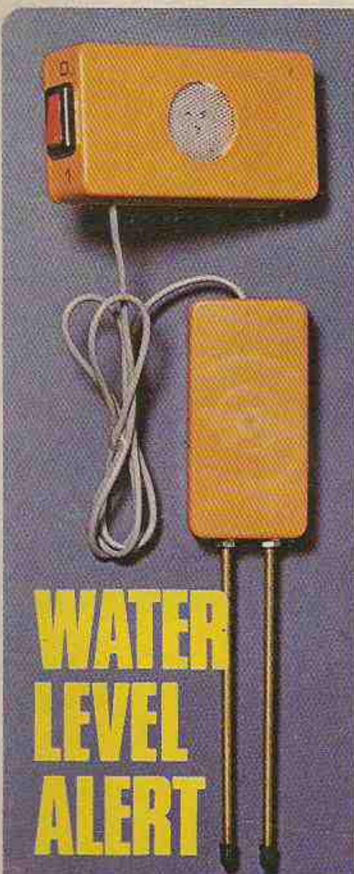
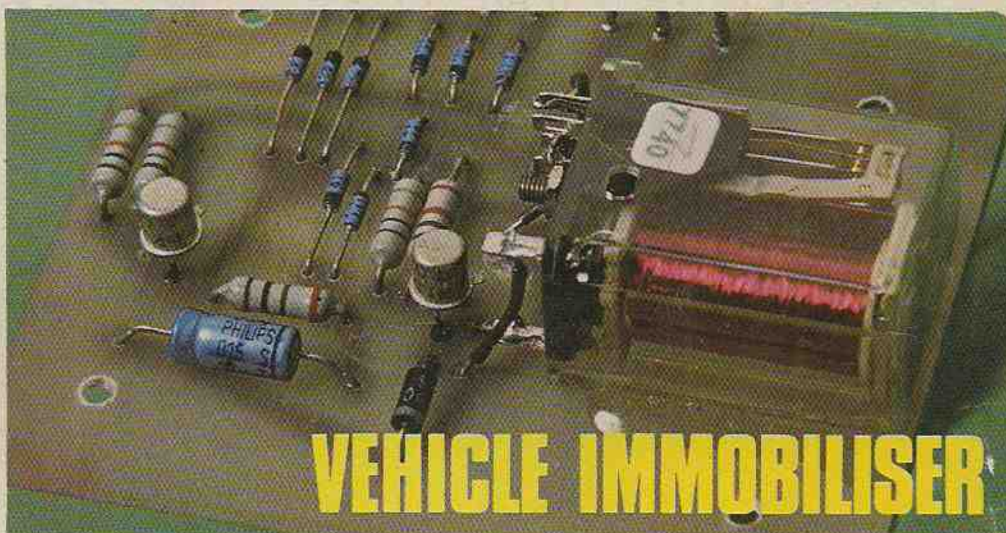
Easy to build projects for everyone

Everyday ELECTRONICS

DEC. 78
40p



WATER LEVEL ALERT



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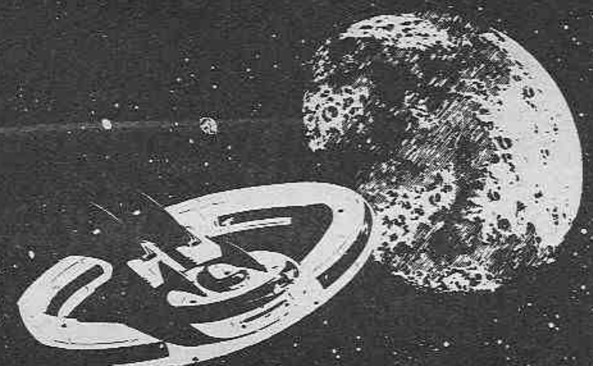

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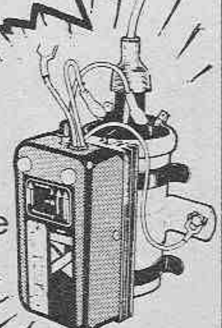
Sparkrite — was featured by Shaw Taylor in 'DRIVE IN'



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POLYESTER CAPACITORS: Axial lead type (Values are in µF) **400V:** 0·001, 0·0015, 0·0022, 0·0033 **7p**; 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p**; 0·022, 0·033, **10p**; 0·047, 0·068 **14p**; 0·10 **15p**; 0·15, 0·22 **22p**; 0·33, 0·47 **39p**; 0·68 **45p**. **160V:** 0·039, 0·15, 0·22, **11p**; 0·33, 0·47 **19p**; 0·68, 1·0 **22p**; 1·5 **29p**; 2·2 **32p**; 4·7 **48p**. **DUBILIER: 1000V:** 0·01, 0·015 **20p**; 0·022 **22p**; 0·047 **26p**; 0·1 **38p**; 0·47 **48p**; 1·0 **175p**.

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

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in 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 **11p**; 63, 100 **27p** **50:** 1·0 **7p**; 50, 100, 220 **25p**; 470 **50p**; 1000; **40V:** 22, 33, **9p**; 100 **11p**; 2200 **68p**; 3300 **62p**; 4700 **64p**; **35V:** 10, 33 **7p**; 330, 470 **32p**; 1000 **49p**; **25V:** 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2200 **41p**; 3300 **52p**; 4700 **54p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 220, 330, 470 **14p**; 1000, 1500 **20p**; 2200 **34p**; **10V:** 100 **6p**; 640 **10p**; 1000 **14p**.
TAG-END TYPE: 70V: 2000 **98p**; 4700 **121p**; **50V:** 10,000 **255p**; **40V:** 2500 **65p**; 3300, 4700 **70p**; 15,000 **450p**; **25V:** 4700 **48p**; 2200 **37p**; **325V:** 200+100+50+100 **190p**.

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

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF **6p**
0·015, 0·02, 0·04, 0·05, 0·056µF **7p**
0·1µF, 0·2 **9p** **50V:** 0·47 **11p**

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

COMPRESSION TRIMMERS
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100-500pF **38p**

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100 **50p**; 1000 **395p**

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Carbon Track. ¼W Log & ½W Linear values
500Ω. 1K & 2K (lin only) Single **27p**
5KΩ-2MΩ single gang **27p**
5KΩ-2MΩ single gang D/P switch **60p**
5KΩ-2MΩ dual gang stereo **70p**

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

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

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

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

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2N5777	45
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TIL313 C Cth 3"	105
TIL321 C An 5"	115
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DL707 C.A. ·3"	99
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MAN3640	175
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TIL307	675

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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**
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1A DP c/off. **15p**
½A DPDT **13p**
4 pole c/over **24p**
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SPDT c/over **65p**
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JACK PLUGS / **SOCKETS**

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

S-DEC **325p***
T-DEC **425p***
U-DEC 'A' **450p***
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3 4 5 Pin Audio	13p	8p	20p
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PHONO assorted colours	9p	5p single 8p double	15p
Metal Screened	12p	10p 3-way	20p
BANANA 4mm	11p	12p	—
2mm	10p	10p	—
1mm	7p	7p	—
WANDER 3mm	8p	8p	—

SWITCHES ★ Miniature Non-Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V
SP changeover centre off **30p**
ROCKER: (black) on/off 10A 250V **23p**
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00 2 365pF **275p**
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C804-5pF 10 15 25 50 pF **175p***
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'L' 3 x 310pF **495p**
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Range 1 to 5 Bl., Rd., Yl. Wht. **86p**
6-7 B.Y.R. **75p**
1-5 Green **92p**
'T' 1 to 5 Bl., Yl., Rd., Wht. **93p**
B9A Valve Holder **25p**
RDT2 **92p**
RFC 5 chokes **91p**
RFC 7 (19mH) **96p**
1 FT 13; 14; 15; 16; 17 **86p**
1 FT 18/1·6 **99p**
1 FT 18/465 **105p**
TOC 1 **86p**
MW5FR **82p**
MW/LW 5FR **103p**

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	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3½	41p	33p	22p
2½ × 5	49p	45p	28p
3¾ × 3½	49p	45p	—
3¾ × 5	58p	60p	39p
2½ × 17	152p	121p	75p
3¾ × 17	195p	163p	107p
4¾ × 17	252p	—	165p
Pkt of 35 pins			30p
Spot face cutter			85p
Pin insertion tool			99p

DIODES

AA119	15
AAZ115	15
BY100	24
BY126	14
BY127	14
CRO	157
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2★	5
IN4003★	6
IN4004/5★	6
IN4006/7★	7
IN4148	4
IS44	20
3A/100V★	18
3A/400V★	22
3A/600V★	27
3A/1000V★	30
6A/600V	50

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

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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
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16A500V	150
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ST2 **25**

TTL 74★							
		7494	78	74193	105	4056	134
7400	13	7495	65	74194	105	4057	2570
7401	13	7496	57	74195	95	4059	480
7402	14	7497	189	74196	99	4060	115
7403	14	74100	119	74197	85	4061	2380
7404	14	74105	62	74198	150	4062	999
7405	18	74107	29	75150	110	4063	110
7406	38	74109	54	75491	75	4066	58
7407	38	74110	54	75492	80	4067	380
7408	17	74111	68	**CMOS★**		4068	22
7409	17	74112	88	4000	15	4069BE	20
7410	15	74116	198	4001	17	4070	32
7411	20	74118	83	4002	17	4071	21
7412	17	74119	119	4006	105	4072	21
7413	30	74120	115	4007	18	4073	21
7414	51	74121	25	4008	87	0475	23
7416	30	74122	46	4009	50	4076	85
7417	30	74123	48	4010	50	4077	40
7420	16	74125	38	4011	18	4078	21
7421	29	74126	57	4012	18	4081	20
7422	24	74128	74	4013	42	4082	21
7423	27	74132	73	4014	86	4085	74
7425	27	74136	73	4015	89	4086	73
7426	36	74141	56	4016	45	4089	150
7427	27	74142	269	4017	89	4093	85
7428	35	74143	314	4018	89	4094	190
7430	17	74144	314	4019	48	4095	105
7432	25	74145	65	4020	99	4096	105
7433	40	74147	175	4021	91	4097	372
7437	30	74148	109	4022	88	4098	110
7438	33	74150	99	4023	20	4099	145
7440	17	74151	64	4024	66	4160	109
7441	74	74153	64	4025	19	4161	109
7442	68	74154	96	4026	180	4162	109
7443	115	74155	53	4027	45	4163	109
7444	112	74156	80	4028	81	4174	110
7445	94	74157	67	4029	99	4175	99
7446	94	74159	210	4030	50	4194	108
7447	82	74160	82	4031	205	4408	720
7448	56	74161	92	4032	100	4409	720
7450	17	74162	92	4033	145	4410	720
7451	17	74163	92	4034	196	4411	995
7453	17	74164	105	4035	111	4412F	1650
7454	17	74165	105	4036	325	4415F	795
7460	17	74166	161	4037	100	4415V	795
7470	28	74167	198	4038	108	4419	280
7472	25	74170	230	4039	320	4422	545
7473	32	74172	625	4040	105	4433	1180
7474	27	74173	170	4041	80	4435	825
7475	38	74174	87	4042	75	4440	1275
7476	36	74175	87	4043	94	4450	295
7480	48	74176	75	4044	88	4451	295
7481	86	74177	78	4045	145	4490F	695
7482	69	74178	102	4046	128	4490V	525
7483	72	74180	85	4047	87	4501	17
7484	95	74181	165	4048	58	4502	120
7485	106	74182	90	4049	48	4503	69
7486	31	74184	135	4050	48	4506	51
7489	210	74185	135	4051	72	4507	55
7490	33	74188	275	4052	72	4508	298
7491	75	74190	115	4053	72	4510	99
7492	38	74191	105	4054	110	4511	150
7493	32	74192	105	4055	128	4512	98

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702	75	MC1312P	195
709C 14 pin	35	MC1488★	85
710★	48	MC1489★	90
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733★	99	MC1496	92
741C★ 8 pin	22	MC1710	79
747C★	70	MC3401	69
748C★	36	MC3340P★	150
753	150	MC3360P	120
810	159	MC724★	175
8038CC★	335	MFC4000B	85
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AY-1-1320	305	MK50362★	650
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AY-3-8710★	850	NE518A★	210
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AY-5-1230★	450	NE556DB★	60
CA3011★	82	NE560★	325
CA3018★	68	NE561★	395
CA3020	170	NE562★	410
CA3023	170	NE564★	425
CA3028A★	80	NE565A★	185
CA3035	240	NE566★	160
CA3043	190	NE567★	155
CA3046	71	NE571★	450
CA3048	200	RAM2102-2★	170
CA3075	175	RC4136D★	120
CA3080E★	70	ROM2513★	595
CA3081	190	SFF96364E★	1150
CA3089E	210	SG3402	295
CA3090AQ	375	SN76003N	175
CA3123E	200	SN76013N	140
CA3130★	85	SN6023N	140
CA3140★	70	SN76033N	175
ICL7106E★	950	SN76115N	215
ICM7205★	1150	SN76227	115
LD130★	452	SN76477★	225
LM3001H	170	TAA621AX1	228
LM301A★	30	TAA960	300
LM308	110	TBA120S	70
LM318★	195	TBA540Q	215
LM324★	79	TBA550Q	330
LM339★	80	TBA641BX11	250
LM348★	95	TBA651	180
LM379★	375	TBA800	90
LM380	95	TBA810S	99
LM381	145	TBA820	70
LM381AN	241	TBA920	260
LM382	125	TCA270	220
LM1458★	50	TDA1022★	575
LM3900★	60	TDA2020	320
LM3909N★	70	TL071CP★	70
LM3911★	125	TL081CP★	52
M252AA★	750	TL082CP★	96
M253AA★	795	TL084CP★	130
MC1303	88	UAA170	198
MC1304P	260	ZN414	90
		ZN424	130

TRANSISTORS

				BF182★	30	OC28★	99	ZTX109	11	2N3108	39
AC117★	35	BC169C	10	BF183★	30	OC29★	160	ZTX300	13	2N3121	40
AC125★	20	BC170	17	BF184★	30	OC35★	80	ZTX301	16	2N3133	43
AC126★	20	BC171	11	BF194	10	OC36★	99	ZTX302	18	2N3135	33
AC127★	20	BC172	10	BF195	10	OC41★	48	ZTX303	21	2N3250	30
AC128★	20	BC177★	17	BF196	10	OC42★	32	ZTX304	24	2N3252	38
AC141★	24	BC178★	17	BF197	10	OC43★	55	ZTX311	17	2N3302	35
AC141K★	38	BC179★	17	BF198	18	OC44★	31	ZTX314	24	2N3442★	131
AC142★	24	BC182	9	BF200★	28	OC45★	20	ZTX326	40	2N3563	20
AC142K★	38	BC182L	10	BF224A	18	OC46★	28	ZTX341	20	2N3614★	169
AC176★	18	BC183	9	BF244	24	OC70★	19	ZTX500	13	2N3615★	135
AC187★	28	BC183L	10	BF256★	50	OC71★	25	ZTX501	14	2N3663	24
AC188★	20	BC184	9	BF257★	26	OC72★	30	ZTX502	19	2N3702	10
ACY17*	35	BC184L	10	BF258★	26	OC76★	36	ZTX503	15	2N3703	11
ACY18★	40	BC186	21	BF259★	32	OC77★	76	ZTX504	25	2N3704	10
ACY19★	40	BC187★	28	BF394	22	OC79★	76	ZTX531	25	2N3705	11
ACY20★	40	BC212	9	BF594	40	OC81★	28	ZTX550	25	2N3706	10
ACY21*	35	BC212L	10	BF595	38	OC82★	45	2N526★	58	2N3707	10
ACY22★	40	BC213	9	BFR39	25	OC83★	48	2N696★	36	2N3708	10
ACY28★	40	BC213L	11	BFR40	25	OC84★	44	2N697★	21	2N3709	10
ACY39	78	BC214	9	BFR79	28	OC122★	48	2N698★	39	2N3710	16
ACY40★	48	BC214L	10	BFR80	28	OC123★	48	2N699★	39	2N3711	10
ACY44	39	BC307B	14	BFX29★	26	OC139★	85	2N706A★	19	2N3715★	250
AD140★	70	BC308	13	BFX81★	130	OC140★	85	2N707★	50	2N3772★	170
AD149★	60	BC328	13	BFX84★	24	OC141★	85	2N708★	19	2N3773★	288
AD161★	42	BC338	12	BFX85★	24	OC170★	40	2N914★	32	2N3819	22
AD162★	42	BC441★	30	BFX86★	28	OC171★	40	2N916★	27	2N3820	32
AF114★	25	BC461★	30	BFX87★	23	OC201★	75	2N918★	30	2N3823★	65
AF115★	25	BC477★	18	BFX88★	24	OC202★	85	2N920★	51	2N3824★	70
AF116★	25	BC547	11	BFY18★	50	OC203★	85	2N930★	18	2N3866★	90
AF117★	25	BC548	11	BFY50★	20	OC204★	85	2N961★	61	2N3903	18
AF118★	55	BC549	11	BFY51★	20	TIP29	43	2N1131★	22	2N3904	18
AF121★	48	BC557	13	BFY52★	20	TIP29A	44	2N1132★	22	2N3905	18
AF124★	55	BC558	12	BFY71★	20	TIP29C	60	2N1302★	35	2N3906	17
AF125★	35	BCY30★	57	BSX20★	18	TIP30	47	2N1303★	50	2N4037★	52
AF127★	35	BCY34★	75	BSY65★	30	TIP30A	47	2N1304★	50	2N4058	17
AF139★	35	BCY39★	80	BSY95★	25	TIP30B	64	2N1305★	28	2N4061	17
AF178★	70	BCY40★	78	BSY95A★	25	TIP30C	65	2N1306★	35	2N4064★	120
AF180★	70	BCY43	75	BU105	140	TIP31★	40	2N1307★	60	2N4236★	145
AF186★	50	BCY58★	22	BU205★	190	TIP31A★	40	2N1308★	46	2N4289	20
AF239★	42	BCY59★	22	BU208★	225	TIP31B★	40	2N1613★	23	2N4859	65
ASY26★	40	BCY70★	15	E5567	65	TIP31C★	66	2N1671★	190	2N5135	42
ASY27★	45	BCY71★	21	MD8001★	158	TIP32★	45	2N1671B★	195	2N5136	42
BC107★	9	BCY72★	21	ME4102	10	TIP32A★	49	2N1893★	28	2N5138	20
BC107B★	10	BCY78★	20	ME6002	14	TIP32B★	70	2N1986★	60	2N5179★	60
BC108★	9	BD115★	62	MJ400★	90	TIP32C★	70	2N2160★	105	2N5180★	60
BC108B★	12	BD121★	95	MJ491	160	TIP33★	80	2N2217★	48	2N5191★	65
BC108C★	12	BD123★	98	MJ2955★	95	TIP33A★	80	2N2218A★	31	2N5305★	24
BC109★	9	BD124★	115	MJE340★	45	TIP33B★	100	2N2219A★	22	2N5457	32
BC109B★	12	BD131★	38	MJE370★	55	TIP33C★	105	2N2220A★	26	2N5458	32
BC109C★	12	BD132★	38	MJE371★	60	TIP34★	85	2N2221★	23	2N5459	32
BC113	17	BD133★	43	MJE520★	45	TIP34A★	85	2N2222★	20	2N5485	32
BC114	19	BD135★	36	MJE521★	65	TIP34B★	110	2N2297	45	2N5777★	45
BC115	19	BD136★	37	MJE2955★	99	TIP34C★	110	2N2303★	45	2N6027	40
BC116	19	BD137★	36	MJE3055★	70	TIP35★	219	2N2368★	21	40311★	50
BC117	15	BD138★	36	MPF102	30	TIP35A★	225	2N2369★	15	40313★	125
BC118	19	BD139★	45	MPF103	36	TIP35C★	270	2N2476★	125	40316★	86
BC119★	26	BD140★	36	MPF104	36	TIP36A★	265	2N2483★	28	40317★	52
BC134	19	BD142★	59	MPF105	36	TIP36C★	325	2N2484★	30	40324*	85
BC135	20	BD145★	198	MPF106	50	TIP41A★	63	2N2646★	48	40326★	52
BC136	18	BD222★	60	MPF107	50	TIP41B★	73	2N2784★	55	40327★	62
BC137	20	BD659A★	75	MPSA05★	24	TIP42A★	64	2N2846★	140	40347★	80
BC140★	28	BD696A★	75	MPSA06★	24	TIP42B★	82	2N2894★	30	40348★	101
BC142★	25	BDY17★	195	MPSA12	42	TIP2955★	63	2N2904A★	22	40360★	43
BC143★	25	BDY60★	110	MPSA55	24	TIP3055★	65	2N2905A★	20	40361★	45
BC147	7	BDY61★	165	MPSA56	24	TIS43	36	2N2906★	18	40362★	48
BC148	7	BF115★	22	MPSA70	34	TIS44	45	2N2907★	20	40407★	50
BC149	8	BF154★	25	MPSU02★	58	TIS46	45	2N2907A★	22	40411★	289
BC153	14	BF156★	28	MPSU05	48	TIS50	47	2N2926G	10	40412★	83
BC154	14	BF167	25	MPSU06	54	TIS60	45	2N2960	8	40467*	95
BC157	10	BF173★	25	MPSU52★	65	TIS62	45	2N2926R	8	40576★	190
BC158	11	BF177★	24	MPSU55★	53	TIS74	47	2N2926Y	8	40594★	80
BC159	11	BF178★	25	MPSU56★	56	TIS90	18	2N3011★	24	Matched	
BC160	27	BF179★	30	MPU131★	39	TIS91	22	2N3053★	20	pair	
BC167A	11	BF180★	28	OC25★	120	ZTX107	11	2N3054★	49	add 10p	
BC168C	12	BF181★	30	OC26★	150	ZTX108	11	2N3055★	55	per pair	

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BC161	21p
BC167	9p
BC168	8p
BC169	9p
BC170	8p
BC171	8p
BC172	8p
BC173	8p
BC174	9p
BC177	12p
BC178	12p
BC179	12p
BC181	13p
BC182	8p
BC183	8p
BC184	8p
BC209	19p
BC212	8p
BC213	8p
BC214	9p
BC237	6p
BC238	6p
BC239	6p
BC251	8p
BC252	8p
BC257	8p
BC261	23p
BC264	40p
BC301	35p
BC302	32p
BC303	37p
BC304	38p
BC307	6p
BC308	6p
BC309	6p
BC327	8p
BC328	8p
BC337	9p

BC338	9p
BC413	8p
BC414	8p
BC415	8p
BC416	8p
BC516	23p
BC517	20p
BC546	6p
BC547	6p
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BC560	9p
BC635	14p
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BC640	17p
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BD115	43p
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BD128	52p
BD135	35p
BD136	36p
BD137	37p
BD138	37p
BD139	37p
BD140	35p
BD142	62p
BD175	46p
BD176	46p
BD179	47p
BD180	54p
BD235	51p
BD236	51p
BD237	51p
BD238	51p
BD433	45p
BD434	45p
BD435	51p
BD436	51p
BD437	54p
BD438	57p
BD439	58p
BD440	58p
BD441	99p
BD442	105p
BD512	399p
BD522	475p
BD645	89p
BD646	89p
BD649	93p

BD650	93p
BD677	75p
BD678	75p
BD679	78p
BD680	78p
BF167	24p
BF173	25p
BF177	36p
BF184	33p
BF185	33p
BF194	23p
BF195	23p
BF196	10p
BF197	10p
BF198	17p
BF199	17p
BF240	17p
BF241	17p
BF245	47p
BF254	11p
BF255	19p
BF256	47p
BF363	47p
BF440	29p
BF441	29p
BF450	19p
BF451	15p
BF457	41p
BF458	43p
BF459	51p
BFW11	90p
BFW12	90p
BFW16	147p
BFW30	147p
BFW92	63p
BFX89	75p
BFY90	132p
BRY39	63p
BRY56	63p
BU105	120p
BU114	154p
BU126	135p
BU205	144p
BU208	199p
BU209	212p
BU310	145p
BU311	145p
BU526	220p
2N1613	21p
2N1711	22p
2N1893	25p
2N2102	25p
2N2218	22p
2N2218A	25p
2N2219	22p
2N2219A	23p

2N2221	20p
2N2221A	22p
2N2222	22p
2N2368	24p
2N2222A	23p
2N2369	24p
2N2369A	24p
2N2484	22p
2N2904	22p
2N2904A	24p
2N2905	28p
2N2905A	28p
2N2906	21p
2N2907	21p
2N2907A	22p
2N3019	30p
2N3904	6p
2N3906	6p
2N4402	6p
2N4404	6p
MJE2355	68p
MJE3055	68p
2N3054	77p
2N3055	50p
2N3055P	77p
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4009	16p
4010	28p
4011	14p
4012	14p
4013	39p
4017	70p
4018	42p
4020	80p
4022	70p
4023	16p
4024	54p
4025	16p
4027	39p
4030	39p
4042	60p
4049	38p
4069	18p
4071	16p
4040	55p

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311H	44p
312H	225p
324	134p
340K	45p
380	40p
387	35p
709C	13p
723	38p
727	38p
733	42p
739	46p
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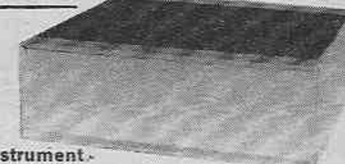
474	35p
7812	60p
7815	40p
7912	60p
7918	45p
L129	75p
3501	120p



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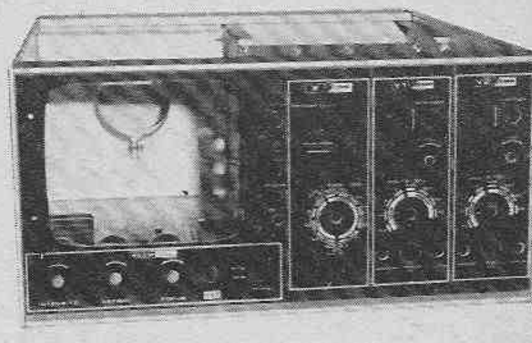
D	8¾″	4½″	5·62	I	16½″	6″	10·42
E	12″	4½″	7·00				

all cases depth 9″ please add 80p for P & P of cases



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Ready to surprise your visitors as their fingers press the bell-push are 8 tunes, stored in Dorachime's micro-circuitry. You can switch between them as you like, merely with a movement to the 'Tune Select' control. Tempo control speeds or slows the music to suit your mood. Ranging from 'Greensleeves' to 'Sailors Hornpipe', the selection has been carefully made to ensure you have something appropriate for every visitor.

The effect on your guests is both stunning and amusing. It is worth the price of the Dorachime, for instance, if just once your bell can play 'O Come all Ye Faithful' to surprise your friends at Christmas.

You can see the possibilities.

Technologically advanced

You may have read in the prestige national press of the research effort currently devoted to micro computer chips. The Dorachime is a musical revelation of its progress.

It produces, from its powerful little loudspeaker, notes similar in value to a miniature electric organ.

- A1 Greensleeves
- B1 God Save The Queen
- *C1 Rule Britannia
- D1 Land of Hope and Glory
- E1 Oh Come All Ye Faithful
- F1 Oranges and Lemons
- *G1 Westminster Chimes
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Section 5

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Taking into account the large numbers now participating in this hobby it must be a fair assumption that the majority of home constructors operate on what might be termed a modest level, that is to say they derive ample satisfaction through building small or medium sized low cost projects and items of equipment. The average constructor we reckon builds a couple of such projects or so each month as the fancy or need of the moment dictates. Typically, each project will take a few evenings or a weekend to complete.

EVERYDAY ELECTRONICS serves the requirements of this great band of enthusiasts who want to make use of modern technology for their own purposes, yet without excessive or total committal of either their spare time or spare cash to this one area of interest.

Having said that we know there also exists an appreciable number of constructors who are deeply absorbed in electronics and who are quite willing to devote the maximum time and effort possible in pursuit of what is, for them, a main leisure activity.

Requests reach us from time to time from representatives of this "minority." Overall, what they ask for is the occasional heavyweight project —something they can get their teeth into, a meal as distinct to a snack or a "starter." Well these requests have not fallen upon unsympathetic or unheeding ears, and after careful deliberation we now launch a major project series warranted to satisfy the most ravenous constructor. We refer to our *2020 Tuner Amplifier*.

This comprehensive hi-fi equipment will appeal to those who desire a major building job to tackle during the coming winter months. In the *Twenty-twenty* we offer them an ambitious and worthwhile project that should give much enjoyment, exercise their practical skills and broaden their experience during its construction; and be a lasting source of satisfaction and pleasure upon its completion. But we do emphasise that this is a project for the experienced constructor.

To return to our "average" constructor, previously defined, who represents the majority: we are sure the *Twenty-twenty* opening article will provide interesting and instructive reading between those practical sessions occupied in building the *Fuzz Box*, the *Mini-Module* or whatever else takes your immediate fancy from our enticing assortment of projects listed on the facing page. In any event do carefully preserve your copies of EE, for who knows, you may be tempted by the big one ere the series has run its course.

Fred Bennett.

Our January issue will be published on Friday, December 15. See page 865 for details.

Readers' Enquiries

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

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

Everyday ELECTRONICS

VOL. 7 NO. 16

DECEMBER 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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

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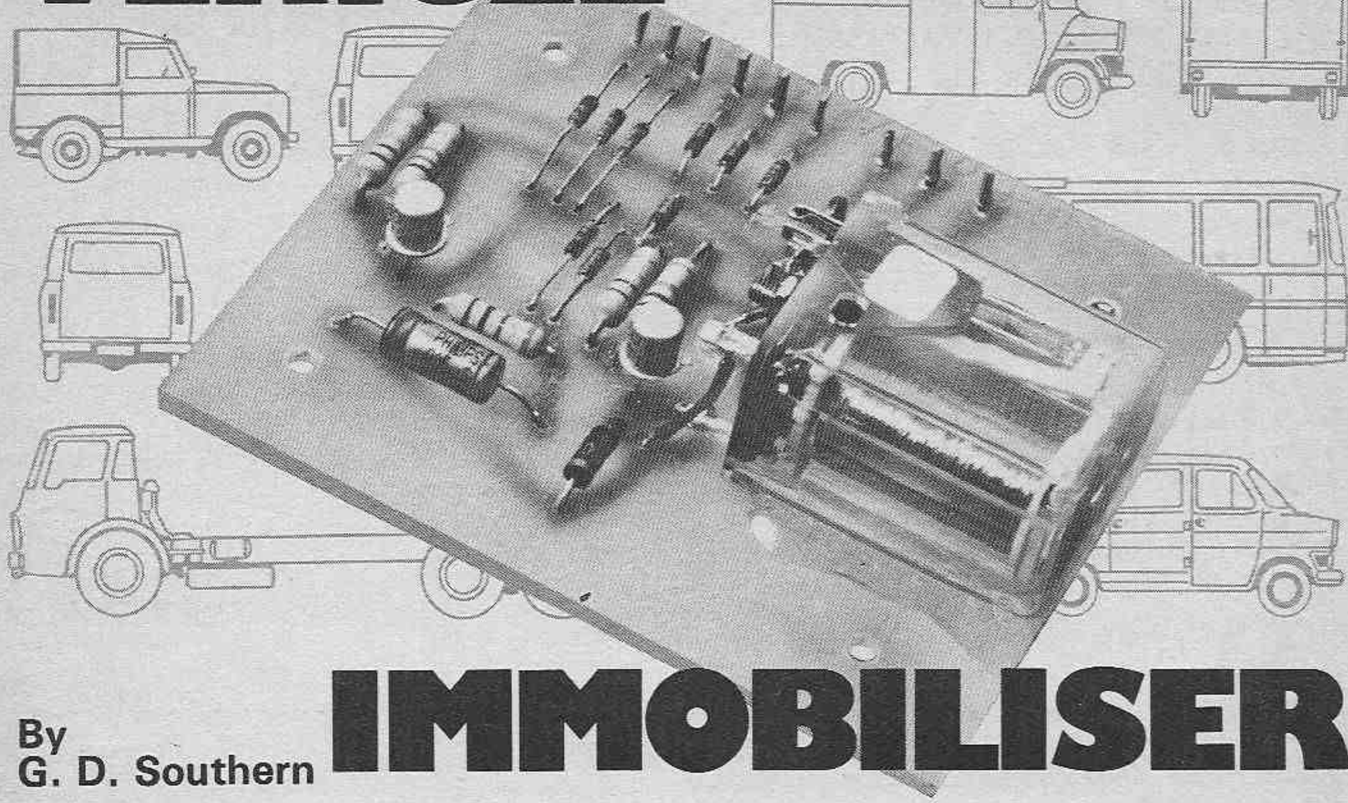
BEGINNERS

YOUR INTRO TO ELECTRONICS

SQUARE ONE

VEHICLE IMMOBILISER



By
G. D. Southern

EVERY day an average of 62 cars are stolen in the area where the author lives. It is claimed that at least 94 per cent of these cars are returned to their legal owners in due course. The majority of cars stolen are used by members of the community for joy-riding or late-night transport. Some of the cars returned have been driven to a remote area and accessories removed from them before the vehicle was abandoned.

