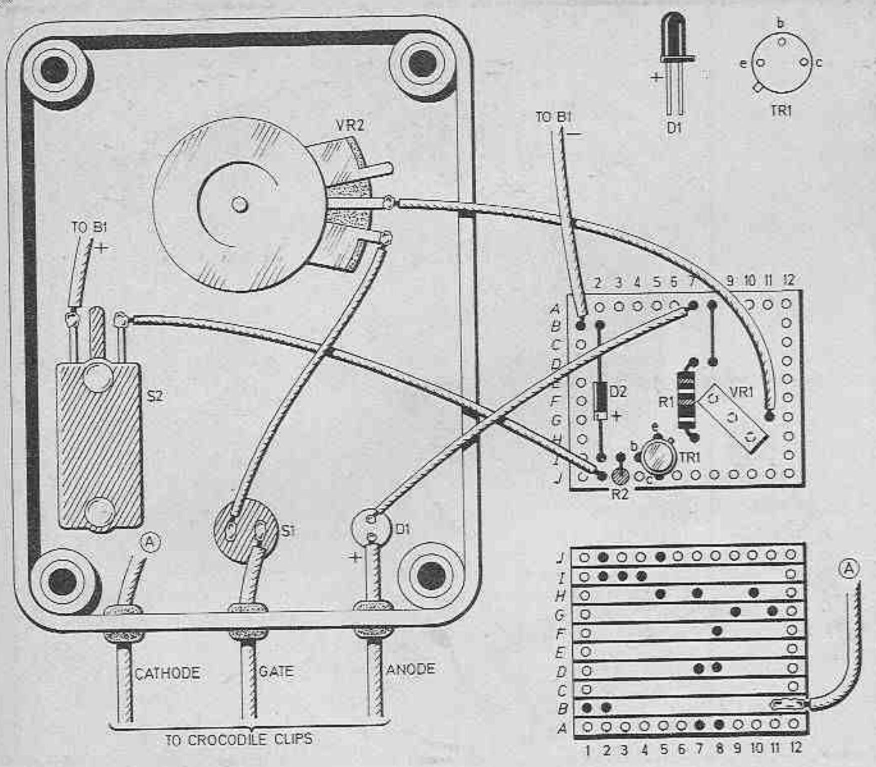


Fig. 2. Complete wiring details for the unit. In the prototype the small piece of stripboard was not fixed down, being suspended only by the wiring. Alternatively one edge could be glued onto the side of the case. When mounting VR1 some manipulation of the leads are required to fit as shown. It would be advisable to use different coloured connecting wires for the test leads.

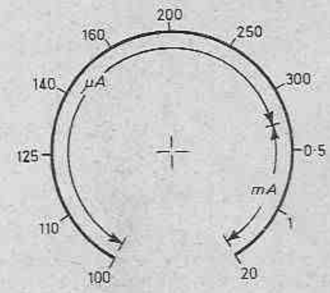


Fig. 3. Full size scale as used for the prototype. Note that although the size will be correct, the markings will not necessarily be so.

COMPONENTS

See Shop Talk page 92

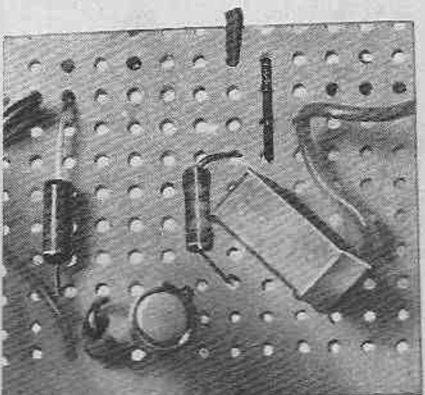
Resistors
- R1 390Ω
- R2 470Ω
- Both $\frac{1}{4}$W carbon ±5%

Potentiometers
- VR1 470Ω miniature vertical preset
- VR2 47kΩ lin.

Semiconductors
- TR1 BC107 *npn* silicon
- D1 TIL209 red l.e.d.
- D2 BZY88C 5·6V 400mW Zener

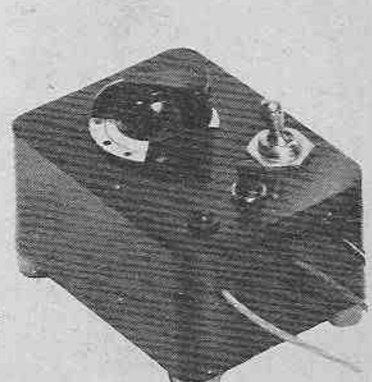
Miscellaneous
- S1 push-to-break release-to-make push switch
- S2 s.p.s.t. toggle
- B1 9V PP3 battery

Stripboard 0·1 inch matrix 10 strips × 12 holes; small plastic case 80 × 60 × 40mm or similar; battery clip for B1; three small crocodile clips; small rubber grommets (3 off); small pointer knob for VR2; material for scale; flexible and standard connecting wire.



Components mounted on the stripboard. No breaks are required in the copper strips.

COMPONENTS approximate cost £2 excluding case



cuts off all gate current to the thyristor. If the l.e.d. remains alight, the anode/cathode section is short circuit. If the l.e.d. fails to light at all, then there are two possibilities:

1. The c.s.r. is open circuit. No current can flow in any direction.
2. The c.s.r. requires a gate current greater than 20 milliamps. However, this is unlikely, and the device can be considered as useless for experimental work and be discarded.

CONSTRUCTION starts here

The main part of the circuit is constructed on a piece of 0·1 inch matrix stripboard having 10 strips by 12 holes. There are no breaks to be made on the board, and this together with the remainder of the wiring is shown in Fig. 2.

No drilling details have been given for the case as they depend on a large extent what size is used. The prototype had overall dimensions of 80×60×40mm, and this seems a reasonable handy pocket size.

As the test leads are subject to a great deal of flexing, they should be of thick multistranded wire. Remember to fit grommets in the case to prevent any wear on the leads. The test leads are fitted with small crocodile clips.

If one wishes a small transistor socket can be fixed to the front panel thus making life easier when testing the small TO5 type thyristor.

SCALE

To some extent the calibration points on the scale shown in Fig. 3 could vary from one model constructed to another. For this reason it is better to individually calibrate each scale, although as a last resort the markings given can be used.

For accurate calibration a voltmeter and ohmeter are required. The accuracy of VR2 depends to some extent on, (a) its tolerance and (b) the setting of the preset

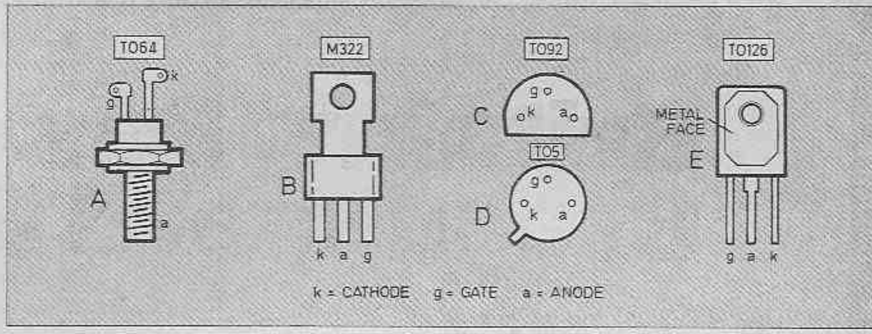


Fig. 4. Examples of thyristor leadouts expected to be encountered in normal work. These are only representative, so check with manufacturers data for latest information.

VR1. Let us asume that VR2 has 100 per cent accuracy and VR1 is set to 250Ω and VR2 is zero.

Ohm's law tells us that;

$$I = \frac{V}{R} = \frac{5}{250} = 20\text{mA}.$$

Thus we have our first calibration point.

If now VR2 is set to its maximum value of 47kΩ, again ohm's law tells us;

$$I = \frac{V}{R} = \frac{5}{47250} = 0{\cdot}00010582$$

or approximately 105μA. This gives us our last calibration point.

The remainder of the points can then be worked out and marked accordingly.

