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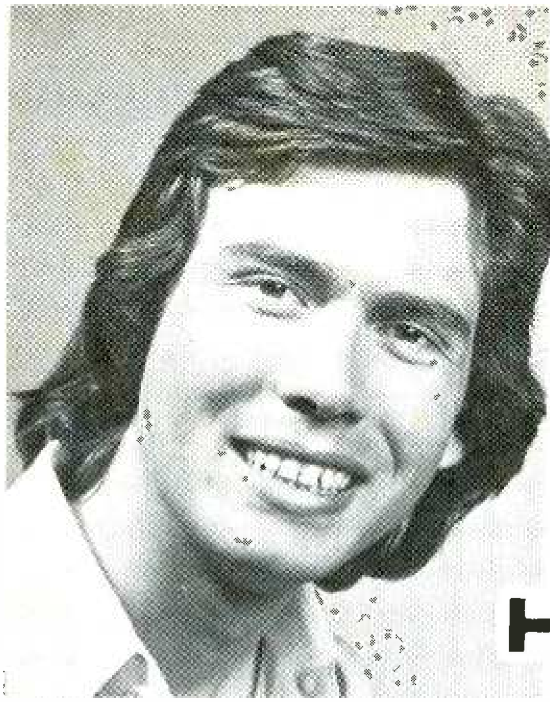

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PRACTICAL WIRELESS

VOL. 50 NO. 5
ISSUE 811
SEPTEMBER 1974

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

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6·8μF	63V	6½p	150μF	63V	15p
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10μF	25V	6½p	220μF	16V	8p
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33μF	40V	6½p	1000μF	25V	25p
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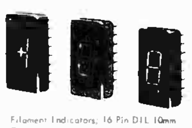

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hfe 2500; Ic 250 MA
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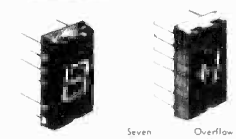

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Character Height 0.3"

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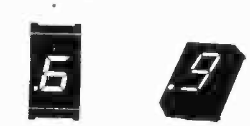

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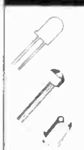

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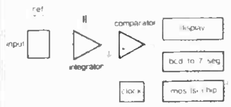

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NAS0652X	200V	·56
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NAS1001X	100V	·60
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NAS1002X	200V	·74
NAS1004W	400V	1·09
NAS1004X	400V	1·04
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3AMP "CLIPPED TAB"

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NAS0301X	100V	·28
NAS0302W	200V	·36
NAS0302X	200V	·34
NAS0304W	400V	·52
NAS0304X	400V	·50
NAS0306W	600V	·70
NAS0306X	600V	·66

8·5AMP ISOLATED TAB

NAS0851W	100V	·52
NAS0851X	100V	·50
NAS0852W	200V	·67
NAS0852X	200V	·64
NAS0854W	400V	·97
NAS0854X	400V	·92
NAS0856W	600V	1·20
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16AMP ISOLATED METAL

NAS1601W	100V	·90
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NAS1602W	200V	·95
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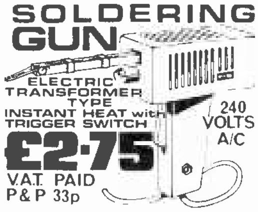

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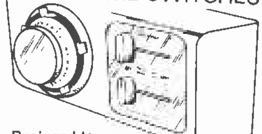

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BC148	11p
BC149	12p
BC157	13p
BC158	12p
BC159	13p
BC147/157	25p
BC148/158	23p
BC149/159	25p
BC167	11p
BC168	10p
BC169	11p
BC169C	12p
BC177	20p
BC178	16p
BC179	20p
BC182	14p
BC182L	14p
BC183	13p
BC183L	14p
BC184	17p
BC184L	16p
BC212	16p
BC212L	16p
BC238	10p
BC238/308	20p
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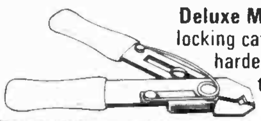

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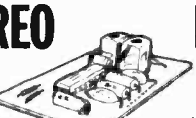

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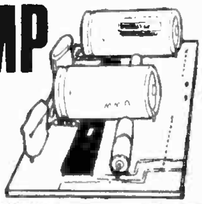

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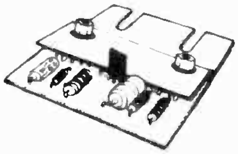

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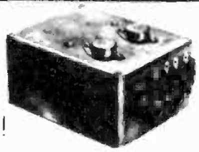

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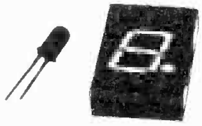

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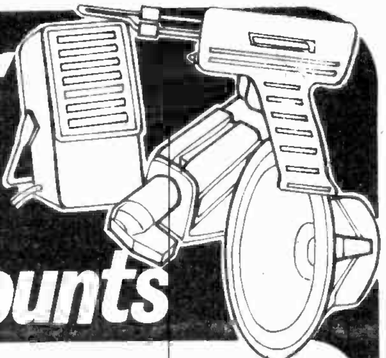

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AC128	0·20	AF118	0·39	BC159	0·13	BD139	0·61	BF195	0·13	OC20	0·70	2G371B	0·13	2N2221	0·22	2N3403	0·23	2N4288	0·19
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ACY17	0·28	BC109	0·15	BC214L	0·18	BF121	0·50	BSY27	0·17	OC171	0·28	2N727	0·31	2N3054	0·51	2N4058	0·13	40362	0·50
ACY18	0·22	BC113	0·11	BC225	0·28	BF123	0·55	BSY28	0·17	OC200	0·28	2N743	0·22						
ACY19	0·22	BC114	0·17	BC226	0·39	BF125	0·50	BSY29	0·17	OC201	0·31	2N744	0·22						
ACY20	0·22	BC115	0·17	BC301	0·30	BF127	0·55	BSY38	0·20	OC202	0·31	2N914	0·16						
ACY21	0·22	BC116	0·17	BC302	0·27	BF152	0·61	BSY39	0·20	OC203	0·28	2N918	0·33						
ACY22	0·18	BC117	0·20	BC303	0·35	BF153	0·50	BSY40	0·31	OC204	0·28	2N929	0·23						
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ACY35	0·23	BC134	0·20	BCY33	0·24	BF160	0·44	C407	0·28	P20	0·55	2N1305	0·19						
ACY36	0·31	BC135	0·13	BCY34	0·28	BF162	0·44	C424	0·28	P346A	0·22	2N1306	0·23						
ACY40	0·19	BC136	0·17	BCY70	0·16	BF163	0·44	C425	0·55	P397	0·46	2N1307	0·23						
ACY41	0·20	BC137	0·17	BCY71	0·22	BF164	0·44	C426	0·39	ST140	0·14	2N1308	0·26						
ACY44	0·39	BC139	0·44	BCY72	0·16	BF165	0·44	C428	0·22	ST141	0·19	8N1309	0·26						
AD130	0·42	BC140	0·33	BCZ10	0·22	BF167	0·24	C441	0·33	T1S43	0·34	2N1613	0·22						
AD140	0·53	BC141	0·33	BCZ11	0·28	BF173	0·24	C442	0·33	UT46	0·30	2N1711	0·22						
AD142	0·53	BC142	0·33	BCZ12	0·28	BF176	0·39	C444	0·39	ZN414	£1·20	2N1889	0·35						
AD143	0·42	BC143	0·33	BD115	0·68	BF177	0·39	C450	0·24	2G301	0·21	2N1890	0·50						
AD149	0·55	BC145	0·50	BD116	0·88	BF178	0·33	MAT100	0·21	2G302	0·21	2N1893	0·41						
AD161	0·39	BC147	0·11	BD121	0·66	BF179	0·33	MAT101	0·22	2G303	0·21	2N2147	0·79						
		BC148	0·11	BD123	0·72	BF180	0·33	MAT120	0·21	2G304	0·27	2N2148	0·63						

DIODES AND RECTIFIERS

Type	Price	Type	Price	Type	Price
AA119	0·09	BY128	0·17	OA10	0·15
AA120	0·09	BY130	0·18	OA47	0·08
AA129	0·09	BY133	0·23	OA70	0·08
AAY30	0·10	BY164	0·55	OA79	0·08
AAZ13	0·11	BYX38/300	·46	OA81	0·08
BA100	0·11	BYZ10	0·39	OA85	0·10
BA116	0·23	BYZ11	0·33	OA90	0·07
BA126	0·24	BYZ12	0·33	OA91	0·07
BA148	0·16	BYZ13	0·28	OA95	0·08
BA154	0·13	BYZ16	0·44	OA200	0·07
BA155	0·16	BYZ17	0·39	OA202	0·08
BA156	0·15	BYZ18	0·39	SD10	0·06
BA173	0·16	BYZ19	0·31	SD19	0·06
BY100	0·17	CG62		1N34	0·08
BY101	0·13	(OA91 Eq)	0·06	1N34A	0·08
BY105	0·19	CG651—		1N914	0·06
BY114	0·13	(OA70-79)	0·07	1N916	0·06
BY124	0·13	OA5	0·39	1N4148	0·06
BY126	0·16	OA5 short		IS021	0·11
BY127	0·17	leads	0·23	IS951	0·07

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72709P	33p	31p	29p
72710	45p	43p	40p
72741	40p	38p	35p
72741C	45p	43p	40p
72741P	38p	36p	34p
72748P	38p	36p	34p
SL201C	59p	45p	40p
SL701C	50p	45p	40p
SL702C	50p	45p	40p
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TAA293	£1·00	95p	90p
TAA350A	£1·85	£1·80	£1·70
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BP933	16p	15p	14p
BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
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7401	0·18	0·17	0·16	7450	0·18	0·17	0·16	74123	1·58	1·54	1·50
7402	0·18	0·17	0·16	7451	0·18	0·17	0·16	74141	0·85	0·82	0·79
7403	0·18	0·17	0·16	7453	0·18	0·17	0·16	74145	1·58	1·54	1·50
7404	0·18	0·17	0·16	7454	0·18	0·17	0·16	74150	2·50	2·40	2·30
7405	0·18	0·17	0·16	7460	0·18	0·17	0·16	74151	1·10	1·05	1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	1·20	1·10	1·00
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	1·98	1·90	1·75
7408	0·25	0·24	0·23	7473	0·41	0·39	0·35	74155	1·20	1·15	1·10
7409	0·25	0·24	0·23	7474	0·41	0·39	0·35	74156	1·20	1·15	1·10
7410	0·18	0·17	0·16	7475	0·60	0·58	0·56	74157	1·20	1·15	1·10
7411	0·28	0·27	0·26	7476	0·44	0·43	0·42	74160	1·73	1·70	1·65
7412	0·30	0·29	0·28	7480	0·74	0·71	0·64	74161	1·73	1·70	1·65
7413	0·32	0·31	9·30	7481	1·30	1·25	1·20	74162	1·73	1·70	1·65
7416	0·40	0·39	0·38	7482	0·90	0·85	0·80	74163	1·73	1·70	1·65
7417	0·40	0·39	0·38	7483	1·20	1·15	1·05	74164	2·20	2·10	2·00
7420	0·18	0·17	0·16	7184	1·10	1·05	1·00	74165	2·20	2·10	2·00
7422	0·30	0·29	0·28	7485	2·00	1·90	1·80	74166	2·35	2·30	2·25
7423	0·40	0·39	0·38	7486	0·35	0·34	0·33	74174	2·00	1·95	1·90
7425	0·40	0·39	0·38	7489	4·00	3·75	3·50	74175	1·40	1·35	1·30
7426	0·40	0·38	0·36	7490	0·74	0·71	0·64	74176	1·60	1·55	1·50
7427	0·40	0·38	0·36	7491	1·10	1·05	1·00	74177	1·60	1·55	1·50
7428	0·45	0·42	0·40	7492	0·74	0·71	0·64	74180	1·60	1·55	1·50
7430	0·18	0·17	0·16	7493	0·74	0·71	0·64	74181	5·00	4·50	4·00
7432	0·40	0·38	0·36	7494	0·85	0·82	0·75	74182	1·50	1·45	1·40
7433	0·42	0·40	0·38	7495	0·85	0·82	0·75	74184	2·40	2·30	2·20
7437	0·45	0·42	0·40	7496	0·96	0·93	0·86	74190	2·15	2·10	2·00
7438	0·45	0·42	0·40	74100	1·50	1·45	1·40	74191	2·15	2·10	2·00
7440	0·18	0·17	0·16	74104	0·70	0·68	0·66	74192	2·15	2·10	2·00
7441	0·74	0·71	0·64	74105	0·70	0·68	0·66	74193	2·15	2·10	2·00
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	1·90	1·80	1·70
7443	1·20	1·15	1·10	74110	0·60	0·55	0·50	74195	1·60	1·50	1·40
7444	1·20	1·15	1·10	74111	0·95	0·92	0·90	74196	1·73	1·70	1·65
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200	0·06	0·10	1N4003	0·07	0·12	0·22	0·25	1·00
400	0·08	0·15	1N4004	0·08	0·15	0·30	0·38	1·35
600	0·09	0·17	1N4005	0·10	0·18	0·36	0·45	1·90
800	0·12	0·19	1N4006	0·11	0·20	0·38	0·55	2·10
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100	0·28	0·37	0·52	0·52	0·55	0·64	0·70	1·54
200	0·39	0·41	0·54	0·54	0·63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
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UIC05	12 × 7405	0·55	UIC54	12 × 7454	0·55	UIC95	5 × 7495	0·55
UIC06	8 × 7406	0·55	UIC60	12 × 7460	0·55	UIC96	5 × 7496	0·55
UIC07	8 × 7407	0·55	UIC70	8 × 7470	0·55	UIC100	5 × 74100	0·55
UIC10	12 × 7410	0·55	UIC72	8 × 7472	0·55	UIC121	5 × 74121	0·55
UIC20	12 × 7420	0·55	UIC73	8 × 7473	0·55	UIC141	5 × 74141	0·55
UIC30	12 × 7430	0·55	UIC74	8 × 7474	0·55	UIC151	5 × 74151	0·55
UIC40	12 × 7440	0·55	UIC76	8 × 7476	0·55	UIC154	5 × 74154	0·55
UIC41	5 × 7441	0·55	UIC80	5 × 7480	0·55	UIC193	5 × 74193	0·55
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PNP: BC177 **25p**, BC178 **23p**, BC179 **24p**, BC257 **14p**, BC258 **13p**, BC259 **14p**.
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DIODES

OA90, OA91, OA95, **6p** each; OA202, **11p**. Other semiconductors: AC128, **17p**; AF117 **34p**; BFY51 **23p**. Full lists and technical data will be found in EV Catalogue 7.

RESISTORS

Code	*Watts*	*Ohms*	*1 to 9*	*10 to 99*	*100 up*	
			(see note below)			
C	1/3	4·7–470K	1·3	1·1	0·9	nett
C	1/2	4·7–10M	1·3	1·1	0·9	nett
C	3/4	4·7–10M	1·5	1·2	0·97	nett
C	1	4·7–10M	3·2	2·5	1·92	nett
MO	1/2	10–1M	4	3·3	2·3	nett
WW	1	0·22–3·9	11	10	8	nett
WW	3	1–10K	9	8	6	nett
WW	7	1–10K	11	10	6	nett

Codes:
C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

Values: All E12 except C ⅓W, C ¾W, and MO ½W.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36 43, 51, 62, 75, 91 and their decades.

Tolerances:
5% except WW 10% ±0·05Ω under 10Ω and MO ½W 2%.

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This is EV Service

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JP.20 DUAL GANG log. 4·7Kohms to 2·2megohms, ea. **48p**
JP.20 DUAL GANG Log/antilog 10K, 22K, 47K, 1 megohm only ea. **48p**
JP.20 DUAL GANG antilog 10K only **48p**
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1000mF/25V **28p** 2200/100 **£1·56** 2000/50 **57p**
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5000/25V **62p**

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0·01, 0·015, 0·022, 0·033, 0·047 ea. **3p**
0·068, 0·1, 0·15 ea. **4p**
0·22, **5p**; 0·33 **7p**; 0·47 **8p**; 0·68 **11p**; 1·0 **14p**; 1·5 **21p**; 2·2 **24p**

SILVERED MICA. *Working voltage 500V d.c.*
Values in pFs—2·2 to 820 in 32 stages ea. **6p**
1000, 1500 **7p**; 1800 **8p**; 2200 **10p**; 2700, 3600 **12p**; 4700, 5000 **15p**; 6800 **20p**; 8200, 10,000 **25p**

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0 mF/35V ea. **14p**
2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V ea. **14p**
4·7/35V, 10/16V, 22/6·3V ea. **18p**
10/25V, 22/16V, 27/6·3V, 100/3V, 6·8/25V, 15/25V ea. **20p**

POLYCARBONATE
Type B42540 Working Voltage—250V
Values in mF:
0·0047; 0·0068; 0·0082; 0·01; 0·012; 0·015 ea. **3p**
0·018; 0·022; 0·027; 0·033; 0·039; 0·047; 0·056
0·068; 0·082; 0·1 ea. **4p**

CERAMIC PLATE
Working voltage 50V. d.c.
In 26 values from 22pf to 6800pF, each, **2p**

EV CATALOGUE 7
2nd printing – Green and yellow cover
112 pages, thousands of items; illustrations; diagrams; much useful technical information. The 2nd printing has been updated as much as possible on prices. It costs only 25p post free including refund voucher for 25p for spending when ordering goods list value £5 or more.

