Easy to build projects for everyone

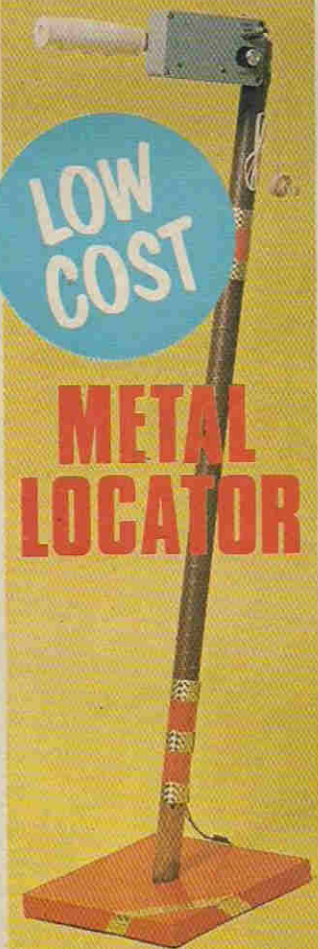
Everyday ELECTRONICS

JUNE 79
45p

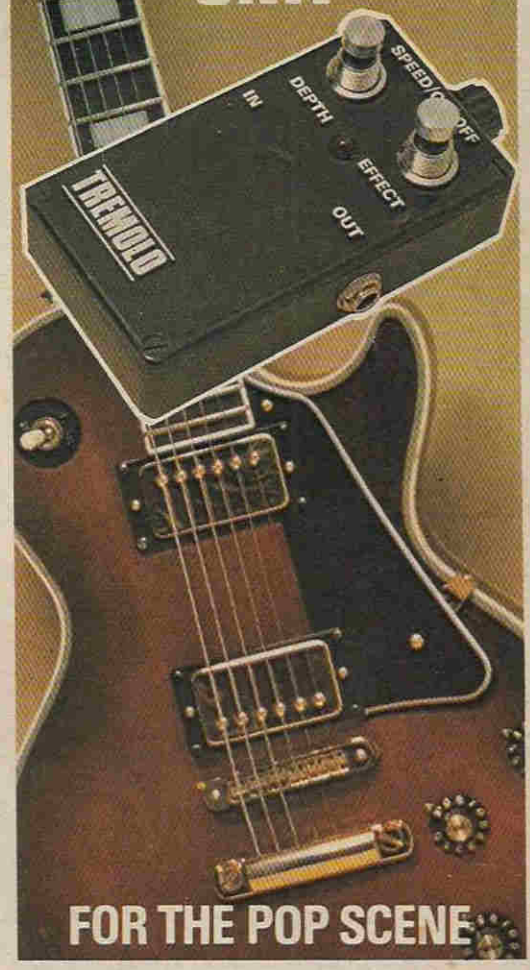
ELECTRONIC CANARY

A NOVEL DOORBELL

LOW COST METAL LOCATOR



TREMOLO UNIT



FOR THE POP SCENE

METER AMPLIFIER

EXTEND THE RANGE OF YOUR MULTIMETER WITH THIS MONTHS MINI-MODULE

Ideal for Measuring Small Audio Voltages

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

Micro*-soldering!

Antex TCSU1 & CTC
... the perfect kit for miniature work

*CTC No.7/010
Tip size: 0.5mm-.02

Heat to any level between 145°-400° (with accuracy of 2%)

Model CX - 17 watts

...a miniature iron with the elements 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 ½" 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

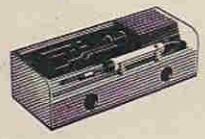
Contains both the model CX230 soldering iron and the stand ST3. Priced at **£6.21** inclusive of VAT and P.&P. It makes an excellent present for the radio amateur, modelmaker or hobbyist.

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.

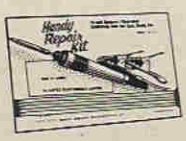
Model SK1 Kit

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.



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.



Finger-tip accuracy combined with strict control of temperature set anywhere between 145 and 400°C.

Negligible leakage current. Earthed and protected by 'fail-safe' circuit. Operates at 24 volts.

TCSU1 station complete with soldering iron (XTC or CTC) £36. nett to industry plus VAT.

Our multi purpose range of soldering irons are all made in England and fully guaranteed. They are stocked by many wholesalers and retailers in the U.K. but if unobtainable locally we will supply direct.

ANTEX

Electronics Ltd.

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

Please send the following .....

.....

Please send the ANTEX colour brochure ☐☐

I enclose cheque/PO/Giro No. 258 1000

Name .....

Address .....

.....

Antex Ltd. Freepost, Plymouth PL1 1BR Tel. 075267377

EE 6 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, 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p**; 0·022, 0·033, **11p**; 0·047, 0·068 **14p**; 0·10 **17p**; 0·15, 0·22 **24p**; 0·33, 0·47 **41p**; 0·68 **48p**.
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 **12p**; 0·22, 0·33 **13p**; 0·47 **17p**; 0·68 **19p**; 1·0 **24p**; 1·5 **30p**; 2·2 **34p**.

FEED THROUGH CAPACITORS
1000pF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF) **500V:** 10 **40p**; 47 **68p**; **250V:** 100 **65p**; **63V** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8 10, 15, 22 **8p**; 47, 32, 50 **15p**; 63, 100 **27p** 50; 50, 100, 220 **25p**; 470 **32p**; 1000 **50p**; **40V:** 22, 33, **9p**; 100 **12p**; 2200 **68p**; 3300 **82p**; 4700 **85p**; **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 **45p**; 3300 **68p**; 4700 **85p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 220, 330 **14p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; **10V:** 100 **6p**; 640 **12p**; 1000 **14p**.
TAG-END TYPE: 70V: 2000 **89p**; 4700 **135p**; **50V:** 10,000 **255p**; **40V:** 2500 **65p**; 3300, 4700 **70p**; 15,000 **450p**; **25V:** 4700 2200 **48p**; **325V:** 200+100+50+100 **190p**; 32+32 **175p**.

TANTALUM BEAD CAPACITORS 35V: 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8 **25V:** 1·5, 10 **20V:** 1·5 **16V:** 10µF **13p** each 47, 100 **40p**. **10V:** 22µF, 33 **20p** **6V:** 47, 68, 100, 30p **3V:** 68, 100µF. **20p**

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

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

COMPRESSION TRIMMERS
3-40pF, 10-80pF **30p**; 25-190pF **33p**
100-500pF **45p**; 1250pF **60p**

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

SILVER MICA (Values in pF) 3·3, 4·7, 6·8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **9p** each
250, 300, 330, 360, 390, 600, 820 **16p each**
1000, 1200, 1800, 2000 **20p each**

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

SOLDERCON PINS*
100 **50p**; 500 **200p**

POTENTIOMETERS
(AB or EGEN)
Carbon Track. ¼W Log & ½W Linear values
500Ω. 1K & 2K (lin only) Single **27p**
5KΩ—2MΩ single gang with D.P. Switch **65p**
5KΩ-2MΩ single gang **27p**
5KΩ-2MΩ dual gang stereo **78p**

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.

LW to MW Converter for Radio 4 Complete kit of parts inc. instructions. **£4·95** inc. VAT

OPTO ELECTRONICS★

LEDs plus clips	
TIL209 Red	13
TIL211 Grn	17
TIL212 Yellow	18
2" Red	15
2" Yellow Green	18
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
DL747 C.A. ·6"	180
FND357	120
MAN3640	175
LCD 3½ digit	875
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	65p
SPDT c/over	70p
DPDT 6 Tag	85p

JACK PLUGS / SOCKETS

	JACK PLUGS Screened chrome	JACK PLUGS Plastic body	SOCKETS open metal	SOCKETS moulded with break contacts
2·5mm	13p	10p	8p	
3·5mm	15p	10p	8p	
MONO	25p	14p	13p	20p
STEREO	32p	18p	15p	24p

S-DEC **250p★**
T-DEC **400p★**
U-DEC 'A' **465p★**
U-DEC 'B' **699p★**

	Plugs	Sockets	In Line
DIN			
2 PIN Loudspkr.	10p	6p	20p
3 4 5 Pin Audio	13p	10p	20p
CO-AXIAL			
plastic	10p	12p	12p
metal	18p	18p	22p
PHONO			
assorted colours	10p	6p single / 8p double	15p
Metal Screened	15p	15p 4-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	6p	6p	—
WANDER 3mm	6p	6p	

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

DENCO COILS

'DP' VALVE TYPE		RDT2	92p
Range 1 to 5 Bl.,		RFC 5 chokes	91p
Rd., Yl. Wht.	86p	RFC 7 (19mH)	96p
6–7 B.Y.R.	75p	1 FT 13; 14; 15; 16; 17	86p
1·5 Green	92p	1 FT 18/1·6	99p
'T' 1 to 5 Bl., Yl.,		1 FT 18/465	105p
Rd., Wht.	93p	TOC 1	86p
B9A Valve Holder	25p	MW5FR	82p
		MW/LW 5FR	102p

VEROBOARD★

	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3¾	46p	39p	24p
2½ × 5	55p	50p	31p
3¾ × 3¾	55p	50p	—
3¾ × 5	62p	67p	43p
2½ × 17	169p	135p	92p
3¾ × 17	218p	180p	120p
4¾ × 17	280p	—	183p
Pkt of 35 pins			30p
Spot face cutter			85p
Pin insertion tool			120p

DIODES

AA119	18
AA129	20
BA100	12
BY126	14
BY127	14
CRO33*	148
OA9	75
OA47	10
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2★	5
IN4003★	6
IN4004/5★	6
IN4006/7★	7
IN4148	4
IS44	20
3A/100V★	15
3A/400V★	20
3A/600V★	24
3A/1000V★	30
6A/600V	60

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

NOISE
25J **180**

★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	150
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	120

DIAC★
ST2 **25**

TTL 74★

7400	13	7494	78	74193	98
7401	13	7495	65	74194	98
7402	14	7496	57	74195	98
7403	14	7497	189	74196	93
7404	14	74100	119	74197	80
7405	18	74105	62	74198	150
7406	38	74107	29	75150	175
7407	38	74109	54	75491	92
7408	17	74110	54	75492	80
7409	17	74111	68		
7410	15	74112	125		
7411	20	74116	198		
7412	17	74118	83		
7413	30	74119	149		
7414	51	74120	115		
7416	30	74121	25		
7417	30	74122	46		
7420	16	74123	48		
7421	29	74125	38		
7422	24	74126	57		
7423	27	74128	74		
7425	27	74132	73		
7426	36	74136	73		
7427	27	74141	56		
7428	35	74142	209		
7430	17	74143	314		
7432	25	74144	314		
7433	40	74145	65		
7437	30	74147	175		
7438	33	74148	109		
7440	17	74150	99		
7441	74	74151	64		
7442	68	74153	64		
7443	115	74154	96		
7444	112	74155	53		
7445	94	74156	80		
7446	94	74157	67		
7447	82	74159	185		
7448	56	74160	82		
7450	17	74161	92		
7451	17	74162	92		
7453	17	74163	92		
7454	17	74164	106		
7460	17	74165	105		
7470	28	74166	140		
7472	25	74167	200		
7473	32	74170	185		
7474	27	74172	625		
7475	38	74173	120		
7476	36	74174	87		
7480	48	74175	87		
7481	86	74176	75		
7482	69	74177	78		
7483	72	74178	153		
7484	95	74180	85		
7485	106	74181	165		
7486	31	74182	88		
7489	210	74184	135		
7490	33	74185	135		
7491	75	74188	275		
7492	38	74190	95		
7493	32	74191	95		
		74192	98		

CMOS★

4000	15	4056	134
4001	15	4059	480
4002	16	4060	115
4006	92	4061	1425
4007	18	4062	999
4008	82	4063	110
4009	38	4066	58
4010	38	4067	380
4011	18	4068	22
4012	18	4069BE	20
4013	45	4070	32
4014	80	4071	21
4015	82	4072	21
4016	45	4073	21
4017	82	0475	23
4018	87	4076	85
4019	48	4077	40
4020	99	4078	21
4021	95	4081	20
4022	85	4082	21
4023	22	4085	74
4024	66	4086	73
4025	19	4089	150
4026	180	4093	85
4027	45	4094	190
4028	81	4095	105
4029	99	4096	105
4030	58	4097	372
4031	205	4098	110
4032	100	4099	145
4033	145	4160	109
4034	116	4161	109
4035	111	4162	109
4036	335	4163	109
4037	100	4174	110
4038	108	4175	99
4039	320	4194	108
4040	105	4408	720
4041	80	4409	720
4042	75	4410	720
4043	94	4411	958
4044	95	4412F	1650
4045	145	4415F	795
4046	128	4415V	795
4047	87	4419	280
4048	58	4422	545
4049	48	4433	995
4050	48	4435	825
4051	72	4440	1275
4052	72	4450	295
4053	72	4451	295
4054	110	4490F	695
4055	128	4490V	525
		4501	19
		4502	120
		4503	69
		4506	51
		4507	55
		4508	298
		4510	99
		4511	150
		4512	98
		4520	108

LINEAR IC's

702	75	MC1488★	85
709C 14 pin	35	MC1489★	90
710★	67	MC1495★	350
723★	45	MC1496	92
733★	125	MC1710	79
741C★ 8 pin	18	MC3401	52
747C★	78	MC3403*	135
748C★	36	MC3340P★	120
753	150	MC3360P	120
810	159	MFC4000B	85
8038CC★	335	MFC6040★	97
AY-1-0212	580	MK50398★	635
AY-1-1313	660	MK50362★	650
AY-1-1320	315	MM2102-2★	170
AY-1-5050	180	MM2112★	105
AY-1-5051	145	MM2112-2N★	210
AY-1-6721/6	195	MM5303*	635
AY-3-8500★	390	MM57160★	620
AY-5-1224A★	260	NE518A★	210
AY-5-1230★	450	NE555★	22
CA3011★	82	NE556DB★	60
CA3018★	68	NE560★	325
CA3020	170	NE561★	395
CA3023	170	NE562★	410
CA3028A★	80	NE564★	425
CA3035	240	NE565A★	120
CA3043	190	NE566★	160
CA3046	71	NE567★	170
CA3048	210	NE571★	420
CA3080E★	70	RAM2102-2★	170
CA3081	190	RC4136D★	120
CA3805★	95	ROM2513★	595
CA3089E	210	SAD1024*	1450
CA3090AQ	398	SFF96364E★	1150
CA3123E	200	SG3402	295
CA3130★	85	SN76003N	170
CA3140★	70	SN76013N	140
ICL7106E★	795	SN6023N	140
ICL8038	340	SN76033N	175
ICM7205★	1150	SN76115N	215
LD130★	452	SN76227	115
LM300H ★	170	SN76477★	225
LM301A★	30	TAA621AX1	228
LM308	110	TAA960	300
LM318★	195	TBA120S	70
LM324★	68	TBA641BX11	250
LM339★	70	TBA651	180
LM348★	90	TBA800	90
LM379★	375	TBA810S	95
LM380	80	TBA820	70
LM381	145	TBA920	260
LM381AN	248	TCA270	220
LM382	125	TDA1004★	290
LM1458★	50	TDA1008★	290
LM3900★	60	TDA1022★	575
LM3909N★	70	TDA2020	320
LM3911★	100	TL061CP★	76
M252AA★	750	TL071CP★	76
M253AA★	795	TL081CP★	48
MC1304P	260	TL082CP★	96
MC724★	175	TL084CP★	130
MC1310	149	UAA170	198
MC1312P	195	ZN414	90
		ZN424	130

TRANSISTORS

				BF182★	35
AC117★	35	BC169C	14	BF183★	35
AC125★	20	BC170	18	BF184★	38
AC126★	20	BC171	11	BF194	12
AC127★	20	BC172	11	BF195	12
AC128★	20	BC177★	18	BF196	12
AC141★	24	BC178★	16	BF197	14
AC141K★	38	BC179★	18	BF198	18
AC142★	24	BC182	9	BF200★	32
AC142K★	38	BC182L	11	BF224A	18
AC176★	20	BC183	9	BF244	29
AC187★	20	BC183L	11	BF256★	60
AC188★	20	BC184	9	BF257★	30
ACY17*	35	BC184L	11	BF258★	26
ACY18★	40	BC186	21	BF259★	30
ACY19★	40	BC187★	28	BF394	27
ACY20★	40	BC212	10	BF594	40
ACY21*	35	BC212L	11	BF595	38
ACY22★	40	BC213	11	BFR39	25
ACY28★	40	BC213L	12	BFR40	28
ACY39	78	BC214	12	BFR79	28
ACY40★	48	BC214L	13	BFR80	28
ACY44	39	BC307B	20	BFX29★	28
AD140★	70	BC308	13	BFX81★	45
AD149★	70	BC328	15	BFX84★	26
AD161★	42	BC338	12	BFX85★	28
AD162★	42	BC441★	36	BFX86★	28
AF114★	40	BC461★	36	BFX87★	28
AF115★	40	BC477★	25	BFX88★	28
AF116★	40	BC547	12	BFY18★	50
AF117★	40	BC548	12	BFY50★	20
AF118★	55	BC549	13	BFY51★	20
AF121★	48	BC557	15	BFY52★	20
AF124★	55	BC558	20	BFY71★	20
AF125★	35	BCY30★	57	BSX20★	18
AF127★	35	BCY34★	75	BSY65★	30
AF139★	35	BCY39★	80	BSY95★	25
AF178★	70	BCY40★	78	BSY95A★	18
AF180★	70	BCY43	85	BU105	140
AF186★	50	BCY58★	90	BU205★	190
AF239★	42	BCY59★	90	BU208★	225
ASY26★	40	BCY70★	15	E5567	65
ASY27★	45	BCY71★	20	MD8001★	158
BC107★	9	BCY72★	20	ME4102	10
BC107B★	10	BCY78★	25	ME6002	10
BC108★	9	BD115★	65	MJ400★	90
BC108B★	10	BD121★	95	MJ491	160
BC108C★	12	BD123★	98	MJ2955★	120
BC109★	9	BD124★	115	MJE340★	54
BC109B★	12	BD131★	45	MJE370★	58
BC109C★	12	BD132★	45	MJE371★	60
BC113	20	BD133★	43	MJE520★	65
BC114	20	BD135★	38	MJE521★	74
BC115	20	BD136★	37	MJE2955★	99
BC116	20	BD137★	36	MJE3055★	70
BC117	20	BD138★	50	MPF102	44
BC118	20	BD139★	40	MPF103	36
BC119★	28	BD140★	36	MPF104	36
BC134	20	BD142★	59	MPF105	36
BC135	20	BD145★	198	MPF106	36
BC136	18	BD222★	75	MPF107	50
BC137	20	BD659A★	65	MPSA05★	25
BC140★	35	BD696A★	65	MPSA06★	25
BC142★	30	BDY17★	195	MPSA12	42
BC143★	30	BDY60★	110	MPSA55	25
BC147	8	BDY61★	165	MPSA56	25
BC148	8	BF115★	34	MPSA70	34
BC149	8	BF154★	25	MPSU02★	58
BC153	27	BF156★	29	MPSU05	50
BC154	27	BF167	30	MPSU06	56
BC157	10	BF173★	25	MPSU52★	65
BC158	11	BF177★	24	MPSU55★	55
BC159	11	BF178★	25	MPSU56★	60
BC160	42	BF179★	30	MPU131★	39
BC167A	11	BF180★	35	OC25★	170
BC168C	12	BF181★	35	OC26★	170

OC28★	150	ZTX109	14	2N3108	32
OC29★	160	ZTX300	15	2N3121	40
OC35★	130	ZTX301	15	2N3133	43
OC36★	130	ZTX302	20	2N3135	33
OC41★	75	ZTX303	25	2N3250	30
OC42★	48	ZTX304	24	2N3252	38
OC43★	55	ZTX311	17	2N3302	30
OC44★	31	ZTX314	24	2N3442★	140
OC45★	28	ZTX326	30	2N3563	20
OC46★	28	ZTX341	20	2N3614★	169
OC70★	28	ZTX500	15	2N3615★	135
OC71★	28	ZTX501	15	2N3663	26
OC72★	30	ZTX502	19	2N3702	11
OC76★	36	ZTX503	15	2N3703	11
OC77★	66	ZTX504	25	2N3704	11
OC79★	76	ZTX531	25	2N3705	11
OC81★	50	ZTX550	25	2N3706	11
OC82★	50	2N526★	58	2N3707	11
OC83★	48	2N696★	36	2N3708	11
OC84★	44	2N697★	25	2N3709	11
OC122★	75	2N698★	44	2N3710	16
OC123★	75	2N699★	44	2N3711	12
OC139★	110	2N706A★	19	2N3715★	250
OC140★	110	2N707★	39	2N3772★	195
OC141★	110	2N708★	19	2N3773★	288
OC170★	40	2N914★	32	2N3819	22
OC171★	40	2N916★	27	2N3820	45
OC201★	75	2N918★	40	2N3823★	95
OC202★	95	2N920★	51	2N3824★	70
OC203★	85	2N930★	18	2N3866★	90
OC204★	85	2N961★	61	2N3903	20
TIP29	43	2N1131★	22	2N3904	18
TIP29A	44	2N1132★	22	2N3905	18
TIP29C	60	2N1302★	35	2N3906	17
TIP30	47	2N1303★	50	2N4037★	52
TIP30A	50	2N1304★	50	2N4058	17
TIP30B	64	2N1305★	28	2N4061	17
TIP30C	65	2N1306★	35	2N4064★	120
TIP31★	50	2N1307★	50	2N4236★	145
TIP31A★	52	2N1308★	46	2N4289	20
TIP31B★	58	2N1613★	23	2N4859	65
TIP31C★	66	2N1671★	190	2N5135	42
TIP32★	55	2N1671B★	215	2N5136	42
TIP32A★	58	2N1893★	28	2N5138	20
TIP32B★	70	2N1986★	60	2N5179★	60
TIP32C★	75	2N2160★	350	2N5180★	80
TIP33★	80	2N2217★	43	2N5191★	70
TIP33A★	85	2N2218A★	34	2N5305★	40
TIP33B★	100	2N2219A★	22	2N5457	32
TIP33C★	110	2N2220A★	23	2N5458	32
TIP34★	85	2N2221★	23	2N5459	32
TIP34A★	85	2N2222★	20	2N5485	35
TIP34B★	110	2N2297	45	2N5777★	45
TIP34C★	110	2N2303★	45	2N6027	40
TIP35★	179	2N2368★	21	40311★	60
TIP35A★	185	2N2369★	15	40313★	125
TIP35C★	220	2N2476★	125	40316★	86
TIP36A★	280	2N2483★	28	40317★	52
TIP36C★	325	2N2484★	25	40324*	85
TIP41A★	66	2N2646★	48	40326★	52
TIP41B★	73	2N2784★	55	40327★	62
TIP42A★	72	2N2846★	140	40348★	105
TIP42B★	82	2N2894★	30	40360★	43
TIP2955★	65	2N2904A★	22	40361★	45
TIP3055★	52	2N2905A★	22	40362★	45
TIS43	34	2N2906★	22	40407★	52
TIS44	45	2N2907★	20	40411★	295
TIS46	45	2N2907A★	22	40412★	65
TIS50	47	2N2926G	10	40467*	95
TIS60	45	2N2960	8	40576★	190
TIS62	52	2N2926R	8	40594★	90
TIS74	47	2N2926Y	8	40673*	68
TIS90	20	2N3011★	24		
TIS91	24	2N3053★	20		
ZTX107	12	2N3054★	55		
ZTX108	12	2N3055★	48		

Matched pair add 20p per pair

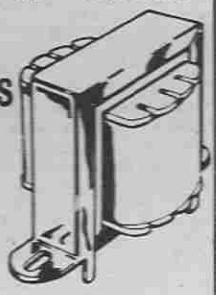
STEVENSON
Electronic Components

REGULATORS

78L05	30p	7805	60p	79L05	70p	7912	80p
78L12	30p	7812	60p	79L12	70p	7915	80p
78L15	30p	7815	60p	7905	80p	LM723	35p

HARDWARE

MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6 - 0 - 6, 9 - 0 - 9 and
12 - 0 - 12. 92p. each.

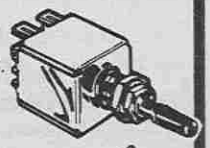
LOUDSPEAKERS

56mm dia. 8 ohms 70p
64mm dia. 8 ohms 75p
64mm dia. 64 ohms 75p
70mm dia. 8 ohms 100p
70mm dia. 80 ohms 110p

TERMINALS

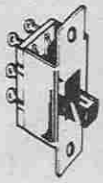
Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES



Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p

Standard toggle
SPST 34p DPDT 48p



Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide switches (DPDT)
Miniature 14p Standard 15p

CONTROL KNOBS

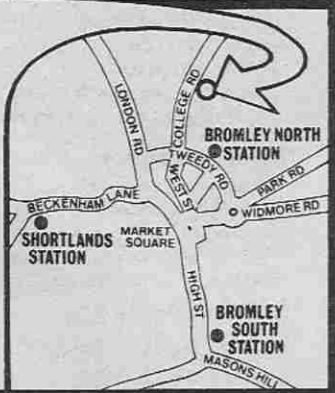
Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

WHY NOT VISIT OUR

NEW SHOP

We welcome callers at our new premises at the address below (5 mins. from High St.) We are open Mon - Sat, 9am - 6pm. Special offers available.

Express telephone order service. Orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Tel: 01-464 2951/5770.



ORDERS DESPATCHED BY RETURN POST

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 100+ 10%, 1000+ 15%. Prices VAT inclusive. Please add 30p for carriage. All prices valid to April 1980. Official orders welcome.

BARCLAYCARD & ACCESS WELCOME.

Mail orders to: STEVENSON (Dept EE)

TRANSISTORS

				ZTX109	14p
				ZTX300	16p
				2N697	12p
				3N1302	38p
AC127	17p	BCY71	14p	2N2905	22p
AC128	16p	BCY72	14p	2N2907	22p
AC176	18p	BD131	35p	2N3053	18p
AD161	38p	BD132	35p	2N3055	50p
AD162	38p	BD135	38p	2N3442	135p
BC107	8p	BD139	35p	2N3702	8p
BC108	8p	BD140	35p	2N3704	8p
BC109	8p	BF244B	36p	2N3705	9p
BC147	7p	BFY50	15p	2N3706	9p
BC148	7p	BFY51	15p	2N3707	9p
BC149	8p	BFY52	15p	2N3708	8p
BC148	9p	MJ2955	98p	2N3819	22p
BC177	14p	MPSA06	20p	2N3904	8p
BC178	14p	MPSA56	20p	2N3905	8p
BC179	14p	TIP29C	60p	2N3906	8p
BC182	10p	TIP30C	70p	2N4058	12p
BC182L	10p	TIP31C	65p	2N5457	32p
BC184	10p	TIP32C	80p	2N5458	30p
BC184L	10p	ZTX107	14p	2N5459	32p
BC212	10p	ZTX108	14p	2N5777	50p
BC212L	10p				
BC214	10p				
BC214L	10p				
BC477	19p				
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914	3p	1N5401	13p
1N4001	4p	BZY88ser.	8p

Full spec. product.
1N4148 £1.40/100. £11/1000

LINEAR

THIS IS ONLY A SELECTION!

		CA3140	38p	NE555	21p
		LM301AN	26p	NE556	50p
		LM318N	85p	NE565	85p
		LM324	45p	NE567	170p
		LM339	45p	SN76003	200p
709	28p	LM380	75p	SN76013	140p
741	16p	LM382	120p	SN76023	140p
747	40p	LM1830	150p	SN76033	200p
748	30p	LM3900	50p	SN76477	220p
CA3046	55p	LM3909	65p	TBA800	70p
CA3080	70p	MC1496	60p	TDA1022	650p
CA3130	90p	MC1458	32p	ZN414	75p

CAPACITORS

TANTALUM BEAD each

0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V 8p
4.7, 6.8, 10uF @ 25V 13p
22 @ 16V, 47 @ 6V, 100 @ 3V 16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047 . . . . . 3p
0.068, 0.1 . . . . . 4p

POLYESTER

Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1 . . . . . 5p
0.15, 0.22 . . . . . 7p
0.33, 0.47 . . . . . 10p
0.68 . . . . . 14p
1.0uF 17p

CERAMIC

Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF 2p

RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	screened	unscreened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits, Red & black. Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each

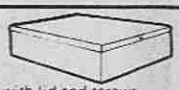
PHONO PLUGS AND SOCKETS

Insulated plug in red or black 9p
Screened plug 13p
Single socket 7p Double socket 10p

VERO

Size in.	0.1in.	0.15in.	Veropins
2.5 x 1	14p	13p	single sided
2.5 x 3.75	42p	40p	per 100
2.5 x 5	52p	50p	0.1in 35p
3.75 x 5	60p	60p	0.15in 40p
3.75 x 17	195p	180p	

BOXES



Aluminium boxes with lid and screws

	Length	width	height	
AL1	3	2	1	48p
AL2	4	3	1½	58p
AL3	4	3	2	65p
AL4	6	4	2	70p
AL5	6	4	3	85p
AL6	8	6	2	116p

THYRISTORS

Plastic-cased Thyristors: Texas

	4A	8A	12A
100V	36p	45p	62p
200V	42p	53p	68p
400V	51p	66p	86p

TRIACS

Plastic cased Triacs. Texas. All rated at 400V.

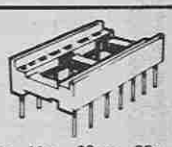
4A	70p	12A	90p	20A	185p
8A	80p	16A	95p	25A	215p

CMOS

		4018	55p	4050	25p
		4023	12p	4066	35p
		4024	40p	4068	18p
4001	12p	4026	90p	4069	12p
4002	12p	4027	30p	4071	12p
4007	12p	4028	48p	4081	13p
4011	12p	4029	50p	4093	45p
4013	28p	4040	60p	4510	65p
4015	50p	4042	50p	4511	65p
4016	30p	4046	90p	4518	65p
4017	48p	4049	25p	4520	60p

FULL DETAILS IN CATALOGUE!

SKTS



Low profile by Texas

8 pin	8p	16 pin	11p	28 pin	22p
14 pin	10p	24 pin	18p	40 pin	32p

Soldercon pins: 100 50p. 1000 370p

OPTO

	0.125in.	0.2in	each	100+
LED's				
Red	TIL209	TIL220	9p	8p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		
DISPLAYS				
DL704	0.3 in CC		130p	120p
DL707	0.3 in CA		130p	120p
FND500	0.5 in CC		100p	80p

RESISTORS

Carbon film resistors. High stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

METAL FILM RESISTORS

Very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

	each	100+	1000+
0.25W	4p	3.5p	3.2p

PLEASE WRITE FOR YOUR FREE COPY OF OUR NEW 64 PAGE CATALOGUE OF COMPONENTS. CONTAINS OVER 2500 STOCK ITEMS.

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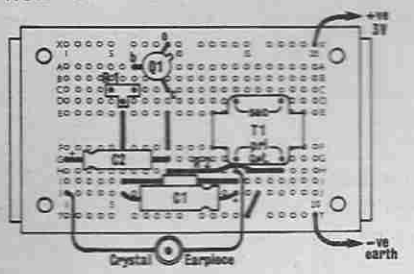
BUILD TWO FREE PROJECTS ON CSC

ELECTRONICS BY NUMBERS FREE PROJECTS NO 1 & NO 2

ELECTRONICS BY NUMBERS FISH'N'CLIKS

Now using **EXPERIMENTOR BREADBOARDS** and following the instructions in "Electronics by Numbers" **ANYBODY** can build electronic projects. Look at the diagram, this has the same letter/number system as all EXP BOARDS. Look at the "YOU WILL NEED" list and select Q1 this is PNP transistor type HEP-230. This plugs into hole X9, A7 and C9. NOW take C1, a 50 uF capacitor, and put into holes J6 and J14 and do the same with all the components.

NOW YOU HAVE FISH'N'CLIKS



YOU WILL NEED

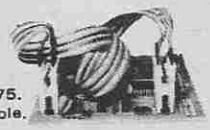
B1, B2 – 2xl.5V AAA batteries
C1, C2 – 50 uF, 12-VDC electrolytic capacitor
E1 – Crystal earphone
Q1 – Motorola HEP-230 pnp transistor
R1 – 5000-ohm pot
R2 – 27000-ohm, ¼ watt resistor
S1 – Spst switch part of R1
T1 – Mini transistor output transformer; 500-ohm center tapped primary to 8-ohm secondary
EXP – ANY EXP. BREADBOARD.

The anglers dream come true. This electronic marvel emits a CLIK-CLIK sound that makes fish really hungry. Shove the whole works in a watertight container lower it over the side and wait for the fish to grab the hook.

FILL IN THE COUPON AND WE WILL SEND YOU FREE OF CHARGE A COPY OF THE FULL PROJECT FISH'N'CLIKS, AND A COPY OF PROJECT No 1 "TWO TRANSISTOR RADIO".

PROTO-CLIP TEST CLIPS.

Brings IC leads up from crowded PC boards. Available plain or with cable with clips at one or both ends.



PC – 16 pin. £2.75.
PC – 16 pin with cable. £6.00.
PC – 16 with cable and 16 pin clips at both ends. £10.25.

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Telephone: SAFFRON WALDEN 21682.
Telex: 817477.

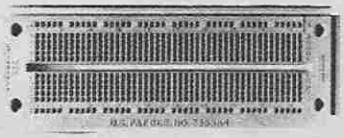
EXPERIMENTOR BREADBOARDS.

No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build breadboard of any size.
All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP.4B.

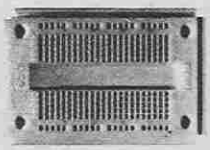
EXP.325. The ideal breadboard for 1 chip circuits.
Accepts 8,14,16 and up to 22 pin IC's.
ONLY £1.60.

EXP.350. £3.15.
270 contact points with two 20-point bus-bars.

EXP. 300.
550 contacts with two 40-point bus-bars.
£5.75.



EXP. 650 for Micro-processors. **£3.60.**



EXP 4B.
More bus-bars.
£2.30.

ALL EXP.300 Breadboards mix and match with 600 series.

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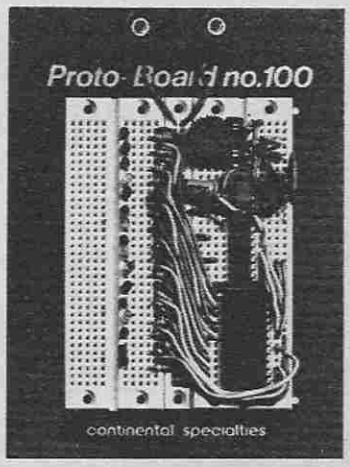
PROTO-BOARD 6 KIT. £9.20.