The unit to be described here will offer some protection against theft by automatically immobilising the ignition system of the vehicle each time the ignition is switched off. Its degree of protection is far greater if the device is used with an electronic ignition system, especially one of the contactless type. With a conventional ignition system, the first thing a car thief will attempt is to bypass the ignition switch of the vehicle with a lead from the battery to the ignition coil.

With a contactless electronic system the above link will not have any effect and the car thief will have to find and eliminate the isolation system. This delays the thief further and as time is usually at a premium, it should prove to be an adequate deterrent.

One of the main advantages of the immobiliser is that no hidden switches .or links are required When the ignition is switched off, the engine is immediately immobilised. If the ignition is switched on again the engine will not start.

In order to start the engine the correct accessory switches must be operated before the ignition is switched on. If the ignition is switched on first before the relevant accessory switches are operated, the ignition system will still remain immobilised. So there is no point in a car thief switching the ignition on and then searching for a sequence of accessory switches.

COMPONENTS approximate cost £3·50 excluding case

CIRCUIT DESCRIPTION

The complete circuit is shown in Fig. 1 and for the purpose of the following explanation, resistor R3 is considered to be open circuit.

When capacitor C1 is discharged, the initial charge current will be at a maximum value, whereas when it is fully charged, the charge current will be at a minimum value, typically just adequate to overcome leakage losses. The charging circuit for the capacitor is via diode D8, resistor R4 and the parallel combination of resistor R5 with the base/emitter junction of transistor TR2.

Thus when the ignition is switched on, capacitor C1 will commence charging and transistor TR1 will tend toward saturation. The speed of transition from cut off to saturation will be limited by the inductive value of the relay coil.

At approximately 10 to 15 milliseconds after the closure of the ignition switch, the relay contacts will close. Once the contacts have closed, the base current for transistor TR1 is supplied from the positive line via the relay contacts, diode D9 and resistor R4, thus "latching" the circuit. The time

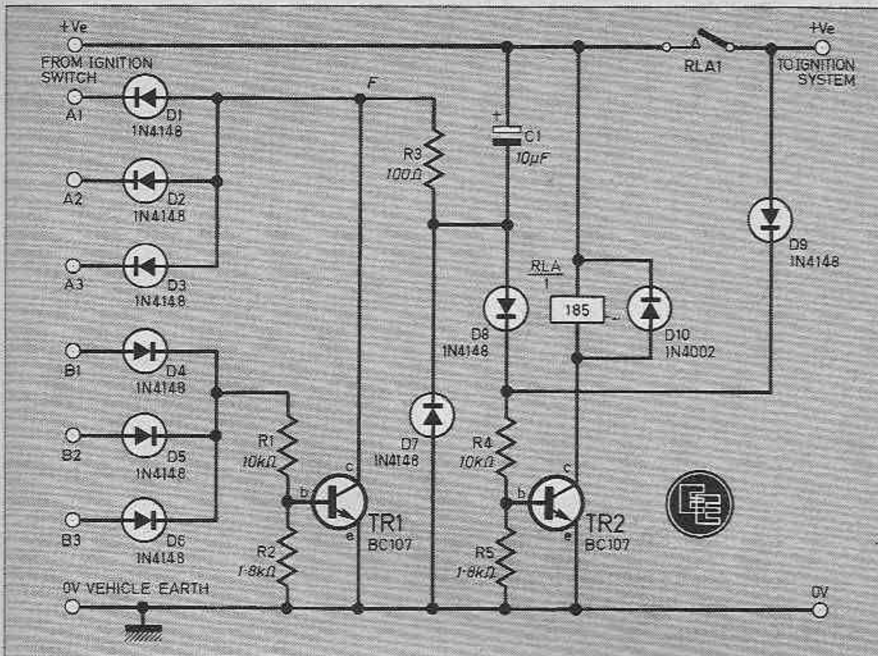


Fig.1. Complete circuit diagram of the Vehicle Immobiliser.

TRUTH TABLES

INPUTS			OUTPUT
B1	B2	B3	F
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

(a)

Fig.2a. Truth Table for a NOR gate.

INPUTS			OUTPUT
A1	A2	A3	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(b)

Fig.2b. Truth Table for an AND gate.

constant of the charging circuit for capacitor C1, via diode D8, resistor R4 etc is far longer than the operate time of the relay, thus allowing the relay to operate and "latch".

Now it can be seen that if the capacitor is charged in a shorter period than the operating time of relay RLA1, the relay will not operate.

TRUTH TABLES

With reference to the Truth Table, Fig. 2a., assume that inputs A1, A2 and A3 equal to + 12V and C1 is discharged. The "0" level in the truth table is considered to be 0 volts and the "1" level is considered to be the battery voltage of the vehicle. From the Truth Table it can be seen that the part of the circuit consisting of diodes D4, D5, D6 and resistors R1 and R2 together with transistor TR1 and resistor R3 form a NOR gate. Thus when all inputs are equal to 0, the collector voltage of TR1 will be high, equal to 1.

From the second Truth Table, Fig. 2b it can be seen that the circuit consisting of diodes D1, D2, D3 resistor R3 and the collector/emitter circuit of TR1 form an AND gate. Thus when inputs A1, A2 and A3 are equal to 1, the output voltage at point *F* will be equal to 1.

To demonstrate the overall operation of the circuit, consider a case where the brake light circuitry is connected to input A1 as illustrated in Fig. 3a with all other inputs left disconnected.

When the ignition is switched on, capacitor C1 is charged via resistor R3, diode D1, and the filaments of the lamps, providing the brake light switch is open. Thus the capacitor is charged before the relay can operate, so the ignition will remain disabled even though the ignition switch is on.

If the authorised driver now realises his/her mistake, the ignition switch would be switched off and the correct sequence of switching attempted. However, this would still not operate the relay because capacitor C1 would still be charged. To overcome this problem a further diode has been added to the circuit, D7.

When the ignition switch is switched off, a discharge path is provided for capacitor C1 through external loads, for example the vehicle's ignition system via diode D7.

Now if the ignition is switched off, the brake light switch closed and the ignition switched on again, the ignition system will function correctly. When the brake light switch is closed before the ignition switch is switched on, the charging path for C1 is now via diode D8, resistor R4 etc, so the relay can operate.

Similarly if inputs A1, A2, A3, B2 and B3 are open circuit and for instance the screen-wash pump

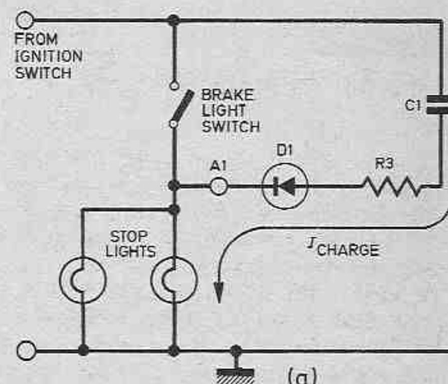


Fig.3a. Illustrating the operation of the circuit when using an "A" input.

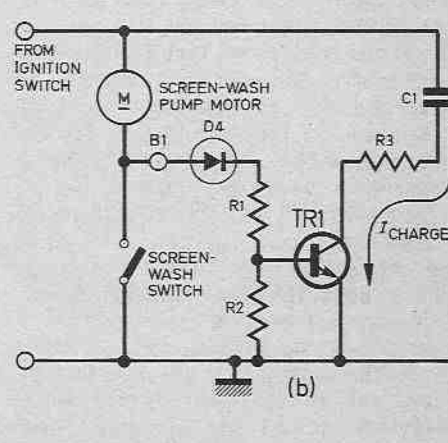
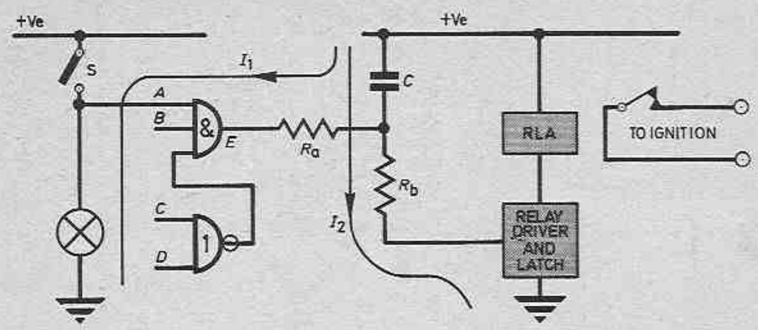


Fig.3b. This time a "B." input is being used to illustrate the operation.

HOW IT WORKS



The circuit consists basically of a timing circuit with two different time constants. the longer of the two is adequate to allow a relay to operate. Once operated the relay is held on by a simple latching circuit.

Consider the case where the inputs *A* and *B* are low, *or* *C* or *D* high. The capacitor will begin to charge via R_a, the AND gate and the lamp. This constitutes the short time constant and is too fast for the relay to operate. Now if *A* and *B* are high (switch *S* operated and lamp on) *and* *C* and *D* low, the capacitor will now charge via R_b and is the longest time constant. The relay will now have sufficient time to operate, and thus connect power to the ignition circuit.

In practice one or more inputs as the example shows, are connected to various accessories, such that a certain combination will enable the ignition circuit.

COMPONENTS

See Shop Talk page 857

Resistors
R1 10kΩ
R2 1·8kΩ
R3 100Ω
R4 10kΩ
R5 1·8kΩ
All ½W carbon film ± 2%

Capacitors
C1 10μF 25V elect.

Semiconductors
TR1 BC107 silicon *npn*
TR2 BC107 silicon *npn*
D1 to D9 1N4148 silicon (9 off)
D10 1N4002 rectifier

Miscellaneous
RLA Relay: 185 ohm coil with single pole contacts to suit load. (RS type 348 908); Printed circuit board as described; connecting wire; small aluminium box if required.

motor circuit is connected to B1, as shown in Fig. 3b capacitor C1 can charge via resistor R3 and the collector/emitter junction of transistor TR1, if the washer switch is off. However, if the washer switch is operated before (and during) the operation of the ignition switch the capacitor will again charge via diode D8, resistor R4 etc, and the relay will latch thus allowing the ignition system to operate normally.

ACCESSORIES

It should be noted that the "A" inputs are for accessories which have a switch connected to the ignition switch line, whereas the "B" inputs are for accessories with a switch connected to earth.

Thus the circuit can be inhibited by only one accessory switch as in Fig. 3, or by several, thus utilising its multiple inputs. For instance, a seat belt warning system could be connected to one of the inputs, with the brake light circuit to another.

So unless the driver, and front seat passenger if present has his/her seat belt on and has operated the brakes before the ignition switch is switched on. the engine will remain immobilised. This illustrates how the device could be used as a safety feature as well as an anti-theft engine immobiliser.

Care should be exercised at this stage, in the selection of a suitable input connection, because on certain makes of car, the starter motor cannot be re-engaged until the ignition switch is firstly moved to the off position and then switched on again. This means that the engine will be immediately immobilised and the correct starting sequence will have to be applied. The worst case condition for this would be if the engine cuts out when the vehicle is on the move.

Use of the brake light switch in this situation could be somewhat hazardous. In the average car there are many other alternatives including for instance, the screenwash circuit, headlamp flasher, etc.

FORD ESCORT MK II

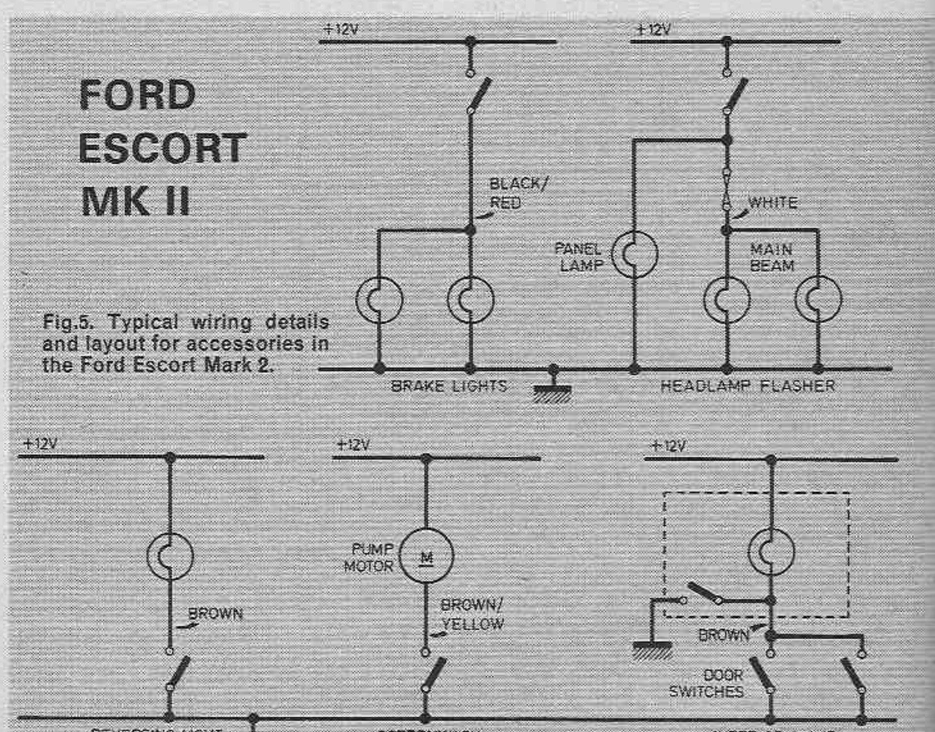


Fig.5. Typical wiring details and layout for accessories in the Ford Escort Mark 2.

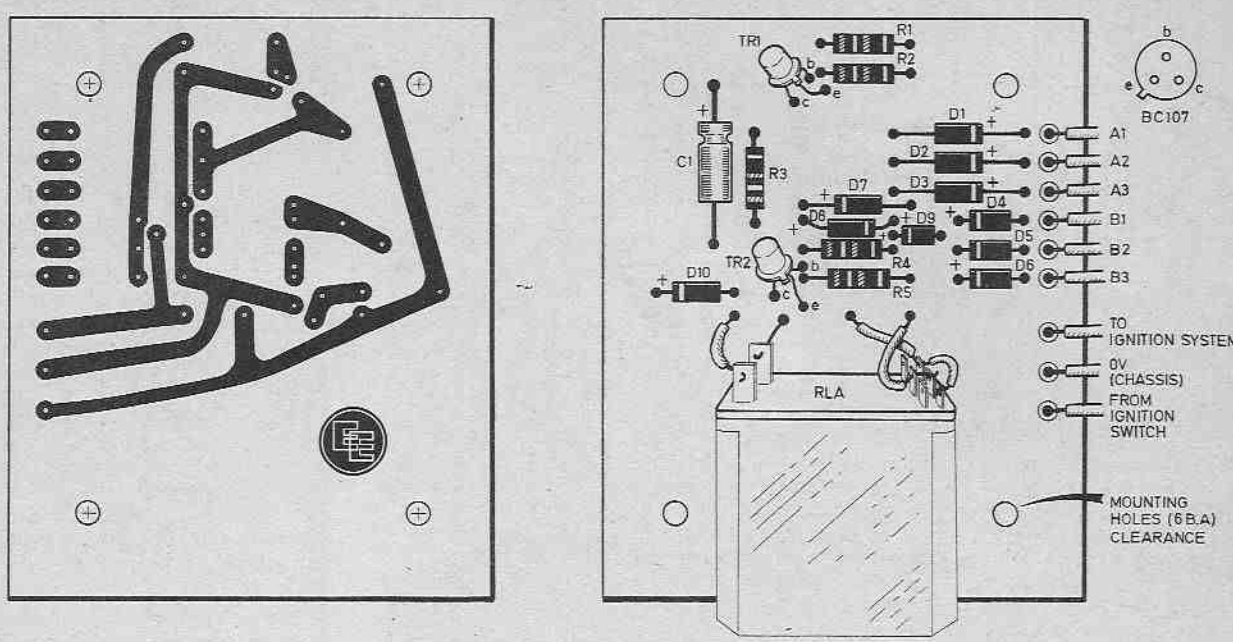


Fig.4. Printed circuit board required. In the prototype the relay is mounted on the board using an epoxy glue.

CONSTRUCTION starts here

Construction is simplified by the use of a printed circuit board which carries all the components and wiring. The layout of the board is shown in Fig. 4 which is reproduced full size.

One method of making the board is as follows. First, either photocopy or trace the copper pattern, position the tracing on the copper side of the board and mark with a sharp pointed tool, the position of the connecting holes. Remove the paper, thoroughly clean the board and draw in the rest of the copper pattern with an etch resist pen. Once dry the board can be etched in the normal way.

Once etched and the board checked for any errors, the components can then be mounted. Here again the layout is shown in Fig. 4. It should be noted that the layout is not critical and can be varied to suit, although a good strong finish is required, hence a printed circuit board.

Good quality connecting wire can be used to connect to the various accessories, and Fig. 5 and Fig 6 show the many possibilities on two popular cars. The top two circuits of each set of drawings relate to "B" inputs, whereas the arrangements below relate to "A" inputs. When wiring to the car accessories the manual applicable to the make of car should be consulted.

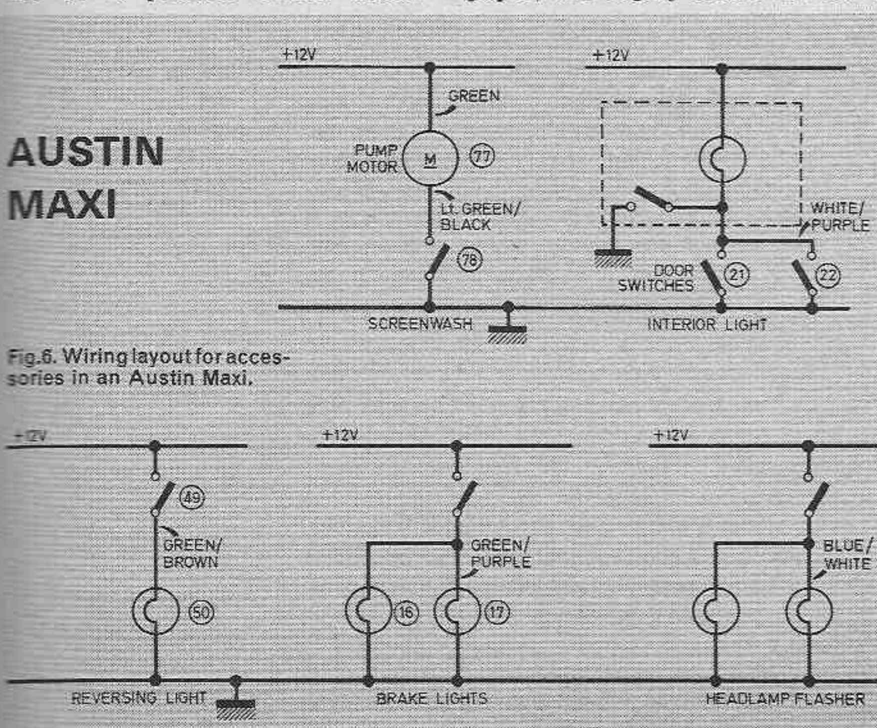


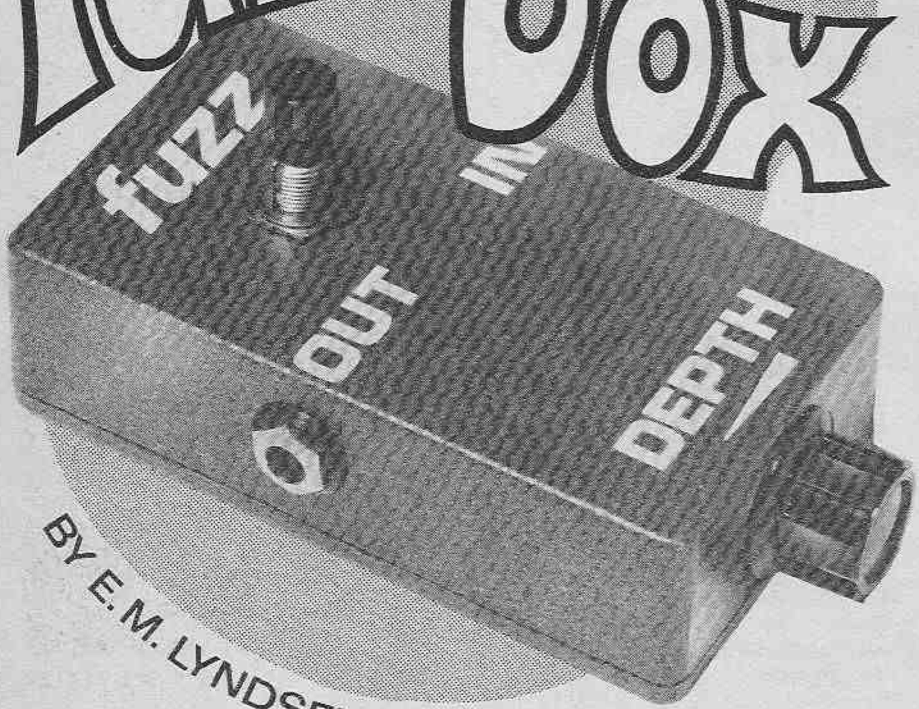
Fig.6. Wiring layout for accessories in an Austin Maxi.

INSTALLATION

The author's prototype circuit board was mounted inside the box of his electronic ignition system. The system used was basically a Bi-Pak kit but had been modified to provide space for the additional board and wiring.

A second unit was then built and fitted into a small aluminium box which was then installed in the engine compartment. If this method is used the box should be positioned away from heat and the weather. ⌑

fuzz box



BY E. M. LYNDSELL

THE POP musician is being constantly bombarded with new and improved musical effects units, but still polling high in the popularity charts is the "old" Fuzz Box.

Some of the earlier designs were not completely satisfactory requiring high input signal level and producing premature cut-off as the input signal decayed. Those fuzz units employing discrete components operated on the verge of instability due to the high gain required. The design appearing below has none of these deficiences and will produce a fuzz gradually decaying into a "clean signal" sound.

The fuzz sound is derived by clipping the input waveform thereby enriching the signal with odd harmonics which provide the harsh sound.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Fuzz Box is shown in Fig. 1.

Use is made of the industry standard op-amp type 741 which is used in a non-inverting configuration. The gain of this arrangement is controlled by the feedback network VR1, R3 and R2 and is equal to

$$\frac{VR1+R3+R2}{R2}$$

Thus minimum gain is approximately nine and maximum gain approximately 92. However, the input signal never actually receives this boost for the anti-parallel diode arrangement comes into play and limits any amplified excursion, positive and negative going, to about 600 millivolts (the voltage drop across a forward biased silicon diode).

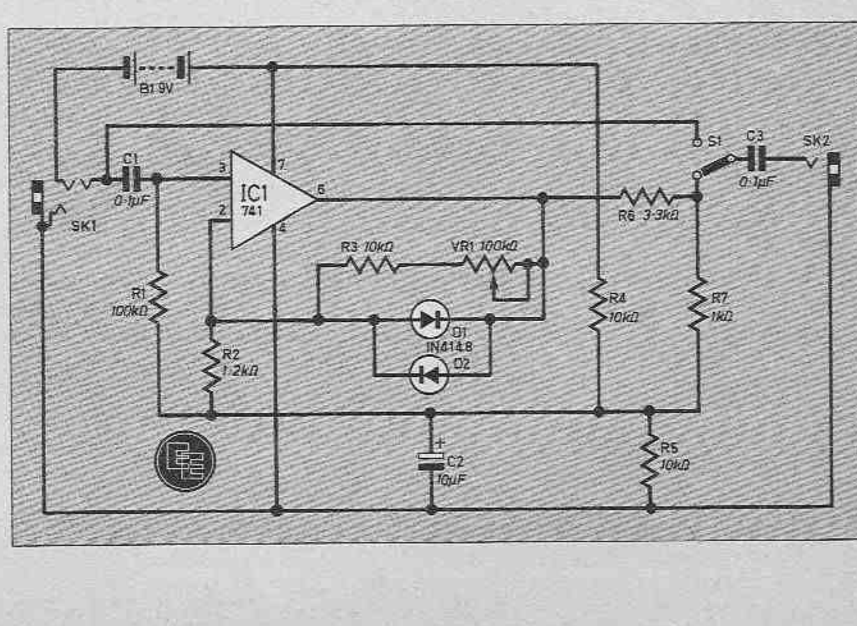
With this limitation on amplitude, it appears that the setting of VR1 has little effect. This is not so, for this control determines the rate of climb up to the clipped level or the rise time as it is called.

This time is inversely proportional to the harmonic content, i.e. the faster the rise the more harmonics produced resulting in a harsher tone; VR1 therefore controls the "depth" of fuzz.

It is apparent from the gain figures quoted that some signals will not reach the clipping levels; those below 6mV for maximum VR1 and those below 60mV for minimum setting of VR1. This is intentional to allow a gradual reduction in "fuzz" as the input signal decays naturally, being a smooth transaction from fuzz to no-fuzz.

Input to the unit is at SK1 a stereo jack socket wired to complete the d.c. power circuit when

Fig. 1. The complete circuit diagram of the Fuzz Box.



fuzzbox

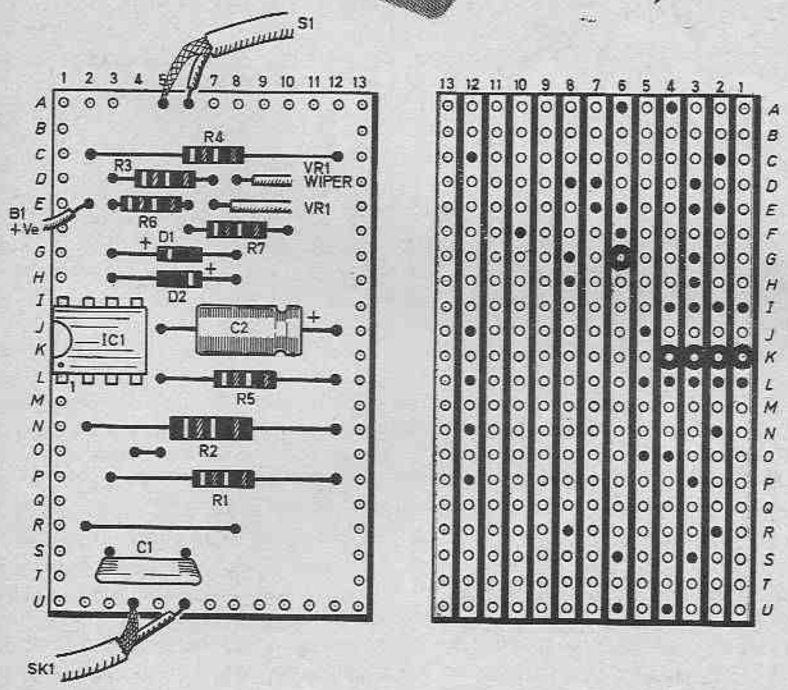


Fig. 2. The layout of the components on the topside of the board and the breaks to be made along the copper strips on the underside.

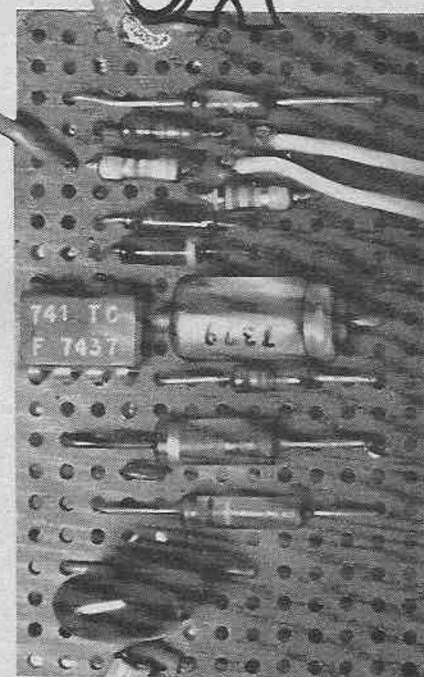


Photo of the completed prototype board.

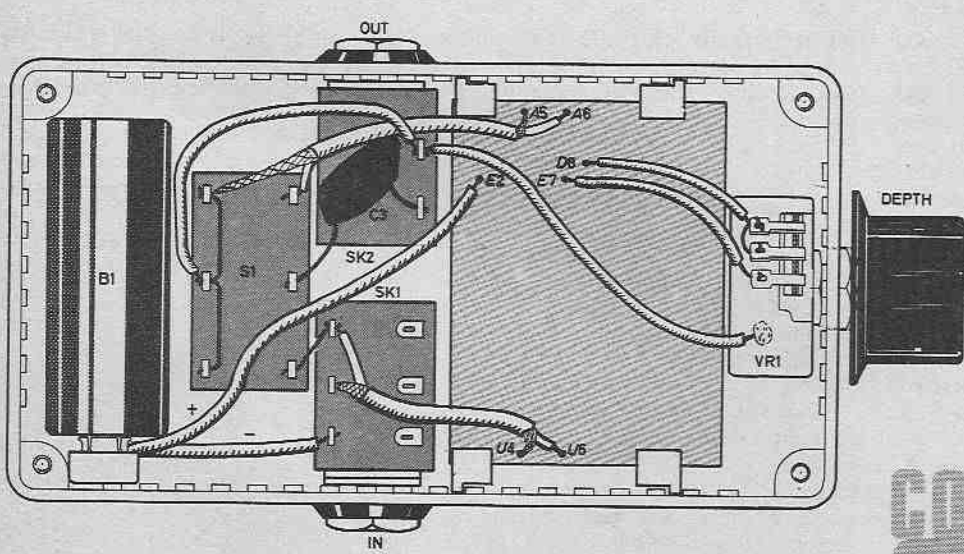


Fig. 3. The positioning of the components and board within the case showing complete wiring up details. Note the connection to the body of VR1 to "earth" the case.

COMPONENTS
approximate cost £5

the input jack is inserted. The signal then passes to the op-amp via d.c. blocking capacitor C1. Resistor R1 sets the input impedance at 100 kilohms which should suit most guitars and electronic organs.

The resulting signal from the op-amp is reduced in amplitude by the potential divide action of R6 and R7, giving an attenuation factor of approximately four. Thus the maximum output signal via C3 available for inputting to an amplifier is about 150mV. This level will be maintained during the period of clipping (fuzz) and will then decay naturally to zero.

The 741 requires a split supply and this is derived by the potential divide action of R4 and R5 producing ±4·5 volts with respect to the op-amp reference line which is decoupled by C2.

A foot-switch S1 is incorporated to allow the unit to be readily bypassed when desired.

COMPONENTS

See Shop Talk page 857

Resistors

R1	100kΩ
R2	1·2kΩ
R3	10kΩ
R4	10kΩ
R5	10kΩ
R6	3·3kΩ
R7	1kΩ

All ¼ watt carbon film ± 10%

Capacitors

C1	0·1μF plastic or ceramic
C2	10μF 6V elect.
C3	0·1μF plastic or ceramic

Semiconductors

IC1	741 operational amplifier 8 pin d.i.l.
D1, D2	1N4148 or similar silicon diode

Miscellaneous

SK1	standard stereo jack socket
SK2	standard jack socket
S1	s.p.d.t. successional action foot-switch
B1	9V PP3
VR1	100 kilohm carbon lin.

Stripboard: 0·1 inch matrix 13 strips × 21 holes; PP3 battery clip; Bimbox aluminium diecast box type 5003/13; Bimadaptors for holding board; knob for VR1; connecting wire.

CONSTRUCTION starts here

The prototype unit was built using a piece of 0·1 inch matrix stripboard size 13 strips × 21 holes and mounted horizontally in a diecast aluminium Bimbox type 5003/13 by use of special adaptors. This eliminates the use of fixing screws on board or case.

The layout of the components on the topside of the board is shown in Fig. 2. Make the breaks on the underside and then assemble the components as shown. It was not thought necessary to mount IC1 in a socket as this is quite a robust device. However the usual care should be exercised when soldering this and the diodes in place.

Attach the flying leads including the battery connector and then proceed with drilling the case. The layout of the components in the case is not critical.

With the components positioned in the case, attach the adaptors to the board and slot in position and wire up according to Fig. 3. Screened lead was used in the prototype for input/output connections as can be seen in the photograph but this is not essential as the case is earthed via VR1 framework. Insert and connect the battery and secure the lid.

The lid forms the base of the Fuzz Box. If the lid is fitted with self-adhesive rubber feet, this will prevent the unit slipping when in use.

IN USE AND TESTING

The box is to be situated between the musical instrument and amplifier. Inserting the input jack plug turns on the unit.

Set VR1 fully clockwise. On playing your musical instrument the sound emanating from your speaker will be fuzzed or clean, depending on the setting of S1. Assuming it is the latter, depress S1 and fuzz should be heard. Playing and turning VR1 anticlockwise should reduce the "depth" of fuzz.

No volume control was found to be required on the author's prototype as resistors R6 and R7 were tailored to give the required balance between fuzz and no-fuzz for the author's guitar. Assuming the initial output signal from the guitar before decaying is 60 millivolts, then switching from no-fuzz to fuzz by S1 will boost the amplitude by 8dB during the fuzz period.