Alternatively, known working thyristors can be used to give the likely gate currents encounted in most instances.

IN USE

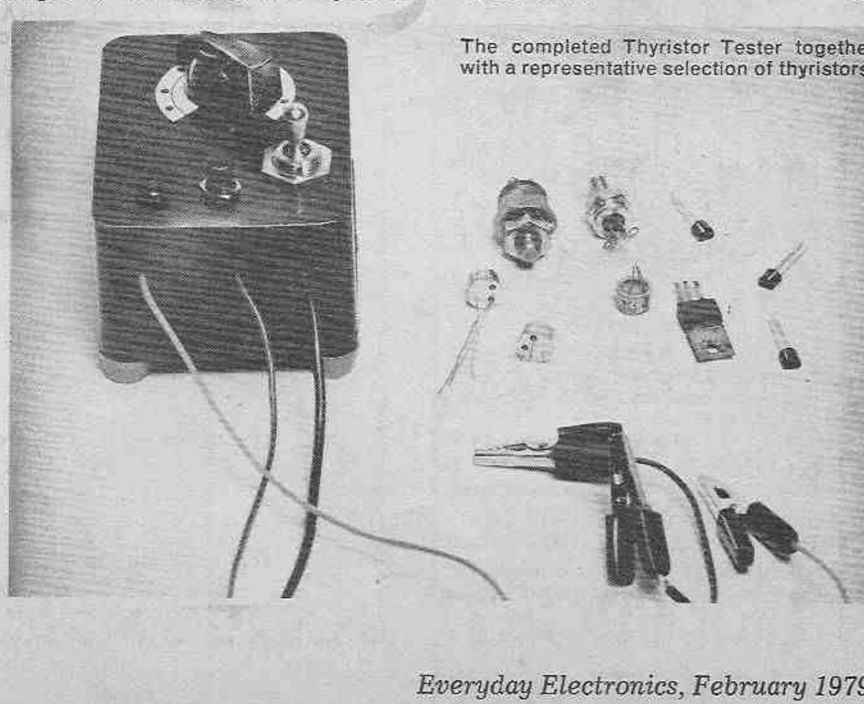
The Thyristor Tester is very simple to use. Select the thyristor to be tested and connect it the right way round to the three crocodile test clips. Switch on and press S1. If the l.e.d. lights the thyristor is short circuit and is discarded with no further testing.

If the l.e.d. does not light, a further test is made. Rotate VR2 slowly until a point is reached where the l.e.d. lights. At this point the thyristor has been turned on, the trigger current, the amount needed to turn it on, can then be read of the scale.

If this test is correct then the thyristor can be used for normal work. Note the tester will only test for the aforementioned conditions, it will not check the thyristor for, say, voltage breakdown.

LEADOUT CONNECTIONS

The drawing of Fig. 4. shows some of the many leadout connections of popular thyristors. There are of course many more, so it is wise to check the leadouts before testing by referring to manufacturers data. ⌑



The completed Thyristor Tester together with a representative selection of thyristors.

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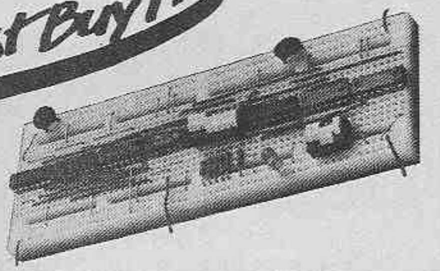

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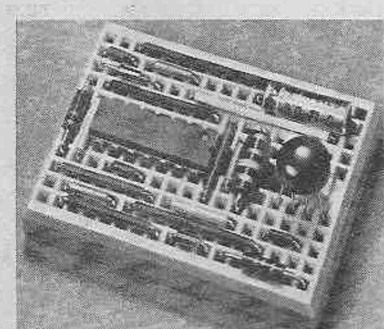

Best Buy 2–8

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Model	*Price*
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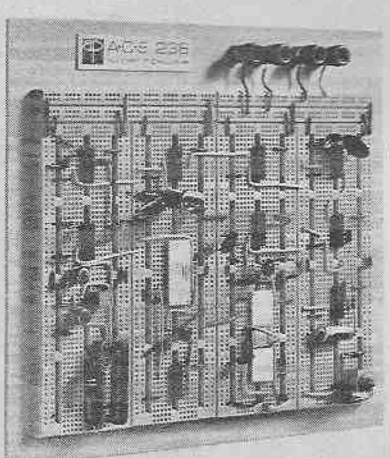

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COMPLETES THE CIRCUIT

Treasure Hunter SOUND ADAPTOR

By N. Hunter

A NUMBER of readers have stumbled upon a disadvantage of meter-indicating metal detectors such as the *E.E. Treasure Hunter*, and that is, the inability of the operator to study the meter and see where he or she is going at the same time. To overcome this problem an add-on audio unit which will drive a small loudspeaker has been designed. This unit produces two different tones, one indicating a ferrous material and the other indicating a non-ferrous material.

CIRCUIT DESCRIPTION

The circuit diagram for the add-on unit is shown in Fig. 1. The input voltage to the circuit is the meter drive voltage that appears at pin 6 of IC1 in the original circuit of the *Treasure Hunter*, Fig. 1 page 715 in the October '78 issue. This voltage is compared by comparators IC1 and IC2 to a reference voltage set by VR1.

When the input voltage exceeds this reference level, by an amount determined by the setting of VR2a, the output of IC1 goes to +9V and causes the astable multivibrator composed of TR1 and TR2 and associated components to start oscillating. The output of the multivibrator passes to an amplifier formed by TR1 and TR2 which drives a loudspeaker. The volume is controlled by VR3.

When the input voltage falls below the reference voltage by an amount fixed by VR2b the output of IC2 goes to +9V, but is attenuated by R3 and R4 thereby causing the multivibrator to oscillate at a lower frequency.

If the input voltage is within the threshold *window* set by VR1 then neither comparator output goes to +9V and so the astable will not oscillate i.e. no tone is produced in the loudspeaker.

CONSTRUCTION

Most of the components are mounted on a printed circuit board. The full-size master pattern is shown in Fig. 2. There is nothing critical about this layout and indeed the unit could be constructed on stripboard if desired.

With reference to the layout of the topside of the board in Fig. 2, begin by inserting the passive components, the resistors and capacitors, and then taking note of the polarities mount the diodes D1 to D3. Next the i.c.s can be inserted, again taking careful note of the correct orientation. It is adviseable to use a heatsink on the leads of the transistors and diodes when soldering and use sockets for the i.c.s.

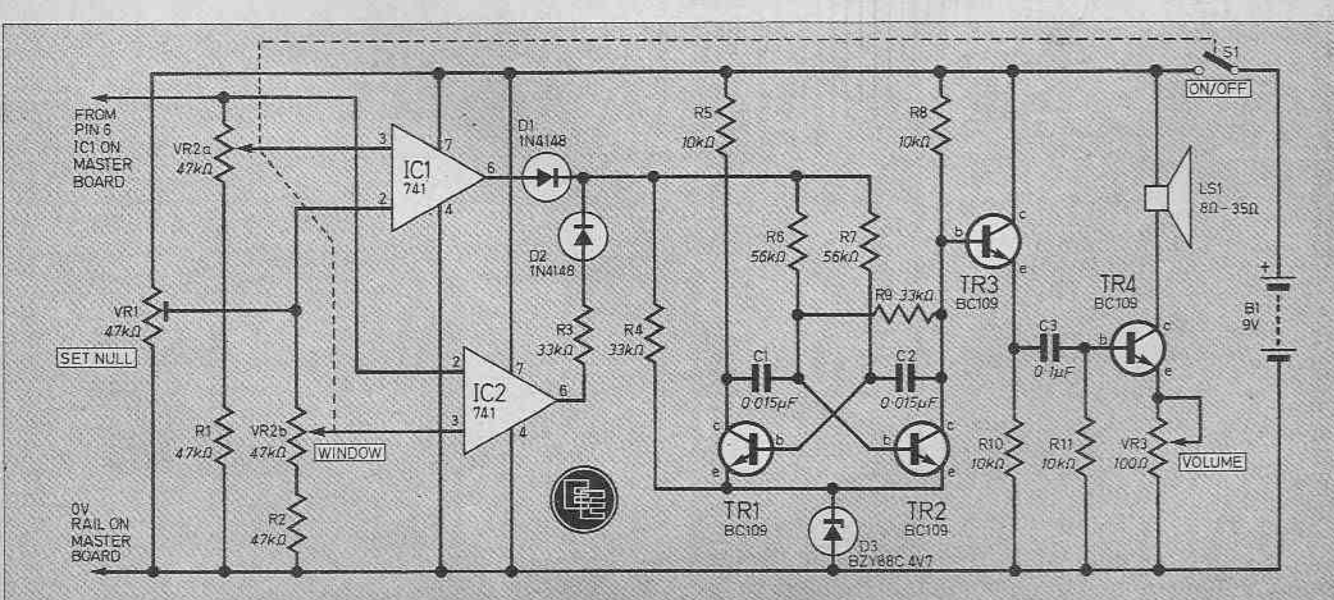
Having mounted resistors R1 and R2 directly on to VR2, the controls and loudspeakers can be wired as shown.