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EXP. 300	550	6	£ 7.29
EXP. 650	270	use with 0.6 pitch Dip's	£ 4.69
EXP. 4B.	Four 40 Point Bus-Bars	Bus-Bar Strip	£ 3.29
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PC.16-18.			£ 7.56
PC. 16-18 Dual Clip.			£12.15
PROTO-BOARDS.			
PB. 6.	630	6	£11.01
PB. 100.	760	10	£13.82

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DIGITAL INTEGRATED CIRCUITS

4000 Buffered C-MOS — High Speed

5–15V 'B' Series, Up to 20MHz

HEF4000	14	HEF4046	100	HEF4514	250	N7400N	9	N7444N	83	N74122N	39	N7419CN	60	N74LS28N	32	N74LS138N	85	N74LS253N	105
HEF4001	14	HEF4047	87	HEF4515	295	N7401N	11	N7445N	65	N74123N	37	N74194N	80	N74LS30N	16	N74LS139N	85	N74LS257N	104
HEF4002	14	HEF4048	28	HEF4516	90	N7402N	11	N7446AN	62	N74125N	32	N74195N	79	N74LS32N	24	N74LS153N	76	N74LS258N	107
HEF4006	95	HEF4050	28	HEF4517	382	N7403N	11	N7447AN	51	N74126N	32	N74198N	120	N74LS33N	32	N74LS154N	122	N74LS260N	26
HEF4007	14	HEF4051	69	HEF4518	69	N7404N	12	N7448AN	44	N74128N	74	N74199N	139	N74LS37N	24	N74LS155N	80	N74LS261N	300
HEF4008	80	HEF4052	72	HEF4519	55	N7405N	12	N7450N	13	N74132N	46	N74221N	160	N74LS38N	24	N74LS156N	80	N74LS266N	40
HEF4011	14	HEF4053	72	HEF4520	65	N7406N	25	N7451N	13	N74145N	60	N74279N	116	N74LS40N	22	N74LS157N	54	N74LS273N	130
HEF4012	14	HEF4066	37	HEF4521	188	N7407N	27	N7453N	15	N74147N	125	N74298N	200	N74LS42N	53	N74LS158N	60	N74LS283N	116
HEF4013	32	HEF4067	390	HEF4528	99	N7408N	13	N7454N	13	N74148N	83	N74365N	150	N74LS51N	22	N74LS160N	120	N74LS290N	90
HEF4014	84	HEF4068	14	HEF4532	120	N7409N	13	N7460N	13	N74150N	65	N74366N	150	N74LS54N	16	N74LS161N	78	N74LS293N	100
HEF4015	60	HEF4069	14	HEF4534	510	N7410N	11	N7470N	26	N74151N	46	N74367N	120	N74LS55N	22	N74LS162N	130	N74LS298N	100
HEF4016	35	HEF4070	14	HEF4539	110	N7411N	18	N7472N	22	N74153N	55	N74368N	150	N74LS73N	29	N74LS163N	78	N74LS324N	170
HEF4017	55	HEF4071	14	HEF4543	155	N7412N	17	N7473N	23	N74154N	96			N74LS75N	40	N74LS164N	90	N74LS365N	105
HEF4018	65	HEF4072	16	HEF4555	76	N7413N	23	N7474N	33	N74155N	53			N74LS76N	33	N74LS170N	200	N74LS366N	105
HEF4019	46	HEF4073	16	HEF4556	78	N7414N	46	N7475N	28	N74156N	48	74LS		N74LS78N	32	N74LS173N	100	N74LS367N	105
HEF4020	88	HEF4075	16	HEF4557	386	N7416N	22	N7476N	26	N74157N	49	N74LS00N	15	N74LS83AN	97	N74LS174N	100	N74LS368N	105
HEF4021	85	HEF4076	85	HEF4585	97	N7417N	23	N7480N	43	N74158N	54	N74LS01N	18	N74LS85N	70	N74LS175N	100	N74LS373N	150
HEF4022	82	HEF4077	14	HEF4724	171	N7420N	11	N7483N	63	N74160N	74	N74LS02N	16	N74LS86N	33	N74LS181N	320	N74LS374N	150
HEF4023	14	HEF4078	16	HEF40097	90	N7421N	26	N7485N	65	N74161N	74	N74LS03N	16	N74LS90N	45	N74LS190N	91	N74LS375N	100
HEF4024	45	HEF4081	16	HEF40098	73	N7425N	27	N7486N	23	N74162N	74	N74LS04N	16	N74LS92N	70	N74LS191N	95	N74LS378N	160
HEF4025	14	HEF4082	16	HEF40106	62	N7426N	22	N7490N	30	N74163N	74	N74LS05N	23	N74LS93N	45	N74LS192N	128	N74LS388N	35
HEF4027	32	HEF4085	64	HEF40160	119	N7427N	22	N7491AN	60	N74164N	65	N74LS08N	16	N74LS95BN	65	N74LS193N	130	N74LS390N	170
HEF4028	52	HEF4086	64	HEF40161	119	N7428N	30	N7492N	33	N74165N	65	N74LS09N	22	N74LS98N	116	N74LS194N	150	N74LS393N	170
HEF4029	60	HEF4093	50	HEF40162	119	N7430N	11	N7493N	31	N74166N	93	N74LS10N	16	N74LS107N	38	N74LS195AN	120	N74LS395N	180
HEF4030	46	HEF4094	175	HEF40163	119	N7432N	21	N7494N	74	N74170N	134	N74LS11N	22	N74LS109N	38	N74LS196N	80	N74LS490N	130
HEF4031	200	HEF4104	166	HEF40174	119	N7433N	30	N7496AN	48	N74173N	111	N74LS12N	23	N74LS112N	40	N74LS197N	110	N74LS670N	170
HEF4035	110	HEF4502	91	HEF40175	119	N7437N	21	N7496N	48	N74174N	63	N74LS13N	38	N74LS113N	38	N74LS240N	160		
HEF4040	68	HEF4505	571	HEF40192	140	N7438N	21	N74100N	88	N74175N	62	N74LS14N	74	N74LS114N	38	N74LS241N	160		
HEF4041	75	HEF4508	151	HEF40193	140	N7439N	60	N74107N	25	N74180N	80	N74LS15N	24	N74LS125N	40	N74LS242N	160		
HEF4042	54	HEF4510	70	HEF40194	119	N7440N	12	N74109N	42	N74181N	165	N74LS20N	16	N74LS126N	40	N74LS243N	160		
HEF4043	79	HEF4511	110	HEF40195	117	N7442N	40	N74116N	148	N74182N	69	N74LS21N	22	N74LS132N	60	N74LS244N	160		
HEF4044	84	HEF4512	98			N7443N	79	N74121N	23	N74192N	65	N74LS22N	24	N74LS136N	37	N74LS251N	90		

LINEAR INTEGRATED CIRCUITS

CA3011	92	NE592K	182
CA3018	75	RC4136	130
CA3020	191	TBA120S	79
CA3028A	96	TCA380	346
CA3046	76	TCA730	450
CA3048	245	TCA740	450
CA3080E	70	TDA1008	326
CA3089E	253	TDA1022	848
CA3130E	90	TDA1028	338
CA3140E	38	TDA1029	338
CA3189E	266	TDA1034B	217
LM301AN	30	TDA2581	266
LM308N	95	TDA2640	292
LM318N	200	TL081CP	75
LM319N	216	TL084CN	140
LM324N	70	UA709CT	46
LM339N	71	UA709CN	40
LM391N	110	UA710CN	41
LM381AN	180	UA711CN	65
LM382	120	UA741CT	42
		UA741CN	18
		UA747CN	50
		UA748CN	35
MC1458N	35		
MC1496N	97	**Voltage Regulator**	
NE531	119	LM309DA (K)	108
NE536T	216	UA723CN	38
NE540	226	UA7805CU	85
NE555N	25	UA7812CU	85
NE556N	50	UA7815CU	85
NE560N	351	UA7905CU	86
NE561N	427	UA7912CU	86
NE562N	461	UA7915CU	86
NE565N	120	UA78L05CS	32
NE566N	156	UA78L06CS	32
NE567N	170	UA78L12CS	32
NE570N	405	UA78L15CS	32
NE571N	459		

OPTO ELECTRONICS

			Order Code
Light Emitting Diodes, Individual			
.125" (3mm)	Red	14	CQY54
	Green	17	CQY96
	Yellow	19	CQY97
Panel Mounting Clip to suit.		3	LED3 Clip
.2" (5mm)	Red	15	CQY24A
	Green	17	CQY94
	Yellow	19	CQY96
Panel Mounting Clip to suit.		5	LED5 Clip
Light Emitting Diodes — 7 Segment Display			
.3" (7.6mm)	C. Anode R.H. Decimal Pt. Red	160	XAN3061
	C. Anode R.H. Decimal Pt. Green	199	XAN3051
	C. Cathode R.H. Decimal Pt. Red, Low current drain	160	XAN3074
.6" (15.2mm)	C. Anode L.H. Decimal Pt. Red	230	XAN6520
	C. Anode L.H. Decimal Pt. Green	230	XAN6520
	C. Cathode L.H. Decimal Pt. Red	230	XAN6640
Photoresistors			
ORP12		90	ORP12
ORP61		90	ORP61
Phototransistors			
OCP71		180	OCP71
BPX25		175	BPX25
BPX29		175	BPX29
Photocoupler			
FCD820		150	FCD820

SWITCHES

				Order Code
Miniature Toggle — Honeywell				
SPDT		2A/250V A.C., 5A/28V D.C.	58	SW BA1011
SPDT	C/Off		67	SW BA1021
SPDT	Double Bias To Centre		75	SW BA1041
SPDT	Single Bias To Centre		75	SW BA1051
SPDT	Bias		70	SW BA1061
DPDT			86	SW BA2011
DPDT	C/Off		92	SW BA2021
DPDT	Double Bias To Centre		102	SW BA2041
DPDT	Single Bias To Centre		102	SW BA2051
DPDT	Bias		96	SW BA2061
Miniature Push — C & K				
SP	Push To Make, Momentary	0.5A/250V A.C., 1A/28V D.C.	54	SW 8531
SP	Push To Break, Momentary		54	SW 8533
Slide — Switchcraft				
DPDT	Standard Actuator		36	SW 46206
DPDT	Slot Actuator, Voltage Change, Marked 110/240		43	SW 46206F

SEMICONDUCTORS

Diodes									
IN827	193	IN4006	7	BB110G	61	OA202	9		
IN914	4	IN4007	8	BY127	15				
IN916	5	IN4148	3	BY206	34				
IN4001	4	IN5402	15	BYX10	19	**Microwave**			
IN4002	4	IN5404	16	OA47	10				
IN4003	6	BAX13	5	OA90	7	BAW95D	1091		
IN4004	6	BAY38	27	OA91	7	CL8960	2592		
IN4005	7	BB106(4)	122	OA200	9	CXY11C	1280		
Zener Diodes									
400mW C4V7-C33				1.3W C7V5-C75					
BZY88/BZX79 + Voltage		8		BZX61 + Voltage		16			
Transistors									
2N929	37	2N4427	206	BC478	24	BSX88	18		
2N1893	30	2N4856	158	BC547	12	MJE340	46		
2N2218A	28	2N4858	134	BC548	10	MPF102	32		
2N2222	21	2N4860	122	BC548B	15	OC28	107		
2N2369	19	2N5294	43	BC549	12	OC35	95		
2N2369A	20	2N5416	106	BC549B	20	OC45	82		
2N2646	42	2N5457	35	BC557	14	OCP71	180		
2N2894	49	2N5458	30	BC558	14	TIP29A	41		
2N2895	28	2N5459	32	BC559	17	TIP29C	53		
2N2904	24	2N6258	432	BCY34	97	TIP30A	44		
2N2904A	24	40673	80	BCY70	14	TIP30C	57		
2N2905	22	AC188	22	BCY71	14	TIP31A	43		
2N2905A	24	AD161	38	BCY72	15	TIP31C	58		
2N2906	19	AD162	38	BD131	35	TIP32A	49		
2N2907	22	BC107	10	BD132	35	TIP32C	63		
2N2907A	25	BC107B	14	BD135	38	TIP41A	59		
2N2918	330	BC108	10	BD136	37	TIP41C	69		
2N2926G	11	BC108B	14	BD137	38	TIP42A	59		
2N3053	17	BC108C	16	BD138	39	TIP42C	69		
2N3054	50	BC109	10	BD139	35	TIP2955	68		
		BC109B	17	BD140	35	TIP3055	54		
2N3055	50	BC109C	18	BF115	28	TIS43	32		
2N3055 Full ISB Test	86	BC147	7	BF180	37	ZTX109C	14		
2N3340	30	BC148	9	BF181	37				
2N3442	141	BC149	8	BF257	35				
2N3702	8	BC157	10	BF258	32				
2N3703	11	BC158	9	BF259	36				
2N3704	8	BC159	11	BFR90	303				
2N3705	9	BC177	15	BFS21	428				
2N3706	9	BC178	15	BFX13	23				
2N3707	9	BC179	18	BFXB4	26				
2N3708	9	BC182	10	BFXB5	26				
2N3709	11	BC182L	10	BFXB6	30				
2N3773	270	BC183	10	BFXB7	22				
2N3819	20	BC183L	11	BFXB8	26				
2N3820	39	BC184	10	BFY50	15				
2N3866	97	BC184L	11	BFY51	15				
2N3903	20	BC212	10	BFY52	18				
2N3904	8	BC212L	11	BFY90	97				
2N3905	12	BC213	10	BLX65	238				
2N3906	12	BC213L	11	BLY35	1889				
2N3962	95	BC214	10	BLY93A	2706				
2N4347	227	BC214L	11	BPX25	175				
2N4401	20	BC327	17	BPX29	175				
2N4403	20	BC328	15	BRY39	45				
2N4416	88	BC337	16	BSW69	33				
		BC338	14	BSX20	19				

SEMICONDUCTORS

Rectifier Bridges		Order Code
1A 400V S.I.L.	93	BY179
1.4A 600V S.I.L.	84	BY164
1.5A 100V D.I.L.	33	VM18
1.5A 400V D.I.L.	35	VM48
1.5A 100V	45	W01
1.5A 400V	52	W04
2A 100V	89	VS148
2A 400V	109	VS448
6A 100V	143	VH148
6A 400V	183	VH448
10A 100V	172	VJ148
10A 400V	201	VJ448
15A 100V	215	VL148
15A 400V	226	VL448
30A 100V	242	VK148
30A 400V	260	VK448
S.C.R.'s		
4A 400V	54	C106D
12A 400V	108	TIC126D
Triacs		
10A 500V	124	BT138-500
15A 500V	177	BT139-500
23A 500V	492	BTW41-500

COMMUNICATIONS INTEGRATED CIRCUITS — PLESSEY

SL360C	242	SL641C	384								
SL362C	302	SL650C	885								
SL610	230	SL651C	788								
SL611C	230	SL652C	329								
SL612C	230	SL680C	230								
SL613C	394	SL701C	220								
SL620C	347										
SL621C	347	SL1610C	166	SL1623C	251	SL1680C	170	SP8629	446	SP8690	907
SL622C	854	SL1611C	166	SL1625C	225	SL8600C	890	SP8630B	1361	SP8760B	680
SL623C	629	SL1612C	166	SL1626C	251	SL8640C	401	SP8655B	1058	SP8790B	454
SL624C	321	SL1613C	193	SL1630C	166	SL8650C	378	SP8657B	1058	SP8794B	454
SL630C	218	SL1620C	225	SL1640C	193			SP8659B	907		
SL640C	384	SL1621C	225	SL1641C	193			SP8660B	907		

MAINS TRANSFORMERS

Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA — Clamp Type Construction

Approx. 18% Regulation. F.C. 54, H36, W35

0-4.5V, 0-4.5V Secondaries	220	Trans 6VA	45
0-6V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200

20VA — Clamp Type Construction

Approx. 16% Regulation F.C. 70, H48, W46

0-4.5V, 0-4.5V Secondaries	335	Trans 20VA	45
0-6V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-17.5V, 0-17.5V			175
0-20V, 0-20V			200

55VA — Clamp Type Construction

Approx. 10% Regulation F.C. 92, H64, W57

0-6V, 0-6V Secondaries	540	Trans 55VA	60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200
0-30V, 0-30V			300

100VA — Frame Type Construction

Approx. 6% Regulation H87, W74, D64

0-25V, 0-25V Secondaries	825	Trans 100VA	250
0-40V, 0-40V			400

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

It can be argued that complete overall dependence upon commercial parts and materials is not desirable in a creative pastime. We believe the exercise of inventive and innovative ability is very much an important element in this hobby and should be encouraged, for its own sake, no matter if "Heath Robinsonish" results are sometimes the outcome. Certainly the thought that unfavourable comparisons will be made with the elegant and professional-looking standards we now take as the norm in our projects, should never be the reason for failing to experiment, at least on the odd occasion, with different and less formal ways for building electronic circuits.

The young, and others whose pockets are not especially capacious, find the use of alternative materials a necessity—and we know what necessity is the mother of, so the point hardly needs labouring. But it is no bad thing for everyone, no matter the size of their pocket, to cultivate the knack of converting for their special purpose some humble run of the mill article or to make use of discarded materials. As an example we can think of the boundless supply of plastic receptacles in infinite variety that have but a fleeting life once taken from the supermarket shelves. As our enterprising readers have demonstrated on innumeral occasions there are possibilities for extending the life of these plastic containers in our own special field.

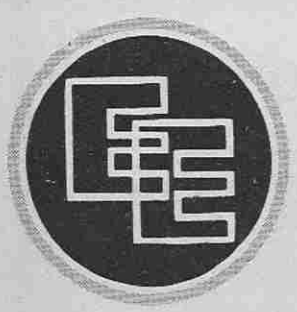
Make and do for oneself is the underlying purpose of our *Mini Module* Series. The tobacco tin motif is not a leaning back to the good old days when do-it-yourself actually meant just that. But it symbolises the homespun as against modern orthodox construction. These useful projects have been used as vehicles to demonstrate simple but effective methods in assembling simple circuits. Cardboard, plywood, pins and nails, have all shared the honours, along with more orthodox items such as tag strips, terminal blocks and stripboard; and the tobacco tin after its inaugural appearance has been superceded by electricians' switch boxes and purpose built plastic boxes.

As readers will already have noticed another contributor has just joined our pages and *Rummaging Around* is intended to reinforce the make and do aspect, albeit in a lighthearted way. And why not, for it is fun.

In any activity, a certain degree of self-sufficiency must always be admired, and in electronics construction it provides a beneficial antidote to the all-too-easy-just-assemble-a-kit attitude which maybe we are in danger of slipping into.

Fred Bennett.

Our July issue will be published on Friday, June 15. See page 343 for details.



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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.

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VOL. 8 NO. 6 JUNE 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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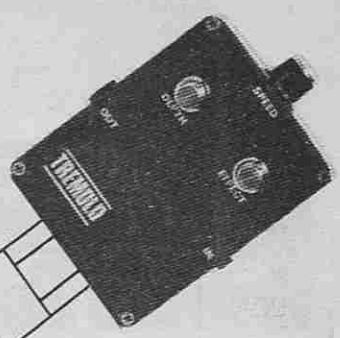
BEGINNERS
YOUR INTRO TO ELECTRONICS
SQUARE ONE

Tremolo Unit



By E. M. Lyndsell

A PROFESSIONAL "PERFORMER" FOR USE WITH ORGAN, GUITAR OR VOICE

THE TREMOLO is believed to be one of the first musical effects units—certainly for use with the electronic guitar—and was featured prominently in "pop" music of the fifties. It is used to a lesser extent in present day music but is still required for certain musical numbers.

In the past many methods have been used to obtain the tremolo effect both electronic and mechanical. One of the mechanical methods was to open and close a shutter sited in front of the loudspeaker.

Tremolo is the name given to the amplitude modulation of the guitar signal by a very low frequency, typically 3 to 10Hz. The result is to produce "packets" of musical signal, see Fig. 1. Varying the speed and depth of the modulation produces different effects.

The unit to be described here has two set depths—deep and shallow, but can easily be made continuously variable by changing one component. The Tremolo is suitable for guitar, organ and voice.

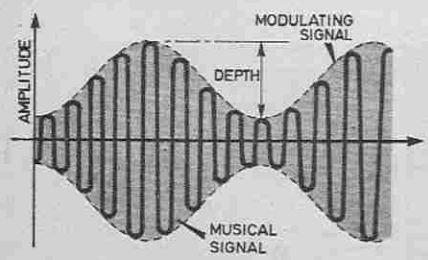


Fig. 1. The tremolo effect in graphical form. A sinewave "music signal" has been shown for clarity.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Tremolo Unit is shown in Fig. 2. It is powered by a single 9V battery. Current consumption is very low typically 1·7 to 2·1 milliamps, so the battery should have a long life.

The circuit is seen to be in two distinct sections: a current controlled amplifier and an oscillator.

CURRENT AMPLIFIER

The amplifier uses a transconductance operational amplifier IC1. In many respects this is similar to "normal" op-amps and has the same pinning as the common 741. The gain of the amplifier however, is controlled by the current flowing into pin 5, producing an output current into a fixed load, R7 in this circuit.

Resistors R1 and R2 effectively produce a split supply for IC1 with C2 performing decoupling. The input impedance of the circuit is approximately 8 kilohms which should suit most electric guitars.

Preset VR1 is used to control the overall gain by setting the quiescent current flowing into pin 5 via R6.

OSCILLATOR

The oscillator is composed of IC2 and associated components connected as a phase-shift oscillator. The output is sinusoidal at a frequency set by VR3 (the SPEED control) which varies the frequency from about 3 to 10Hz. The peak-to-peak amplitude of the oscillator output is 5 volts about mid-supply, which is fed via R3 and C4 to R6 and then into pin 5. Thus the gain IC1 is controlled by the oscillator output. The result is to cause the output signal from IC1 to be amplitude modulated as depicted in Fig. 1.

Resistors R13 and R14 effectively produce a split supply for IC2 with decoupling by C8.

The depth of modulation is controlled by R8 and S1, the DEPTH switch. For a deep effect S1 is set to short out R8. This resistor is in circuit for a shallow effect.

The oscillator is caused to cease oscillating by closing S2, the EFFECT control. The musical signal appears at SK2 unaffected with an amplitude controlled only by VR1.

If a continuously variable depth control is required, R8 should be

COMPONENTS approximate cost £6

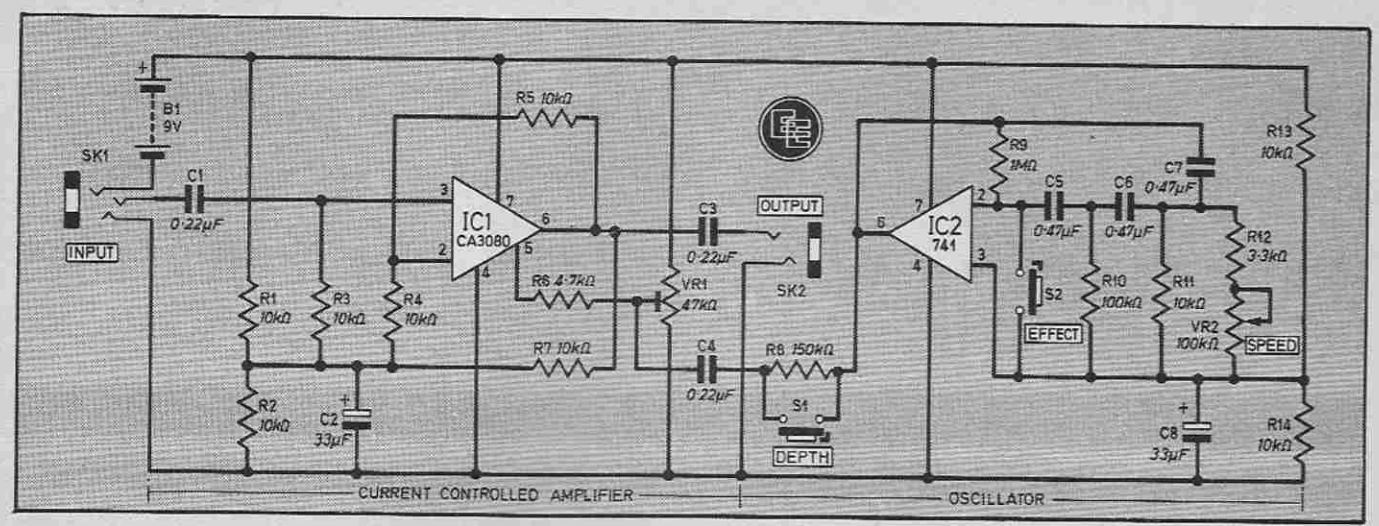


Fig. 2. The complete circuit diagram of the Tremolo Unit.

replaced with a 220 kilohm potentiometer wired as a variable resistor, S1 would then of course not be needed.

CONSTRUCTION starts here

The construction of the unit differs a little from that shown on the front cover as the design has been modified slightly, to improve its performance. The l.e.d. has been removed in the interests of battery economy and a larger case has been employed to make construction more easy.

CIRCUIT BOARD

The circuit is built on a piece of 0·1 inch matrix stripboard, size 31 strips x 29 holes. The layout of the componets on the topside of the board and the breaks to be made along the strips on the underside are shown in Fig. 3.

No fixing of the board was found necessary on the prototype. It was laid on a piece of polystyrene tile and the case mounted switch and sockets held the board steady. If board fixings are required holes should be made in the case and board before proceeding; spacers to hold the board clear of the case are essential as well as fixing isolating breaks on the copper strips.

Begin by mounting the resistors, capacitors, link wires and preset followed by the i.c.s; IC1 is a TO-5 type and its legs have been formed to suit a d.i.l. arrangement. Pin 8 is adjacent to the tag on the body. These devices can also be obtained with pre-formed d.i.l. arrangement and IC2 is available also in a plastic d.i.l. package as is more commonly found.

Attach sufficient lengths of flying leads to reach the case mounted components. Note that some

COMPONENTS

Resistors

R1	10kΩ	R8	150kΩ
R2	10kΩ	R9	1MΩ
R3	10kΩ	R10	100kΩ
R4	10kΩ	R11	10kΩ
R5	10kΩ	R12	3·3kΩ
R6	4·7kΩ	R13	10kΩ
R7	10kΩ	R14	10kΩ

All ¼ watt (or less) carbon ± 10%

See Shop Talk page 333

Capacitors

C1	0·22μF polyester	C5	0·47μF polyester
C2	33μF 6V elect.	C6	0·47μF polyester
C3	0·22μF polyester	C7	0·47μF polyester
C4	0·22μF polyester	C8	33μF 6V elect.

Integrated Circuits

IC1 CA3080 transconductance op-amp. 8 pin d.i.l. (preferable)
IC2 741 differential op-amp 8 pin d.i.l.

Miscellaneous

VR1 47kΩ horizontal carbon preset
VR2 100kΩ carbon Lin. potentiometer
S1, 2 single-pole successional action footswitch (2 off)
SK1 stereo jack socket
SK2 mono jack socket
B1 PP3 9 volt battery
Stripboard: 0·1 inch matrix 31 strips × 29 holes; PP3 battery clip; knob for VR2; aluminium diecast box approximate size 115 × 90 × 50mm; screened cable; connecting wire.

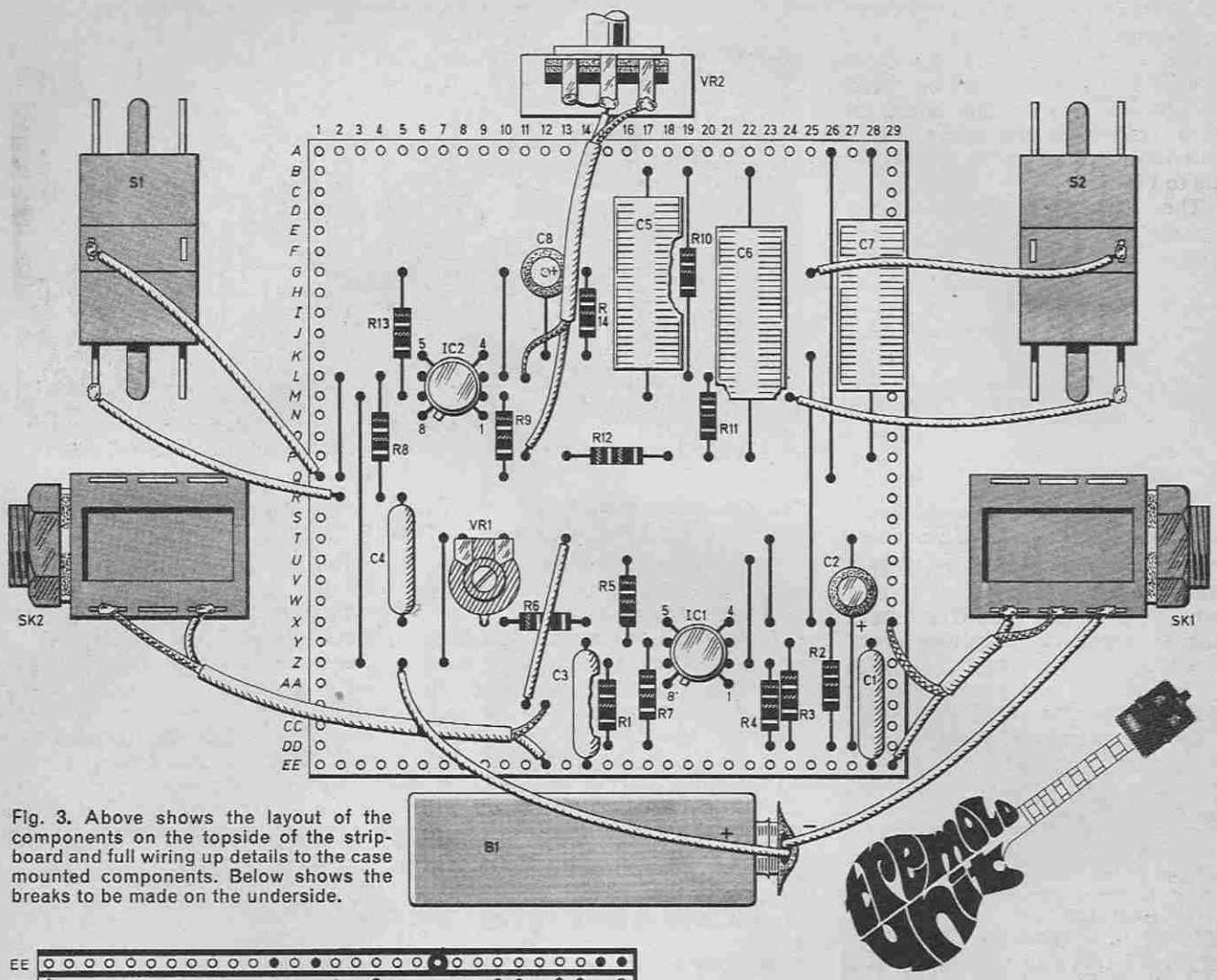
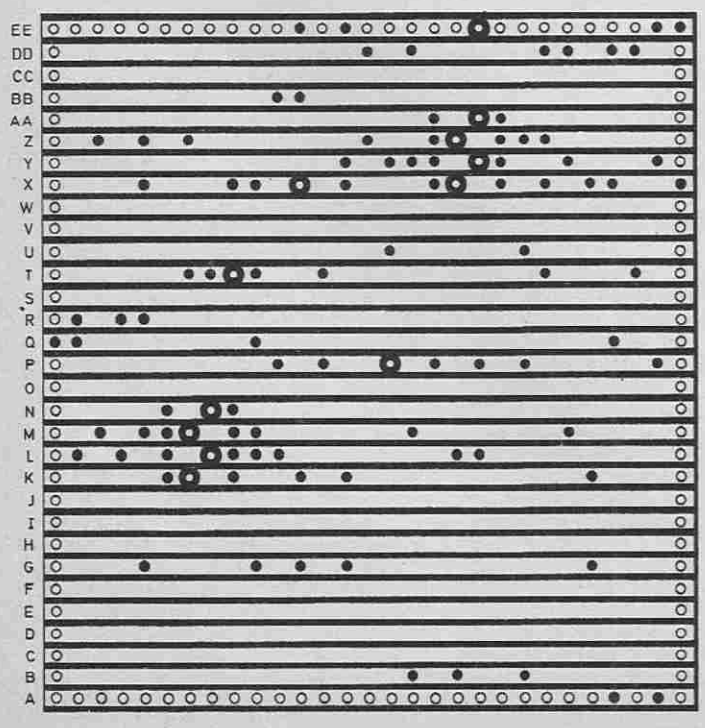
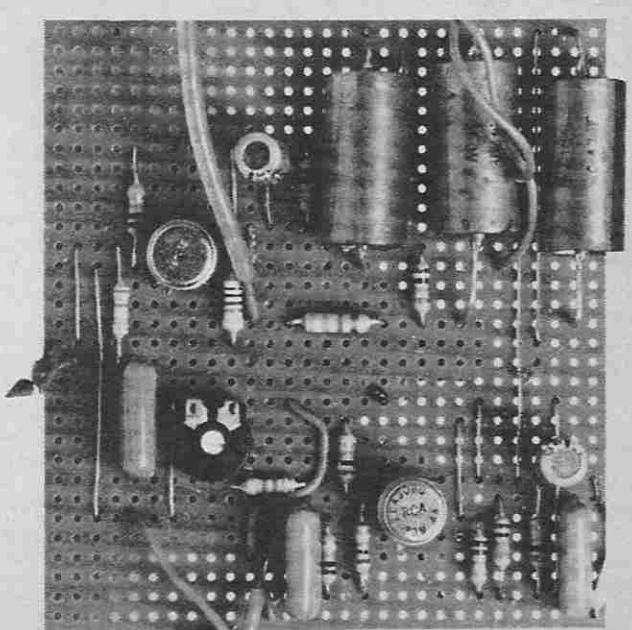


Fig. 3. Above shows the layout of the components on the topside of the stripboard and full wiring up details to the case mounted components. Below shows the breaks to be made on the underside.





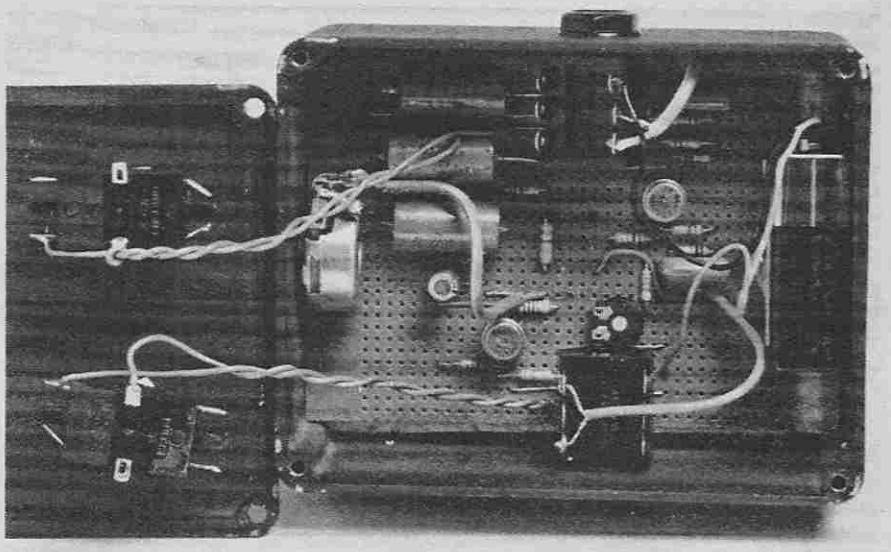
The completed component board removed from its case.

of these are screened cable to reduce extraneous hum and noise.

Prepare the case to accept the sockets, switches and potentiometer. The switches can be fitted to the lid. Secure the board in place and then the sockets and potentiometer and wire up according to Fig. 3.

The prototype used stereo sockets but a stereo type is only required for SK1. The rear earth tag is used as the battery on/off switch. This is made along the shank of the input mono jack plug when inserted. The unit is automatically switched off when the input jack is removed from the unit.

Before connecting the battery set VR1 fully anti-clockwise.



The completed prototype unit with lid removed showing case mounted components, board positioning and wiring to the lid mounted switches.

SETTING UP AND USE

Plug the instrument in at SK1 and connect via a suitable lead from SK2 to the amplifier input. A high impedance amplifier input is required for best results.

With S2 set for EFFECT, S1 for maximum DEPTH, and VR2 fully clockwise (maximum SPEED), strum the guitar and finely adjust VR1 with a small screwdriver until the tremelo sound is obtained. Turn VR2 anticlockwise and the modulation rate should decrease.

Operate S1 to obtain a less deep effect. The value of R8 may need altering to suit but will probably be in the range 100 to 220 kilohms.

Operate S1 to inhibit the effect and allow straight-through-playing.

If all the above tests are successful, the unit is ready for use.

The prototype was sprayed matt black (after application of a primer) and labelled using Letraset to produce a professional looking unit. Four rubber feet glued to the case underside prevents the unit sliding under operation. ⌑

By Dave Barrington

Mail Order Only

IT IS sad that Home Radio Components Ltd, one of the oldest names in the electronic components business (at least on the retail side) had to move due to rent increase. To soften the blow, I am informed by the managing director that despite their enforced move they were in good heart and delighted with results of their moving sale. He reported that at the moment they cannot forecast the restoration of a counter service and at the moment only trade by mail order.

He does advise that if you require something in a hurry to telephone first, the number is 01-648 8422.

Constructional Projects

Some readers may experience difficulty in obtaining the tuning capacitor C2 called for in the *Pocket Radio*. The final value of this component is not critical and provided the value is near to 126pF any type may be used.

The one used in our prototype was a miniature 4-gang a.m./f.m. type for printed circuit board mounting. These are quite common and ours was ordered as a "Min Tuner", Cat. No. FF52G, from Maplin.

The length of the ferrite aerial is non-standard and will have to be cut to size. This material is very brittle and extreme care must be taken during cutting. We suggest you "score" around the rod before final cutting as sometimes it tends to snap unexpectedly.

Our *Low Cost Metal Locator* this month is a very simple design, but the results have been very good, and should not present any problems regarding purchase of components. The p.v.c. insulated wire for the search coil is available generally and the final housing is left to individual choice.

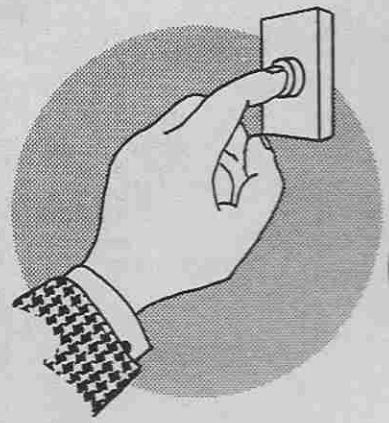
In respect of the housing, the original search coil cover called for in our last article and available from Arrow Electronics, Dept. EE, Leader House, Coptfold Road, Brentwood, Essex, or a moulded plastic search coil head case available from Ambit International, Dept. EE, 2 Gresham Road, Brentwood, Essex, could be used.

The only component likely to cause any concern in the *Electronic Canary* is the transformer. Practically any type can be used in this project, but component values may have to be changed to obtain the desired sound effects if other than the specified type is used.

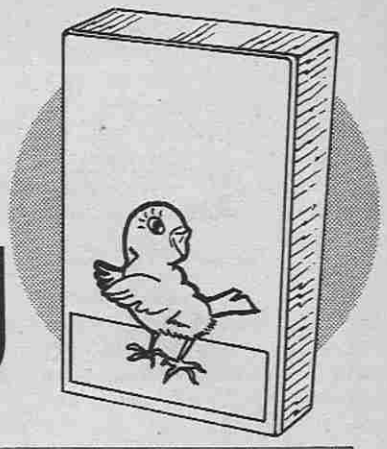
The LT700 transformer is available from Electrovalue at a cost of 44p, including VAT, plus 27p handling charge if ordered as a separate item.

The only point to be made regarding the *Quad Simulator* is that wirewound components rated as specified or greater must be used.

The *Tremolo Unit* and this month's *Mini Module* project use standard easy to obtain components and should not give any buying problems.



Electronic Canary



By F. G. Rayer

THE TWITTERING or chirping sound from this Electronic Canary unit is very distinctive, and will find use in replacing the traditional door bell or buzzer. Children will also find the sound novel, and will doubtless play with it purely for fun. Operation is economical, the current drain from a PP6 battery being very low and will give many hours of use.

CIRCUIT DESCRIPTION

The circuit diagram for the Electronic Canary is shown in Fig. 1.

The oscillator is the type known as "self-quenching" or "squegging", and is based on the effects of phase reversal in a transformer.

The primary of the centre-tapped speaker transformer T1 is connected between collector and base of TR1 and drives the base in the correct phase to produce audio oscillation. In a short interval the charging of C1 cuts off the oscillator, which however recommences when the charge leaks away. This effect continues so long as the push is held closed. When the push is released oscillation is maintained for a short while by the charge in C5, but falls away and ceases.

The capacitors C2, C3 and C4 are selected to produce a clear chirping or whistling sound, and the preset potentiometer VR1 allows some adjustment to this.

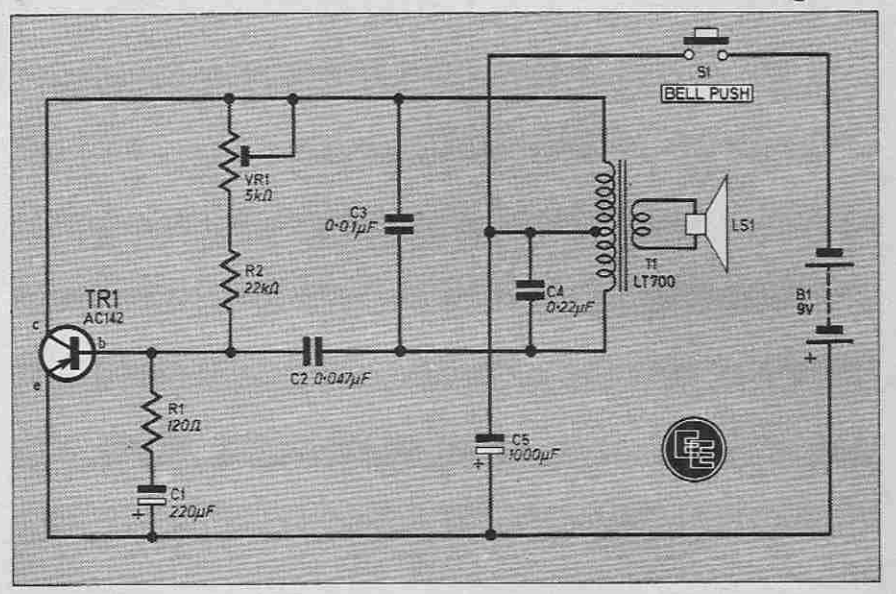


Fig. 1. Complete circuit diagram of the Electronic Canary.

COMPONENTS approximate cost £5

Experiment shows that none of the values need be exactly as shown, but that all influence the result obtained. Changes to values are not recommended except as a basis for tests and experimenting for other sounds.

The author's prototype in fact used a different type to that specified in the components list, being a type T/T7. As far as we know, this is not generally available and the circuit has been slightly modified to use an Eagle LT700 type.