If other boost factors are required change the value of R6 and R7 or both to suit your requirements. This combination could be replaced by a log. potentiometer to give continuously variable output level.

Unless sub-miniature potentiometers are used, if a volume control is incorporated, a larger case than specified will be required.

Battery drain is low and a PP3 should provide many hours of use. A Duracell battery will allow even longer periods between battery changes.

The case specified and used by the author has a durable grey enamel finish and thus required only socket and control lettering to complete the unit. Letraset with spray-on protective varnish was found satisfactory for this. ⌑

By Dave Barrington

Calculators

With so much "hysteria" in the media lately about silicon chips (microprocessors) and their possible impact on our future way of life, people tend to forget that the electronic calculator is a prime example were they have been used and accepted, without any fuss, into our everyday life. In fact, the range, popularity and versatility of these machines is so wide that any new additions are now taken for granted.

Two new additions we should like to mention which highlights the latest trends are the TI-2550-IV from Texas and the Casio ST-24 Time Card.

Featuring a built-in instant replay facility allowing the user to check back on the last 20 entries, the TI-2550-IV is obviously aimed at the accountant/student and could be used in place of some of the more expensive paper printout calculators.

The calculator is a general purpose hand-held type with the normal addition, subtraction, multiplication and division functions together with percentage and sign-change keys and full-function memory. The machine uses an 8-digit vacuum fluorescent display, with a floating decimal point (adjusts its position in the readout automatically) and negative sign, plus overflow error indication.

The replay facility, which operates with up to 20 steps, is activated by pressing a single key. The playback key allows the user to check through calculations step by step and any necessary corrections made by keying in the new entry and pressing the "equals" key. This saves re-entering the entire program.

The TI-2550-IV operates from a rechargeable battery pack and an a.c. adaptor/charger is included in the recommended retail price of £29·95 (inclusive of VAT).

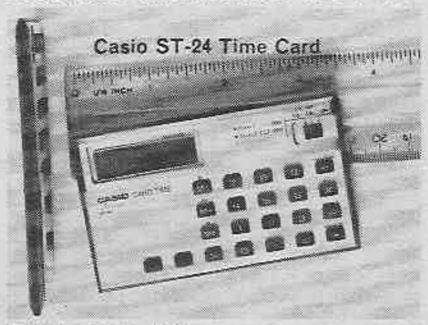
For the busy executive, travelling salesman or the housewife, the Casio ST-24 Time Card could be classed as the latest "state-of-the-art" in the current craze for the credit card size of small calculator. Not content with a miniature machine they have incorporated a time/stopwatch with alarm setting facilities, ideal for those important meetings and elapsed time when leaving the car parked to make calls or do some shopping.

The calculator section is a four-function type with the usual standard facilities including memory and percentage.

The 24 hour timer has two kinds of alarm setting: straightforward alarm setting for a single specified interval, or to sound repeatedly at predetermined intervals. In both cases, capacity of the timer is from a few seconds up to 23 hours, 59 minutes, 59 seconds. A countdown is possible as the display shows time remaining before alarm is due.

Operating modes for the stopwatch are normal start/stop, lap timing, or first/second place timing. Indication is to one-tenth of a second up to 10 hours, or to one second beyond 10 hours. Use of calculating facilities does not affect function of alarm timers or stopwatch.

The Casio ST-24 Time Card is supplied in a leatherette pouch with a separate compartment for credit or business cards, and has a recommended retail price of £24·95 (including VAT). For addresses of nearest stockists readers should write to Casio Electronics Co. Ltd., Dept EE, 28 Scrutton Street, London EC2A 4TY.


Casio ST-24 Time Card

Beginners Kit

Designed with the very young in mind, the Tutronik Timesaver System introduces the total beginner to the very fundamentals of electronics. A "course" of 30 different circuits is provided, covering a wide range from a simple series circuit to a novel police siren.

Each circuit is accompanied by an instruction sheet giving essential information on what components you need, what you have to do, how and why the circuit behaves as it does. Throughout the course experimentation is encouraged. Written in an easy to follow language, sometimes distractingly lighthearted, every detail is covered to ensure the beginner does not go astray.

An unusual type of breadboarding system using the actual circuit as the wiring diagram, and plastic screw terminals to hold the component leads is used throughout. Rather disappointingly components are not provided. Full details from: Technocentre, Dept EE, 54 Adcott Road, Acklam, Middlesbrough, Cleveland.

Constructional Projects

This month there should be no difficulties with component availabilities except possibly the major constructional project, *EE2020 Tuner Amplifier*, which we shall deal with separately.

The relay for the *Ignition Immobiliser* should be able to handle the current requirements of the ignition circuit. In the prototype the relay used had two sets of contacts wired in parallel.

For the *Water Level Alert* a 35Ω 40mm diameter loudspeaker can be used in place of the Post Office earpiece. If any difficulties are experienced with the rocker switch S1 this can be ordered from Maplin as a "Hekla Switch".

There should be no problems with the rest of the constructional articles in this issue.

2020 Tuner Amplifier

The *EE 2020 Tuner Amplifier* is larger than our usual run of projects, and so it follows that the components used add up to an impressive list. Yet because of the large quantity of similar components called for, the constructor should be able to purchase many items at especially favourable rates.

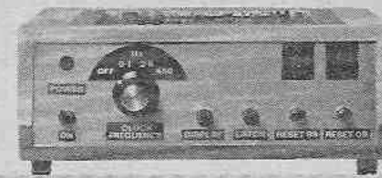
Capacitors should be of the kind as specified in the Bulk Components List; this is to ensure suitability for mounting on the printed circuit boards. This is particularly important in the case of electrolytic capacitors. Here RS Components types have been specified. In most instances a voltage rating of 63V is stated. This is higher than actually needed in the *2020* circuit and lower rated capacitors of an alternative make may be used *provided* the physical dimensions and the lead spacing are as the RS types specified.

The r.f. unit and some related parts are obtainable direct from Ambit Ltd, 2 Gresham Road, Brentwood, Essex. This firm can also supply the special multi-turn potentiometers for varicap diode tuning.

The pushbutton switches specified are marketed by both RS Components and ITT, under these firms own stock numbers (see Bulk Components List).

Readers should note that manufacturers such as RS Components and ITT (and Mullard and Texas) do not supply to individuals. But their components are readily obtainable from distributors and retailers who cater for the retail market.

DOING IT DIGITALLY



PART 3

By O. N. Bishop

Last month we used the NAND gates of a 7400 i.c. to build a NOT gate and a bistable. These two logic elements, as well as the NAND gate itself, are often required in building logic circuits that it is useful to have them ready-wired on the patchboard. On the Test-Bed these elements are permanently wired in, the form of IC3, see Figs. 3.1 and 3.2.

FAN-OUT

Each of the inputs of these elements has a single input pin and each output has a pair of output pins. Though each input of a logic gate can receive its input from only one source, the output is able to be connected to several other gate inputs. The number of inputs that may be connected to an output is known as the *fan-out* of the output. Here we provide pins for a fan-out of two, since this is as many as we shall normally need. However, most outputs have a fan-out of eight loads.

These circuits have already been tested when building the Test-Bed, but it is a good idea to test them again. This time you know a little more of what you are doing.

With the supply pin P34 connected to be +5V line first test the NAND gate. Connect the output *V*26 or *V*28 to l.e.d. D7 at location *V*40. The l.e.d. should be dark (off) but should light when either of the input pins at S25 or T25 are grounded to one of the pins on strip *N*, the 0V rail.

Unconnected inputs of a NAND gate are effectively "high" so there is no need to connect them to the positive rail for testing. You can easily check this by linking one of the inputs to ground and noticing no change in the state of the l.e.d. when the other input is connected to one of the pins on strip *L*, the +5V rail.

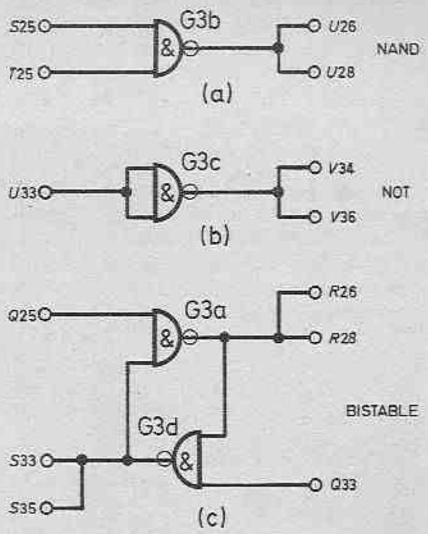


Fig. 3.1. The three basic elements contained in IC3 with pin locations for inputs and outputs on the Test-Bed.

To test the NOT gate, connect one of the NOT outputs, pins *V*34 or *V*36 to one of the l.e.d.s, e.g. *U*43 for D8. The l.e.d. remains dark when the input is unconnected (effectively "high") or connected to strip *L*. The l.e.d. lights when its input, pin *U*33 is grounded (connected to 0V rail).

Finally to test the bistable: connect each bistable output to an l.e.d. e.g. pin *S*36 to *U*49 and *R*28 to *U*40. One l.e.d. should light and the other remain dark. When the appropriate input pin *Q*24 or *Q*33 is briefly grounded, the l.e.d.s change state.

A TTL CLOCK

Compare the circuits shown in Fig. 3.3 with the bistable circuit of Fig. 3.1c. Their similarity suggests that they may behave in a similar way—for example, they can both alternate between two opposite states. The bistable changes state when one of its inputs is grounded. The clock circuit changes state automatically after a fixed period

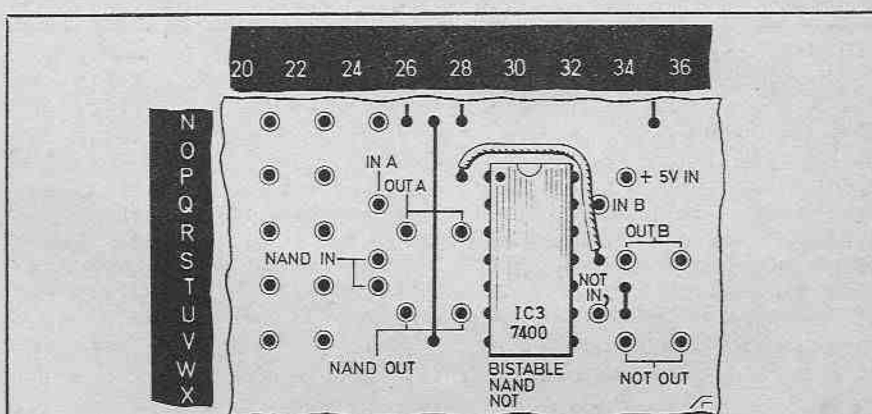


Fig. 3.2. The positioning of IC3 on the Test-Bed showing input and output pinning.

of time. Suppose that it has just changed to the state shown in Fig. 3.3a. The output of G1 (gate 1) has just gone high (as indicated by the shading) and the l.e.d. at its output has just come on.

The sudden increase in output voltage raises the voltage of both sides of capacitor C1 to a "high" level. Both inputs of G2 are now high (remember the unconnected input is effectively "high") so its output goes "low". This lowers the voltage of both sides of C2; G1 now has one "high" input and one "low" input, so its output is "high". The circuit has the state indicated in Fig. 3.3a. Why is it not stable in this state?

For the answer to this question, look at R1. This has a high voltage at one end and is grounded at the other. A current *I* flows through R1, as indicated by the arrow. As current flows, the voltage on one side of C1 falls and finally reaches a "low" level that acts as a "low" input to G2.

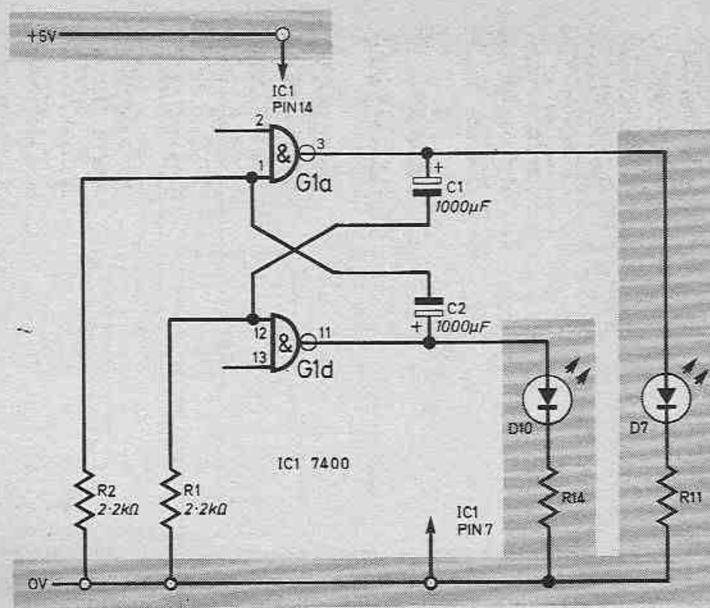


Fig. 3.4. The circuit of Fig. 3.3 redrawn in a more conventional form with the state of its outputs indicated by l.e.d.s.

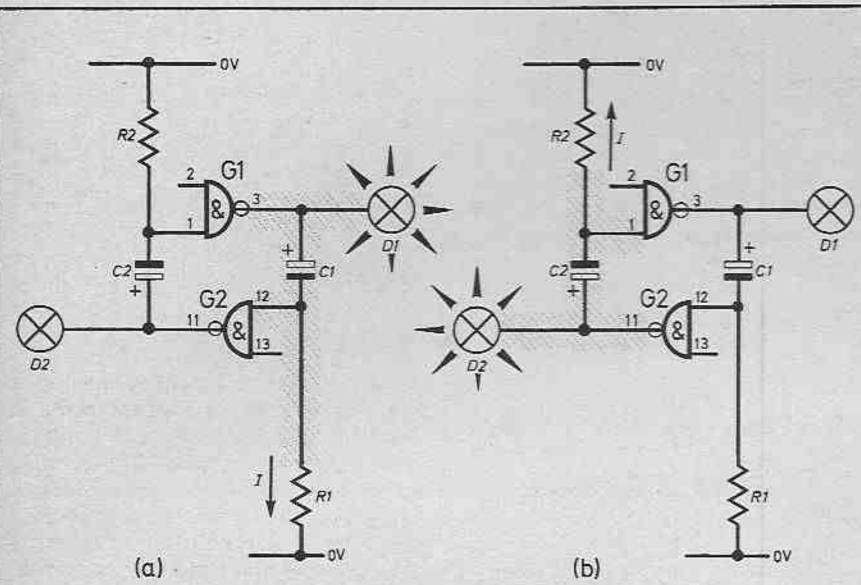


Fig. 3.3. The circuit diagram of a TTL Clock. It alternates between state (a) and state (b). The shaded regions of the circuit indicate "high" voltage.

Now the output of G2 suddenly goes high; D2 lights; the voltage on both sides of C2 is raised; G1 now has two "high" inputs; its output goes low and D1 is extinguished; the voltage on both sides of C1 is lowered. We have reached that stage shown in Fig. 3.3b. The circuit remains in this state while a current flows to ground through R2; as soon as the voltage has fallen low enough at the input to G1, the circuit reverts to the state of Fig. 3.3a and the cycle repeats.

The clock circuit is unstable (we call it an *astable multivibrator*) in either of its states. The length of time it remains in either state depends on how long it takes for the voltage on one side of each capacitor to fall from "high" to "low". This time depends on the values of the capacitors and resistors involved.

With high capacitance and high resistance a small current flows and gives a relatively small rate of change in voltage, resulting in a long period of time in each state.

EXPERIMENTAL TTL CLOCK

We shall now observe the operation of this circuit which is redrawn in its more common form in Fig. 3.4 is shown wired up on the Test-Bed in Fig. 3.5. The clock should change state approximately every 5 seconds. In other words, it takes 10 seconds to complete its cycle of operation, from the time D7 comes on to the time it comes on again. We say the clock is oscillating or vibrating at 0·1Hz.

Different value capacitors will produce different frequencies. If capacitors with a value of 0·47µF are substituted, the l.e.d.s glow at about half their normal intensity but no flashing can be detected. The frequency is so great that the eye cannot follow.

To prove that the clock is really working connect a crystal earpiece across one of the l.e.d.s and the 0V rail. This is done easily with two pairs of leads terminated in crocodile clips. You will then hear a note of about 400Hz (around the same pitch as middle A on a musical instrument).

We have been calling this circuit a clock, but it is simply the equivalent of the pendulum or balance wheel that is used to regulate the speed of mechanism of an ordinary mechanical clock; it is an astable multivibrator.

In a clock there are gear wheels, hands and a dial to indicate the time, which is related to the number of times the pendulum has swung to and fro. Similarly we can connect further logic circuits to the

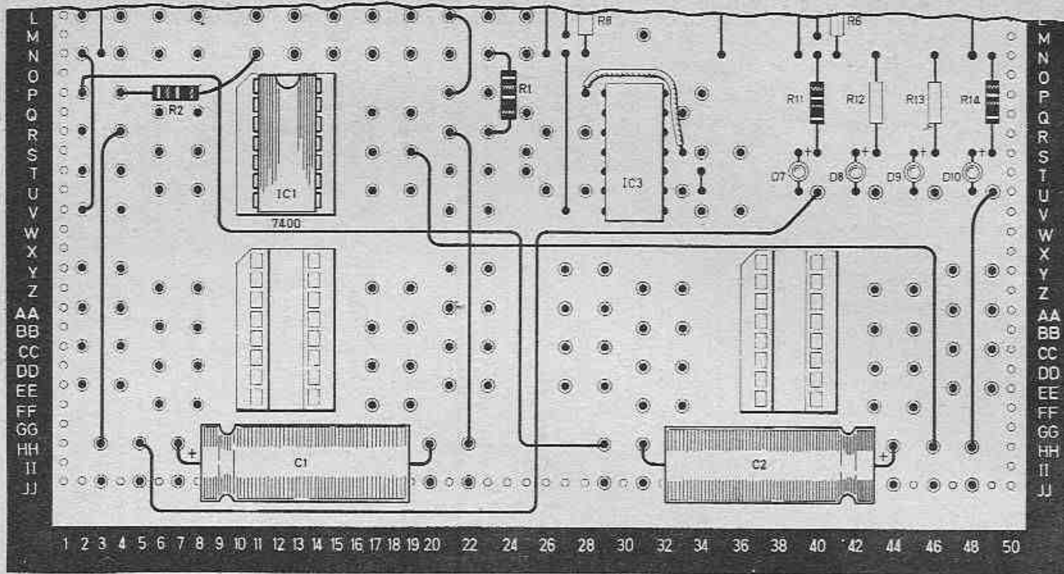


Fig. 3.5. The layout of the components on the Test-Bed for the circuit shown in Fig. 3.4. Experiment with different values for the capacitors and use a crystal earpiece for observing high frequency oscillations. The earpiece can be wired across either of the l.e.d.s.

TTL clock to count the number of times it changes state and so allow us to measure elapsed time. We shall return to this idea later in the series.

A clock or oscillator is a vital piece of equipment when testing logic circuitry and has been included in the Test-Bed on the internal component board. Three pairs of capacitors are fitted, any one of these pairs being selected by front panel switch S2. The output from this clock is available at pins D14, 16 and 18 on the Test-Bed.

LATCH

The output of a latch is identical to its input, but at any moment the output can be "frozen" or "latched" and then remains in the state that it was in when latched, even though the input may subsequently change.

Part of the latch circuit consists of a bistable discussed last month. In Fig. 3.6 the bistable in this circuit is drawn in a slightly different manner to that shown before, comparison with Fig. 3.1c shows that the connections are identical.

The bistable changes state when a low input is applied to it from one of the NAND gates. To find out how these work we shall use the NAND gate and NOT gate wired in IC3 on the Test-Bed; the remaining NAND gate is supplied by a further 7400 (IC1) inserted in a socket on the Test-Bed. We shall first examine the outputs from the two

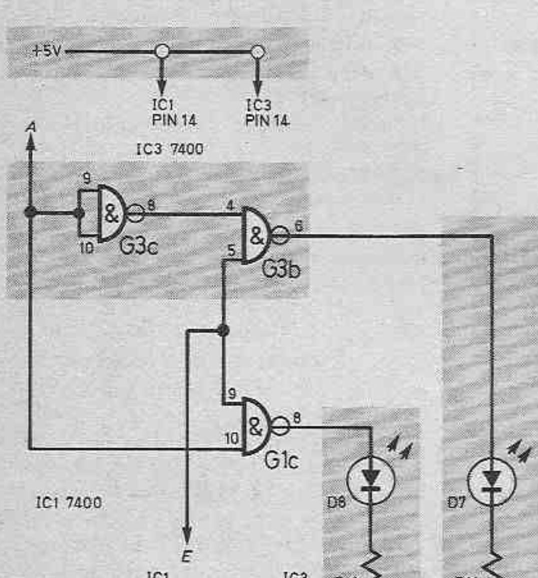


Fig. 3.6(a). Circuit of the front section of a "latch" circuit to observe the outputs which form the inputs to the remaining bistable section to be added later.

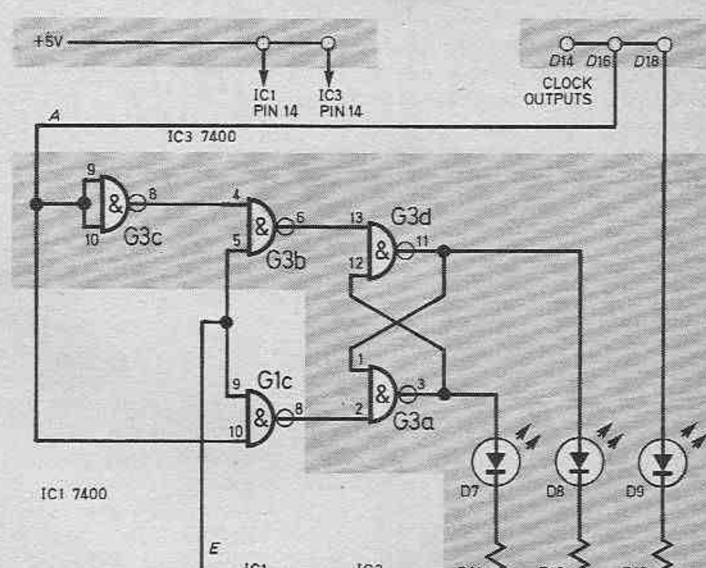


Fig. 3.6(b). The circuit diagram of a complete "latch" being driven by the in-built clock and outputs observed by means of l.e.d.s connected to the outputs.

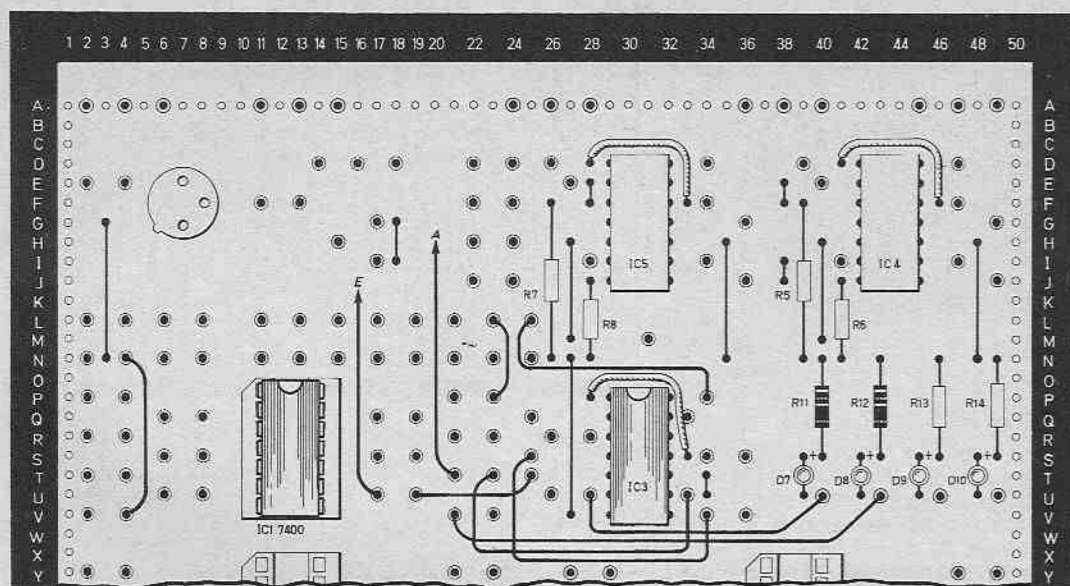


Fig. 3.7. The layout of the components and interwiring for the circuit of Fig. 3.6(a). For the circuit of Fig. 3.6(b) amend this layout according to the text.

NAND gates, see Fig. 3.7 for connection details.

USING THE IN-BUILT CLOCK

Connect wire *E* to the +5V rail, strip *L*. Now connect wire *A* alternately to the +5V rail and to the 0V rail and observe how the outputs change. Instead of changing wire *A* back and forth between +5V and 0V, make use of the in-built clock. Connect wire *A* to clock outputs (*D*16) and set the clock to low or medium frequency. The clock output automatically alternates between +5V and 0V, which can be observed by connecting another clock output pin to l.e.d. D9. You can now concentrate on watching the l.e.d.s.

Repeat your observations after having removed wire *E* from +5V and connecting it to 0V. Then return *E* to +5V and note what happens.

You will find that when *E* is "high" the l.e.d.s go on and off in time with the changes in clock outputs; always one lamp is on and the other off. When *E* is "low", both lamps are on all the time. This means that there is no "low" output, so a bistable connected to the outputs of the NAND gates will not change state. This is just what we need for a latch circuit, so the next step is to add the bistable.

Disconnect the output wires from l.e.d.s D7 and D8 and run them to the bistable input terminals instead (*Q*25 and *Q*33). From the bistable output terminals (*R*26 and *S*34) run wires to D7 and D8. This completes the latch circuit with two outputs—one following the input, and the other the inverse of the input.

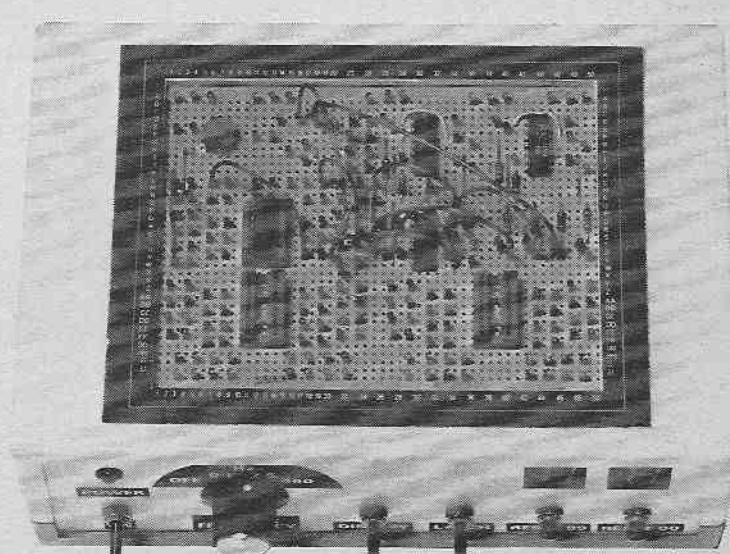
Test this circuit to see the effect of first making *E* "high" and then making it "low." Run the clock at medium frequency and see if you can ground wire *E* at just the right moment to latch the circuit with D7 lit and the other dark. With a certain amount of skill you can do this, but with the clock running at a high frequency it is entirely a matter of chance—equivalent to tossing a coin for "heads" or "tails".

This provides an idea for a simple project that can be built from three 7400 i.c.s two l.e.d.s a few resistors and capacitors, with a push-button for grounding *E*. This can be wired up on a small piece of circuit board and mounted in a small plastic case. Depending on whether the capacitors give you medium or high frequency operation, you have either a game of skill or a heads-and-tails gambling machine that could be fun at parties, or help raise money at the local fête.

A latch facility is very useful when experimenting with logic and this same circuit has been incorporated in the Test-Bed. It appears on the lower board with input and output terminals on the top board. The wire labelled *E* in Fig. 3.7 can be grounded by means of a front panel switch.

(To be continued)

Photograph of the interwiring on the Electronic Test-Bed for the circuit in Fig. 3.6(b).



MINI-MODULES

By George Hylton

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

3 MICROPHONE AMPLIFIER

This microphone amplifier is really a general-purpose amplifier for small audio voltages. It has a high input impedance and a gain which is adjustable from about 20 to a maximum of over 1,000, by means of a preset potentiometer.

The amplifier is designed for dynamic microphones of medium to high impedance. The prototype worked well with a popular type of microphone whose impedance can be set to either 600 ohms or 50 kilohms.

THE CIRCUIT

The circuit is a conventional two-stage amplifier of the type once known as a "d.c. feedback pair". TR1 is operated at a low collector current to minimise noise. Overall negative feedback via R3 sets the gain, in conjunction with the preset potentiometer VR1. Gain is maximum when VR1 is minimum.

For the moderate gains, which are all that is needed in practice, the gain is very nearly R5/VR1 so if it is known in advance of building the circuit just how much gain is needed it is possible to use the appropriate value of VR1 in the form of a fixed resistor. For example if a gain of 100 is required VR1 should be 1kΩ.

The input impedance varies with the gain but at low to moderate gains it is likely to be in the region of 200kΩ. It cannot exceed 330kΩ because of R1 which is connected across the input as far as audio signals go, since its lower end is "earthed" via C3 to audio frequencies.

Because the input impedance is quite high it is possible to use a low-impedance microphone (for example 30 ohms) and a step-up transformer to increase the signal voltage. The inset diagram shows how to connect a transformer with a hum-reducing "balanced" input winding.

The maximum output voltage before overloading is about 2V peak and the output impedance is fairly low. However the amplifier should not be used to drive loads of less than about 10kΩ or output will be severely restricted.

C2 is a radio frequency bypass capacitor to attenuate any r.f. signals accidentally fed in via the microphone cable. These can cause "breakthrough" of radio programmes into audio circuits.

COMPONENTS

Resistors

R1	330kΩ	R4	10kΩ
R2	100kΩ	R5	3·3kΩ
R3	100kΩ	R6	1kΩ

All carbon film 5% ¼W

Potentiometer

VR1 5kΩ carbon miniature preset 20% tol.

Capacitors

C1	100nF (0·1μF) polyester
C2	1nF (1,000pF) ceramic disc
C3	47μF 3V miniature elect.
C4	3·3μF 12V elect.
C5	47μF 12V elect.

Transistors

TR1, TR2 BC109 (or any high-gain low-noise silicon *npn* type) 2 off

Miscellaneous

Metal box about 100 × 70 × 40mm (Norman AB9). Tag strip with 12 insulated tags, to fit box. Jack socket (SK1). Output terminals: 3-terminal chocolate block or similar.
6BA bolts, nuts, earth tags, and spacers.

CONSTRUCTION

Since this kind of amplifier is designed for low-level signals hum can be a problem and a metal screening box is needed. The input must also be capable of screening; the microphone used with the prototype had a screened lead which terminated in a jack plug so a suitable jack socket was fitted to the screening box.

Obviously, other types of screened input socket may be needed for other types of microphone or signal source.

The main part of the circuitry can be accommodated on a tag strip. With this type of construction the components are soldered to a simple tag strip with the solder tags in a straight line. Interconnections are made with insulated wire.

This is a relatively cheap form of construction as tag strips cost only a few pence and can often be salvaged from old equipment and cleaned up for re-use. It is not a type of construction which has much use for high-frequency circuits because it is rather hard to avoid accidental couplings between input and output, which cause r.f. instability. But it is usually all right for audio.

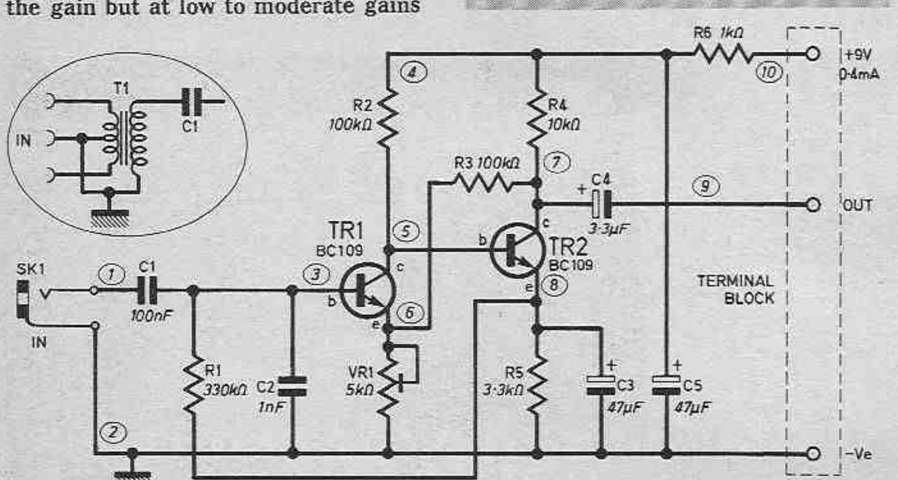


Fig. 1. The circuit of the microphone amplifier. The encircled numbers (1 to 10) are common connecting points on the tag strip, see Fig. 2. The small inset diagram shows how a step-up transformer can be used to suit a low-impedance microphone.