WIRING TO MAIN BOARD

Attach sufficient lengths to reach the main *Treasure Hunter* board. The type of connection between the two units will be a matter of choice e.g. soldered connections, jack plug/socket, banana plugs/

COMPONENTS approximate cost £3·75

Fig. 1. The complete circuit diagram of the Treasure Hunter Sound Adaptor.



sockets etc. The take-off point from the main board is shown in Fig. 3. The final casing is left to the constructor but can employ the same fixing as the main case i.e. plastic pipe clips bolted to one face and the interconnecting wires fed up through tubing forming the frame.

SETTING UP AND USING

With the two boards interconnected and sensitivity control set to minimum, switch on the detector and unit and allow it to settle down. Turn VR2 fully clockwise and adjust VR1 until the oscillator frequency just changes. Turning VR2 slightly anticlockwise should make the oscillator stop and nothing will be heard in the loudspeaker. When a tone is being produced in the loudspeaker, clockwise rotation of VR3 will increase the volume.

Normally the loudspeaker is silent but whenever the meter is deflected left or right from mid-position a high or low frequency tone, respectively, is generated. The amount of deflection necessary before the audio unit sounds is adjustable by means of the poteniometer VR2. These facts should enable the operator to discriminate between small and large deflections and also between ferrous and non-ferrous metals. ⌑

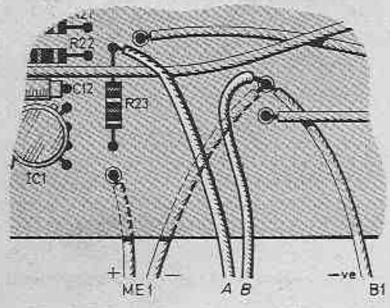


Fig. 3. Take-off points from the main Treasure Hunter circuit board.

COMPONENTS

Resistors

R1	47kΩ	R7	56kΩ
R2	47kΩ	R8	10kΩ
R3	33kΩ	R9	33kΩ
R4	33kΩ	R10	10kΩ
R5	10kΩ	R11	10kΩ
R6	56kΩ		

All ¼W carbon ±10%

Potentiometers

VR1 47kΩ lin. vertical pre-set
VR2/S1 47kΩ + 47kΩ lin. carbon dual-ganged with switch
VR3 100Ω log.

Capacitors

C1 0·015μF
C2 0·015μF
C3 0·1μF
All polyester ±20%

See **Shop Talk** page 92

Semiconductors

TR1, 4 BC109 silicon *npn* (4 off)
D1, 2 1N4148 or similar silicon diode (2 off)
D3 BZY88C 4·7 volt 400mW Zener
IC1, 2 741 operational amplifier 8 pin d.i.l. (2 off)

Miscellaneous

LS1 miniature 8 to 35 ohm moving coil loudspeaker
Printed circuit board size 80 × 33mm; knobs to suit VR2 and VR3 (2 off); connecting wire; case; pipe retaining clips; 4BA fixings.

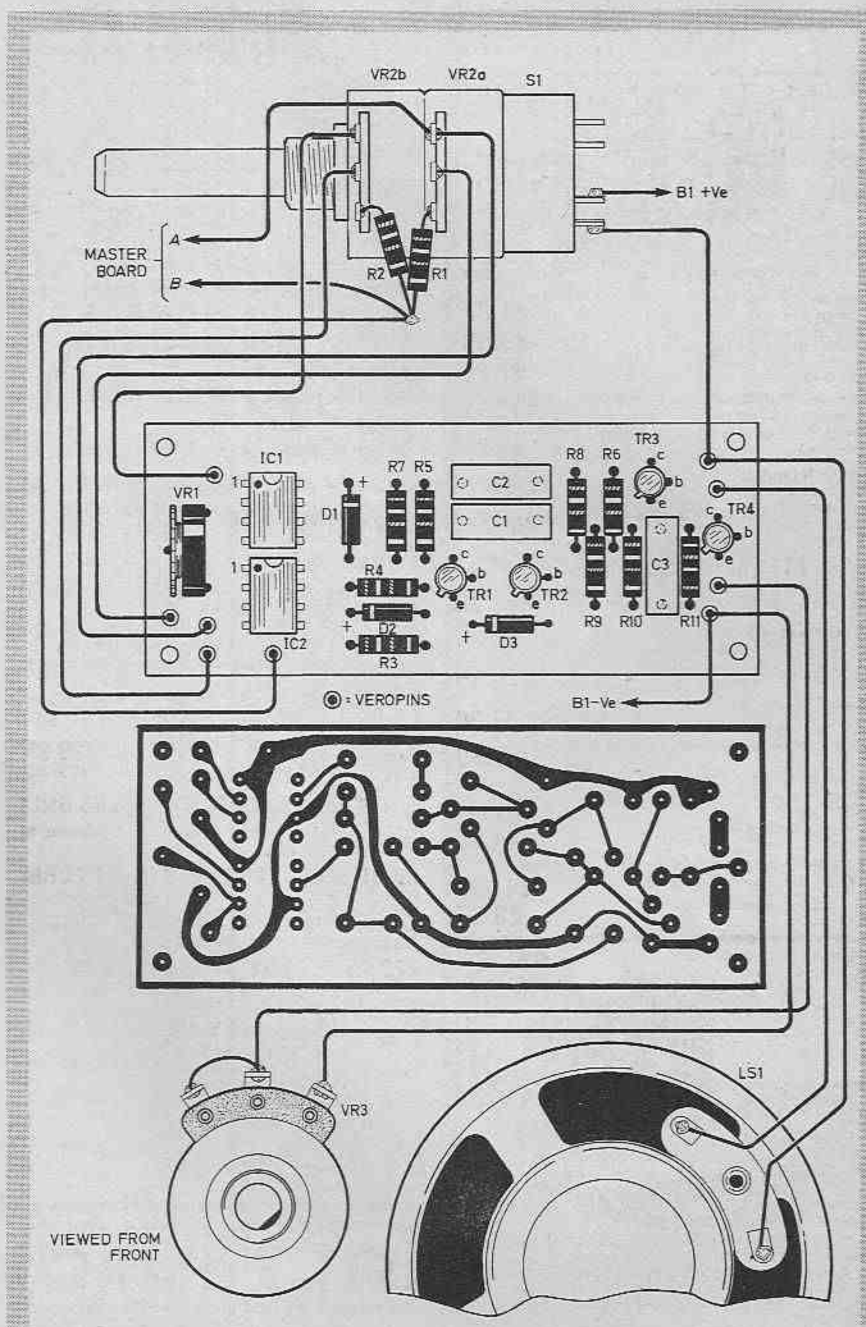


Fig. 2. Shows the p.c.b. master full size, component layout on the topside of the board and interwiring details.