If any constructors are able to obtain or already have this type three component values need to be changed back to their original values to use the T/T7. These are R1 to 470 ohms, R2 to 10 kilohms and C1 to 100 microfarads.

If other types of audio output transformers are to hand, these could be used but will almost certainly need resistor and capacitor value changes to obtain the same result—or other sounds and effects

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is constructed on a piece of 0·15 inch plain matrix board having 19 x 12 holes and is shown in Fig. 2. The transformer has two tabs which project through slots in the board—these can be made by drilling a few holes closely side by side. The tabs are bent or twisted to hold the transformer.

The variable resistor, VR1, is fitted in a similar manner. Its wiper and one outer tag are connected together. If a fixed resistor is substituted for VR1 and R2, connect this from collector to base of

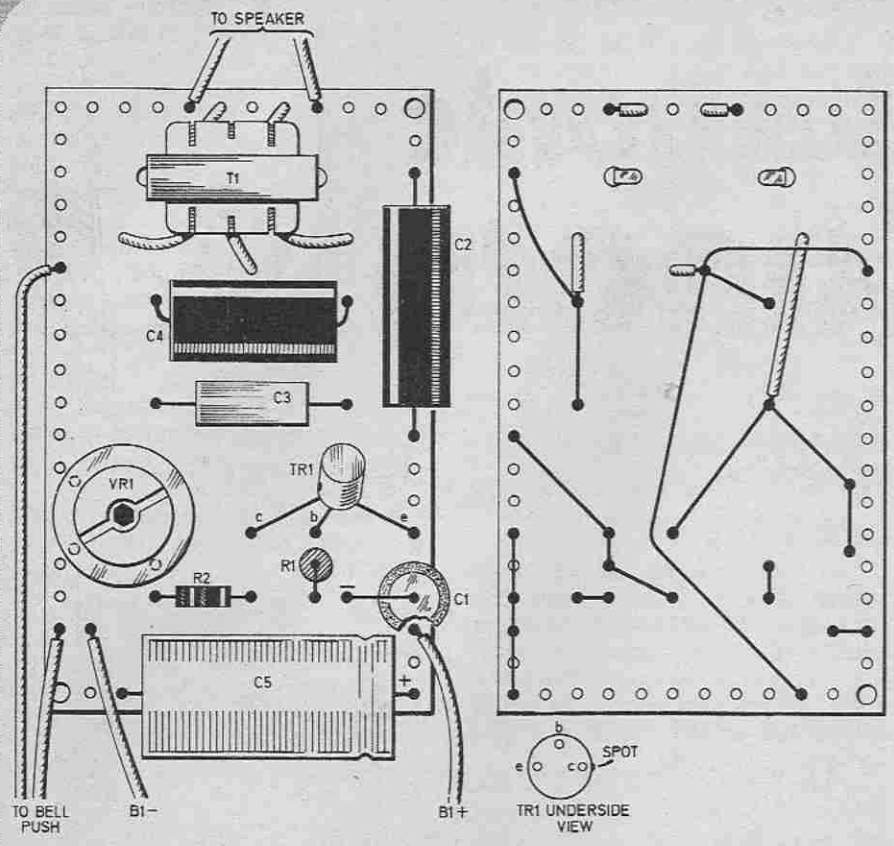


Fig. 2. Matrix board layout. The style of the preset may differ from that shown, but the connections will remain the same.

COMPONENTS

Resistors
R1 120Ω
R2 22kΩ
¼W carbon ± 10%

See Shop Talk page 333

Potentiometer
VR1 5kΩ miniature preset

Capacitors
C1 220μF 10V elect.
C2 0·047μF polyester
C3 0·1μF polyester
C4 0·22μF polyester
C5 1000μF 10V elect.

Semiconductor
TR1 AC142 germanium *pnp*

Miscellaneous
T1 Eagle LT700 audio output transformer
LS1 8Ω 60mm diameter or similar speaker
S1 single-pole push switch (door bell type)
B1 PP6 9V battery
Matrix board, 0·15 inch 19 × 12 holes; plastic or metal case —or—material for a home made case; aluminium for mounting brackets; connecting wire; battery clip to suit B1.

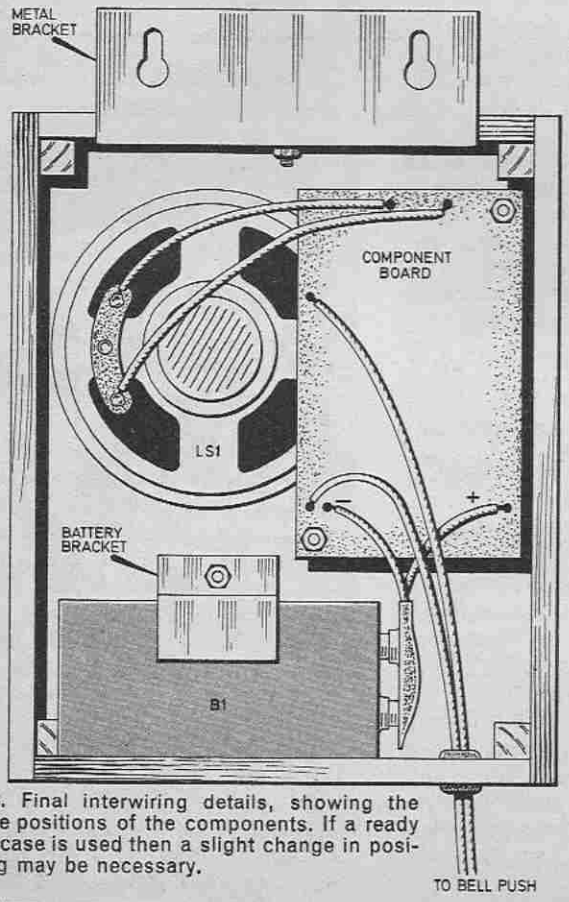
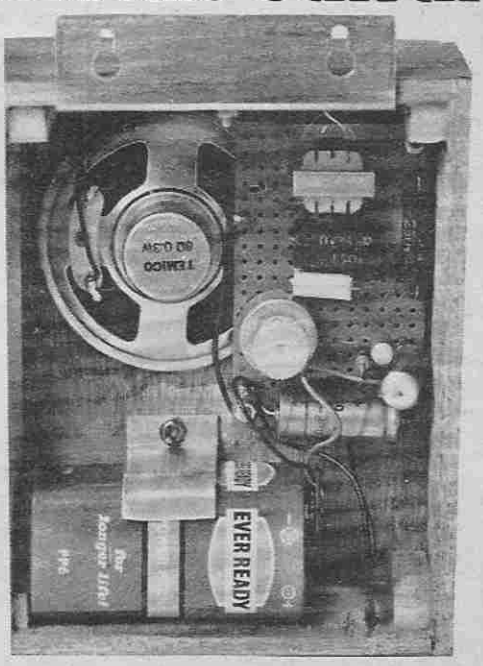
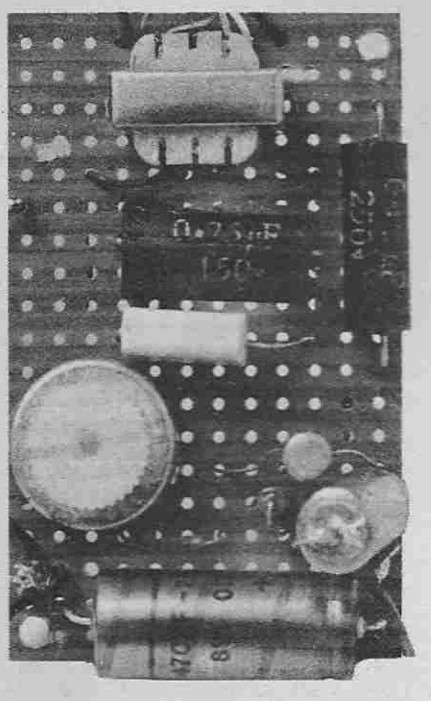


Fig. 3. Final interwiring details, showing the relative positions of the components. If a ready made case is used then a slight change in positioning may be necessary.

Electronic Canary



The completed Electronic Canary showing positioning of components. The preset potentiometer UR1 can be any common "skeleton" type.



Layout of components on the completed circuit board.

TR1. If the value is rather high, say over 27 kilohms, chirping is less strong. But if the resistor is too low in value, say under about 15 kilohms, only a continuous whistle is obtained. It is for this reason that VR1 is included.

Note the polarity for C1 and C5. Solder on the battery connector.

Two Veropins are inserted for the bell push connections.

Twin flexible bell wire runs from these two pins, through a small hole in the bottom of the case, and to the bell push.

CASE

A ready-made plastic or metal box can be used, or a case may be easily constructed from 6mm plywood as used on the prototype. The front panel is 145 x 115mm, the top and bottom edges 100 x 65mm and 100 x 38mm respectively. The sides are sloped from 65mm at the top to 38mm at the bottom, and are 145mm long. An aperture to match the speaker cone is first cut in the front.

The sections are secured together with woodworking adhesive. Four 10mm square or similar strips in the corners will give additional strength.

WIRING

The remainder of the wiring is shown in Fig. 3, and shows the connections to the board and other components. The mounting bracket can easily be made from 18 s.w.g. aluminium and is screwed to the top so the whole unit can be hung on a wall

A small bracket for holding the battery in place is required and can be made from the same aluminium. Alternatively a self-adhesive strip or Blu-Tak can be employed.

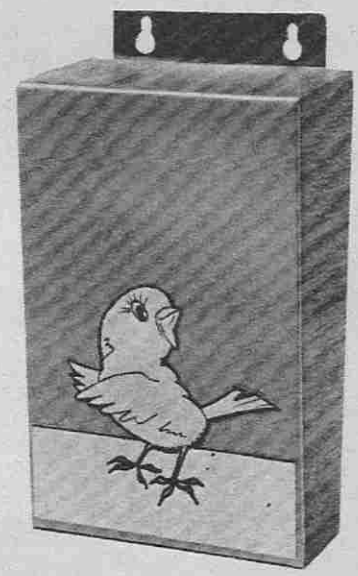
Place the circuit board as in Fig. 3 (speaker omitted) and drill through both board and case front for countersunk 6BA bolts. These are about 25mm long so that the board will clear the speaker when fitted with spacers or "spacing" nuts.

A piece of suitable material about 180 x 140mm is placed over the front and held taut with adhesive spread along the sides of the case. A strip of woodgrain or other self-adhesive material about 560mm long is fitted to cover sides of the case to improve appearance.

The bird motif was cut from a greetings card and various decorations of this kind would be in keeping with the unit. A bird outline could be cut from coloured paper for use here instead.

Once completed the unit can be installed in any convenient position. The sound produced is quite loud and should be heard over quite a distance.

Once fitted it will certainly add that touch of individuality to your front door! ⌑



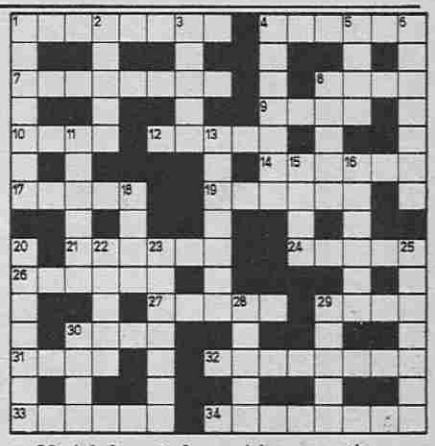
EE CROSSWORD No 16 BY D. P. NEWTON

ACROSS

1 Wiry and identical at the heart of it (4, 4).
4 Audible indicator due to electromagnetic action.
7 Wiry but like air.
8 Fine feathers for a set of clues.
9 Spacer.
10 Have a strong dislike.
12 Set of eight.
14 Puzzle variation.
17 Knee-deep in want.
19 Unlicensed radio station.
21 Base material.
24 Register a light garment of some calculators.
26 To charge up a battery in the generalised sense.
27 Necessary computing characteristic.
29 Horse-drawn carriages.
30 Patron Saint of sparks?
31 If you can't make these meet there's an open circuit.
32 Underground device for keeping the feline whiskers in trim?
33 A contract it LED for heading one of the nobility.
34 Tuneful set of calculator digits.

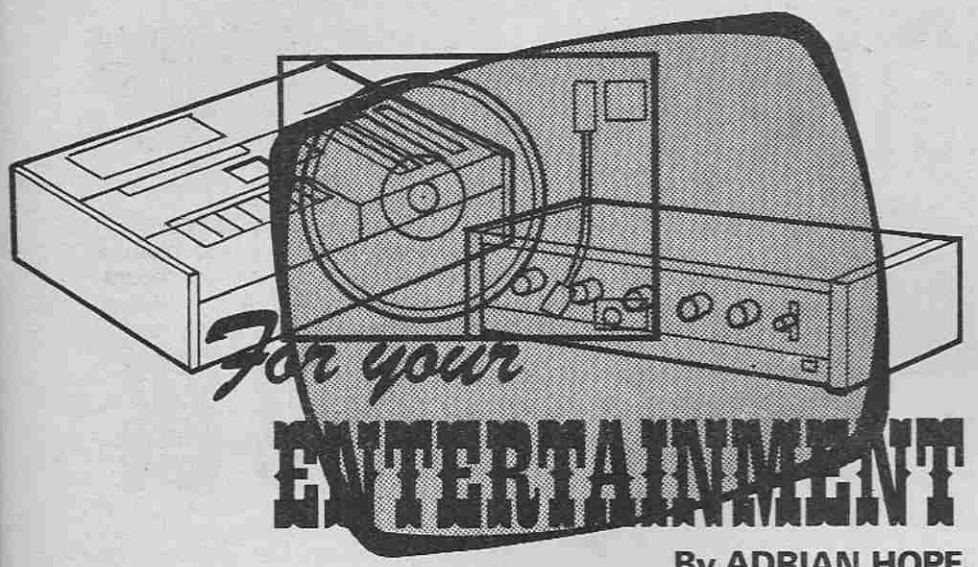
DOWN

1 An educational series (5, 2).
2 One is about a discord (Anag.).
3 Revered ancient object.
4 Amplifier, of a kind.
5 High-powered optical amplifier in a hurry.
6 Electrons getting out of hand, usually on a thermal basis.
8 It figures in a computer.
11 Entrusted with aerial defence from afar (3, 3).
13 Repetitive noise on coils.
15 A reverse span.
16 Spacecraft from a stellar twin.
18 Transforms a core with a burdensome device.
20 Throw an electronic task.
22 Found before storms.



23 Adulterated with another metal.
25 No sleep on this for the prototype (4, 3).
28 Not the object of the screen.
29 Lizard.
30 Cut a tape, but not to open a fete.

Solution on page 382



By ADRIAN HOPE

Sound Off

As far as I know there has never yet been a divorce action based solely on the grounds of over-loud hi fi. But disputes over home listening levels have certainly undermined many a state of marital bliss. The senario will be familiar to many a male; listening to a favourite piece of music he turns up the volume of the hi fi system and is berated with a "why must you play it so loud". Recently I chanced on some fascinating research work in the USA which explains why this should be.

Around 10 years ago the CBS laboratories in Stamford, Connecticut were commissioned to investigate modern methods of measuring the true loudness of sound. It's important to realise that there is a world of difference between volume level (as for instance) measured by a VU (volume unit) meter and subjective loudness.

In fact for a given VU meter reading, tones of different frequency may differ in loudness level by as much as 20 to 30dB. Likewise although a sound level meter can provide an accurate measure of energy in a sound field, there is still no agreement on how the meter circuits should be "weighted" or filtered to bring their electronic characteristics into conformity with the sensory characteristics of the human ear and brain.

There are also more subtle factors. For instance if two recordings are made at identical energy levels, one of someone shouting and the other of the same person speaking, the shout recording will always sound subjectively louder. CBS argue that this is probably because of the feeling of urgency in the shouting voice.

Recording engineers and broadcasters have long since recognized that it is possible to make an announcement, of solo voice or instrument sound artificially loud by doctoring its frequency characteristic. The Tamla Motown sound of a few years ago was achieved by packing as much energy as possible into every band of the frequency range; likewise radio commercials can be made artificially obtrusive by a similar technique.

Unfortunately existing sound level and VU meters may not show up such artificial loudness tricks and CBS was looking at new approaches to metering. For this research they asked teams of guinea pig listeners to compare the relative loudness of wide band signals. Some of the guinea pig teams were male and others female.

What CBS discovered to their surprise was that women hear high frequencies better than men. The maximum sensitivity in women being 4.5kHz and in men 3kHz.

This could well explain why women do object to loud hi fi sounds. Modern music has a very high energy content at around these levels, so it just sounds louder to women than men. And any distortion will be much more noticeable.

Quite *why* this should be is not entirely clear. Certainly the pitch of female speech is higher than male speech; but surely female ears should be equally well tuned to hearing both male and female sounds.

Miniature Chatter Box

"We ain't seen nothing yet", as Jolson once said. In the USA recently a life sized robot called Argon walked into a bar and freaked out staff and drinkers alike by proclaiming "It sure is cold outside, I need a scotch".

In the event it turned out that the exercise was part hoax, because although the robot walked well enough on its own, it wasn't talking on its own. The words were coming from a man outside the bar transmitting by radio to a receiver and amplifier inside the robot's head. But talking gadgetry is now a reality. There are two major developments in this area.

For years now audio engineers have been able to replicate human speech with reasonable intelligibility, by gating, filtering and modulating tones and hisses produced by generator circuits. But the circuits have been daunting in their complexity and Texas Instruments deserves the most hearty congratulations for now miniaturizing the essential elements into a package the size of a calculator. In fact the heart of the Texas speech synthesis package is a single MOS chip made in the same way as a calculator chip.

The details routinely released to the press by Texas in the UK so far have been very sparse, and written as if either the writer doesn't really understand how the system works or is a computer freak unable to speak plain English. Texas talk of LPC or linear predictive coding which appears to be a rather grand way of describing a filter which varies its parameters under fairly rough digital control to modify input signals so that acceptable analogue speech sounds result.

There are two forms of input signal, periodic or pitched and random noise.

The periodic input signals are used as the basis for vowels or voiced fricatives such as the sounds Z, B or D. The random input signal is used for unvoiced sounds such as S, F, T and SH. Two ROMS, each with the capacity to store enough digital instructions for 100 seconds of speech, control the filter action on the periodic and random inputs.

Translating Calculator

The inevitable next step will be to mate the voice synthesis chips with a fascinating new type of calculator which is being sold in the USA for around 200 dollars. These look like normal calculators, and perform all function calculations and metric conversions, but the calculator display is alpha-numeric; that is to say it reads off both numbers and letters. So a word punched into the keyboard comes up on the display.

Now here's the clever part. The calculator is designed to take plug-in memory modules, which contain well over a thousand words and phrases of a foreign language. With a French, Italian, German, Spanish or Japanese module plugged into the calculator a word or phrase punched into the keyboard in English will appear in the appropriate foreign language on the display.

A Russian translation module is planned in time for the 1980 Moscow Olympics and the logical, in fact inevitable, next step must be to couple speech synthesis with translation display. After all, most foreign phrases are quite worthless, unless you know how to pronounce them correctly.

DOING IT DIGITALLY

By O. N. Bishop

PART 9

THIS month we use TTL for solving a logical problem and making a game.

Jack Plug was browsing through his back numbers of EVERYDAY ELECTRONICS.

"It seems," he said, "that I have made everything except the *Roulette Game*, the *Power Supply*, the *Air Freshener*, and the *Hot Line Game*. What shall I make next?"

"The *Roulette Game* and the *Power Supply* are big projects", he added, "and I can't afford to make them both."

Jack's daughter was first off the mark.

"Please make at least one of the games", she begged.

Mother said, "*Hot Line* would be useful for my stall at the fête, but if you decide not to make that, then please make me the *Air Freshener* for the kitchen".

Jack's son said, "If you make one or both of the small projects for the home—I mean the *Air Freshener* or *Hot Line*—to be fair you should make the *Power Supply* for the workshop".

"Well I hope I can please everybody," said Jack, "for if I make the *Power Supply* I will not have time to make the *Air Freshener* too."

This set the family off again, each repeating their requests to Jack and to each other. But Jack strolled off and sat down quietly at the table. He began to connect together a few i.c.s. on his Test Bed. After a while an l.e.d. flashed.

"I've solved it", Jack exclaimed, "there is only one way of pleasing all of you—I'll make the . . .".

What project or projects did Jack decide to make?

LOGIC CIRCUIT LANGUAGE

This problem is not a difficult one and you can easily solve it on paper in a few minutes, but we will take it as an example of the way in which problems may be solved by logical i.c.s.

A computer or microprocessor system can be programmed to solve problems much more difficult than this one and to produce an error-free answer in a few minutes (or less), but we shall learn more by "doing it digitally" with a few simple i.c.s on the Test Bed.

First we need to set out the problem in a way that a logic circuit can understand. We need a set of symbols for the projects that Jack might make, or might not make:

If R stands for making the *Roulette Game*, P for the *Power Supply*, F for the *Air Freshener* and H for *Hot Line*, and if $\bar{R}$, $\bar{P}$, $\bar{F}$, and $\bar{H}$ stand for *not* making the project indicated, we can put the statements of Jack and his family in simpler form:

Jack (1st): not R and P (cannot afford to make both)

Daughter: R or H or both

Mother: If $\bar{H}$, then F

Son: If F or H, then P

Jack (2nd): If P, then $\bar{F}$

The next step is to sort out what logical relationships occur in these statements. To remind you of the main ones, see Table 9.1.

Table 9.1. Composite truth table.

Inputs A	B	Outputs AND	OR	NAND	NOR
0	0	0	0	1	1
0	1	0	1	1	0
1	0	0	1	1	0
1	1	1	1	0	0

In the input columns of Table 9.2, 0 means not make, that is to say $\bar{R}$ and $\bar{P}$ respectively. In the output column, 0 means false, i.e. not consistent with Jack's statement. Conversely, 1 means true, i.e. consistent with his statement. From this we can see that the only action that is inconsistent with his statement is to make both P and R—which is precisely what he said he would not do.

Table 9.2. The first condition in truth table form.

Inputs R	P	Output
0	0	1
0	1	1
1	0	1
1	1	0

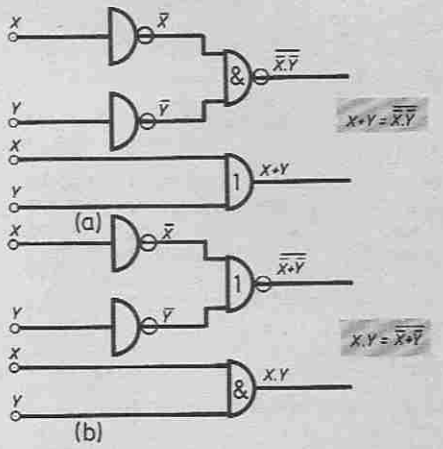


Fig. 9.1. Using basic logic gates to illustrate De Morgan's Laws.

The sequence of outputs shows that this is a truth table for the NAND of P and R. A NAND gate will give electronic form to this statement. In symbolic form we write the statement: $\overline{R.P}$.

The full-stop signifies the operation AND; the line above signifies NOT; combined they indicate AND followed by NOT, which we usually refer to as NAND, or negative AND.

Daughter's statement is obviously an OR, and can be written: $R+H$. The "+" sign signifies the OR operation.

Mother's statement is less obvious, but if you set out the possibilities in a truth table you will recognise that the relationship is OR (remember that Mother does not say what she wants Jack to do about making F if he does make H). We write mother's statement as: $F+H$.

By writing a truth table for Jack's second statement we find that this reduces to a NAND, giving us $\overline{P.F}$.

The son's statement is a little more difficult to analyse, as it has three terms in it. We can try re-wording it.

If Jack makes P, his son will certainly be satisfied. But if Jack does not make P then he must not make F and not make H. In short, make P or not F and not H. In symbols this is written: $P+\overline{F.H}$.

To suit all the family we have to find a solution Z consistent with every one of the separate statements. We AND all the statements together:

$$Z=\overline{R.P}.(R+H).(H+F).(P+\overline{F.H}).\overline{P.F}$$

Three more lines of Boolean algebra would reduce this equation to its final solution but let us make the i.c.s. take over the work for us, as explained below.

DE MORGAN'S LAW

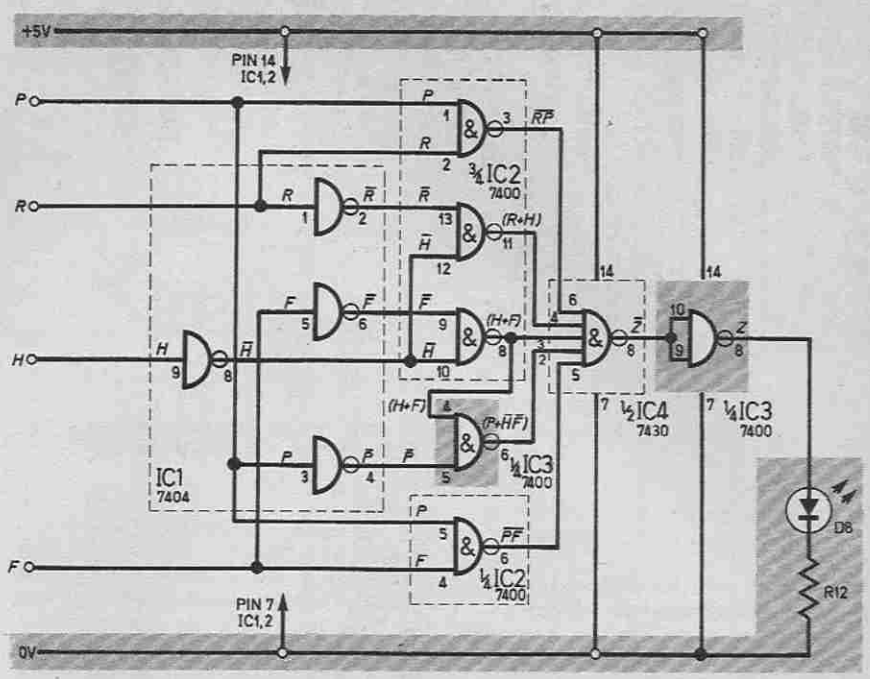
The equation for Z contains a number of ORs and ANDs yet most of our i.c.s contain NORs and NANDs. To convert from ORs and ANDs to NORs and NANDs we make use of two simple equations:

$$X+Y=\overline{\overline{X}.\overline{Y}}$$

$$X.Y=\overline{\overline{X}+\overline{Y}}$$

In words—to OR two (or more) quantities, invert them, then NAND them; to AND two (or more) quantities, invert them, then NOR them. There is no space here to prove these two equations, but you can check that they really do work by wiring up the circuits shown in Fig. 9.1.

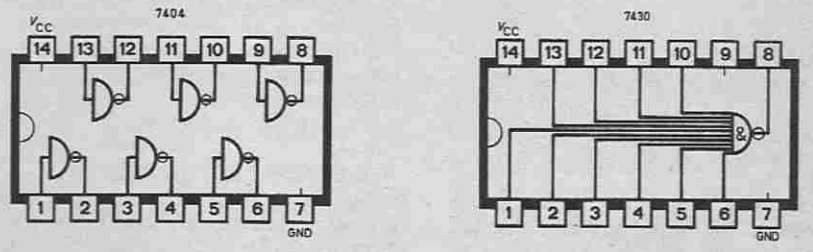
Using the upper equation we can see that the daughter's and mother's statements can be re-written as $\overline{\overline{R}.\overline{H}}$ (the NAND of the inverted R and H) and $\overline{\overline{H}.\overline{F}}$ respectively. Then we can notice that the son's statement can be rewritten as the NAND of the inverted P and the inverted mother's statement. Now we are ready to turn this into a TTL circuit.



TTL SOLUTION

The realisation of these conditions in terms of logic gates appears in Fig. 9.2a and built up on the Test-Bed in Fig. 9.2b. The circuit has four inputs, R, P, F and H and only one output, Z.

Fig. 9.2a. Circuit diagram for solving Jack Plug's project building problem. Below shows pinning details for two of the i.c.s used.



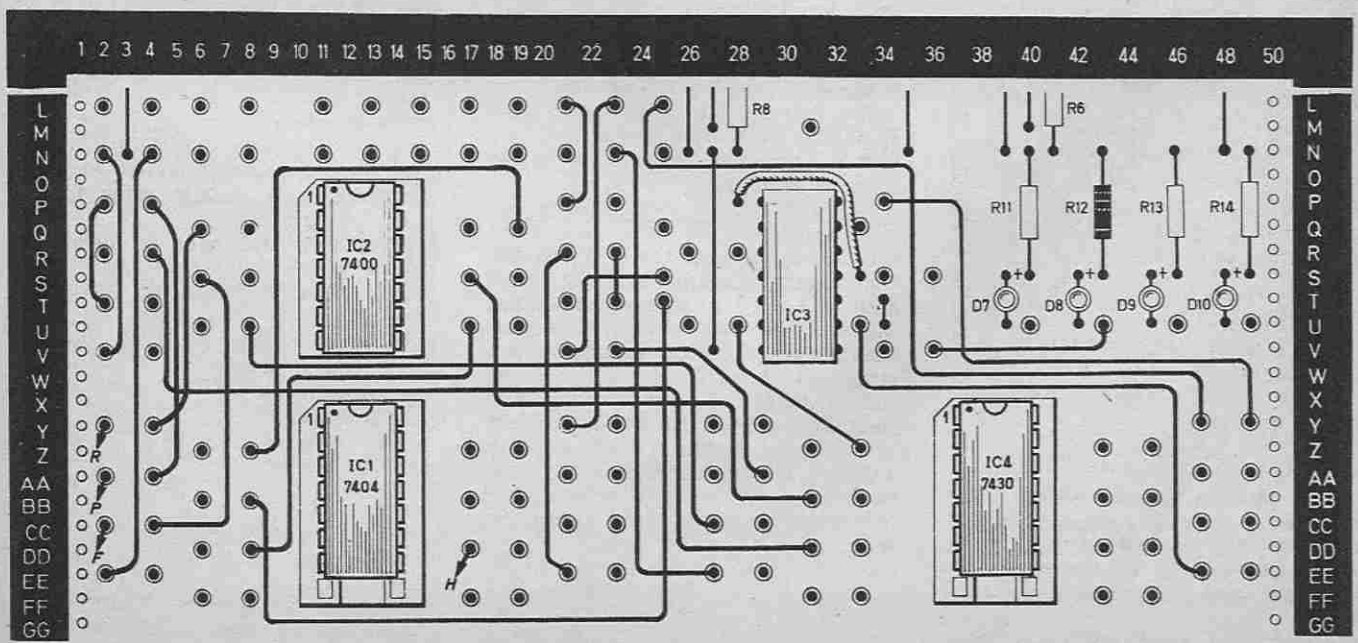


Fig. 9.2b. The circuit of Fig. 9.2a built up on the Test-Bed.

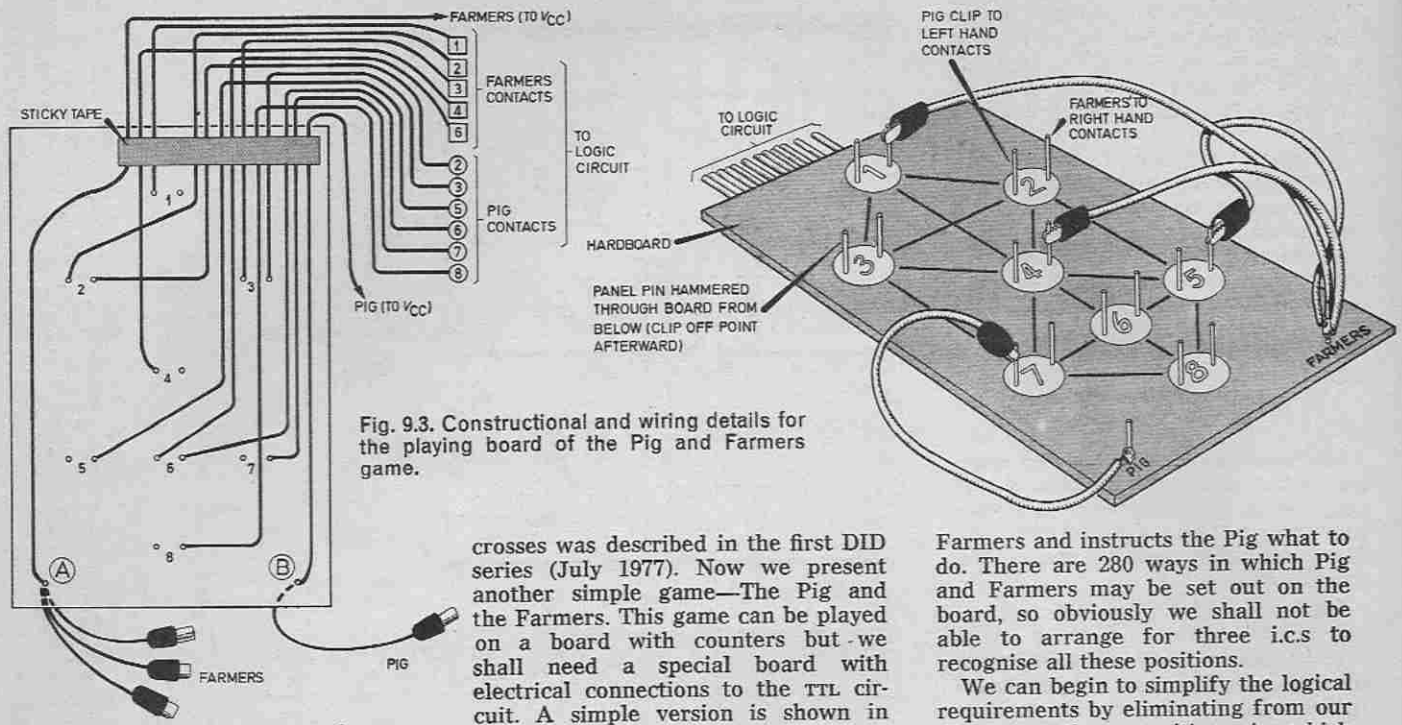


Fig. 9.3. Constructional and wiring details for the playing board of the Pig and Farmers game.

There are five NAND gates each corresponding to one of the statements, and each fed by two inputs either direct or inverted.

The son's NAND receives one of its inputs from the output of the mother's NAND. The five NAND outputs are all ANDed (to please everybody) by using a five-input NAND followed by an INVERT gate. Actually we have to use an eight-input NAND (the 7430) and let the three unused inputs float "high" (logic 1).

To find out which solutions (if any) are possible we need to apply all possible combinations of high and low inputs to the circuit. To do this systematically we can apply a four-digit binary count, from 0000 (build nothing) to 1111 (build all). Any set of inputs which causes the l.e.d. to light indicates a combination of projects that satisfies all the requests of Jack and his family. If the l.e.d. never lights, there is no way of satisfying everybody.

The keyboard coder (Figs. 5.4 and 5.5) is useful for providing the binary inputs 0000 to 1001 (0 to 9 decimal); simply operate keys 0 to 9 in turn. To obtain inputs from 1010 to 1111, hold key 8 down and press keys 2 to 7 in turn. Try it and find out what Jack decided to build.

PLAYING GAMES

If you want to play Chess against a logical circuit you will have to spend more than £100 on a microprocessor-based system. To learn a little about how logic circuits can be used for playing certain kinds of game, we must be content to analyse one of the more simple games.

A circuit that plays noughts-and-crosses was described in the first DID series (July 1977). Now we present another simple game—The Pig and the Farmers. This game can be played on a board with counters but we shall need a special board with electrical connections to the TTL circuit. A simple version is shown in Fig. 9.3.

When the Pig or a Farmer is to occupy a certain position on the board, the corresponding crocodile clip is attached to the appropriate contact. Note that there are two contacts at each position—one for the Pig and one for a Farmer. This makes the logic simpler. Pig and a Farmer may not occupy a contact at the same position at any time.

RULES OF THE GAME

The three farmers begin at the positions marked 1 to 3, the Pig begins at any one of the positions marked 5 to 8. The Pig moves first and may move in any direction along one of the lines to the next contact along that line.

The Farmers move (one each turn) along the lines from contact to contact, but may not move backward. No jumping is allowed.

The Pig (which is played by the logic circuit) is aiming to move from his end of the board to the opposite end. If he reaches one of the contacts marked 1 to 3 he wins, scoring one point: if he reaches that at the extreme end, (No. 1), he scores two points.

The aim of the Farmers (played by you) is to corner the Pig at his end of the board, in which event you win a point. If the Pig is able to move backward and forward between the two same contacts three times, he wins.

ANALYSING THE GAME

The logic circuit is designed so that it recognises the positions of the Farmers and instructs the Pig what to do. There are 280 ways in which Pig and Farmers may be set out on the board, so obviously we shall not be able to arrange for three i.c.s to recognise all these positions.

We can begin to simplify the logical requirements by eliminating from our discussion those positions in which (a) Pig is trapped and has no move available and (b) Pig has only one contact available to move to. We can also eliminate those positions in which Pig has choice but among these choices is free to move in a forward direction. In general Pig should always take a forward move if this is open, so we can make this a "standing instruction to Pig". Also in the rare cases where Pig has no forward or sideways move available he can take any backward move. Thus the standing instructions to the person moving the Pig are:

(1) If you have no move available—stay put—you have probably lost.

(2) If you have only one move available—take it.

(3) If you have a forward move available—take it.

(4) If you have no forward or sideways moves available—move back.

(5) If none of the above instructions apply, refer to the logic circuit.

This leaves to the logic circuit the task of deciding what to do when the

Table 9.3. Required logic positions for Pig/Farmers game.

Pig on	Farmers on*	Pig should move
8	2 and 6	left (to 7)
8	3 and 6	right (to 5)
7	3 and 4	right (to 6)
6	2 and 4	left (to 7)
6	3 and 4	right (to 5)
5	2 and 4	left (to 6)
3	1	right (to 2)
2	1	left (to 3)

* only two farmers matter; the position of the third farmer, if it is important, is taken care of by applying the standing instructions.

Pig has a choice of sideways moves. There are only a few such positions, which is why it is possible to cover the logic required using only the three i.c.s that can be accommodated on the Test Bed. The positions in which logic is required are listed in Table 9.3.

From this table we can see that the circuit needs six inputs to describe the position of the Pig, and five inputs to describe the position of the Farmers. It needs two outputs, one to indicate "move left", the other to indicate "move right".

Certain combinations of positions occur twice in the table, see Table 9.4.

Table 9.4.

Pig on	Farmers on
8	6
—	3 and 4
—	2 and 4

We can make use of this fact to simplify the gate connections. These pairs of inputs can be ANDed and each used as a single input at later stages in the logic.

AND-OR-NOT GATE

There is a combination of gates in one i.c. that will solve the logical problems of playing Pig and Farmers, the 7454. The pin-out details are shown in Fig. 9.5. It has eight inputs and one output. The output is normally high, but goes low when the following inputs go high:

A AND *B* OR *C* AND *D* OR *E* AND *F* OR *G* AND *H* OR any two or more pairs of inputs listed above.