DESIGNING TAG STRIP LAYOUTS

If you design your own tag-strip component layouts a fairly careful pen-and-paper design is needed to ensure that the circuit will fit an available tag strip. To begin with, you should study the circuit diagram and mark each connecting point with a number (as in Fig. 1). Points which are connected directly to one another by plain connections count as one and the same point and are given just one number. (The "earth line" is a typical example.)

The present circuit has ten such connecting points which means that at least ten tags will be needed. In practice it usually turns out that a few extra tags are needed because of the physical limitations of the components, whose leads can only span a limited distance. A typical case is the preset "pot" VR1 which must be firmly soldered to two adjacent tags: (with some types of "pot" three tags may be required).

The resulting layout bears little relationship to the layout of the symbols on the circuit diagram; this may make fault-tracing tedious so tag-strip construction is perhaps best restricted to simple circuits.

When a finished tag strip circuit is fitted into a metal box provision must be made to hold it away from the metal to prevent short circuits. In the prototype long fixing bolts were used; stand-off spacers were slipped over the bolts to hold the tag strip well clear of the metal. These stand-offs were cut from the barrel of an old ball-pen.

BOXING

The screening box must be substantial enough to withstand repeated pluggings-in of the microphone. A small aluminium case is suitable and is easily drilled to take the input socket, etc. The prototype was built in a "Norman" case Type AB9, which measures about 100×70×40mm and accepted the 12-way tag strip comfortably.

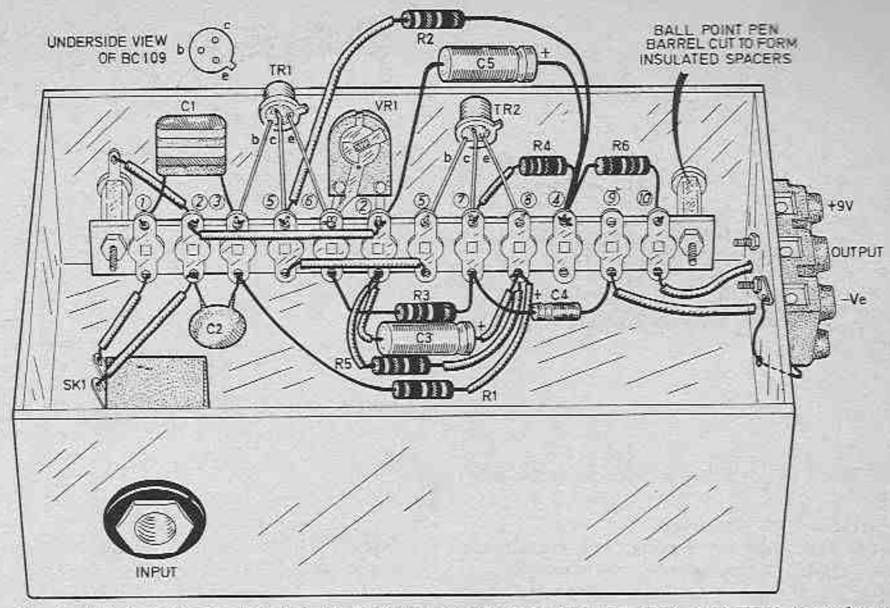


Fig. 2. Interior of completed unit. Certain components (R2, C5, TR1 and TR2) have been swung away from their normal position in this drawing for clarity. Encircled numbers on a tag strip correspond with those on the circuit diagram.

The type of output connection is not crucial and can be chosen to suit the needs of the user. Some type of multi-way socket is possible: the connections needed are power supply positive, live output and common (earth) so a three-way connection (or two plus "earth") is needed.

SCREW CONNECTOR BLOCKS

For the prototype the leads were brought out through small holes and taken to a strip of screw-terminal connectors (of the type sold in electrical shops and sometimes called a "chocolate block" from the colour of some makes).

The plastic kinds of chocolate block (which are usually made of transparent polythene these days) are easily cut into convenient lengths with a sharp knife. This kind of output connector can be used for either permanent or temporary connections and is easily adapted to quick hook-ups with croc-clip leads by fitting short pieces of thick bare wire to the terminals.

USING THE AMPLIFIER

The only adjustment needed is to set VR1 to suit the microphone. (It is assumed, of course that there will be a volume control elsewhere in the complete audio system of which the amplifier forms part.) For this reason VR1 should be positioned so that it is easily accessible when the lid is removed. It can then be adjusted while the microphone is in use.

If for some reason a higher gain than normal is needed VR1 should be given a lower value. (Presets down to about 100 ohms are readily obtainable.) However it should always be remembered in audio work that it is a good rule to use the lowest gain that will do the job in hand.

Next Month: Continuity Tester

JACK PLUG & FAMILY...

BY DOUG BAKER

SQUARE ONE FOR BEGINNERS

IN the two previous SQUARE ONE articles we have talked about the materials used to assemble circuit components and the essential tools for constructors; and we have had a look at the three most significant and widely used electronic components, the resistor, the capacitor, and the transistor.

Now it is time to consider putting these items together—that means soldering. But first of all we have to obtain our components.

BUYING COMPONENTS

If you are lucky, there may be an electronic component shop in your town or within easy reach. But it is a fact that the majority of constructors obtain their components by mail order. A look through our advertisement pages will show many retailers who operate a mail order service (some of these do also have retail shops for personal shoppers).

The first step should be to obtain two or three or more catalogues from different advertisers. The charge made for catalogues varies, from a few pence upwards to a £1, and reflects the size of the publication, the range of stock described, the technical detail included, and the amount of illustrations. A small collection of retailer's catalogues will prove a most valuable source of reference.

Component retailers include those who offer a very wide, nearly comprehensive, range of electronic components and those who specialise in a more restricted range of particular items. In the course of time, the constructor finds himself dealing with both kinds of retailers.

Studying these catalogues will make you famliar with components and the typical sizes and values usually stocked.

When ordering from a catalogue, do follow carefully the retailer's instructions; quote appropriate catalogue or stock number for each item and use the order form if one is provided. In the absence of any particular instructions from the supplier, describe the required components in the same manner as in our Components Lists (see any EE Constructional Projects).

SOLDERING

The essence of practical circuit building is soldering. This is the technique—some will call it an Art—of permanently joining together two or more wires or metal parts so that a good electrical contact is made. The joint must be (1) sound mechanically, and (2) it must form a very low resistance path.

While a soldered joint might appear to satisfy (1), it could fail on (2). This is where the ART of soldering comes in.

The two surfaces to be joined must be clean and free from grease. The wire leads of resistors, capacitors, and transistors are pre-tinned and no other preparation is normally required for brand new components.

Insert the component leads into the appropriate holes in the circuit board. Check once again the correctness of the connections by referring to the component layout diagram and/or the circuit diagram.

Make each lead mechanically secure by bending its protruding end to a slight angle with a pair of thin-nosed pliers. Fig. 1a.

Switch on the soldering iron. Wait about 15 seconds and then touch the end of a piece of resin core solder to the tip. If the solder runs instantly over the bit surface, the iron is sufficiently hot for work. Fig. 1b.

Well "tin" the iron bit with molten solder (a thin covering—NOT a pool) then apply the bit to the point of contact of the lead strip and at the same time apply the solder. Solder should flow almost immediately. As soon as the immediate area of connection is covered with molten solder quickly remove first the solder and then the iron. Fig. 1c.

Take care not to disturb the leads or components at any time during this operation, or for a few seconds after the iron has been removed. A good reliable joint will have a bright lustre. A bad (possibly "dry joint") will have a dull surface.

PRACTISE IS ESSENTIAL

Before working with actual components knock a few copper panel pins into a block of wood. Practise tinning the tops of these pins. Next hook short lengths of thin tinned copper wire (of about 22 or 24 s.w.g.) around these pins, squeeze tight with thin-nosed pliers; and solder.

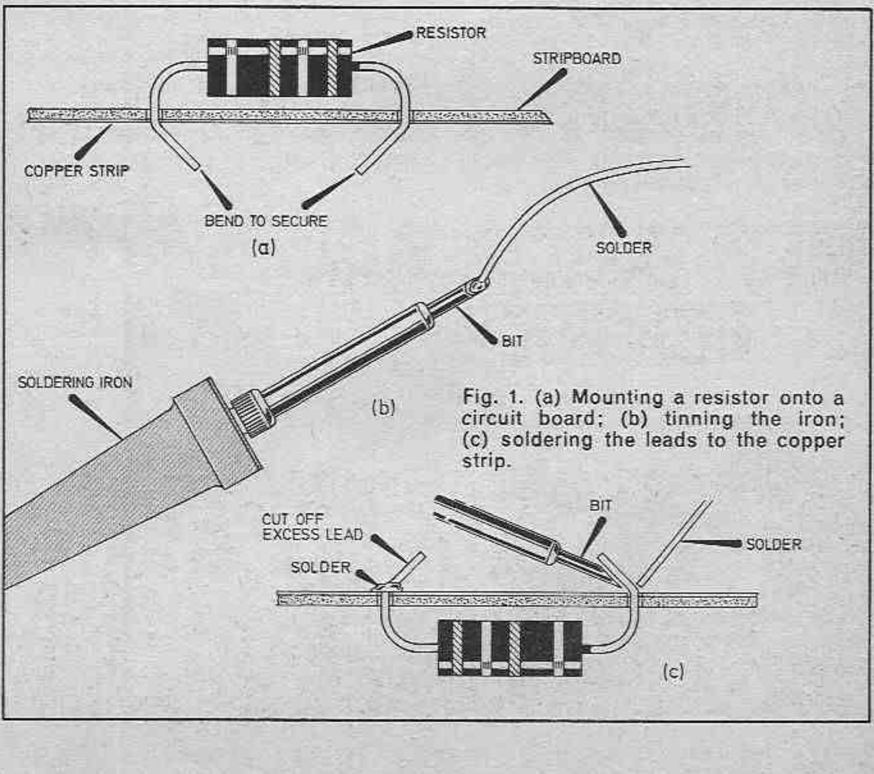


Fig. 1. (a) Mounting a resistor onto a circuit board; (b) tinning the iron; (c) soldering the leads to the copper strip.

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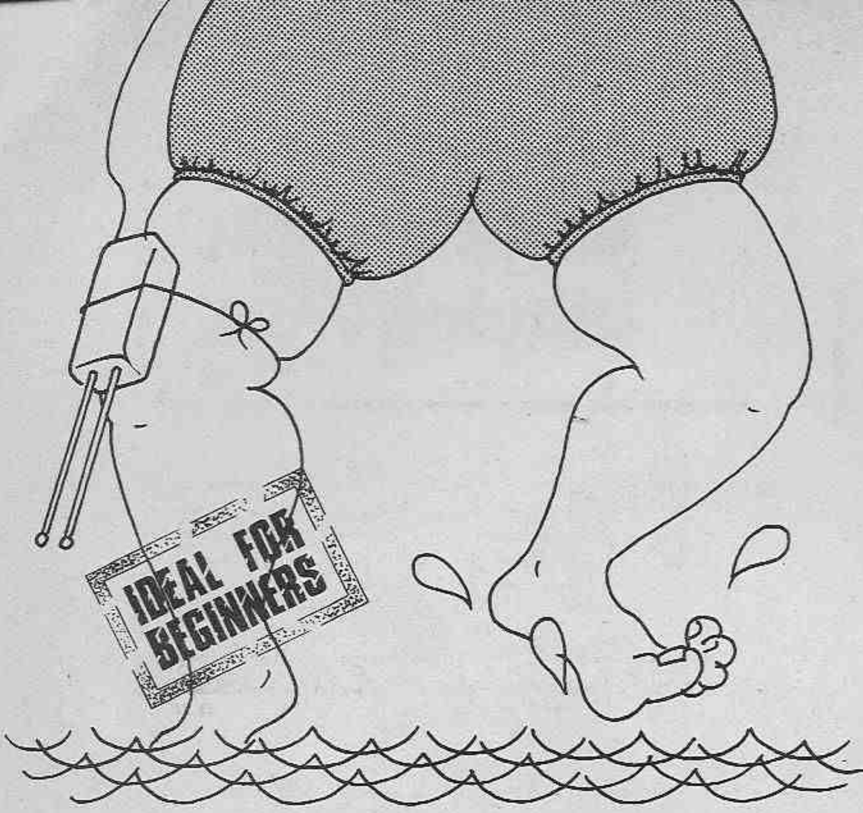


Water Level Alert

By A. R. Winstanley

NO DOUBT we have all at one time or another been somewhat unpopular with the other members of the household because all of the available hot water has been consumed by a certain person whilst taking a bath!

Possibly one of the safer ploys here is to ardently deny using up the hot water and blame the inherent inefficiency of the water heating system, but somehow this does not seem to work.

Whilst the device to be described would not indicate how much hot water is left it will tell you in no uncertain terms when to let up on the taps, and thus hopefully keep the peace.

A specially designed sensor is placed inside the bath, and when the rising water touches the sensor, an alarm tone sounds. At this point you should turn off the taps or continue to draw water at your peril! On a slightly more serious note though, its main use, of course, is to enable the user to run a bath and leave it unattended, the alarm sounding when the water has reached the required level.

APPEARANCE

This device is a little different from others previously described in that the actual physical appearance of it has been kept as aesthetic as possible. In particular the design of the sensor has, in the author's opinion, been greatly improved. After all, the appearance of a unit which is to be used in a domestic environment *is* important.

It is recognised that Veroboard-type sensors, where the water bridges adjacent strips of copper, thus sounding the alarm, are quite cheap and effective, but their appearance is none too pleasing and the actual construction does not make them suitable for use in the bathroom. On the other hand, custom designed printed circuit board sensors look very pleasing, but it is reckoned that not too many people have printed-circuit etching facilities.

One of the design criteria, therefore, was to come up with a water level sensor which could be assembled out of readily available materials, but which was quite cheap, durable and most of all attractive.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Water Level Alert appears in Fig. 1.

When water bridges the two probes, C1 charges up very quickly and turns on TR1 and TR2, which form a high-gain transistor switch. Each *npn* transistor requires the base to be about 0·6V more positive than the emitter for the device to switch hard on.

Thus when the base of TR1 is at 1·2V both transistors will switch on. The emitter current of TR1 becomes the base current of TR2, and so only a very tiny current is required in the base of TR1 to switch TR2 hard on.

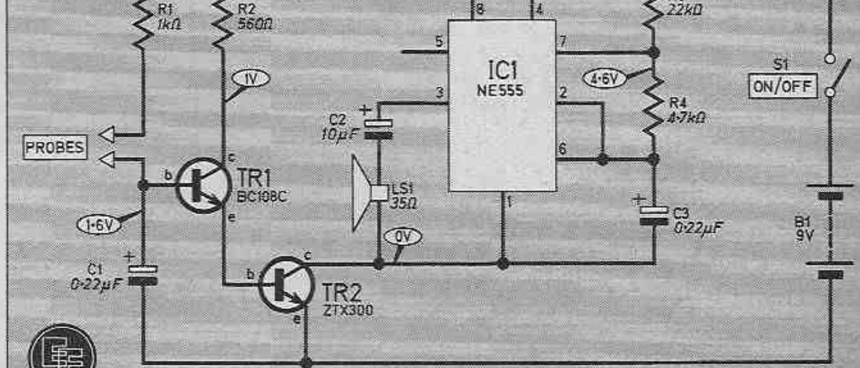
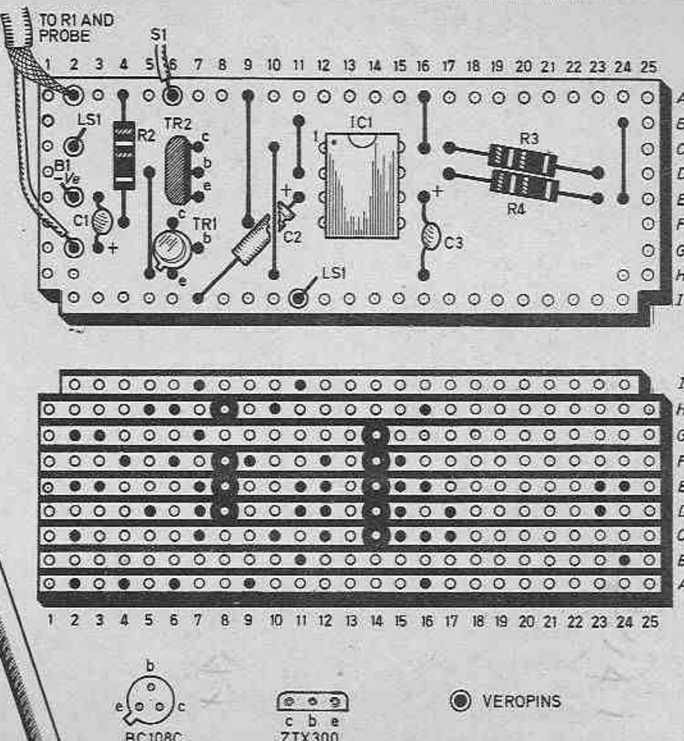
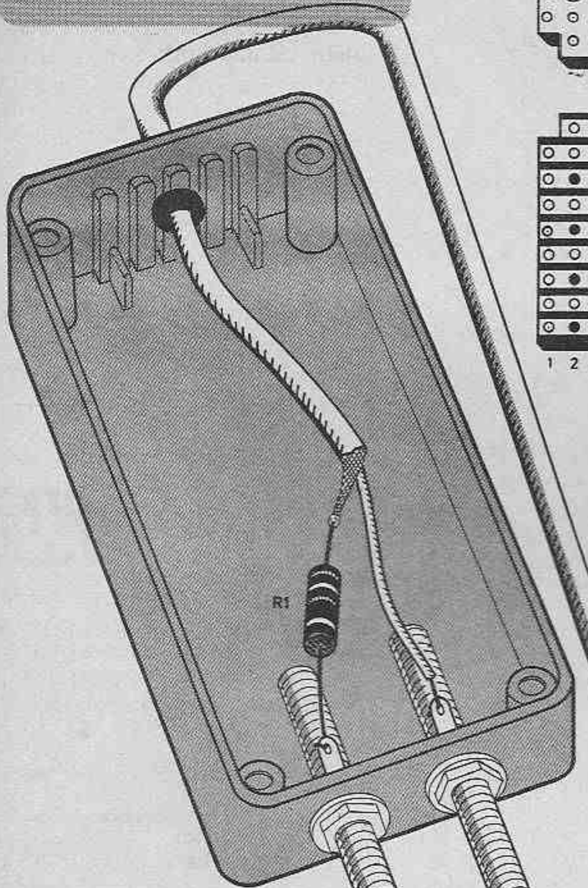


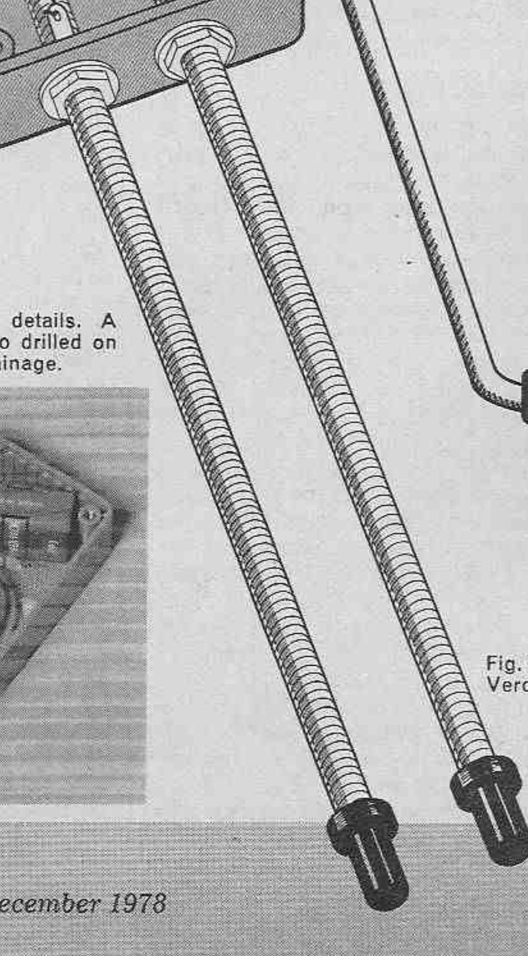
Fig. 1. Circuit diagram of the Water Level Alert.

COMPONENTS

approximate cost £3.00 excluding cases







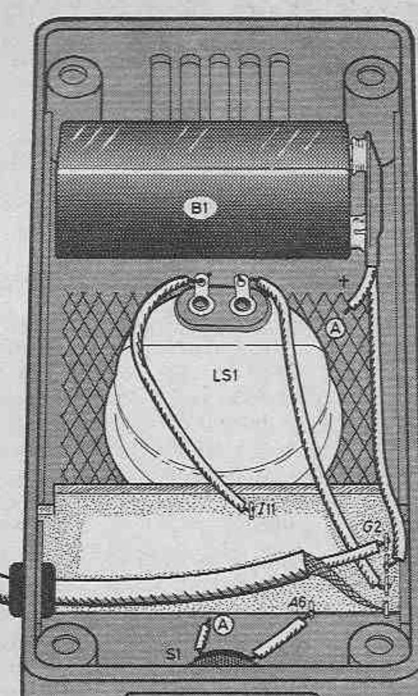


Fig. 2. Probe construction details. A series of small holes are also drilled on the underside to allow for drainage.

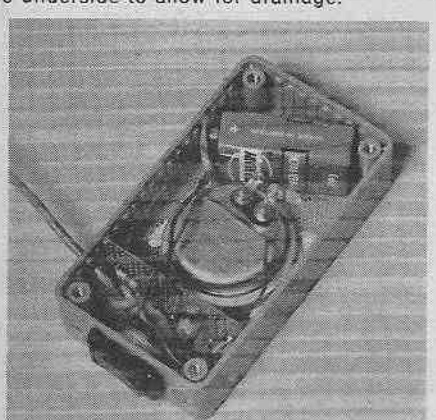


Fig. 3. Complete wiring details for the unit. Veropins are used as required.

Integrated circuit, IC1 and its associated components form an astable oscillator, and power is applied to this when TR2 switches on. The output, pin 3, is differentiated by C2 and LS1 which converts the rough square wave into a positive and negative spie.

CONSTRUCTION starts here

The system is housed in two plastic boxes. The first measures 100×50×25mm and forms the probe; the second measures 110×60×30mm and carries the electronics.

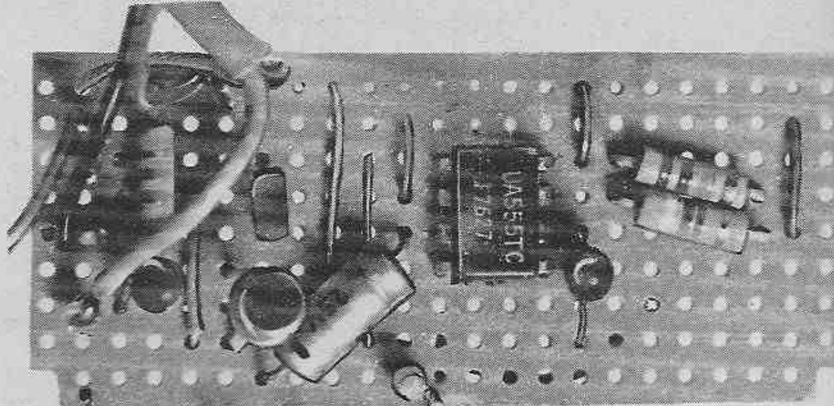
PROBE

The construction of the probe unit is illustrated in Fig. 2. Two 2BA threaded brass rods are used, each 150mm in length, and these are bolted to the case so that two 130mm probes protrude outwards. Connections to the rods are made by using a couple of 2BA solder tags, and a length of single core screened cable connects them to the other case. Note how R1 is included in the sensor unit.

DRAINAGE

Finish off the sensor by lettering it as necessary. Then glue two end pieces onto the ends of the brass rods. This will prevent the rods from scratching the bath enamel, and it will further enhance the appearance. Two plastic caps from some discarded Biro refill tubes were used on the prototype.

If water does manage to get into the sensor case, it will accumulate inside at the bottom and eventually short the probes, sounding the alarm tone. To counter this, a series of 1mm holes are drilled near the bottom of the back panel to allow the water to drain away. The use of brass rods in the manner described has resulted in a quite attractive and very strong probe unit.



Component layout for the alarm circuit board.

COMPONENTS

Resistors		Capacitors		Semiconductors	
R1	1kΩ	C1	0·22μF 25V tantalum	IC1	NE555V timer i.c.
R2	560Ω	C2	10μF 25V elect.	TR1	BC108C *npn* silicon
R3	22kΩ	C3	0·22μF 25V tantalum	TR2	ZTX300 *npn* silicon
R4	4·7kΩ				

All ¼W carbon ±5%

Miscellaneous

LS1 35 ohm earpiece (or similar moving coil loudspeaker approx. 40mm diameter)
S1 single pole, single throw rocker switch
B1 9V PP3 battery

Stripboard 0·1 inch matrix 23 holes by 9 strips; clip to suit battery; two 150mm lengths of 2BA studding; 2BA hardware; 8 pin socket to suit IC1; length of screened cable; piece of aluminium speaker grille; one plastic case 100 × 50 × 25mm, one plastic case 110 × 60 × 30mm; epoxy glue; connecting wire.

See Shop Talk page 857

ALARM UNIT

The remainder of the circuit is built on a small piece of stripboard 23 holes by 9 trips. These dimensions allowed the circuit board to be retained by the guides in the case, and a different size (and layout) could be used if necessary, to suit the type of case purchased by the constructor.

The stripboard arrangement and other wiring is shown in Fig. 3. During construction, make certain that the capacitors are soldered in the right way round. Tantalum capacitors are used for C1 and C3 because of their small size, but they are very polarity sensitive.

It is recommended that an 8 pin d.i.l. socket is used with IC1. This will prevent damage being caused to the NE555 through excessive heating during soldering.

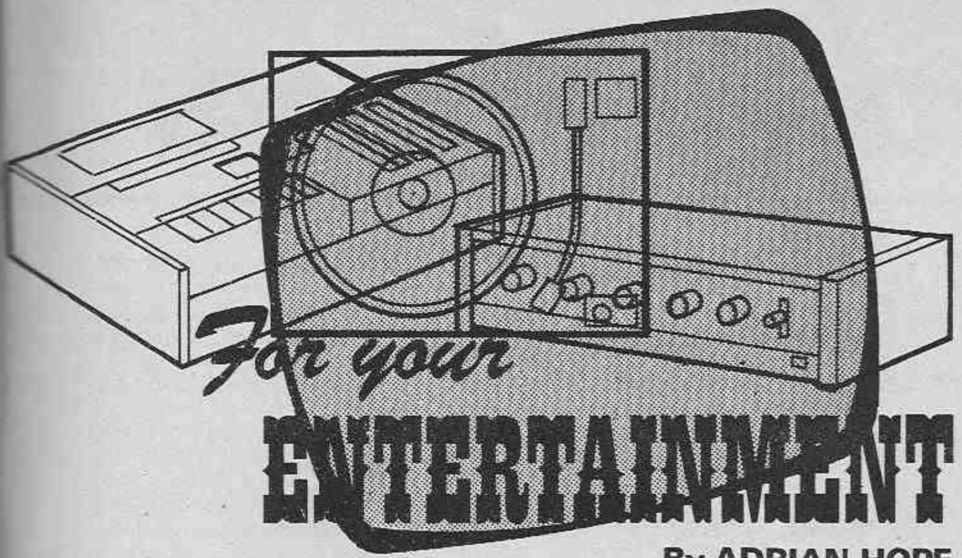
In particular observe the orientation of the transistor leads.

Drill the larger case to take the on/off switch and cable entry from the sensor. A 30mm cut-out was made for the loudspeaker. A small piece of aluminium mesh was stuck inside the case over the cut-out, and then the earpiece was fixed over this using epoxy glue. Finally letter the case as necessary and apply a coat of clear protective lacquer.

With both cases completed, and all interconnections made, thoroughly check out the circuit board for mistakes. Look out for reversed polarities of components, whiskers of solder bridging adjacent strips, etc.

If all is well, connect the battery and switch on. Bridge the probes with a finger and thumb, this should cause the alarm to sound. Release the sensor and the tone should cease.

The device is now completed and ready for use. The probe can be stuck inside the bath using double-sided adhesive strip. The main unit should be positioned where it can be heard with the bath running. ⌑



For your ENTERTAINMENT

By ADRIAN HOPE

Last month we looked at paging but left unmentioned the important matter of the transmission frequencies used.

Inductive systems, relying on a closed loop running round the site to be paged, operate on a frequency of between 16 and 150kHz, often around 35kHz. But closed loop induction is inflexible and can't possibly serve a large site, for instance a sprawling factory or airport. So radio systems must be used on many sites, the transmission power being very carefully calculated and controlled to ensure that the paging signals do not stray off site.

The power involved can be remarkably low; the whole of London airport is paged with just a two-watt transmitter. Only occasionally will on-site powers reach 5 watts.

Radio transmission is, of course, also used for public paging. In London, the Post Office uses nine transmitters each of a hundred watts. Their aerial patterns overlap so the receivers have to be carefully designed to ignore phasing errors. This isn't too difficult because the signals being transmitted are in digital code rather than analogue speech. But clearly there is unlikely ever to be city area paging with speech.

Wave lengths

Now, the actual wavelengths. In Britain legitimate on-site walkie-talkie paging systems are split between u.h.f. and v.h.f, the speech is sent out from control on u.h.f. (at around 458MHz) and speech back to control comes in on v.h.f. (around 161MHz). The Post Office Radio Paging, bleep-only digital system also operates on v.h.f., at around 150MHz.

But the majority of on-site bleep systems are on 27MHz and hospitals are by a special dispensation allowed in emergencies to transmit real or synthesised speech as well as bleeps on this frequency. Return speech, that is from the bleeped doctor, is again on 161MHz. In fact return speech, whether in response to a message sent out on an inductive loop on 27MHz or on 458MHz, is always on the 161MHz band in the UK.

Citizen Band

Finally does that frequency 27MHz ring any bells with you? It should, because it's the frequency on which most Citizens Band walkie-talkies operate. If CB on 27MHz were to be legalised in the UK, it would effectively cripple the hospitals of England overnight, by jamming their bleep and emergency speech communication systems. This, more than anything else, confirms that if we do get CB in the UK it won't be on 27MHz.

Ultrasonics

Although the Home Office and Post Office together strictly regulate any transmissions (whether of bleeps, speech, radio control or anything else) their terms of reference leave some methods of transmission unregulated. Thus although it is illegal to remote-control a television or Hi-Fi System using modulated radio waves, it is quite legal and legitimate to remote-control using modulated sound waves.

For obvious reasons the sound waves used for remote-control are ultra-sonic, that is of too high a pitch to be heard by human beings, and more and more domestic systems are now using ultrasonic remote control.

The only snag is that some people, especially very young children, and most animals can hear frequencies inaudible to the average middle-aged engineer. So ultrasonic controls are not welcome in all households. This is why another type of control—infra red, is becoming popular.

The Post Office and Home Office only have powers to regulate *radio* transmission and the infra red band comes next to the radio bands in the electro-magnetic spectrum. It is in fact sandwiched between visible light and the very highest radio frequencies as used for radar. Infra red beams can be used not only for remote control but high quality speech transmission as well.

There are already conference systems and cordless HiFi headphones that rely on modulated infra red as the unseen connecting link, and very good they can be. The only snag with infra red links is that they are, like visible light, directional. Whereas a radio aerial can send out control signals in virtually all directions, at the same time, an infra red transmitter has to be aimed fairly accurately at the receiver.

Light Links

Another type of link that falls outside the Post Office and Home Office regulations is the light link. In practice this usually means laser links and it is possible to carry very high fidelity audio, and even video, signals by modulating a laser beam. The beam can either be carried along optical fibres, and thereby round corners, or can be beamed direct like a pencil-thin searchlight.

Bugging

Already laser links are being used to replace hard wire electrical links in some situations (for example; for security against fire, interference or illegitimate tapping) and for the most part they involve the use of optical fibres.

Clearly it is for the most part unsatisfactory to carry messages via a direct laser beam travelling in space from A to B. But there is however one case where direct laser beams are used as links and that is in the rather shady area of bugging.

However shady the area may be, laser beam bugging devices come outside the wavelength regulations and have already been openly advertised for sale to the public through the press.

The beam from a low power laser is aimed at a window of a room to be bugged. The window will be vibrating to a minute extent in sympathy with whatever speech is going on in the room and the laser beam is so angled on the window surface that it reflects back to the source where there is a light detector.

The reflected beam carries an exact replica of the window vibrations and on demodulation produces an exact reproduction of the speech in the room. Perhaps fortunately such systems can be defeated. For one thing the beam is fairly easily visible, especially if you wear polarising spectacles.

For another thing it is possible to muffle the sound reproduced by drawing curtains across the window or confuse the sound by playing a radio set close to the window pane.