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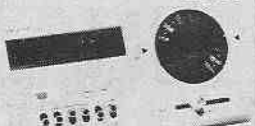

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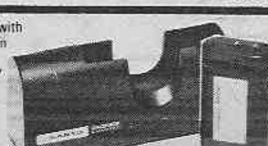

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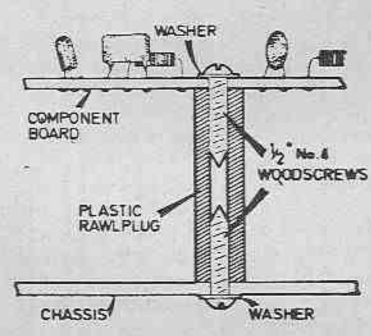
BRIGHT IDEAS

RAWLPLUG POST

Mounting posts used for mounting component boards are often expensive, an alternative which I have used consists of using plastic rawlplugs. The cylindrical types, purchased in one inch lengths are the best ones to use. The drawing shows how simply this can be achieved using round-head wood screws.

This idea can be further adapted to make a terminal post by using appropriately sized bolts which pass through the rawlplug. A solder tag can then be fitted underneath and a nut on the top.

K. Burgess,
Bracknell,
Berks.



PLASTIC CIRCUIT COVER

When building or checking circuits, particularly the latter, I have found it very useful to place the circuit diagram in a plastic LP cover.

As a project is assembled, the components may be checked off by tracing over the circuit diagram with a felt tipped pen. This allows the diagram to be followed without marking it. The plastic cover is easily wiped clean with a damp cloth afterwards.

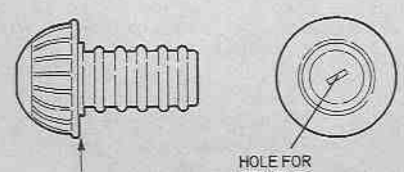
M. G. Roberts Leicester.

WINE CORK KNOB

When building a project I often find that I need to spend a lot of money on elementary components such as control knobs. I then came up with an idea which uses cheap plastic wine corks.

Take a cork and cut off the threaded section, fill the stopper part with Blu-Tak, lining the hole with adhesive as this is done. Now take the threaded section and cut a small section from the end. Cut a small rectangular hole in the middle, and glue it over the hole in the stopper. When it is dry, fill the hole with glue and insert the components spindle. Once dry the stopper can be painted as desired.

J. C. Light, Marlow, Buckinghamshire.



AVO MULTIMETER COMPETITION

A list of prize winners will appear next month. All five winners have already been notified by post.

BOOK REVIEWS

BEGINNER'S GUIDE TO TAPE RECORDING

Author	I. R. Sinclair
Price	£2·95
Size	185 × 120mm 167 pages
Publisher	Newnes Technical Books
ISBN	0 408 00330 8

In this informative book the reader is taken right back to the beginning of the story where the basics are fully explained in easy to follow terms and straight-forward diagrams.

The following chapter takes a long and detailed look at microphones, the various types, sensitivities and impedances as well as directional properties (introducing polar diagrams simply). At this point some basic mathematics appear but only to enable a deeper understanding of the problems involved when connecting the inputs and outputs of various equipments or microphones without introducing distortion.

Throughout this well written and on the whole clearly illustrated book (a few illustrations seem out of place and poorly drawn), the reader is given a precise account of what goes on within modern machine systems; the advantages and disadvantages of reel-to-reel, cassette, 8 track, ELCassette, Dolby; and the different tapes available—many of them making a nonsense of the peak indicator/recording level indicator or even the VU meter, fortunately the problem is not left there and a course of action is clearly given to help avoid bad recordings.

No owner of a tape recorder can be accused of not experimenting with microphone positions as we all learn from our mistakes, so it is good to find a book full of useful facts but also providing sound basic instruction on the importance of knowing your own equipment, the sensitivity of the microphone, using the best (recommended) tape for your particular machine and then finally leading into the more advanced techniques involving mixers, editing, tape/slide synchronising, film sound and nature recording. In other words, a good buy. D.J.G.

LIVING WITH COMPUTERS

Authors	Barry Blackely and Robert Lewis
Price	£3·50
Size	225 × 200mm 88 pages
Publisher	Wayland
ISBN	0 85078 2147

The emphasis is on the first word, for this is not a technical account of computers but a collection of simply told, interesting stories about people and how they are affected by computers in ordinary everyday life. These stories explain the role of the computer in widely different areas of modern society, such as hospitals, airlines, police, supermarkets and in engineering.

This book is written for children of 10 years upwards. They are going to have to live with computers even more than their parents. Their whole future will be governed and influenced by these technological juggernauts so it is certainly not premature for the 10 year old boy or girl to strike up an acquaintance with computers as useful instruments. That is the purpose of this book, and it does this well, in easy to follow text backed by copious photographic illustrations.

ELECTRONIC PROJECTS INDEX 1972-1977

Compiler	M. L. Scaife
Price	£1·50
Size	297 × 210mm 113 pages
Publisher	North Tyneside Metropolitan Borough Council, Libraries and Arts Department
ISBN	0 906529 01 8

There is building up a tremendous literature in applied electronics. Projects described in constructors' journals such as Everyday Electronics have a long life. That is a satisfying and rewarding fact for authors and publishers alike.

The quest for a design one vaguely remembers seeing in print a year or maybe more ago is a familiar experience. Enquiries to the EE editorial office and back numbers department testify to the truth of this.

So the fruits of painstaking research by Mr. Scaife will be warmly received. This compilation lists over 2500 projects that have appeared in 10 well-known magazines over a five-year period. The projects are arranged in 36 groups making the search for particular circuits straightforward. Brief details against each entry include a useful component count which gives the reader a quick means of essaying complexity and probable cost of the project.

ADVENTURES WITH ELECTRONICS

Author	Tom Duncan
Price	£2·50
Size	250 × 190mm 58 pages
Publisher	John Murray
ISBN	0 7195 3554 9

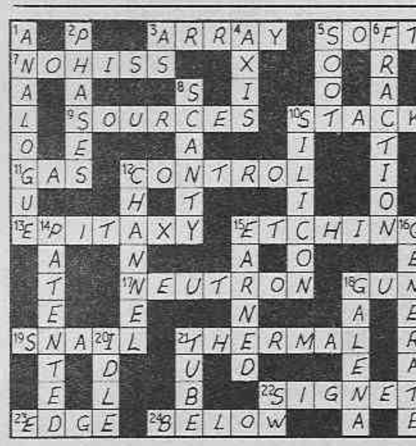
An exciting and appealing title and the contents live up to the promise. Good layout, large type and the bonus of two-colour printing help the clarity, especially of the component assembly diagrams. It is undoubtedly a fine first book for the budding constructor.

But one important fact not revealed in the title is that all the projects are built on S. Dec. So the book is actually a user's manual for this proprietary breadboard.