In short, the inputs are ANDed in pairs, the AND outputs are all ORed, and the OR output is inverted (NOT), so giving this combination of gates its rather lengthy name; Fig. 9·4(a) shows

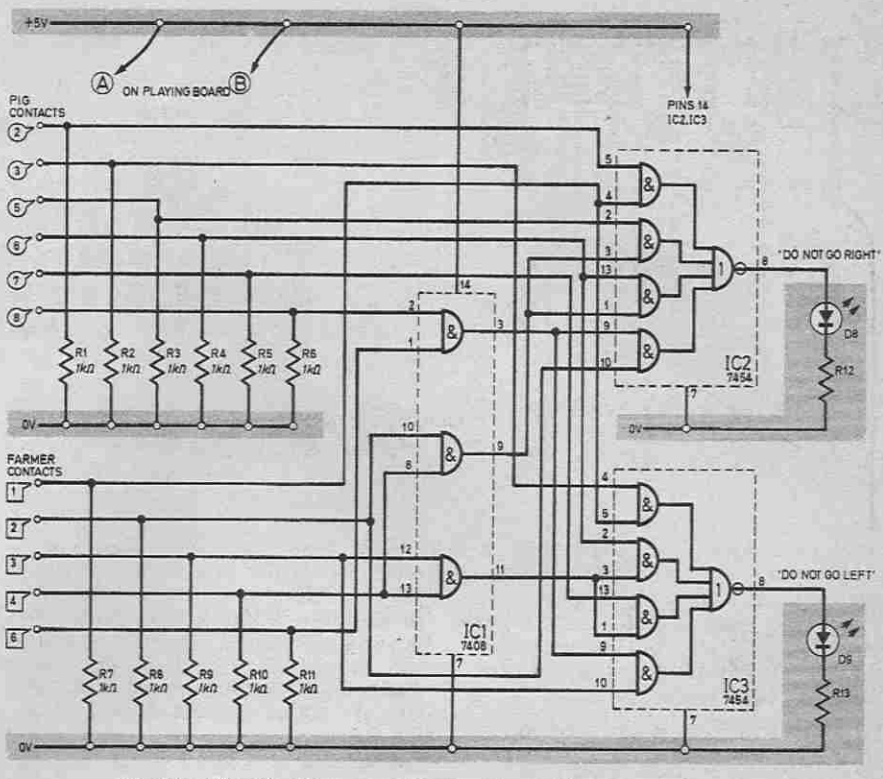


Fig. 9.4a. The circuit diagram for the Pig and Farmers game.

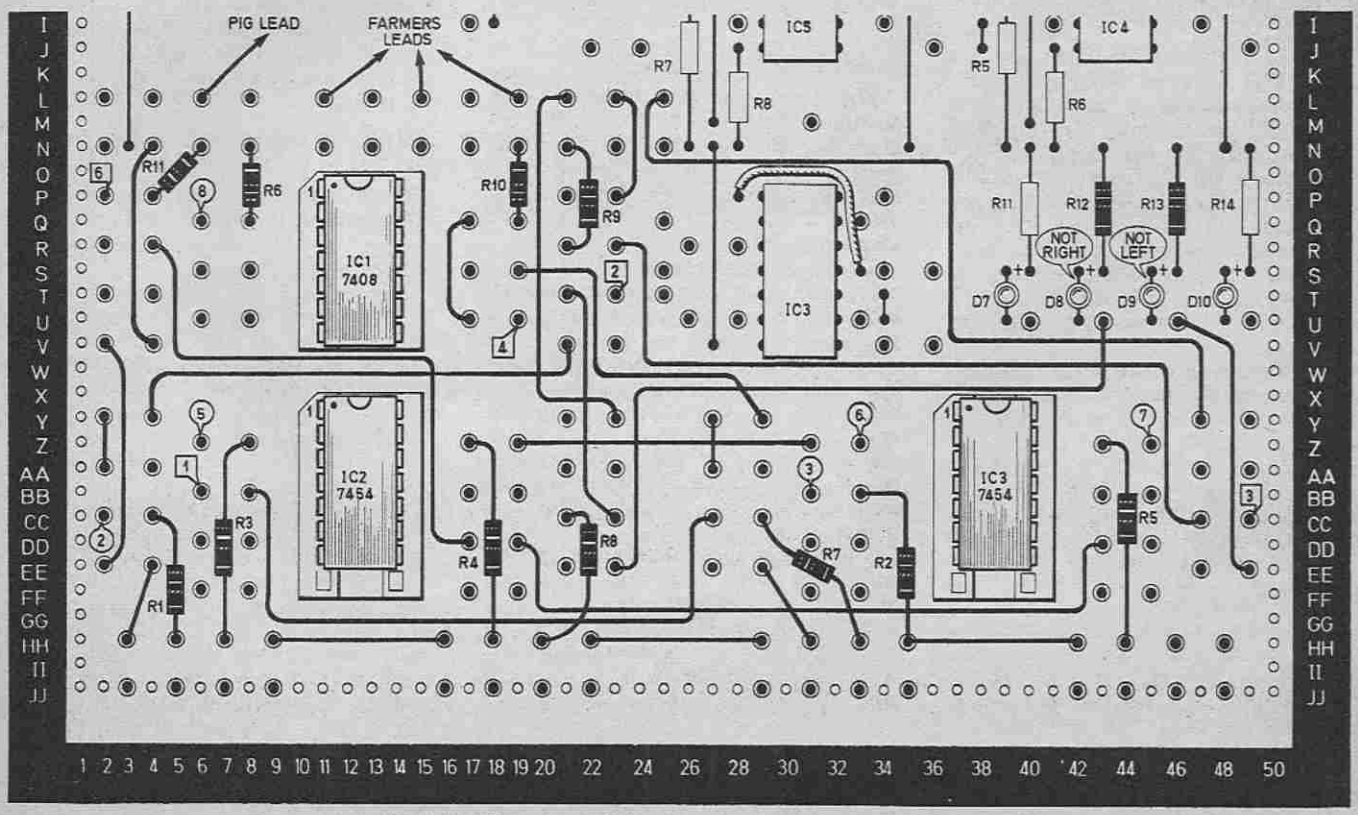


Fig. 9.4b. The circuit of Fig. 9.4a wired up on the Test-Bed.

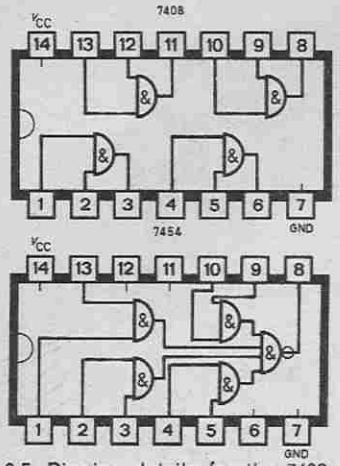


Fig. 9.5. Pinning details for the 7408 and 7454 logic i.c.s.

how we use it in the game.

The AND-OR-NOT gate needs high inputs to activate it, and most of these come directly from the contacts on the playing board. The contacts are normally held low by the grounded resistors, R1-R11, but any given input becomes high when contacted by a Pig or Farmer occupying that position on the board. To obtain the combinations of positions listed in the previous section, we use three AND gates in a 7408 i.c. (pin out details in Fig. 9.5). The complete layout of the logic circuit on the Test Bed is given in Fig. 9.4(b).

When both members of any pair of inputs of the 7454 is made high, the output goes low and the l.e.d. is extinguished. Thus the normal state is for both l.e.d.s to be lit, and this is to be interpreted as a red warning "do not go left or right, but keep straight on if possible". If one l.e.d. goes out, this is interpreted as advice to move to that side, and a warning not to go to the opposite side.

COMPUTER GAMES

The Pig and Farmer circuit is designed for that game and for no other. The circuit has fixed wiring so connected as to maximise the Pig's chance of victory. The wiring is in effect part of the programming.

Note also that *immediately* contacts are made, the circuit indicates the recommended move (ignoring propagation delays in the gates). This scheme is different from that found in most computer games. The computer and microprocessor are extremely complex *general-purpose* logic circuits, not dedicated to any particular game.

The logic of the game exists not in the way gates are connected together, but in the program stored in memory. A memory programmed to play Pig and Farmers would instruct the microprocessor to scan the contacts regularly and very frequently to find out and record which positions were occupied. The program would then cause the inputs from occupied positions to be ANDed, and the resulting outputs ORed, then inverted. But the difference is that in our circuit we have an AND gate an OR gate and an INVERT gate *for each logical operation.*

In the microprocessor or computer the ANDing and other logical operations are all done by one special part of the device, the arithmetic and logic unit (ALU) which is used over and over again for each operation. Results of one operation are stored temporarily in memory, and recalled for the next operation. Thus analysis of the state of play involves a sequence of operations and at the end of perhaps a hundred steps the final output is used to control the indicator l.e.d.s.

Although microprocessors are very much in fashion these days, there are still many instances when their great flexibility and versatility are of no particular advantage, and the logical operations can be more cheaply and directly performed by a few simple logic i.c.s.

To be continued

Talking recently to the managing director of one well-established purveyor of electronic components, he reminded me of the Credit, Deposit Account Scheme which he started some twelve years ago. The scheme is so good, that I think it deserves to be more widely known. Let me just say a brief word about it.

It had always been the directors dream, to provide facilities where it was possible for any customer to pick the phone up and say to their supplier "Please send ten of your XYZ capacitors" and get them, perhaps the next day. The problem he had to solve was this: he could not open up accounts for all and sundry, without the time consuming and irritating process of taking up references, for obvious reasons.

He finally solved it in a quite ingenious way. He laid down that the customer made a deposit for half the amount of credit he required, that is to say, if he wanted £10 credit, he deposited £5, and this obviated the need for any references, he just signed a simple form and he, (the customer) was in business. To make the scheme more attractive he supplied all account customers with prepaid envelopes.

He even went to the lengths of promoting an advertising campaign, called "Shopper A" and "Shopper B". Shopper "A" trudging from shop to shop, and likely to die of exposure and shopper "B", by the fire, with his feet up, buttered toast in one hand and the telephone in the other, completing the same exercise in comfort. He tells me that he has over 1200 customers who use this method of purchase and he is surprised that the idea has not been adopted by other component retailers. With a scheme like that, who needs a counter service.

When I was a humble service engineer, my wages were such that I never expected to own anything more luxurious than a second hand push bike. Today, if the charges are anything to go by, I would expect a service engineer to call on me in a chaffeur driven Rolls. This was forcibly brought to my attention the other day when one of our electronic calculators went wrong.

As it will do almost any calculation and give you a print out, it is invaluable and I was anxious to get it back into service as soon as possible. I telephoned to the makers, who asked "Have you a maintenance contract?" When I answered in the negative, they informed me that their terms are £21 for the first half hour and £12 for each subsequent half hour.

It seemed to me that the minimum bill would be £33. If these charges cannot be justified, and I am sure they cannot, one wonders if it is done to encourage customers to buy a new machine. Perhaps the manufacturers argue if it lasts too long, then they will not, so let's kill it off by making repair charges impossibly high.

I am reminded of course of one of the first electric light bulbs, made 75 years ago and still working in a Chicago Fire Station. The company, sad to report went bankrupt. To me, the moral of the story, is not that they should have made a less durable lamp, but, that they needed better communication. Just imagine a company today advertising a product that would last a lifetime, customers would fight to buy it and the company's factories would be working 24 hours a day for years to meet the demand.

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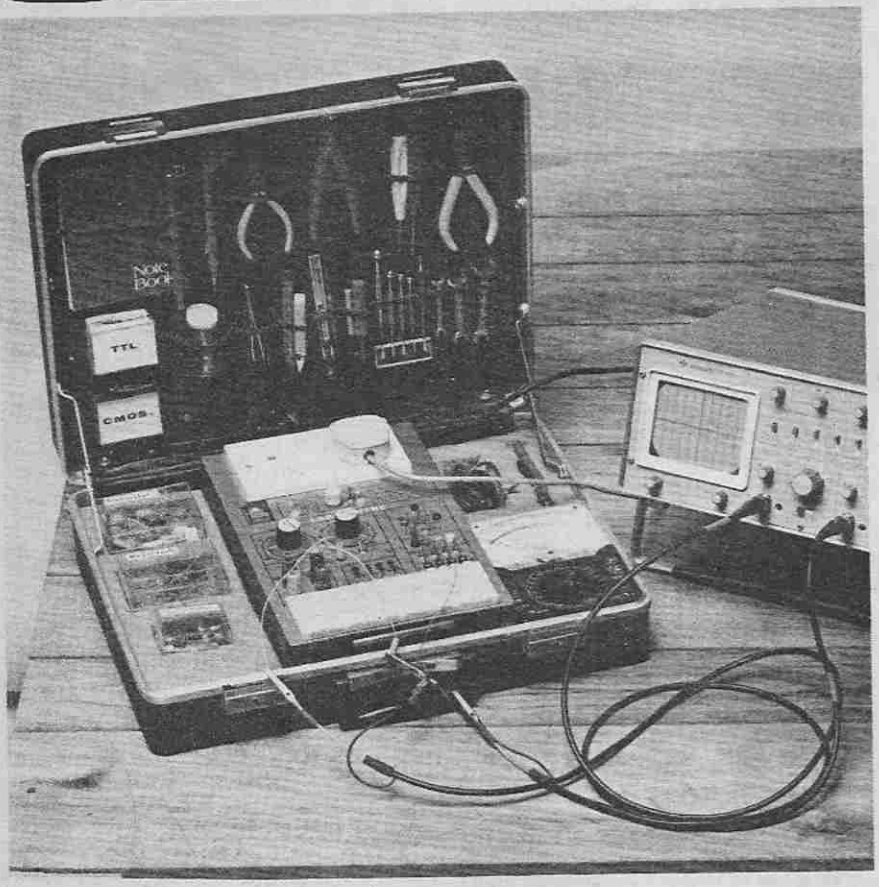


PART 4

By R. W. Coles and B. Cullen

WITH the construction of Labcentre completed we can now move on to testing the various facilities which the system offers, and to the important task of setting up the function generator.

Most of the testing is straightforward and can be carried out using the other Labcentre circuits and a simple multimeter. The function generator is rather different because there are five potentiometers which can be used to coax the maximum performance from the circuit, and these must be adjusted with care to achieve the very best results.

Ideally, the setting up of the function generator should be carried out with the aid of an oscilloscope, but many constructors will not have access to an oscilloscope, and so a simplified setting up procedure has been produced which will provide adequate results for most purposes.

A supply of jumper leads with 2mm plugs at each end should be made up to facilitate testing. These should be made up on several colours to avoid confusion, and will also be found useful during the use of Labcentre for experiments at a later date.

TESTING LABCENTRE

If all wiring has been completed and thoroughly checked, a three-pin plug fitted with a 2 amp fuse can be fitted to the end of the mains cable and the power turned on. First, the 13 amp distribution sockets can be checked by plugging in an appliance such as a table lamp and turning it on with the switches mounted adjacent to the sockets.

Please note that this is *not* a safety check, merely a final operational check. It is vital that the wiring to these sockets should have been very carefully checked before final assembly. A proper safety check can be carried out at this stage with the aid of a "Tester-Plug", of which there are several examples now available from electrical shops.

If the sockets are operational, the mains on/off switch can be set to on, at which point the neon-lamp within the rocker switch should illuminate to show that the mains supplies are now available to the Labcentre power supply circuits.

Using a multimeter set to an appropriate d.c. voltage range, the +5 volts +15 volt −15 volt supplies can now be checked at the front panel screw terminals, SK1 to SK4. Remember to check not only that the correct voltages are available, but also that they are wired up to the correct terminal, (+5V to yellow, +15V to red, −15V to black and 0V to green).

A further check of correct power supply operation can be carried out by shorting each supply in turn to the 0V terminal using the multimeter set to a 5 amp or greater d.c. current range. This test ensures that the current limiting circuitry within the regulator i.c.s is operating correctly.

Do not maintain the meter connections for more than a few seconds, as this could cause the regulators to get quite hot. If you wish to omit this test due to pure cowardice, you have my fullest sympathy! If, however, you do carry it out, the actual currents measured will vary depending on the type of regulators you have used.

Typically the 5V supply will limit at about 1 amp, and the 15V supplies will limit at about 750mA. The precise current is unimportant, but it is wise to recheck the voltages to make sure they have returned to their operational levels when the short circuit test has been completed.

PUSH BUTTON PULSER

With complete confidence in the power supply circuitry now established, it is time to move on to the logic circuitry.

Set the CMOS/TTL switch to TTL and connect a multimeter set to the 20 volt range between the Q output of the push-button pulser and 0 volts. A reading of 0 volts should be obtained which changes to +5 volts when the button is depressed and back to 0 volts when released. Transfer the positive meter lead to the $\overline{Q}$ output and check that it behaves in the opposite way to the Q output.

Now switch the CMOS/TTL switch to CMOS and recheck the pulser outputs.

This time they should swing between 0 volts and 15 volts as the button is operated. Switch back to TTL and connect the Q output to each of the l.e.d. inputs in turn using a jumper lead. Operation of the button should cause each l.e.d. to blink on and off. Try this again with the switch in the CMOS position, there should be no difference in l.e.d. operation.

Also, to test the four switches, you can wire one input of each uncommitted switch to the +5 volt supply and connect jumper leads from the other inputs to the l.e.d.s. Operation of each switch should control the appropriate l.e.d.

FUNCTION GENERATOR

The function generator has to be set-up as well as tested, and this means that access to the five preset potentiometers and the circuit board will be required. The function of these presets is shown in Table 4.1.

With the circuit board accessible all five preset potentiometers should be set to mid travel (note that VR1 and VR3 are multi-turn components), before power is applied.

If no oscilloscope is available, access to the front panel will also be necessary so that the l.e.d.s and other facilities can be used to advantage to aid with the setting up process.

LOW FREQUENCY

Connect the f and $f/8$ outputs of the clock divider to convenient l.e.d.s using jumper leads, and set the function generator range switch to x10 and the frequency control to the counter-clockwise position. With these control settings the function generator frequency is required to be about 10Hz, and therefore the output of the $f/8$ divider stage will be about 1·25Hz.

This is a low enough frequency to be directly observed on the l.e.d. and so the setting up procedure can begin with the adjustment of VR3 until an l.e.d. on period of about half a second is observed. With the low frequency roughly set, VR4 can be adjusted to obtain equal on and off times on the l.e.d. connected to the f divider output. This will be quite difficult to judge unfortunately, although it is worth spending some time to try to get it right because VR4 controls the half cycle duration ratio or "symmetry" of the sine and triangular waveforms as well as that of the square output.

If you do find this is too difficult to judge at the normal 10Hz low frequency limit, try readjusting VR3 to get the very lowest frequency at which the 8038 still oscillates before adjusting VR4 for equal on and off times. But remember you must watch the f output, not the $f/8$, which will always have a symmetrical output due to the action of the binary counter stages.

When you are satisfied with the on-to-off ratios of the f waveform, readjust VR3 while watching the $f/8$ l.e.d. to set the lowest frequency to about 10Hz; l.e.d. on periods of from a half to 1 second will be quite satisfactory in view of the lack of precise dial calibration. The Labcentre function generator is not, after all, meant to provide an absolute calibration standard, but can claim to be a flexible tool for experimentation and design.

With the low frequency setting of the function generator completed the other divider outputs of $f/2$ and $f/4$ can be checked out by connecting them in turn (or at the same time) to the l.e.d.s on the front panel.

When this has been carried out, the jumper leads can be removed from the dividers, the function generator "triangle/sine" S2 switch should be set to "sine" and the output voltage control should be set about one quarter clockwise, in readiness for the setting of the high frequency preset.

CAUTION!

Removal of the front panel exposes dangerous mains voltages. It is essential that power is turned off at the wall switch before removal, and that every precaution is taken to avoid contact with the mains wiring while adjustments are being made with the power applied. Failure to observe these precautions could result in electrocution.

HIGH FREQUENCY

Without the aid of an oscilloscope or frequency counter, the high frequency setting will have to be done by ear, and for this the audio amplifier is needed.

Set the function generator frequency dial (VR2) fully clockwise and connect a jumper from the red output socket (SK5) to the blue audio amplifier input socket SK13. (No earth connection is required.)

Turn the loudspeaker switch to the "on" position whereupon an audio tone should be heard from the speaker. Reduce the volume to a comfortable level using either the amplifier volume control or the function generator output level control and then adjust the VR1 preset to achieve a tone frequency of about 1kHz.

Most people can judge a 1kHz tone frequency fairly accurately, it being the *brrr* . . . and below the *seee* . . . in about the *wheee* . . . area! Those with musical inclinations will no doubt be able to use their skills (and their instruments) to good effect to facilitate the more accurate setting of this preset control.

Table 4.1. Preset Functions

Potentiometer	Function
VR1	Set high frequency
VR3	Set low frequency
VR4	Set mark/space symmetry
VR5	Set sine shape (+ve)
VR6	Set sine shape (−ve)

The setting-up process described above also takes care of the x1000 range, although of course the absolute frequencies achieved will depend upon the value of the capacitor C15.

The last two presets to be adjusted are VR5 and VR6 which control the action of the sine control and the action of the sine converter in the 8038.

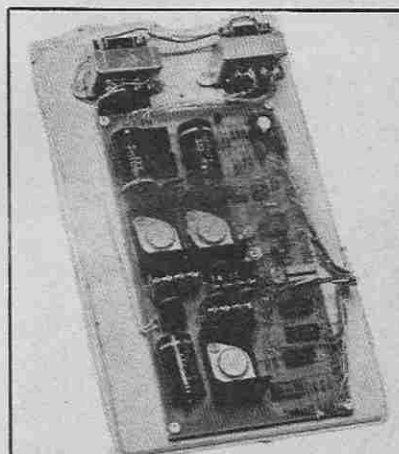
The sine converter, you may remember, "whittles away" sharp corners of the trangular waveform which is produced across the capacitors C14 and C15 to produce a very good approximation to a sine waveform. The positive and negative half cycles of the sine waveform are tailored by individual transistor "trees", and the presets VR5 and VR6 are provided so that each half cycle can be separately adjusted.

Adjusting these presets for the best sine shape is difficult without an oscilloscope, but fortunately the range of adjustment is not large, and if you are unable to detect any difference by ear, the skeleton pots can be set to mid travel and left there.

With the function generator now set up, the Labcentre console is now ready for use and so the mains power can be turned off at the wall switch and the system reassembled.

FINISHING THE JOB

If you plan to invest in a briefcase for your Labcentre system, then you will no doubt wish to achieve a really professional looking finish. Careful attention to detail at this stage will allow you to produce a portable laboratory which is not only extremely



The completed component board fitted to console base removed for setting up.

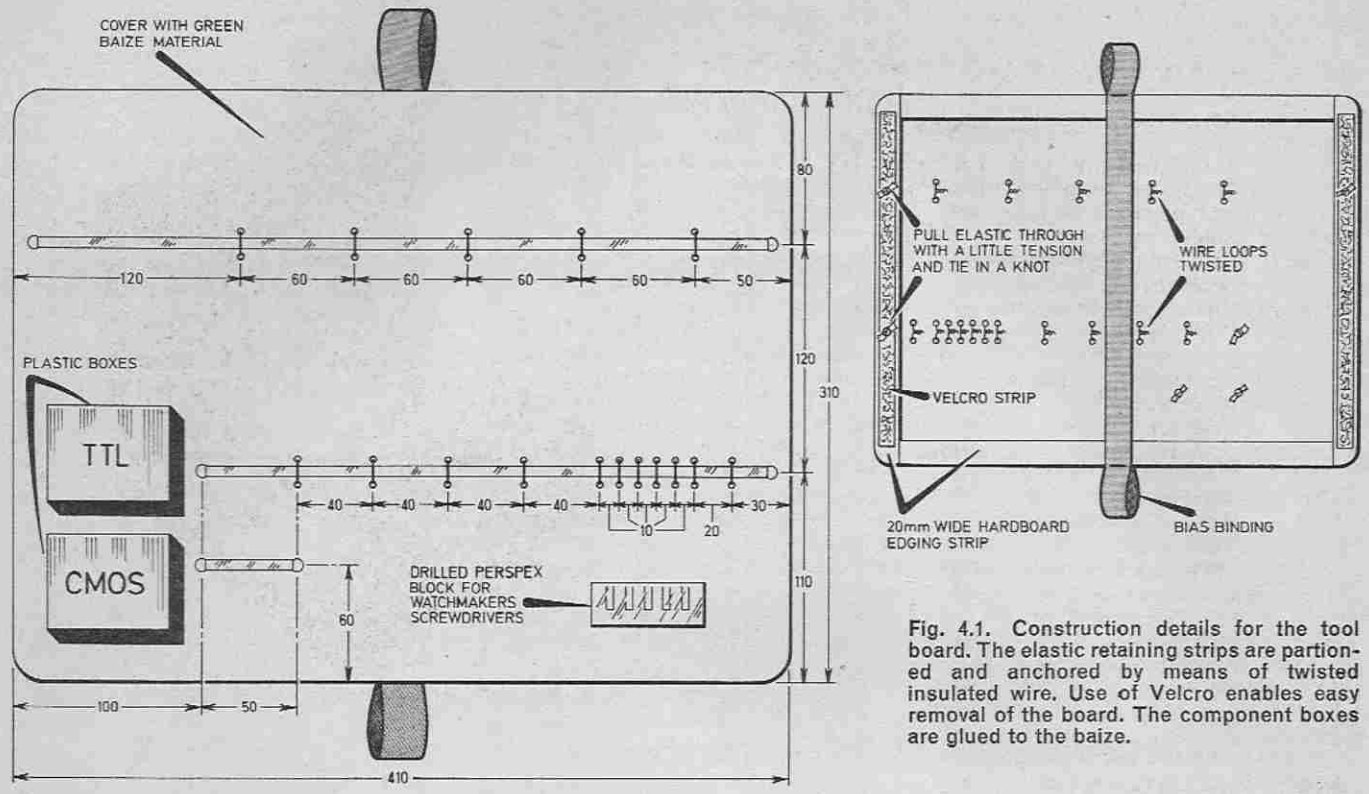


Fig. 4.1. Construction details for the tool board. The elastic retaining strips are partioned and anchored by means of twisted insulated wire. Use of Velcro enables easy removal of the board. The component boxes are glued to the baize.

practical, but also attractive enough to be the envy of all your friends!

After fitting the console, it is necessary to take stock of what other items need to be carried in the Labcentre case. The most useful accessory is an analogue multimeter, and no doubt many constructors will already possess one of these. Those who haven't will find the small investment well worth it.

Other items which you may wish to use include: a logic probe, a signal injector or tracer, a digital multimeter or counter and perhaps even a calculator for those tricky design calculations!

When you have decided just what other test instruments are to go into the Labcentre case you should obtain a quantity of polyurethane foam and fit it around the central console using a hobby knife or razor blade to trim it to shape.

Cut-outs for the various accessories can also be made by careful application of the blade, and delicate items can also be given a foam "lid" to ensure their protection during the possible rough and tumble of the Labcentre existence.

In the prototype, the only extra equipment added was a multimeter, but a quantity of small plastic boxes were obtained and used to house components such as resistors, capacitors and semiconductors.

TOOL BOARD

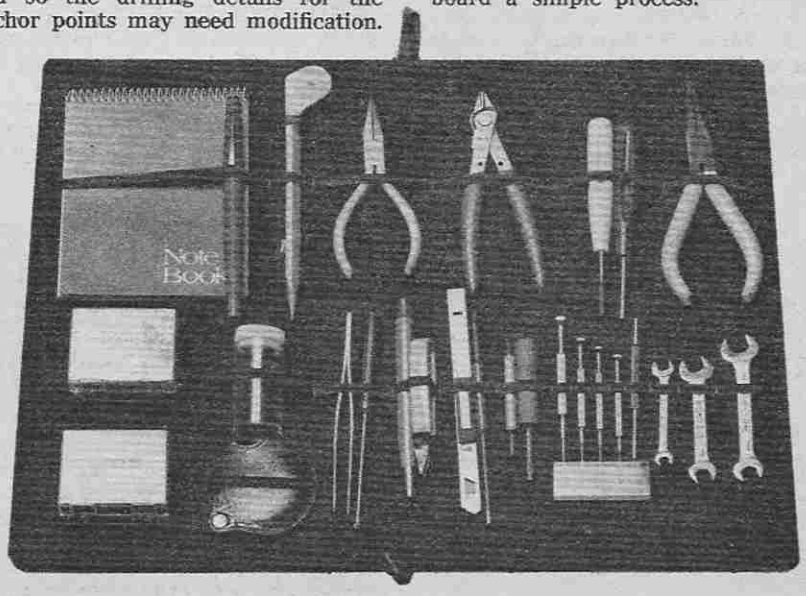
The final touch, and a very important one, is the tool board which fits in the lid of the case. The owners of the prototype wanted to be able to remove the tool board and so it was mounted using Velcro strips. This allows the briefcase to be used for other purposes when necessary, and it can be useful to be able to move the tool board to the workbench when a constructional session is in full swing.

The construction of the toolboard is detailed in Fig. 4.1. The exact size may need to be changed to fit your own particular case design, and of course, everyone will have their own ideas about what tools are needed and so the drilling details for the anchor points may need modification.

The hardboard can be cut to size with a saw, or better still, one of the nibbling tools available for the purpose. The covering material used on the prototype was green baize, which gave a very businesslike finish.

Various other materials could be used, and another possibility would be to paint the hardboard, say, green, and then paint on the tool outlines in white so that you can see at a glance if any tool is missing.

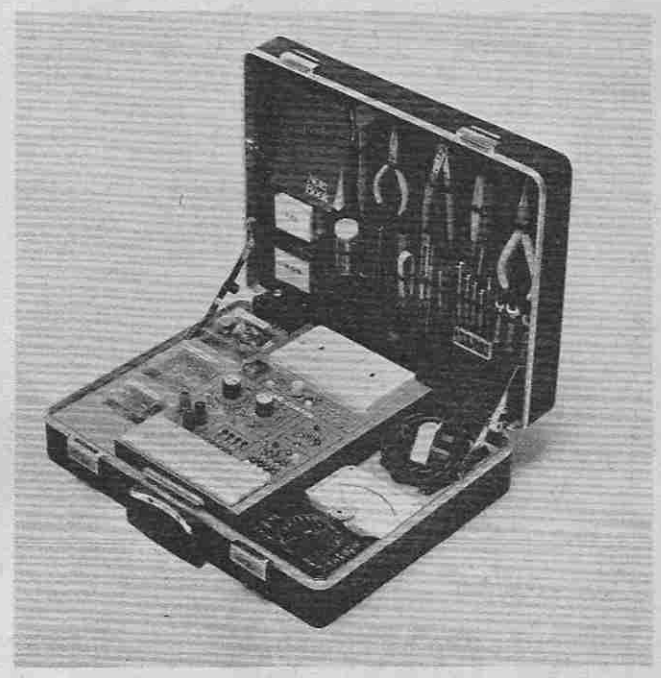
The tools can be supported with elastic as shown, and the bias binding is added to make the removal of the board a simple process.



The prototype tool board removed from the lid of the briefcase for use on the construction bench.

SOME SUGGESTED TOOLS

Tools for use with Labcentre can be chosen from the following list to suit personal preferences:
Solder sucker
Soldering iron (miniature)
Screwdrivers (various)
Pliers (pointed nose)
Wire cutters
Wire Strippers
Spanners (BA or metric)
Modelling Knife
Trimming Tools
Spot face cutter (for stripboard)
Terminal pin insertion tool
Wiring Pen
Wire Wrap Tool
Heat Shunt
Wire Bending Gauge
I.C. Insertion Tool
I.C. Extractor Tool
Small files
Contact burnisher
Tweezers



USING THE LABCENTRE

There is no set procedure for using Labcentre, everyone will have their own ideas on how to use it, and what to use it for. It can be used in many different fields, such as design, experimentation, tutoring and trouble shooting, and for all kinds of circuits including the digital and analogue variety. Most of the detailed uses for Labcentre haven't even been invented yet!

Despite this wide scope, a few operational guidelines may help.

PRECAUTIONS

1. To ensure circuit safety, *always* turn off the mains switch while making interconnections.

2. Be sure to check the position of the CMOS/TTL switch before using the pulser or divider outputs. Remember, the CMOS position will damage TTL and CMOS circuits powered from 5V rails.

3. Be careful not to short the pulser, divider, or function generator outputs to any of the supply rails as this can result in ruined i.c.s.

4. Do try and avoid power supply short circuits. The regulators *are* short circuit protected to 0 volts but extended shorts could cause overheating. Short circuits between power rails could destroy the regulators.

5. *Never* try to wire up any circuits on the breadboard which use mains or other high voltages.

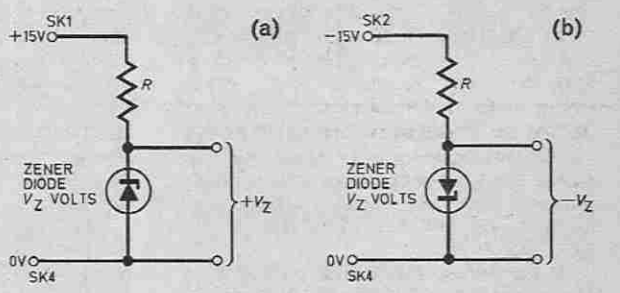


Fig. 4.2. Using a Zener diode and series current limit resistor to provide intermediate voltage levels: (a) positive (b) negative with respect to OV.

OPERATING TIPS

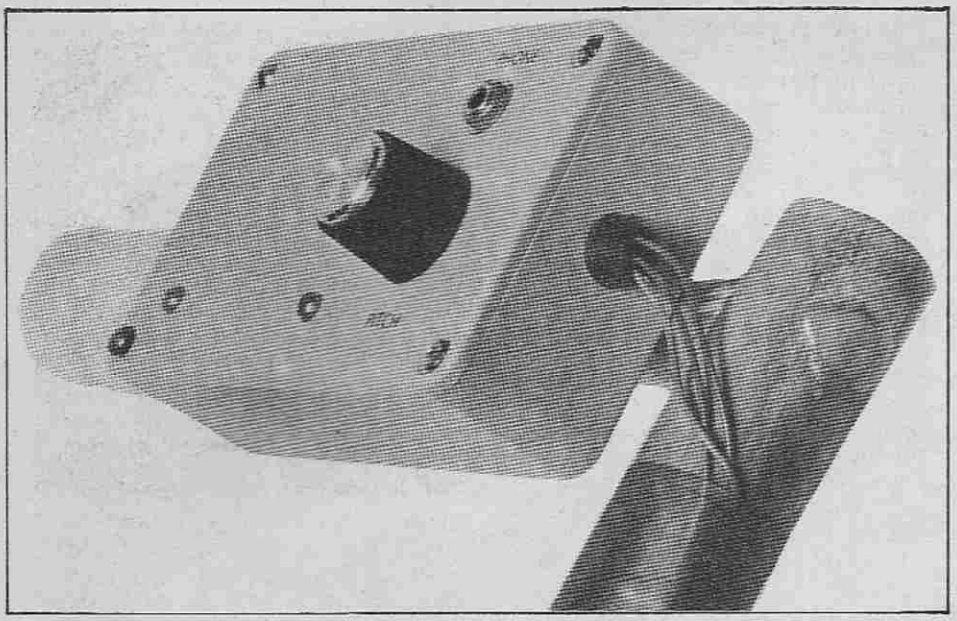
1. Use insulated, solid, tinned copper wire of about 24 s.w.g. for breadboard wiring. Using wires with different insulation colours for different types of signal can make life a lot easier.

2. Keep breadboard wiring neat and don't let a birdsnest situation develop. Tidy wiring reduces stray capacitance and helps to avoid short circuits.

3. Most breadboard sockets come complete with power bus lines at top and bottom. Using these bus lines for power distribution is very desirable. Power coupling can be achieved between each supply rail and 0 volts by using an appropriate combination of electrolytic and ceramic capacitors. This is particularly necessary for high speed logic circuitry.

4. When connecting the function generator output to the breadboard it is advisable to carry the earth connection through on a separate wire, even though the function generator earth is connected to 0 volts internally. The two wires from the function generator can be formed into a "twisted pair" to reduce radiation.

5. Voltage rails between 5 and 15 volts can be generated with a Zener diode and a resistor as shown in Fig. 4.2. The resistor should be chosen so that the voltage drop across it is equal to $(15-V_z)$V at the maximum load current of your circuit, where V_z is the Zener voltage. To get a useful output current range, 1 watt Zener diodes are best for general use. ☐



LOW COST METAL LOCATOR

By R. A. Penfold

THE MAIN design requirement for this metal locator was for the most simple and inexpensive unit that would give a good level of performance.

A beat frequency oscillator (b.f.o.) type circuit is used, and this is based on a single inexpensive CMOS i.c. and very few passive components. The performance of the unit is very much in line with that of other simple locators with small coins; ½p, 1p, or similar are detectable at depths of up to approximately 25mm, and larger coins such as 2p, 10p and 50p pieces detectable at depths of up to about 50 or 80mm. Large pieces of metal can be detected at depths in excess of 300mm.

The unit is self-contained apart from the crystal earpiece which is used to provide the output tone. The presence of metal is indicated by a small change in the pitch of this tone.

B.F.O. PRINCIPLE

This type of locator uses an inductive/capacitive (*LC*) type oscillator as the basis of the unit. The frequency at which the oscillator operates is dependent upon both the value of the inductor and the capacitor used in the tuned circuit, and a change in either will result in a change in operating frequency. The inductor is a large air-core type and it is usually termed the search coil.

FREQUENCY SHIFT

If a piece of metal is brought close to the search coil it will cause a change in its inductance, and hence also a change in the operating frequency of the oscillator. The problem with this system is that the frequency shift produced will usually be only about 0·1 per cent or less, and is too small for the human hearing mechanism to readily perceive.

This is overcome by using the b.f.o. principle which is outlined in Fig. 1. Here the output from the oscillator is fed to one input of a circuit known as a product detector. The other input of the product detector is fed from a second oscillator which is termed a beat frequency oscillator. The output from the product detector will contain a number of frequencies, most of which are filtered out by an r.f. filter leaving just the difference frequency which is fed to the earpiece.

In practice the search oscillator operates at quite a high frequency, and this design employs a nominal frequency of 125kHz. The b.f.o. is adjusted to a frequency just above or below the search oscillator frequency so that the difference frequency at the output of the product detector is a low audio one, which will be reproduced by the earpiece.

If a piece of metal is brought close to the search coil, causing a change in frequency by about 0·1 per cent, with a nominal operating frequency of 125kHz this represents a frequency shift of 125Hz (0·1 per cent or one thousandth of 125,000Hz = 125Hz). The difference in the frequency of the two oscillators will obviously change by this amount, causing the output tone from the earpiece to change by about 125Hz. Since the tone from the earpiece could have previously been less than 125Hz if desired, this shift in output frequency can produce a significant change in the output tone that will be readily apparent to the user.