JACKS AND PLUGS

Sockets

2-circuit unswitched S1/SS	12p
2-circuit /2 break contacts S1/BB	15p
3-circuit unswitched (Not GPO) S3SSS	17p
3-circuit with 3 break contacts S3/BBB 20	20p
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with 2 break contacts S5/BB	20p
Miniature 3.5mm 2-circuit, (black) 2 br. cont S6/BB	9p

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side entry SEP1	36p
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3 circuit unscreened, bl/grey/wh. P4	46p
2 circuit, unscreened, bl/whi/red/bl/grn/gry P2	18p
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side entry SEP3	55p
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In moulded polypropylene, with nickel plate on brass. With insulating set, washers, tag & nuts. 15A/250V in blk/brwn/red/yel/grn/bl/gry/wh.
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Type TP2, 2mm each **4p**

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Full range E24 values: 400mW: 2·7V to 33V, **14p** each; 1W: 6·8V to 82V, **21p** each; 1·5W: 4·7V to 75V, **67p** each. 20W: 7·5V to 75V, **94p** each. Clip to increase 1·5W rating to 3 watts (type 266F), **5p**.

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As designed by P. J. Baxandall and described originally in "Wireless World." Simple to assemble, fantastically good results and a greater money saver. Carries 10 watts RMS, 15 ohms impedance. Size 18in x 12in x 10in. Complete kit, including pack-flat cabinet, **£14·90**.
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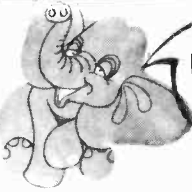

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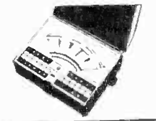

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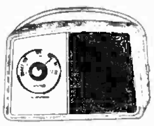
BUILD THIS RADIO
Portable MW/LW radio kit using Mullard RF/IF module. Features MW—bandspread for extra selectivity. Slow motion tunning. Fibre glass PVC cabinet. 600MW output. All parts £7·98 (battery 22p), carr. etc. 32p.



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HANIMAX H101 STEREO COMPACT RECORD PLAYER 2 x 7 watts. Complete with Speakers (List £54·50) Price £39·95. Plus free pair of stereo phones.

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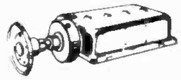
Brand new transistorised geared tuners for 625 Line Receiver IF output. £2·50. Post 20p.



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New purchase of 4 button transistorised UHF tuners. £3·50 + post 20p.

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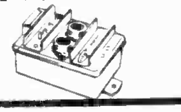

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MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2¼" x 3¼". All parts £5·25, carr. 15p.

Mullard FM Modules
LP1186 Tuning Heart Module.
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Complete module kit 9v 100mA output £1·95, p & p 25p.

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Suitable alternative to SL403D.
5/30 volt operated. 8/16 ohm
5 watt output.
With circuits and data £1·50.
Kit with printed circuit panel £2·70. All kits available from stock.

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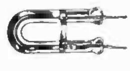

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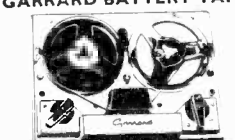

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608, 10 watt 24 volt	£4·95
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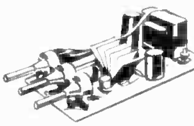

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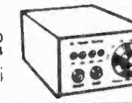

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BSR LATEST SUPERSLIM

STEREO AND MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13¼ × 11¼in. Above motor board 3¼in. Below motor board 2½in. With STEREO and MONO XTAL **£6·75** Post 45p.

PORTABLE PLAYER CABINET

Modern design. Black rexine covered Silver front grille. Chrome fittings. Motor board cut for BSR deck. **£4·50** Post 45p.

COMPACT PORTABLE STEREO HI-FI

Two full size loudspeakers 13½ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13½ × 10 × 8½in. 3 watts per channel, plays all records 33 rpm, 45 rpm. Separate volume & tone controls. 240v AC mains.

Attractive Teak finish Weight 13lbs. Bargain Price **£25** 85p carriage

SPECIAL OFFER

SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0-60 MINUTES

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burgular lights, etc. Variable knob. Turn on or off at full or intermediate settings. Makers last list price £4·50. Brand new and fully guaranteed. Fully insulated. OUR PRICE £1·95 Post 25p

WEYRAD P50—TRANSISTOR COILS

RA2W Ferrite Aerial .. 85p	Printed Circuit, PCA1 .. 65p
I.F. P50/2CC 470 kc/s .. 40p	J.B. Tuning Gang 65p
3rd I.F. P50/3CC 40p	Weyrad Booklet 10p
Spare Cores 3p	OPT1 .... 65p
Driver Trans. LFDT4 .. 65p	

Ferrite Rod 8 × ⅜in. 20p 6 × ⁵⁄₁₆in. 20p 3 × ⅜in. 10p

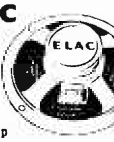
VOLUME CONTROLS

5 K. ohms to 2 Meg. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.P. 75p. Edge 5K.S.P. Transistor 25p

80 Ohm Coax 5p. yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1·75; 60 yd. £2·60. FRINGE LOW LOSS Ideal 625 & colour **10p** yd.

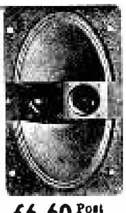
8in & 10 x 6in ELAC HI-FI SPEAKER



Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 c/s. Bass resonance 55 c/s. 8 ohm 10 watt. **£3·75** Each Post 52p

10 inch 12 watt £4·50

E.M.I. 13½ × 8in. SPEAKER SALE!



With twin tweeters and crossover, 10 watt. State 3 or 8 or 15 ohm. (As illustrated) **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 25p **£2·75**

BOOKSHELF CABINET Size 16 × 10 × 9in. teak finish **£6·60** Post 25p

E.M.I. 13 × 8 in. BASS WOOFER. 20 WATTS 15Ω RUBBER CONE SURROUND. £5·50 Post 25p.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 × 4in. 45p; 8 × 6in. 53p; 10 × 7in. 65p; 12 × 8in. 85p; 14 × 9in. 90p; 16 × 6in. 90p; 12 × 3in. 50p; 16 × 10in. £1. ALUMINIUM BOXES 3 × 3 × 3in. 60p; 4 × 4 × 4in. 70; 6 × 4 × 4in. 80p; 9 × 4 × 4in. £1; 12 × 4 × 4in. £1·30. ALUMINIUM PANELS 18 s.w.g. 6 × 4in. 12p; 8 × 5in. 19p; 14 × 3in. 20p; 10 × 7in. 24p; 12 × 5in. 25p; 12 × 8in. 34p; 16 × 6in. 34p; 14 × 9in. 40p; 12 × 12in. 47p; 16 × 10in. 60p PAXOLIN PANEL 10 × 8in. 20p.

SPECIAL OFFER

100 ohm 20W Rheostat 2½in. diam. Ceramic Former, screw terminals, ¼in. diam. spindle. 95p, post 25p.

ANOTHER RCS BARGAIN!

ELAC 9 × 5in. HI-FI SPEAKER. TYPE 59RM. THIS FAMOUS AND WIDELY USED UNIT NOW AVAILABLE AT BARGAIN PRICE 10 WATT, 8 OHM. CERAMIC MAGNET. **£3.30**

R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer. Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1½ × 1½in. **£2·20** Post 20p

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. d.c. operation. Size 1¾" × 1¼" × ¾". Response 25 c/s. to 25 Kc/s. 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 20p

TEAKWOOD LOUDSPEAKER GRILLS. Will easily fit to baffle board. Size 18¼ × 10¼in—75p. 10¼ × 7¼in—45p.

E.M.I. WOOFER AND TWEETER KIT

Woofer 10½ × 6½in. Ceramic Magnet, 44oz. 13,000 lines, Tweeter 3½in. square, 10,000 lines. Crossover condenser full instructions supplied. Impedance 8 ohms. Power 12 watts. **£6·75** Post 45p.

BRITISH FM/VHF TUNING HEART

88 to 108 M/CS British made. 2 Transistors ready aligned requires 10·7 M/CS I.F. Complete with tuning gang. Connections supplied but some technical experience essential. **Our price £3·95** Post 20p

MAINS TRANSFORMERS

All post 25p each

Eagle MT12 12-0-12V 50mA 99p
250-0-250 80 mA. 6·3V 3·5A 6·3V 1A or 5V 2A ...... £2·50
350-0-350 80 mA 6·3V 3·5A, 6·3V 1A or 5V 2A .... £3·00
300-0-300V 120mA, 6·3V 4A C.T.; 6·3V 2A .... £3·25
MINIATURE 200V 20mA, 6·3V 1A £1
MIDGET 220V 45mA, 6·3V 2A £1.10
HEATER TRANS. 6·3V 1½ amp £1.20
GENERAL PURPOSE LOW VOLTAGE. Trapped outputs at 2 amp, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £3·00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £3·00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6·00
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
5, 8 and 13V 5 amp £1·20. 8 amp, 3, 5, 8, 10, 13 and 5-0-5V £1·30, Ditto 5 amp. £1·50; 6-0-6V 500mA 90p 9V 1 amp 95p 12V 300mA 75p 12V 500mA 85p 12V 750mA 95p. 22V, 0·22V 2 amp £2.
AUTO TRANSFORMERS, 115V to 230V or 230V to 115V 150W £2·95; 500W £7·50; 750W £10; 1000W £15
CHARGER TRANSFORMERS. Input 200/250V. for 6 or 12V, 1½ amp £1·50; 2 amp £1·80; 4 amp £3·50
BATTERY CHARGERS. Ready built with leads and clips 1½ amp £2; 4 amp £4; 5 amp £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS; 6 or 12V outputs. 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER

Primary 0-110-240V. Secondary 0-240V. 3A. 720W. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. OUR PRICE **£10** Carr. 95p Famous make. (Value £19) Can be used as 800W auto transformers 240-110V. IDEAL FOR COLOUR T.V. OR GARDEN TOOLS.

NEW ELECTROLYTIC CONDENSERS

2/350V .. 14p	100/25V .. 10p	32+32/350V .. 40p
4/350V .. 14p	250/25V .. 14p	50+50/300V .. 50p
8/450V .. 18p	500/25V .. 20p	60+100/350V .. 85p
16/450V 22p	1000/25V .. 35p	32+32/250V .. 20p
32/450V 35p	1000/50V .. 47p	32+32/450V .. 60p
32/500V 50p	8+8/450V .. 22p	32+32+32/350V 65p
25/25V .. 10p	8+16/450V 25p	32+32+32/450V 85p
50/50V .. 10p	16+16/450V 40p	

LOW VOLTAGE ELECTROLYTICS
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF. 15V. 10p. 500mF. 12V. 15p; 25V. 20p; 50V. 30p. 1000mF. 12V. 20p; 25V. 35p; 50V. 47p; 100V. 70p. 2000mF. 6V. 25p; 25V. 42p; 50V. 57p. 2500mF. 50V. 62p; 3000mF. 25V. 47p; 50V. 65p. 5000mF. 6V. 25p; 12V. 42p; 25V. 75p; 35V. 85p; 50V. 95p.

CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p. PAPER 350V-0·1 4p, 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p. TWIN GANG. "0-0" 208pF+176pF, 75p; 500pF standard 75p; 365+365 with 25+25pF Slow motion drive 50p. SHORT WAVE, SINGLE. 10pF 30p; 25pF 55p; 50pF 55p. NEON PANEL INDICATORS, 250V AC/DC Amber 25p. RESISTORS. ⅛W, ¼W, 1W, 20% 1p; 2W, 5p. 10 Ω to 10M. HIGH STABILITY. ½ w. 2% 10 ohms to 6 meg., 10p. Ditto 5% Preferred values 10 ohms to 10 meg., 4p. WIRE-WOUND RESISTORS. 5 watt, 10 watt, 15 watt 10 ohms to 100K 10p each. TAPE OSCILLATOR COIL. Valve Type 35p.

NEW MODEL "BAKER LOUDSPEAKER" 12in. 50 watt GROUP 50/12 8 or 15 ohm high power full range. Professional quality. **£16**

BAKER MAJOR 12" £9·90

Post free 30-14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s Rated 20 watts. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£12·50** Post free Please state 3 or 8 or 15 ohms.

BAKER "BIG-SOUND" SPEAKERS Post free

'Group 25'	'Group 35'	'Group 50'
12 inch 25 watt **£8·80** 3 or 8 or 15 ohm	12 inch 35 watt **£9·90** 3 or 8 or 15 ohm	15 inch 50 watt **£20** 8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER CABINETS
For 12in. or 10in. dia. speaker 20 × 13 × 9" £10·50 Post 25p
For 13 × 8in. or 8in. speaker 16 × 10 × 9" £6·60 Post 25p
For 8 × 5in. speaker 16 × 8 × 6" £4·95 Post 25p
For 6in. and tweeter 12 × 8 × 6" £4·00 Post 25p
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft

EMI 6½in. HI-FI WOOFER

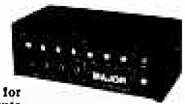
8 ohm, 10 watt. Large ceramic magnet. Special Rubber cone surround. Frequency response 30-12,000 c/s. Ideal P.A. Columns, Hi-Fi Enclosure Systems, etc. **£4** Suitable cabinet 12 × 8 × 6 £4·00. Suitable Tweeter £2·00.

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3½ × 3½ × 2in. deep. Rating 10 watt, 3 ohm Suitable Crossover £1·30 **£1·90** Post 20p

SPEAKER COVERING MATERIALS. Samples Large S.A.E. Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £1·95. CROSSOVERS TWO-WAY 3000cps 3 or 8 or 15 ohm £1·30 LOUDSPEAKERS 3 OHMS. 7 × 4in. £1·25; 6½in. £1·50. 8 × 5in. £1·60 8in. £1·75; 10 × 6in. £1·90; 10in. £2·00. SPECIAL OFFER: 80 ohm, 2½in.; 2½in. 35 ohm. 2in., 3in., 25 ohm. 2½in. dia., 5in. dia. 6" × 4" 15 ohm, 3½in. dia.; 6 × 4in.; 7 × 4in.; 8 × 5in. 3 ohm, 2½in.; 2½in.; 3½in.; 5in. dia. (6 × 4in. 8 ohm £1·50) **£1** EACH TYPE RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8 in. diameter 4 watt £2·50. 10in. diameter 5 watt £2·50; 12 in. diameter. 6 watt £2·95. VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p. Mike trans. mu metal 100:1 £1·25.

MAJOR 100 WATT ALL PURPOSE GROUP OR DISCO AMPLIFIER



All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. **£49** Carr. £1·00
SUPER VALVE MODEL 100 WATT CALLERS ONLY £69.

3-WAY CROSSOVER 950 CPS and 3000 CPS with leads **£1·95**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt. **£4·50**
TWO CHANNEL STEREO VERSION **£5·95**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume, treble and bass controls 18v. DC operation. **£4·50**

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p COAXIAL OUTLET BOXES, surface, 35p. BALANCED TWIN FEEDER 300 ohms 7p yard. JACK SOCKET Std. open-circuit 15p, closed-circuit 23p. Chrome Lead Socket 45p. Phono Plugs 8p. Phono Socket 8p. JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 25p. DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS. 5p; CERAMIC 10p; CANS 5p.

REVERSIBLE 4 POLE MOTOR £2·25

1,400 r.p.m. Reversible 42 Watt. Post 25p spindle 1¼" × ⁷⁄₃₂", size 3½" × 3". As illustrated. With Cooling Fan 240V A.C.

E.M.I. GRAM MOTOR **£1·00**
120v. or 240v. A.C. 2,400 rpm. 2-pole 70mA. Size 2¼ × 2¼ × 2¼ in. Post 25p.

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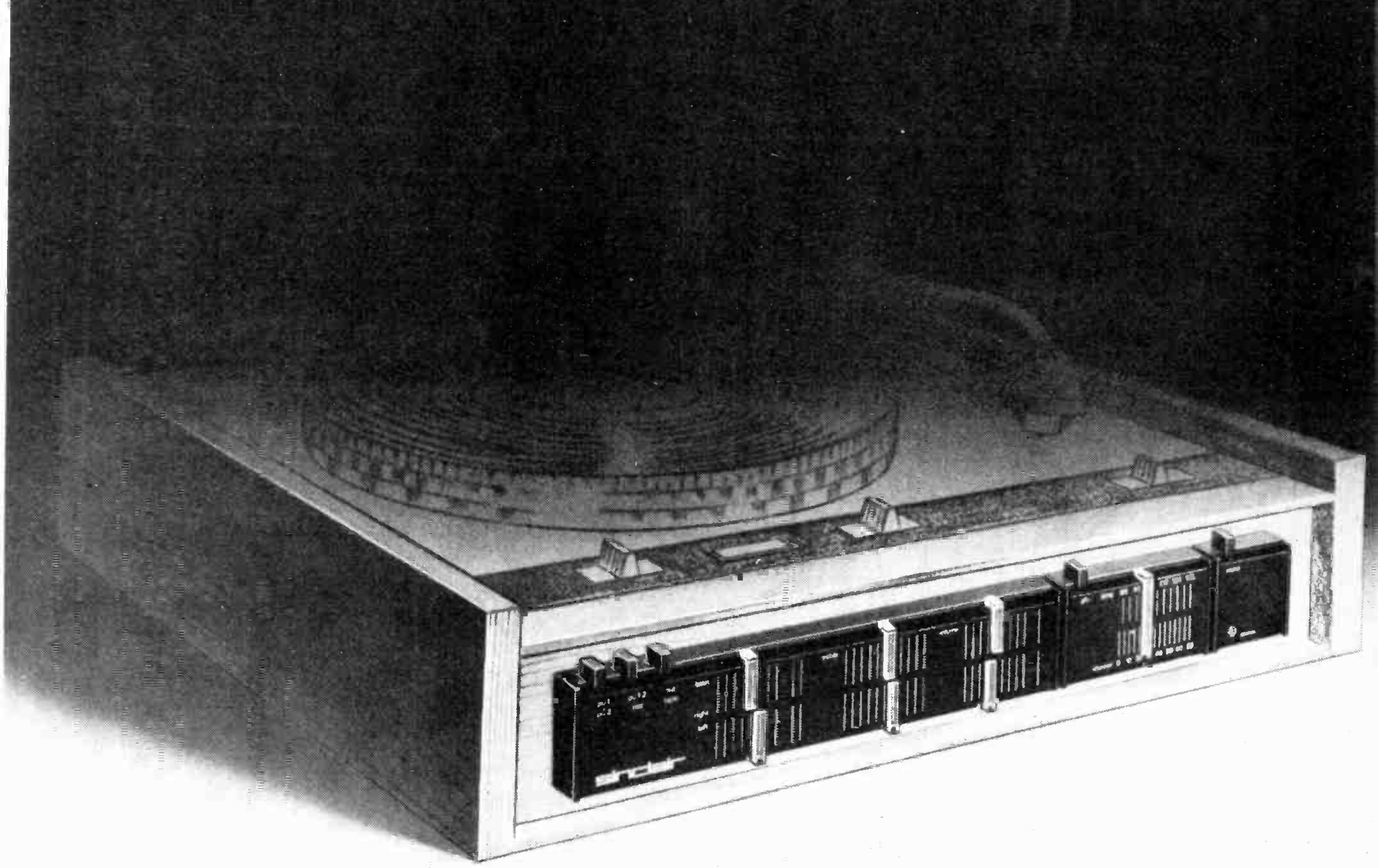
Minimum post 20p. Illustrated Brochure, Radio Books & Components Lists 10p.