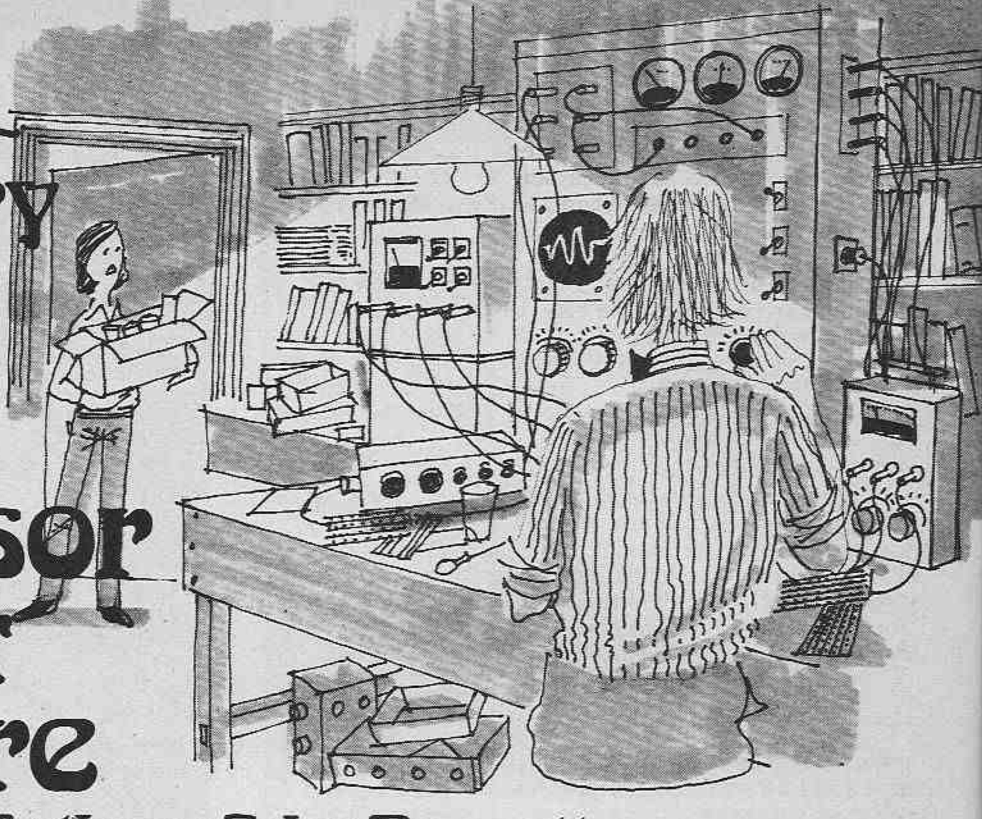
The book opens with a good explanation of the function of the more common components and other information on basic matters. After some simple circuits using a lamp and battery then a diode and finally a transistor, come 15 useful projects which become progressively more advanced; for example, a parking light, rain detector, burglar alarm, electronic organ, radio's and a timer.

If practical use is to be made of these circuits, they can of course be rebuilt in a permanent form using normal construction methods.

Crossword No. 12—Solution



The Extraordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

Bob and the Prof. are about to add a built-in valve-tester to an audio amplifier type VOX AC30.

Bob was very curious about the valve-tester and had a lot of questions for the Prof:

"What does it consist of?" he asked, "How is it used to test valves? Why does it need to be built-in to the amplifier? Why not have a separate valve-tester which could be carried around and used to test valves from various amplifiers?"

These were only some of the questions which he asked the Prof.

SELECTOR SWITCH

"The valve-tester will consist basically of a small milliammeter or microammeter, a 12-way single pole rotary selector switch and a few resistors," the Prof. told Bob.

"It will test the valves by measuring the cathode voltage of each. The selector switch will be used to connect the cathode of the valve being tested to the meter by way of the resistor. Here is a suitable meter."

The Prof. showed Bob a small recording-level meter of the type used on cassette recorders. The scale of the meter was not numbered, but divided into a number of coloured segments.

"Because the various valves operate with different cathode voltages a different value of resistor is used for each, and preset potentiometers may be used where a suitable value of fixed resistor is not available. The idea is to use a resistor which will cause the meter needle to move to the middle of the green sector of the scale when the cathode voltage is correct. Then as the valve cathode loses its emission, the meter needle will move down to the red sector, and finally to the black.

"The valves with the worst emission can be detected rapidly by rotating the selector to test each valve in turn, and it can then be quickly seen which has deteriorated the most."

The Prof. drew a simple sketch (Fig. 1.) to demonstrate the basic idea of the valve tester.

WORKING PRINCIPLE

"Here is how it would work with one valve," he told Bob, "so in this diagram the selector switch is not shown, but components inside the dotted line are parts of the meter circuit. One terminal of the meter is connected to the amplifier chassis, zero volts. The other terminal receives a current from the valve cathode by way of the meter-divider-resistor and the trimming-preset-resistor.

"The magnitude of the current depends upon the cathode voltage, and upon the combined resistance of the divider resistor, the trimmer preset resistor, and the resistance of the meter itself.

"If the correct value of meter divider resistor can be found, a trimmer may not be needed. But usually it is best to use a preset resistor of a value smaller than that

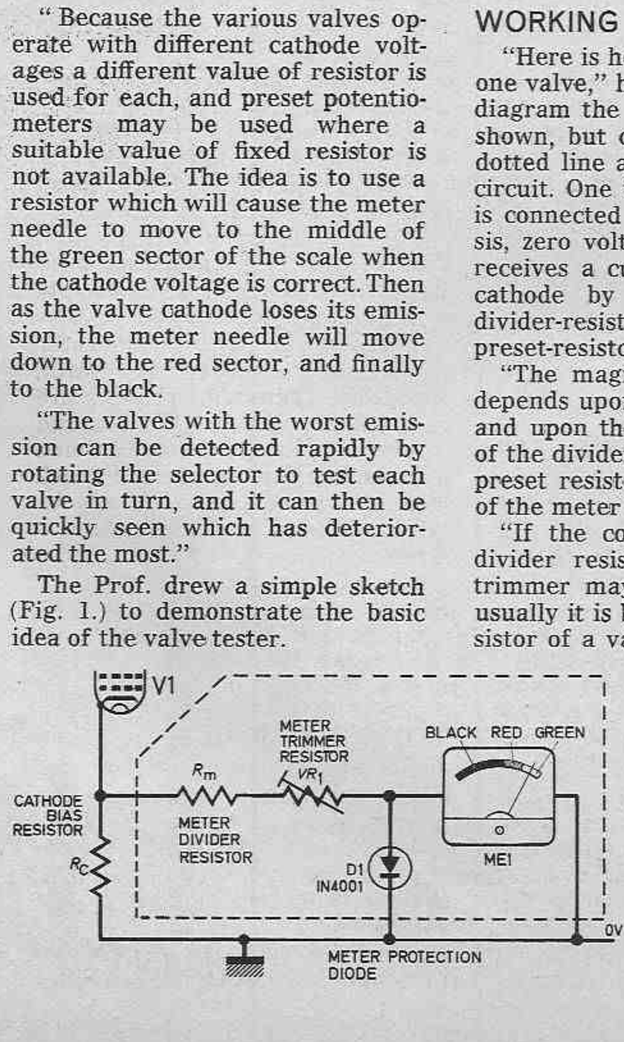


Fig. 1. Basic principle of testing a single valve. The coloured areas of the meter indicating the condition of the valve.

of the divider resistor, in order to make final adjustments to the meter reading. Otherwise the meter may read in the red or black segment, or even off-scale, when the voltage is correct, and this could be very misleading."

"The circuit seems so simple and inexpensive," remarked Bob, "I am surprised that this type of built-in valve tester is not used more often in amplifiers."

"Probably because until recently meters have been such expensive items" said the Prof.

"But in recent years, with the advent of low-cost cassette recorders, mass-produced record-level meters have become available at low prices and can now be bought for about £1.00 or sometimes less. Of course they can be pressed into service for many alternative purposes where accurate figures are not needed—just an indication is enough. So maybe in future more valve amplifiers will have their own built-in valve testers!"

"Why should the tester be built-in, Prof?" asked Bob. "I would have thought that a separate portable valve-tester would be a good idea!"

"There are such things, of course, Bob, but because they have to cater for a large range of valves, thousands of different types, they are big, heavy, complicated and expensive, and often more prone to failure than the amplifier itself. Our simple built-in circuit has none of these disadvantages because it only has to cope with a small number of valves."

OTHER FUNCTIONS

"Can the built-in tester be used to test other things besides the valves?" Bob wanted to know. "In the AC30 amplifier it seems that every position of the 12-way switch will be in use, but in simpler amplifiers there would be spare switch positions but it seems a shame to waste them if other functions can be called up easily."

"Yes Bob," the Prof. replied. "The various h.t. voltages could be tested by using high-value divider resistors of suitable voltage, and one position of the switch might be an audio output meter or overload indicator. This could be done very easily by means of a small rectifier diode in series with another divider resistor." The Prof. began another sketch (Fig. 2.).

"This shows a tester circuit incorporating an h.t. test audio output indicator positions. By switching to h.t. test we know whether the h.t. supply is present and correct. This is a very useful test, because if there is no h.t. or if the h.t. voltage is very low, all the other valve test positions would read as if faulty when in fact the valves might be satisfactory but unable to operate and give good test indications due to lack of h.t.