CIRCUIT DESCRIPTION

The complete circuit diagram of the detector is given in Fig. 2. The only active component in the unit is a CMOS quad 2-input NOR gate. Although this is a logic i.c. it readily lends itself to use in this type of circuit.

Gates G1a and G1b of the i.c. are used as the b.f.o., and these are connected in a conventional CMOS astable or free running multivibrator circuit. This can be tuned several kilohertz either side of the search oscillator frequency by means of VR1.

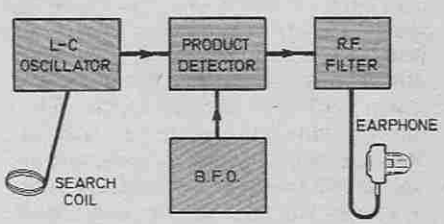


Fig. 1. Principle of the beat frequency oscillator circuit. Here two oscillators run at very nearly the same frequency thus producing an audible beat note in the earpiece. Any slight shift in the *LC* oscillator frequency will cause a change in the beat note heard. This change in frequency is caused by bringing a piece of metal in the vicinity of the search coil. This alters the inductance of the coil, thus changing the frequency of the tuned circuit.

Conventionally an *LC* oscillator is used as the b.f.o., but this is comparatively expensive due to the need for an inductor and a variable capacitor. This *CR* alternative seems to work perfectly well and give good stability provided it is operated from a stabilised supply. The unit is therefore powered from a simple Zener shunt stabiliser circuit formed by R5 and D1.

Gate G1d is used as the basis for the search oscillator and this uses a rather unusual configuration. The two inputs of the gate are connected together so that it functions as an inverter. Search coil L1 then biases the inverter to act as an amplifier. The series capacitance of C4 and C5 acts as the capacitive part of the tuned circuit and the junction of these two acts as an earthed tapping.

This produces a phase inversion through the tuned circuit at its resonant frequency, which with the inversion through the amplifier results in positive feedback and oscillation at the resonant frequency of the tuned circuit. This has a nominal frequency of 125kHz, and the prototype had a measured operating frequency of 123·86kHz.

There will be minor variations between various units built to this design, but provided the correct components are used and the search coil is constructed exactly as described, the unit will operate well within the permitted frequency band used for metal locators.

Gate G1c is used as the product detector, and again this is a rather unusual configuration. The output from the b.f.o. is coupled to one input of G1c via R2, and the output from the search oscillator is coupled to the other input by way of R3. The output from a NOR gate will be high, virtually equal to the positive supply voltage if both inputs are low, almost at the negative supply voltage. Any other combination of input states will produce a low output state.

Therefore, an input from the search oscillator as in Fig. 3a and a slightly higher input frequency from the b.f.o. as in Fig. 3b would produce the output waveform of Fig 3c. If this output is then passed through a suitable r.f. filter so that the rapid changes in the signal are smoothed out and the pulses are integrated to produce a sort of averaging of the output level, a waveform something like that of Fig. 3c will be obtained. This final signal is the required difference signal, as is demonstrated by the fact that the total number of pulses in a and b equals the number of pulses in b.

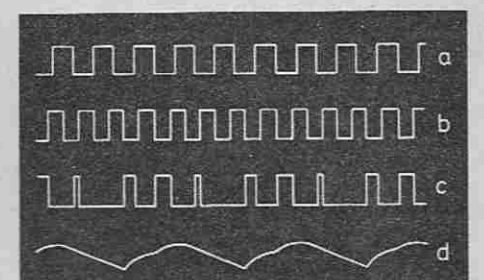


Fig. 3a. Output waveform from the search oscillator. (b) A slightly higher frequency is produced by the b.f.o. (c) When mixed the waveform appears as this. (d) After passing through an r.f. filter, the pulses are averaged out producing the low note beat.

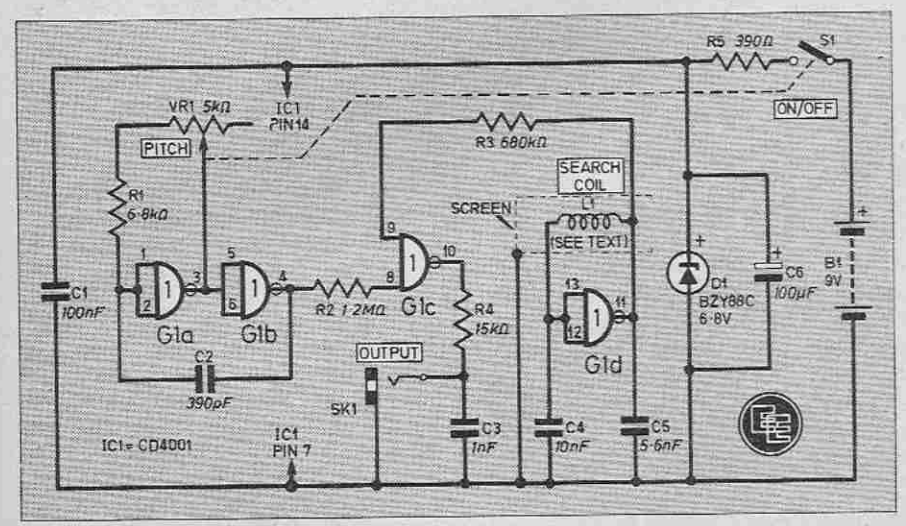


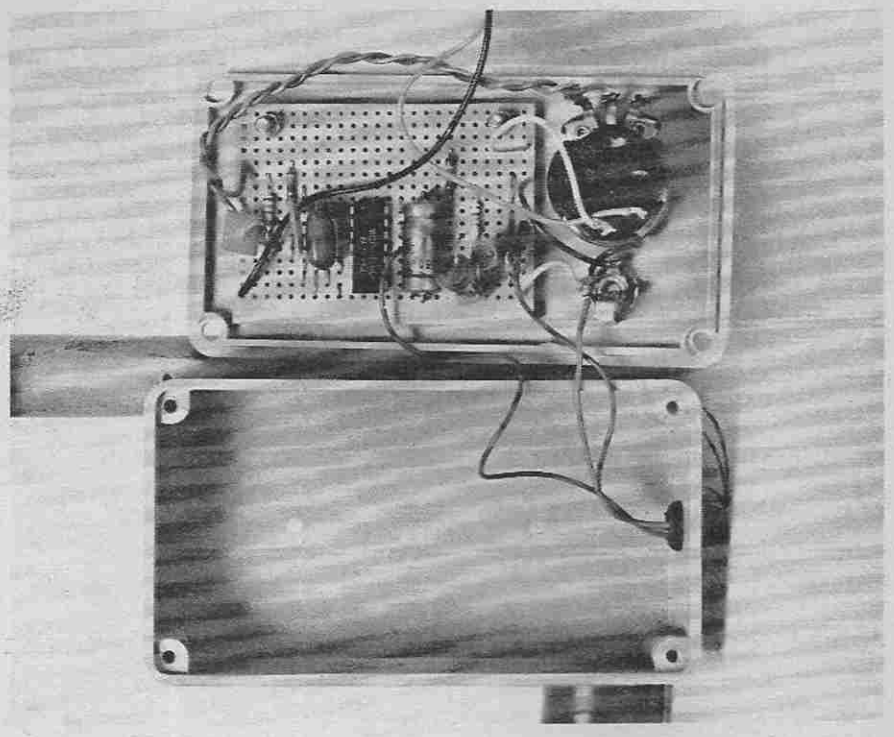
Fig. 2. Complete circuit diagram of the Metal Locator.

R.F. FILTER

Resistor R4 and C3 are the r.f. filter network. The inputs to G1c are couped via high value resistors rather than directly as it is advisable to use a very loose coupling here. With a tighter coupling there is a tendency for the two oscillators to lock onto the same frequency even when they should be a few hundred cycles apart. This would make the unit difficult to use and insensitive. The use of loose couplings and supply decoupling capacitors C1 and C6 virtually eliminates this effect, and the oscillators have to be within a very few cycles of each other's frequency before locking will occur.

Switch S1 is an ordinary ON/OFF switch and is ganged with VR1. The unit has a current consumption of about 5·5mA which gives many hours of operation from a PP3 battery.

CONSTRUCTION starts here



COMPONENT BOARD

All the small components are assembled on a piece of 0·1 inch matrix stripboard using the component layout given in Fig. 4. The board has 16 strips by 24 holes and is cut down from a larger piece using a hacksaw.

The two 3·2mm diameter mounting holes and the breaks in the copper strips are then made, after which all the components and link wires are soldered into place.

The i.c. is a CMOS device and will be supplied in some form of protective packaging to prevent damage due to high static voltages. This should be the last component to be soldered into circuit and it should not be removed from the packaging until then. It is advisable to use a soldering iron having an earthed bit when connecting this device. A socket could be used for the i.c., but due to the low cost of the device this is probably not justified.

The case is a small plastic box which measures about 111 x 60 x 27mm, and VR1 and the output socket are mounted at one end of the lid. This leaves sufficient room for the completed component panel to be mounted on the lid using two short 6BA screws.

It is advisable to earth the body of VR1 to the negative supply rail of the unit, as otherwise a slight hand capacity effect will make precise tuning of the unit a little difficult. This earthing can be accomplished by looping the bare end of a short insulated wire around the mounting bush of VR1 when it is being mounted. This lead will then be trapped against the body of VR1, and the free end of the lead can be earthed to the appropriate tag of SK1.

SEARCH COIL

To make the search coil a temporary coil former having a perimeter or circumference of 508mm is required. The author used a 152 x 102mm chassis that was at hand, but a suitable former can easily be constructed from wooden battens if no ready made alternative is available.

The winding consists of 35 turns of 10/0·1mm p.v.c. insulated wire wound fairly tightly around the former (but not so tightly that it will be difficult to remove the coil) with leadout wires one metre long. Four bands of insulation tape are used to hold the winding together so that it can be removed from the former.

These initial steps of the search coil construction are illustrated in Fig. 5.

COMPONENTS

Resistors
R1 6·8kΩ
R2 1·2MΩ
R3 680kΩ
R4 15kΩ
All are ¼W carbon ± 5%

Capacitors
C1 100nF polyester
C2 390pF ceramic plate ± 5% or better
C3 1nF ceramic plate
C4 10nF polystyrene ± 5% or better
C5 5·6nF polystyrene ± 5% or better
C6 100μF 10V elect.

Potentiometer
VR1/S1 5kΩ Lin. carbon with double-pole switch

See Shop Talk page 333

Semiconductors
IC1 CD4001 Quad 2-input NOR gate
D1 BZY88C6V8 6·8V 400mW Zener diode

Miscellaneous
B1 9V PP3 battery
L1 35 turns 10/0. 1mm wire (see text)
SK1 3·5mm jack socket
Stripboard, 0·1 inch matrix 16 strips by 24 holes; small plastic box, 111 × 60 × 27mm or similar; battery connector to suit B1; small round control knob; crystal earpiece with 3·5mm plug; connecting wire.
Materials for framework; (see text), 800 × 25mm dowel (broomstick or similar, 250 × 15mm dowel, hardboard or thin plywood 200 × 180mm (2 off) insulating tape, bicycle handgrip, aluminium foil if required.

LOW COST METAL LOCATOR

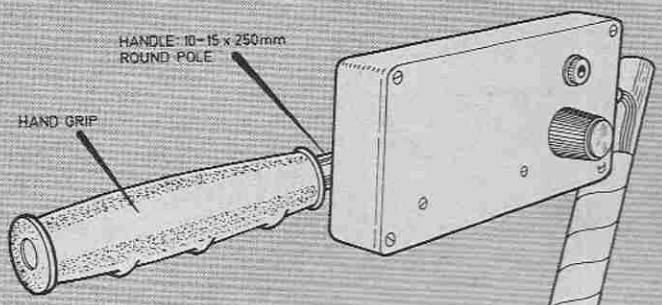


Fig. 6. Constructional details for the framework as used on the prototype. Dimensions are not critical and if required can be varied to suit individual requirements.

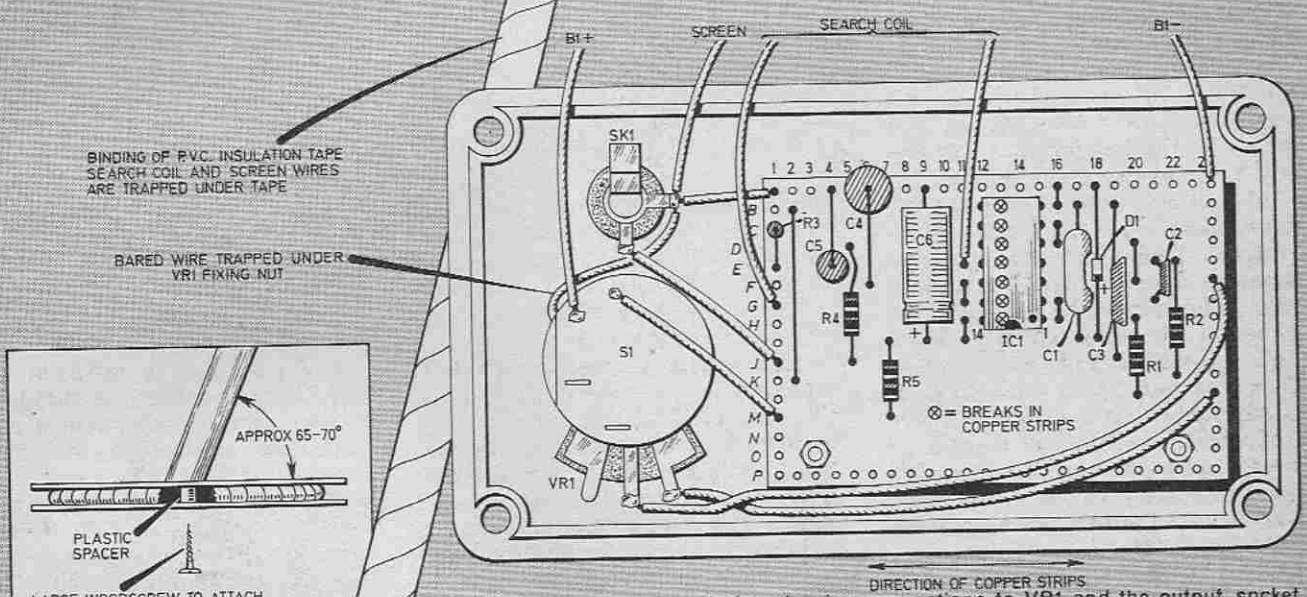
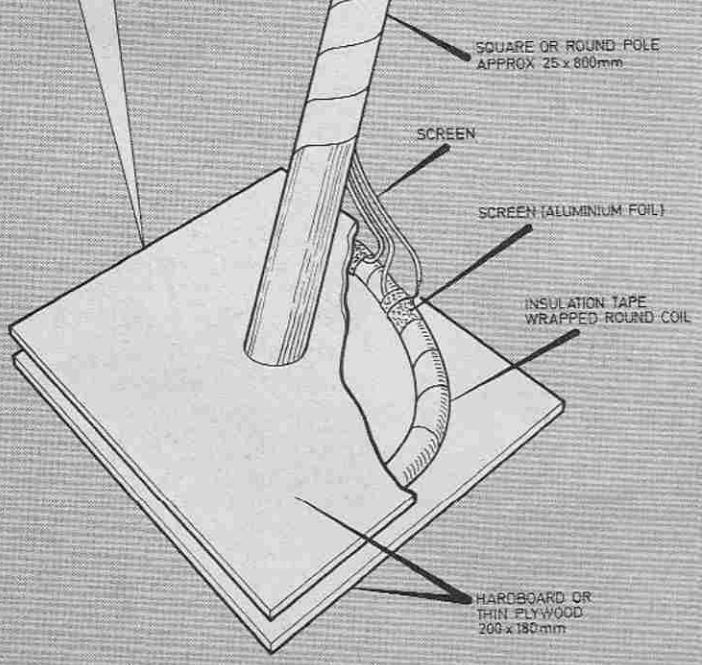


Fig. 4. Stripboard layout also showing connections to VR1 and the output socket The board is mounted on the lid of the case using short 6BA screws.



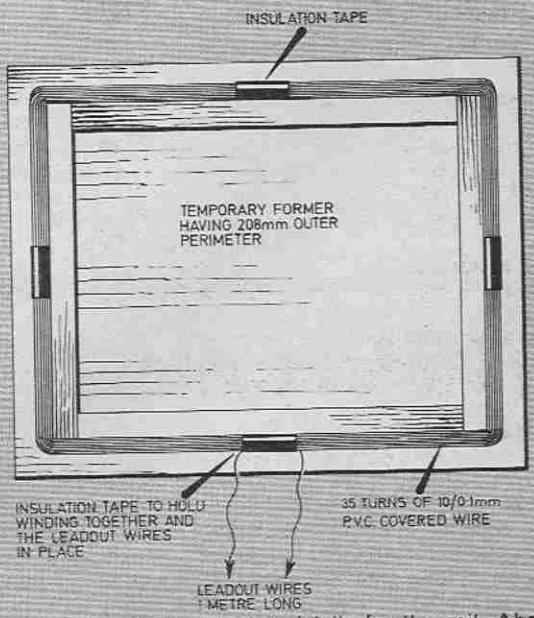
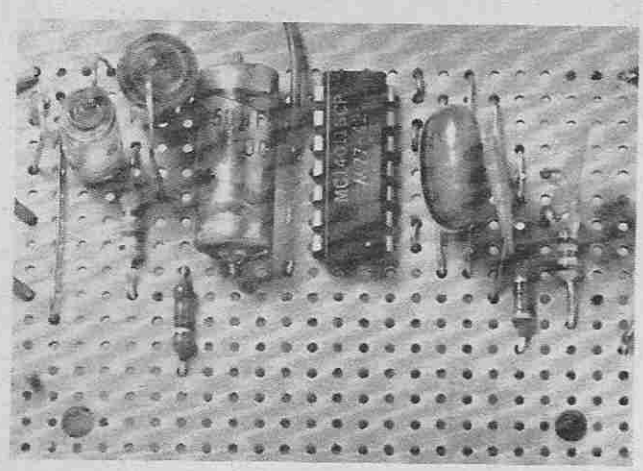


Fig. 5. Construction details for the coil. About 15 metres of wire is required. If a shield is required it should be fitted at this stage.



Layout of components on the completed circuit board for the Low Cost Metal Locator.

SHIELD

The search coil is formed into an oval shape about 180 x 150mm, and it is then a good idea to fit it with a shield. This is not essential, but without a shield there will be a small change in the output frequency when the search coil is placed close to the ground, even in the absence of any metal there. This would make the unit more difficult to use with a consequent indirect loss of performance.

A shield can simply consist of strips of aluminium cooking foil used to completely cover the coil, except over the band of insulation tape at the point where the two leadout wires emerge from the coil.

A lead about one metre long must be attached to the shield so that it can be earthed to the negative supply. This can be achieved by baring about 40mm at one end of a p.v.c. multistrand lead one metre or so long. The bare wires are twisted together, heavily tinned with solder, and then tightly wound around the shield close to where the two leadout wires emerge from the coil.

To complete the search coil it is tightly bound with a layer of insulation tape to hold the whole assembly together.

FRAMEWORK

Details of the wooden framework used on the prototype locator are provided in Fig. 6. This can of course be altered slightly to suit the particular materials to hand or locally available, but make sure that the search coil is held very firmly in place and that its leadout wires are not allowed to simply flap around.

Strong, rigid construction is essential, or as the detector is moved around there will be small changes in the output frequency without any metal in the vicinity of the search coil.

The main part of the case is screwed to the handle part of the framework using a couple of small woodscrews. A hole is drilled in the side of the case near to the upright pole to provide an access point for the leadout wires from the search coil and shield (if fitted). The final wiring of the unit can then be completed. The lead from the shield connects to the earthed tag of SK1.

It is a good idea to fit a handlebar grip (as sold by cycle shops) over the end of the handle. The handle will almost certainly be too small in diameter for the grip to be a good tight fit over the end, but this can be rectified by using some bands of insulation tape around the end of the handle.

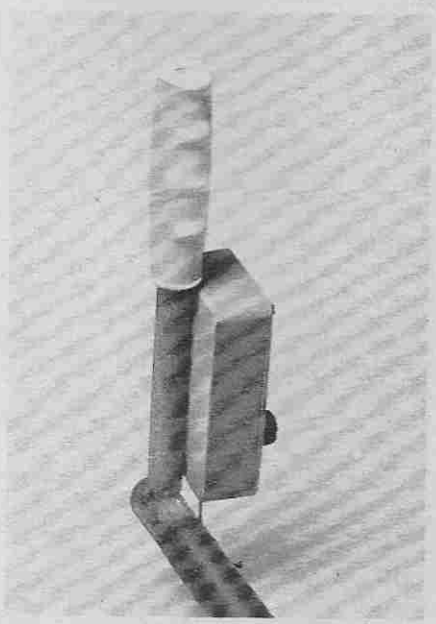
IN USE

With a crystal earpiece plugged into SK1 and the unit switched on, by adjusting VR1 (PITCH) it should be possible to produce a strong audio tone from the earpiece. It is likely that it will be possible to produce an output tone at virtually any setting of VR1, but most of these signals are weak spurious ones, and it will be obvious when the main response has been found due to the far higher output volume.

The variable resistor VR1 will control the pitch of the output tone, and if this is adjusted for the lowest possible tone, the two oscillators should lock to the same frequency, producing a *null* in the output. In use VR1 is just slightly offset from this setting so that a very low pitched tone is produced.

OPERATING LICENCE

Under the terms of the Wireless Telegraphy Act 1949, a licence is required to operate this Metal Locator in the UK. The unit has been designed to operate on a frequency of 125kHz, as such the design should not be altered. Applications for a licence should be made to the Home Office, Waterloo Bridge House, Waterloo Road, London SE1.



Positioning of the circuit case and the handle grip.

A very low output note will provide the best sensitivity since, for example, a frequency shift of 10Hz is quite significant on a 20Hz signal, but would probably not be perceptible on a signal at a frequency of, say, 2kHz.

With VR1 set one side of the null point it will be found that the presence of most types of metal produces a reduction in the output tone, whereas an increase in the tone will usually occur if it is offset in the other direction.

Sensitivity is best if it is adjusted so that a reduction in the output pitch is provided, as a small reduction in the pitch of a tone is a little more easily detected than a similar increase in pitch. ⌑

MINI-MODULES .... in combination

By George Hylton

So far in this series, a number of audio modules have appeared. We thought it might be a good idea to demonstrate how these can be connected together and used in combination.

The **Audio Effects Oscillator** (*November 1978, p. 818*) is a good starting point because it forms a handy source of signals. It can be used in conjunction with the **Audio Modulators** (*February 1979, p. 86*) to manipulate the signal from some other audio source such as a radio tuner or the output of the **Microphone Amplifier** (*December 1978, p. 862*).

Several signals can be mixed and faded in or out with the help of the **Passive Mixer** (*October 1978, p. 746*). And, of course, for more ambitious setups you can build more modules and add them to your system.

If you don't want to be stuck with battery power, the **Versatile Power Supply** (*March 1979, p. 157*) enables them all to be worked off the mains.

This really exhausts the ostensibly *audio* modules, but if you happen to have built the **Meter Amplifier** (*this issue*) it can be pressed into service as a low-power monitor amplifier for driving a high-impedance speaker (though its quality of reproduction is poor) and even the **Continuity Tester** (*January 1979, p 24*) could be operated as a second variable frequency audio source!

One important general point is that none of the audio modules produces any appreciable output power. They are designed for use in conjunction with a normal audio chain consisting of a power amplifier with its own power supply unit and preferably its own tone controls because these are always a useful adjunct to a sound effects "kitchen" where weird noises have to be cooked up.

DRAMATIC EFFECTS

The Audio Effects Oscillator in its original form has a frequency control, an output level control and an input terminal for applying a modulating voltage if required. The modulation facility is optional and the oscillator can be used as a straightforward tone source.

It is very useful to build two oscillators, one for frequencies in the speech and music range and the other for very low frequencies. In my original article I suggested a range of 1-30Hz for the v.l.f. version. This, with suitable application of tone controls, can produce passable imitations of clocks ticking, hearts beating and similar repetitive noises.

The other, higher-frequency oscillator can be used on its own to make whistles and lower tones. Switched on and off it can give "time pips" or "morse code".

When modulated by the v.l.f. oscillator it can produce quite a good imitation of a two-note police siren. The quality of the modulated output varies with the amount of modulation voltage. A few tenths of a volt produces continuously varying pitch. A volt or so produced on-off modulation; interrupted bursts of tone.

easily get into a muddle, with leads going in all directions, so for any sort of permanent or semi-permanent installation it may be preferable to settle for a fixed arrangement whose facilities though limited are quickly got used to. Building an extra Passive Mixer will enable a fair degree of flexibility to be preserved.

A possible arrangement is shown in Fig. 1 (but it must be stressed that the user is at liberty to make any interconnections he likes and that this one is merely for the purposes of illustration). Here the v.l.f. oscillator output is tied permanently to the audio oscillator's modulation input. The audio oscillator can still be used unmodulated, however, by turning down the v.l.f. output.

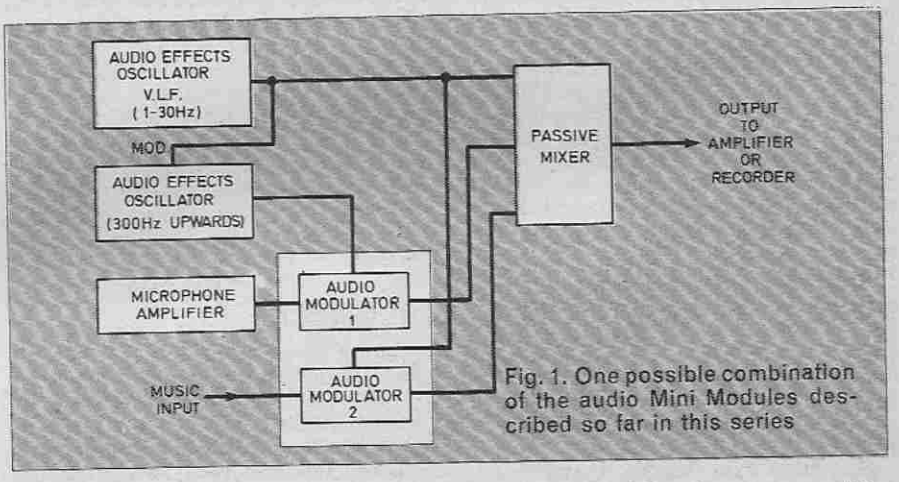


Fig. 1. One possible combination of the audio Mini Modules described so far in this series

Using a pair of effects oscillators (one v.l.f., the other audio) you can equip yourself to make tape recordings of stories or plays with at least some of the sounds needed for dramatic effects. You can, with the aid of a gram deck and the mixer, bring in background music as well. In no time at all you can be your own radio programme producer!

INTERCONNECTIONS

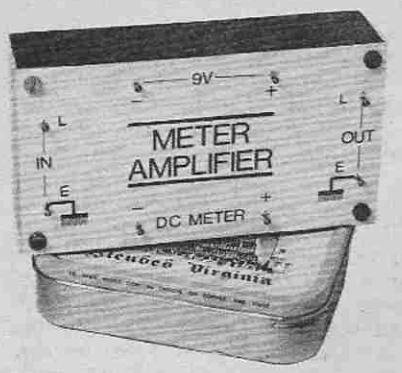
The most versatile means of interconnecting the various modules is old-fashioned flexible leads with crocodile clips at each end. With these you can connect anything to anything and see what happens. The snag is that you can

The output of the microphone amplifier is taken to one of the modulators. Modulating speech with a very low frequency can produce "Dalek" type sounds. Modulating with a high frequency produces odd sounding distortions. Modulating with both at once . . . well, why don't you try it and see!

Connecting the audio oscillator via a slide switch is useful for producing morse-code-like sounds. Choose a switch which can be operated quickly and silently.

Modulating music (from a radio, tape deck or gramophone playback unit) at v.l.f. produces a tremolo effect.

No doubt readers will develop their own tricks for making use of these audio modules. If you hit on something useful, please tell us about it!



MINI-MODULES

By George Hylton

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

8 METER AMPLIFIER

MANY otherwise very good multimeters fall down rather badly when it comes to measuring small a.c. voltages. I have an excellent general purpose multimeter, for example, which in theory will measure down to 1 volt a.c. full-scale. Unfortunately, on this 1V a.c. range its internal resistance is a mere 300 ohms or so; this is so low that in many situations accurate measurement is impossible because the meter's impedance loads the circuit to which it is connected so much that the voltage I'm trying to measure falls.

Another problem is that a good many of the audio voltages one would like to measure are 100mV or less and a 1-volt a.c. range cannot measure them accurately.

An answer to this problem is to provide the meter with a pre-amplifier which does three jobs.

Firstly, it amplifies by some convenient small amount such as 10 times, which is enough to convert the meter 1V range to a 0·1V (100mV) range.

Secondly, it has a high enough input impedance (in the present circuit about 90 kilohms) to avoid serious loading of the majority of sources of audio signals.

Thirdly, it has the ability to supply large enough output currents at a low enough impedance to drive the meter.

The amplifier in this Mini Module does all this but can do more besides. In addition to driving an a.c. voltmeter it can also act as a self-rectifying circuit to drive a d.c. meter with a current proportional to the a.c. input voltage. In this way almost any standard d.c. milliammeter or microammeter can be turned into a sensitive a.f. voltmeter with a full-scale deflection of around 100mV r.m.s.

The same d.c. meter can also be converted into a linear frequency meter or a capacitance meter with the aid of an external audio oscillator, which need not be accurately calibrated.

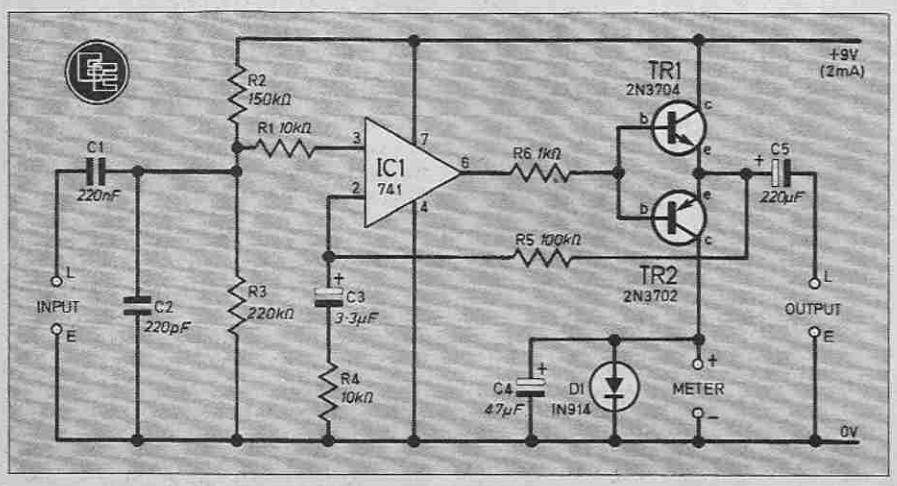
THE CIRCUIT

The circuit consists of an operational amplifier in i.c. form (which provides the required gain) and a complementary class B output stage (which provides the output current). Negative feedback (via R5 and R4 in Fig. 1) sets the gain and removes most of the distortion of the unbiased output pair TR1, TR2.

With the values of R5 and R4 shown the gain is 11. This is a very useful gain when a d.c. meter is used for a.c. voltage measurement because it corrects for a cause of error which would make the meter "read low".

For use as a pre-amplifier for an a.c. meter however a gain of exactly 10 is needed and can be arranged by increasing R4 to 11 kilohms (for example, two 22 kilohms in parallel) or by connecting 1 megohm across R5.

Fig. 1. Circuit diagram of the meter amplifier



CONSTRUCTION

The prototype is housed in an electrician's metal switch box of the type designed to hold two standard sized square light switches. These are the boxes ("patresses") which are often buried in house walls to take flush-mounting switches.

The older kinds, designed for deeper switches than the modern "plaster depth" switches are more useful for electronics construction and are still obtainable. The box I used measures 130 x 70 x 32mm deep but anything similar should be usable.

The front panel is a piece of Formica and to the back of this is glued the circuit board, which in this case is a piece of plywood. This was converted into a component board by tracing the layout diagram and sticking it to the plywood, then inserting pins at every junction to act as solder tags.

Miniature household pins were used, of the kind known to stationers as "lills". These are about 15mm long and can be inserted with pliers. They are pushed right in until they hit the Formica.

For lead-through connections I used coppered hardboard pins. To avoid damage to the panel and base, holes were drilled for the pins, just large enough to enable them to be pushed through. They were then locked in place by applying a "collar" of solder where they emerged on either side.

It seemed hardly worth providing an internal battery for a piece of equipment which may only occasionally be needed so the 9V supply was also terminated on pins to enable an external battery to be connected.

The component layout (Fig. 2) is not critical and may be altered to suit some other shape and size of container.

USING THE AMPLIFIER

(1) As a Meter Pre-amp

For use as a "x10" meter pre-amp the a.c. voltmeter is connected to the OUTPUT terminals. The gain is set to 10 as described earlier, by adjusting R4 or R5. For gains other than 10 which may be needed for some meters, keep R5 at 100 kilohms but

use a new value for R4, calculated from: R4 (new = 100 kilohms (A − 1) where *A* is the required gain.

This formula should work for gains up to about 100. *Example:* your a.c. meter has a range 0-300mV and you want to use the meter to convert this to 0-50mV. The gain required is 300/50 = 6 and the formula shows that the new R4 must be 100 kilohms/ 6 − 1) = 20 kilohms.

Note that the meter amplifier will not give outputs of much more than 1V r.m.s., so whatever meter you use in this mode must have a full-scale deflection of 1V r.m.s. or less.

(2) As Self-Rectifying Meter Amp

To use as a self-rectifying meter amplifier the meter must be a d.c. moving coil type, with a linear scale and full-scale deflection of not more than about 10mA. The d.c. voltage drop across the meter should not exceed 500mV (0·5V), at full-scale current. (Most detached milliammeters and microammeters meet this requirement but some multimeters on their d.c. ranges do not.)

It is not always realised that a class B amplifier functions as a rectifier. It does so in that the current drain from the battery is in proportion to the amplitude of the driving signal. Measure the d.c. which flows through either output transistor and you have measured the strength of the signal. If the amplifier is linear (distortionless) then so is the meter indication.

Ordinary class B audio amplifiers are not suitable because the output transistors are biased so as to pass a small current even without an input signal and a meter would read this all the time. The class B output stage in the Meter Amplifier is unbiased and passes no current until an input is applied. Most of the resulting distortion is removed by negative feedback and the circuit gives good linearity in meter terms though not in hi-fi terms.

COMPONENTS

Resistors

R1	10kΩ
R2	150kΩ
R3	220kΩ
R4	10kΩ see text
R5	100kΩ see text
R6	1kΩ

All carbon film ± 5% tolerance or better, ¼ or ⅓W.

Capacitors

C1	220nF (0·22μF)
C2	220pF
C3	3·3μF
C4	47μF } 10V elect.
C5	220μF

Working voltage 12V d.c. or over. Type and tolerance not important.

Semiconductors

IC1	741 operational amplifier in 8-pin DIL package
D1	1N914 or any small silicon diode
TR1	2N3704 silicon *npn*
TR2	2N3702 silicon *pnp*

Miscellaneous

Electrician's box for two switches, deep type (or any box about 130 × 70 × 30mm). Formica for front panel (Light coloured plain design so that lettering can be put on). Bolts for fixing panel (usually 4BA); 4 off. Plywood for base. Not too thin. Pins for use as tags. 15mm long "lills". ¾ inch hardboard pins, coppered, for lead-throughs. Earth tag.

Since no output current can flow unless there is an a.c. load it is necessary to connect a load resistance to the OUTPUT terminals when the circuit is used in this way. The required value depends on the meter but is easily calculated:

Load resistance = 1000/(twice meter full-scale current).

If the meter current is in mA the answer comes out in ohms; if in μA, in kilohms. *Example:* Meter current, 2mA full-scale d.c.; load required = 1000/4 = 250 ohms. Remember to set the gain at 11 for this application. The d.c. meter is connected to the METER terminals.

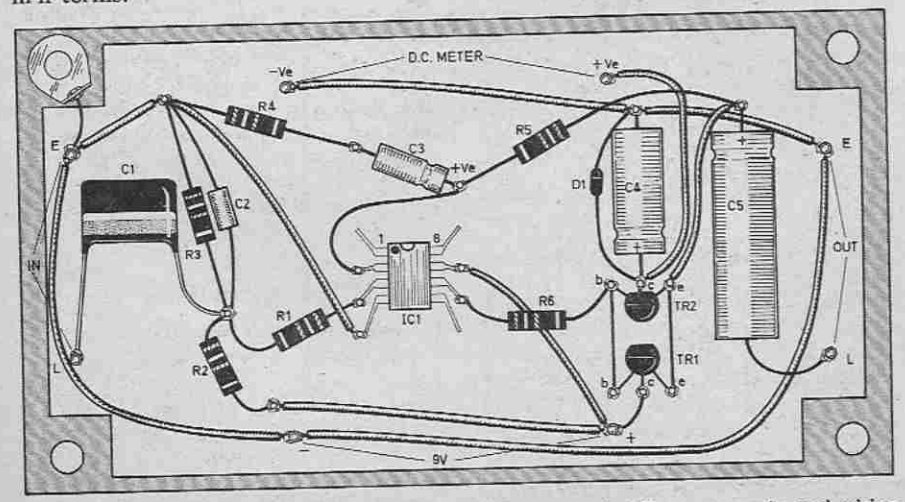


Fig. 2. Plywood circuit board glued to Formica front panel. All components and wiring soldered to miniature household pins.

CAPACITANCE

If the load is a capacitance rather than a resistance the current taken depends on the frequency of the input signal since the reactance (impedance) of a capacitance goes down as the frequency goes up. If an audio oscillator with adjustable frequency and output level is available this effect enables the Meter Amplifier in its self-rectifying connection to be used as a capacitance meter.

Some sort of standard capacitance is needed to set up the circuit. This can take the form of any close-tolerance capacitance of very roughly the size you want to measure.

Connect the standard capacitance to OUTPUT. Apply about 100mV of audio to INPUT. Adjust the frequency until the scale reading fits the standard: *for example:* if your standard is 47nF adjust for a reading of 47. Leave the audio oscillator as set and remove the standard. Connecting the capacitor to be measured will now give a reading proportional to its capacitance; *for example:* 33nF will read 33, and so on. The waveform of the oscillator is not important. (Readers who built Mini Module 2, the *Audio Effects Oscillator*, may like to try using it for this purpose.

FREQUENCY

Frequency can be measured by much the same means as capacitance. If a certain frequency gives half-scale reading when a certain capacitance is connected as the load then twice the frequency will give full scale reading and all lower frequencies will give readings in proportion.

This is strictly true only if the strength and waveform of the input signal are kept constant. This is not always possible, but variations can be largely ironed out by applying an oversized input signal, big enough to overload the op. amp. The op. amp output will then be a square wave of constant amplitude.