Project 80

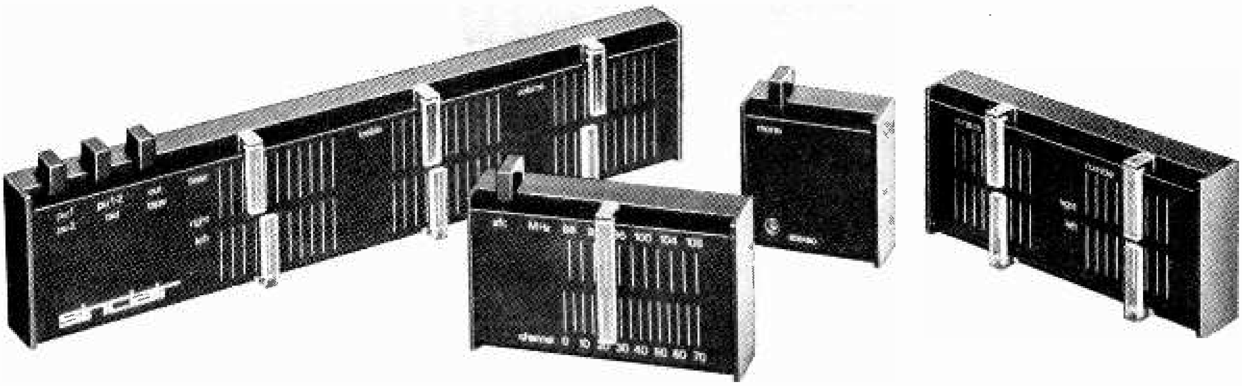
a brilliant new concept in modular hi-fi



Project 80 is going to be the ultimate in modular hi-fi construction for a very long time to come. It combines the qualities most demanded of any modern domestic system – good circuitry, reliability and fine performance – with other features to be found nowhere else in the world. For example, *compactness* – Project 80 control units are $\frac{3}{4}$" deep × 2" high, and each one is completely self-contained. *Elegance* – all of Sinclair's design leadership has been concentrated on producing designs of outstanding functional elegance unsurpassed for styling and simplicity. *Flexibility* – the size and styling of Project 80 modules makes them the most versatile units ever. Combine them how you will, where you will, the Project 80 System of your choice gives you the best.

sinclair

Sinclair Project 80



technically the world's most advanced

Project 80 gives you choice from a range of 9 different modules for combining in a variety of ways to suit your requirements. The Stereo 80 is a versatile pre-amp control unit designed to meet all domestic hi-fi requirements including tape monitoring, high sensitivity magnetic cartridge input, and of course, individual slide controls on each channel for precise output matching. By separating the F M. tuner and stereo decoder, useful economies can be effected where stereo radio reception is not needed. Two power amplifiers – Z.40 (18 watts RMS continuous into 4 ohms using 35V) and Z.60 (25 watts RMS continuous into 8 ohms using 50V) are available with choice of 3 different power supply units. The PZ.8 with its virtually indestructible circuitry is particularly recommended. For the final word in system building, the Active Filter Unit puts the finishing touch of quality to what are easily the world's most technically advanced hi-fi modules Any further units likely to be added to Project 80 range will be compatible with those already available.

Stereo 80 Control Unit Size – 260 50 20mm (10¼ 2 ¾ins) Finish Black with white indicators and transparent sliders Inputs – Magnetic pick up 3mV RIAA corrected Ceramic pick up 350mV Radio 100mV. Tape 30mV Signal/noise ratio 60db Frequency range – 20Hz to 15KHz 1dB 10Hz to 25kHz 3dB Power requirements – 20 to 35 volts Outputs – 100mV AB monitoring for tape Controls Press button tape radio and P U Sliders on each channel for volume bass treble RRP (add £1 19 VAT) **£11.95**

Project 80 FM Tuner Size – 85 50 20mm (3½ 2 ¾ins) Tuning range Dual varicap 87 5 to 108MHz Detector – I C balanced coincidence One I C equal to 26 transistors Distortion – 0 2% at 1KHz for 30% modulation 4 pole ceramic filter in I F section Aerial impedance – 75 Ω or 240 300 Ω Sensitivity 5 microvolts for 30dB S/N ratio Output – 300mV for 30% modulation Power requirements – 25 to 35 volts (RRP add £1 19 VAT) **£11.95**

Project 80 Stereo Decoder Size – 47 50 20mm (1⅞ 2 ¾ins) One 19 transistor I.C Channel separation greater than 30dB Power requirements – 25V Output 150mV per channel RRP (add 74p VAT) **£7.45**

Active Filter Unit Separate controls on each channel Size – 108 50 20mm (4¼ 2 ¾ins) Voltage gain – minus 0 2dB Frequency response – 40Hz to 22KHz controls minimum Distortion – at 1KHz – 0 03% using 30V supply H F cut off (scratch) 22 KHz to 5 5KHz 12dB/oct slope L F cut off (rumble) 28dB at 20Hz 9dB/oct slope RRP (add 69p VAT) **£6.95**

Z.40 Power Amplifier Size – 55 80 20mm (2⅛ 3⅛ ¾ins) 9 transistors Input sensitivity – 100mV Output 18 watts RMS continuous into 4 Ω (35V) Frequency response – 30Hz 100KHz 3dB S/N ratio – 64dB Distortion – at 10 watts into 8 Ω less than 0 1% Power requirements – 12 to 35 volts built in protection against overload RRP (add 54p VAT) **£5.40**

Z.60 Power Amplifier Size – 55 98 15mm (2⅛ 3¾ ¾ins) 12 transistors Input sensitivity – 100 250mV Output 25 watts RMS continuous into 8 Ω (50V) Distortion – typically 0 03% Frequency response – 15Hz to more than 200KHz 3dB S/N ratio – better than 70dB Built in protection against transient overload and short circuiting Load impedance 4 Ω min safe on open circuit RRP (add 69p VAT) **£6.95**

Power Supply Units PZ 8 Stabilised Re entrant current limiting makes damage from overload or even direct shorting impossible Normal working voltage (adjustable) 50V RRP £7·98 79p VAT Without mains transformer PZ 6 35V stabilised RRP £7·98 79p VAT PZ 5 30V un stabilised RRP £4·98 49p VAT

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If within 3 months of purchasing any product direct from us, you are dissatisfied with it your money will be refunded on production of receipt of payment Many Sinclair appointed stockists also offer this guarantee Should any defect arise in normal use we will service it without charge

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PW 8

SCS FOR QUALITY COMPONENTS

MOTOROLA

		each
F.M. Multiplex Stereo Decoder	MC1310P	2·93
Four Channel SQ Decoder	MC1312P	2·24
O P Power Transistor	2N3055	0·65
O P Power Transistor	MJE3055	0·68

SIGNETICS

I/C Timer	NE555V	0·80
Dual I/C Timer	NE556A	1·40
High Phased Locked Loop	NE560B	4·20
High Phased Locked Loop with AM Demod	NE561B	4·20
High Phased Locked Loop with Open VCO	NE562B	4·20
Precision Phased Locked Loop	NE565A	2·90
Function Generator	NE566V	1·55
Tone Decoder	NE567V	2·90

G.I.M.

Eight Digit Calculator Chip	C500	11·00
Eight Digit Calculator Chip	C550	9·50
3½ Decade DVM Chip	AY-5-3510	6·40
Decade Counter, Latch, Driver	AY-5-4007D	8·35

ORGAN CIRCUITS

7 Stage Generator	AY-1-0212	5·55
7 Stage Divider	AY-1-5050	2·35
4 Stage Divider	AY-1-5051	1·20
5 Stage Divider	AY-1-6721/5	1·30
6 Stage Divider	AY-1-6721/6	1·45

STATIC SHIFT REGISTERS

Static Shift Register	SL-6-2064	2·90
Static Shift Register	SL6. 4032	4·00
Static Shift Register	SL5. 2128	3·45
Static Shift Register	SL7. 2128	3·80
Static Shift Register	SL7. 4056	3·45
Static Shift Register	SS6. 8211	3·30
Static Shift Register	SS6. 8212	2·15

FERRANTI

Radio Receiver	ZN414	1·20

ELECTRONIC CALCULATOR

Details of the Offer:
1—eight-digit calculator i.c. (General Instrument Microelectronics, Type C500), plus
8—seven-segment l.e.d. alpha-numeric displays (Monsanto, Type MAN3).
Data sheets are supplied.
Price for the "package" offer: £14·00 plus 10% V.A.T.

Data information supplied with each device.

Write for free catalogue of our large stocks of Ferranti, Motorola, G.I., Monsanto, Mullard, Signetics and R.C.A. components.
On total of order add 20p Postage and Packing plus 10% V.A.T. on total of order.

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SOLARTRON Precision Laboratory Oscilloscope type CD643. DC–15 MHz. 5" flat face-tube. £45 each. Carr. £1·50.

12" LONG PERSISTANCE CRT. Full spec. Price £7·50 to include V.A.T. and Carriage.

MAKE YOUR SINGLE BEAM SCOPE INTO A DOUBLE WITH OUR NEW LOW PRICED SOLID STATE SWITCH. 2 Hz to 8 MHz. Hook up a 9 volt battery and connect to your scope and have two traces for ONLY £5·50, P. & P. 25p. (Not cased, not calibrated.)

NEW WIDE RANGE WOBBULATOR. 5 MHz to 150 MHz up to 15 MHz sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for 10·7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6 3V A.C. and use within minutes of receiving. All this for ONLY £5·75, P. & P. 25p. (Not cased, not calibrated.)

20 Hz to 200 kHz WB.
SINE and SQUARE GENERATOR. Four ranges. Independent amplitude controls, thermistor stabilised. Ready to use, 9V supply required. £7·85 each, P. & P. 25p. (Not cased, not calibrated.)

GRATICULES. 12cm x 14cm high quality plastic 15p each, P. & P. 5p.
£1 worth of 'UFS'. Six Brand New capacitors all between 15V and 100V. Total capacitance not less than 7,000mfd. P & P 45p.

Large quantity of good quality components — **NO PASSING TRADE** — so we offer 3lbs of **ELECTRONIC GOODIES** for £1·50. Post paid.

ROTARY SWITCH PACK—6 brand new switches (1 ceramic; 2 off 4pole 2 way etc.). 50p P & P 20p.
COMPONENT PACK consisting of 5 pots, various, brand new: 250 resistors ½ and ¼ watt, many high stabs, etc. Fine value at 50p, P. & P. 27p.
P.C.B. PACKS S & D. Quantity 2 sq ft—no tiny pieces. 50p plus P. & P. 20p.
FIBRE GLASS as above £1 plus P. & P. 20p.
5 **CRYSTALS** 70 to 90kHz. Our choice. 25p, P. & P. 15p.
METERS by SIFAM type M42. 25-0-25 micro amp. Scaled 25-0-25 green; 250-0-250 red. Linear. As new £3·50 each. P. & P. 37p.
CAPACITOR PACK—50 Brand new components, only 50p, P. & P. 20p.
POTS—10 different values, Brand new. 50p, P. & P. 20p.
TRIMMER PACK. 2 Twin 50/200pF ceramic 2 Twin 10/60pF ceramic; 2 min. strip with 4 preset 5/20pF on each; 3 air spaced preset 30/100pF on ceramic base. ALL BRAND NEW. 25p the lot P. & P. 10p.
C.R.T. 5" type CV1385/ACR13. Brand new with spec sheet. 63p each. P. & P. 45p. Bases for above 20p each. P. & P. 15p.
LIGHT EMITTING DIODES (Red) from Hewlett-Packard. Brand New. 38p each. Holder 1p each. Information 5p.
PHOTOCELL equ. OCP71, 13p each.
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Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.
Technical specification:
(1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth.
(2) **Integrated circuit** output stage, pre-built three stage IF Module.

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See July issue for full specification

STEREO 21

QUALITY SOUND(*) FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit, – no soldering required. Includes:—
BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
For the technically minded:—
Specifications:
Input sensitivity 600mV; Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8–15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs. **Overall Dimensions.** Speakers approx. $15\frac{1}{2}$″ × 8″ × 4″. Complete deck and cover in closed position approx. $15\frac{1}{2}$″ × 12″ × 6″. Complete only **£18.95** +£1.60 p & p.
Extras if required.
Optional Diamond Styli **£1.37**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**

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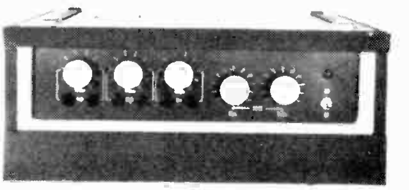
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs * 4 Electrically Mixed Inputs *3 Individual Mixing controls. *Separate bass and treble controls common to all 4 inputs *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.
INPUT SENSITIVITIES
–Input–1.) Crystal mic. guitar or moving coil mic. 2. and 10 mV. (selector switch for desired sensitivity.–Inputs–2), 3), 4. Medium output equipment—ceramic cartridge, tuner, tape recorder, organs etc.
– all 250mV sensitivity.
AC Mains 240V. operation.
Size approx. $12\frac{1}{2}$ ins × 6 ins × $3\frac{1}{2}$ ins
£15.00 + 60p. post & pack

DISCO 50



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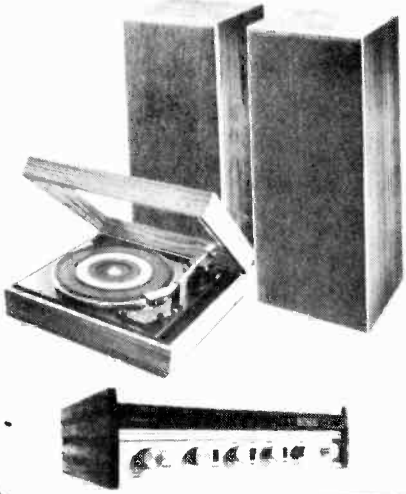
Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: $19\frac{1}{4} \times 10\frac{1}{2} \times 8$ins. approx Amplifier **£27.50+£1.50 p. & p.**

Special Offer: Disco 50 plus two 15″ E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00+£4.00 p&p.**

COMPLETE(*) STEREO SYSTEM



£51·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes.
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.
Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K, equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) −58dB.
Crosstalk better than 35dB on all inputs. Overload characteristics better than 26dB on all inputs. Size approx. $13\frac{3}{4}'' \times 9'' \times 3\frac{3}{4}''$
Garrard SP25 deck, with magnetic cartridge, de luxe plinth and hinged cover.
Two Duo Type II matched speakers – Enclosure size approx. $17\frac{1}{2}'' \times 10\frac{3}{4}'' \times 6''$ in simulated teak. Drive unit 13″ × 8″ with parasitic tweeter. 10 watts handling

Complete System £51.00

£69·00

System II
Viscount III amplifier. (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers—
Enclosure size approx. $31'' \times 13'' \times 11\frac{1}{2}''$. Finished in teak veneer. Drive units approx. $13\frac{1}{2}'' \times 8\frac{1}{4}''$ with $3\frac{1}{4}''$ HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2 20 p & p
Garrard SP25 with MAG. cartridge de luxe plinth and hinged cover *	£21.00 + £1.75 p & p.
total	£59.20

Available complete for only £51.00 + £3·50 p. & p.

PRICES: SYSTEM 2

Viscount R102 amplifier	£24·20 + £1·00 p. & p.
2 Duo Type IIIA speakers	£39·00 + £4·00 p. & p.
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21·00 + £1·75 p. & p.
total	£84·20

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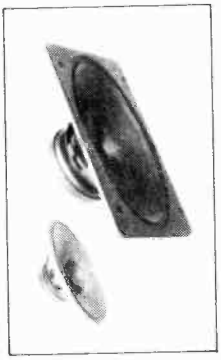
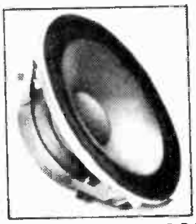


20 WATT SPEAKER SYSTEM

System consists of a 13″ × 8″ (approx) eliptical woofer unit with a 8″ × 5″ (approx.) mid range unit incorporating parasitic tweeter and crossover components.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–$1\frac{1}{2}''$, Cone, Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, speech coil-1″ with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.

OUR PRICE £6.60. Complete + 90p p & p.



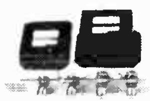
15″ 14A/780 BASS UNIT

Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz, flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3″ voice coil.

Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p & p

950 KIT

Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
Huge 19″ × 14″ (approx.) high efficiency Bass-Speaker with 16,500-gauss magnet built on a heavy diecast frame.
The four 10,000 gauss tweeters, each $3\frac{3}{4}''$ dia. approx., are fed by the crossover which critically adjusts signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2″, others 0·5″. Recommended list price £44·00 **OUR PRICE £19.50 + £1·50 p & p Special Offer.**



BUILD YOUR OWN STEREO AMPLIFIER(*)

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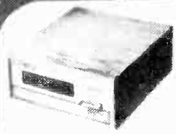
£7·64 + 55p. p & p



8 TRACK CARTRIDGE PLAYER(*)

Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21. Technical specification: Mains input, 240V, Output sensitivity 125mV. Comparable unit sold elsewhere at £24·00 approx.

Yours for only £10.95 + 90p. p & p

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PROGRESS

FOR many years, radio has perhaps been taken for granted, probably because it has long been accepted as a part of our way of life. From time to time history is dug up and given an airing. For those of us who were born before the Second World War, radio was an important medium of home entertainment, a means of communication, or a mysterious status symbol that required the owner to visit the local electrical shop to have the batteries topped up.

When television gained a foothold, radio was soon relegated to a position of "seen but not heard", tucked away in a corner and almost forgotten. But for the new "cult" of high fidelity sound in the fifties and sixties, radio could conceivably have finished entirely in the hands of groups of enthusiasts, just as the steam trains were so destined. It was largely the efforts of a few that were ultimately to pursuade the broadcasting authorities and commercial enterprise of the future of local radio.

Now the "few", or indeed, all of us, can help to steer the future of broadcasting. The Government Committee of Enquiry into the future of Broadcasting, headed by Lord Annan, is openly inviting anyone, individually or collectively, to express their considered views on radio and television broadcasting in the U.K.

Letters or details of evidence can be sent to the committee at the Home Office, Waterloo Bridge House, Waterloo Road, London SE1 8UA. Almost any aspect of the technical or programme side will be covered and suggestions for the 1980s will be very welcome.

If we all accepted radio with unfair complacency the standards would not be as good as they are today. Unfortunately, being utterly human by nature, we are never entirely satisfied and we are still looking for improvements. At the top of our list are (not in any special order) for v.h.f./f.m.—the so-called "interference free" medium—to ban entirely all non-broadcasting users from the 87·5 to 100MHz range; to "shoot" the "birdies"; to slant polarise all local radio transmitter aerials. For a.m.—to re-allocate medium wave broadcast stations and to limit further the radiating power when close to local stations; to de-congest the 180 to 300 metre band. For broadcasting authorities we would like to see more energy put into the promotion of stereo and quadraphonic sound broadcasting at a signal level at least 10dB higher than it is now.

Finally, we think it high time that radio and television departments got together in producing composite television programmes with stereophonic sound.

It is probably easier said than done, but we will always look for improvements in home entertainments media. We are sure you will join us, even if it does seem to take a long time for progress to materialise to the full.

M. A. COLWELL—Editor

The October issue of Practical Wireless will have added to it the first part of the P.W. Buyers' Guide which no reader can afford to miss. The next project in the P.W. Super Separates series is a high quality f.m. tuner; also included will be an audio mixer and an article on the East European and Russian f.m. broadcast stations, specially for the D.X. enthusiast. Look for news of the "P.W. Kempton" project coming soon.

Further details on page 423.

(All advanced details are subject to the current industrial situation)

NEWS...

40 years of tape

AUGUST 1974 marks the fortieth anniversary of the birth of the first magnetic recording tape. It was produced in Germany, but the London Philharmonic Orchestra gave the world the first real taste of the potential of this new medium.

In August 1934, the German chemical company BASF delivered 50,000 metres of the newly developed tape. It was made of plastic and coated with iron particles, and opened up a whole new field of communication. A year later it was shown, now coated with the superior iron oxide, at the 1935 Berlin Radio Exhibition with the new AEG K3 'Magnetophon' recorder.

It was not until 1936, however, that the world first began to appreciate the implication of electromagnetic recording. Sir Thomas Beecham and the London Philharmonic Orchestra made a special trip to Ludwigshafen in West Germany to make the first public recording of music on magnetic tape.

Biggest in Europe

HIGH FIDELITY 1974, claimed by its organisers to be the biggest Hi-Fi exhibition in Europe, will be held in Milan from 5th-9th September.

A total of 240 brand-names from 14 countries will be on show at the exhibition.

Torbay transmitter

RADIO 1 listeners in the Torbay area should now tune to 202 metres (1484kHz), instead of 247 metres (1214kHz). A new transmitter at Torquay started a full programme service on 25 July.

The new transmitter serves about 120,000 people in the area extending from Teignmouth to Brixham and inland to Newton Abbot and Totnes. At night the service area will be reduced because of interference but listeners are reminded that, at certain times, Radio 1 programmes are broadcast on v.h.f. from North Hessary Tor on 88·1MHz.

NEWS... NEWS... NEWS...

Enquiry into Broadcasting

THE Committee of Inquiry into the Future of Broadcasting, under the Chairmanship of Lord Annan is now meeting to receive and consider evidence on broadcast radio and television in the U.K.

The Committee's terms of reference are: "To consider the future of the broadcasting services in the United Kingdom, including the dissemination by wire of broadcast and other programmes and of television for public showing; to consider the implications for present or any recommended additional services of new techniques; and to propose what constitutional, organisational and financial arrangements and what conditions should apply to the conduct of all these services."

It is expected that the Committee will take about two and a half years to report and that a similar period of time will be needed for consultation on the Committee's recommendations and for any legislation that may be necessary.

To allow the necessary time for the Committee to complete its task and for consideration of its proposals the Government have introduced a Bill to extend the Independent Broadcasting Authority Act 1973 to July 1979: it would otherwise expire in July 1976. The Charter of the BBC will be extended for a similar period.

After the first meeting of the Committee on the Future of Broadcasting, the Chairman, Lord Annan, said, "The Government has asked us to make recommendations about the broadcasting services in the 1980's. Before we do this, we shall have to review the services which have been provided in the last ten years. Committees of Inquiry are one of the ways in which broadcasters are made accountable to the public.

"We all know that we've taken on an enormous task. It's also an important task. Most people watch television or listen to radio. People say that broadcasting has a greater influence than any other medium today. That is why there are such frequent inquiries into a public service which is in almost everyone's home and is of such social significance.

"We are bound to receive evidence from many organisations and individuals with an interest in broadcasting. But in the first instance, we want viewers and listeners to write to us to let us know what they think of the present services. We want them to tell us what they like and what they dislike and—if they care to—why. A Committee of this kind really will give all viewers and listeners an opportunity to influence the kind of radio and television they will have in the future. The Committee hope many viewers and listeners of all outlooks and ages will take this opportunity and will write to us so we know their views".

(See leader article "PROGRESS.")

VAT—New Rate

AS a result of the new rate of VAT at 8% as from 29th July, readers purchasing goods are advised to check that they pay the correct rate.

Advertisers' announcements and prices quoted in this issue were prepared before the revised rate was announced. Where VAT is quoted as extra add 8% of the price. Where VAT is quoted as inclusive under the old 10% rate, deduct 1/55 from the total inclusive price. For future reference, where an inclusive price is quoted at the new rate of 8%, the VAT can be calculated by dividing the inclusive price by $13\frac{1}{2}$.

The new rate applies to all goods and services that are taxable.

PUBLISHER'S ANNOUNCEMENT

Due to production difficulties existing at the time this issue went to press, we strongly advise readers to check with advertisers the prices shown, and availability of goods, before purchasing

BSR boost

BSR Limited have decided to extend their working day in order to step-up production to meet the increasing demand for their record changers, both at home and abroad. The Company has four factories in the United Kingdom, three of which are in the Midlands, at Cradley Heath and Stourbridge, and one at East Kilbride, Scotland.

With the full co-operation of the workforce and the Union, extra hours are being worked at each factory with the net result that overall production has increased considerably. At the end of the first week since the new working hours have been in operation, total output was uplifted by 10 per cent.

Doram Electronics

DORAM is an associate company of RS Components Ltd and hopes to provide a "return-of-post" mail order service for components, kits and electronic accessories.

The whole range will be shown in a 64-page catalogue priced at 25p. The firm say full details of each product will be given including some circuits, operating parameters and dimensional diagrams.

Doram will have a stand at the Amateur Radio Trades Exhibition at Granby Hall, Leicester from October 31 to November 2.

Further gen and catalogues (post free) from; Frank Chable, Doram Electronics Ltd., P.O. Box TR 8, Wellington Road Industrial Estate, Leeds LS12 2UF (Tel: Leeds (0532) 34222).

Radiomobile guide

RADIOMOBILE Ltd. have once again co-sponsored the British Airways book 'Golf in the Sun'. This 1974 guide to over 200 golf courses in 26 countries from Iceland to Morocco provides colour photos, maps and plans showing the layout of many of the courses.

Radiomobile will make the book available to its dealer network for promotional activities and as a customer service.

audio SQUELCH UNIT

R. A. PENFOLD

PROBABLY the area in which squelch systems are most used is in mobile radio telephone equipment. The circuit mutes the audio stages of the receiver when no carrier is being received, but permits normal operation in the presence of a carrier. The reason for adding a squelch system is that without it, when no signal is being received, a strong signal consisting of just random noise is reproduced by the speaker.

Squelch systems are not only used in radio communication systems but in any system where a similar problem exists. For instance, it can be used in an intercom system in a noisy office or factory building, in public address equipment or any similar equipment where there is likely to be an annoyingly high background noise level.

In a system such as this, the squelch circuit is activated by the audio signal level. It would be adjusted so that the normal background noise level would be inadequate to operate the squelch circuit and one of the stages of the main equipment would be muted in this condition. The signal level during normal use would be higher than the background level and the circuit would be adjusted so that this normal operating level would operate the squelch circuit and allow the controlled audio stage to function normally.

Practical Circuit

A simple squelch circuit has been developed based on the RCA CA3046 IC, an internal circuit of which is shown in Fig. 1. The circuit of the full squelch system is given in Fig. 2. The CA3046 is a very simple IC, containing five transistors, three have their leadouts taken to separate pins and two share a common emitter connection. In Fig. 1 the transistors have been numbered to aid the circuit description. The IC is contained in a standard DIL 14 pin encapsulation.

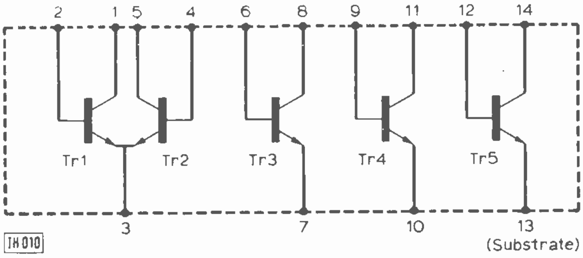
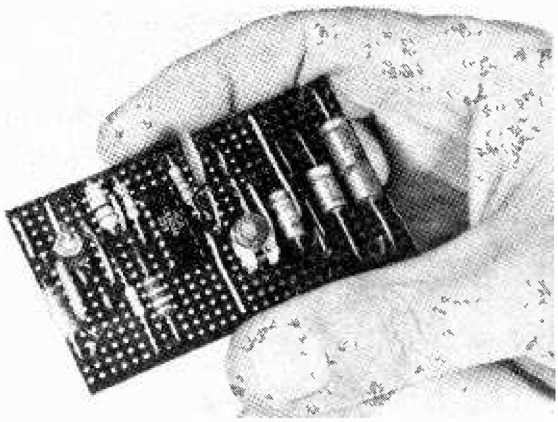


Fig. 1: Diagram of pin connections to the five transistors contained in the CA3046 integrated circuit.

Tr1 and Tr2 are used as emitter followers, with R6 as their emitter load resistor. Tr2 is biased for linear operation by the potential divider R1/2. The input signal is coupled to the base of Tr2 via C2 and the output taken from its emitter via C6.

Tr5 is operated as a common emitter amplifier, having R4 as its collector load resistor. The output of this is direct coupled to the base of Tr1. Tr3 is connected as an emitter follower, with its output direct coupled to the base of Tr5 and is required in order to raise the input impedance of Tr5.

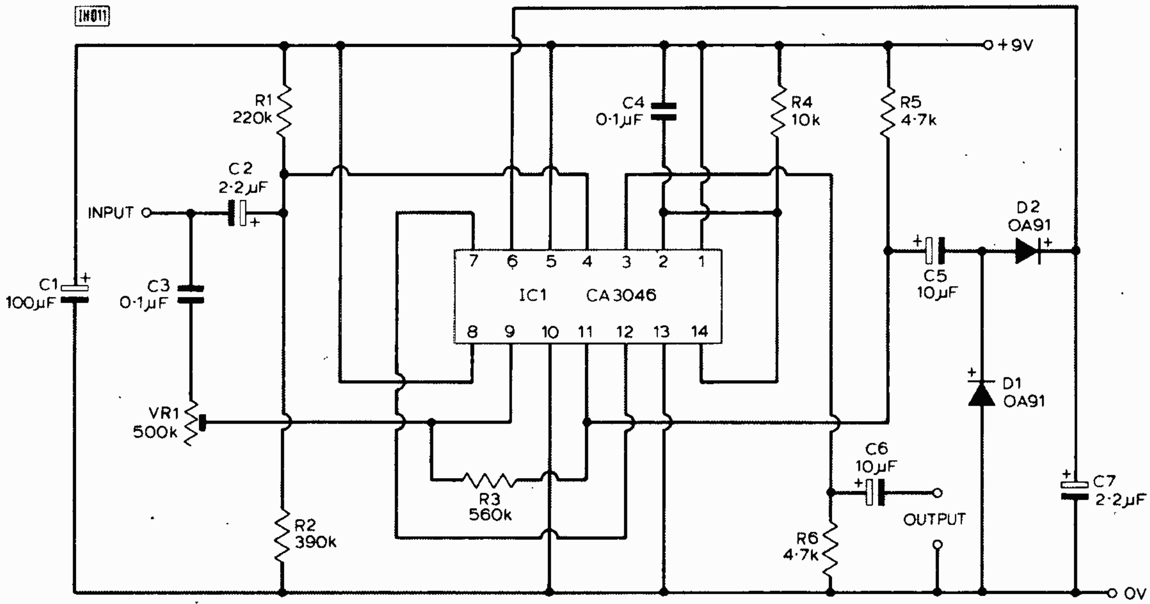


The PCB is quite small, enabling it to be fitted into existing equipment

Part of the input signal is coupled via VR1 and C3 to the base of Tr4. Tr4 is operated as a linear amplifier in the common emitter mode with biasing resistor R3 and collector load resistor R5. The ouput of this stage is coupled to a voltage doubler circuit, D1-D2-C7, via C5, and the smoothed rectified DC appears across C7. This bias voltage is proportional to the input signal level and is direct coupled to the base of emitter follower Tr3.

VR1 is adjusted so that the background signal level produces a potential across C7 of about 1V or less. The transistors are silicon types and about 1·2V is needed at the base of Tr3 before both it and Tr5 will begin to conduct. Therefore these will both be cut off.

Tr1 is therefore biased hard on by R4 which is in its base circuit and, in consequence, almost the full supply potential appears across R6. This in effect cuts Tr2 out of circuit and the signal at its base has no effect on the voltage at its emitter. This stage is therefore muted.



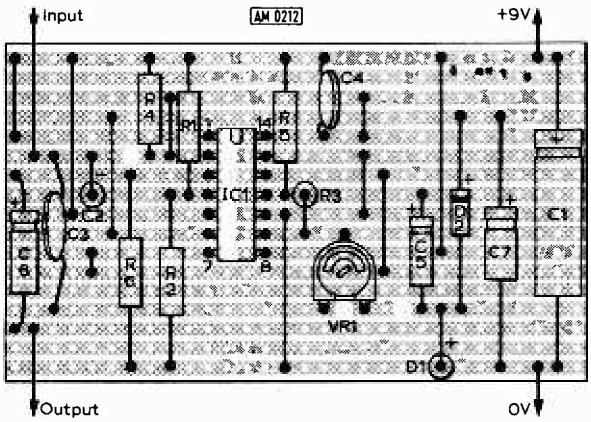


Fig. 2: above, Complete circuit of the squelch unit. The 9V supply could be obtained from the equipment with which the unit is used. Fig. 3: left, Top of PCB with copper rails below. Note seven breaks in rails beneath IC1, one between R4 and C2 and two near VR1 and C5.

When a proper signal level is present the voltage produced across C7 will be high enough to turn Tr3 and Tr5 hard on. This will reduce the voltage at Tr1 base to virtually zero and Tr1 will be turned hard off. It will now have no noticeable effect on Tr2, which can now operate as a linear emitter follower amplifier. The muting is thus removed by the presence of a proper signal level.

★ components list

Resistors

R1	270kΩ	R4	10kΩ
R2	390kΩ	R5	4·7kΩ
R3	560kΩ	R6	4·7kΩ
VR1	500kΩ min. horizontal preset		

Capacitors

C1	100μF	C5	10μF
C2	2·2μF	C6	10μF
C3	0·1μF disc	C7	2·2μF
C4	0·1μF disc		

Miscellaneous

IC1 RCA 3046. Stripboard 3 x 1.7in. 0·1in. matrix.

Construction

The unit is constructed on a 0·1in pitch Veroboard panel measuring 3in×1·7in. Details of this are shown in Fig. 3. Ensure that the copper strips run lengthwise. Then cut the copper strips as shown in the diagram using either a sharp knife or the special spot-face cutting tool. Then connect the eight link wires, which are thin insulated wire.

Next, mount all the components and solder them into circuit. Leave the IC and the two diodes until last and be careful not to damage these through overheating, especially the diodes which are germanium types. Make sure that no adjacent copper strips are shorted together by any drops of excess solder, particularly around the connections to the IC, where this is most likely to occur. Finally, fit four Veropins for the connections to the input, output and supply lines.