Everyday News

About 75 per cent of military communications are carried out on f.m. at very high frequencies (v.h.f.). Yet under tactical conditions in the field, the local terrain may make v.h.f. communication difficult, or impossible.

A major breakthrough by Plessey is likely to overcome the direct-line-of-sight "problem" and so have a major impact in battlefield v.h.f. communications. This new concept in radio technology, Groundsat, provides common-channel automatic repeater facilities for both the command post and soldiers on the battlefield using an un-manned station which operates on the same frequency.

Groundsat is no larger than a conventional man-pack radio. Whilst being carried to a position for deployment it may be used as a conventional v.h.f. f.m. manpack radio. Once deployed in position Groundsat works entirely unattended and can be easily hidden. Groundsat only goes into operation on demand. The radio operator can summon Groundsat to his aid by simply depressing his press-to-talk switch twice.

Unlike conventional rebroadcast stations which require the use of several different frequencies to avoid interference, Groundsat allows reception and transmission of messages simultaneously on the same channel.

In military operations the Command Post and the detachments can take full advantage of hollows for concealment and protection, while reliable communication is assured through the unattended relay station Groundsat deployed on a nearby hillside.

During field demonstration in hilly terrain witnessed by EE a 100mW Groundsat relay station sited on a hill permitted good communication to be maintained over a distance of 3 to 4 kilometres between base and mobile stations. Whereas from the same locations direct contact with the base was impossible, even when using a higher-powered packset with 20W output. At the relay site the two vertical rod aerials placed 18 metres apart were unobtrusive and apparently were not adversely affected by nearby trees.

The Ministry of Defence has expressed the view that Groundsat will have great potentials and has ordered equipment for field tests by the Army.

Space for Communications

The United Kingdom was the 16th nation to sign up as a partner in the European Communications Satellite (ECS) project. The satellite is expected to be launched in 1981 and will be used for trials until 1983 when a second, standby, will be launched and the service will commence. Design aim is for 12,000 telephone channels and two TV channels which can all be used simultaneously.

Each nation's cash contribution is proportional to the estimated use of the satellite. Britain's share is 15 per cent, equal with France, the largest contributors. The estimated overall cost of the project is not revealed. As well as the satellites, in geostationary orbit over the equator, it is expected that a network of at least 15 major earth stations plus six TV-only smaller dishes will be installed.

Marine Links

Increased use of satellites has in no way diminished the need for submarine cables which are also used to contain the international communications explosion. New cables are currently being laid between Eastbourne and St Valery-en-Caux, France, and between the Norfolk coast and Denmark to expand the Nordic service to Denmark, Norway, Sweden and Finland.

Each will carry 4,000 simultaneous telephone channels and the repeaters, of which 108 will be used in the Nordic link, will use the latest type 40 long-life transistors developed by the British Post Office.

An experimental fibre optic data communication link 550 metres long has been installed at a pulp mill in Sweden. It links a microcomputer-based remote terminal to a central computer.

MACS on the way

"Early next year" is scheduled for the introduction of Motorola Advanced Computer System (MACS). MACS is the 16-bit microcomputer which will be developed into a microcomputer family".

The single-chip central processor will have 70,000 devices packed into the same size as present MPU chips and will have ten times the throughput of the original Motorola M6800 MPU. It is forecast, in fact, that MACS will exceed the performance of many of today's minicomputers—on a single chip!

PERSONAL "SHRINK"

The microcomputer software people, Petsoft, have just released a new catalogue of over one hundred business, educational and applications programs for the Comodore PET home computer, including the long awaited Microchess program (£14).

One program from the new range which is already causing a stir is "Eliza", which simulates a consultation with a psychiatrist. The program runs on the standard 8K PET, and is believed to be the first conversation simulator available in UK.

The popular PET microcomputer is now being assembled in the UK at Eaglescliffe. Commodore Business Machines (UK) Ltd forecasts that production in the UK will reach 250 units a week by the end of the year.

... from the World of Electronics

In Camera

Five independent TV companies in the UK have now joined the shopping list for Marconi Mk IX family of colour TV cameras introduced to the market last April.

Biggest single order came from Granada Television, Manchester, for 27 cameras valued at over £1 million. Eighteen are for studio use and nine portables for outside broadcasts. The other four users are Scottish TV, Tyne Tees, Anglia TV and Southern TV.

Marconi have also been busy supplying new medium wave transmitters for the big programme wavelength reshuffle due this month (November). Of 24 new transmitters, each of 50kW output, eleven were contracted to be installed and operational by mid-November and the remainder during next year.

World First

The IBA-developed system of digital video recording, claimed to be the most advanced system yet demonstrated, is being taken up by two of the world's leading VTR (Video Tape Recording) manufacturers, and negotiations are at an advanced stage with several others.

Agreements have been signed between the Independent Broadcasting Authority and Bosch Fernseh (Robert Bosch Ltd) and Sony Broadcast, representing major broadcast engineering companies with headquarters in West Germany and Japan respectively.

Under the agreements IBA engineers will provide full know-how and technical advice on the world's first digital system capable of producing colour television pictures on one inch magnetic tape at tape speeds of under ten inches per second.

Back To School

Our Photograph shows the Speak & Spell microprocessor learning aid from Texas that was mentioned in these pages last month.

The learning aid is aimed at helping children to spell and pronounce over 200 basic vocabulary words and has been developed with the guidance of leading educators. The aid helps children learn by letting them hear, see and spell a word; keying in the correct answer scores points, incorrect gives a "try again" readout.

Further news from Texas is the announcement that their popular maths learning calculator "Little Professor" has been reduced in price to £11·50 including VAT.

✲ ✲ ✲

The Sinclair 2-inch Microvision TV is used as the basis of a video monitor, now available as either a stand-alone portable unit with internal batteries or as a panel-mounted unit.

Picture resolution is stated to be 325 lines and used as a data terminal the unit can resolve up to 40 characters per line, 24 lines.

✲ ✲ ✲

Atomic Surveillance

The new nuclear power stations being built at Hartlepool and Heysham will have TV surveillance for remote handling of irradiated fuel in the underwater storage ponds.

The submerged cameras will be in stainless steel waterproof casings which also contain the remote focus and iris controls.

RANDOM TIME

It seems likely that Texas Instruments will be first in the field with the 64k random access memory (RAM). Samples are expected to be available to the trade this month (November) and production quantities should be available soon afterwards.

—ANALYSIS

VERY WELL, THANK YOU!

The silicon chip and, by implication, the whole of electronics has experienced this year an unprecedented barrage of popular publicity, much of it adverse. Instant opinions, mainly from the technologically illiterate, have even suggested that the chip, harmless in itself, is inherently evil and that its widespread application can do nothing but harm. Well, we must all form our own judgements. Almost anything you can think of can be put to use for good or bad.

There is one application of electronics, however, on which there should be no disagreement that the outcome is wholly beneficial and that is in health care. Medical electronics is now fully established as a specialist branch of the electronics industry.

It all started before the chip, in the valve era of the 1930's, with radio diathermy for the relief of aches and pains. It was in those days too, that advances in valve technology allowed the development of high-gain low-noise amplifiers to detect and amplify to a useable level the feeble electrical impulses then only suspected to be generated in the brain, the heart, and in other parts of the human frame.

Electronics soon became a powerful ally in medical research and in the relief of human suffering. What a revolution! Remember that for three hundred years medical science had, as its best tool, only the optical microscope. The advent of the electron microscope, infinitely more powerful, revealed tissue structures and other tiny details, perhaps imagined but never before actually observed.

Similarly with X-ray technology, much refined since Rontgen's discovery of X-rays in 1895, but still with inherent defects in its application until Hounsfield's brilliant concept in 1967 which led to the first clinical trials of the EMI Scanner in 1971 and world-wide adoption since then.

The solid-state era and component miniaturisation made possible the first body implants. The first endoradiosondes ("radio pills") for measuring internal temperatures and pressures. Later, the cardiac pacemaker which has prolonged the lives of countless people, keeping them actively involved in affairs rather than confined to home or hospital.

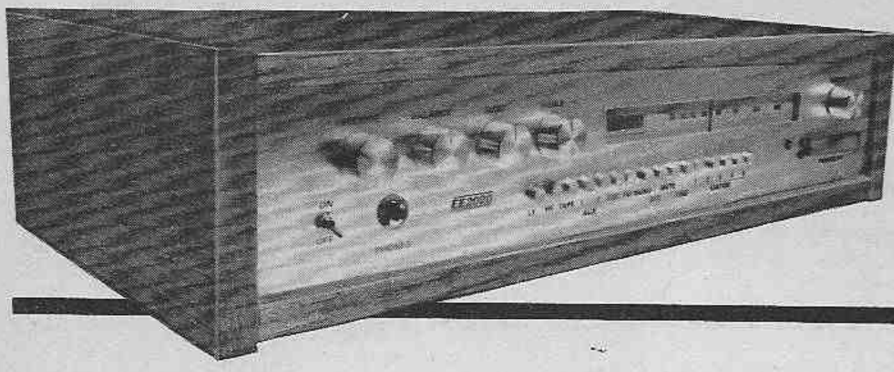
No operating theatre today is complete without its battery of electronic instruments to display and record parameters like respiration, temperature, heart rate. CCTV allows students to observe every detail of surgery in colour close-up, although at some distance away.

Intensive-care wards have elaborate patient monitoring systems with recorders and alarms which respond to the slightest change in physical condition. And the electroencephalograph (EEG) is a most valuable tool both for research and treatment of mental disorders.

Electronics has transformed the practice of "conventional" medicine and surgery. Now I note with some interest it is also penetrating the areas of "fringe" medicine. A Racal company is supplying £15,000 worth of special panel meters to a West German medical supply company for inclusion in electro-acupuncture equipment. Even this ancient Chinese science can apparently benefit from an electronic up-date.

Electronics and the silicon chip which it is now based will remain a good friend, whatever the critics say. Many of us have cause to thank the contribution of electronics when greeted with "How d'you do?" and being able to respond with a heartfelt "Very well, thank you!".

Brian G. Peck



EE2020 TUNER A

HI-FI SERIES

THE EVERYDAY ELECTRONICS 2020 TUNER AMPLIFIER is primarily intended for the more advanced constructor who would like to build a quality stereo equipment at a cost well below that of a commercial unit of similar performance.

The total outlay for components and materials will be in the region of £90-£120 for the completed project.

All components are readily available and no special equipment is needed for setting up or alignment. The amplifier section has been designed for 20+20 watts output, which, together with a very sensitive f.m. radio section will provide top quality signals under almost any conditions.

Included in the amplifier section are separate controls for bass, treble, volume, balance, high and low frequency filters, and tape monitoring. There is provision for adding a quadraphonic decoder or perhaps a graphic equaliser at a later date.

The tuner section uses the latest techniques including a mosfet r.f. stage, band pass coupling, varicap tuning, separate oscillator with automatic frequency control (d.f.c.), ceramic i.f. filters, quadrature discriminator and a phase lock stereo decoder. Five preset stations are provided in addition to manual tuning.

This may seem a large project to undertake, but in fact, any one who can solder properly and follow the step by step instructions should be able to produce a tuner amplifier equal to those available commercially at a much higher price. The secret of success is to take each section in turn and look upon it as a project in its own right. Thus, instead of one mammoth project, treat the 2020 as a series of small ones.

This is a practical project and no technical knowhow is required other than to be able to follow the diagrams and instructions. Don't rush the construction, take your time, carefully checking each completed section and you will finish up with a tuner amplifier with which you can justifiably be proud to say "I built it myself".

GENERAL DESCRIPTION

The EE 2020 Tuner Amplifier is assembled on a metal chassis consisting of a base plate and front and rear panels.

All operating controls appear at the front panel; input and output sockets and terminals are located on the back panel. Complete enclosure can be effected by means of a simple wooden case or "sleeve", and details will be provided for the construction of such a case.

Most of the electronics are assembled on printed circuit boards. There are five p.c.b.s in all. This arrangement is most convenient for the construction, and enables the work to proceed by instalments in an orderly fashion, section by section.

The plan of the 2020 series of articles is as follows:

Part 1 Introduction, Specification, Circuit Diagrams and Technical Description. Bulk Components List.

Part 2 & 3 Construction of the p.c.b.s and Individual Component Lists.

Part 4 Construction of Chassis

Part 5 Assembly within the Chassis and Inter-unit Wiring

Part 6 Setting Up and Operation

BULK COMPONENTS LIST

All resistors, potentiometers, capacitors, semiconductors and pushbutton switches required are listed below. This will assist the constructor to obtain the advantages of bulk buying.

Fully detailed Components Lists for each sub-section will accompany the p.c.b. and component layout diagrams to be published in the next two articles.

All miscellaneous items including hardware and material for the chassis will be specified in the appropriate parts of this series.

CIRCUIT DESCRIPTION

An overall view of the EE 2020 Tuner Amplifier System is given in the block diagram Fig. 1.1. Apart from showing the electronic organisation, this block diagram broadly indicates the physical arrangement: the subdivision of the whole into easily manageable sections, each built on a printed circuit board. These boards are designated A, B, C, D and E.

Interconnections between boards are made via terminal pins. These are shown as open circles on the circuit diagrams Fig. 1.2a and Fig. 1.2b and each has a unique identification. Following "T" the second letter indicates the board; TA1, TE8 and so on. The useful function provided by these terminal pins will become apparent when the practical building work is in hand.

Where the circuitry is duplicated for the left and right stereo channels, terminal pins are marked in all layout and wiring diagrams with an additional letter "(a)" or "(b)" signifying left or right channel respectively. For example, TB9a, TB9b. The circuit diagram however shows only one channel ("a" or "left") and all terminal pins which are duplicated are shown with a suffix "a".

Beyond the stereo decoder IC2 and up to and including the Power Amplifier stages the circuitry divides into two identical channels. Only one channel ("a" or "left") is shown in the circuit diagrams, but the second is an exact replica of that shown. All these additional components are fully accounted for in the component lists and in the detailed layouts for the appropriate p.c.b.s.

In all these lists and diagrams duplicated or "twinned" components are distinguished by the suffix ("a") for left hand channel and ("b") for right hand channel.

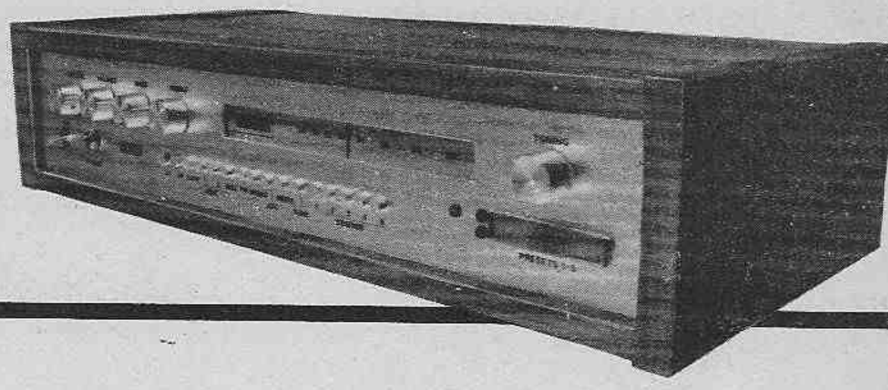
In the circuit diagrams Fig. 1.2a and Fig. 1.2b one channel only is shown, and all the components in these areas can be considered as having the suffix ("a") (for example, R41(a) and TR5(a)), although only a few components, such as the pushbutton switches and the phono sockets, have actually been so labelled in Fig. 1.2a and Fig. 1.2b.

R.F. SECTION

In any hi-fi receiver system one of the most important parts is the radio frequency (r.f.) section. Radio signals can range in strength from a few microvolts in a fringe area, to perhaps a hundred millivolts or more close to a transmitter. The weaker signals

BY E.A. RULE*

MPLIFIER PART 1



must be amplified without adding any noise or distortion (as this could not be removed later) to a suitable level for the mixer stage, and very strong signals may need to be reduced in level to prevent overload of the mixer.

A range of signal levels from 1 microvolt to 100 millivolts is a working range of 100dB and in some locations signals of over 1 volt could be encountered (a range of 120dB!). Should the r.f. sections fail to handle this range of signal levels, then cross modulation and other undesirable effects could take place.

Under practical conditions, there would be more than one signal presented to the r.f. section at any one time and another important requirement is r.f. selectivity. The r.f. section must select the wanted signal and reject all the others. In general the more tuned circuits before the mixer stage the higher the r.f. selectivity.

The selected signal is mixed with a local oscillator signal to produce the intermediate frequency (i.f.), the difference between the two, at which all further processing of the signal takes place. As a narrow bandwidth (250kHz approximately) is used in the i.f. amplifier to provide good adjacent channel selectivity the local oscillator must be very stable in frequency, otherwise the resulting i.f. signal would drift out of the i.f. pass band and distortion of the signal would result.

For the Everyday Electronics 2020 tuner amplifier it was decided to use a commercial r.f. section and the unit selected for this is the excellent TOKO EF5600U. This uses a dual gate MOSFET r.f. amplifier with automatic gain control and is capable of handling signals over a range from 0·8 microvolts to well over 100 millivolts. It has four varicap tuned circuits before the mixer which provide a very high degree of r.f. selectivity—with over 90dB of rejection at the image and other unwanted frequencies being obtained.

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*T and T Electronics
Our author has been engaged in research and development in the Hi Fi field for the last 30 years, and has been responsible for many commercial products.

SPECIFICATION

AUDIO SECTION

Power Output (both channels driven) into 8 ohm load 20 + 20 watts r.m.s.
Power Bandwidth at −1dB: 20Hz−20kHz
Harmonic distortion at rated power:

at 10kHz	0·24%
at 1kHz	0·18%
at 40Hz	0·10%
at 1 watt	0·16%

Damping Factor: 40

Rise Time: Power Amplifier only	5μsec
Overall	7μsec
Stability	unconditional

Frequency response:

Power Amplifier only −1dB	20Hz—20kHz
Overall: Aux inputs ±1dB	20Hz—20kHz
Disc inputs RIAA ±1dB	20Hz—20kHz

Input	*Sensitivity*	*Overload*	*Impedance*	*Hum/Noise*
Aux (1+2)*	90mV	2·5V	1 MΩ+200pF	−68dB
Tape	90mV	—	50kΩ approx.	−67dB
Disc**	4mV	110mV	47kΩ approx.	−67dB

* For ceramic or crystal pickup ** For magnetic pickup

Tape Output: 90mV

Tone Controls:

Bass	±15dB at 70Hz
Treble	±15db at 14kHz

Filters:

HF (See curves) −3dB at 4·5kHz
LF („ „) −3dB at 26Hz

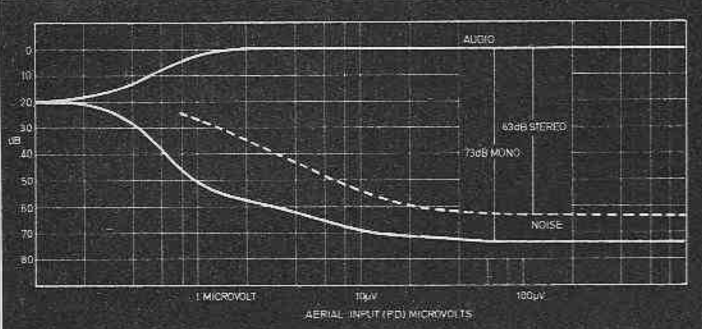
RADIO SECTION

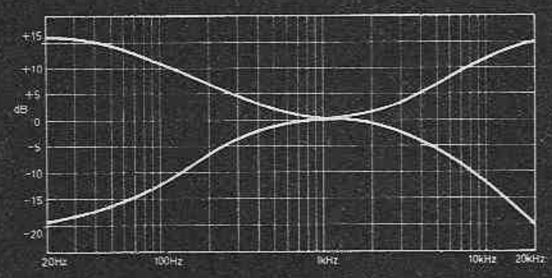
Frequency range 88—102 MHz

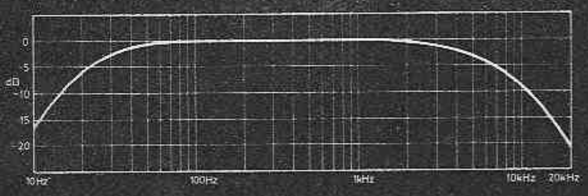
	Mono	Stereo
Sensitivity 1HF 30dB (EMF)	1·6μV	
S/N 50dB „	2μV	20μV
Ultimate signal/noise	72dB	69dB
Harmonic distortion at 100% 1kHz modulation	0·3%	
Image rejection	−100dB	
Repeat spot (F1 + ½1F)	−100dB	
Capture ratio	2dB	
Selectivity ±400kHz	60dB	
Signal strength meter range	1μV—100mV	
Mute signal level	0·5μV	
„ Deviation ±	45kHz	
A.F.C. Hold ±	1MHz	
„ Pull in ±	500kHz	

GENERAL

Headphone Jack mutes loudspeakers and couples phones to Power Amplifier output
Cost to make, between £90—£120.







2020 TUNER AMPLIFIER CHARACTERISTIC CURVES

(a) F.M. Radio. Overall signal to noise for various input signals

(b) Frequency response of I.f. and h.f. filters

(c) Frequency response of tone controls showing maximum and minimum settings.

Board A

I.F. AMPLIFIER

The main job of the i.f. amplifier is to provide selectivity, remove unwanted impulse noise and any other amplitude modulation (a.m.) on the signal. The f.m. detector is included in this section, which as well as converting the frequency modulated signal to audio, provides control voltages for automatic frequency correction (a.f.c.). Automatic gain control (a.g.c.) voltage for the r.f. stage is also obtained from the i.f. amplifier section.

A single integrated circuit IC1 provides all these functions except selectivity, which is obtained by using two 10·7MHz ceramic filters F1, F2, which do not require alignment.

IC1 is the RCA CA3198E, a later version of the CA3089. This is a monolithic integrated circuit that provides all the functions of a f.m. i.f. system. It includes a three-stage amplifier/limiter with level detectors for each stage, a double-balanced quadrature detector and a low distortion audio amplifier which features a muting circuit. It also has a programmable delayed a.g.c. for the r.f. section. An output voltage with a log. law is available to drive a signal strength meter, ME1, which will show a useful range of inputs from 1 microvolt to 100 millivolts when used with the EF5600 r.f. unit.

An a.f.c. voltage is provided and this is further amplified by transistors TR1 and TR2 so that it can be operated in conjunction with the main varicap tuning voltage. This method ensures that all the r.f. circuits remain correctly tuned to the required frequency. (The other method of only applying a.f.c. voltage to the oscillator tuned circuit can cause loss of sensitivity due to mistracking of the r.f. tuned circuits with that of the oscillator.)

A single coil L1 is used with the quadrature detector and provides a low distortion signal to the audio section of the IC1. A double-tuned circuit would give lower distortion, but special equipment would be needed to correctly align the two coils—the single-coil circuit can be simply adjusted using the tuning meter.

The output from the audio section (pin 6) IC1 is at the correct level for feeding into the stereo decoder.

STEREO DECODER

The stereo decoder is designed around the Texas Instruments SN76115AN phase lock loop stereo decoder IC2.

The composite audio signal from IC1 is fed into IC2 at pin 2. IC2 demodulates the audio difference information from the 38kHz subcarrier contained in the composite audio signal. The 38kHz subcarrier is regenerated using an internal 76kHz oscillator phase locked to the pilot tone, the internal oscillator requiring no inductors. The level of the 19kHz pilot tone in the composite signal is detected and used to automatically switch a stereo/mono switch.

The stereo beacon lamp D1 is switched by a signal appearing at pin 6.

Channel 1 (left) signal appears at pin 4 of IC2 and is fed via C18 to a two-stage low distortion amplifier TR3, TR4.

This provides some amplification and also the correct matching for the low-pass stereo filter F3. This filter removes any unwanted 19kHz and 38kHz signals produced by the decoding process and prevents these beating with a tape recorder bias oscillator. If this happened, recordings from stereo radio would be almost impossible due to unwanted whistles.

Channel 2 (right) signal appears at pin 5 of IC2 and follows a similar route as Channel 1 to the second input of F3. The circuitry between IC2 pin 4 and F3 involving TR3, TR4 and associated components is thus duplicated—appearing between IC2 pin 5 and the second input of F3, although not shown in the circuit diagram.

In all component lists and layout diagrams duplicated components are distinguished by the suffix "a" for left hand channel and "b" for right hand channel.

The two outputs from F3 are fed to their respective pushbutton switches S13a (left hand channel) and S13b (right hand channel) located on Board B.

Only a single preset potentiometer (VR2) requires adjustment to set the correct frequency of the phase lock for optimum stereo separation.

VARICAP TUNING

The varicap diode circuit consists of two main sections: the manual tuning and the pre-set tuning.

The 14·5V stabilised d.c. supply from the power supply module provides the voltage required for tuning. This supply is fed in via TA3 and applied via R28 to the top end of the manual and preset potentiometers, VR3 to VR8 inclusive. The bottom ends of these potentiometers go via the preset VR10 to earth. VR10 is used to set the voltage at the bottom end of the potentiometer to exactly 3·2 volts.

The a.f.c. control circuit is connected to the junction of R28 and the top ends of the tuning potentiometers.

As the current through TR2 varies due to the a.f.c. voltage from the i.f. section it will cause the voltage at the end of R28 to vary and correct any tendency to drift or errors in tuning, by changing the actual voltage supply to the varicap diodes.

This change in voltage is of course arranged to be in the correct phase. If the tuning voltage goes higher the varicaps will adjust to a lower capacity and therefore the frequency of the tuned circuits will go higher. This change will cause the i.f. frequency to also go higher which will mean that the detector will be off tune. A voltage will occur at its output which will increase the current through TR1 and TR2 and in turn cause the voltage drop across R28 to increase thus lowering the varicap voltage and off-setting the original increase. Similarly with the reverse process.

L.E.D. TUNING INDICATOR

The output of each potentiometer goes to a pushbutton switch and any one can be selected for use. In order that the presets can be correctly adjusted to a wanted station it is necessary to provide some means of showing the correct turning point. An op-amp, IC3b, is used for this. One input of the op-amp is connected to the manual tuning potentiometer VR3 and the other input is connected to the selected preset. The output of the op-amp goes to two l.e.d.s connected in parallel but with reverse polarity and these are connected to a d.c. supply exactly half the supply rail voltage of the op-amp.

If both inputs of the op-amp are equal, the output will be exactly half of the supply voltage and in theory neither l.e.d. will light up. (In practice some unbalance may cause one to light). Now, by first tuning the manual control to the required station and then selecting a preset, at the same time keeping the manual tune button pressed, the voltage from each will be fed to opposite inputs of the op-amp. Adjusting the preset until the l.e.d.s go out (or just change over) will mean that the preset voltage is the same as the manual tuning voltage and that the pre-set is tuned to the same station.

The l.e.d.s will show if the preset is high or low in frequency relative to the manual tuning potentiometer. Final adjustment is made using the tuning meter as an indicator.

Preset VR9 is provided to adjust the offset voltage of IC3.

The other half of the dual op-amp, IC3a, is used to isolate the r.f. unit from the varicap tuning so that its loading effect does not cause inaccurate settings of the presets. It also provides a low impedance drive voltage for the varicap diodes in the r.f. unit.

Board B

CONTROL UNIT

The lower half of Fig. 1.2a is now to be described. All circuitry in this area is, in reality, duplicated, although only one channel is shown in the diagram.

Apart from the small bottom left corner section (which is the Pick-up Pre-amplifier) the whole of this lower portion of Fig. 1.2a is the Control Unit. All this circuitry is assembled on Board B, except for the four variable controls and the phono sockets which are mounted on the front and rear panels respectively.

Two auxiliary inputs are provided, SK2 and SK3. Either of these may be used with a crystal or ceramic pick-up as their high input impedance of 1 megohm would provide a reasonable match. These inputs are also suitable for any other signal source whatever its output impedance, providing that the signal is approximately 90mV.

A disc input is provided at SK4 (see Pick-up Pre-amplifier).

The output from the pick-up preamplifier, along with the AUX inputs from the FM tuner section go to the pushbutton input selector switches S9 to S13 inclusive. All unselected inputs are shorted to earth.

After the required input has been selected it goes to the first stage in the control unit, comprising TR5 and TR6. This is a boot-strapped two-stage amplifier with a high amount of negative feedback. The stage gives around 8dB of gain and has a 1 megohm plus 200pF input impedance and low output impedance.