An input voltage of around 1V is suitable: don't apply huge inputs or you will damage something.

Example: You want to use the 50Hz mains (at low voltage from an insulated step-down transformer) as the standard of frequency. Apply about 1V. Connect various capacitors to the output until you find one (or several in parallel) that makes the meter read "50". It will read other frequencies in proportion, e.g. 33Hz will now read "33" and so on.

Next month: Voltage Splitter

MICROPROCESSOR BASICS 4

By R. W. Coles

As explained in Part 3, *static* RAM will be the likely choice for most hobby purposes.

The 2112 (Fig. 4.1) is a typical example of a static RAM. This device is organised as 256 words of four bits and is therefore a 1K RAM. Two of these chips used together will provide 256 bytes of memory which can be used for programs or data in small microprocessor systems. By adding further pairs of 2112 devices and an external chip-select decoder, a memory array of almost any size can be constructed.

If you study the block diagram of the 2112 you will see that there are a total of eight address inputs ($2^8 = 256$) and four bidirectional lines which provide the data input/output connection to the microprocessor data bus. The four remaining pins are used for 5 volt power (V_{CC} and GND), Read/Write selection (R/W), and finally Chip Enable (CE) which gates the data at the current address on to the I/O bus, and can therefore be used as a chip select input in a large memory array.

Notice that the memory latches themselves are organised into a 32 x 32 array (not 256 x four) and that the low address bits select a complete row of 32 locations from which the three high address bits select the required four data bits.

The select circuits are actually logic gates, arranged as a decoder in the ROW case, and as a data selector for the COLUMN case. The data out of the column selection circuits is connected back to the data I/O pins via three-state buffers controlled by CE and R/W to ensure that memory data will only be gated on to the bus when this chip is selected and is in the READ state. This ensures that during a WRITE operation the data out of an addressed location does not conflict with the input data, the outputs of the three-state buffers being forced to the third, or high impedance, state.

Well, so much for ROM and RAM. Now let's have a look at input/output circuits.

INPUT/OUTPUT PORTS

Microprocessors operate very rapidly. So when they carry out an

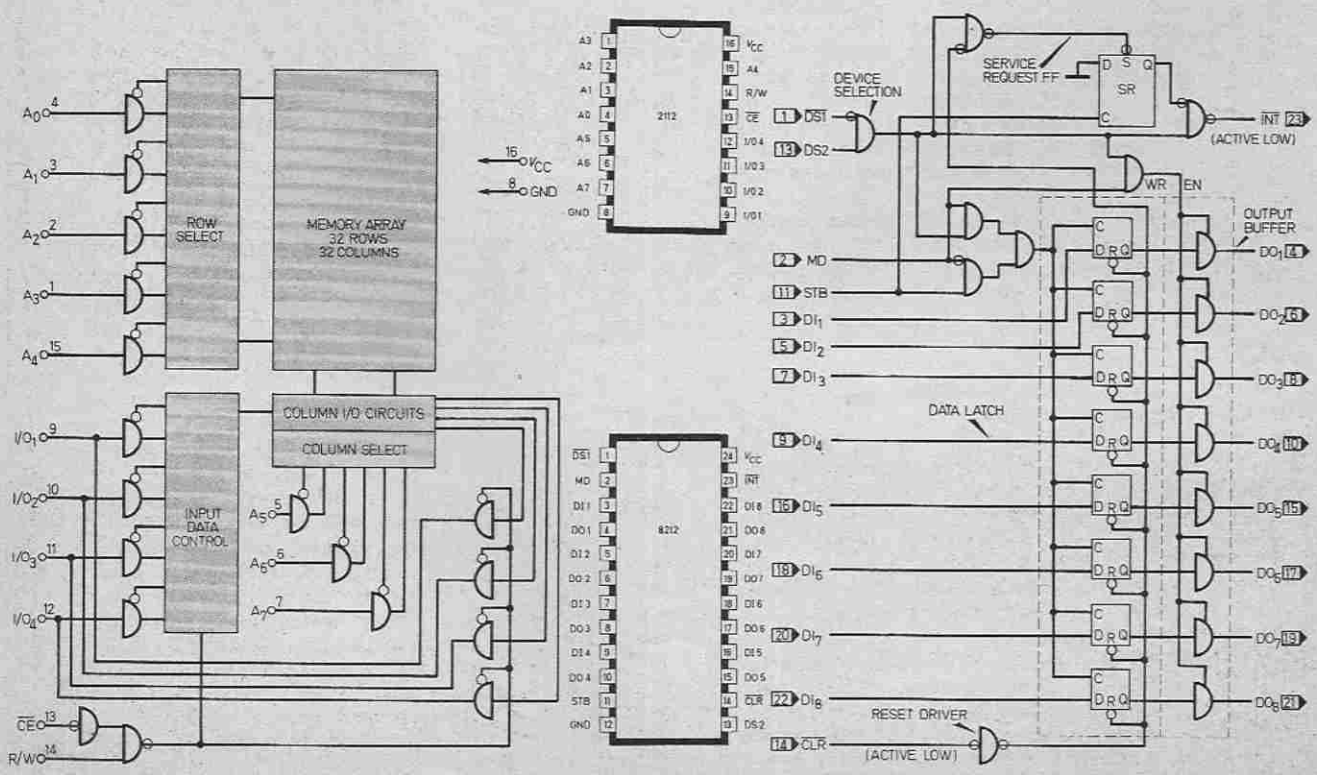


Fig. 4.1. The Intel 2112 1,024-bit Static Random Access Memory. No "refreshing" is required with this type of RAM.

Fig. 4.2. The Intel 8212 8-bit Input/Output Port. All principal functions of a microprocessor system can be implemented.

MICROPROFILE: "BUILD YOUR OWN ROM"

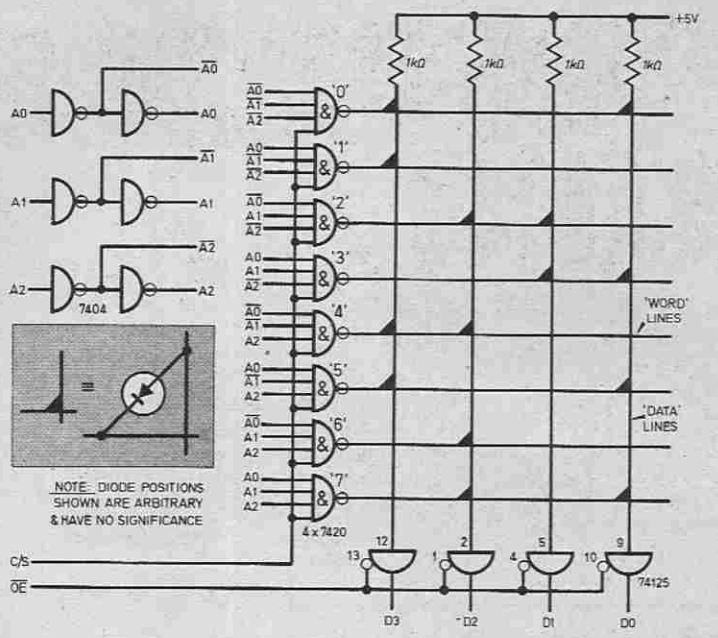


Fig. 4.4. Circuit for the home-brew ROM, made up from standard TTL components.

At first reading, information about ROMs, PROMs, EPROMs and RAMs is all pretty confusing isn't it. But don't despair, it's really quite simple, and the best way to prove it to yourself is to build a ROM of your own so that you can find out at first hand just what makes these mysterious circuits "tick."

The ROM design presented here is not really intended for use in a real microprocessor system because of its limited capacity, but it's not just an ornament either, and I have no doubt that you will be able to dream up all sorts of uses for it. (One possibility would be to expand the design to provide, say ten seven-bit words so that you can make a "custom programmed" seven-segment display decoder.)

The circuit of our home-brew ROM is shown in Fig. 4.4. As you can see, it uses readily available TTL parts, four 7420 dual four-input NAND gates, one 7404 hex. inverter and one 74125 quad three-state buffer. The only other things you need are four 1kohm resistors and some IN4148 diodes.

The circuit shown provides a 32-bit ROM organised as eight four-bit words, but this is easily expanded by adding an extra 74125 device to give a 64-bit ROM organised as eight words of eight-bits. Expanding the number of words is a little more difficult.

CIRCUIT OPERATION

The 7420 gates are used to perform the address decode and the "chip select" function. Individual four-input gates will give a "low" output only if *all* their inputs are "high", in normal NAND gate fashion. Each gate is connected to a particular combination of the address inputs which are buffered and inverted by the 7404.

The three address inputs have a total of eight possible states from A0, A1, A2=logic zero or "low" to A0, A1, A2=logic one or "high". Each word in the ROM must respond to one of these eight combinations and this is what the 7420 gates are for.

Consider the address pattern 010. This is the address code for word number 2 in the ROM and so gate number 2 is connected to $\overline{A0}$ A1 $\overline{A2}$. Only when the pattern 010 occurs on the address inputs will all of these three signals be at a logic one, and in this event the output of gate 2 will go low, *providing the common C/S input is also a one.*

Notice that only one gate output will be low at any one time, and also that if we had several of these ROMs wired up as a larger memory array, we could select between them by using external gates driving their individual C/S inputs. The use of the C/S input then, is to allow memory expansion—easy isn't it!

Well, we have selected our word in the memory, but what happens now? The horizontal lines in the ROM matrix can be thought of as "word" lines, and the vertical lines can be thought of as "data" lines. To program a logic zero into any data bit location, all you have to do is connect a diode between the data line and the word line. To program a logic one, you don't make any connection at all. Let's see what happens.

With our 010 input code, the output of gate 2 is low and if there are any diodes connected to this word line they will pull their respective data lines low also. The data lines which are not connected to word line 2 with a diode will remain high, pulled there by the 1kohm resistors. The result is a pattern of four logic levels applied to the input of the 74125.

A low level on the common "three state control" input of the 74125 will transmit that pattern to any external circuit, and in a microprocessor application the OE signal as it is often called, would be in the form of a fast low-going pulse. With a handful of IN4148 diodes you can go through programming each word to have any four-bit data pattern you desire, using a soldering iron as a programming aid!

What you have made is not really a ROM is it? It's actually a PROM or even a EPROM if you are good at unsoldering diodes! But if you think of yourself as the manufacturer, and if you encapsulate your completed circuit in a block of Araldite, it really is a ROM I suppose.

Those who know something about logic have probably realised that the diodes and the 74125 form OR gates with the distinction that the number of inputs on these gates varies with the number of words which happen to have zeroes programmed in those bit locations. If you don't quite see how it works, build it. You can use toggle switches on the address and C/S lines, and for test purposes you can wire OE to ground. You can use L.E.D.s at the outputs of the 74125 (don't forget a series resistor) or you can use a meter.

Once you understand this circuit, other memory circuits are easy. To visualise a RAM for example, just imagine flip-flops being used in place of diodes!

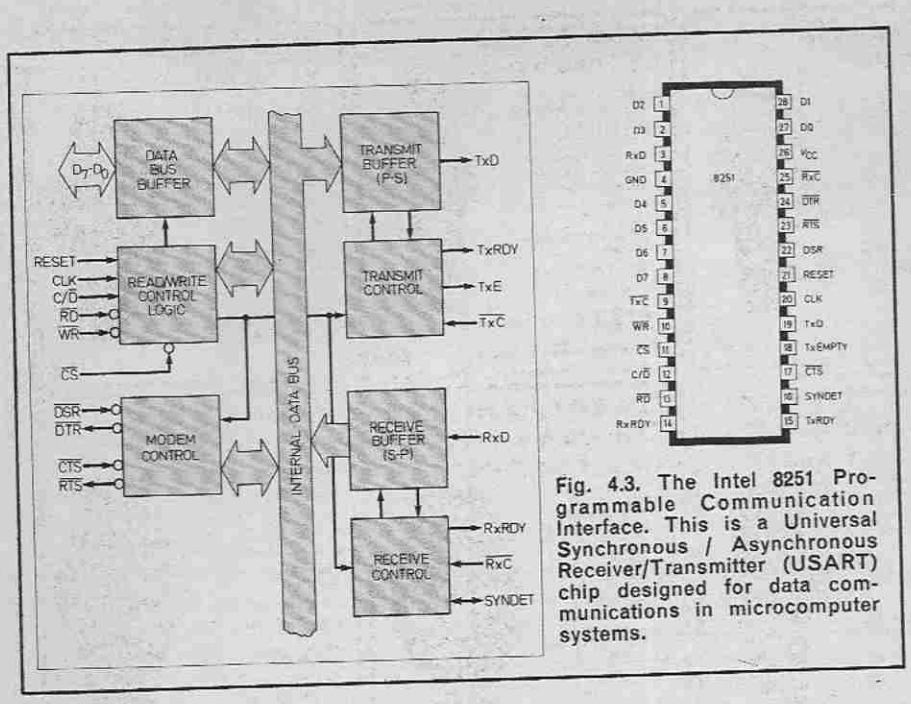


Fig. 4.3. The Intel 8251 Programmable Communication Interface. This is a Universal Synchronous / Asynchronous Receiver/Transmitter (USART) chip designed for data communications in microcomputer systems.

output operation, to send an eight-bit word to a peripheral device such as a seven-segment l.e.d. display for example, the data word remains on the microprocessor data bus for only a few microseconds. This isn't much use to the display as it stands of course, and so it is necessary to add an eight-bit storage latch to the system which is strobed at just the right time to catch the data sent by the microprocessor and hold it for the peripheral as long as may be necessary.

LATCH REQUIREMENTS

Now an eight-bit latch is no great problem, a flick through your old "steam-TTL" data book will reveal lots of likely candidates, but before declaring "problem solved" let's think about what other features we need in this application.

First of all, the latch inputs must not load the data bus too much. (Rule out the rusty old 7475 latches you had in the junk box!)

Secondly, the microprocessor may need many of these output ports, and so it sends out a port address to select the one it is about to talk to. We therefore need a latch which can be "selected" as well as "clocked."

Finally, we need to consider the requirement for input ports because latches are used for output *and* input, and a device which can do both jobs will be an asset.

For input ports, the latch is simply connected the "other way round" so that its inputs are controlled by the peripheral (say a keyboard) and its outputs are connected to the data bus. In this case the microprocessor does not want the latch outputs controlling the bus when the port is deselected and so we add the further requirement of three-state outputs, so that a high impedance is presented to the bus for most of the time.

INPUT/OUTPUT CHIP

One device which meets all of these requirements is the 8212 eight-bit input/output chip made by Intel and others. (Fig. 4.2.) When used as an output port the inputs DI 1 to DI 8 are connected to the data bus, and the outputs DO 1 to DO 8 are connected to whatever peripheral component (lamps, displays, relays, printer, etc) the system needs to drive.

To make an input port, just connect up the other way round, although in this case the peripheral components may be switches, sensors, or a keyboard, for example.

Address selection is carried out by means of the DS1 and DS2 inputs, which may be enough by themselves in some smaller systems, or may be driven by the outputs of a memory decoder chip in larger ones.

Data is clocked into the latches with the STB line which is connected to the control bus in the case of an output port, or is controlled by the peripheral device for an input port.

A reset line, CLR, is provided to clear the latches. This can be connected to the microprocessor reset line so that the system is initialised when power is applied.

The three-state output buffers only need their third state when the 8212 is used as an input port. In this case the DS1 and DS2 inputs control the three state outputs, only allowing the latch data through to the bus when the port is selected.

For output port use, this three-state facility isn't required, and so a mode input, MD, is provided so that microprocessor output data can remain available whether the 8212 is selected or not.

The other flip-flop and gates are for use in a very powerful type of microprocessor input/output scheme called Interrupt Driven I/O, and we may return to this in later articles.

L.S.I. CHIPS

The 8212 is a very handy chip to have around, but really it's no more than a super-TTL part and is quite modest in its capabilities despite the appearances of its bulky 24-pin package!

By using MOS LSI technology, chip manufacturers are able to produce much more useful devices than the simple 8212. Chips which can be changed from input to output under software control, and chips with three eight-bit I/O ports in a single 40-pin package are all available, at a price!

These input/output "systems" make microprocessors even more powerful and at the same time they reduce the amount of software needed for some jobs. Some of the many complex peripheral chips now available do special dedicated jobs, and one such device is known as a UART (Universal, Asynchronous, Receiver/Transmitter).

A UART lets a microprocessor system talk not in parallel eight-bit bytes, but in a serial bit-by-bit fashion to peripherals such as teletypewriters or VDUs. The UART contains a serial transmitter, a serial receiver, and all the control circuitry to make the communication timing and formatting "transparent" to the microprocessor. One example of this type of device is the Intel 8251 Programmable Communication Interface. (Fig. 4.3.)

To be continued

QUARTZ LCD 5 Function

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

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Guaranteed same day despatch.

Very slim, only 6mm thick.

M1

QUARTZ LCD 7 Function

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

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Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication. Perpetual calendar, day, date, month and year. 24 hour alarm with on/off indication. 1/10 second chronograph measuring net, lap and first and second place times. Dual time zone facility night light. Only 9mm thick.

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M6

SOLAR QUARTZ LCD Chronograph with Alarm Time Zone Facility

Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication. Perpetual calendar, day, date, month and year. 24 hour alarm with on/off indication. 1/10 second chronograph measuring net, lap and first and second place times. Dual time zone facility night light. Only 9mm thick.

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M7

QUARTZ LCD Alarm Chrono

22 function, 6 digit. Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light. FRONT BUTTON OPERATION.

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Guaranteed same day despatch.

METAC ★ PRICE

M8

SOLAR QUARTZ LCD Chronograph

6 digit, 11 function. Hours, mins., secs. 1/100, 1/10 secs., mins. Split and lap modules. Auto calendar and back light. Powered from solar panel with battery back-up.

£13.95

M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

£105.00

M10

SEIKO Chronograph

LCD, hours, mins., secs., day of week, month, day, date, 12 hour chronograph, 1/10th secs. and lap time. Back light, stainless steel water resistant, HARDLEX glass.

List Price £85.00

METAC PRICE

£68.00

M11

SOLAR QUARTZ LCD 5 Function

Genuine Solar

Solar panel with battery back-up. Back light and auto calendar. Hours, mins., secs., day, date. Quality metal bracelet.

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M12

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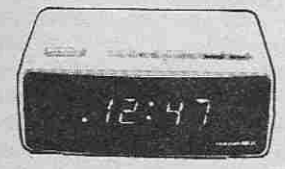

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M15

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M16

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RADIO WORLD

By Pat Hawker, G3VA

RECENTLY, BBC audience research has suggested that more than 40 per cent of all radio listeners tend to keep their receivers tuned to just one single channel. It is by no means certain whether this is due primarily to preference (channel loyalty), lack of information on programme schedules, ingrained sloth, or as I suspect, lack of confidence in their ability to tune to other channels.

Very few listeners really bother to memorise wavelengths or frequencies and at best tend to remember the "spot on the dial". In some parts of the world "channel numbers" are used, particularly for v.h.f./f.m. stations. Almost certainly a large number of radio listeners cannot readily find their way among the radio waves without the distortion that comes from inaccurate tuning or (on v.h.f.) the unpleasant sounds that stem from signals below the "f.m. threshold" unless some adjustment or repositioning is made at the same time to the telescopic rod aerial.

A couple of years ago, Duncan MacEwan, BBC's Chief Engineer, Radio, described his "ideal" radio set of the future. First on a long list of requirements was the elimination of the conventional dial and the elimination of all manual tuning in favour of touch-button or "memorised" selection.

In support of this view, I consider that one of the more important benefits to the viewer that came from moving television on to u.h.f. instead of v.h.f. was the general adoption of push-button channel selection instead of the old "turret plus fine tuner". Anyone of any age can readily change channels even if they do have to get up from their chairs to do so. The recent attempts to popularise quite complex remote control systems for television (some including "multi-function" buttons which do different things at different times) seems to me a retrograde step, at least for older viewers.

For some years I used a three-position switch-tuned v.h.f. tuner which, in combination with automatic frequency control, proved extremely easy and reliable to use; however when LBC and Capital Radio opened in the London area I was forced to modify the unit so that it now includes a manual tuning knob.

Simple to operate is not necessarily the same thing as electronically simple, of course. Indeed some of the latest tuning systems on the new, better-class of shortwave receivers are often electronically complex but, almost for the first time, make it reasonably simple for the owner to tune to a required station without having "safe-cracker's fingers"—though the constantly changing conditions of h.f. will never make shortwave broadcast reception (unless we eventually have 26MHz satellite transmissions) really granny-proof.

Saturday's private army

The dreadful news of the brutal death of Airey Neave, M.P., in the House of Commons car-bomb explosion brought back to me memories of the month I spent as an "unofficial" radio operator for his Escape-line Unit (IS9) in Holland in 1944.

At the end of October, that grim winter, I had come with an MI6 officer to Nijmegan where there existed, unknown to the enemy, a private power-supply telephone network over which it was possible to talk directly to Dutch Resistance groups in the occupied north of the country. But hardly had I set up my radio station in a house on the outskirts of the town when Major Fraser (Hugh Fraser, M.P., one-time SAS and Phantom officer) then second-in-command to Airey Neave ("Saturday" of MI9) arrived next door with his own signals operator. Foreseeing mutual interference, I attempted to argue prior rights but my claims were cheerfully swept aside by the simple expedient of IS9 moving into both houses and taking me over in a manner, I soon realised, that had characterised the Escape Unit's roystering campaign across France, Belgium and Holland.

It had certainly been an imaginative War Office appointment to put Airey Neave, the first British officer to escape successfully from Colditz, in charge of IS9 whose official task was to recover "evaders" (aircrew and others hidden in occupied territory)—but it was asking a lot of an essentially gentle character, no matter how resourceful, to keep fully under his control the cheerful tearaways and tough romantics who made up his small "private army", which had by then expanded to include sundry Canadians, Belgian SAS parachutists, Belgian and Dutch resistance workers.

They came to Nijmegan fresh from the first highly successful "Pegasus" operation which brought back some 140 Arnhem survivors, but still embarrassed by the loss of Peter Baker ("Harrier", later to be first an M.P. and then a guest of HM Prisons) who had gone bravely but foolishly and against orders across the rivers into occupied territory. IS9 began planning a "Pegasus 2" operation but from the first such plans seemed doomed. Baker had been in close touch with "King Kong" (the Dutch resistance leader who had been turned by the Germans) and there had also been an ill-advised press conference at which one of the senior officers brought out in Pegasus had spoken openly of the many Arnhem evaders still hidden on the wrong side of the rivers, Maas and Waal.

However, Pegasus 2 was helped by unusually good communications: apart from the power-supply telephone and 450MHz "S-phones" there were clandestine h.f. links via London and Eindhoven, including those of the Dutch internal radio service of the RVV and OD resistance groups. After several weeks of preparation, the operation proved, as Airey Neave described it in his book "Saturday at MI9", a grim disappointment. Many of the evaders were killed or captured in a carefully prepared ambush and it was clear that the Germans knew in advance what was afoot.

But although Pegasus 2, the last major evader operation mounted by IS9, was a tragedy, it should not be forgotten that the exploits of the escape-lines of MI9 as a whole were remarkably successful, with several thousands brought out of occupied Europe.

Shortly afterwards I left Nijmegan and the private army of IS9 to pursue a rather different aspect of the secret radio war that continued until May 1945, taking as a souvenir of those interesting weeks one of IS9's silk escape maps that is on my wall now as I write this small tribute to the man who led it.

New Contacts

Those short-wave enthusiasts and radio amateurs who assume that reflection from the F2 layer of the ionosphere always fades out above about 30MHz have been caught out already in this high maximum sunspot cycle.

Apart from reports of the reception of British television signals in the United States, many long-distance signals have been heard in Europe on the 50MHz amateur band (not normally available to amateurs in the UK). Signals from North America, South America and southern Africa have all been heard at good strength.

A new world record has been set up with a two-way 50MHz contact between amateur stations in Argentina and Korea.

Everyday News

MADLEY–1

With phone calls to and from Britain doubling every four to five years, and telex and computer data growing just as fast, the strain on the Post Office resources increases each year.

Currently running at 12 million a month, of which 4 million are accounted for by Intercontinental calls and six out of every ten go by satellite.

To help cater for this huge growth in overseas phone calls, the Post Office has just brought a new satellite communications station, Madley 1, into operation at Madley near Hereford.

With a diameter of 32m (105ft), this dish aerial is the biggest so far built for the Post Office, and will eventually be carrying up to 2,000 phone, telex or computer data calls, as well as TV transmissions, between Britain and East Africa, the Middle and Far East, India, Australia and New Zealand. Its powerful microwave radio signal, operating in the 4/6GHz band, is beamed to an *Intelsat IV*a satellite positioned 22,300 miles out in space over the Indian Ocean.

The site at Madley was selected, after a three-year search, for several reasons, namely: an "electrically quiet" area free from radio interference, particularly from the inland microwave network which uses the same frequencies. Plenty of room for expansion, altogether six such aerial complexes are planned. And, finally, easy access to good telecommunication links with London.

Work first began in autumn 1976 and it was built for the Post Office under a contract in which Marconi Communications Systems Ltd., was prime contractor, supplying the radio and communications equipment and supervised the main sub-contractors IDC Ltd. (buildings) and the Mitsubishi Electric Corporation (aerial dish). As prime contractor, Marconi Communication Systems also co-ordinated the efforts of an international team of subtractors including Mitsubishi Electric Corporation, Japan, for the antenna sub-system and Comtech, in the USA for the low-noise amplifiers.

It is foreseen that Madley 1 will be used with the next generation of international telecommunication satellites, *Intelsat V*, where the system channel capacity will be doubled. In terms of quantity of equipment, Madley 1, with its 32-metre antenna, is one of the largest satellite earth stations operating in the *Intelsat* system. In all, 55 chains of receiving equipment, 14 chains of transmitting equipment and 10 high power amplifiers give Madley 1 the capability to communicate with about 40 countries simultaneously and Marconi is already manufacturing equipment to extend this capacity.

So far, the Post Office has spent about £10 million at Madley, under its £1,000 million-a-year programme of investment in new plant needed to cater for growth and provide for new services in the future. Of this Marconi's share has been £6 million and IDC of Stratford on Avon share £1 million.

Olympic Feat

Seventy radio and 18 TV studios will be used at the Moscow Olympic Games in 1980. They will need 135 mixing consoles and to achieve all the programme, switching and talkback lines a total of 500 full-sized 19-inch racks of equipment will be needed.

Among the other equipment needed are 576 monitoring loudspeaker systems and 77 technical checking and control desks.

Shetland growth

New primary and secondary radars are being supplied to Sumburgh Airport in the Shetland Isles by Marconi and Cossor as part of a £30 million airport development programme.

North Sea oil has made Sumburgh Britain's fastest growing airport. Last year it averaged nearly 1,000 aircraft movements a week and handled nearly 700,000 passengers.

NEW LAUNCH

The latest in the UK/Ariel series of scientific satellites, *UK6*, is scheduled for launch on Ascension Day, May 24, from Wallops Island, Virginia.

It will carry cosmic ray and X-ray experiments designed by Leicester and Birmingham Universities, and University College London, to extend knowledge of high-energy astrophysics. The Royal Aircraft Establishment also has two experiments in the payload in the field of solar and CMOS arrays.

The project is funded by the Science Research Council and cost £4·0 million with Marconi Space and Defence Systems as main contractor for the spacecraft.

Just the Byte

Believed to be London's first "walk-around" Computer Store has just been opened in Tottenham Court Road, a well known landmark amongst amateur electronics enthusiasts.

At the Byte Shop, its name is derived from the computer technical term for a unit of information, everything needed to computerise a small to medium sized business is on show, from a few hundred to thousands of pounds.

In parallel with the rising demand for business and educational-type systems, the leisure and home computer markets have come into their own in recent times. For these, the Byte Shop offers a broad selection of advanced computer games, with shoppers being invited to pit their skills against chess, poker and backgammon programs compiled by "experts". Small computers that help with personal budgeting, calculate the income tax and look after the timing of H.P. instalments, are also on view.

China Trade

Trading with China, now the "in" thing, is nothing new to SE Labs (EMI) Ltd. Recent orders worth £500,000 for transducers and recording equipment are only a follow-on from trading links first established some 15 years ago.

ANALYSIS

DOING TRICKS WITH PACKETS

During the next few years we can expect to hear quite a lot about packet switching. The idea is to load international communications networks far more effectively and thus help to contain the enormous increase in traffic already forecast without a proportionate increase in the number of communications channels.

One way of obtaining higher utilisation is to increase the speed of transmission so that for any given length of time a longer message can be transmitted or, conversely, for a given message length the transmission time is reduced. This is already happening but once a channel is "seized" it is occupied by the subscriber for the duration of his call whether or not a message is actually being transmitted. And if there are pauses, then the time taken for pauses is wasted. But if the channel is shared by a number of subscribers or users and they are sending and receiving at comparatively low data rates on their local lines, all their messages can be interleaved at a high data rate on the trunk channel and it can be used continually by all subscribers rather than intermittently by single subscribers.

One way of doing this is to break up each message into small "packets" of information at local packet switching exchanges and squirt the packets down the high speed link.

The packets are then re-assembled into the complete message at the remote exchange and passed to the recipient. Although the user has lost exclusive use of a line because other peoples packets are also being transmitted, it all happens so quickly that the user appears to have a continuous and exclusive path.

You can see the snag right away. Imagine yourself at the receiving exchange of the high speed trunk channel with all these bits of messages coming in a constant stream, none of them as complete messages and for different destinations. Happily electronics comes to the rescue in the form of the mini and micro computer. Each packet of message is tagged with destination and with error protection codes and the sorting and switching is all automatic. So is automatic routing so that if long-distance satellite links are full your message can go by submarine cable or vice versa. Conversion of local low-speed data to the high-speed long-distance links and reconversion at the remote end is also automatic.

Packet switching is already in use on some private data networks. With the huge growth in data traffic it must come universally on the public networks and electronics will make it possible. The British Post Office has just started a packet switching service to the USA and will start extending the system to internal use next year.

Brian G. Peck

Take-overs

Taking over the former Tandberg colour TV factory in Scotland is Mitsubishi. The Japanese audio company Aiwa is reported as being in negotiation for a plant in Ulster.

Japanese electronics companies already manufacturing in the UK as Sony, National Panasonic (Matsushita), Hitachi (with GEC) and Toshiba (with Rank), the last two being joint ventures.

The latest entry into the great large scale memory race is ITT Semiconductors. Their Footscray, Kent, division is to produce a 64k random access memory (RAM) with samples available by mid-year and production by the end of the year.

At present they manufacture 4k and 16k memories and the 64k device is part of a £10 million development programme, of which £2 million is being funded from the Department of Industry.

PRESTEL GOES PUBLIC

The Post Office Prestel viewdata system (available only in the London area), got away to a "low-key" start with only 400 or so private subscribers due, it was said, to non-availability of suitably adapted TV sets. Rapid expansion of the service is, however, expected with a hoped-for million customers in the UK after five years.

Later this year the public service will become available to business users as well, and will be extended to Birmingham, Manchester and Edinburgh.

Prestel is based on the world-leading viewdata system invented at the Post Office's Research Centre. It puts, it is claimed, Britain years ahead of any other country in the mass marketing of electronic information.

Overseas Sales

The Post Office has exploited this world lead by selling the technology to West Germany, The Netherlands, Hong Kong and the USA, and is currently engaged in sales discussion with many other countries.

The latest country to sign an agreement to purchase Prestel software is Switzerland. This takes the form of programmes, or instructions, which control the operation of the computer on which the information is stored.

Like those with Germany and Holland, the Swiss deal is for the "pilot trial" software, designed primarily for demonstration and information development. Because Switzerland is multilingual, all the index pages will be translated into French and German.

The Post Office budget for Prestel this year is £30 million and the technology is selling world-wide.

New Standards

The first part of a major revision of BS3549 "Methods of Measuring and Expressing the Performance of Television Receivers" has just been published by the British Standards Institute.

Of particular interest to television manufacturers and service engineers, it is being extended to include appropriate requirements for colour television.

Part one is entitled "General Considerations and Electrical Measurements Other Than Those at Audio Frequencies" and copies can be obtained from BSI Sales Department, price £12·20. The complete works will consist of four parts and will be issued at a later date.

A solid-state matrix camera for industrial and commercial use has been developed by Reticon Corp. It has 10,000 photodiodes on a 6mm square silicon chip. It can be used for generating a TV picture or for applications like optical character recognition and pattern and shape recognition. UK agent is Herbert Sigma, Letchworth, Herts.

RUMMAGING AROUND

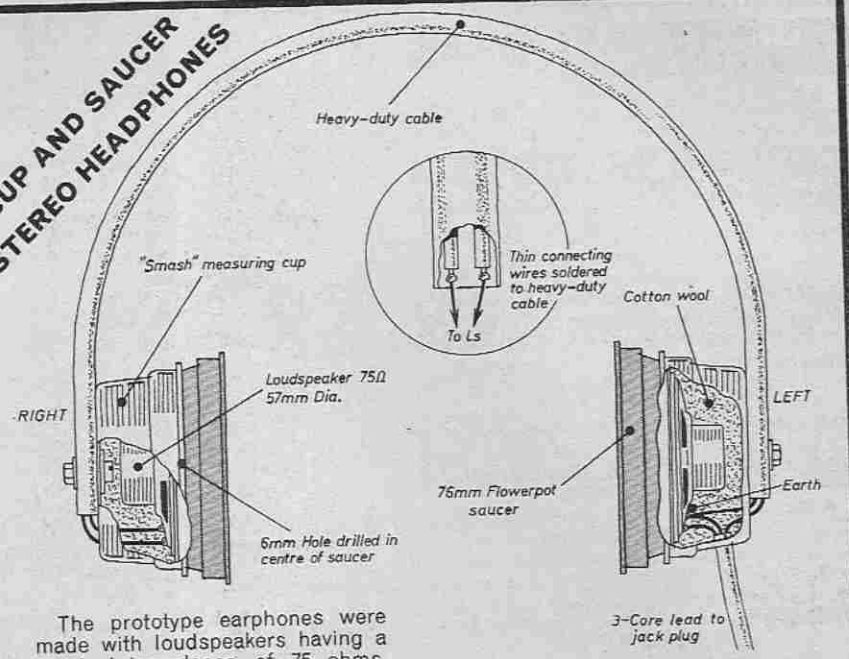
with Keith Cadbury

ONCE one "goes into" electronics, and friends and relatives discover one's new interest, the well-meaning darlings start to off-load all manner of old electrical fittings and super-heterodyne white elephants. We smile and thank them politely, dumping ninety per cent of it straight in the dustbin, but we do not discourage them, for the odd ten per cent of their junk may prove of value.

Such was the case when I took delivery of a car boot-load of old 15A ceramic wall sockets and plugs, from a relative whose house had recently been rewired. Having decided that 15A plugs do not marry easily with 0·1 inch Veroboard transistor and i.c. layouts, the screws were removed, and the rest dumped.

Amongst this stuff was also a few yards of heavy duty wiring cable, which was kept, for some unthinkable contingency. This cable, some 15mm wide, and 8mm thick, and covered in heavy grey plastic sleeving, has made a fine headband for the home-made stereo headphones which I describe this month.

CUP AND SAUCER STEREO HEADPHONES



The Stereo Headphones described here can be constructed with items that will be found in many a junk box, yet the prototype was found, after many comparisons, to be capable of better sound reproduction than some commercial phones.

First, acquire two plastic measuring cups, as found in tins of Smash instant potatoes. Purchase two 76mm plastic flowerpot saucers. After drilling a $\frac{3}{8}$ inch hole through the centre of each flowerpot saucer, you will find that a 57mm diameter loudspeaker will fit snugly between the flanges on the underside of the saucer, and that the *Smash* measuring cup will fit over the two, with an amount of swivel adjustment available from the "ball-and cup" movement.

The prototype earphones were made with loudspeakers having a nominal impedance of 75 ohms, which allows them to be used of course with any output up to that impedance, and the higher rating means that they are slightly reduced in sensitivity, which is an asset particularly when the phones are to be connected to the loudspeaker outputs of equipment that does not boast an earphones socket.

Obtain a length of heavy duty electrical cable (as referred to above). About 460mm should be sufficient.

The beauty of a headband made from such cable is that it is suitably bendable, already covered, and has insulated conductors through the middle. With a little manoeuvring, the copper conductors can be cut and worked back into the outer sleeving, after soldering a length of single- or multi-stranded wire of more manageable diameter, to the ends of the two outer conductors.

Drill a $\frac{3}{16}$ inch hole through the centre of the cable, about 20mm from each end, make a similar diameter hole through the centres of the *Smash* measuring cups, and fix with suitable bolts, washers and nuts.

Now fix the speakers to the flowerpot saucers, a suitable adhesive being *UHU*, or aircraft glue. After making two tiny holes in suitable places in each cup, thread the small wires through, and allowing the minimum working length, cut, bare and solder to the speaker at one end, soldering the wires to the speaker at the other end.

A suitable hole is made in the second cup also for the supply lead, which must have three cores —low-current mains cable would suffice, although the writer used four-core GPO cable, one core being cut back, and not used.

Having bent the headband into shape, and checked that all is working OK, the saucer baffles and cup enclosures are now adjusted to suit the wearer, and then glued together.

After fixing a stereo jack plug to the other end of the supply flex, the headphones are ready to be used. Some sort of lambswool, chamois leather or plastic edging could be affixed to the edges of the plastic saucers, but the bare rims have proved to be very comfortable when worn for long periods of recording, and certainly less "sweaty" than conventional padded plastic muffs previously endured.

The omission of such material probably also improved the bass response, through direct contact with the bone area around the ears. In tests, there seemed to be response even when a 100Hz Baxandall bass circuit was adjusted.

Such a claim would appear to be unlikely, and the only explanation seems to be that there is a direct transmission of bass notes through the bone. The 76mm flowerpot saucer does however allow a greater area for resonance than conventional headphones, and this may also contribute to the increased sound spectrum evident.

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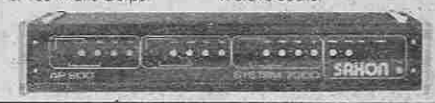

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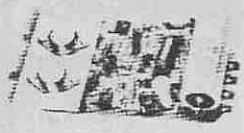

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POCKET RADIO

By J. Herron

IT IS VIRTUALLY impossible today to build a pocket radio which can compare in price and performance with the mass produced Japanese radios which are currently on the market. To build a radio of similar performance would involve a great deal of time and would probably cost much more than if you had purchased one in the first place.

However, the cost is not the most important factor in this hobby, it is the experience and knowledge gained and the excitement of putting together electronic components to produce, in this case, a source of entertainment and information.

This receiver is not intended to compete with the far superior superheterodyne type of radio, but was designed with simplicity in mind and the use of a p.c.b. makes it a suitable project for the novice constructor.

CIRCUIT DESCRIPTION

Two integrated circuits are used, one is the ZN414 t.r.f. radio i.c., the other an LM380 small power amplifier i.c. The circuit diagram of the radio is shown in Fig. 1.