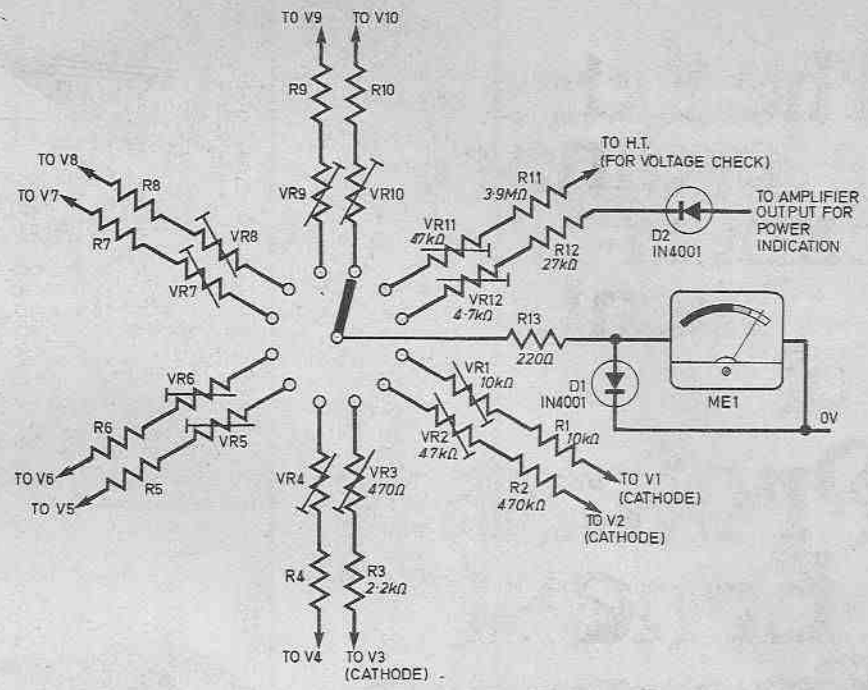


Fig. 2. Extending the usefulness of the built-in tester by adding a rotary switch to test other valves. A position for monitoring output power is also shown.

"So if there is no h.t. test position on the rotary switch and all the valves read low, the h.t. supply is to be suspected!

"The audio output indicator facility may also be very useful, especially where the speakers are in separate cabinets. If no sound is heard from the speakers when the amplifier is operated, a quick look at the meter will usually be very helpful in tracking down the cause.

"If the meter gives an indication but no sound is heard, this indicates a fault in the speakers, or their connecting wires.

However, if the meter gives no reading, this usually indicates a fault in the amplifier or in the audio source. A short-circuit between the speaker wires can also give a low or zero meter reading, and this can be checked by disconnecting the speaker wires from the amplifier and testing at low volume."

"Prof. I am amazed at how useful a simple indicator meter and a few components can be, especially when, by means of a selector-switch, it can be used to keep tabs on so many functions! I think that multi-function indicators of this type can be tremendously helpful and should be used more often in equipment!

TRANSISTOR EQUIPMENT

"I suppose that such indicators can also be used for multi-purpose functions in transistor equipment!"

"Yes of course, Bob, even more so. However, the meter in such circuits is often replaced with a solid-state or liquid crystal display, which may vary in complexity from the simple on/off warning lamp, through bar line indicators which give the impression of a moving bar or a line of lights, to digital and graphic displays as used on calculators, computers and the head-up displays on aircraft viewscreens.

"Now the display on one of my computer viewscreens, for instance, is indicating to me that one of my latest experimental gadgets is nearly ready; and as I know that you are interested in the behaviour of electron beams, lasers, charged particles, ion beams, and all sorts of modern developments to do with space-travel and spin-off technology, perhaps you would care to join me in my preliminary assessment of this new device which the robots have just constructed for me! It's over there."

To be continued

GEORGE HYLTON brings it down to earth

Pots Law

A READER, finding that one of the components specified in a recent article was a "log law potentiometer", asks for an explanation. Here it is.

The log law pot was, I would guess, the result of one of the earliest encounters between electronic engineering and human psychology. Not the kind of psychology symbolised by the psychiatrist's couch but the experimental kind, one of whose concerns is to measure how a human being perceives the world around him.

Hearing is one form of perception and it is the peculiarities of hearing which are responsible for the evolution of the log law potentiometer, otherwise known as a volume control.

Wire Wound

To get into the subject let's think about how pots are made. We'll stick to the round, rotary type for the purpose of this article. Some of the earliest were wirewound pots.

To make one you took a long thin oblong strip of insulating material and wound it with insulated resistance wire, making a long flat coil. This was then bent into a circle, Fig.1. and mounted on some sort of base or holder. A sliding contact on a rotary shaft was then fitted to form the moving contact. The insulation was scraped off the wire where the slider touched it, allowing contact to be made along the edge of the strip.

Wirewound pots are not used nowadays as volume controls because as the slider jumps from turn to turn of the resistance wire it is apt to make unwanted noises. Also, and perhaps more important, wirewound pots are expensive! In the modern volume control the wound strip is replaced by a ring of insulating material on whose surface is deposited a thin layer of carbon, which forms the resistive "track". But the wirewound pot will do to illustrate my point.

If an input of 200mV is applied to such a pot and the slider turned up from zero, Fig.2. The output voltage increases steadily. The more the shaft is turned the greater the output. The output is in fact proportional to the angle through which the shaft is rotated, as shown by the upper line on the graph. I've assumed that the shaft can turn through 200 degrees to keep the arithmetic easy. In practice most pots turn through about 270 degrees.

As you can see, turning through 100 degrees gives an output of 100mV and through 200 degrees, 200mV. The output is in exact proportion to the angle. Every change of one degree gives a change of one millivolt. If the shaft is turned steadily the output increases steadily.

Linear Pots

Just what is needed for a volume control, you might think. But it isn't.

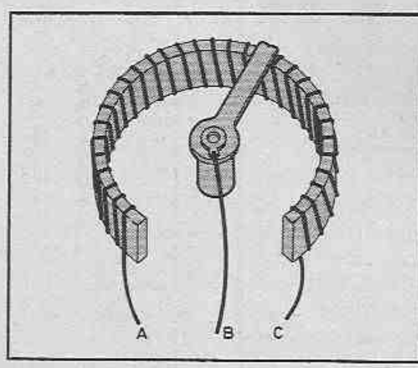


Fig.1. Typical construction of a wire wound potentiometer.

Linear pots are most unsatisfactory as volume controls, and this is a linear pot because its graph is a straight line. If you use a linear pot as a volume control you'll find that as you turn up the volume from zero there is at first a very rapid increase then, as you go on turning, the control has less and less effect.

In fact, over the second half of its travel it might just as well not be there for all the difference it makes.

Why? This is where the psychology comes in. It's natural to suppose that halving the voltage halves the volume. Actually this is not so. Halving the voltage has a good deal less effect than that on the volume.

Looking at the graph again, suppose the slider is at 40 degrees. The volume is at a certain level. To reduce it 40 per cent you have to halve the length of track below the slider. That is, you turn it down to the 20 degrees point. A change of 20 degrees has reduced the volume 40 per cent. Now turn the volume up to maximum, that is to the 200 degrees point. To reduce volume by 40 per cent you now have to turn down by 100 degrees.

So a change of 100 degrees at this end of the track produces the same effect on volume as a change of only 20 degrees at the other end.

This explains the very sudden increase in volume from a linear pot as it is turned up from zero. Near zero, a tiny change in the angle is all that's needed for a 40 per cent increase in volume. Near the high end, the same sort of tiny increase has virtually no effect at all.

Graded Tracks

What is needed is a track whose resistance increases slowly at first then more and more rapidly as the maximum is approached. The nearest thing to this with a wirewound pot is to wind the first section with low resistance wire, the middle with medium resistance wire and the rest with high resistance wire. There will be some rather abrupt changes as the slider passes the joins between sections but the ear is not very sensitive to these.