Following this stage are the high- and low-pass filters. These are active filters giving approximately 12dB/octave slopes. The active stage uses

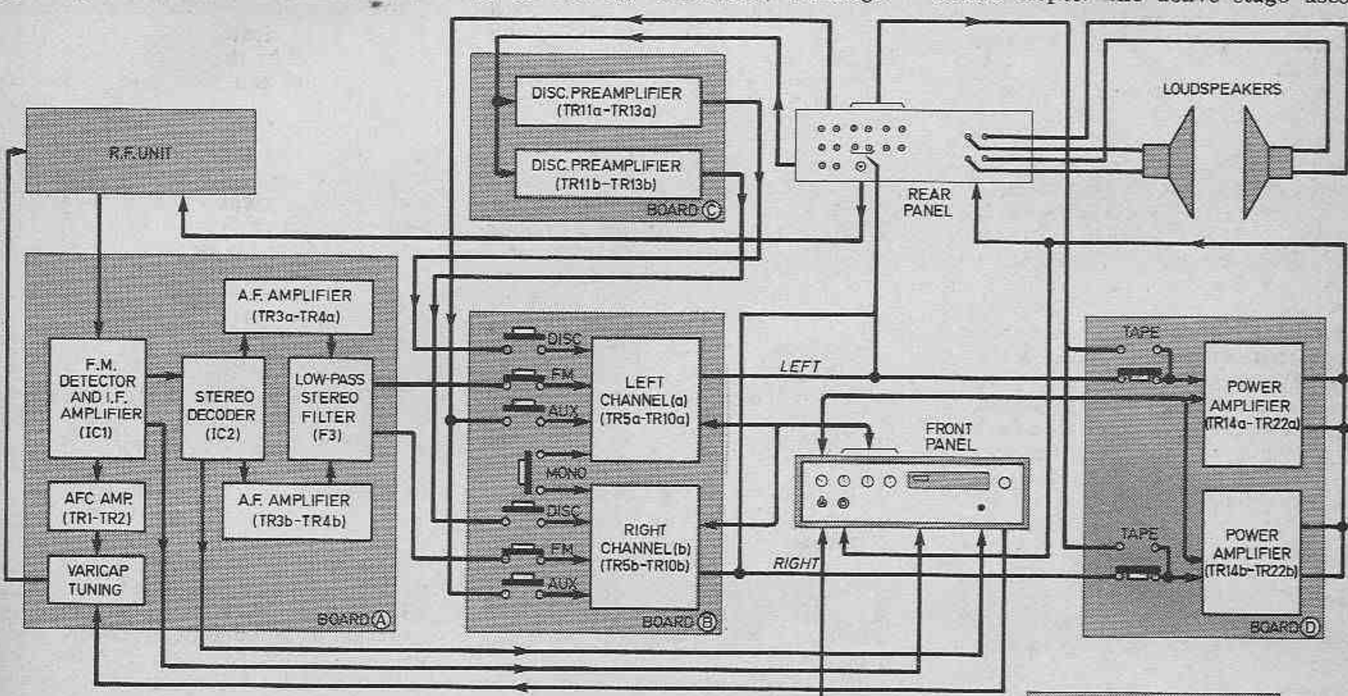
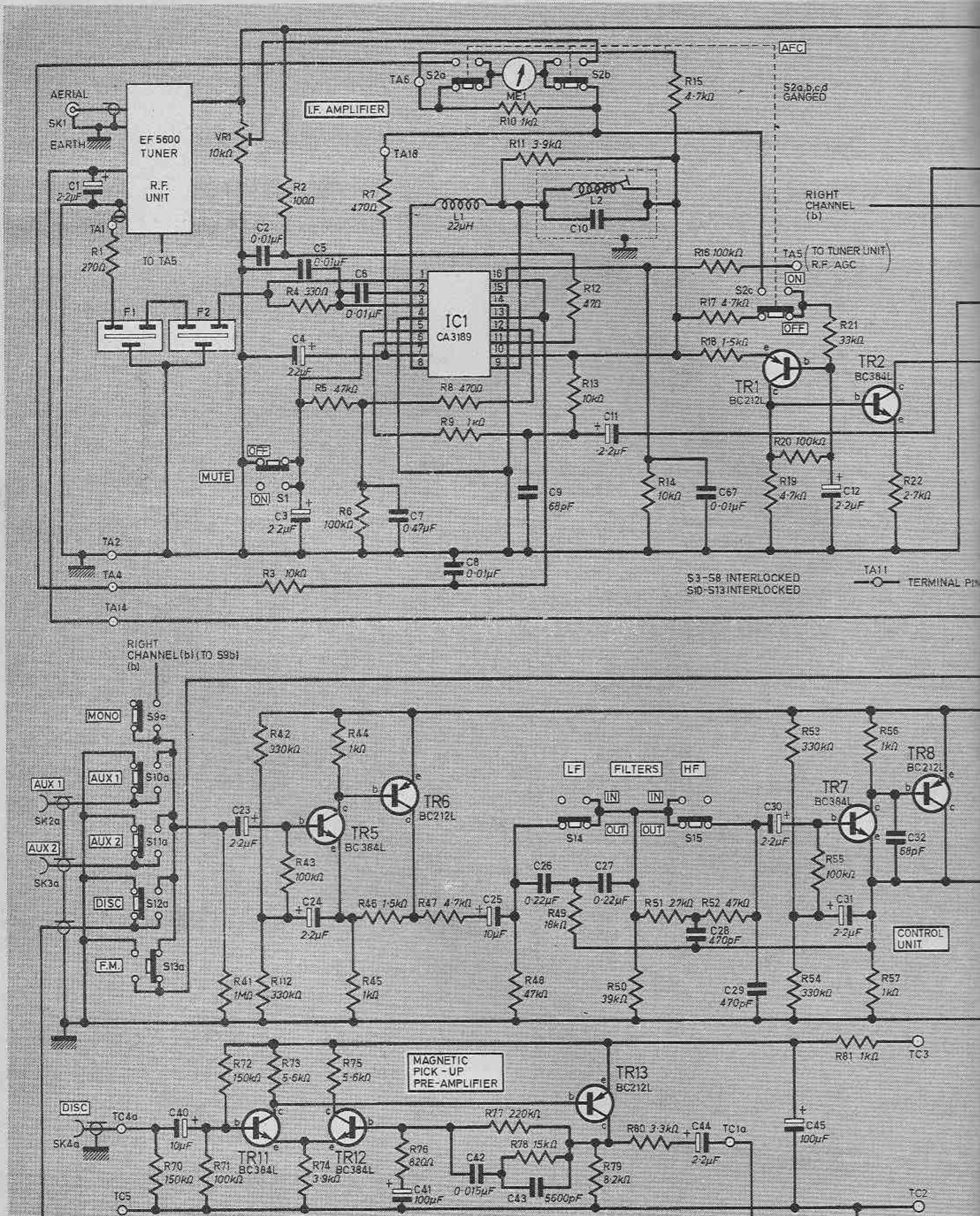


Fig. 1.1. Block diagram of the 2020 Tuner Amplifier


AFC
S2a,b,c,d GANGED
I.F. AMPLIFIER
AERIAL
SK1
EARTH
EF 5600 TUNER
R.F. UNIT
TO TA5
VR1 10kΩ
TA6
S2a
S2b
ME1
R10 1kΩ
R15 4·7kΩ
R11 3·9kΩ
TA18
R7 470Ω
R2 100Ω
C1 2·2μF
TA1
R1 270Ω
L1 22μH
L2
C10
RIGHT CHANNEL (b)
C2 0·01μF
C5 0·01μF
C6
R4 330Ω
0·01μF
IC1 CA3189
R16 100kΩ
TA5 (TO TUNER UNIT) R.F. AGC
ON
S2c
OFF
R12 47Ω
R17 4·7kΩ
R21 33kΩ
F1
F2
C4
2·2μF
R18 1·5kΩ
TR1 BC212L
TR2 BC384L
R5 47kΩ
R8 470Ω
R13 10kΩ
R9 1kΩ
C11 2·2μF
R20 100kΩ
MUTE
OFF
ON
S1
C3 2·2μF
R6 100kΩ
C7 0·47μF
C9 68pF
R14 10kΩ
C67 0·01μF
R19 4·7kΩ
C12 2·2μF
R22 2·7kΩ
TA2
C8 0·01μF
TA4
R3 10kΩ
S3–S8 INTERLOCKED
S10–S13 INTERLOCKED
TA11
TERMINAL PIN
TA14
RIGHT CHANNEL (b) (TO S9b) (b)
MONO
S9a
AUX 1
S10a
AUX 2
S11a
DISC
S12a
F.M.
S13a
SK2a
SK3a
R42 330kΩ
R44 1kΩ
TR6 BC212L
TR5 BC384L
C23 2·2μF
R43 100kΩ
C24 2·2μF
R46 1·5kΩ
R47 4·7kΩ
C25 10μF
LF
FILTERS
HF
IN
OUT
S14
S15
C26 0·22μF
C27 0·22μF
R49 18kΩ
R51 27kΩ
R52 47kΩ
C28 470pF
C30 2·2μF
R53 330kΩ
R56 1kΩ
TR7 BC384L
TR8 BC212L
C32 68pF
R55 100kΩ
C31 2·2μF
CONTROL UNIT
R41 1MΩ
R112 330kΩ
R45 1kΩ
R48 47kΩ
R50 39kΩ
C29 470pF
R54 330kΩ
R57 1kΩ
MAGNETIC PICK-UP PRE-AMPLIFIER
R72 150kΩ
R73 5·6kΩ
R75 5·6kΩ
TR13 BC212L
R81 1kΩ
TC3
DISC
TC4a
C40 10μF
SK4a
TR11 BC384L
TR12 BC384L
R77 220kΩ
R76 820Ω
R78 15kΩ
R80 3·3kΩ
C44 2·2μF
TC1a
C45 100μF
R70 150kΩ
R71 100kΩ
R74 3·9kΩ
C41 100μF
C42 0·015μF
C43 5600pF
R79 8·2kΩ
TC5
TC2

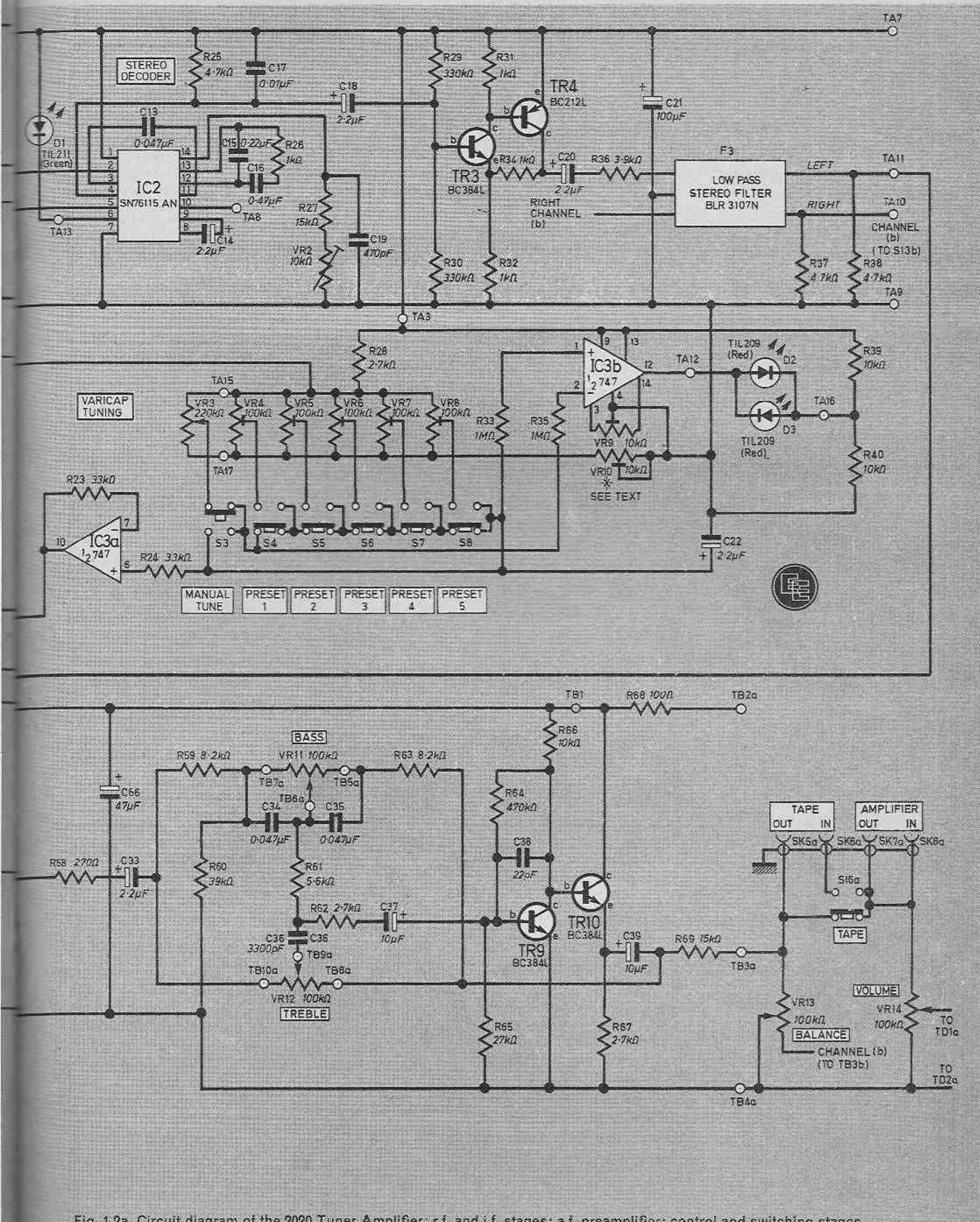
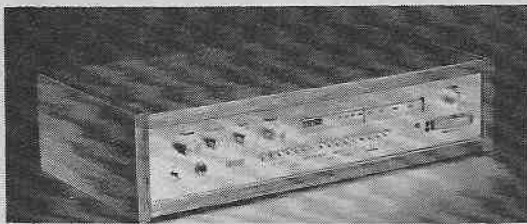


Fig. 1.2a. Circuit diagram of the 2020 Tuner Amplifier: r.f. and i.f. stages; a.f. preamplifier; control and switching stages.



EE2020 BULK COMPONENTS

See page 872

SEMICONDUCTORS

Transistors

Type		Qty
BC182L—TO5	silicon *npn*	10
BC212L—TO5	silicon *pnp*	13
BC384L—TO5	silicon *npn*	16
BFY51	silicon *npn*	2
TIP33A	silicon *npn*	2
TIP34A	silicon *pnp*	2

NOTE

Type BC384L—TO5 is a very low noise transistor and has been used throughout the receiver to standardise on types. Type BC184L—TO5 may be used instead with a slight increase in noise.

Most transistors used in the equipment have the suffix TO5. This means that the leads are preformed by the maker to the TO5 pin circle. If devices with a different suffix (or none) are obtained it will be necessary for the constructor to form the leads to suit the TO5 configuration before using.

Diodes

Type	Qty
1N4001 silicon rectifier 1A	4
TIL209 l.e.d., red	2
TIL211 l.e.d., green	1
BZY88C 12V Zener, 400mW	1

Integrated Circuits

Type	Qty
CA3189E f.m. i.f. system (RCA)	1
SN76115AN stereo decoder (Texas)	1
SN72747 dual op-amp.	1
µA723 voltage regulator	1

PUSHBUTTON SWITCHES

Description	Qty
2-pole changeover (RS type 338-434)	15
4-pole changeover (RS type 338-636)	1
4-switch latching assembly (RS type 338-254)	1
6-switch latching assembly (RS type 338-614)	1

R. F. UNIT

R. F. Unit	EF5600
Stereo Filter	BLR3107N
Choke	220K/22µH
Coil	KACSK586HM
Tuning Meter	906
10·7MHz filters	CFSE/SFE 10·7 (2 off)

(Available from Ambit Ltd.)

FIXED RESISTORS

¼W 5% High Stability Carbon Film

Value	Quantity
47Ω	1
100Ω	2
270Ω	3
330Ω	1
470Ω	2
820Ω	4
1kΩ	23
1·5kΩ	3
2·2kΩ	3
2·7kΩ	7
3·3kΩ	2
3·9kΩ	7
4·7kΩ	14
5·6kΩ	8
8·2kΩ	6
10kΩ	10
15kΩ	9
18kΩ	2
27kΩ	4
33kΩ	3
39kΩ	4
47kΩ	5
82kΩ	2
100kΩ	17
120kΩ	2
150kΩ	4
180kΩ	2
220kΩ	2
330kΩ	10
470kΩ	2
1MΩ	4

½W 10% carbon

Value	Quantity
2·2Ω	1

1W 5% Carbon

Value	Quantity
1kΩ	2

2·5W 10% Wirewound

Value	Quantity
0·22Ω	4

25W 10% Wirewound RS type 157-588

Value	Quantity
100Ω	1

POTENTIOMETERS

Open Skeleton Presets, Miniature Horizontal Mounting (RS type 184/5)

Value	Quantity
2·2kΩ	2
10kΩ	4
47kΩ	2

Open Skeleton Cermet Presets, Miniature Horizontal Mounting RS type 185-432

Value	Quantity
10kΩ	1

Ganged Potentiometers ± 20%, Tracks Matched To 2dB (RS type 161/162)

Value	Quantity
100kΩ log. law	1
100kΩ Lin. law	2

Single Potentiometers ± 20%

Value	Quantity
100kΩ	1
220kΩ	1

Multi-turn Potentiometers, Special Log. Law For Diode Tuning (Ambit type AB47)

Value	Quantity
100kΩ	5

CAPACITORS

Disc ceramic, low voltage

Value	Quantity
0·01µF	5

Polyester, Mullard type C280

Value	Quantity
0·001µF	2
0·047µF	7
0·1µF	2
0·22µF	8
0·47µF	2

Polystyrene 5% or better; or sub-miniature Plate Ceramic

Value	Quantity
68pF	3
470pF	5
3300pF	2
100pF	5
15pF	2
22pF	2
5600pF	2
4700pF	1

Polyester 5%

Value	Quantity
0·015µF	2

Electrolytic, Printed Circuit type

Value	Quantity
2·2µF 63V	22
4·7µF 63V	2
10µF 63V	11
22µF 63V	1
100µF 16V	5
220µF 63V	3
47µF 63V	3
22µF 63V	2

Electrolytic, Single-ended

Value	Quantity
4700µF 63V	1
2200µF 63V	2

Electrolytic, Double-ended

Value	Quantity
47µF 63V	2

two transistors TR7, TR8 with a bootstrapped input to provide a high impedance load for the low-pass filter. Hundred per cent negative feedback is used to keep distortion to a negligible level.

The low impedance output goes to the following tone control stage, which uses a Baxandall circuit with voltage amplifier and emitter follower stages TR9, TR10. Some high frequency roll-off is introduced to limit the frequency response above 20kHz as this helps prevent transient intermodulation distortion by ensuring that the rise time of the control unit is longer than that of the power amplifier.

The output from the tone control stage is fed to the balance control VR13, and to the tape output and tape monitor switch S16. The tape monitor switch selects either the output from the control unit or tape. As the tape input goes directly from this switch to the power amplifier, the tone controls and filters do not operate on tape replay. However, they are operated on tape record. This method enables a tape to be corrected during recording and means it can be replayed on any amplifier with a flat frequency response.

From the tape monitor switch the signal goes via the "pre-amp out" "main amp in" link to the volume control VR14, which is a dual-ganged potentiometer matched to within 2dB, and ensures a balanced output over a wide range of control settings.

The signal then goes to the power amplifier input. See Fig. 1.2b.

Board C

PICK-UP PRE-AMPLIFIER

A disc input of 47 kilohms impedance is also provided and this will match most magnetic cartridges available at the present time. Its sensitivity is 4 millivolts with an overload limit of 110 millivolts, i.e. approx. 29dB. Pick-ups rated at more than 4 millivolts/cm/Sec may need an external attenuator. As the noise level with reference to 4 millivolts is 67dB a full dynamic range of some 96dB is available. Using a pick-up rated at around 1 to 2 millivolts/cm/sec should be about optimum to make full use of the excellent dynamic range available.

The magnetic pick-up pre-amplifier (TR11 to TR13) uses a differential input configuration. This isolates the pick-up from the effects of any feedback used for R1AA equalisation and enables an almost pure resistive load to be obtained. RIAA equalisation is obtained with an RC network in the negative feedback path and this method ensures low distortion as well as the correct RIAA frequency response. The distortion of the magnetic pre-amplifier alone, is less than 0·1 per cent.

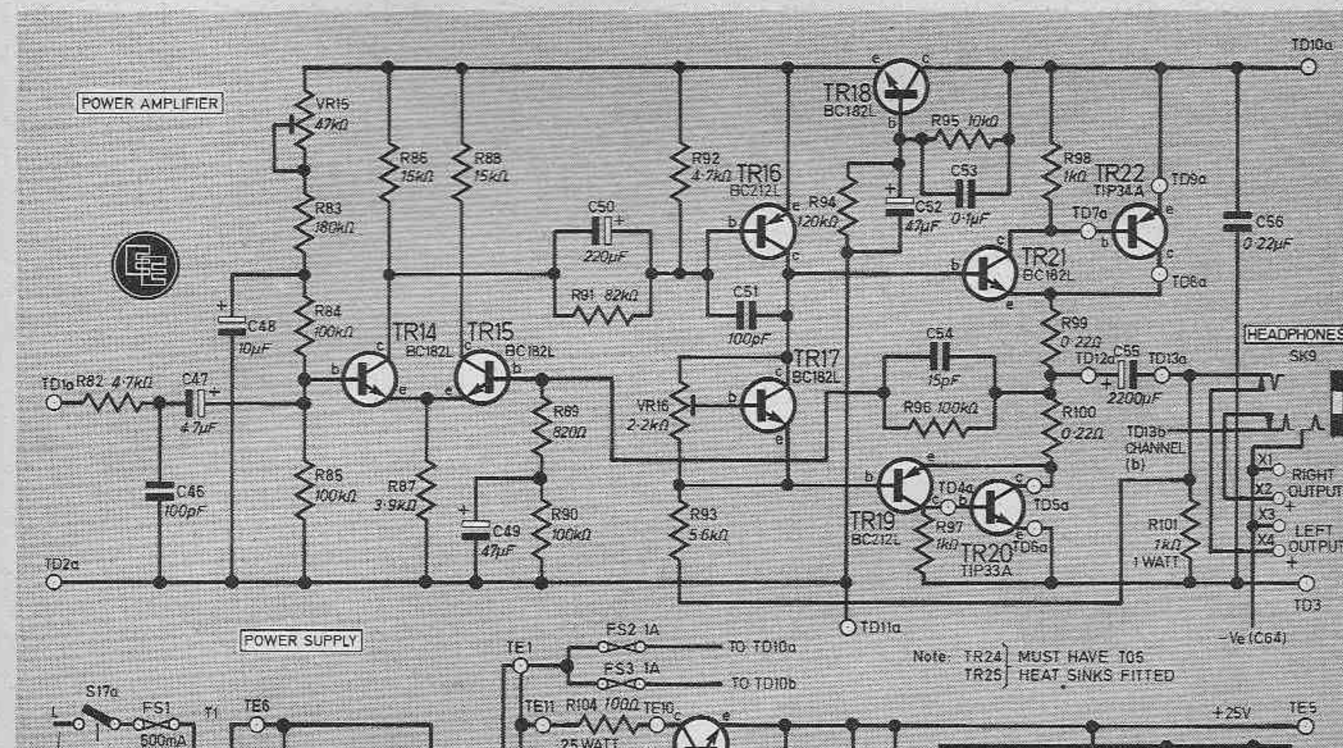


Fig. 2b. Circuit diagram of the 2020 Tuner Amplifier: Power Amplifier and Power Supply stages.

Board D

POWER AMPLIFIER

The power amplifier section of the 2020 is of a well known Texas Instruments design and was chosen because of its excellent performance and reliability. The circuit forms the top half of Fig. 1.2b.

The input signal from the volume control VR14 is fed in at TD1 and applied via a low pass filter comprising R82, C46, which helps prevent radio frequency interference (r.f.i.) and also helps prevent transient intermodulation distortion.

The input stage consists of a long-tailed pair TR14, TR15. This arrangement offers the following advantages:
(a) Excellent temperature stability on the d.c. level of the output mid-point voltage, since any changes in the base emitter voltage of transistor TR14 due to temperature changes will be cancelled by a similar change in the base emitter voltage of transistor TR15. Also since resistors of similar value are used in the input and feedback paths connected to the bases of the two transistors, any changes in base current requirements of the transistors due to temperature changes produce almost equal off-sets on the two sides of the circuit and prevent any drift of the output mid-point.
(b) A high impedance input to both sides of the long-tailed pair allows a smaller value capacitor to be used to decouple the negative feedback circuit. Transistor TR18 is an addition to the original Texas circuit. This provides electronic smoothing of the supply line to the early stages and reduces supply line ripple to a negligible level. It also reduces "switch on" thump as the output voltage from TR18 is only able to increase slowly due to C52 having to charge up, which in turn causes a slow build-up of the mid-point voltage.

Preset VR15 sets the current through the input transistor which in turn sets the mid voltage point of the output transistors. VR16 adjusts the quiescent current.

Both d.c. and a.c. negative feedback is applied to the base of TR15. The action of the circuit is that the d.c. level of the output mid-point changes until the base voltages of the transistors TR14 and TR15 are equal. If the mid-point voltage tends to rise (say) then the base voltage of TR15 will also tend to rise, this will increase its collector current and hence decrease the collector current of TR14. This reduces the collector current of TR16 reducing the voltage drop across R93 and corrects the tendency of the mid-point voltage to rise.

The a.c. feedback applied to the base of TR15 takes the same path as the d.c. feedback, but in this case C49 in effect shorts out R90. The total amount of a.c. feedback is approximately 40dB. As the input long-tailed pair is a subtractive arrangement the feedback signal can be said to be subtracted from the input signal.

A full description of the power amplifier circuit is given in the Texas Instruments book *"High Fidelity Audio Amplifier Circuits"*.

Board E

POWER SUPPLY

The power supply section is shown in the lower half of Fig. 1.2b.

A toroidal type of mains transformer is used; this has advantages of the virtual absence of an external magnetic field as well as a low physical profile. The two 0-20V secondaries of T1 are connected in series to provide 0-40V. This feeds a full-wave bridge rectifier D4-D7. The d.c. output from the reservoir capacitor C58 is fed to the power amplifier via fuses FS2 and FS3. Output from C58 also goes to stabiliser circuit TR23, TR24.

A series pass transistor TR24 is used as an emitter follower to provide the stabilised supply. The emitter of TR24 is held at 25V by the action of the regulator transistor TR23. The preset potentiometer VR17 controls the current through TR23 which in turn adjusts the voltage on its collector to the required 25 volts. Any variation in output voltage is fed back via VR17 to the base of TR23 and the negative feedback action will correct and maintain the voltage to that set by VR17. The 25V stabilised supply is taken from the emitter of TR24 to TE5.

To ensure that the voltage to the varicaps is stable enough for varicap tuning a μA723 voltage regulator IC4 is used to provide the required 14·5 volts. Input to the voltage regulator IC4 is from the 25V stabilised line. The 14·5V regulated output is fed via an emitter follower TR25 to TE9. This double stabilising ensures complete freedom from drift due to mains or supply voltage fluctuations.

The 14·5V line also supplies the pick-up pre-amplifier, the double stabilising ensuring complete decoupling from the power amplifier supply rail and preventing hum and noise entering the pre-amplifier.

To be continued

BRIGHT IDEAS

SLEEVING

Those little sticks with cotton wool on each end are these days most useful for the electronics enthusiast. When mother has finished doing incredible things to baby with "Q Tips" or "Cotton Buds", to name a couple of brand names, salvage them, cut the ends away, and presto, 60 to 70 mm of stiff sleeving—for free.

Even some ice lollies have plastic tubular sticks, so through the summer you can also keep plenty of sleeving in stock whatever the weather—you can ignore the flavours and choose the colour stick that suits your current project!

And don't forget your own electronics bench—Ersin Multicore solder size 5 dispenser has 80mm of transparent plastic tubing inside.

K. Croft,
Broadstairs,
Kent.

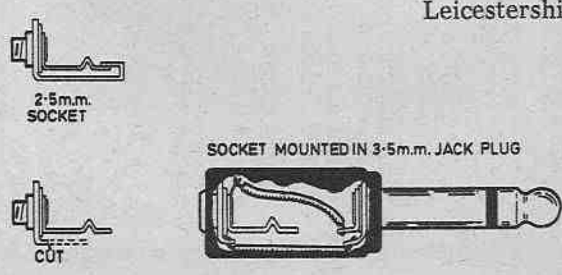
PLUG CONVERSION

I have devised a very simple method of using a 2·5mm earpiece with a 3·5mm socket, thus solving a very old problem.

Take a 3·5mm plug and remove the barrel, cut the connectors to a length of 3mm. Now take a 2·5mm socket, cut off the part shown and solder two thin wires to the contacts. Now screw the socket into the barrel, and solder the wires to the plug contacts.

Finally screw the barrel onto the plug. It is important to ensure the connecting wires are long enough to allow for the twisting they will experience when the barrel is screwed on.

A. R. Jones,
Loughborough,
Leicestershire.



SEMICONDUCTORS

TRANSISTORS

Type	Price
AC107	£0·22
AC113	£0·20
AC118	£0·20
AC117	£0·30
AC117K	£0·34
AC121	£0·20
AC122	£0·14
AC125	£0·18
AC126	£0·18
AC127	£0·18
AC128	£0·18
AC128K	£0·60
AC132	£0·20
AC134	£0·20
AC137	£0·20
AC141	£0·22
AC141K	£0·20
AC142K	£0·30
AC151	£0·20
AC153	£0·22
AC153K	£0·30
AC154	£0·20
AC156	£0·20
AC157	£0·25
AC165	£0·20
AC166	£0·20
AC167	£0·20
AC168	£0·25
AC169	£0·20
AC171	£0·25
AC176	£0·18
AC176K	£0·26
AC178	£0·25
AC179	£0·25
AC180	£0·26
AC180K	£0·24
AC181	£0·20
AC181K	£0·28
AC187	£0·18
AC187K	£0·28
AC188	£0·16
AC188K	£0·24
ACY17	£0·32
ACY18	£0·26
ACY19	£0·25
ACY20	£0·24
ACY21	£0·28
ACY22	£0·20
ACY27	£0·24
ACY28	£0·21
ACY29	£0·35
ACY30	£0·25
ACY31	£0·25
ACY34	£0·25
ACY35	£0·25
ACY36	£0·35
ACY40	£0·22
ACY41	£0·25
ACY44	£0·28
AD130	£0·70
AD140	£0·80
AD142	£0·85
AD143	£0·75
AD149	£0·60
AD161	£0·42
AD162	£0·42
AD161/162	£0·85
AD/140	£0·55
AF114	£0·21
AF115	£0·21
AF116	£0·21
AF117	£0·21
AF118	£0·40
AF124	£0·30
AF125	£0·30
AF126	£0·30
AF127	£0·32
AF139	£0·35
AF178	£0·60
AF179	£0·60
AF180	£0·60
AF181	£0·58
AF186	£0·50
AF239	£0·38
AL102	£1·20
AL103	£1·18
ASY26	£0·38
ASY27	£0·40
ASY28	£0·38
ASY29	£0·38
ASY50	£0·30
ASY51	£0·30
ASY52	£0·30
ASY54	£0·30
ASY55	£0·30
ASY56	£0·30
ASY57	£0·30
ASY58	£0·30
ASY73	£0·30
AU104	£1·40
AU110	£1·40
AU113	£1·40
BC107	£0·08
BC107A	£0·08
BC107B	£0·08
BC107C	£0·08
BC108	£0·08
BC108A	£0·08
BC108B	£0·08
BC108C	£0·08
BC109	£0·08
BC109B	£0·08
BC109C	£0·08
BC113	£0·16*
BC114	£0·16*
BC115	£0·19*
BC116	£0·19*
BC116A	£0·19*
BC117	£0·20*
BC118	£0·14*
BC119	£0·25
BC120	£0·40
BC125	£0·17*
BC126	£0·22*

Type	Price
BC132	£0·18*
BC134	£0·18*
BC135	£0·15*
BC136	£0·18*
BC137	£0·18*
BC138	£0·32
BC140	£0·30
BC141	£0·28
BC142	£0·22
BC143	£0·22
BC145	£0·46
BC147	£0·08*
BC148	£0·08*
BC149	£0·08*
BC150	£0·20*
BC151	£0·22*
BC152	£0·20*
BC153	£0·25*
BC154	£0·19*
BC157	£0·10
BC158	£0·10*
BC159	£0·10*
BC160	£0·32
BC161	£0·38
BC167	£0·12*
BC168	£0·12*
BC169	£0·12*
BC109C	£0·14*
BC170	£0·10*
BC171	£0·10*
BC172	£0·10*
BC173	£0·12*
BC174	£0·15*
BC175	£0·35*
BC177	£0·16
BC178	£0·10
BC179	£0·16
BC180	£0·25
BC181	£0·25*
BC182	£0·10*
BC182L	£0·10*
BC183	£0·10*
BC183L	£0·10*
BC184	£0·10*
BC184L	£0·10*
BC186	£0·22
BC187	£0·22
BC207	£0·11*
BC208	£0·11*
BC209	£0·12*
BC212	£0·11*
BC212L	£0·11*
BC213	£0·11*
BC213L	£0·11*
BC214	£0·12*
BC214L	£0·12*
BC225	£0·26*
BC226	£0·36*
BC227	£0·16*
BC238	£0·16*
3C251	£0·15*
BC251A	£0·16*
BC301	£0·28
BC302	£0·28
BC303	£0·28
BC304	£0·38
BC327	£0·16*
BC328	£0·15*
BC337	£0·15*
BC338	£0·15*
BC440	£0·30
BC441	£0·30
BC460	£0·38
BC461	£0·38
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BC556	£0·14*
BC557	£0·13*
BC558	£0·12*
BC559	£0·14*
BCY30	£0·55
BCY31	£0·55
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BD138	£0·40
BD139	£0·36
BD140	£0·36
BD139/140	£0·80
BD155	£0·80
BD175	£0·60
BD176	£0·60
BD177	£0·68
BD178	£0·68
BD179	£0·75
BD180	£0·75
BD181	£0·85
BD182	£0·90
BD183	£0·95
BD184	£1·10
BD185	£0·68

Type	Price
BD186	£0·68
BD187	£0·75
BD188	£0·75
BD189	£0·78
BD190	£0·78
BD195	£0·90
BD196	£0·95
BD197	£0·95
BD198	£0·95
BD199	£0·99
BD200	£0·99
BD201	£0·80
BD202	£0·80
BD201/202	£1·70
BD203	£0·80
BD204	£0·80
BD203/204	£1·70
BD205	£0·80
BD206	£0·80
BD207	£1·00
BD208	£1·00
BD222	£0·47
BD225	£0·47
BD232	£0·55
BD233	£0·48
BD234	£0·55
BD235	£0·55
BD236	£0·55
BD237	£0·58
BD238	£0·60
BDX32	£2·29
BDY11	£1·36
BDY17	£1·80
BDY20	£0·80
BDX77	£0·90
BF115	£0·22
BF115	£0·50
BF117	£0·50
BF118	£0·75
BF119	£0·75
BF121	£0·50*
BF123	£0·60*
BF125	£0·50*
BF127	£0·60*
BF152	£0·25*
BF153	£0·25*
BF154	£0·22*
BF155	£0·35
BF156	£0·28
BF157	£0·28
BF158	£0·35*
BF159	£0·35*
BF160	£0·30*
BF162	£0·30*
BF163	£0·30*
BF164	£0·50*
BF165	£0·50*
BF167	£0·24
BF173	£0·20
BF176	£0·38*
BF177	£0·28
BF178	£0·28
BF179	£0·30
BF180	£0·30
BF181	£0·30
BF182	£0·30
BF183	£0·30
BF184	£0·20
BF185	£0·20
BF186	£0·25*
BF187	£0·28
BF188	£0·40
BF194	£0·10*
BF195	£0·10*
BF196	£0·10*
BF197	£0·12*
BF198	£0·14*
BF199	£0·14*
BF200	£0·30
BF202	£0·90*
BF222	£0·90
BF224	£0·17
BF240	£0·17*
BF241	£0·17*
BF244	£0·30*
BF257	£0·30
BF258	£0·30
BF259	£0·42
BF262	£0·60*
BF263	£0·60*
BF270	£0·36
BF271	£0·31
BF272	£0·80
BF273	£0·36*
BF274	£0·38*
BF324	£0·35*
BF336	£0·35
BF337	£0·30*
BF338	£0·38
BF457	£0·37
BF458	£0·37
BF459	£0·38
BF594	£0·30*
BF596	£0·28*
BFR39	£0·24
BFR40	£0·25*
BFR79	£0·28*
BFR80	£0·28*
BFX29	£0·22
BFX30	£0·30
BFX84	£0·22
BFX85	£0·24
BFX86	£0·25
BFX87	£0·22
BFX88	£0·22
BFX90	£0·55*
BFY50	£0·16
BFY51	£0·16
BFY52	£0·16
BFY53	£0·16
BIP19	£0·38
BIP20	£0·38
BIP19/20	£0·80
BSX25	£1·45
BSX19	£0·18