Notes on use

The unit is intended to be coupled between two stages of amplification in transistorised audio equipment. The input impedance obtained depends largely on the setting of VR1 but is likely to be in the region of 20kΩ. The output impedance is low and the unit has almost unity gain. It is intended to operate with an input level of around 100 to 200mV but it will operate with input levels outside these limits.

VR1 is adjusted to the least sensitive setting (maximum anticlockwise direction) at which the circuit will hold reliably on a signal of normal strength. The circuit has virtually instantaneous attack but the decay takes about ½ to 1 second, so that the muting does not come into effect during brief pauses between words or syllables. A slightly longer decay can be obtained, if required, by increasing C7 to 4·7 or 10μF. Current consumption is about 2·5mA from a 9V supply. ■

all about FETs

PART 1 T. BAILEY

THE aim of this article is to give, with a minimum of theory, an account of the way in which field-effect transistors operate and their advantages and disadvantages. It is hoped that after reading this article constructors will understand the FETs in their projects and experimenters will be able to incorporate them into their circuits.

The FET

Without wishing to get engrossed in history it is interesting to note that the FET was analysed in detail by the famous Professor Shockley in 1952 but remained a "laboratory-object" for some time until the necessary technology for commercial production arrived.

As far as construction is concerned there are two types of FET, each of which may be made, like ordinary bipolar transistors, with two distinct polarities. The simplest and still the most common form is the junction-gate type, abbreviated to JFET and JUGFET. Reference to Fig. 1 shows that two of the terminals, the source and the drain, are connected within the FET by an n-type semiconductor layer.

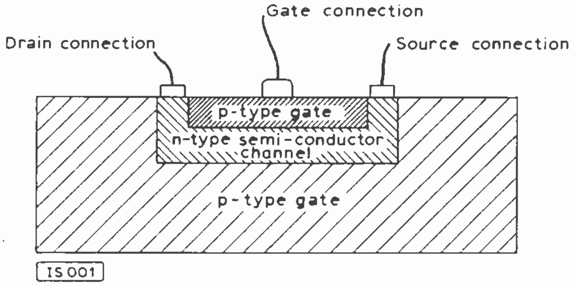


Fig. 1: Simplified cross-sectional diagram of an n-channel JFET.

Where this region is narrow and surrounded by p-type semiconductor material it is called the n-channel. The device is hence called an n-channel FET, it could also be made with a p-type channel and an n-type surround when it would be known as a p-channel device. It would operate in the same way as will be described for n-channel devices but with opposite supply voltage polarity.

Supposing now that a positive voltage is applied to the drain with respect to the source. Negative charge carriers will carry a current from the source to the drain. The region of opposite polarity to the channel that surrounds it is called the gate and we must now consider the effect of applying a voltage to this electrode. In junction FET's the p-n junction which this gate forms is kept reverse biased. This means that in our example of an n-channel FET a negative bias voltage is applied to it, relative to the source.

When a p-n junction is reverse biased a region of the semiconductor material near the interface between the layers becomes devoid of charge carriers. The size of this depletion zone, as it is known, depends on the magnitude of the reverse voltage. In FETs the size of the depletion zone varies with the gate voltage from being negligible when there is no bias voltage at the gate to occupying the whole channel if several volts of reverse bias are applied. The current which will flow in the channel depends on the number of charge carriers present, so as the gate voltage varies the channel current, which is equal to the source and drain currents, varies also. This is how a field-effect transistor amplifies, a varying gate-source voltage causes a varying drain current.

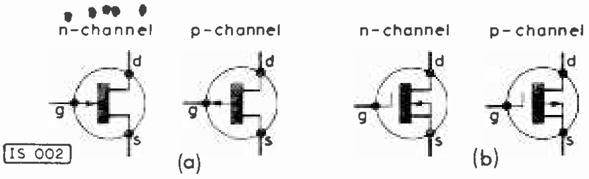


Fig. 2: (a) Symbols for the two types of JFET and (b) symbols for the MOSFET with internally connected sub-strate.

It is very important to notice that as the gate is reverse biased with respect to the channel the amount of current flowing in the gate is minute, like that which flows in an ordinary reverse biased p-n junction. It can easily be as small as a few nano-amps and it is because of this that FETs have exceedingly high input impedances. The conventional symbols for junction-FETs are shown in Fig. 2 (a).

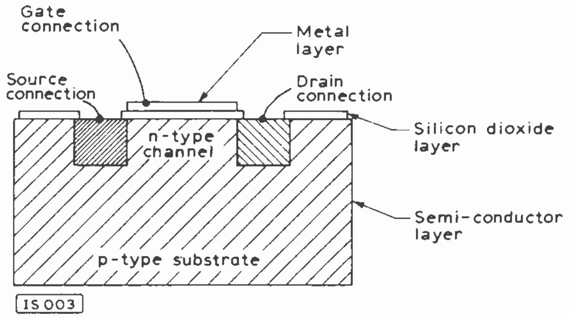


Fig. 3: Construction of an n-channel MOSFET.

The IGFET

The difference between IGFETs and JFETs is that a layer of insulating material is inserted between the gate and the channel. The most common form of IGFET is with a metal gate connection followed by a silicon dioxide insulating layer on top of the semiconductor material, see Fig. 3. The device so formed is called a metal oxide semiconductor field-effect transistor or MOSFET. These devices operate in a similar way to JFETs with one major exception, because of the insulating layer the gate-channel junction may be forward biased and no gate current will flow (it is because a gate current of more than a few milli-amps destroys JFETs that their gates may not be forward biased).

It is this which makes it possible to manufacture MOSFETs with two different modes of operation. Firstly there are "normally on" types which need several volts of reverse bias to turn off the current in the channel and which may have characteristics which extend into the forward biased mode. These types are often called "depletion-mode" devices because they rely on depleting a normally conducting channel as opposed to "enhancement-mode" devices which constitute the other category and are "off", that is they have zero drain current when the gate-source voltage is zero. These devices need several volts of forward bias on the gate to cause a drain current to flow. The channel of these devices is normally depleted of carriers and the forward bias draws carriers into the depletion zone. A set of possible characteristics for a JFET and both types of MOSFET are shown in Fig. 4 and the symbols used for a MOSFET are depicted in Fig. 2(b).

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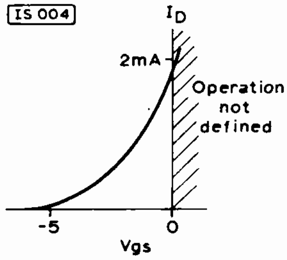
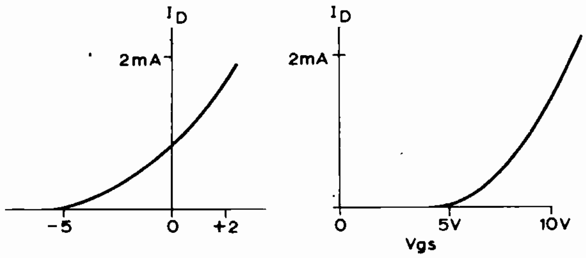


Fig. 4: Possible characteristics of different types of n-channel FETs. Left, JFET. Below left, depletion-mode MOSFET. Below, enhancement-mode MOSFET.



Two points should be made at this stage. Firstly, because of their insulating layer, the input impedance of MOSFETs is even higher than that of junction gate devices. So high is it that static electricity, which may develop to tens of thousands of volts on a human, can damage them. Special precautions must be taken when handling MOSFETs to prevent this happening. Any protective device applied by the manufacturer, such as a shorting ring or conductive foam on the leads, should not be removed until the FET has been soldered in place. The tips of soldering irons should be earthed or the plug removed from the socket just before use. Secondly, many MOSFETs are tetrodes, with four leads. The fourth may be from the substrate if that is not internally connected to the source or it may be a second gate in which case the device is a dual gate MOSFET, often used in mixer stages.

Characteristics

There are not many characteristics that need concern the experimenter as long as he is prepared to adjust the values of resistors after he has completed his circuit. In Fig. 5 an n-channel JFET is shown with its drain connected by a resistor to a positive supply voltage (V_{CC}). Its source is earthed and a variable negative bias voltage applied to the gate from VR1. It should be clear that as the slider of VR1 is moved from ground to the negative supply voltage (V_{DD}) the drain current will become less and less until, at a voltage known as V_P it is negligible.

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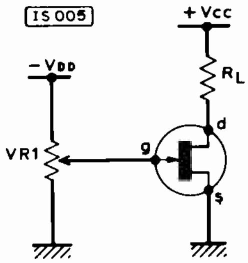


Fig. 5: Arrangement to demonstrate JFET characteristics.

A typical value for $V_{P\,(MAX)}$ that is the greatest value for the reverse bias necessary to produce a negligible drain current, might be 8 volts. V_P is sometimes referred to as $V_{GS\,(off)}$ and the required "negligible" drain current may be 1 or 2 nano-amps. This parameter also applies to MOSFETs but it may be the maximum value of forward bias ensuring the device is off, if the FET is an enhancement type.

The second parameter really only applies to JFETs. It is the drain current which will flow if the gate-source voltage (V_{GS}) is zero at some specified drain voltage and temperature. This parameter (I_{DSS}) is usually quoted as a maximum and minimum value. A typical form might be 25°C, $V_{DS}=15V$ $I_{DSS}=2mA$ min., 20mA max.

The third parameter applies to all types of FET. If the gate voltage varies by a small amount $\triangle V_G$ then the drain current will vary by a small amount $\triangle I_D$. The ratio $\frac{\triangle I_D}{\triangle V_G}$ is called the transconductance or forward transfer admittance (known as g_m and Y_{fs} respectively). The units in which transconductance is usually quoted are milli-amps/volt (mmho) or micro-amps/volt (μmho) and a typical value might be 2000 μmho min. 6500 μmho max. The value of g_m varies with V_{GS}, V_{DS} and the frequency of the applied signal. A typical FET might have g_m quoted for $V_{DS}=15V$, $V_{GS}=0V$ F = 1kHz and 1MHz. Transconductance varies with V_{GS} in such a way that it is at a maximum with a gate-source voltage of zero and gives the device a "square-law" transfer characteristic. It is this which is being referred to when data-sheets talk of "square-law characteristic minimises cross-modulation" and it is a feature of all FETs.

The most important parameters of all, the values quoted for a particular device, should never be exceeded. It must be remembered that FETs are more delicate than bipolar transistors. The easiest way to destroy a JFET is to let gate current flow. Maximum gate current may be just a few milli-amps and it is worth checking, especially in DC coupled circuits, that even if the stage before or after the FET is faulty that no more than the maximum rating can flow.

It is also wise to keep the supply voltage less than the maximum drain-source voltage by a considerable safety margin. For an FET with a maximum V_{DS} of 25V it would be best to aim for a supply voltage of less than 15V.

Circuitry

It is now possible to get down to some practical circuits. The first example, Fig. 6, shows an n-channel JFET as an audio frequency amplifier. The resistor R1 serves to keep the gate at earth potential and the voltage drop across R2 due to the source current provides the reverse bias on the gate-source junction.

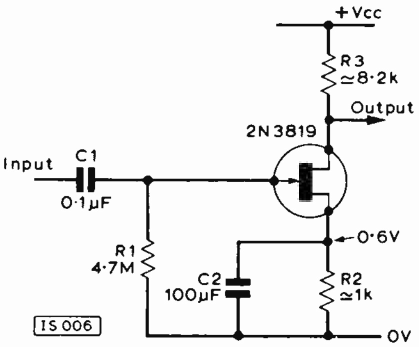


Fig. 6: An n-channel JFET in circuit of a small-signal audio amplifier.

The value of R1 is not at all critical and it would only affect the input impedance if it were varied between 10kΩ and 10MΩ. Indeed, if R1 is less than about 5MΩ then at low frequencies its value may be taken as being the input impedance. However, the same does not apply to R2 and R3. It really is essential because of the great spread which exists in FET characteristics to check, after building a circuit, that the voltages at the source and drain are approximately what they ought to be or, if the correct values are not known, that there is at least a volt or two dropped across the drain load resistor and also a volt or two between the drain and source potentials. This does not apply to RF circuits when an inductance is used for the drain load.

Getting back to the circuit under discussion, the purpose of C1 is to couple the input signal to the gate and because of the high input impedance its value can be considerably less than in corresponding bipolar transistor circuits. A value of 0·2µF would give good performance to below 10Hz in our circuit. As the input impedance is lowered, by making R1 less in value, then a larger coupling capacitor would be necessary. C2 is a decoupling capacitor and without it our circuit would have lower gain but less distortion. It serves the same function as the emitter resistor bypass capacitor in bipolar circuits. The output is developed across the load resistor R3. It is because the source terminal is common to both the input and output circuits that this mode of operation is called "common source" and is the mode which is often used for audio amplification.

To give an example of the problems which can arise, examine the circuit shown in Fig. 7 an input

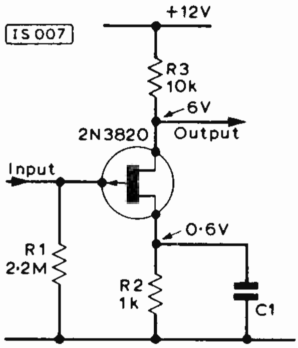


Fig. 7: Input stage of audio amplifier using a p-channel FET.

stage for a small amplifier. A p-channel FET (2N3820) was used in order to make it fit in better with the pnp transistors following it. The designer stated that the drain current should be 600µA and hence the source voltage ought to be 0·6V. This state of affairs can only exist if, for the FET used, $V_{GS}=0{\cdot}6V$, $I_D=600\mu A$ is on the characteristic curve (see Fig. 4). It was stated that FET parameters are subject to a wide spread, for example I_{DSS} for the type 2N3820 used is 0·3mA min., 15mA max. and we can assume that I_D with 0·6V reverse bias is not far removed from these figures. This would mean that to maintain the source voltage at 0·6V R2 might have to be any value between about 2kΩ and 40Ω. This procedure would lead to values of drain current far removed from 600µA and because this value was chosen to make the stage economical and reasonably free from noise it would be good not to change it too much. It is best to keep the drain current between about 300µA and 2mA by letting the source voltage change.

It must be remembered that changing the value of the source resistor R2 means altering the drain resistor R3. Generally the drain voltage should be half-way between the source and supply voltages. Altering the drain resistor will change the stage voltage gain (the gain of this sort of stage with no feedback is equal to the FET's transconductance multiplied by the value of the load resistor or $G_V=g_m.R_L$ and so to alter a circuit in this way means an output of an amplitude different from that expected.

RF amplifiers

FETs are used in two principal modes at radio frequencies, common gate and common source, which correspond to the common base and common emitter modes of bipolar transistor. Fig. 8 shows a common source amplifier. L2 is tuned to resonance by C1 and the signal is applied to the gate by C2. Resistor R1 is taken to the AGC line to control the gain. If this facility is not required then R1 may be taken to earth or omitted but if this is done then C2 must be removed and the signal applied directly so that L2 keeps the gate at earth potential. Bias is provided by R2 in the same way as for an audio amplifier but because the DC drop across the inductive load L3 is very small, biasing problems should not occur. The source resistor is decoupled by C3 which may be much smaller than at audio frequencies, 0·1µF or less. Output is taken from the transformer L3 and L4 and the stage is decoupled by C4 which earths the supply line.

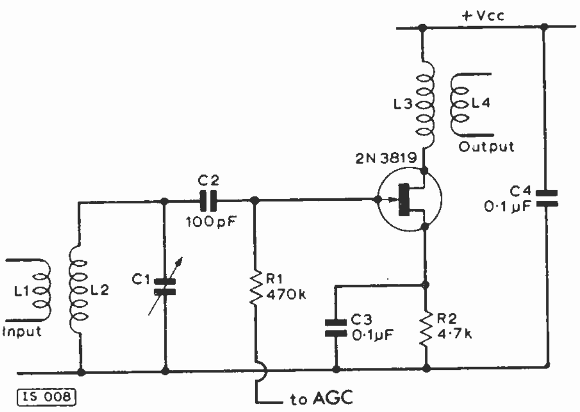


Fig. 8: RF amplifier circuit using an n-channel JFET in common source mode.

A common gate RF stage is shown in Fig. 9 and it can be seen that, with the exception of the fact that the gate resistor is omitted and the gate taken directly to ground, the DC biasing arrangement is the same as that for common source amplifiers. The signal is applied across the source resistor but this is not the only possible method. Fig. 10 is a similar circuit but with the signal applied by a tuned transformer. If this is done then the source resistor should be decoupled by a capacitor, C2.

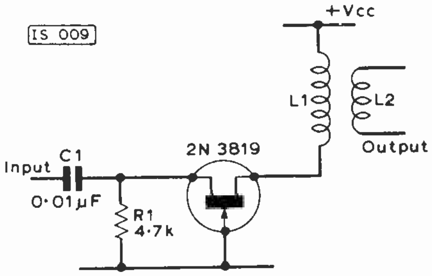


Fig. 9: Common gate RF amplifier.

In either of these variations the stage could be tuned by a parallel capacitor across the primary of the transformer in the drain circuit. It should not be difficult to see how this mode of operation produces amplification providing it is remembered that it is not the gate voltage which decides the drain current but the gate-source voltage. There are two principal ways to alter the gate-source voltage, either the source is kept at a fixed AC potential (ie. earthed) and the gate voltage allowed to vary or the gate voltage is fixed and the signal applied to the source. These alternatives correspond to the common source and common gate modes respectively. The common gate method of operation has the advantage of better performance at very high frequencies and a low input impedance which can be useful, for example, when the input is a coaxial line.