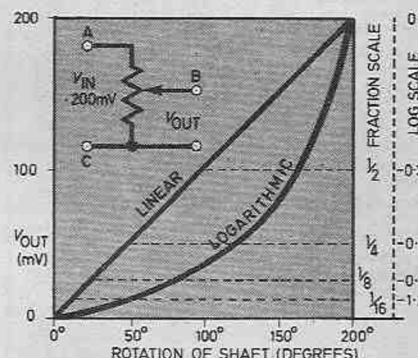


Fig.2. Typical curves obtained by using linear and logarithmic pots.

Carbon track

With a carbon track it is possible in theory to "grade" the carbon to produce just the right smooth increase in resistivity.

In practice, carbon pots with "tapered" tracks seem to be produced in sections, like the tapered wirewound one I've just described, which is why there are abrupt changes in their resistance as the shaft is turned instead of the required constant rate of increase. But it doesn't seem to matter.

The curved lower line of the graph shows how the output should increase to produce the desired steady changes of volume. The curve shows a doubling of output for every 40 degrees of rotation, except near minimum where the desired increase is hard to achieve. It is only one of an infinite number of possible curves, you could double for every 10 degrees, say, if necessary.

ELECTROVALUE Buying Guide

Section 2

IMPORTANT ANNOUNCEMENT With completion of our present series of itemised advertisements, we announce release of our new catalogue, CATALOGUE No. 9— completely revised, enlarged and best yet. SEND FOR YOUR FREE COPY NOW TO DEPT. EE792.

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0·068µF 63V 6p

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8, 10, 16µF 30p
25µF 35p
40, 60µF 56p
100µF 65p

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2200µF 40V 1·21
2200µF 63V 1·50
4700µF 25V 1·46
4700µF 40V 1·50
4700µF 63V 2·04

ELECTROLYTIC CANS●
Daly, *sleeved*
1000/25 46p
2200/50 94p
5000/25 98p
4700/100 3·61

ELECTROLYTIC, axial lead●
Siemens B41313/B41283/B41010

µF	volts	
0·47	63	21p
0·47	100	12p
1·0	40	21p
1·0	100	12p
2·2	25	12p
2·2	63	12p
2·2	100	·12p
4·7	16	21p
4·7	40	12p
4·7	63	12p
4·7	100	14p
10	6·3	21p
10	25	12p
10	40	12p
10	63	14p
10	100	15p
22	10	12p
22	25	12p
22	40	13p
22	63	15p
22	100	16p
47	3	12p
47	10	12p
47	25	14p
47	40	15p
47	63	16p
47	100	19p
100	3	12p
100	10	14p
100	16	15p
100	25	16p
100	40	16p
100	63	22p
100	100	28p
220	3	13p
220	6·3	15p
220	10	15p
220	16	17p
220	25	20p
220	40	24p
220	63	30p
220	100	47p
470	6·3	16p
470	10	19p
470	16	24p
470	25	22p
470	40	31p
470	63	49p
470	109	74p
1000	3	18p
1000	6·3	22p
1000	10	21p
1000	16	30p
1000	25	40p
1000	40	45p
1000	63	76p
2200	3	23p
2200	10	30p
2200	16	45p
2200	25	70p
2200	40	77p
4700	16	85p
4700	25	96p
10,000	3	40p

ELECTROLYTIC PLUGGABLE●
Siemens B41316 series

µF	volts	
1·0	63	13p
2·2	63	13p
4·7	63	13p
10	63	13p
22	40	13p
22	63	14p
47	16	13p
47	40	14p
47	63	18p
100	6·3	14p
100	16·16	14p
100	25	15p
100	40	18p
100	63	24p
220	3	8p
220	10	16p
220	16·16	18p
220	25	19p
220	40	23p
470	6·3	16p
470	10	19p
470	25	25p
470	40	29p
1000	16	26p

ELECTROLYTIC TANTALUM BEAD
Siemens B45134 series

µF	volts		
0·1	35	●	14p
0·15	35	●	12p
0·22	35	●	14p
0·47	35	●	14p
0·68	35	●	14p
1·0	35	●	14p
2·2	16	●	14p
2·2	35	●	14p
3·3	16	●	14p
4·7	16	●	16p
4·7	35	●	18p
6·8	25	●	18p
10	6·3	●	16p
10	16	●	18p
10	25	●	20p
15	25		31p
22	6·3	●	18p
22	16		22p
22	25		45p
33	10		22p
47	6·3		22p
47	16		35p
100	3	●	22p
100	6·3		45p
100	10		67p

ELECTROLYTIC, TANTALUM, AXIAL
Siemens series D
0·1/35, 0·47/35 35p
1/35 35p
2·20/4·7/10 35p
2·2/35, 4·7/35 37p
10/20, 22/15 37p
47/10 66p

LACQUER FILM
(*non-polarised*)
Siemens B32110 series 20% tol.

µF	volts	
0·1	100	76p
0·15	63	62p
0·22	63	65p
0·33	63	70p
0·47	63	78p
0·68	63	84p
1·0	63	91p
1·0	100	1·45
1·0	250	2·01
1·5	63	93p
2·2	63	1·60
3·3	63	1·82
4·7	63	2·07
6·8	63	2·59
10	63	3·00
10	100	5·06

SILVERED MICA, 350V ●
1% (or ½pF)
R611, 12·7 × 8mm
All in pF.
2·2, 3·3, 5 11p
6·8, 10, 15 11p
18, 20, 22, 25 11p
27, 30, 33 11p
39, 47, 50 11p
56, 68 11p
100 12p
150 14p
220 17p
330 20p

R1015
16·5 × 11·4mm
82, 100 11p
120, 150 11p
180, 200, 220 12p
250, 270, 300 12p
330 15p
470 16p
1000 20p

R1524
28·0 × 17·8mm
330 18p
390, 470, 500 18p
560, 680 18p
820, 1000 22p
2200 24p
3300 36p
4700 46p

R2032
35·6 × 23·0mm
1500, 1800 18p
2200, 2700 24p
3600, 3900 29p
4700, 5000 33p
6800 41p
8200, 10,000 56p

MIXED DIELETRIC, M.D.C.
600V
0·1 **27p** 0·47 **72p**
1000V
0 001, 0·0022 18p
0·0047 18p
0·01 **20p** 0·022 **21p**
0·1 **27p** 0·22 **48p**

POLYESTER
Mullard C280, PC mtg.
0·01, 0·015 ● 6p
0·022 ● 6p
0·033, 0·047 ● 6p
0·068 ● 7p
0·1 ● 7p
0·15 ● 8p
0·22 ● 9p
0·33 ● 13p
0·47 ● 15p
0·68, 1·0 24p
1·5, 2·2 42p

POLYESTER
PC mounting
Mullard 334 or Siemens B32234 series as available

100V
0·047 ● 9p
0·068 ● 9p
0·1 ● 10p
0·15 ● 11p
0·22 ● 12p
0·33 ● 16p
0·47 ● 18p
0·68 22p
1·0 27p
2·2 46p
4·7 79p
6·8 1·08

250V
0·01 ● 6p
0·015 ● 6p
0·022 ● 8p
0·033 ● 8p
0·047 ● 8p
0·1 ● 11p
0·68 24p
0·82 24p
1·0 27p
2·2 48p

400V
0·01 ● 7p
0·015 ● 7p

POLYESTER, Axial lead
Siemens B32231 series

µF	volts		
0·01	630		13p
0·015	630		13p
0·022	630		13p
0·033	400	●	13p
0·047	250	●	13p
0·047	400	●	14p
0·047	630		16p
0·068	250	●	14p
0·1	750	●	14p
0·1	400	●	15p
0·1	630		25p
0·12	250	●	13p
0·15	250	●	14p
0·22	250	●	15p
0·33	250	●	18p
0·47	250	●	21p
0·68	250		27p
1·0	250		31p
1·0	400		46p
2·2	250		51p
4·7	250		1·04
10	250		1·81