The ZN414 is in itself a complete a.m. receiver (less aerial and tuning capacitor) and as such could be used on its own without an amplifier if only headphone reception is required.

This i.c. requires a supply of between 1·1 and 1·5 volts, and unless this is reasonably stable, whistles and distortion will result. Perhaps the easiest method of obtaining this voltage is the system shown in the circuit. Here two diodes are connected in series across the supply voltage.

In a silicon diode, the junction does not conduct until the potential across it reaches a certain minimum, about 0·6V. When the diode does conduct the voltage across it remains steady at this voltage. Thus with two diodes connected in series we obtain 1·2V, which is within the limits of the i.c. Resistor R3 is a current limiting resistor for the diodes.

TUNED CIRCUIT

The tuned circuit, consisting of L1 and C2 selects the required frequency. After amplification and detection within the i.c. an audio output is available at pin 3, and thus across the volume control VR1.

Resistor R1 provides feedback between the output of IC1 and its input. Resistor R2 together with the supply voltage sets the overall gain, and in most cases will be sufficient. However there may be times where more sensitivity is required, if this is so then the value may be adjusted to suit. However, the value is rather critical, and if a value very different from that specified is used, it may result in instability.

With the given values for L1 and C1, a high *Q* tuned circuit is produced resulting in good selectivity. The values of both coil and capacitor may be altered if a tuning range other than medium waves is required. It is possible by careful changes in values to tune from the long wave band up to the 160m Amateur band.

AUDIO AMPLIFIER

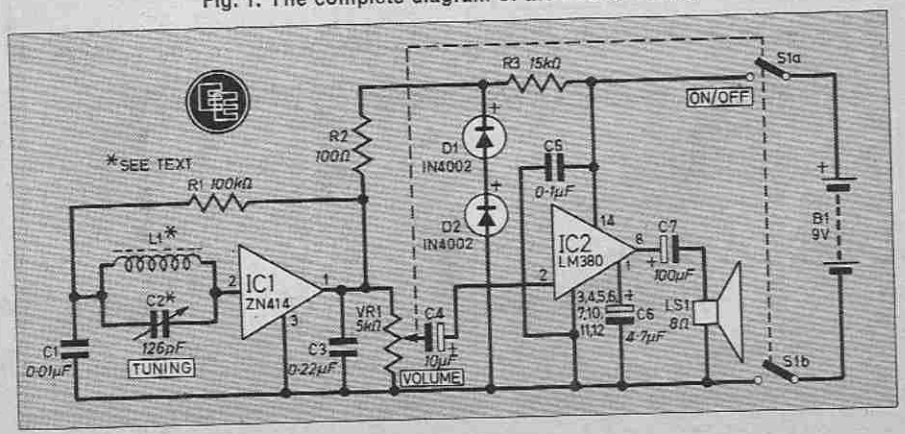
As the output from the ZN414 is unsuitable for direct connection to a loudspeaker an amplification stage is incorporated in the form of IC2, a general purpose audio i.c. type LM380. This i.c. has a fixed gain of 50 and can deliver up to 2 watts.

The only component which needs to be mentioned is C5. This decouples the power supply and eliminates instability. It is important that this is mounted close to the i.c.

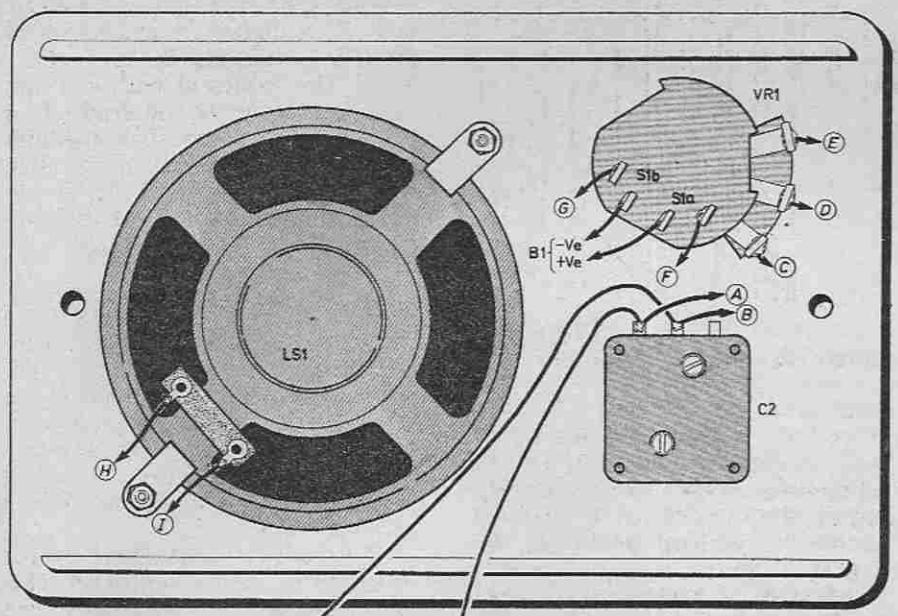
CONSTRUCTION starts here

All the wiring details are shown in Fig. 2. A printed circuit board layout is shown and in the interests of stability this should be used. It *is* possible to use some other form of wiring, such as stripboard but this is not really to be

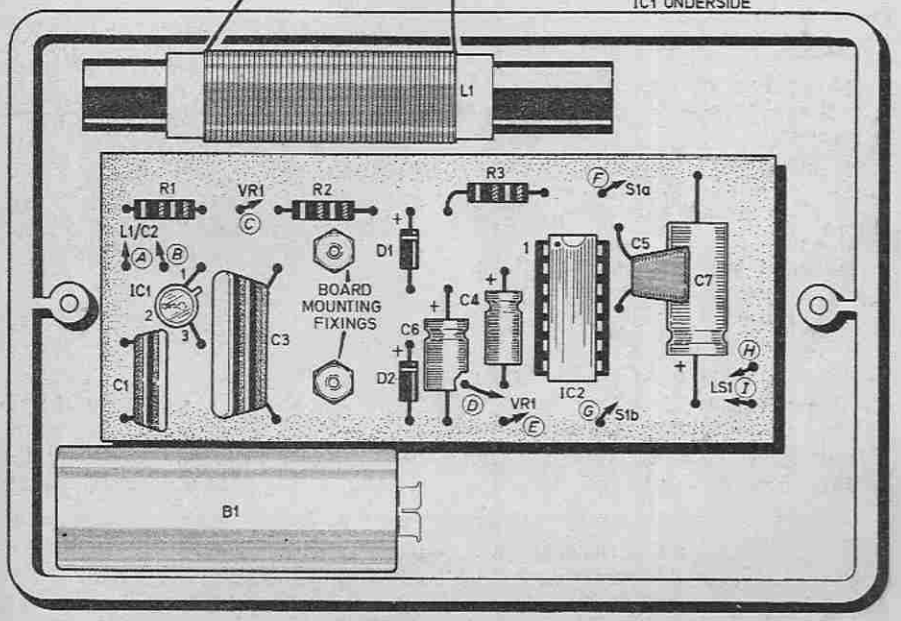
Fig. 1. The complete diagram of the Pocket Radio.

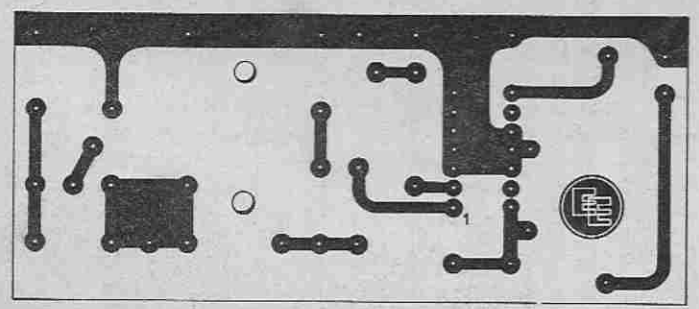


POCKET RADIO



IC1 UNDERSIDE





COMPONENTS

Resistors
- R1 100kΩ
- R2 100Ω
- R3 15kΩ

All ¼W carbon ± 5 %

Potentiometer
- VR1/S1 5 kilohm log. with ganged switch.

Capacitors
- C1 0·01μF polyester
- C2 126pF nominal, plastic dielectric tuning capacitor
- C3 0·22μF polyester
- C4 10μF 10V elect.
- C5 0·1μF polyester
- C6 4·7μF 10V elect.
- C7 100μF 10V elect.

Semiconductors
- IC1 ZN414 t.r.f. radio i.c.
- IC2 LM380 audio amplifier
- D1, D2 1N4002 silicon diode (2 off)

Miscellaneous
- L1 80 turns 28 s.w.g. enam. copper wire (see text)
- LS1 8Ω 60mm diameter loudspeaker
- B1 9V PP3 battery

Plastic case type PB1 or similar, minimum size 115 × 75 × 40mm; printed circuit board; ferrite rod, 10 × 75mm; 28s. w.g. enamelled copper wire; battery clip to suit B1; one 14-pin i.c. socket; small round control knob; tuning knob 40mm diameter; connecting wire.

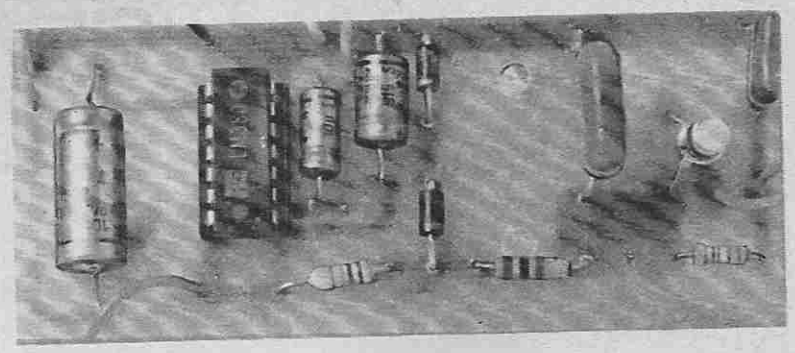
Fig. 2. Complete wiring details for the radio. At top left is shown the topside of the p.c.b. and its position in the case. Note also the positions of the battery and coil. It is important that they are placed in these positions otherwise the lid will not fit in place. Next comes the rear of the front panel showing the connections required to the various controls. Finally at bottom is the underside of the printed circuit board, which is shown full size.

COMPONENTS approximate cost £6.50

recommended. Incidentally for those who have never made a p.c.b., this is an ideal project to start with as it is very simple to build.

All interconnecting wires should be as short as possible, particularly the leads from the coil to the tuning capacitor, and from the capacitor to the board.

If the beginner is unsure about his ability to solder, particularly IC1, it is recommended that a three-pin transistor socket is used.



Components mounted on the printed circuit board.

CASE

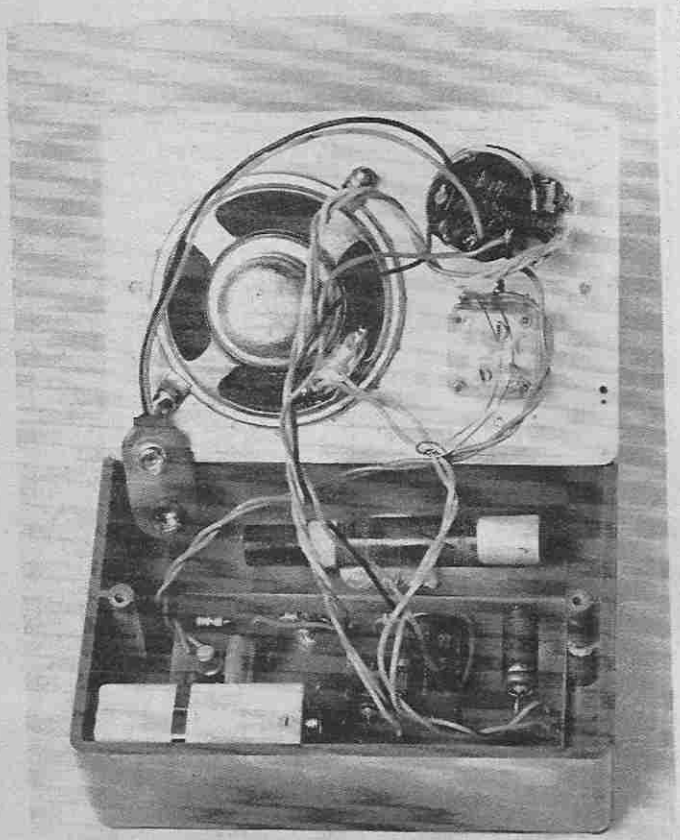
The prototype was built in a commercial plastic case, type PB1. There is of course no reason why a different case already to hand cannot be used, providing it is not metal and has minimum dimensions of 115 x 75 x 38mm. No drilling details are given as they and the size of the case will depend to a large extent on the size of components used.

The p.c.b. was mounted on the bottom of the case using two 6BA screws and nuts. The battery can be held in place by double-sided adhesive tape or Blu-Tak.

COIL

The coil, L1, is a home-made component and is constructed by winding 80 turns of 28 s.w.g. enamelled copper wire, close wound on a paper former, which is then slid over a 10mm ($^3/_8$ inch) ferrite rod. The length is unimportant providing it is at least 75mm long and can also fit in the case.

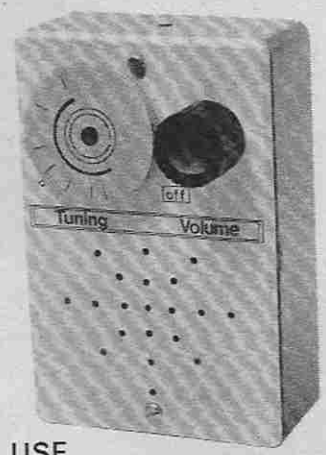
The tuning capacitor C2 was salvaged from an old miniature radio, but a readily available type can be obtained from a number of suppliers. It is not essential to keep to the value specified as the tuning range is quite wide. Indeed, it may be an advantage to use an old capacitor already to hand, and change the number of turns on the coil, particularly if a different tuning range is envisaged.



SPEAKER

The speaker was attached to the front panel using two small clamps and countersunk 6BA screws. Alternatively the speaker can be stuck down using an impact adhesive if it is desired not to mar the front panel.

Letraset or similar can then be used to label the front panel as required.



IN USE

After construction has been completed, and the board and other wiring checked for errors the battery may be connected.

Connect the battery and switch on, rotate the volume control until a "hissing" sound is heard—this is white noise being picked up by the radio and suggests that it is working correctly.

Rotate the knob of C2, whereupon a number of stations should become audible. If none are heard then this is probably due to the coil being in the wrong position on the ferrite rod. Sliding the coil along the rod while at the same time adjusting C2, you should be able to find a position where a number of stations come in at roughly the same level. If all is well the coil can be stuck in position. Blu-Tak or similar is suitable.

The receiver gives good reception of local stations, and after dark many overseas stations can be picked up. The number and their level depends to a large extent on your location and of course the time of day.

Although the ZN414 is not being utilised to its full capacity, it nevertheless gives quite good results despite its simplicity. ☐

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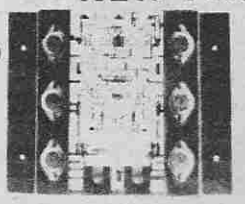

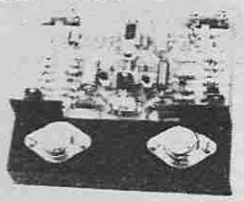

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CA3076	250p	LM710T05	60p	TAA550	35p	TCA760	300p
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CA3084	250p	LM723T05	40p	TAA661B	140p	TDA1008	350p
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CA3086	60p	LM741	20p	TAA790	350p	TDA2002	300p
CA3088	190p	LM748	40p	TAD100	150p	TDA2020	300p
CA3089	160p	LM1303N	100p	TAD110	130p	TL084	120p
CA3090AQ	360p	LM1458	100p	TBA120S	60p	XR320	250p
CA3123E	130p	LM3080	75p	TBA120T	85p	XR2206	450p
CA3130	100p	LM3900	55p	TBA480Q	200p	XR2207	450p
CA3140	60p	LM3909N	65p	TBA520Q	200p	XR2208	600p
LF356	90p	MC1310P	140p	TBA530Q	200p	XR2216	650p
LF357	80p	MC1312P	150p	TBA540	200p	XR2567	250p
LM211H	250p	MC1314P	190p	TBA550Q	250p	XR4136	150p
LM300TRS	170p	MC1315P	230p	TBA560C	250p	XR4202	150p
LM301AN	30p	MK50398	850p	TBA641A12	250p	XR4212	150p
LM304	200p	MM5314	380p	TBA700	180p	XR4739	150p
LM307N	65p	MM5316	488p	TBA720Q	225p	ZN414	100p
LM308T05	100p	NE529K	150p	TBA750Q	200p	95H90	700p
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LM309K	100p	NE556	90p				
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7411	15p	7448	50p	7497	120p	74147	100p	74174	60p	74197	50p
7412	15p	7450	12p	74100	80p	74148	90p	74175	60p	74198	100p
7413	25p	7451	12p	74104	40p	74150	65p	74176	50p	74199	100p
7414	45p	7453	12p	74105	40p	74151	45p	74177	50p	74293	90p
7416	25p	7454	12p	74107	25p	74153	45p	74178	75p	741500	18p
7417	25p	7460	12p	74108	100p	74154	70p	74179	120p	745112	80p
7420	12p	7470	25p	74109	25p	74155	45p	74180	90p		
7421	20p	7472	20p	74118	75p	74156	45p	74181	130p		
7422	15p	7473	25p	74120	80p						
7423	20p	7474	25p	74121	25p						
7425	20p	7475	25p	74122	35p						
7426	22p	7476	25p	74123	40p						
7427	22p	7480	40p	74125	35p						
7428	25p	7481	85p	74126	35p						
7430	12p	7482	75p	74128	60p						
7432	20p	7483	75p	74130	120p						

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S.W. CONVERTER
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SHAVER INVERTER
TOUCH BLEEPER
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We can supply all parts required except the components for the RF unit for approx. **£40.** Send SAE for detailed list.

NOTE: A more detailed list of parts supplied in these and other kits is available on receipt of a SAE.

Most E.E. Projects back to SEPTEMBER 1978 available.

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RELAYS
W847 Low profile PC mntg 10×33×20mm 6V coil, SPCO 3A contacts. **93p**
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Copper TO5 sink 17mm dia × 20mm. 10 for **40p**; 100 for **£3**; 1000 for **£25**

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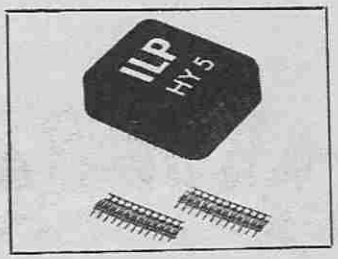
Size 36 × 18" 200g. Hundreds of uses around the home. 100 sheets for **£1·50**. Box of 1500 for **£19**

15—240 Watts!

HY5
Preamplifier



The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

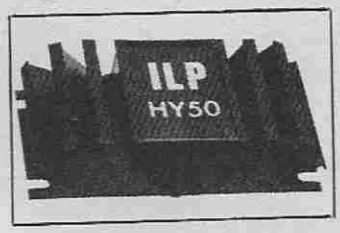
FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; Input impedance 47kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.

Price £6·27 + 78p VAT P&P free.

HY30
15 Watts into 8Ω



The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.

Price £6·27 + 78p VAT P&P free.

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

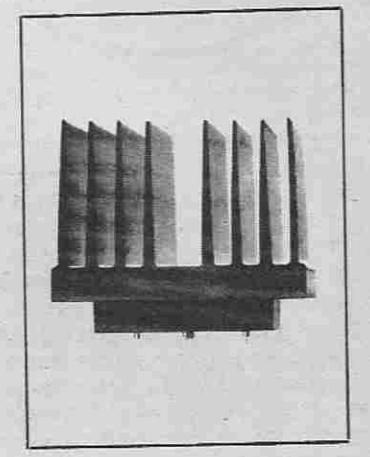
FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm

Price £8·18 + £1·02 VAT P&P free

HY120
60 Watts into 8Ω



The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm

Price £19·01 + £1·52 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

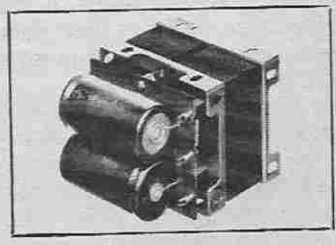
FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm

Price £27·99 + £2·24 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm

Price £38·61 + £3·09 VAT P&P free.

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PSU35 suitable for two HY30's **£6·44** plus **81p** VAT. P/P free.
PSU50 suitable for two HY50's **£8·18** plus **£1·02** VAT. P/P free.
PSU70 suitable for two HY120's **£14·58** plus **£1·17** VAT. P/P free.
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QUAD SIMULATOR

BY B. YORK

FOR THREE OR FOUR SPEAKER SYSTEMS

Optional headphone output available.
Stunning results from stereo records!

TRUE QUADRAPHONIC systems often use complex electronic circuitry to achieve the end result, which to many people is basically a surround-sound type of effect.

The original concept has probably been largely forgotten due to the often fanciful "gimmicky quad" type of records. It would seem therefore perfectly acceptable to relate the "surround-sound" type of effect to true Quad, although one must make the statement that the two are completely different but in most instances the effect is hardly noticeable.

This has in fact been proved by the prototype which has been in use by the author now for several months, and on many occasions has fooled a few "hi fi knowalls" in believing that they are listening to true quadraphonic.

The purpose of this article is to describe an add-on unit, which when connected to your existing stereo equipment will give quite a good quadraphonic effect. The difference in signals between the two rear speakers is sufficient to be detected, the resulting overall sound akin to that of "surround-sound". In fact the more the stereo separation in the original recording, the greater and more dramatic the quadraphonic effect will be.

PRINCIPLES

The basis of the Quadraphonic Simulator is a modification of the Hafler configuration.

Hafler demonstrated, that by adding a single speaker behind the listener and using the difference signals between left and right channels, interesting quadraphonic effects could be achieved, Fig. 1. However by using two speakers out of phase with each other a more realistic effect can be achieved, Fig. 2.

There are at least two disadvantages to the arrangement of Fig. 2.

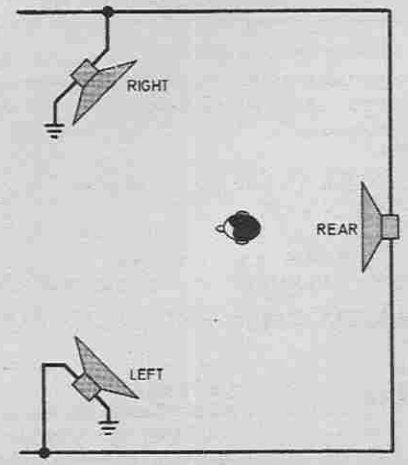


Fig. 1. Hafler's basic idea of adding a single speaker.

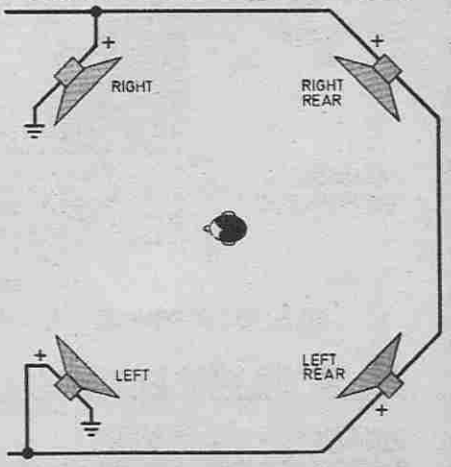


Fig. 2. By using two speakers, a more dramatic effect is obtained.

QUAD SIMULATOR

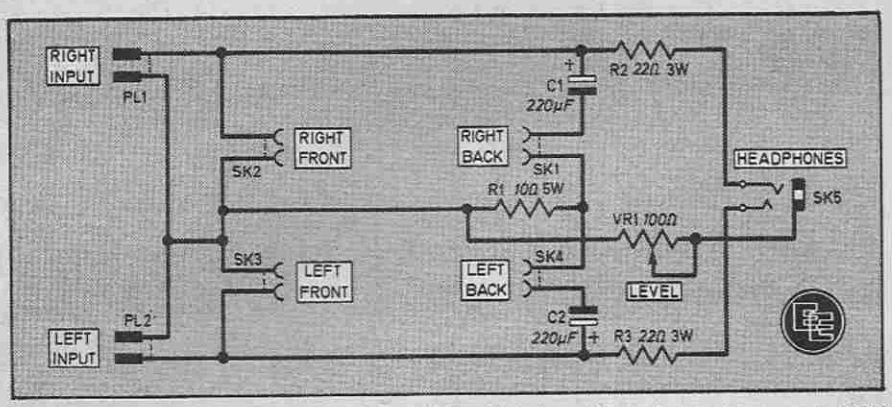
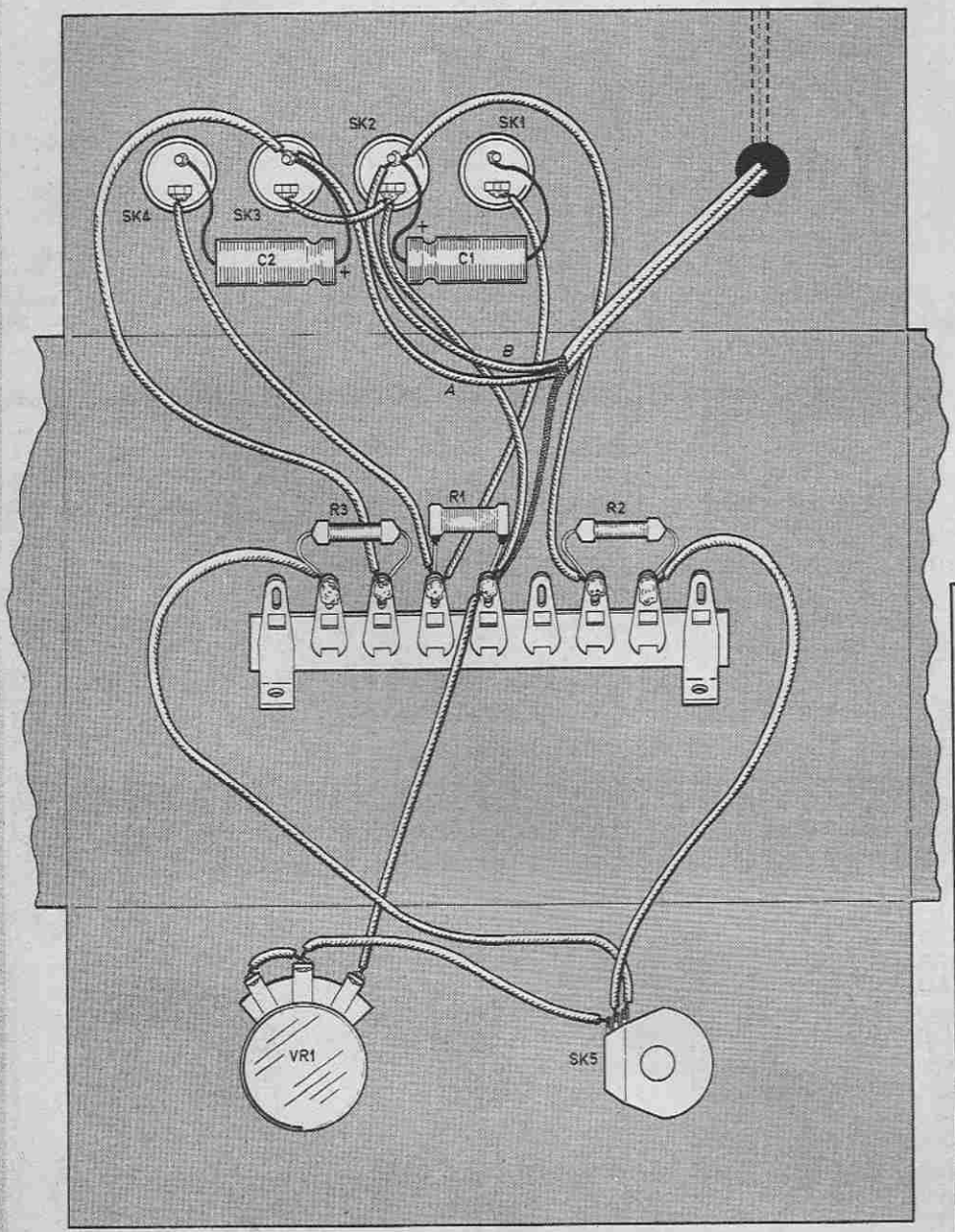
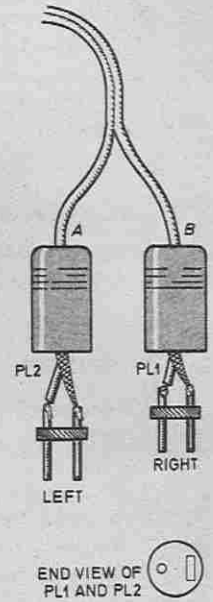


Fig. 3. Circuit diagram of the Quad Simulator. This is suitable for systems up to 10W r.m.s. output.





COMPONENTS

Resistors
R1 10Ω 5W
R2 22Ω 3W
R3 22Ω 3W
All are wirewound ± 5%

Potentiometers
VR1 100Ω 3W wirewound

Capacitors
C1 220μF 16V elect.
C2 220μF 16V elect.

Miscellaneous
PL1, 2 2 pin DIN plug (2 off)
SK1-4 2 pin chassis mounting DIN socket (4 off)
SK5 standard insulated stereo jack socket
Aluminium or plastic case to choice, approximate dimensions: 152 × 102 × 57mm; small round plastic knob; length of twin screened cable; nine way tag strip with two tags earthed; connecting wire.

Fig. 4. Complete wiring details for the unit. Note the case has been "opened out" for clarity. There is nothing critical about the layout and could be varied as required.

COMPONENTS approximate cost £3.25

One being that the connection of the extra speakers tends to reduce the separation between the main channels. Secondly, the volume of the rear speakers can only be adjusted by adding low value resistors in the main speaker circuit: this may be inconvenient and could cause a mismatch.

Despite these disadvantages the circuit here seems to function quite well.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Quadraphonic Simulator is shown in Fig. 3.

The first point to notice about the circuit is the similarity between it and the Hafler configuration. The one major difference being the inclusion of R1. This is basically included to reduce the level of signal applied to the rear speakers.

Remember of course that not a great deal of volume is needed in the rear speakers, thus the reduction in volume is hardly noticeable.

HEADPHONE OUTPUT

An addition to the basic circuit is the provision of a headphone output, this part of the circuit consists of R2, R3, VR1 and the output socket, SK5. Here the two fixed resistors set the basic limit on the volume through the headphones.

Since you are mixing both front and back signals, the effect in the headphones is not the same as with speakers, nevertheless, the effect is still quite original. From this point of view, the variable resistor VR1 is included to be able to mix the two signals in varying degrees, to produce the most pleasing effect.

CONSTRUCTION starts here

The unit is quite easy to build, and could if desired be incorporated inside your hi fi system. This would mean a fair amount of change in the hi fi set-up so is not recommended for the beginner.

An option is available whereby the headphone output components could be omitted. If this is done, wiring it into the hi fi system would be that much easier. The option also exists if the unit is to be as originally intended, and that is as an outboard item.

All the wiring details are shown in Fig. 4. There is nothing critical about the layout and could be varied if required. A tag strip is used as a central connection point for most of the wiring. Note that although twin screened cable is shown for the input connection, this is by no means essential and ordinary four core cable can be used.

The choice of case is also up to the constructor, either a metal or plastic type can be used, and it is not essential to keep to the dimensions specified. Thus any case which the constructor has to hand can be used.

When using a metal case it is important to use insulated sockets, particularly for SK5. If this is not observed then a situation will occur where the jack plug could possibly come into contact with earth, the resulting large increase in volume doing something terrible to the listeners nerves!

IN USE

Once constructed and checked for any mistakes the unit can then be put to use.

Simply disconnect the original loudspeakers from the hi fi and plug them into the unit sockets marked LEFT FRONT and RIGHT FRONT. Connect an additional pair of speakers to the remaining two sockets, and connect the two leads into the speaker output sockets of the hi fi. When completed the unit is ready for use.

As stated earlier, VR1 is used to give a reasonable balance when using headphones.

The Quad Simulator has now been used by the author for some time, and has been found of sufficiently high quality to solicit several requests for the cricuit and other details.

It is for this reason that the design has been presented here with the hope that many who build the simulator will have many hours of pleasure rediscovering old stereo recordings. ⌑

JACK PLUG & FAMILY... BY DOUG BAKER

WORKSHOP MATTERS

By Harry T. Kitchen

Organisation

The pleasure that is derived from the construction of electronic equipment is very largely governed by the quality of that construction, and that in turn can be governed by the facilities available. My earliest forays in this direction were in a tiny bedroom that constituted my "digs", and this in turn required a very surreptitious manner of working. I now have the luxury of a room devoted to photography and electronics. In between I have made do in all sorts of ways. The advice that follows is therefore exceedingly practical.

Firstly, always endeavour to avoid falling foul of the authorities, be they wife, mother, landlady, or who ever. This is plain commonsense, since falling foul of them may mean that your activities may be curtailed; terminated even. There is a more basic reason than this, and this is good old fashioned courtesy. Let courtesy be your key word, and if anything fails, at least you will have a clear conscience.

Component Storage

Assume you have been granted certain facilities. Off you go. Then comes the time to clear all up after you. Where do you store everything? The less storage space, the greater the need for a disciplined mind. You can stuff everything into cardboard boxes, and of course they will suffice. Until they disintegrate. Jam jars are more durable if handled with care, and the contents can be reasonably easily identified. Better, but not ideal.

I have yet to find anything better, for the storage of most electronics components, than the plastic drawers that slot into one another, both vertically and horizontally. They are available in several sizes, all compatible. Labels can be inserted into the fronts of the drawers aiding identification of the contents; the transparent fronts are an aid here. I have a large number of these drawers, bought over a period of several years. These house all my resistors, capacitors, transistors, diodes, as well as the veritable multitude of "small things" that are such an adjunct to our hobby.

The resistors and capacitors are housed in decade increments. Resistors of differing wattages or tolerances are segregated. Similarly, capacitors are segregated into types; electrolytic, polycarbonate, polystyrene. Transistors are segregated into types: germanium or silicon; r.f. or a.f.; high power or low power.

Rigid segregation is the key to efficiency and speed, and whilst it may sound profligate, remember that you can buy drawers as you require them; I bought mine in lots of two dozen. I have never regretted doing so.

Tool Care

Tools cost money. In the interests of reliability and longevity, they should be treated with care and not chucked carelessly into a pile. Cardboard boxes can be pressed into use, within the foregoing proviso. Tool rolls can be made or bought, and are to be preferred.

If your tool collection is at all extensive, a proper tool box is well worth while. I have several "engineers" tool boxes, bought when they were around £4 each. They very probably cost double that now, but they are to be recommended. A useful compromise is the partitioned drawer sold for the storage of cutlery.

When you have completed a constructional session, particularly on "borrowed" premises, i.e. the kitchen table (beware, I have a patent on 'em!), always clear up properly after you. It takes very little time, but it can go a very long way indeed towards the maintenance of cordial relations all round.

Buying Components

We have so far considered the organisation of the home workshop as though it were *fait accompli*. This it will not always be. There will be the occasional constructor who will buy his components as he requires them. No storage problem for him. Others, like myself, will like to keep a large variety of components in stock so that almost any project can be commenced without the infuriating delay of obtaining components to suit.

My decade storage may be a clue to my buying philosophy. Yes, I buy my resistors and capacitors in decades, in every sense of the word. Several years ago I saw an advertisement for 5 per cent ½W carbon film resistors at ridiculous prices. I bought a few to check. They were eminently satisfactory, so in I plunged.

I bought 10 off every decade in the E12 series from 10Ω to 10MΩ. A lot of resistors indeed, and they have been very well worth while. At a later date I added 5 per cent ¼W carbon film resistors, and a variety of wire wound types. Then came a consignment of "computer stock" 2 per cent ¼W metal film.

Similarly with capacitors. I bought 10 off every decade in the Mullard C280E series, plus a wide variety of electrolytics and polystyrenes. The electrolytics are axial-ended, and I set an upper limit of 16 volts working as I did not envisage frequent use of higher voltages. Besides, my money had run out!

Transistors

The transistor problems were solved by buying a selection of the most commonly used types, a.f. and r.f., low and high power. Some complementary types were also bought. For diodes, I decided to standardise on the 1N4004 and 1N914 types, and these fulfil the vast majority of existing equipments. These semiconductors augmented an existing stock, and not for worlds would I part with my "red spot", "white spot" or "top hat" germanium transistors, or the equally venerable GEX34 series of diodes, plus the odd GET1 transistor. They're almost museum pieces!

My philosophy is designed primarily for convenience, and if you agree with it, fine. If not, modify it to suit yourself. Many firms now advertise resistors and capacitors at very low prices, and give a small discount if 10 or more of each value are bought.

The same sometimes applies to semiconductors. I have never, ever, bought dubious ("unmarked", "remarked", or whatever) semiconductors. Use such components, and what do you do if your equipment fails to function? You could end up mystified and miserable, all for the sake of a few coppers. Is it worth it?

"Make me happy, darling—give me the run of your electronic components shop."