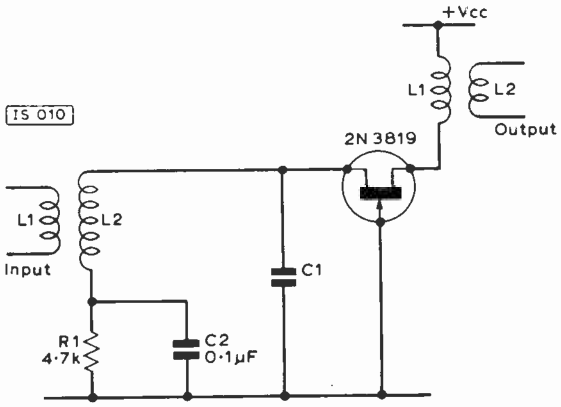


Fig. 10: Similar to Fig. 9 but the input is tuned by L2/C1.

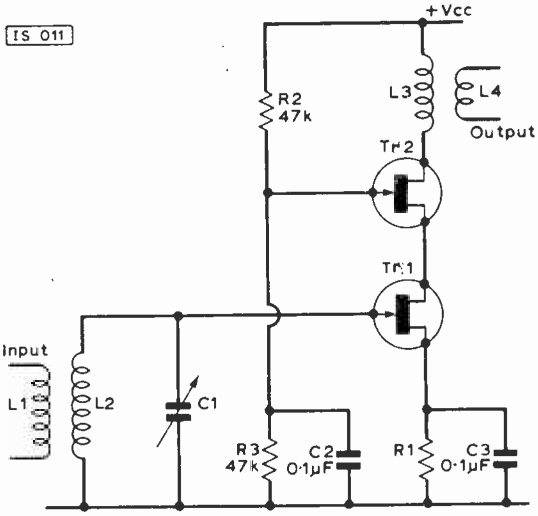


Fig. 11: FETs in a cascode RF amplifier circuit.

An interesting combination of the two modes is shown in Fig. 11, an FET cascode circuit which was popular with valves and is often useful, particularly at VHF, because of the good gain it gives with very little noise. It can be seen to consist of a common source amplifier Tr1 directly coupled to a common gate amplifier Tr2. The DC biasing is made simpler by giving the FETs a common drain current and returning the gate of the grounded gate amplifier to a voltage set by the potential divider R2 and R3, bypassed to ground for AC by C2.

PART 2 NEXT MONTH

EXPERIMENTAL WORKSHOP

M. J. HUGHES M.A.

LEARNING BY PRACTICAL PROJECT STEPS

PART 11—LOUDSPEAKER DRIVERS

(continued from last month)

An alternative output using a.c. coupling to LS1 is shown in Fig. 76, where the standing current is taken by R6 and a.c. currents are shared between R6 and the loudspeaker (in series with C3). Note that in either of these circuits considerably higher audio output levels are obtained in the loudspeakers.

Obviously the most conventional application for an amplifier is for handling music and in Fig. 77 we show a simple class A output record player amplifier. This is designed to work from a crystal cartridge and the signal levels expected (before distortion sets in) will not cause Tr3 to pass excessive current nor exceed its power limitations. Output into LS1 will be in the order of 70mW and will be found to be ample for a bedroom or playroom record player. Note the high quiescent current!

Different pick-up cartridges have quite different ranges of output signal so it is worth experimenting with the value for R1 until a good compromise between volume and distortion has been reached. Reducing its value will compensate for lower output pick-ups. If you wish to obtain a higher power output then substitute the components of Fig. 76 for Tr3 and its associated devices. For the record Tr1 has very heavy negative feedback at high frequencies to compensate for the output response of the cartridge and is there more as an equaliser than a gain stage; Tr2 acts as a simple voltage amplifier.

You can change the input to suit a crystal microphone as shown in Fig. 79, and, if required, you can introduce a volume control instead of R4.

Perhaps the most common type of power stage used in most modern amplifiers is the type called Class B. The basic circuit is shown in Fig. 80. Its prime advantage is that it has considerably higher power efficiency than its Class A counterpart and under "no signal" conditions its quiescent current is very small. It is thus admirable for portable battery operated applications. Its main drawback is that it is rather more complicated and ideally should use matched components for Tr2 and Tr3. It needs setting up carefully to prevent a particularly nasty form of distortion known as "cross over distortion."

Tr2 and Tr3 are basically a couple of complimentary emitter followers and biasing is arranged

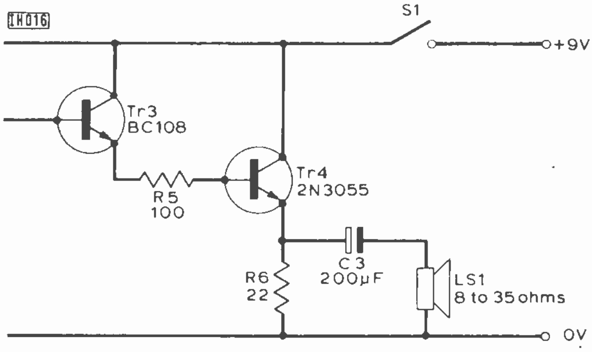


Fig. 76: An alternative output from Fig. 74. Using C3 and R6 prevents a standing direct current through the loudspeaker coil.

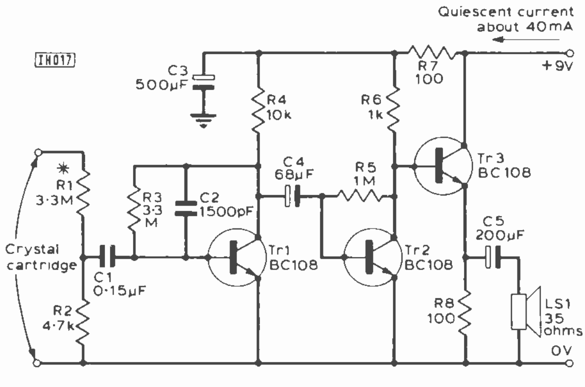


Fig. 77: A simple low power record player amplifier. This is only suitable for crystal cartridges. R1 should be reduced in value for low output pick-ups but should not be less than 100kΩ. The alternative output stage of Fig. 74 or Fig. 76 could be used if an 8Ω speaker is available. Note the high quiescent current.

with R3 so that the collector potential of Tr1 is mid rail. By careful adjustment of R2 we can arrange that there is sufficient difference between the base voltages of the two output transistors to overcome their respective voltage drops so that a small current flows from the positive rail to ground through both devices. When this happens the potential at the posi-

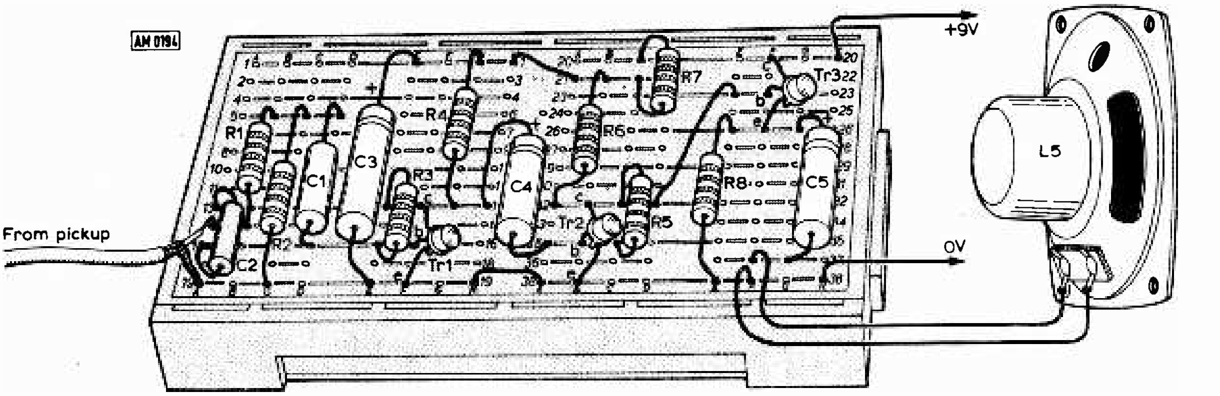


Fig. 78: Layout for Fig. 77. If a volume control is required R4 should be omitted and flying leads taken from holes G1 and G13 to VR1 (see Fig. 79) The centre connection from VR1 goes to G6 and the +ve end of C4 goes to H6.

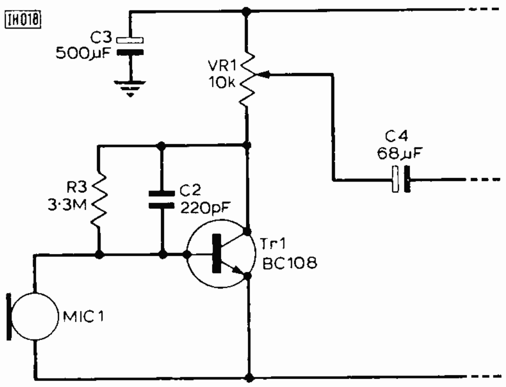


Fig. 79: Alternative input stage for Fig. 77 if (a) a crystal microphone is used or (b) a volume control is required.

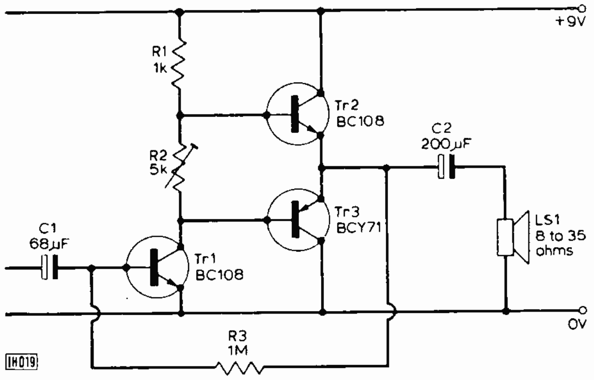


Fig 80: Basic circuit for a complementary transistor output stage. R2 should be adjusted until the quiescent current is about 15mA.

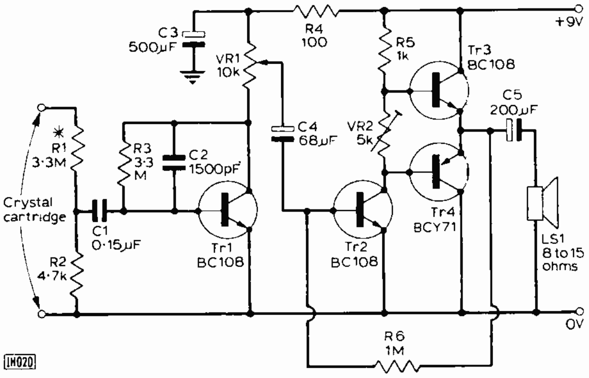


Fig. 81: A complete low power portable record player amplifier using class B output. In this application Tr4 can be any general purpose pnp silicon device.

tive end of C2 should be approximately mid rail by normal emitter follower action.

If a positive going input signal is applied to C1 the collector potential of Tr1 falls and Tr2 will go out of conduction while Tr3 goes harder into conduction thereby causing current to flow round the circuit LS1, C2 and Tr3; when the input signal goes in a negative direction the converse will happen and current flows into the loudspeaker via Tr2, C2 and LS1.

The transistion between Tr2 and Tr3 taking over the conduction cycle is very important because there is a point when both transistors are conducting slightly, this is the "cross over condition" and must occur smoothly. The best way of ensuring this is to make sure that in the absence of any signal both transistors are conducting a little; if they are not there will be a gap between the two halves of the cycle and cross-over distortion will occur. You can see the effect by making up the record player amplifier of Fig. 81.

The input stages are identical to those already described. Initially set VR2 to minimum resistance and in the absence of input signal measure the quiescent current; it should be no more than 4 or 5mA. Put on a record and the sound will be atrocious. This is because we have deliberately allowed cross-over distortion to take place. Now remove the sound source and while monitoring the quiescent current slowly increase the value of VR2 until the standing current reaches about 15mA then replay the record and the sound quality should be excellent. *Do not* allow more than 20mA of quiescent current otherwise you might damage the output transistors but try manually reducing the value of VR2 while the record is playing and you will suddenly hear the nasty effect of cross-over distortion. To ensure freedom from distortion it is obviously desirable to have some standing current but notice that the amount required is very much lower than the Class A circuit already discussed.

Next month-R C filters

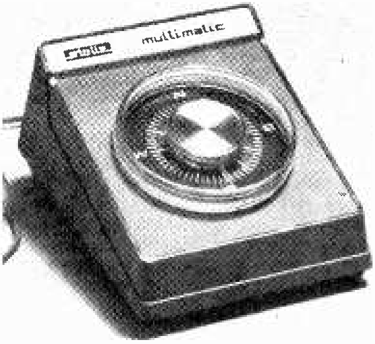
PRODUCTION LINES

colin riches

JAYBEAM AERIAL ROTATOR

The Stolle rotators available in the U.K. have up to now been of two types, each of which had its own advantages.

The new MULTIMATIC model ingeniously combines the advantages of both the Automatic and Memomatic models. A large outer control knob is set to the required bearing and the aerial begins to rotate and at the same time, a repeater dial inside the main control knob indicates the actual bearing of the aerial. Thus if a signal is peaked at a bearing other than the expected one, the angle is known and can be repeated or the rotator may be stopped by turning the control knob back to the indicated bearing.



A) Control Unit.

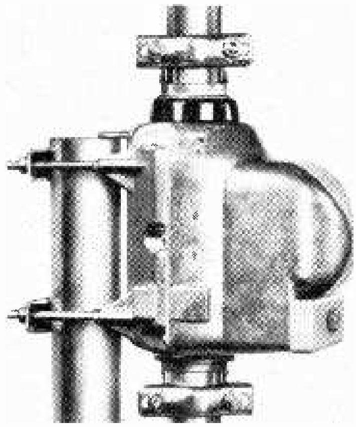
A double-wound mains transformer fitted into the control unit reduces the mains voltage to 20 volts a.c. This low voltage is used to operate the shaded pole motor within the watertight housing of the drive unit which rotates the aerial.

The drive unit has a hollow shaft to take revolving aerial masts of up to 38mm dia, (approx 1·5in) and a universal bracket for support masts of up to 52mm dia. (approx 2in). The carrying capacity is 25kg (55 lbs).

An entirely separate information feedback circuit is used to operate the direction indicator dial. This avoids errors due to overswing or excessive wind loading.

The Multimatic is recommended for use with TV, f.m. and Amateur aerial systems. Amateur h.f. beam aerial systems may be fitted as long as the drive unit spec. is not exceeded.

Price is £35 plus VAT. Post free U.K. Further details upon application to Jaybeam Ltd. The sole U.K. importers of the Multimatic are *Jaybeam Ltd, Moulton Park Industrial Estate, Northampton.*



B) Drive Unit.

BSR 8-TRACK RECORDER

BSR recently announced their TD8 8-track cartridge recorder (T156). It is a reasonably-priced unit which will be a boon to all those who have 8-track players and don't want to keep paying out for pre-recorded tapes.

Tape speed is 3¾in. per sec.; the programme selector is for automatic or manual operation; track-playing sequence is 1 and 5, 2 and 6, 3 and 7, 4 and 8 and infinite repeat.

Wow and flutter is quoted as being less than 0·3% total and frequency response better than 50-10,000Hz.

Power supply is 210-250V a.c. Output is 650mV nominal. 1kHz standard ref. level tape. Input has automatic recording level, 50mV-2V with 100kΩ impedance and signal to noise ratio is quoted as being better than 40dB playback alone and better than 36dB overall.

The price of the T156 was not available at time of going to press. Further information can be obtained from *BSR Limited, Monarch Works, Cradley Heath, Warley, Worcs. 64 5QH.*

BBC CARTRIDGES

Four 8-track cartridges have recently been released by the BBC. The first is Monty Python's Flying Circus (RCT 8001)—a mono recording which contains such all-time classics as 'Flying Sheep', and the 'North CheamBye-Election'.

The other mono cartridge is entitled Unique Hancock (RCT 8002). Recordings of Tony with the usual team of Sid, Kenneth, Hattie and Bill bring back most pleasantly hilarious memories. Tracks like 'With My Woggle I Thee Worship' and 'Christmas—East Cheam Style' bring back once again the realisation of what a unique person Hancock was—hence the title!

The Last Goon Show of All (RCT 8000) is recorded in stereo and is—the last Goon Show of all. What more can I say? It's well worth adding to the collection and is a 'classic of our time'.

BBC Top Tunes (RCT 8003) completes the quartet and makes an excellent 'in-car' tape with tracks which include TV and radio themes like 'Onedin Line', 'Owen M.D.', 'Archers', 'Lotus Eaters', 'Dad's Army' and 'Tomorrow's World'.

The cartridges cost £3 each and they are obtainable from most record stores.

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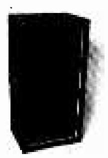
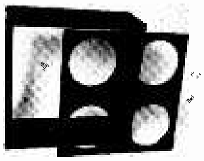
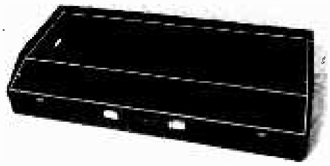


2′ x 12″ Cabinet



4′ x 12″ Cabinet



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Kits are available in all specifications and all the kits contain everything you need as follows:-

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PRICE & TYPE LIST

Type	*Size*	*Price manufactured*	*Kit price*
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4 x 12″ (illustrated above)	31″ x 31″ x 13″ x $\frac{3}{4}$	£24.50	£17.50
4 x 12″ P.A. Column	48″ x 27″ x 13″ x $\frac{3}{4}$	£30.00	£21.50
1 x 18″	31″ x 31″ x 13″ x $\frac{3}{4}$	£24.50	£17.50
1 x 15″ with two top horn cutouts	36″ x 20″ x 13″ x $\frac{3}{4}$	£21.00	£13.50
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SN7406	45p	SN7447	£1·30	SN7493	65p	SN74165	£2·01
SN7407	45p	SN7448	£1·50	SN7494	85p	SN74167	£4·10
SN7408	25p	SN7450	16p	SN7495	80p	SN74174	£1·80
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SN7427	45p	SN7480	75p	SN74150	£1·44	SN74198	£3·16
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Prices correct at September 1974

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Transistor Detectors

G. R. WILDING

ALTHOUGH diodes are used as detectors in at least 90% of AM receivers, transistors can be used with advantage in many circuits to improve stage gain and to confer amplified AGC.