POLYESTER
B32560 PCM 7·5mm

µF	volts		
0·001	250	●	6p
0·0015	250	●	6p
0·0022	250	●	6p
0·0033	250	●	6p
0·0047	250	●	6p
0·0068	250	●	6p
0·0082	250	●	7p
0·1	250	●	9p
0·01	250	●	6p
0·012	250	●	7p
0·015	250	●	6p
0·018	250	●	8p
0·022	250	●	7p
0·027	250	●	8p
0·033	250	●	7p
0·039	250	●	8p
0·047	250	●	7p
0·056	250	●	9p
0·068	250	●	8p
0·082	250	●	11p
0·1	100	●	9p
0·12	100	●	12p
0·15	100	●	10p
0·18	100	●	14p
0·22	100	●	12p
0·27	100	●	19p
0·33	100	●	16p
0·39	100	●	23p
0·47	100	●	20p
0·56	100		30p
0·68	100		25p

POLYESTER,
B32561 PCM
0·01 150 ● 5p
0·022 250 ● 6p
0·047 250 ● 7p
0·1 250 ● 9p
0·22 100 ● 11p
0·47 100 ● 17p
1·0 100 28p

POLYESTER,
B32562 PCM
0·47 100 ● 17p
1·0 100 30p
2·2 100 48p

POLYESTER,
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1·0 400 72p
(*Good pulse discharge ratings*)

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B33063, 160V ●
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5100pF 4p
6800, 10,000pF 6p

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B31110, 160V
5, 7, 10, 12pF 6p
15, 22, 27, 33pF 6p
39pF 6p
47, 56, 68, 82pF 5p
100, 120, 150pF 5p
160, 180, 220pF 5p
270, 330, 390pF 5p
470, 560pF 5p

POLYSTYRENE,
31310, 160V
560, 680, 820pF 5p
1000, 1500pF 5p
2200, 3300pF 5p
1200, 1800pF 8p
2700, 3900pF 8p
4700, 5600pF 8p
6800, 8200pF 8p
10,000pF 8p
12,000, 15,000pF 12p
18,000, 22,000pF 13p

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5·5-65pF 34p
2-22pF 27p

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20pF 1·48 150pF 1·89
50pF 1·48 15pF 1·39
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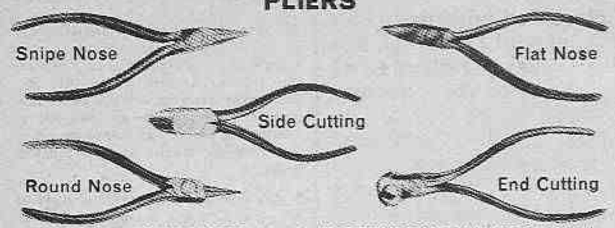

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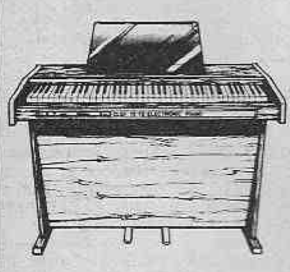

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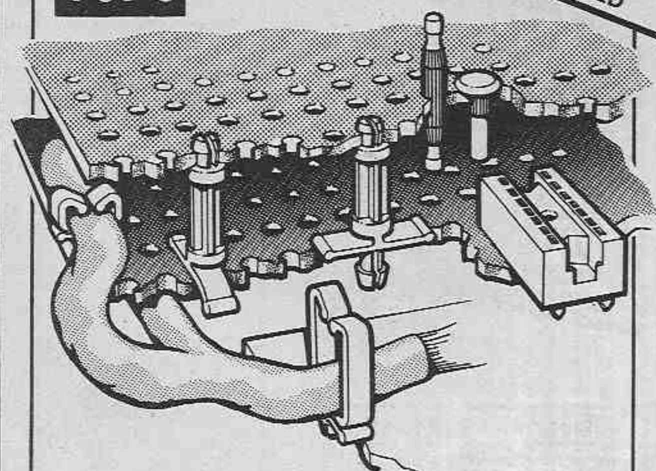

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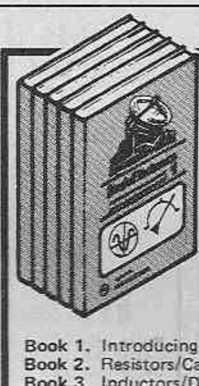

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74LS189N	3·74	7412N	0·20	74148N	1·35
74LS190N	1·00	7413N	0·36	74145N	0·86
74LS191N	1·00	7414N	0·80	74150N	1·20
74LS193N	1·98	7416N	0·36	74151N	0·78
74LS196N	1·28	7417N	0·36	74153N	0·76
74C00N	0·24	7420N	0·22	74154N	1·20
74C02N	0·24	7423N	0·32	74155N	0·70
74C04N	0·24	7425N	0·32	74157N	0·78
74C08N	0·24	7427N	0·32	74160AN	1·10
74C10N	0·24	7430N	0·22	74161AN	1·10
74C14N	1·41	7432N	0·30	74162AN	1·10
74C20N	0·24	7437N	0·35	74163AN	1·10
74C30N	0·24	7438N	0·32	74164A	1·36
74C32N	0·24	7440N	0·20	74165N	1·36
74C42N	0·92	7441AN	0·84	74167N	2·50
74C48N	1·38	7442N	0·76	74174N	1·60
74C73N	0·54	7445N	1·40	74175N	1·00
74C74N	0·56	7446AN	0·90	74176N	0·90
74C76N	0·54	7447AN	0·80	74177N	0·90
74C83N	1·30	7448N	0·80	74180N	1·00
74C85N	1·30	7450N	0·22	74181N	2·00
74C86N	0·64	7451N	0·22	74182N	0·80
74C89N	4·39	7453N	0·22	74185N	1·50
74C90N	0·85	7454N	0·22	74185AN	1·50
74C93N	0·85	7460N	0·22	74188AN	3·25
74C95N	1·04	7470N	0·46	74189N	2·60
74C107N	1·22	7472N	0·30	74190N	1·40
74C150N	4·14	7473N	0·44	74191N	1·20
74C151N	2·47	7474N	0·32	74192N	1·20
74C154N	3·68	7475N	0·80	74193N	1·20
74C157N	2·21	7476N	0·45	74196N	1·20
74C160N	1·11	7480N	0·60		
		7481N	1·00		

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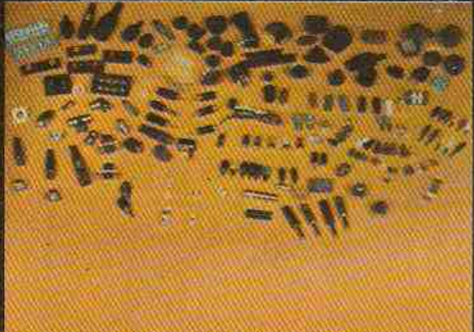

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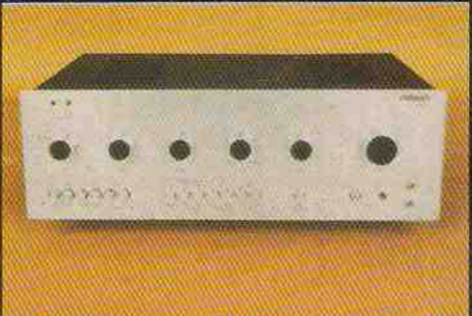

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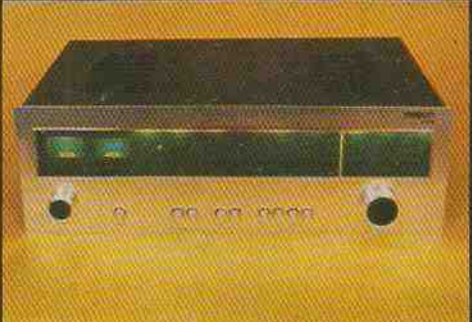

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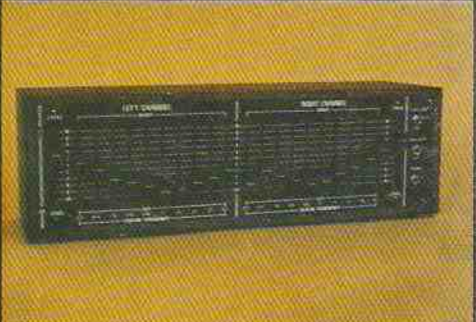

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