BOOKS AND COMPONENTS

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BP50	IC LM3900 Projects	£1·35†
BP55	Radio Stations Guide	£1·45†
BP160	Coil Design & Construction Manual	85p†
BP202	Handbook of Integrated Circuits Equivalents & Substitutes	75p†
BP205	1st Book Hi-Fi Speaker Enclosures	75p†
BP213	Circuits for Model Railways	85p†
BP215	Shortwave Circuits & Gear for Experimenters & Radio Hams	85p†
BP216	Electronic Gadgets & Games	85p†
BP217	Solid State Power Supply Handbook	85p†
BP221	28 Tested Transistor Projects	95p†
BP222	Short-wave Receivers for Beginners	95p†
BP223	50 Projects using IC CA3130	95p†
BP224	50 CMOS IC Projects	95p†
BP225	A Practical Intro to Digital IC's	95p†
BP226	Build Advanced Short-wave Receivers	£1·20†
BP227	Beginners Guide to Building Electronic Projects	£1·25†

NEWNES BOOKS

V.A.T. Zero Rated

Order No.	Description	Price
	QUESTIONS & ANSWERS:	
216	Transistors 3rd Ed.	£1·00
217	Integrated Circuits	£1·00
218	Radio & Television	£1·25
219	Electronics	£1·15
220	Colour TV 2nd Ed.	£1·15
221	HI-FI	£1·15
222	20 Solid State Proj. for Car	£1·95
223	20 Solid State Proj. for Home	£1·95
224	110 Int. Circ. Proj. for Home	£2·95
225	110 Thrysistor Projects	£2·50
226	Operational Amp. Proj. for Home	£2·50
227	110 Practical IC Proj. for Home	£2·75
228	Electricity	£1·15
229	Beginners Guide to Electronics	£2·25
230	Beginners Guide to Television	£2·25
231	Beginners Guide to Transistors	£2·25
232	Beginners Guide to Electric Wiring	£2·25
233	Beginners Guide to Radio	£2·75
234	Guide to Colour T.V.	£2·25
235	Electronic Diagrams	£1·80
236	Electronic Components	£1·80
237	Printed Circuit Assembly	£1·80
238	Transistor Pocket Book	£3·90
239	50 Photoelectric Circuits	£1·88
240	Semiconductor Handbook Part 1	£5·25
241	Semiconductor Handbook Part 2	£4·28
242	Electronics Pocket Book	£3·90
243	Radio Value & Semiconductor Data	£2·40
244	Beginners Guide to Integrated Circuits	£2·75
209	BI-PAK TTL Data Book	50p
	BI-PAK CMOS Data Book	45p

P.C.B. BOARDS

C26 4 pieces 8" × 3½" (approx.) Single-sided fibreglass 80p
C27 3 pieces 7" × 3½" (approx.) Double-sided fibreglass 60p

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	14p*
DPDT standard slide	1974	15p*
Toggle switch SPST 1½ amp 250V a.c.	1975	33p*
Toggle switch DPDT 1 amp 250V a.c.	1976	42p*
Rotary on-off mains switch	1977	50p*
Push switch—Push to make	1978	14p*
Push switch—Push to break	1979	18p*

ROCKER SWITCH	Colour	No.	Price
A range of rocker switches SPST—moulded in high insulation. Material available in a choice of colours ideal for small apparatus.	RED	1980	30p*
	BLACK	1981	30p*
	WHITE	1982	30p*
	BLUE	1983	30p*
	YELLOW	1984	30p*
	LUMINOUS	1985	30p*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	70p*
Miniature SPST toggle, 2 amp 250V a.c.	1959	75p*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	80p*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	95p*
Push button SPST, 2 amp 250V a.c.	1962	90p*
Push button SPST, 2 amp 250V a.c.	1963	95p*
Push button DPDT, 2 amp 250V a.c.	1964	£1·20

MIDGET WAFER SWITCHES

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

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

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

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	7p*
1¼in x ¼in chassis mounting	507	12p*
1¼in car inline type	508	16p*
Panel mounting 20mm	509	20p*
Panel mounting 1¼in	510	30p*

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611 6p	1A	615 5p	3A	619 5p
250mA	612 5p	1·5A	616 6p	4A	620 9p
550mA	613 5p	2A	617 5p	5A	621 5p
800mA	614 7p	2·5A	618 6p		

ANTI-SURGE 20mm

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

All 7p each

QUICK BLOW 1¼in

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

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
2A	637	3A	639	5A	642

All 6p each

NUTS AND BOLTS

BA BOLTS—packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·20	¼in 4BA	846	32p
¼in 0BA	840	75p	¼in 4BA	847	25p
1in 2BA	842	65p	1in 6BA	848	40p
½in 2BA	843	45p	½in 6BA	849	21p
¾in 2BA	844	52p	¾in 6BA	850	25p
1in 4BA	845	44p			

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

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

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

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

SOLDER TAGS—not tinned supplied in multiples of 50.

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

TRANSFORMERS

MINIATURE MAINS Primary 240V

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

MINIATURE MAINS Primary 240V with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1·00
2025	MT150-0-12V, 0-12V RMS	£1·00

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·60*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
2029	15V-0-15V 1 amp	£2·75*	P. & P. 65p
2030	30V-0-30V 1 amp	£3·45*	P. & P. 85p

STANDARD MAINS Primary 240V

Multi-tapped secondary mains transformers available in ½ amp. 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

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

No.	Rating	Price	
2031	½ amp	£3·40	P. & P. 85p
2032	1 amp	£4·40	P. & P. 85p
2033	2 amp	£5·45	P. & P. £1·10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	60p*
113	3·5mm Jack plug to 3·5mm jack plug. Length 1·5m	75p*
114	5 pin DIN plug to 3·5mm. Jack connected to pins 3 & 5. Length 1·5m	85p*
115	5 pin DIN plug to 3·5mm. Jack connected to pins 1 & 4. Length 1·5m	85p*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·25*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	68p*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·08*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0·2m	90p*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	80p*
123	6·6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·80
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	75p*
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	75p*
126	5 pin DIN plug to Tinned open end. Length 1·5m	75p*
127	5 pin Din plug to 4 Phone Plugs. All colour coded. Length 1·5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	80p*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	68p*
131	5 pin DIN plug to 3 pin DIN plug. 1 & 4 and 3 & 5. Length 1·5m	83p*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	98p*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3 & 5. Length 1·5m	75p*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3 & 5. Length 23cm	68p*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3 & 5. Length 23cm	68p*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1·75*
178	AC mains lead for calculators etc.	45p*

CASES AND BOXES

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

No.	Length	Width	Height	Price
155	8in	5¼in	2in	£1·25
156	11in	6in	3in	£2·12
157	6in	4¾in	1¾in	£1·38
158	9in	5¼in	2¼in	£1·78

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

No.	Length	Width	Height	Price
159	5½in	2¼in	1¼in	62p
160	4in	4in	1½in	62p
161	4in	2½in	1¼in	62p
162	5½in	4in	1¼in	70p
163	4in	2½in	2in	64p
164	3in	2in	1in	44p
165	7in	5in	2¼in	£1·04
166	8in	6in	3in	£1·32
167	6in	4in	2in	88p

V.A.T. Add 12½% to prices marked*, 8% to those unmarked. Items marked are zero rated.
P&P. 35p unless otherwise shown. Giro Acc No. 388-7006

BI-PAK

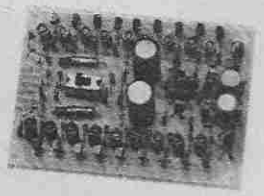
DEPT. EE6, P.O. Box 6, Ware, Herts.
COMPONENTS SHOP: 18 BALDOCK STREET, WARE. HERTS.

TOTAL AMPLIFICATION FROM **CRIMSON ELEKTRIK**

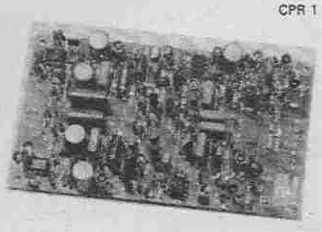
— WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS —

STEREO PRE-AMPLIFIERS

MC 1



CPR 1



CPR 1 – THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion < .005% at 30dB overload 20kHz.
Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS; T.H.D. 20Hz – 20kHz < .008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 130 × 80 × 20mm. Supply to be ±15 volts.

MC 1 – PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Send for details. XO2 : XO3 - **ACTIVE CROSSOVERS** XO2 – two way, XO3 – three way. Slope 24dB/Octave. Crossover points set to order within 10%.

REG 1 – POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

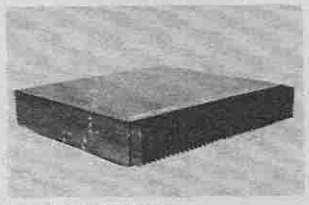
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc. who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically .01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, -3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 × 80 × 25mm.

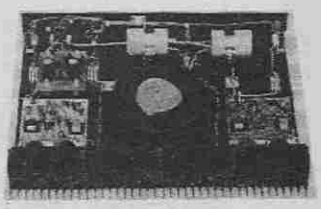
POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.





ACTIVE CROSSOVERS
XO2 . . . . . £14·83
XO3 . . . . . £23·06

POWER AMPLIFIER MODULES
CE 608 60W/8 ohms 35-035v . . £16·30
CE 1004 100W/4 ohms 35-0-35v . . £19·22
CE 1008 100W/8 ohms 45-0-45v . . £23·22
CE 1704 170W/4 ohms 45-0-45v . . £29·12
CE 1708 170W/8 ohms 60-0-60v . . £31·90

TOROIDAL POWER SUPPLIES
CPS1 for 2 × CE 608 or 1 × CE 1004 . £14·47
CPS2 for 2 × CE 1004 or 2/4 × CE 608 £16·82
CPS3 for 2 × CE 1008 or 1 × CE 1704 £17·66
CPS4 for 1 × CE 1008 . . . . . £15·31
CPS5 for 1 × CE 1708 . . . . . £22·68
CPS6 for 2 × CE 1704 or 2 × CE 1708 £23·98

HEATSINKS
Light duty, 50mm, 2°C/W . . . . £1·30
Medium power, 100mm, 1·4°C/W . . £2·20
Disco/group, 150mm, 1·1°C/W . . . £2·85
Fan, 80mm, state 120 or 240v . . . £18·50
Fan mounted on two drilled 100mm heatsinks, 2 × 4°C/W, 65°C max. with two 170W modules. . . . . £29·16

THERMAL CUT-OUT, 70°C . . . £1.38

POWER AMP KIT . . . £32·40

PRE-AMPS:
These are available in two versions – one uses standard components, and the other (the S) uses MO resistors where necessary and tantalum capacitors.
CPR1 . £29·49 CPR1S . £39·98
MC1 . £18·50 MC1S . £29·49

POWER SUPPLY:
REG1 . . £6·75 TR6 . . £1·75

BRIDGE DRIVER, BDI
Obtain up to 340W using 2 × 170W amps and this module.
BDI . . . . . £5·40

CRIMSON ELEKTRIK
1A STAMFORD STREET,
LEICESTER LE1 6NLL
Tel. (0533) 537722

All prices shown are UK only and include VAT and post. COD 90p extra, £100 limit. Export is no problem, please write for specific quote. Send large SAE or 3 International Reply Coupons for detailed information. UK – please allow up to 21 days for delivery.

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New **Heathkit electronic test equipment course.**

Section 1. Analogue and digital meters.
Section 2. Oscilloscopes.
Section 3. Frequency generation and measurement.
Section 4. Special measuring instruments.

New **Heathkit car electrical systems course.**

Section 1. Electrical principles of the car.
Section 2. Starting system fundamentals.
Section 3. Car charging systems.
Section 4. Accessories and body electrical.

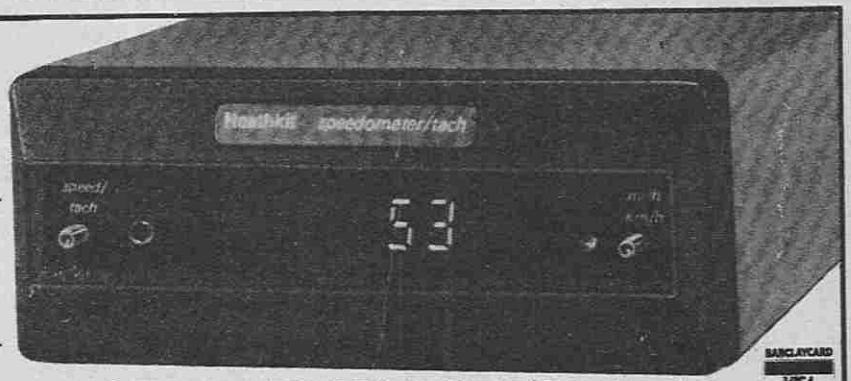
Two new self-instruction courses from Heathkit. Based on step-by-step programmed instructions, they let you learn at your own pace in your own home.

Each course is complete and contains audio/visual material, text, and parts for 'hands on' experiments with the optional Heathkit experimenter trainer. So all you need is a cassette player and the will to learn.

Full details of Heathkit courses are available in the Heathkit catalogue, together with hundreds of kits you can build for yourself — computers, oscilloscopes, transceivers etc. . . . Send for your copy now.

There are Heathkit Electronics Centres at 233 Tottenham Court Road, London (01-636 7349) and at Bristol Road, Gloucester (0452 29451).
Registered in England, No. 606177.

Soldering iron offer FREE



BARCLAYCARD VISA

New **Heathkit CI 1265 Digital Tach/Speedometer.**
Push-button digital readout. Displays engine speed/rpm. Accurate to 1 mph or rpm variations of 100.

To: Heath (Gloucester) Limited, Dept. EE6/79 Bristol Road, Gloucester, GL2 6EE.
Please send a copy of the Heathkit catalogue. I enclose 20p in stamps. ☐
Please send a copy of the Computer Brochure. I enclose 20p in stamps. ☐

Name_____

Address_____

N.B. If you are already on the Heathkit mailing list you will automatically receive a copy of the latest Heathkit catalogue without having to use this coupon.
When you receive your catalogue you will get details of this free offer.

HEATHKIT

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EE SPECIAL REPORT

CONNOISSEUR PACKAGE DEAL

DOUBTLESS some builders of the EE2020 Tuner Amplifier will be looking around for a pickup-turntable unit. For them, and others starting out into the hi fi field, the choice has to be made from a large range of record playing equipment, and many factors have to be taken into account.

There is one particularly interesting possibility for the handyman to consider. That is the purchase of a kit of parts for assembly at home. This is precisely what is offered by Connoisseur with their new "Package Deal" which has been announced at an opportune time. It comprises the BD1 Turntable Kit, SAU2 Pickup Arm, and Plinth with acrylic cover.

The BD1 Belt Drive Turntable Kit has been available for home assembly for many years, and is justifiably popular. It operates at $33\frac{1}{3}$ and 45 r.p.m. using a flexible belt drive system. The Connoisseur Pickup Arm Type SAU2 is equally popular and is an ideal complementary precision instrument. The wooden Plinth provides stylish housing and completes the ensemble.

The work involved in assembling this kit is by no means onerous, and requires hardly anything more than a screwdriver and a pair of pliers, save a special spanner—and that's provided.

BD1 BELT DRIVE TURNTABLE KIT

The eight-page instruction booklet gives minutely detailed assembly instructions for the BD1 Belt Drive Turntable Kit and is well illustrated with practical diagrams.

This booklet, however, requires revising, for our copy states on the front page "Speed change is accomplished by push button . . .". In fact, a lever is used for this purpose on the actual equipment submitted to us.

We followed the stage-by-stage directions, during which it became apparent that further revisions are required to this booklet. "Operation 1" revealed that a different type of connector block was supplied to that illustrated.

KIT SPECIFICATION

MAINS SUPPLY
200/240 or 100/125 volts a.c. Adjustable by user. Power. 5W.

MOTOR
Synchronous constant speed motor runs at 375 r.p.m. at 50Hz; 450 r.p.m. at 60Hz. Drive pulleys for 50Hz or 60Hz available.

TURNTABLE
10¼ in (260mm) lathe turned aluminium casting. Precision ground spindle. Manganese bronze bearing.

DRIVE
Precision ground round section rubber belt. Unique drive arrangement via groove in outer surface of turntable rim.

PERFORMANCE
Rumble: −60dB } (Maker's figures)
Hum: −80dB }
Wow and flutter: Less than 0·1%

FINISH
Black hammer with satin silver and matt black trim.
Control knob: bright finish turned alumium.
Plinth: Afromosia wood, waxed finish. Dust cover: transparent acrylic.

The mains switch panel assembly came as a completed unit. The 10W ballast resistor in the mains input line was mounted in such a way that one end would have made direct contact with the brass spacing pillar when this was fitted. (Mains to chassis!) Disaster was averted by easing the resistor upwards and away from the pillar hole by a distance of $\frac{1}{4}$ inch. (In addition to this action, it would be a wise precaution to fit a piece of plastic sleeving to this pillar.) NOTE: A plastic-sleeved pillar is now being provided by the manufacturer.

The motor came with the two-speed pulley already fitted. After the motor was mounted, the turntable and belt in position, it was found necessary to move the pulley slightly upwards on spindle to align correctly with turntable belt groove.

Hand rotation of the turntable proved the correct operation of the speed change device: the belt moving from one pulley groove to the other as the lever was thrown.

A hinged plastic cover protects the pulley. There is not too much room for comfort. When initially closed the cover was found to foul the pulley. The only remedy was to slacken the motor screws and ease the motor away (towards the rear corner of the platform). This cleared the trouble.

Then mains was applied and the action of the speed change checked. It functioned perfectly, at $33\frac{1}{3}$ and 45 r.p.m.

SAU2 PICKUP ARM

A template is provided to ensure correct positioning of pickup base in relation to the turntable centre spindle. But this was not required in the present case since the mounting board (part of the BD1 Plinth and Cover Kit) came already drilled for the pickup and the arm rest. It was therefore a simple task to mount and secure the pickup with its locking nut.

Dual signal output leads are supplied. These terminate at one end in a 5-pin plug and this fits into the socket on pickup base. The other end of the cables are fitted with phono plugs. A separate earth lead is provided and is intended to be connected to the preamplifier chassis.

The head shell is suitable for all standard cartridges with $\frac{1}{2}$in fixing centres. Lateral adjustment is provided to give minimum tracking error.

The SAU2 instuction leaflet explains how to adjust for required height of arm; for required tracking weight, which is performed with the aid of the precision balance supplied; and for correct bias weight. An additional small weight is supplied to substitute for the larger weight when lower tracking weights are used.

A hydaulic arm lifting device is incorporated. This is set correctly at the factory.

The Connoisseur BD1/SAU2 "Package Deal" is currently available from retailers at a price of less than £50.00 (VAT extra).

SQUARE one FOR BEGINNERS

THIS month we explain some of the alpha, and alpha-numeric codes to be found on resistors, capacitors and transistors to aid value and application identification.

BS1852 RESISTANCE CODE

It is common nowadays to find the value of a resistor printed on the body in the form of an alpha-numeric code.

Letters R, K, and M, are used as multipliers R = ×1, K = ×1,000 and M = ×1,000,000. The position of these letters among the two most significant digits also acts as the position of the decimal point. For example, 4K7 = 4·7 kilohms, M22 = 0·22 megohms = 220 kilohms.

The tolerance of the resistors is indicated by the addition of a second letter appearing in the last position: F = 1%, G = 2%, H = 2·5%, J = 5%, K = 10%, M = 20%.

Example of the full code: 4K7J = 4·7 kilohms ±5%; 2R2K = 2·2 ohms ±10%.

ALPHA—NUMERIC CAPACITOR CODING

Ceramic plate capacitors of Russian origin are commonplace nowadays and these use a alpha-numeric coding similar to the above-resistor system. For example 33K, 4K7, the K acting as a ×1000 multiplier and decimal point position giving the value in picofarads. Therefore 33K = 33,000pF or 0·033μF, and 4K7 = 4,700pF or 0·0047μF. The K can also be used merely as a decimal point with the units in nanofarads, (nF), i.e., 4K7 = 4·7nF.

The letter H is sometimes used in place of K for some values (reason unknown) e.g., 1H5 = 1·5nF or 1,500pF or 0·0015μF.

We have also in our possession some ceramic capacitors (unknown origin) marked 4n7 which is 4·7nF. Also another tiny bead type ceramic marked with only 10, the value being 10pF.

TRANSISTOR CODING

Since the invention of the transistor in 1948 there have been tens of thousands of transistors manufactured and marketed. There are many different shapes, sizes, pinning configurations and employing various numbering systems for identifying the devices.

At present there are three main numbering systems and a number of "house" systems from different manufacturers.

In the USA, the "Jedec" system is used and prefixes three and four digit numbers by "2N". Tables have to be consulted for *all* information concerning the device.

In Europe the "Proelectron" system is employed. Two letters followed by three numbers (eg BC109) are classified as consumer devices while three letters/two numbers (eg BFY52) identifies an industrial device.

The first letter is always **A** (germanium) or **B** (silicon), see Table 1 for decoding of second letter.

JAPANESE SYSTEM

The Japanese Institute of Standards has the "2S" system. The 2S is followed by a letter and then numerals, the letter having application significance: **A** *pnp*/high frequency; **B** *pnp*/low frequency; **C** *npn*/high frequency; **D** *npn*/low frequency; **H** unijunction; **J** *p*-channel f.e.t.; **K** *n*-channel f.e.t.; **OS** photodevice.

Some Texas Instruments devices are coded with a 2S followed by up to four numerals.

TABLE 1: Explanation of the Pro-electron coding system for transistors.

Germanium	Silicon	Applications
AC	BC	Low power, low frequency
ACY	BCW BCX BCY BCZ	
AD	BD	Power, low frequency
ADY ADZ	BDX BDY	
AF	BF	
AFY AFZ	BFR BFS BFT BFV BFW BFX BFY	Low power, high frequency
AL	BLX BLY	Power, high frequency
ASY ASZ	BSS BSV BSW BSX	Low power, switching
AU	BU	Power, switching
AUY	BUY	
	BPX BPY	Photodevice

HOUSE CODES

Some of the popular "house" codes are:

Motorola:	MJ	—Silicon, power, metal
	MJE	—Silicon, power, plastic
	MP	—Germanium, power, metal
	MPF	—f.e.t., plastic
	MPS	—small signal, plastic
Texas:	TIP	—power, plastic
	TIS	—Small signal
Ferranti:	ZTX	—Small signal, plastic

ABBREVIATIONS

The direct meaning of some common abbreviations to be found in EVERYDAY ELECTRONICS are shown below.

a.c.	alternating current
a.f.	audio frequency
a.m.	amplitude modulation
BA	British Association (nut and bolt sizes)
d.c.	direct current
d.p.d.t.	double-pole double-throw
elect.	electrolytic
e.m.f.	electromotive force
f.e.t.	field effect transistor
f.s.d.	full scale deflection
f.m.	frequency modulation
i.c.	integrated circuit
l.d.r.	light dependent resistor
lin.	linear
log.	logarithmic
mm	millimetre
m.w.	medium wave
npn, *pnp*	transistor structure (two types)
p.v.c.	polyvinyl chloride
r.f.	radio frequency
r.m.s.	root mean square
s.p.s.t.	single-pole single-throw
s.r.b.p.	synthetic resin bonded paper
s.w.g.	standard wire gauge
t.r.f.	tuned radio frequency
u.j.t.	unijunction transistor
v.h.f.	very high frequency
%	per cent
A	ampere (amp)
dB	decibel
F	Farad
H	Henry
Hz	Hertz (cycles per second)
Ω	ohm
V	volt
W	watt
p	pico (÷ 1,000,000,000,000)
μ	micro (÷ 1,000,000)
m	milli (÷ 1,000)
k	kilo (× 1,000)
M	mega (× 1,000,000)

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W02	1A	200V	0·32	B80C1500	1.5A	200V	0·82
W04	1A	400V	0·40	B80C3200	3.2A	200V	1·25
W06	1A	600V	0·50	PW005	6A	50V	0·90
W08	1A	800V	0·60	PW01	6A	100V	0·95
VM18	1A	100V	0·44	PW02	6A	200V	0·97
VM28	1A	200V	0·48	PW04	6A	400V	1·08
VM48	1A	400V	0·50	PW06	6A	600V	1·18
BY164	1.4A	120V	0·75	PW08	6A	800V	1·28
BY179	1A	800V	0·70	PW10	6A	1000V	1·60
S005	2A	50V	0·39	K005	25A	50V	2·20
S01	2A	100V	0·44	K01	25A	100V	2·37
S02	2A	200V	0·48	K02	25A	200V	2·75
S04	2A	400V	0·60	K04	25A	400V	3·40
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S08	2A	800V	0·84				

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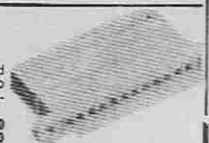

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74LS00N	0·26	SN74S300N	5·06	74LS194N	0·70
74LS01N	0·26	SN74S301N	3·71	74LS195N	0·70
74LS02N	0·26	SN74S387N	3·05	74LS196N	0·80
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74LS22N	0·26	SN7497N	1·95	74LS257N	1·00
74LS26N	0·32	SN74100N	1·40	74LS258N	1·00
74LS27N	0·26	SN74107N	0·24	74LS259N	1·55
74LS28N	0·29	SN74118N	0·95	74LS261N	3·25
74LS30N	0·26	SN74119N	1·40	74LS266N	0·44
74LS32N	0·27	SN74121N	0·28	74LS273N	1·30
74LS33N	0·29	SN74122N	0·55	74LS275N	3·20
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74C08N	0·24	74C76N	0·54	74C151N	2·47	74C174N	0·90	74C902N	0·54
74C10N	0·24	74C83N	1·30	74C154N	3·68	74C175N	0·90	74C903N	0·54
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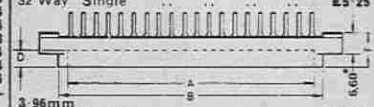

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2N489A	U71	5·40	2N727	P70	·50	2N1553	P66	1·50	2N2221A	N70	·25	40233	N70 ·70	AC188K	P54	·65
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2N490B	U71	6·50	2N760	N70	·35	2N1638	P54	·70	2N2223	N73	6·78	40242	N65 ·66	AD143	P66	1·45
2N490C	U71	6·90	2N869	P70	·35	2N1711	N70	·30	2N2223A	N73	6·99	40251	N66 1·15	AD149	P66	2·85
2N491A	U71	5·75	2N914	N70	·38	2N1889	N70	·30	2N2270	N70	·49	40254	P66 ·66	AD150	P86	3·10
2N491B	U71	6·25	2N916	N70	·33	2N1890	N70	·30	2N2270	N70	·49	40264	N70 ·95	AD161	N66	1·00
2N491	U71	7·50	2N917	N65	·38	2N1893	N70	·30	2N2303	P70	1·54	40280	N70 3·70	AD162	P66	1·00
2N492	U71	6·25	2N918	N65	·45	2N1907	P66	5·95	2N2368	N70	·27	40309	N70 ·60	AF106	P65	·60
2N492A	U71	6·75	2N929	N70	·37	2N1974	N70	·98	2N2369	N70	·27	40310	N66 ·85	AF109	P65	·82
2N492B	U71	7·75	2N929A	N70	·37	2N1990	N70	·45	2N2369A	N70	·27	40311	N70 ·55	AF114	P64	·70
2N492C	U71	10·00	2N930	N70	·37	2N1991	P70	1·10	2N2405	N70	·66	40312	N66 ·99	AF115	P64	·70
2N493A	U71	7·99	2N930A	N70	·95	2N2060	N73	7·00	3N81	SCS90	3·50	40313	N66 1·38	AF116	P64	·70
2N493B	U71	8·75	2N1131	P70	·32	2N2102	N70	·50	3N83	SCS90	2·25	40315	N70 ·60	AF117	P64	·70
2N494	U71	6·90	2N1132	P70	·35	2N2147	P66	1·55	3N128	NF92	1·35	40316	N66 ·95	AF118	P64	·70
2N494A	U71	7·65	2N1204	P70	1·65	2N2160	U71	1·55	3N139	NF82	1·60	40317	N70 ·60	AF124	P20	·70
2N494B	U71	8·40	2N1302	N70	·80	2N2192	N70	·58	3N140	NF92	1·10	40324	N66 ·95	AF125	P20	·70
2N494C	U71	9·35	2N1303	P7	·80	2N2193	N70	·50	3N141	NF92	·95	40325	N66 1·35	AF126	P20	·70
2N549	N70	3·25	2N1304	N70	·80	2N2193A	N70	·52	3N142	NF82	·70	AC126	P54 ·48	AF139	P65	·75
2N696	N70	·39	2N1305	P70	·80	2N2194	N70	·42	3N143	NF82	·88	AC127	N54 ·48	AF172	P98	·70
2N697	N70	·31	2N1306	N70	1·00	2N2194A	N70	·45	3N152	NF82	1·10	AC128	P54 ·48	AF178	P64	1·30
2N698	N70	·49	2N1307	P70	1·00	2N2195	N70	·49	3N153	NF82	1·89	AC151	P54 ·43	AF186	P65	·55
2N699	N70	·58	2N1308	N70	1·10	2N2195A	N70	·49	3N154	NF82	·99	AC152	P54 ·54	AF200	P20	1·30
2N706	N70	·30	2N1309	P70	1·10	2N2217	N70	·55	3N159	NF92	1·35	AC153	P54 ·59	AF201	P20	1·30

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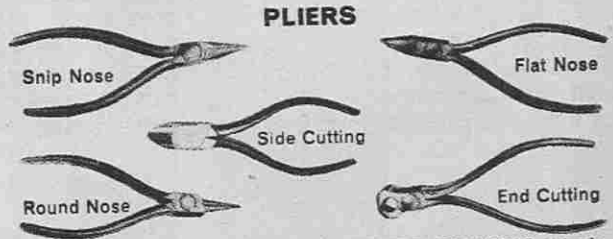

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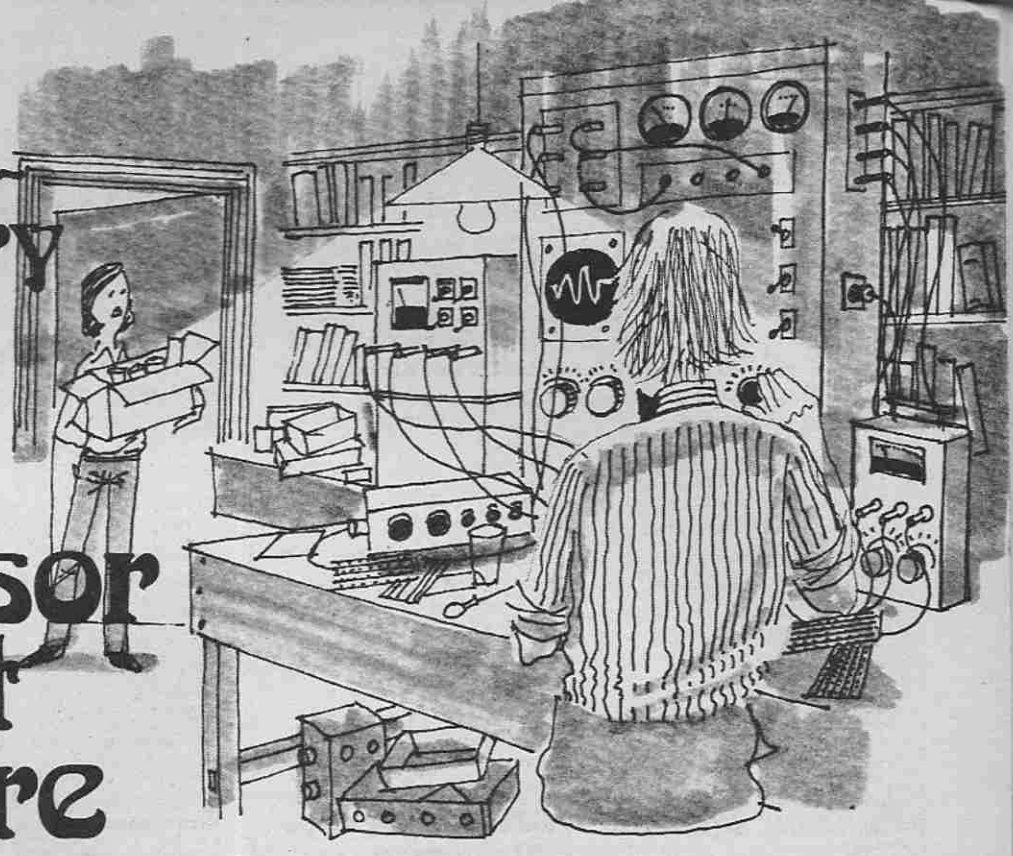


by Anthony John Bassett

Bob and the Prof. are inside a giant vacuum chamber. Dressed in "space suits" which the Prof's robots have made to protect them from the vacuum, they are carrying out experiments on uses of electronics in vacuum conditions. As Bob and the Prof. are both keen followers of the Space Explorations which are in progress, they can see that there is certain to be a large expansion in the use of electronics in the vacuum of Space; a very interesting field to follow and one which will in future provide an increasing number of really interesting jobs for electronics experts.

Who knows, some of today's readers of this magazine might be fortunate enough to participate in this exciting work!

ELECTRON BEAM

Bob has noticed that an electron beam when passed through various vapours which the Prof. has released into the vacuum chamber, does not appear to be scattered by collision with the molecules of vapour; rather to his surprise, the opposite seems to happen and the presence of the vapour molecules seems to improve the focusing of the electron beams.

They can observe the electron beam directly in the presence of certain vapours which glow with the spectral colours of the elements or ions present along the path of the beam.

"It is the presence of a trail of positive ions along the path of the electronbeam which keeps the path of the beam narrow and prevents the electrons from being scattered," the Prof. informed Bob.

"When an electron beam passes through a vapour or gas at low pressure, it produces mainly positive ions from the atoms or molecules which it encounters. Thus the presence of a gas vapour is necessary in order to observe this effect."

"I find this very puzzling, Prof. Surely the beam should produce equal numbers of positive ions and negative ions? At school we are taught that when an ionising beam passes through a gas or vapour, it spits the molecules into equal numbers of opposite charges! How can the electron beam produce more positive ions than negative ions when the molecules of the substance are neutral to start with?"

The Prof. explained: "This is because the mechanism of ion production is different. With a beam of ionising radiation, the radiation is so energetic that it splits the molecules up into ions of opposite charge. The oppositely charged ions fly apart under the influence of the radiation bombardment, and exist as charged particles for a time until they become neutralised.

"The electron beam which we are using behaves differently and the predominant mechanism of ion production is by 'knocking off' electrons from the outer electronic shells of atoms to produce simple ions, or vapour molecules to produce more-complex positive ions. Only a small number of molecules are split, so the production of negative ions along the path of the electron beam is comparatively little."

CORE OF POSITIVE IONS

"The positive ions are much heavier than electrons and they remain in the path of the electron beam to give a 'pencil' of positive charge along the path of the beam, and this tends to keep any electrons which tend to stray or scatter, attracted back to the path of the beam, thus improving the focus of the beam and the 'point size' where it may hit a fluorescent viewscreen or radar screen.

"Most of the electrons which are

picked off to do not join the main electron beam, but travel for a short distance away from the beam, and then combine with a neutral molecule to form a negative ion. Thus, surrounding the beam and its core of positive ions is a tube of negative ions which help to keep the electrons of the beam on the correct path, as any which stray are repelled back by the negative charge.

BETTER RADAR

"This combined action of attraction by a positive column of ions and repulsion by a surrounding tube of negative ions, is a powerful influence in keeping the electrons to a narrow path to give a finely focused radar display.

"Use of this technique has resulted in very considerable savings in cost of production of radar sets, because the electron beam can remain focused with a much lower e.h.t. voltage than would be needed for a radar tube which used a high vacuum. The radar tube itself can be cheaper because it does not need a separate e.h.t. connection. Due to the lower voltage used, this may be connected in some cases on an ordinary tube base.

"The power supply is much simpler, and because the velocity of the electrons in the beam is lower, less deflection energy is needed, which means that the deflection circuits are less critical and less likely to go wrong!

"So, just by introducing a very small quantity of gas into each radar tube, the makers have contributed to the spread of the safety which has been brought about by the increased use of radar, both by making it affordable for more users and more reliable!

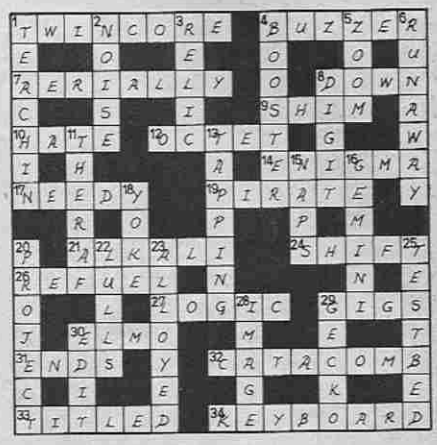
"Just as the developments in rocketry by the Germans during World War II were very important in forming the basis for the development of modern space rockets, so the British developments in radar and ion beam technology are now being taken further, and the behaviour of such beams in the conditions of space will be very important for future explorations and uses. Such beams may be used to probe areas where men cannot go!"

"This sounds really interesting, Prof., can you tell me more about the use of electronically produced beams in space?"

"Yes, certainly, Bob."

To be continued

Crossword No. 16—Solution



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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 **37p** each. Don't miss this exceptional bargain!

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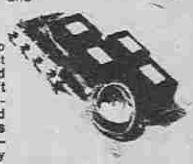

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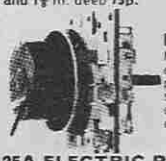

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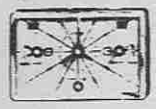

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IT'S FREE

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 isloation transformer for safety and a 2 amp variac for adeptability. 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 **£29·75.**

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

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. **£9·50.**

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.**

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.**

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 instrument 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 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 special 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.**

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. **£4·50** 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/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.**

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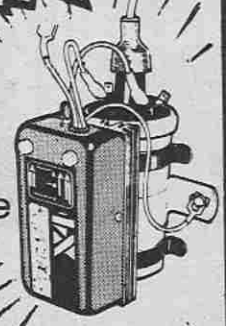

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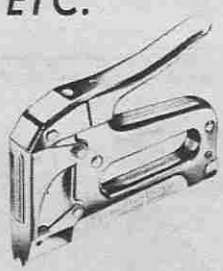

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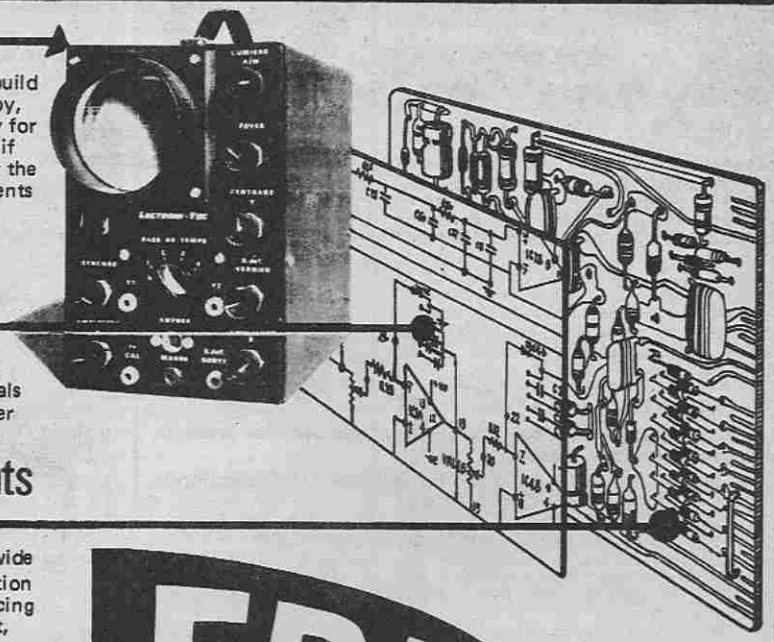

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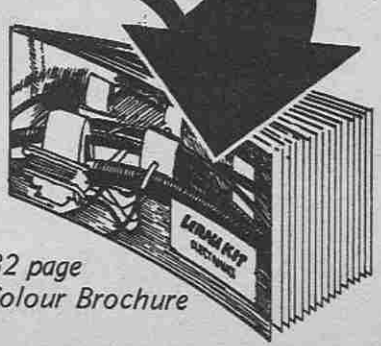

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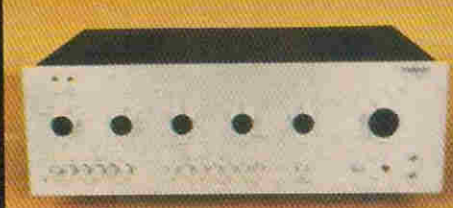

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