In recent years, Philips, Alba, Cossor, KB and RGD have all marketed models using transistors as detectors, either in common-base or common-emitter mode.

Common-base stages have a low input impedance but as their voltage gain is similar to that of common-emitters this disadvantage can be greatly reduced by a suitable step-down ratio for the driving IFT.

The input impedance of common-emitters, on the other hand, especially with an undecoupled emitter resistor, is relatively high even with unity transformer ratio, and imposes no more loading on the preceding stage than does the load resistor of a conventional diode.

For constructors, it will be found a simple matter to include a transistor detector in experimental hook-ups, or even to try in an older type receiver, for apart from the few components involved, it will usually only be necessary to make a minor re-adjustment to the alignment of the last IFT to compensate for slight changes in circuit capacitance.

C-B Mode

A circuit using an OC71 as AM detector in common-base mode is shown in Fig. 1 as incorporated in several Philips models.

Transistor Tr2 is without forward bias, and being PNP with base directly connected to positive chassis, only conducts when the positive half-cycles are applied to its emitter, this being equivalent to driving its base negative to emitter.

Collector current and therefore collector voltage will vary with the AF modulation, the latter's mean value tending to decrease with rising signal strength due to increased voltage drop across the load resistor R1.

As will be seen, forward bias to the IF amplifier is taken via the secondary of IFT1 from the junction of R2 and R3, the former resistor being supplied from Tr2's collector.

Increasing signal strength will therefore reduce forward bias to the IF stage, the AF component of the DC feed from Tr2's collector being filtered out by C1.

C-E Mode

When transistors are used in common-emitter mode, their operation is similar to that of anode bend valve detectors, and in fact are sometimes known as collector-bend detectors, since they are biased to just above cut-off, to where the transfer characteristic has most curvature, so that while input half-cycles of one polarity greatly increase Ic, those of the opposite polarity decrease Ic only slightly.

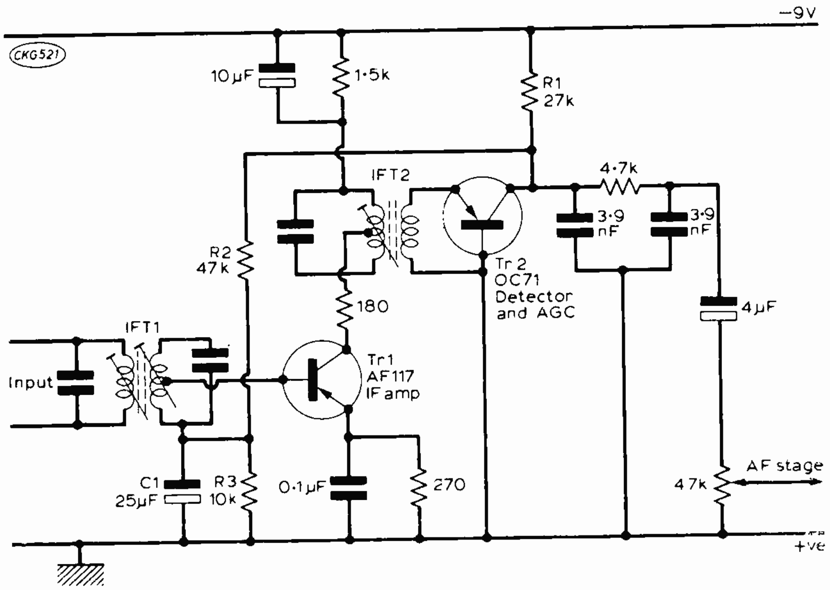

Fig. 1. Common-base detector used in Philips L2G43T receivers. Tr2 being without forward bias conducts only when positive half-cycles are applied to its emitter and the resulting decrease in its collector voltage reduces forward bias to the IF amplifier, thus providing a measure of amplified AGC.

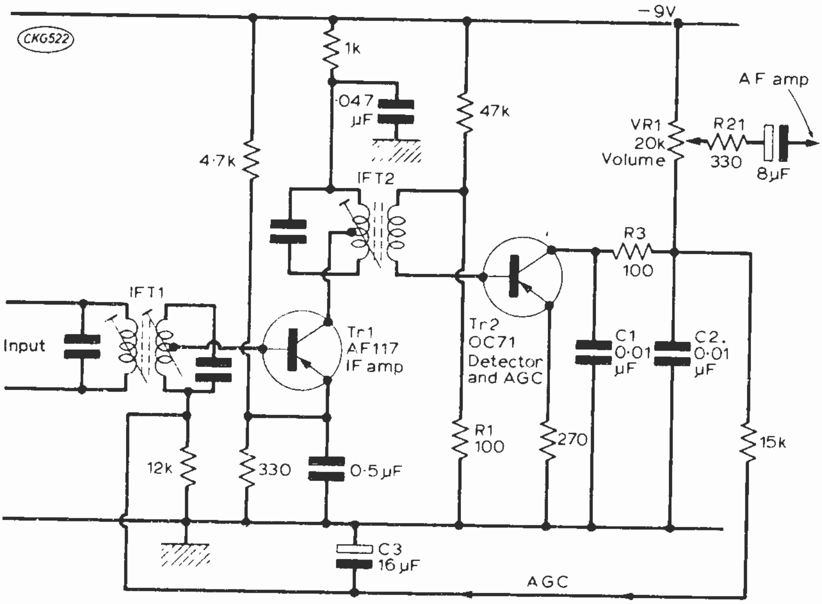

Fig. 2. Common-emitter detector used in Alba 939 receivers. Tr2 is slightly forward biassed so that negative half-cycles produce a greater increase in Ic than positive half-cycles produce a decrease. Net result is that collector current varies with the AF modulation, and, as the collector load VR1 of Tr2 is part of the bias supply circuit to Tr1, the latter transistor is reverse AGC controlled. The 47kΩ resistor in the base circuit of Tr2 should be shown as R2.

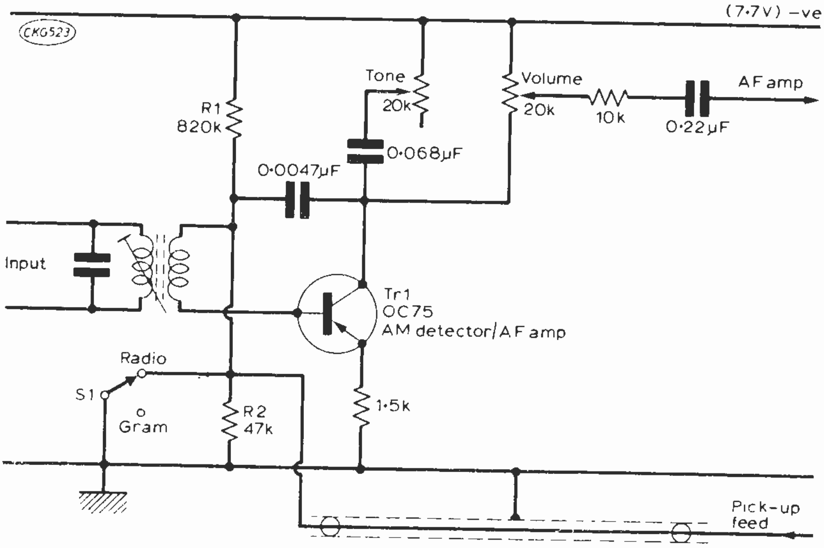

Fig. 3. Common-emitter used as detector without forward bias on AM reception and as a conventional AF amplifier with forward bias during record reproduction (STC GC6).

Net effect therefore is a rise in collector current which follows the signals amplitude modulation.

Of course an ideal detector would have negligible resistance to current in one direction, but of infinite value to current in the reverse direction, and though thermionic diodes have extremely high 'reverse' resistance, their forward resistance is appreciable. On the other hand, semiconductor diodes have a much lower forward resistance but have a reverse resistance probably no greater than 1MΩ at most.

A typical common-emitter arrangement is shown in Fig. 2 as used in some Alba receivers, with the very small forward bias to the detector made evident by the low value of R1, connected across the transistor b/e junction, to that of R2, connected from 9V rail to transistor base.

As with the previous Philips example, collector current increases according to input amplitude, and the resulting decrease in collector voltage is used to decrease forward bias to the IF stage by including the load resistor, VR1, in the DC feed circuit of this transistor. C1/R3/C2 form a pi filter to remove the IF carrier and attenuate HF response, while C3 removes the AF component from the AGC feed to Tr1.

An interesting variation on the basic common-emitter arrangement is used in the STC GC6 radiogram chassis, where the OC75 used as detector on radio reception without forward bias, is used as a conventional first AF amplifier with normal bias for record reproduction.

The circuit is shown in Fig. 3 with S1 effecting the bias change by shorting out the bottom resistor of the R1/R2 potential-divider while earthing the live pick-up lead. In common with the other examples, the emitter resistor is left unbypassed and though this leads to negative feedback, greatly increases the effective input impedance to minimise loading on the final IFT and kept selectively at maximum. ■

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¼	2%	10Ω–1MΩ	E24	3·5p	3p
½	10%	1Ω–3·9Ω	E12	1·3p	1·1p
⅓	5%	4·7Ω–1MΩ	E12	1·3p	1·1p
4	10%	1Ω–10Ω	E12	8p	7p

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160V: 0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, 0·068µF, **3p**. 0·1µF, **3½p**. 0·15µF, **4½p**. 0·22µF, **5p**. 0·33µF, **6p**. 0·47µF, **7½p**. 0·68µF, **11p**. 1·0µF, **13p**.

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MYLAR FILM CAPACITORS 100V

0·001µF, 0·002µF, 0·005µF, 0·01µF, 0·02µF, **3p**. 0·04µF, 0·05µF, 0·068µF, 0·1µF, **6p**.

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0·22µF 35V, 1·0µF 35V, 4·7µF 35V, 10µF 25V, 33µF 10V, 100µF 3V

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	0·1	0·15
2½ x 3¾	26p	22p
2½ x 5	28p	28p
3¾ x 3¾	28p	28p
3¾ x 5	34p	34p
17 x 2½	95p	77p
17 x 3¾	130p	108p
17 x 3¾ (plain)	86p	72p
17 x 2½ (plain)	—	57p
2½ x 5 (plain)	—	18p
2½ x 3¾ (plain)	—	15p
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Standard screened	28p	2·5mm insulated	12p
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2 pin, 3 pin, 5 pin 180, 5 pin 240, 6 pin, 7 pin.
Plug 12p. Socket 8p.
4 way screened cable, **25p/metre**.
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9V mains power supply. Same size as PP9 battery.

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Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

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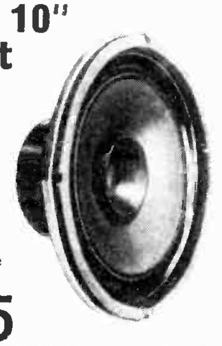

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Fitted Tweeter Cone
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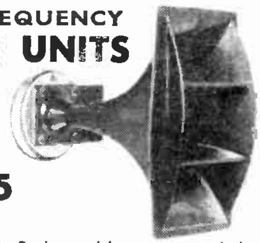

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Prices shown correct at July 17, 1974

Oscilloscope techniques

PART 7

ALAN AINSLIE

OSCILLOSCOPE APPLICATIONS

THE previous "chapters" on the oscilloscope should have given sufficient background for the reader to appreciate the functions of the essential controls of a typical oscilloscope. It is not considered necessary to go through the test of controls therefore, quoting their purpose, but where necessary special uses will be described in detail.

PHOTOGRAPHY

It is often necessary to provide on film a permanent photographic record of a trace. There are two different ways of going about this. If one has a lot of spare cash, or needs to take a lot of oscillographs, a special oscilloscope camera can be purchased to fit into the front of the scope. The film used is either normal or polaroid, providing "instant" pictures. The lens is normally of fairly large aperture (f2) and is provided with a focus control. Once focused this need never be done again unless the position of the tube or graticule is moved. There are so many different special cameras that it would be necessary to consult the instruction manual carefully before using one that is unfamiliar.

The approach taken by many amateurs is to use a conventional camera fixed on a tripod in front of the screen. Single lens reflex cameras (perhaps with extension tubes) make probably the best choice, the other types of camera needing measurements to be made of phosphor to film distance. Most simple cameras focus to 3ft. This is not close enough for oscilloscope photography and generally a 2 or 3 dioptre close up lens is fitted allowing photography to 10in. The actual distance must be measured as according to the details supplied with the supplementary lens, but as the measurements cannot be made to better than $\pm\frac{1}{4}$in. a small stop (f5·6, 8 or 11) is needed to give the necessary focusing latitude. Also one must bear in mind that in many cases the phosphor and graticule are separated perhaps by $\frac{1}{2}$in. this implies a still larger depth of field. Bearing these facts in mind the choice must come round to the single lens reflex, as focusing is easily accomplished, with great accuracy. It is also possible to see the exact area of the image in the view finder. Extension tubes may be needed with a single lens reflex to get close enough but it must be remembered that there is an accompanying increase in exposure required.

It is difficult to assess the required exposure but experience gives a clue of the appropriate magnitude. It must be remembered that the shutter takes 1/30th or 1/60th second to "scan" the whole of the image and this produces difficulties when the scan on the tube is of the same order of period. The only solution is to change to a slower speed, say $\frac{1}{2}$sec, or give a single shot exposure with the shutter open. When taking single shot pictures it is necessary to ensure that the waiting spot is fully extinguished or else the film will fog, The trace brightness is usually kept fairly low for maximum resolution of the CRT. The table gives typical exposures as used by the author with a Minolta SRT101 camera and 125ASA film with satisfactory trace brightness (as for normal viewing in a normally lit laboratory).

Sweep Speed	Mode	Shutter	Aperture
Very slow to 1ms/cm	Single Shot	Bulb	f5·6/f8
	Recurrent	Bulb to $\frac{1}{8}$	f11/f16
1ms/cm to 10μs/cm	Single Shot	Bulb	f4·5/f5·6
	Recurrent	$\frac{1}{8}$ to 1/30	f2/f2·8
10μs/cm to 100ns/cm	Single Shot	Bulb	f1·7
	Recurrent	1s	f2
100ns/cm and faster	Single Shot	Bulb	f1·7
	Recurrent	5s	f1·7

As the image is of contrast and not tones over-development can be used to increase film speed and overdeveloped Agfa pan 1000ASA can be rated at 2600ASA giving much more sensitivity, but the definition is not good, the image appearing to flare. When taking single shots at high speed it is necessary to ensure that the beam is not defocused when "bright up" is applied. This is checked by letting the timebase free run and noting the focus of the free running trace.

The graticule illumination (white not red) is set to be just visible in the view finder, this ensures that it will not overpower or mask the trace. When taking oscillographs of jittery signals or signals that are difficult to lock it is always best to take a single shot to avoid multiple images. On slow shutter speeds the single shot can be fired by the camera. A lead from the X sync socket on the camera (for electronic flash) is connected through a battery to the external trig socket on the scope. When the shutter is fired and open the battery is momentarily connected to the ext. trig socket on the scope, starting the time-base. This method ensures that the shutter is open as little as possible, admitting little extraneous light.

The room should be dark and the phosphor should be given time to settle down as it tends to glow a little after exposure to light. A cardboard tube can be placed between the lens and the screen, but is cumbersome and rather restricts accessibility of the camera controls. The prints can be made on hard or extra hard paper to create plenty of contrast and produce a clean image. Careful manipulation of the enlarger enables life-size prints to be made from which measurements can easily be taken.

LISSAJOUS FIGURES

No discussion of oscilloscope practice would be complete without reference to Lissajous figures. These figures are used for frequency comparison and can be extremely useful, and extremely accurate as they are a comparison method.

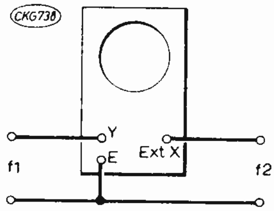

Fig. 1: Connections to scope for frequency measurements.

Fig. 1 shows how the signals are applied to the scope. The signal applied to the X amplifier must be well within its pass band to prevent phase shifts and non-linearity. Alternatively if a high signal level is available it can be fed directly to the CRT plates in the manner prescribed by the oscilloscope manufacturer. If the X and Y amplitudes are about equal then patterns will be seen when the two frequencies are at a ratio expressable by low value integers. Fig. 2 shows three simple patterns and the general case, where fx:fy is in the ratio m to n and the number of horizontal intercepts is n and the number of vertical intercepts is m.

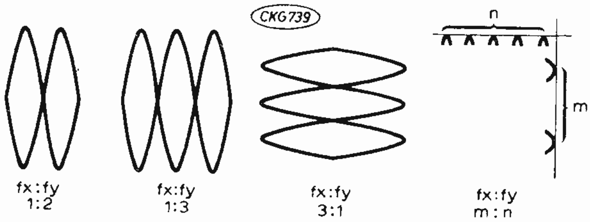

Fig. 2: Assessing frequency from Lissajous figures.

These figures are stationary when the ratio is an exact number and the signals are in phase, but a very slight change of frequency causes a changing phase difference and the pattern is seen to rotate slowly, the frequency of rotation being the frequency "error" of one of the signals. An accuracy of 1Hz is easily obtainable in setting an oscillator against a standard and 0·1Hz is not very difficult. The ratios, something:1, are easy to recognise without counting and enable oscillators to be calibrated against a standard very easily. When the signals are the same frequency, same amplitude and in phase a 45° line is drawn, a 90° phase shift giving a circle.