Type	Price
BSX20	£0·18
BSY25	£0·16
BSY26	£0·16
BSY27	£0·16
BSY28	£0·18
BSY29	£0·18
BSY38	£0·19
BSY39	£0·19
BSY40	£0·29
BSY41	£0·29
BSY51	£0·25
BSY95	£0·13
BSY95A	£0·13
BRY39	£0·45
BU105	£1·40
BU105/02	£1·95
BU204	£1·70
BU205	£1·70
BU208	£2·25
BU208/02	£2·95
E1222	£0·38
MAT100	£0·19
MAT101	£0·20
MAT120	£0·19
MAT121	£0·20
MJ480	£0·95
MJ481	£1·05
MJ490	£0·95
MJ491	£1·15
MJE340	£0·45
MJE370	£0·68
MJE371	£0·80
MJE520	£0·65
MJE521	£0·72
MJE2955	£0·98
MJE3055	£0·50
MJE3440	£0·52
MP8113	£0·52
MPF102	£0·35
MPF104	£0·38
MPF105	£0·38
MPSA05	£0·30*
MPSA06	£0·30*
MPSA55	£0·28*
MPSA56	£0·28*
ND120	£0·18
OC19	£0·85
OC20	£1·85
OC22	£1·50
OC23	£1·50
OC24	£1·35
OC25	£1·00
OC26	£1·00
OC28	£0·80
OC29	£0·95
OC35	£0·90
OC36	£0·90
OC41	£0·20
OC42	£0·22
OC44	£0·24
OC45	£0·26
OC70	£0·24
OC71	£0·19
OC72	£0·24
OC74	£0·26
OC75	£0·30
OC76	£0·35
OC77	£0·50
OC81	£0·22
OC81D	£0·24
OC82	£0·24
OC82D	£0·30
OC83	£0·26
OC84	£0·38
OC139	£1·20
OC140	£1·15
OC169	£0·35
OC170	£0·35
OC171	£0·35
OC200	£0·38
OC201	£0·95
OC202	£1·20
OC203	£0·85
OC204	£0·90
OC205	£1·15
P346A	£0·35
P397	£0·45
R2008B	£2·50
R2010B	£2·60
ST140	£0·15
ST141	£0·20
TIC44	£0·25*
TIC45	£0·35*
TIP29A	£0·40
TIP29B	£0·52
TIP29C	£0·50
TIP30A	£0·50
TIP30B	£0·60
TIP30C	£0·90
TIP31A	£0·45
TIP31B	£0·47
TIP31C	£0·49
TIP32A	£0·49
TIP32B	£0·51
TIP32C	£0·53
TIP41A	£0·48
TIP41B	£0·51
TIP41C	£0·53
TIP42A	£0·53
TIP42B	£0·55
TIP42C	£0·57
TIP2955	£0·65
TIP3055	£0·50
TIS43	£0·24
TIS90	£0·22*
UT46	£0·22
ZTX107	£0·10*

Type	Price
ZTX108	£0·10*
ZTC109	£0·10*
ZTX300	£0·12*
ZTX301	£0·12*
ZTX302	£0·16*
ZTX303	£0·16*
ZTX304	£0·20*
ZTX330	£0·15*
ZTX500	£0·14*
ZTX501	£0·12*
ZTX502	£0·16*
ZTX503	£0·12*
ZTX504	£0·45*
ZTX531	£0·26*
ZTX550	£0·16*
2G301	£0·22
2G302	£0·22
2G303	£0·22
2G304	£0·30
2G306	£0·40
2G308	£0·38
2G309	£0·38
2G339	£0·20
2G339A	£0·18
2G344	£0·20
2G345	£0·18
2G371	£0·18
2G371B	£0·12
2G373	£0·18
2G374	£0·18
2G377	£0·32
2G378	£0·18
2G381	£0·18
2G382	£0·18
2G401	£0·32
2G414	£0·32
2G417	£0·26
2N388	£0·36
2N388A	£0·56
2N404	£0·20
2N524	£0·40
2N527	£0·50
2N598	£0·40
2N599	£0·46
2N696	£0·13
2N697	£0·12
2N698	£0·12
2N699	£0·32
2N706	£0·10
2N706A	£0·12
2N707	£0·48
2N708	£0·14
2N711	£0·30
2N717	£0·30
2N718	£0·25
2N718A	£0·50
2N726	£0·29
2N727	£0·29
2N743	£0·20
2N744	£0·20
2N914	£0·15
2N918	£0·30
2N929	£0·20
2N930	£0·18
2N946	£0·40
2N1131	£0·18
2N1132	£0·20
2N1302	£0·15
2N1303	£0·18
2N1304	£0·18
2N1305	£0·18
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2N2218	£0·22
2N2218A	£0·20
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2N2222	£0·20
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2N2646	£0·47
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2N2904	£0·18
2N2904A	£0·20
2N2905	£0·18
2N2905A	£0·20
2N2906	£0·18
2N2906A	£0·19
2N2907	£0·20
2N2907A	£0·22
2N2923	£0·15*
2N2924	£0·15*
2N2925	£0·15*
2N2926G	£0·09*
2N2926Y	£0·08*
2N2926O	£0·08*
2N2926R	£0·08*
2N2926B	£0·08*
2N3010	£0·65
2N3011	£0·15
2N3053	£0·15

Type	Price
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2N3055	£0·40
2N3391	£0·20*
2N3391A	£0·22*
2N3392	£0·20*
2N3393	£0·20*
2N3394	£0·20*
2N3395	£0·22*
2N3402	£0·21*
2N3403	£0·21*
2N3404	£0·29*
2N3405	£0·42*
2N3414	£0·16*
2N3415	£0·16*
2N3416	£0·29*
2N3417	£0·29*
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2N3615	£1·05
2N3616	£1·05
2N3646	£0·09*
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2N3703	£0·08*
2N3704	£0·07*
2N3705	£0·07*
2N3706	£0·08*
2N3707	£0·08*
2N3708	£0·07*
2N3708A	£0·07*
2N3709	£0·07*
2N3710	£0·07*
2N3711	£0·07*
2N3772	£1·60
2N3773	£2·50
2N3819	£0·20
2N3820	£0·35
2N3821	£0·60
2N3823	£0·60
2N4903	£0·15*
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2N3905	£0·15*
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40407	£0·35
40408	£0·52
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40410	£0·75
40411	£2·70
40430	£0·95
40476	£1·60
40494	£0·70
40495	£0·80
40512	£1·35
40594	£0·90
40638	£1·10

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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7401	£0·11	7428	£0·33	7473	£0·25	74107	£0·27	74164	£0·85
7402	£0·11	7430	£0·12	7474	£0·25	74110	£0·45	74165	£0·85
7403	£0·11	7432	£0·22	7475	£0·29	74111	£0·67	74166	£0·95
7404	£0·11	7433	£0·30	7476	£0·25	74116	£0·80	74174	£0·86
7405	£0·11	7437	£0·23	7480	£0·44	74119	£1·18	74175	£0·65
7406	£0·20	7438	£0·23	7481	£0·85	74121	£0·24	74176	£0·74
7407	£0·26	7440	£0·12	7482	£0·60	74122	£0·09	74177	£0·75
7408	£0·13	7441	£0·50	7483	£0·70	74123	£0·49	74180	£0·84
7409	£0·13	7442	£0·54	7484	£0·38	74135	£0·55	74181	£1·60
7410	£0·12	7443	£0·88	7485	£0·68	74141	£0·74	74182	£0·74
7411	£0·17	7444	£0·88	7486	£0·25	74145	£0·62	74184	£1·10
7412	£0·20	7445	£0·35	7489	£1·05	74150	£0·95	74190	£1·00
7413	£0·24	7446	£0·65	7490	£0·32	74151	£0·56	74191	£1·00
7414	£0·50	7447	£0·60	7491	£0·95	74153	£0·58	74192	£0·85
7416	£0·26	7448	£0·56	7492	£0·37	74154	£0·08	74193	£1·00
7417	£0·26	7450	£0·12	7493	£0·30	74155	£0·60	74194	£0·69
7420	£0·12	7451	£0·12	7494	£0·50	74156	£0·60	74195	£0·82
7421	£0·20	7453	£0·12	7495	£0·75	74157	£0·60	74196	£0·85
7422	£0·18	7454	£0·12	7496	£0·30	74160	£0·78	74197	£0·95
7423	£0·23	7460	£0·12	74100	£0·92	74161	£0·78	74198	£1·45
7425	£0·19	7470	£0·25	74104	£0·30	74162	£0·78	74199	£1·45
7426	£0·23								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·15	CD4015	£0·98	CD4026	£1·70	CD4043	£0·93	CD4070	£0·48
CD4001	£0·16	CD4016	£0·50	CD4027	£0·60	CD4044	£0·94	CD4071	£0·23
CD4002	£0·16	CD4017	£0·98	CD4026	£0·98	CD4045	£1·4	CD4072	£0·23
CD4006	£0·98	CD4018	£1·00	CD4029	£1·25	CD4046	£1·30	CD4081	£0·20
CD4007	£0·18	CD4019	£0·55	CD4030	£0·55	CD4047	£1·10	CD4082	£0·23
CD4008	£0·98	CD4020	£1·10	CD4031	£2·20	CD4049	£0·55	CD4510	£1·30
CD4009	£0·58	CD4021	£0·88	CD4035	£1·30	CD4050	£0·55	CD4511	£1·60
CD4010	£0·58	CD4022	£0·90	CD4037	£0·95	CD4054	£1·10	CD4516	£1·40
CD4011	£0·20	CD4023	£0·20	CD4040	£0·95	CD4055	£1·40	CD4518	£1·25
CD4012	£0·20	CD4024	£0·80	CD4041	£0·82	CD4056	£1·35	CD4520	£1·25
CD4013	£0·52	CD4025	£0·20	CD4042	£0·82	CD4068	£0·40		

LINEAR ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£1·05*	LM304	£1·60	MC1351	£1·40*	72709	£0·46*	SH6115	£1·00*
CA3014	£1·70*	LM308	£1·40*	MC1456	£1·40*	709P	£0·25*	SN76580	£0·75*
CA3018	£0·75*	LM309	£1·50	MC1468	£4·50	UA719C	£0·40*	S1414A	£1·95*
CA3020	£1·70*	LM320-5v	£1·50	MC1469	£2·35	74710	£0·30*	TAA550B	£0·35
CA3028	£1·02*	LM320-12v	£1·50	MC1496	£0·98*	UA711C	£0·32*	TAA621A	£2·00*
CA3035	£1·70*	LM320-15v	£1·50	NE536	£3·50*	72711	£0·32*	TAA621B	£2·50*
CA3036	£1·35*	LM320-24v	£1·50	NE515	£3·50*	UA723C	£0·45	TAA661	£1·62*
CA3042	£1·50*	LM380	£0·85*	NE540	£1·50*	72723	£0·45	TAD100	£1·08*
CA3043	£1·85*	LM381	£1·55*	NE550	£0·55	UA7410	£0·24*	TBA560	£2·20*
CA3046	£0·80*	LM3900	£0·65*	NE555	£0·32	72741	£0·24*	TB800	£0·80*
CA3052	£1·60*	MC1303L	£1·48*	NE556	£0·62	741P	£0·23*	TBA810	£1·85*
CA3054	£1·35*	MC1304	£1·90*	NE561	£3·95*	UA747C	£0·70*	TBA829	£0·80*
CA3057	£1·50*	MC1310	£0·95*	NE562	£3·95*	72747	£0·75*	TBA920R	£3·40*
CA3081	£1·50*	MC1312	£1·50*	NE565	£1·75*	UA748	£0·35*	TCA270S	£2·20*
CA3088	£2·10	MC1330	£1·20*	NE566	£1·50*	7274	£0·385*		
CA3090	£4·25*	MC1350	£1·20*	NE567	£1·80*	745P	£0·35*		
CA3123	£1·90*			UA702C	£0·46*	SH760134	£1·75*		
CA3130	£0·93			72702	£0·48*	SH76023	£1·75*		
CA3140	£0·90			UA703	£0·25*	SH6110	£1·50*		
LM301	£0·39*			UA709	£0·25*				

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	£0·03	BAX13	£0·07	BY164	£0·51	OA10	£0·05	SD10	£0·06
AA120	£0·08	BAX16	£0·08	BY175	£0·75*	OA47	£0·08	SD19	£0·06
AA129	£0·08	BY100	£0·22	BY206	£0·30	OA70	£0·05	I534	£0·07
AAY30	£0·09	BY101	£0·22	BYZ10	£0·45	OA79	£0·13	IN34A	£0·07
AAZ13	£0·15	BY105	£0·22	BYZ11	£0·45	OA81	£0·16	IN914	£0·08
BA100	£0·10	BY114	£0·22	BYZ12	£0·45	OA85	£0·16	IN916	£0·06
BA102	£0·32	BY124	£0·22*	BYZ13	£0·40	OA90	£0·07	IN4143	£0·06
BA148	£0·15	BY126	£0·15*	BYZ15	£0·41	OA91	£0·07	IS44	£0·06
BA154	£0·12	BY127	£0·16*	BYZ17	£0·36	OA95	£0·07	IS920	£0·06
BA155	£0·14	BY129	£0·16	BYZ18	£0·36	OA182	£0·13		
BA173	£0·15	BY130	£0·17*	BYZ19	£0·36	OA200	£0·08		
BB104	£0·15	BY133	£0·21*	OA5	£0·60	OA202	£0·08		

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10 Amp Volts	TO48 Case No.	Price
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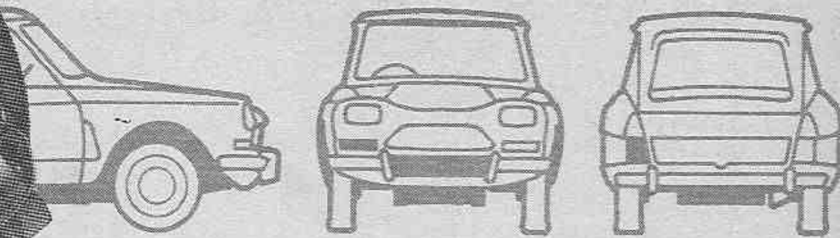


By B. N. Ryerson

IN MANY cars on the roads there is no indication, save just a bulb, to alert the driver that his indicators are working correctly. This simple add-on unit to be described here does just that by emitting a loud click with each flash of the indicators.

CIRCUIT DESCRIPTION

The unit is simplicity itself in operation, and the circuit diagram is shown in Fig. 1. Each time the warning lamp receives a pulse from the flasher unit, part of it is passed to C1. This capacitor charges up, in doing so it will produce a loud click in the speaker.

In the interval between pulses the capacitor is discharged through R1, ready to charge up again on the next pulse.

COMPONENTS approximate cost £1.20

CONSTRUCTION

As there are few components, point to point wiring is used. First of all decide where to mount the the speaker. A position somewhere behind the dashboard is suitable, and it can be mounted with glue, or metal brackets. The capacitor and resistor are both mounted on the speaker in some convenient position and glued in place. The diagram of Fig. 2 shows the components opened out for clarity.

Leads long enough to reach the flasher unit and a convenient point on the car chassis are connected as shown.

Some experimenting may be required to find suitable values for the capacitor and resistor to give a resonably loud click, and so as not to load the flasher unit. The values given should prove suitable in most cases.

The unit has been installed in the author's car for some time now and does its job effectively. It is always audible and the click is less offensive than some electronic whine. ¤

COMPONENTS

Resistor
R1 220Ω ¼W ± 10%

Capacitor
C1 470µF 16V elect.

Miscellaneous
LS1 8 ohm 50mm speaker
Connecting wire.

See Shop Talk page 857

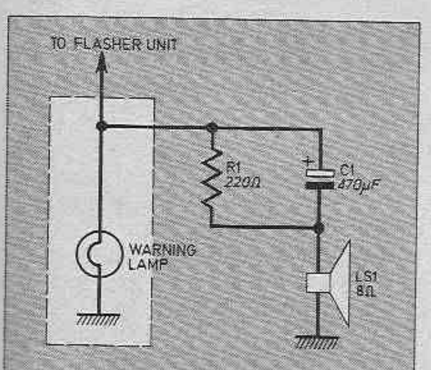


Fig. 1. Circuit diagram of the unit. The wiring shown inside the dotted box is the existing car wiring.

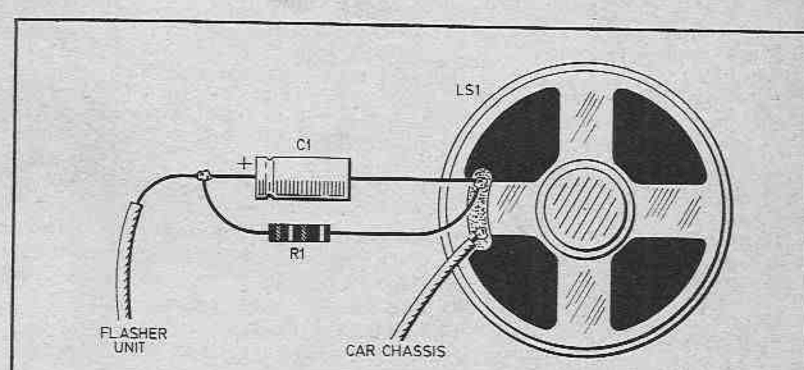


Fig. 2. Wiring details. The speaker can be mounted in any convenient position behind the dashboard. All wiring is point to point using stranded connecting wire. For positive earth systems, reverse the polarity of C1.

MOST of us scribbling chaps are fascinated by etymology, and when a few months ago I was asked by the Editor of *The Educationalist,* if I would write a series of articles on "Learning Electronics" the first thing I did was to find out exactly what the word meant. I quote "Electronics is a branch of Electrical Engineering dealing with the theory, design and application of apparatus based on the flow of electrons outside ordinary conductors in which Ohm's laws is valid".

Fifteen years ago that was an apt description, but the term is now used so widely that it would appear, that, "The tail is wagging the dog" and it would not suprise me, if future scholars reverse this definition and say "That Electrical Engineering is a branch of Electronics".

Setting a New Course

I was delighted to read in the *Sunday Times* recently, that if the appropriate examining board approves there will be a new O-level course in electronics tried out in schools this year. I quote "The experiment reflects growing concern that schools are failing to prepare children for a world in which electronics will dominate part of their lives".

It appears that of the 40,000 children in London who took C.S.E. only 461 took a paper in electronics which is just over 1 per cent. One lecturer said that in his opinion children should be given plenty of electronic projects to build as an aid to their learning. He can say that again, and I would add also, make EVERYDAY ELECTRONICS compulsory reading.

In The Bag

One sees a lot of amusing things happen if they stand behind a counter all day. Normally it is my staff who man the front line, but occasionally on a busy day I get pressed into service.

I remember several years ago when we had one of those Mullard Valve Testers and on a Saturday it was quite usual to have a line of customers each with a bag full of valves to be tested. The explanation was simple enough. The night before the television had broken down. So next day off would come the back, out would come all the valves and they would come to us to help find the culprit.

We had to get rid of it in the end as it was too time consuming. So their next ploy was to make a list of all the valves in the set (any number up to 20) come in and buy a complete new set. They would then go home and find the trouble by a process of elimination, come back on Monday morning with nineteen valves and expect you to take them back and refund their money! No wonder some of us wound up on the analyst's couch! Needless to say we soon squashed that one too!

Even so I still find it hard to keep a straight face when someone comes in with a small paper bag and tips the contents out on the counter and says "Have you anything like that?" "That" usually being something that was originally a half-watt resistor, charred to a cinder and in about four pieces.

Being a whimsical chap, I would dearly love to have some burnt and broken resistors, so I could whip one out, present it to the customer, while saying "Yes certainly Sir, here you are!"

EE CROSSWORD No 10 BY D.P.NEWTON

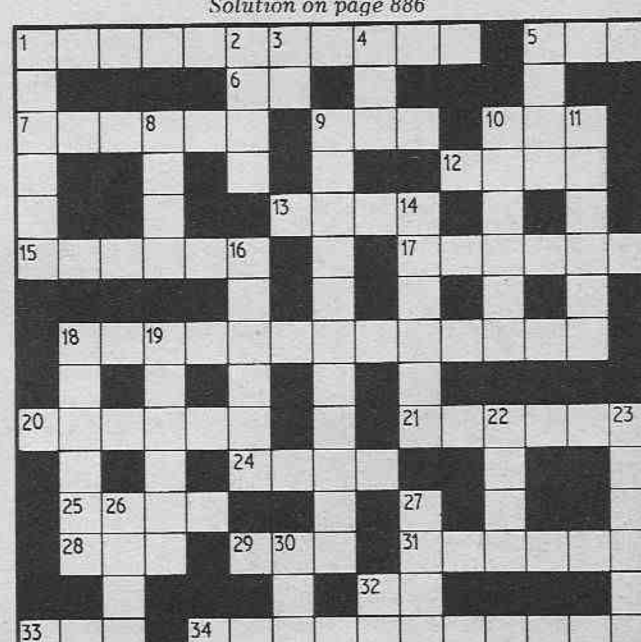
CLUES ACROSS

1 Storm fear is potentially a changer (Anag.)
5 A tiny morsel
6 Sin without the nineteenth letter
7 His physical laws are very forceful
9 Way beyond the usual vibration rate
10 Senior citizen
12 Better than half-wave rectification
13 A reverse rail which tells untruths
15 A.C. waveform left its autograph
17 To use up
18 Half an insulator
20 Repaired
21 The head blanked out the tape
24 A mite out of a transistor
25 Electrical snakes?
28 Less and yet more than none
29 The males are in the omen
31 Wet, short-life oscillations
32 A wizard in every dozen
33 Once a radio call of extreme distress
34 Oscillations which are not quite with it in a rectangular sort of way

CLUES DOWN

1 Devices for inducing electrical resonance
2 An expensive punishment from a nife cell (Anag.)
3 Not off
4 Ohm gives us a short wait (Anag.)
5 Reverse the lead for a fair one
8 Lathe waste, clipped a bit
9 Singularly a transistorised join
10 Mismatching might reduce it
11 A flattish sort of transistor?
14 A mains repair turned down?
16 Crack the signal
18 Two speakers who sound things out in depth
19 A handy unit
22 Mighty small
23 One-track mind devices
26 Some can't make them meet
27 Dad's old cutting tool?
30 Get the bird from EBC
32 A NOR gate does not give us the option

Solution on page 886



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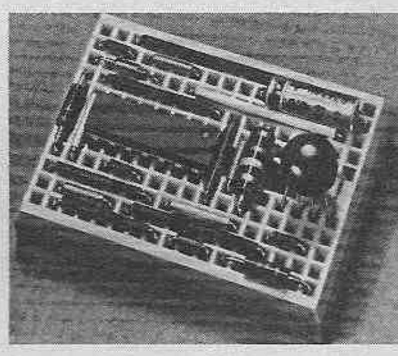

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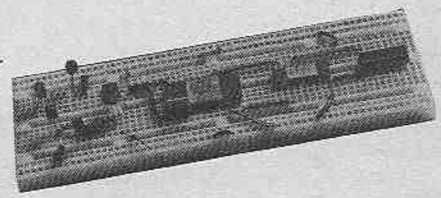

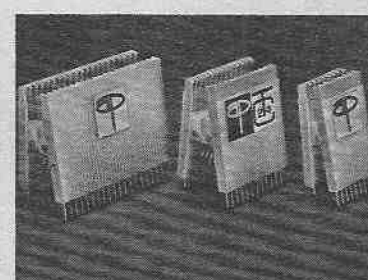

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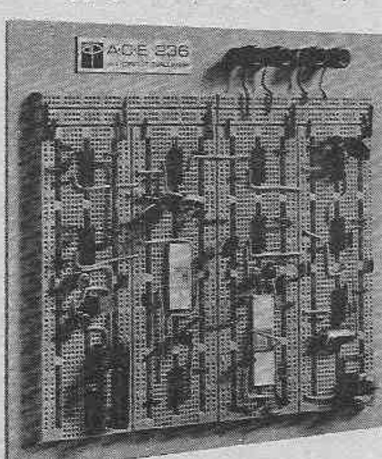
With ACE, you just plug in components and make connections with ordinary 22-gauge solid wire. No soldering. You can build any working project *complete*, as fast as you could lay out a circuit diagram before.



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LEKTROKIT COMPLETES THE CIRCUIT

RADIO WORLD

By Pat Hawker, G3VA

SOME years ago an American telecommunications expert told an international audience of engineers that they should concentrate less on exotic new systems and more on "POTS"—the Plain Ordinary Telephone Service. The subsequent history of the attempt to establish the Picturephone video-telephone service served to prove his point.

International Broadcasting Convention

At the recent IBC78 at the Wembley Conference Centre I could not help being reminded of "POTS" but this time translated as the "plain ordinary television & sound" services. So many of the sessions seemed to be taken up with optimistic accounts of complex new systems that have yet to establish that they are what listeners and viewers really want.

Of course, it is entirely right and proper that the broadcasting organisations should be looking ahead and investigating new systems, but at the same time they need to make sure that they give equal or greater weight to those developments which could and should improve their "ordinary" services.

At IBC78, for example, little or no attention was paid in the technical sessions to the electronic news gathering (ENG) revolution that has taken over news operations in the States while still bogged down in the UK. On the other hand, who now really believes that s.s.b. (single-sideband) broadcasting is likely in the next decade? Or that wideband multiplexed p.c.m. (pulse code modulation) digital sound broadcasting is really going to occupy the v.h.f. channels when they are vacated by 405-line television? Or that there will be a dedicated network of traffic information stations in the near future.

And should people be developing medium-wave station identification systems that, if adopted, would make it impossible ever to implement medium-wave a.m. stereo?

The slow growth of Teletext is an ever present reminder of the chicken-and-egg situation of advanced micro-electronics: prices drop only when there is mass-demand, but mass-demand can hardly develop while prices are high. Optional Teletext subtitling could be a boon to hearing-impaired viewers—but then so could a simple electrically-isolated output socket for headphones, and there are still precious few of these (although some firms can supply headphone adaptors for those who require them).

The Phase-locked Goldfish

Surround-sound and quadraphony appeal to many enthusiasts but has been described as likely to benefit initially only "a minority of a minority of a minority" on the grounds that even today v.h.f./f.m. reception attracts only a minority of listeners and stereo broadcasting only a minority of those.

Indeed one of the fundamental problems in audio is that nobody has yet unravelled all of the mysteries of the deceptively simple ear. For instance there are two crucial phenomena that cannot be explained satisfactorily: directional hearing and sound analysis. Nobody can really account for the capability of some people to distinguish pitch so accurately.

Surprisingly it seems possible that the solution to this particular mystery may emerge from current studies of the common goldfish. Work at the Loyola University of Chicago suggests that frequency discrimination may in part stem from a natural form of "phase-locking" in the nerve fibres of auditory system: if this proves really to be the case then a natural extension of the theory may help crack wide open the long-lasting mysteries of how we detect an off-pitch performer.

Down-to-earth satellites

Paradoxically one of the new developments at IBC78 that seemed welcomely down-to-earth was the future application of space satellites to broadcasting. The Japanese NEC/NHK 12GHz domestic receiver with its compact dish aerial that can even be set up indoors was there to be examined; so was the IBA transportable "up-link" 14GHz station with 2·5m trailer-mounted dish that enabled ITN to put out a newscast from Wembley via the OTS satellite stationed above Africa.

In the conference sessions the detailed plans for the Arab 2·5GHz community system (which should be operational by the early 1980s) were unfolded. Domestic satellite systems for television and sound distribution are already in full operational use in Canada, the USSR and the USA.

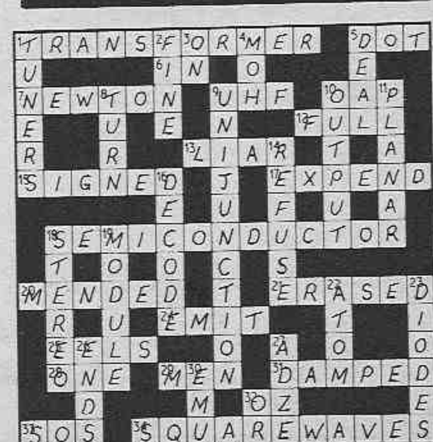
But it was disappointing to find that many of those directly concerned with planning space broadcasting seemed to have so little knowledge of the alternative "aerostat" systems based on tethered balloons carrying aerials and transmitters at heights up to about 20,000ft. A number of such systems are currently planned in Africa and Asia, although there have apparently been a series of teething troubles that have delayed their operational use. But basically the technique seems a good one.

Sunspot joys

The high level of sunspot activity expected over the next few years gives the radio amateur and short-wave listener a rare (and possibly even unique) opportunity to sample long-distance reception and transmission on h.f. in their most satisfying form. Not only during the long hours of darkness when signals on 14 and 15MHz can be expected to come through rather than fading out but also the outstanding daylight reception possible on the 26MHz broadcasting band (which may one day be used for satellite sound broadcasting), the crowded 27MHz citizen's band direct from the United States and above all on the wide open 28MHz amateur band.

In good conditions even low-power stations with simple aerials can come through from thousands of miles away as though they were local stations. By the end of September good signals were coming through from Asia and North and South America and conditions should peak around November and then again around February and March, 1979. I find myself working many of the Russian "RA" prefixes which represent "technician v.h.f." licences and cannot be heard on the bands below 28MHz.

Crossword No. 11—Solution



15—240 Watts!

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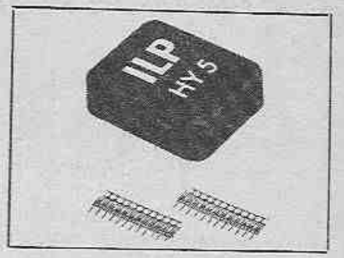
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits 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 4·7kΩ 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

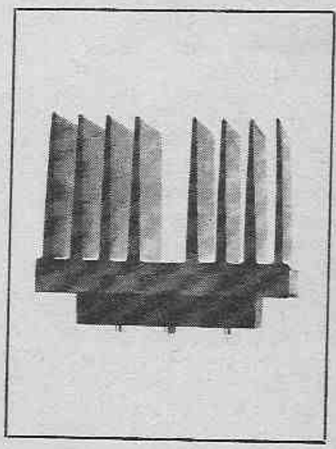
The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

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 ±25V
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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PSU36 suitable for two HY30's **£6·44** plus **81p** VAT. P/P free.
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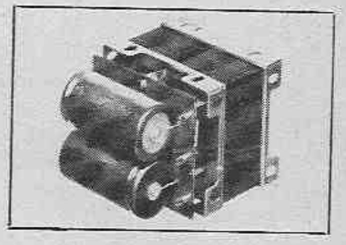

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4v	7amp	TM 32	£2·70	60p
6v	¾ amp	TM 3	85p	40p
6·5v	3 amp	TM37	85p	40p
6·5v	200 mA	TM 21	£1·62	40p
6·5v–0–6·5v	100 mA	TM 21	£1·62	40p
6·5v–0–6·5v	750 mA	TM 7	£2·16	45p
6·3v–0–6·3v	100 mA	TM 33	£1·62	40p
6·3v	2 amp	TM 4	£1·89	50p
8·5v	1 amp	TM 12	£1·62	40p
8·5v+8·5v sep. winding	½ amp	TM 12	£1·62	40p
9v	1 amp	TM 5	£1·62	45p
9v	3½ amp	TM11	£2·70	50p
9v	5 amp	TM 38	£3·24	60p
10v	25 amp	TM 15	£4·86	£1·25
10v–0–10v	4 amp	TM 50	£3·78	£1·25
10v–0–10v	12½ amp	TM 15	£4·86	£1·25
12v	½ amp	TM 9	£1·05	50p
13v	100 mA	TM 21	£1·62	40p
13v	¾ amp	TM 7	£2·16	50p
12v	1 amp	TM 10	£1·89	50p
12v–0–12v	50 mA	TM 19	£1·62	40p
12v–0–12v	1 amp	TM 41	£3·24	50p
15v tapped 9v	2 amp	TM11	£2·70	50p
17v	½ amp	TM 12	£1·62	50p
18v	¾ amp	TM 13	£1·90	50p
20v	½ amp	TM 14	£1·62	50p
20v (with 6v ½ amp)	2 amp	TM 50	£3·78	£1·25
20v	6 amp	TM 46	£4·32	£1·25
20v	12½ amp	TM 15	£4·86	£1·25
20v–0–20v	6 amp	TM 15	£4·86	£1·25
24v	1½ amp	TM 16	£2·12	60p
24v	2 amp	TM 17	£2·70	60p
24v+2v 7 amp	2 amp	TM 39	£2·97	70p
24v	4 amp	TM 40	£3·78	80p
25v	1½ amp	TM 18	£2·43	60p
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30v	8 amp	TM 15	£4·86	£1·25
37v	37 amp	TM 34	£31·86	enquire
40v	3 amp	TM 46	£4·32	£1·25
40v	5 amp	TM 48	£5·02	£1·25
40v	6 amp	TM 15	£4·86	£1·25
40v–0–40v	2½ amp	TM 48	£5·02	£1·25
50v & 6·3v	2 amp	TM 22	£4·86	£1·25
50v	8 amp	TM 29	£11·65	£1·75
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75v	4½ amp	TM 24	£7·02	£2·50
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100v	1 amp	TM 25	£7·02	£1·75
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250v–0–250v & 6·3v	50 mA	TM 36	£3·78	£1·00
000v	100 mA	TM 36	£3·78	£1·00
500v	50 mA	TM 36	£3·78	£1·00
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1000v	60 mA	TM 43	£6·50	£2·00
4 kv	5 mA	TM 49	£4·05	70p
5 kv	5 mA	TM 30	£7·02	£1·00
8 kv	5 mA	TM 45	£4·05	£1·00
8·5 kv	10 mA	TM 31	£10·26	£2·00

Full range of Mains to 120v Auto transformers available.

Pot Cores. We have now received our delivery of Ferrox pot cores. These are ex unused equipment. They contain the bobbins but of course these have to be wound and you would have to unwind. Three pairs available.

	Diameter	Thickness	Price	
FX 2243	4·5 cm	3·0 cm	81	per pair
FX 2242	3·5 cm	2·3 cm	70	
FX 2240	2·5 cm	1·6 cm	60	

Quantity discounts apply.

Component Panel Ref. 3055. Taken from unused P.S.U.'s, these contain 4 × 2N 3055 power transistors with mica insulators all on heat sink and 4 variable pots, preset type with spindle locks. Real bargain at **£1·08** each.

Component Board 421. Again from unused equipment, major items on these are two power silicon transistors, Motor Rola ref. SJ 5433 mounted on a heat sink with mica insulators, also behind the panel are two power rectifiers ST NS 1008. Price **96p.**

E.H.T. Mains Transformer. With Inductance control, normal primary and output voltage approx. 4kv 3mA. Voltage can be varied by applying DC to lower bobbin. Unused, ex P.S.U.'s Price **£4·32.**

Music Centre Dust Cover. Size 12" × 10" × 1½" with attachments for hinging. Price **£3·95.** Callers only.

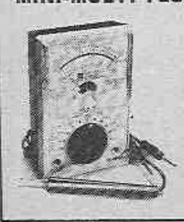
Telephone Answering Machines. Used, but apparently complete and probably in working order. However, we are allowed to supply these only for breaking up, they should be very suitable for conversion to open reel tape recorder, background music machine, echo chamber, etc. All untested but we guarantee to replace any major item in the machine should it be faulty. Machines less outer case **£7·50,** case slightly broken but substantially whole **£10·26.** Unbroken cases **£12·45,** and finally with new looking cases **£14·50.** Post **£2·50** per machine. Many accessories available for these machines. Please enquire.

Wall Mounting Thermostat. The Satchwell room stat. Mains 20 amp settable over normal air temperatures between 30-80°F. Suitable also for greenhouse control. Nicely finished in white enamel. Price **£3·25.**

10 r.p.m. Motor with 230v mains coil, not like the usual of these geared motors this has a good length of ½" shaft. Price **£2·50 + 20p.**

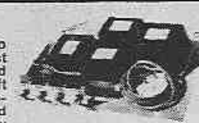
Rigonda Intermezzo 10 + 10 hi-fi amplifier with belt driven record deck with speed control and strobe check. The best hi-fi offered by Rigonda original selling price was in excess of **£125.** We have approx. 50 of these unused but with various faults. Untested, believed complete except for cartridge and speakers. Offered at **£33·50,** less than the price of the very high quality deck incorporated. If cannot collect add **£3·00** o cover the special packing and carriage charge.

MINI-MULTI TESTER

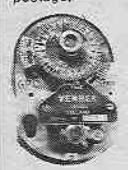


Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 150, 1000.
DC amps 0–1 mA and 0–100 mA
Continuity and resistance 0–150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.
Unbelievable value only **£6·50+50p** post and insurance.

MULLARD UNILEX



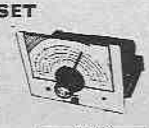
A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£15** including VAT and postage.



42 HOUR TIMERS VENNER

As illustrated with sun correction made for G.P.O. phone boxes used perfect **£2·95** 20 amp switching contacts.

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

SOUND TO LIGHT UNIT

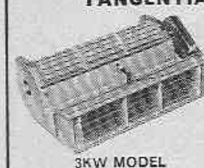
Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components, and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1" long—the diodes have approx. ½" leads.

List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which we made to receive these units). The price of this four unit parcel is **£1** including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

TANGENTIAL HEATER UNIT

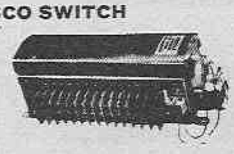


3KW MODEL
£5·95
+ £1·50 P & P

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

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

MOTORISED DISCO SWITCH



With 10 amp changeover switches. Multi adjustable switches are rated at 10 amps. This would provide a magnificent display. For mains operating. 8 switch model **£5·25.** 10 switch model **£5·75.** 12 switch model **£6·75.**

FLUORESCENT TUBE INVERTOR

For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer invertor for 21" 13 watt miniature tube for only **£3·75** with tube and tube holders as well.

RELAYS

12 volt two 10 amp changeover plug in **95p.** 12v three 10 amp changeover plug in **£1·28.** 12v two changeover miniature wire ended **95p.** 12 volt open single screw fixing two 10 amp changeovers **85p.** 12 volt open three 10 amp change overs **£1·25.** Latching relay mains operated 2 c/o contacts **£2·11.** Mains operated three 10 amp changeovers open type one screw fixing **£1·25.** Many other types with different coil voltages and contact arrangements are in stock, enquiries invited.

Terms: Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. E. E.), 103 TAMWORTH RD., CROYDON CR8 1SG

IT'S FREE

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

Pot Cores. These are ex-unused equipment. They contain the bobbins. Three sizes available.

	Diameter	*Thickness*	*Price*	
FX 2243	4·5 cm	3·0 cm	**81p**	per pair
FX 2242	3·5 cm	2·3 cm	**70p**	
FX 2240	2·5 cm	1·6 cm	**60p**	

Quantity Discounts apply.

Component Panel Ref. 3055. Taken from unused P.S.U.'s, these contain 4 × 2N 3055 power transistors with mica insulators all on heat sink and 4 × 3W type variable pots, preset type with spindle locks. Real bargain at **£1·08.**

Component Board 421. Again from unused equipment, major items on these are two power silicon transistors, Motor Rola ref. SJ 5433 mounted on a heat sink with mica insulators, also behind the panel are two power rectifiers ST NS 1008. Price **96p.**

Heavy Duty 3 Core Appliances Lead. 15 Amp wire 6ft long, conventional yellow green, brown and blue cores, grey pvc outer, prepared ends, this flex normally sells at 30p per metre. 10 leads for **£2·50 + 20p.** Post **£1·00.** Good quantity available.

E.H.T. Mains Transformer. With inductance control, normal primary and output voltage 3·5kv. The core, however, is made of a very good quality grain oriented transformer steel, and its flux can be varied by applying a DC voltage to the lower bobbin. We are not sure how much the output voltage may be increased or decreased but using a 9 volt battery we seem to get a rise or fall of about 50 volts. These transformers are unused ex-P.S.U.'s which we are breaking down. Price **£4·35.**

Music Centre Dust Cover. Size 12" × 10½" × 1½" with attachments for hinging. Price **£3·95.** Callers only.

Hi Fi Console. This is a pleasingly designed shelving arrangement which could tidy up your equipment, sorry but it's another callers only item but a real bargain at **£6·50.**

Battery Charger Kit. Soon the dark nights will be with us and chances are your battery will become gradually discharged. Keep it topped up at low cost from the mains. Our kit consists of transformer, full wave rectifier, charging meter and battery clips. Bargain price **£4·60.**

Electrical Wiring Cables. 2·5mm twin and earth, flat p.v.c. covered grey outer, 100 metre coils, price **£15·00.** This is the cable you need for ring main circuits but for lighting a smaller 1mm cable will do. We can supply this at **£9·00.**

Power Packs for the Telephone Answering Machines have just arrived, these isolate the machine from the mains and provide the correct voltages for driving the record and playback motors, etc. On metal chassis with voltage selector and fuse, these have a plastic cover to make them safe. Not new of course but fully guaranteed. Price **£5·86.**

Telephone Answering Machines. We have sold all last month's delivery and the new lot we find rather varied. There are some without cases, some with slightly broken cases and some which look perfect. The description we gave in last month's newsletter cannot apply to this new lot. So we now restate this as follows:— **"Telephone Answering Machine,** used, but so far as we can see complete and quite possibly in working order. However, we are allowed to supply these only for breaking up, they should be very suitable for conversion to open reel tape recorder, background music machine, echo chamber, etc. The list of parts contained in the machine are as in our August newsletter (copy on request). They are all untested but we guarantee to replace any major item in the machine should this item be faulty. We are repricing these as follows. Machines less outer case **£7·50** with outer case slightly broken but substantially whole **£10·50.** Machines with unbroken outer cases **£12·50** and finally machines with very good, new looking outer cases **£14·50.** Post **£2·00** per machine less case, others **£2·50."**

Wall Mounting Thermostat. The Satchwell room stat. This will handle mains heaters up to a total of 20 amp and is settable for normal air temperatures between 30-80°F. Suitable also for greenhouse control. Nicely finished in white enamel. Also has a cover to prevent interference with control setting. **Price £3·00.**

10 r.p.m. Motor with 230v mains coil, not like the usual of these geared motors, this has a good length of ½" shaft price. **£3·00 + 20p.**

Can Anyone Help US? We are looking for fairly large quantities of the items listed below. If you have any stock yourself or can put us on to a reasonably priced supplier we would be obliged.
7-Segment displays common anode red or green.
BZY88C5V6 Zener.
TIL209 red l.e.d.s.
Soldercon pins.
0·1 inch matrix Veroboard 52 holes × 46 strips.
0·1 inch matrix Veroboard size 34 holes × 34 strips.
CA3130 1C. Operational amplifier 1C.
MPF102. Transistor.
We are also looking for VDU's, oscilloscopes, computers and most instruments. If you know of any surplus please send details or 'phone Mr. J. Bull, 01-688 1833.

Charge Discharge indication meter. This is a heavy panel mounting instrument made originally for the GPO, rather old design but still we feel will fill an urgent need. Basically the operation of this depends upon a Mercury motor which revolves clockwise or anti-clockwise depending upon whether the batteries are charging or discharging. A pointer shows the state of charge of the batteries at any time. Also fitted within the instrument are auxilliary contacts which could be used to set off alarms like lamps, etc. Price **£5·95.**

Resettable Fuses (thermal trips). Two new types have come in, one made by ETA is a 6 amp model which is mounted through a single hole rather like a volume control. This is suitable for 250 volts AC or 24 volts DC. Price **54p. 4·5 Amp Model** made by AEG is held by two screws thus a bank of these could be mounted between metal straps. Price **54p.**

Disc Motor, mains operated. This is very thin in fact less than ½" thick and only approx. 2" dia. Spindle revolves at 250 rpm and the spindle which is approx. 1/32" dia. pushes through so motor could be used to drive clockwise or anti-clockwise. The spindle being a friction fit can be pushed completely out and replaced by your own spindle, a knitting needle for instance. Price only **38p.**

75 rpm Mains Induction Motor with gearbox. This motor is quite powerful and has 1½" stack and the final 75 rpm drive shaft is 1½" long by ⅜" dia. The motor also has a spindle coming from the opposite end to which could be fitted another pulley. Overall size approx. 3" × 5" × 2½" + spindles. Price **£3·35.**

24 Hour Motor, beautifully made by Sangamo. This is 200-240v mains driven motor with gearbox together in one housing, size approx. 1¾" dia. by 1½" deep. If you are contemplating making a 24 hour switch with a lot of on/offs, then this is obviously the motor. Price **£1·89.**

BOX IT

By George Hylton

SMALL cabinets for electronic equipment are easily and cheaply made from readily-available materials. They can also be improvised from other containers, such as tobacco tins, or electricians' switch boxes. Of course, if you wish you can purchase one of the many standard plastic and metal cabinets which can be obtained from components stockists. —But it's not the same as building your own!

This article deals with the cheapest home-constructed and improvised cabinets, suitable for the smaller types of equipment, up to the size of a portable radio.

HARDBOARD

The common hardboard is the cheapest do-it-yourself cabinet material, and one of the easiest to work with. It is often obtainable from timber merchants and do-it-yourself shops as "offcuts", with the advantage that quite narrow strips, down to about an inch wide, are still quite useful for small cabinet construction but generally go cheaply in the shops because they are too narrow for most household jobs.

Hardboard has no grain and is easily cut with a wood saw. If kept dry it is an excellent insulator and can be used for circuit boards. (the "outdoor" variety of hardboard, which is waterproofed with an oily substance, is even better.)

GLUING

Small hardboard boxes can be made simply by gluing pieces of hardboard together at the edges (Fig. 1). It is easiest first to cut the top, bottom and end pieces and glue them to form a short open-ended "tube". Front and rear panels can be added later. Alternatively, you can make a "tray" by starting with the back panel and gluing four sides to it.

Almost any type of adhesive can be used but a good general-purpose type is the so-called "impact" adhesive, available as Evo-Stik Impact Adhesive or Dunlop Thixofix. The instructions on the tube tell you to coat the mating surfaces with the glue then let them dry for about 15 minutes, then press them together, whereupon they stick.

The trouble with this method is that it is difficult to make any adjustments once the surfaces are brought into contact. You may find it easier just to let the surfaces get tacky then bring them together, when they can still be slid over one another. Used this way the glue needs to be left to dry for a few hours but this is advisable anyway.

FINISHES

Hardboard has a rough side and a smooth side, and you can use it "rough side out" or "smooth side out" according to taste. The ordinary non-oiled kind can be tinted with a dye or coloured ink, and the rough side gives a more even colour. The smooth side can be covered with "Fablon" adhesive plastic film which is available in a variety of decorative finishes.

If you want to paint hardboard it will suck up the paint like blotting paper unless you give it a coat of "size" first.

Hardboard is also available with a decorative plastic film bonded to one or both surfaces. Plain finishes are good for front panels, and the lighter colours can be marked with waterproof ink for calibrating controls.

It is often advantageous to use a front panel of a thinner material than hardboard, which can be too thick to accommodate some switches and potentiometers. Aluminium sheeting and laminates such as Formica are best suited for front panels.

To make the front panel easily removable stick small pieces of square-section wooden beading to the inside of the box to provide pillars to insert screws through the front panel, Fig. 1.

THIN-WALLED BOXES

When the entire box is to be made of Formica or some other thin-walled laminate sheeting this cannot be glued by its own edges because there is just not enough width to the edges to give a strong join. So use corner braces. These are just bits of square-section beading ("moulding") which costs about 3p per foot (or 10p per metre) from timber merchants.

Quarter-inch (6mm) square beading is suitable for small cabinets and three-eighths inch (9 or 10mm) for larger ones. (Other shapes of beading such as quadrant or half-square may look better but they provide less target area for fixing screws.) A suitable construction is shown in Fig. 2.

CUTTING LAMINATES

The best method of cutting the laminate sheets is with a hacksaw or a tenon saw but the professional way is the score-and-snap method. This is rather like glass-cutting, but a lot easier.

The line of cut is marked with a deep scratch through the decorative surface and the material is then snapped along the score mark.

There is a standard type of scoring knife designed for the job. It is made by fitting a hooked blade, called a Stanley scoring knife blade, to one of the same maker's Type 199 handles. (These are the handles which also accept the ubiquitous trimming knife blades, which are NOT suitable for scoring laminates.)

A deep scratch is made by repeated scoring along the line of cut, which must be straight and must go right across the sheet from one side to the other. The scored sheet is placed on a firm, level surface, with the scored (decorative) side up. The piece to be cut away is then bent upwards along the score mark while the rest of the sheet is pressed down on the level surface. Eventually it breaks, often with a loud crack.

The broken edge may be a bit rough but can be smoothed off with glass paper or a file. Once you have learned the knack (preferably by practising on scrap material) is becomes very quick and easy.

METAL BOXES

The two-ounce square tobacco tin is a godsend to the electronics enthusiast since it is big enough to house many small circuits and to provide screening as well (see our *Mini Module* series).

More clumsy and heavy, but still useful, are the galvanised steel "boxes" used to mount switches in walls. Lids (front panels) can be cut from aluminium sheeting which, like Formica and hardboard, is also obtainable as cheap offcuts.

Metal cabinets are useful for audio circuits where the signals are small, since if earthed they then screen out stray mains voltages which can cause hum. Note that they are of no use for radio receivers with ferrite rod aerials because they screen out the radio signals as well!

INPUTS AND OUTPUTS

Many cabinets require connections to the outside world. Mains leads should be brought in through holes fitted with rubber grommets to prevent chafing of the insulation. Inside the box the mains flex should be anchored firmly by means of a clamp or clip, preferably insulated. If the cabinet is of metal it should be connected to the Earth lead of a three-core mains cable (usually coloured with green and yellow stripes in the UK).

Where signals are taken into or out of the cabinet and standard plugs and sockets are not available several makeshift types of lead-through connectors can be used. When the panel is metal these lead-throughs must be insulated. Fig. 3 shows a cheap and simple way to do this.

With hardboard panels, pins or screws can be driven straight through. Laminate board is rather too thin to hold pins firmly and in any case holes must be drilled in it to allow the pins to pass. It, too, can be thickened up by sticking strips of hardboard behind it.

Ordinary bolts can also be used as lead-throughs, fixed by a nut on each side of the panel. Earth-tags on the inside make handy soldering points.

FIXING CIRCUIT BOARDS

It is often tempting to use the back of the panel or the bottom of the box as a "breadboard" for mounting components. In many cases, however, it is better to construct the circuit on its own separate board so that it can be removed for servicing or modification. Some method of holding it in place is then needed. Fig. 4 shows two simple but effective arrangements. ⌑

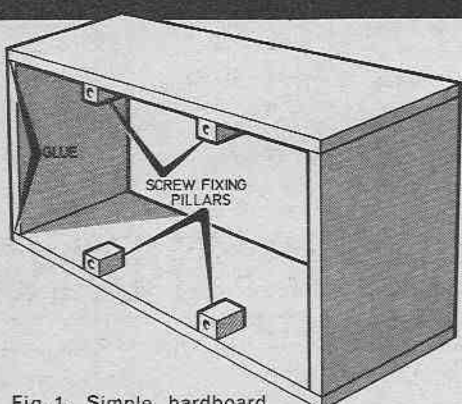
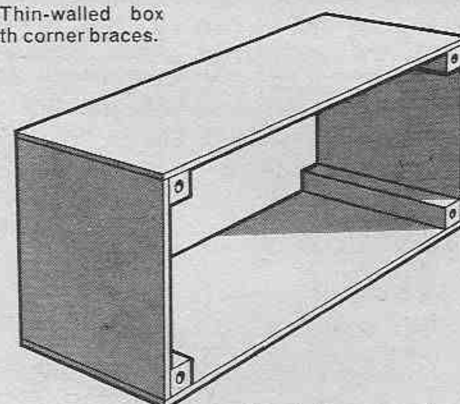


Fig. 1. Simple hardboard box "tube".

Fig. 2. Thin-walled box "tube" with corner braces.



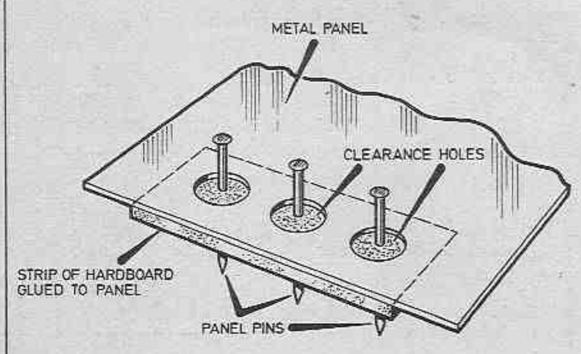
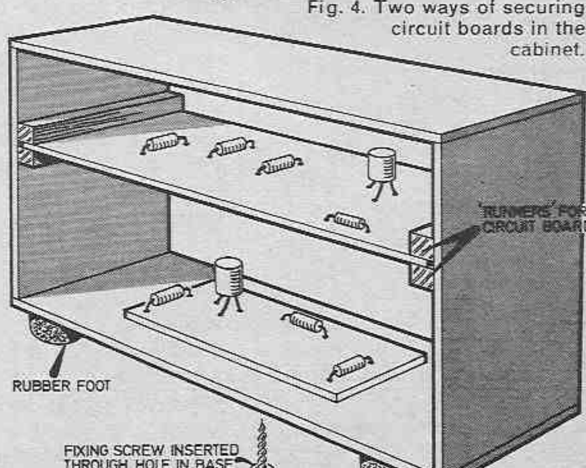
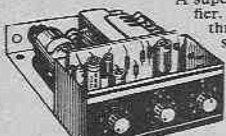


Fig. 3. Method of making feed-through connections on metal panels.

Fig. 4. Two ways of securing circuit boards in the cabinet.



SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz 30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15·00. P. & P. £1·20.

HARVERSONIC MODEL P.A. TWO ZERO

An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage pre-amp). Input 1, 15mv into 47k. Input 2, 15mv into 47k. (suitable for use with mic. or guitar etc.). Input 3 200mv into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12½" w. × 5" h. × 7½" d. Special introductory Price **£28·00** + £2·50 carr. & pkg.

Mullard LP1159 RF-IF Module 470 kHz **£2·25** + P.&P. 20p. Full spec. and connection details supplied. Pye VHF/FM Tuner Head covering 88-108 M/Hz. 10·7 M/Hz I.F. output. 7–8 Volt + earth. Supplied pre-aligned, with full circuit diagram with precision-geared FM gang and 323Pf + 323Pf A.M. Tuning gang only **£3·15** + P. & P. 35p.

STEREO DECODER
SIZE 2" × 3" × ½" ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. **£6·00** plus 20p. P. & P. Stereo beacon light if required **40p** extra.

MAINS OPERATED SOLID STATE AM/FM STEREO TUNER

200/240V Mains operated Solid State FM AM Stereo Tuner. Covering M.W. A.M. 540-1605 KHz VHF/FM 88-108 MHz. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600m/v RMS into 20K. Simulated Teak finish cabinet. Will match almost any amplifier. Size 8½"w × 4"h × 9½"d approx.
LIMITED NUMBER ONLY at £28·00 + £1·50 P. & P.

MAINS TRANSFORMER
Pri. 0·110 and 240. Sec. 28v at 1·8 amps. Also tapped at 12v ·3 amp. Overall size 2¾"h × 3¼"w × 2¾"d. **£2·50** + £1·00 P. & P.

10/14 WATT HI-FI AMPLIFIER KIT
A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **25p** + SAE (Free with parts). **All parts sold separately.** ONLY **£14·50** P. & P. £1·40. Also available ready built and tested **£19·00** P. & P. £1·40.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14 11/16" × 1 7/16" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details.
Only **£8·40** each + p. & p. (one 90p, two £1·10).
Now available in either 8" round version or 4½" × 8½" rectangular. 10 watts RMS 60Hz-20KHZ **£5·25** + P. & P. (one 65p, two 75p).

STEREO MAGNETIC PRE-AMP. Sens. 3mV in for 100mV out. 15 to 35V neg. earth. Equ. ± 1dB from 20Hz to 20KHz. Input impedance 47K. Size 1⅝" x 2⅛" x 5⅜" H. £2·60 + 20p P. & P.

2" PLASTIC CONE HF TWEETER 4 ohm, **£3·50** per matched pair + 50p P. & P.

HARVERSONIC SUPERSOUND 10 + 10 STEREO AMPLIFIER KIT

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WORKSHOP MATTERS

By Harry T. Kitchen

The Great 13A Fuse Fallacy

The flat pin 13-amp plug has been the standard British domestic plug for a number of years, and whilst the concept is a laudable one, the realisation of that concept leaves much to be desired. The concept was, of course, that the user of the plug fitted a fuse appropriate to the equipment in use, up to a maximum of 13 amps, and if necessary a fuse having a much lower rupturing value could be fitted, so affording the maximum protection to the equipment being protected.

So much for the concept, but what of the realisation? The realisation was the sale of plugs already fitted with a 13-amp fuse, with no thought of the equipment to be protected, and certainly with no thought of giving advice to the hapless user, who cheerfully fitted the plug onto anything and everything, and thereby, albeit quite innocently, created potential hazards to life limb and property.

Now why should a 13-amp fuse be a hazard?

In order to answer this, we have to ask the question: "what is a fuse and why is it fitted, and where?" The answer is that a fuse is a specially designed weak link placed in series with any circuit to protect that circuit and the user should the current exceed a *specified value*. And this is where the conceptual realisation of the 13-amp plug has so dismally failed, in my opinion, because the equipment may not draw 13 amps, and in many cases will draw significantly smaller currents.

Let us return, momentarily, to the 13-amp plug, and consider its implications. Now we know that the total consumption of any equipment is the wattage, and the wattage in turn is given by multiplying the current drawn by the voltage applied. Conversely, the current drawn can be calculated by dividing the wattage by the voltage, and the voltage can be calculated by dividing the wattage by the current.

The nominal mains voltage in the UK is 240 volts, within a tolerance decided by the CEGB, but the actual tolerance can be greatly influenced by the loading on the "spur" and upon the time of day or evening. For example, I live in the country, and my own mains voltage drops quite significantly when all the neighbourhood ladies, bless 'em, are indulging their culinary prowesses! To continue: 13 amps times 240 volts gives a wattage of 3,120, and that, if you care to think about it, is a lot of expensive wattages.

How often do *you* cheerfully consume 3,120 watts? An electric fire, going flat out, will approach this figure, but what else that you have, that is portable, that is not an electric cooker, consumes so much electricity? Precious little I'll warrant. Think about it for a moment, and if necessary do a few simple sums about the electrical or electronic equipment that *you* use, and when you've done so you will see the utter fallacy of selling 13-amp plugs complete with 13-amp fuses; in my book it ought to be a criminal offence.

Rules of Thumb

There are regulations which, if one cares to study them, and perhaps more important, if one can understand the legalistic jargon, will outline the precise measures to be adopted. Such pedantic accuracy is by no means essential, and a few simple rules of thumb will enable all equipment to be fused such that the maximum of protection can be obtained.

The first rule of thumb is to use a fuse value no larger than is necessary, the value being calculated by dividing the wattage by the voltage.

Here we come up against a practical difficulty, that of obtaining suitably rated fuses; the lowest current rated fuse is the 1-amp fuse, and here we are talking strictly of the 13-amp plug itself. So, perforce, we must use a 1-amp fuse even if the calculated current is significantly lower, and this value will be perfectly safe.

However, mains surges, or equipments having higher current consumptions than calculated, or fuses having a lower rupturing current than marked, may cause the fuse to blow, even though there is no actual fault in the equipment. It is therefore prudent to add a contingency allowance to the *calculated* rating, and a value between 50 per cent and 100 per cent is normal. So if your calculated current is, say, 1 amp, use a fuse of $1\frac{1}{2}$ amps or even 2 amps. But no higher.

An Exception

An exception to the rule involves inductive, capacitive, or tungsten circuits, where for a finite time a current greater, or much greater, than calculated flows, and then reduces to the calculated value.

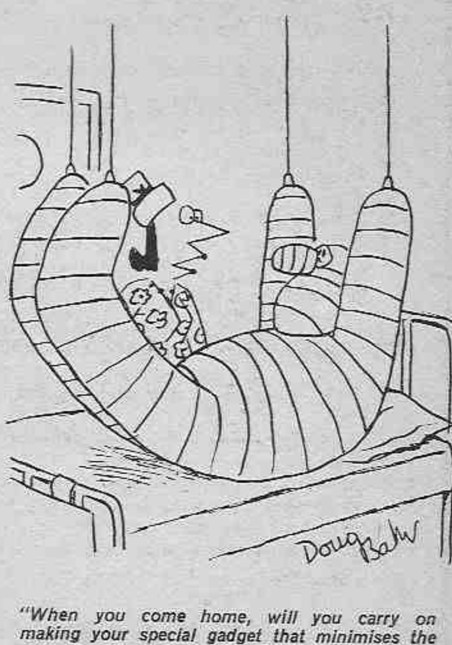
The surge current for inductive and capacitive circuits will depend on the inductance or capacitance present, but it is interesting to note that, with car bulbs at any rate, the filament resistance when cold is approximately one eleventh the hot or working temperature, and so for a finite time the current is eleven times that calculated. Fortunately, that time is measurable in milliseconds, and one does not have to use fuses uprated by a factor of eleven! A factor of three or four times is adequate for domestic lighting.

Anti-surge Fuses

With inductive or capacitive loads, the only method of fusing that is likely to be effective all round is that of using anti-surge fuses which will withstand an increased load for a finite time, typically ten times rated current for a period of 10 milliseconds to 20 milliseconds. Such fuses will withstand the initial surge of current, but will still blow, usually with time to spare—but not always—so be careful if the current exceeds the nominal value for an appreciable period of time.

Fusing equipment is *essential*, and the above maligned 13-amp plug, which let me repeat is fundamentally sound in concept, may very well prove to be better than nothing at all. But the margin of safety is so much greater when just a little time is taken to work out a few simple maths, and then use the fuses most appropriate to the application.

Until the authorities see fit to ban the sale of plugs complete with 13-amp fuse and also offer concrete and simple advice on choosing the most appropriate fuse, it is up to the intending user to help himself. Its very simple and well worth while.



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SEPTEMBER 1977 TO DECEMBER 1978

(Sixteen issues following introduction of larger format)

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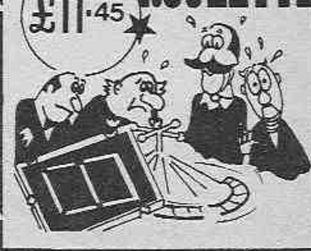

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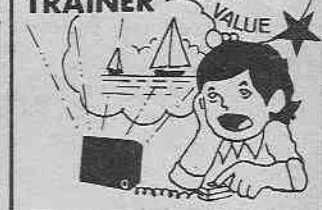

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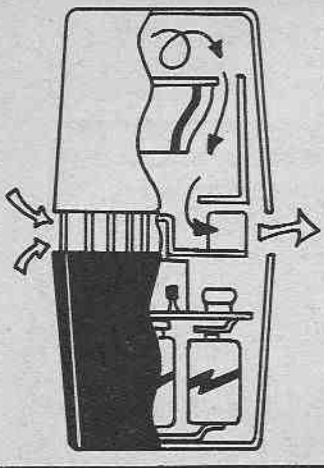

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	Chaser Light Display	E007	1·75	8·19	6·79	3·15	19·88
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Mar. 78	Audio Test (2 p.c.b's)	E009	1·74*	7·06	5·98	—	14·78
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	Catch-a-Light	E011	82*	2·65	2·70	2·15	8·42
	Weird Sound	E012	62*	2·71	1·17	79	5·29
Apr. 78	Roof Rack Alarm	E013	60*	1·52	1·71	—	3·83
	Mains Delay Switch	E014	94*	1·71	7·68	2·15	12·48
	Packet Timer	E015	60*	1·45	96	45	3·46
May 78	Flash Meter	E016	75*	3·15	6·40	79	11·09
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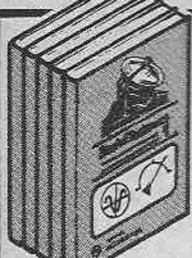

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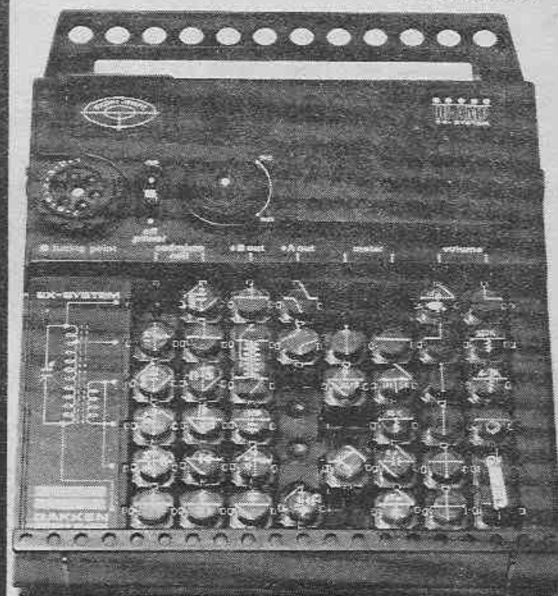

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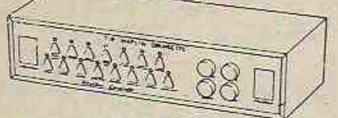

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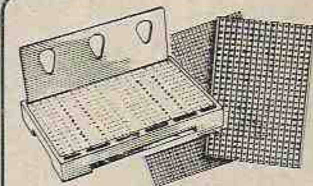

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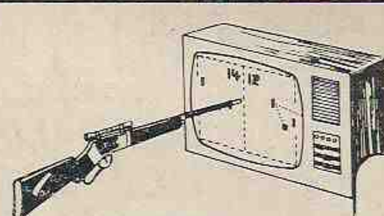

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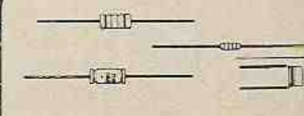

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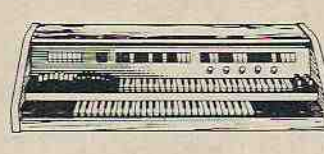

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