A variation of the above method is shown in Fig. 3. A circular trace is obtained, brightness modulated by the higher frequency. When a stationary trace is obtained the ratio of the frequencies is given by the number of bright spots on the trace. The 90° phase shift is given by the C and R network when $R=\frac{1}{2\pi fc}$ with C in farads. A $0\cdot1\mu F$ and $33k\Omega$ gives a near circle for a 50Hz supply.

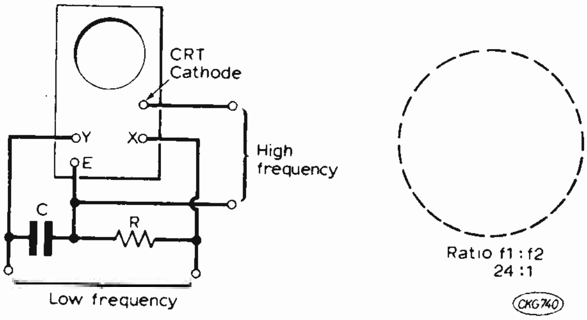

Fig. 3: Brightness modulationf or determination of frequency.

FREQUENCY BASES

In many applications it is required to show a plot of gain versus frequency for an amplifier, for example a TV IF strip or a selective amplifier. To produce such a display a sweep frequency oscillator or WOBBULATOR, is used. This produces an output whose frequency is dependent on the voltage at a certain input terminal. If this voltage is obtained from the timebase on the oscilloscope the frequency will shift with X deflection. Thus the X scale can be calibrated in terms of frequency. If the amplitude of the oscillator is constant (as it is arranged to be with a good design) for all output frequencies, the output of an amplifier driven by the wobbulator will, if fed to the Y amplifier, show on the screen of the scope as a frequency response plot.

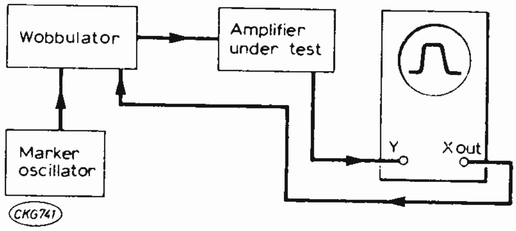

Fig. 4: Set-up for amplifier alignment.

This technique is used mainly for high frequency amplifiers in order to align them satisfactorily. In such cases the sweep speed must be slow (10 or 15 sweeps per second) in order that high Q tuned circuits can follow the changing frequency. A marker oscillator produces a "pip" on the display when the swept frequency and marker are at the same frequency, serving as calibration. Fig. 4 shows the general layout of the equipment as used for this type of test.

FM ALIGNMENT

The range of tests is very wide but the one application that is of great interest to the amateur is the FM detector alignment procedure. When aligning the FM strip there are two outputs to be monitored, the audio output (zero at 10·7MHz) and the response shape (max. at 10·7MHz). A double beam oscilloscope (chop or true DB) can be used to show the responses simultaneously. Fig. 5 shows the general method. The 10·7 marker is moved out of the way once 10·7MHz has been found as it can cause disturbing effects. The bandwidth (curve A) is usually about 200kHz depending on the quality of the IF transformers; but a narrower response may have to

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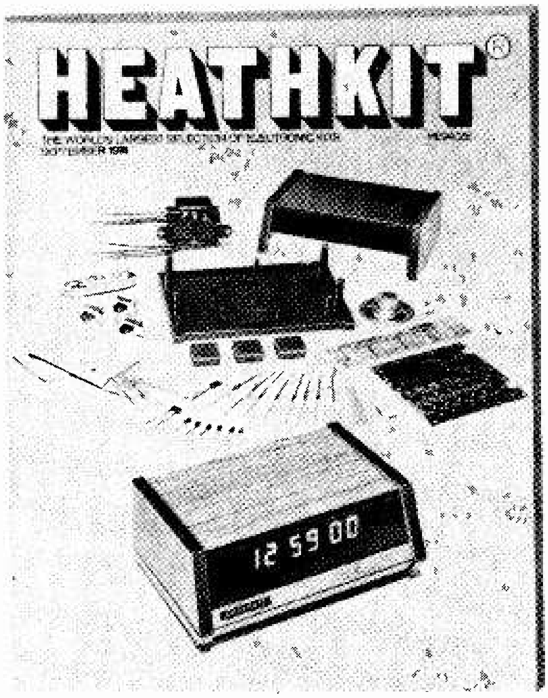

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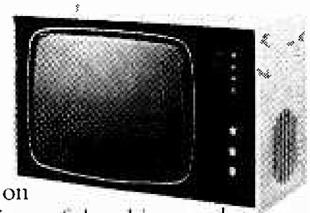

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be tolerated for a receiver that does not tune well, to avoid adjacent channel interference. An electrolytic is usually coupled in the discriminator circuit and this must be removed for curve A to show properly.

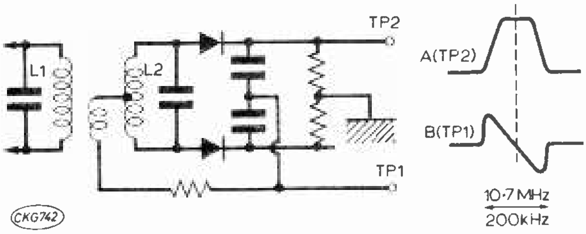
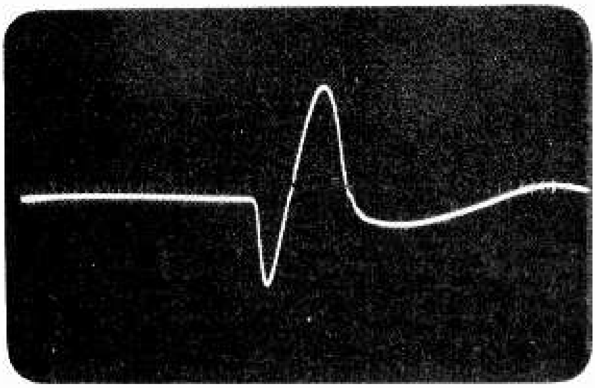


Fig. 5: Response curves of FM detector stage.

The sweep frequency can be in the audio band as this is, after all, how the discriminator will be used. The wobbulator output is applied to the grid of the last IF amplifier via a 4·7kΩ resistor. The discriminator coil L_1 is then adjusted to bring curve A to a maximum amplitude at 10·7MHz. The discriminator secondary L_2 is set so that the response B is symmetrically displaced about the 10·7MHz line. The wobbulator can then be introduced to the anode circuit of the frequency changer by wrapping a few turns of wire round the frequency changer valve, coupled to the inner core of the wobbulator signal lead. The IF cores are then trimmed to produce the required bandwidth.



Wobbulator response of poorly aligned domestic FM receiver. Response should be symmetrical and free from response outside pass band.

The input signal is kept as low as produces a reasonable trace for producing the curve A, to prevent limiting. The curve B is most faithfully reproduced as if in normal operation with the signal level of the wobbulator such that the IF amplifier is limiting, as shown by the tuning indicator or the fact that the response curve does not increase in amplitude as the wobbulator output is increased.

With transistor equipment the impedances are much lower so a direct connection must be made to the collector of the frequency changer via a 4·7pF capacitor and 100kΩ resistor in series, as near to the transistor as possible. This is to avoid detuning the first IF transformer.

RISE TIMES

It is often necessary to know the rise time of an active device (or indeed a passive device, such as a probe) in order that performance limitations can be appreciated. The method is simple enough; just inject a pulse of negligible rise time and measure the rise time coming out.

The best source of very rapid rise time pulses is probably the "mercury relay" type where a coaxial mercury relay alternately charges and discharges a transmission line into a load. With this type of arrangement rise times of only a fraction of a nanosecond are possible. Such a pulse can be used to measure the rise time of an oscilloscope directly and also shows up errors in the delay line. The snag (there is always one!) to this simple type of pulse generator is that a pulse repetition frequency (PRF) of much over 200Hz is very difficult to achieve, giving a dim trace even on a 10kV tube.

Solid state pulse generators using ICs can be easily designed to have rise times of about 9 or 10ns. Fig. 6 shows how a simple pulse generator can be constructed to operate from the output of a signal generator, giving pulses of about 10ns rise time, PRF same as frequency of input. The NAND gates are all in a single 7400 IC. The supply can be a 4·5V flat battery and the whole unit can be built up as a small probe pulse generator. The output of the signal generator is increased until pulses appear at the output and no difficulty should be found in operation. The unit will feed impedances over 5KΩ satisfactorily but a 4·7kΩ limiting resistor should be used with 75ohm cable output. If the wiring is neat and short a very good pulse is obtained up to a PRF of about 1MHz.

When assessing an amplifier the rise time can be shown to be:—

$$T_{amp} = T^2_{SCREEN} - T^2_{PULSE} - T^2_{CRO}$$

where T SCREEN is the displayed rise time, T PULSE is the rise time of the pulse, and T CRO is the rise time of the scope. This assumes that the

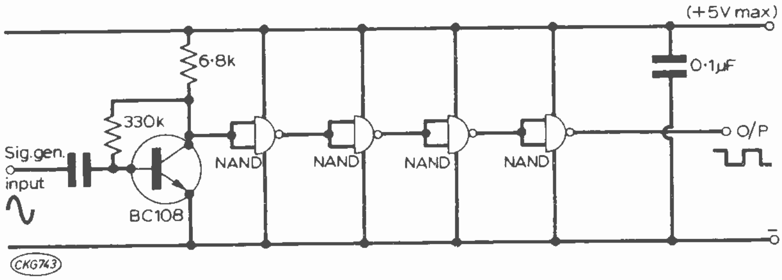


Fig. 6: Basics of a simple pulse generator using a single 7400 integrated circuit. It could be powered from a small 4·5V battery to make a very compact unit or probe.

network has a reasonable group frequency delay, which is usually the case unless tuned circuits are involved to produce other than a "flat" response.

Mercury relay type of pulse generator with rise time of less than 1ns.

In practice T CRO is measured by a mercury pulse generator and T PULSE found by displaying the pulse:—

$$T\text{ PULSE} = T^{2}\text{SCREEN} - T^{2}\text{CRO}$$

These pulse methods can be elaborated ad infinitum but the above relationship is the one to remember and in most cases will prove to give the required results to a fair degree of accuracy.

CONCLUSIONS

These few examples have served to give a little insight into the use of the oscilloscope. Of course there are many more applications and one field that we have not even been able to touch on is television, where perhaps the oscilloscope is used more than anywhere else. However, most of the uses in television involve the display and measurement of signals in very much the same way as we have considered earlier, the main difficulty being in the interpretation of the results displayed. In this series we have looked at various aspects of design, calibration and operation of oscilloscopes that are typical of those in everyday use in amateur laboratories and workshops and in industry. Armed with this basic knowledge it is not too difficult to delve further into the more specialised aspects of oscilloscopy and be able to devise the best method of presenting a visual representation of the dynamic operation of a circuit or system. ■

IN NEXT MONTH'S PRACTICAL WIRELESS

STARTING IN THE OCTOBER ISSUE
Want to know who stocks what in electronic components? Are you sometimes confused over carriage and V.A.T. charges? Do you want a permanent listing of component suppliers? Can you identify circuit symbols and know what to ask for when ordering? All these questions plus a few more will be answered in the next four issues of Practical Wireless.

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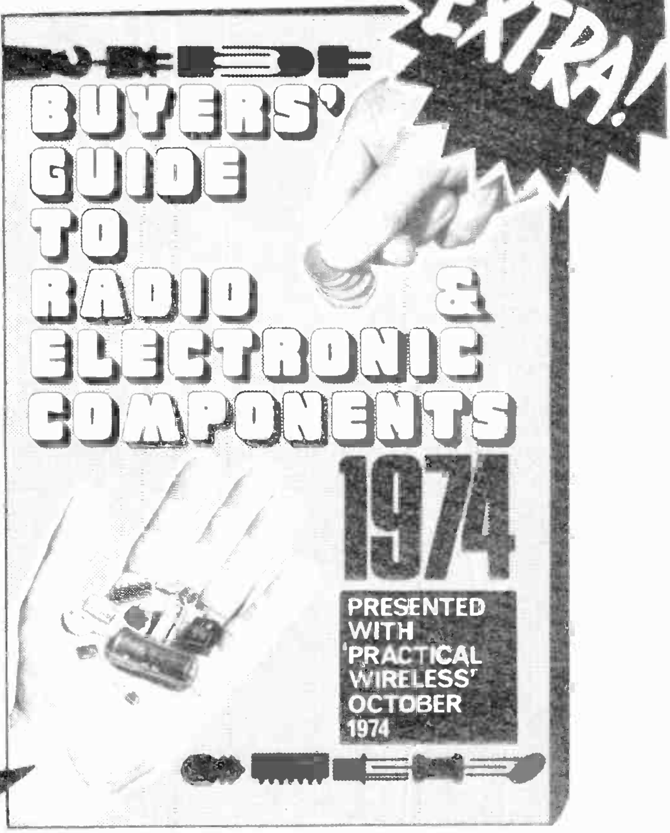

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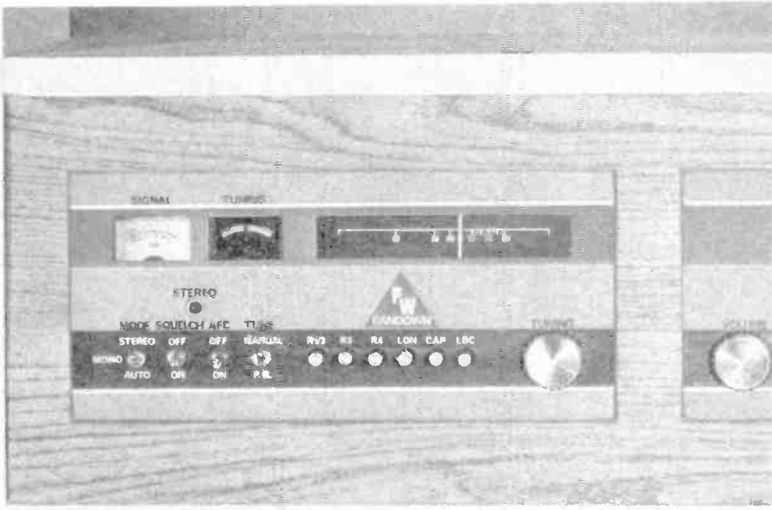
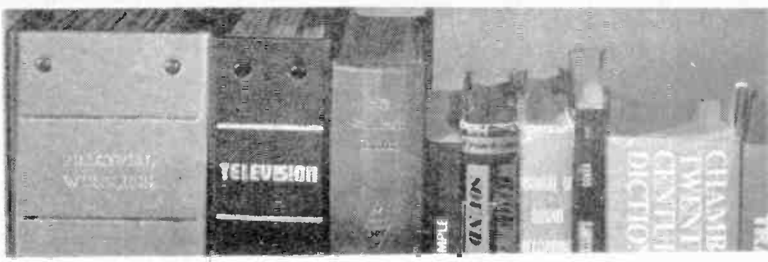
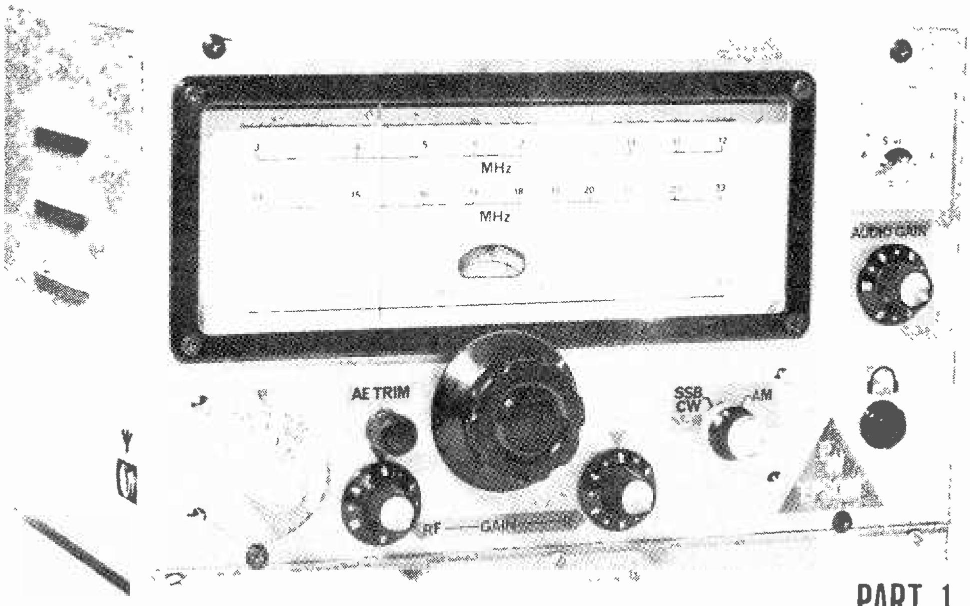




MANY OTHER CONSTRUCTIONAL ARTICLES AND FEATURES. ON SALE IN SEPTEMBER

The above details are subject to the national industrial situation at the time of going to press.



PW EPSOM

GEN COVE

PART 1

AFTER listening around the short wave bands on various transistorised receivers it is very evident that they were all prone to an effect known as "cross-modulation". Transistors have a very limited linear input characteristic compared to valves so that early stages in a transistorised set are easily overloaded by strong input signals.

The resulting non-linearity causes strong signals to be impressed upon weak ones even when the two signals are widely spaced in terms of frequency. Two or more strong signals will combine to produce more spurious signals and the general impression is of reduced sensitivity in the presence of strong signals.

The early tuned stages should be capable of rejecting unwanted signals but strong signals can be found to exist on the leads of the transistors themselves by direct pick-up, thus driving them into non-linearity. This effect is not unknown to users of solid state hi-fi equipment when broadcast or TV signals break through from local or semi-local transmitters.

Valves can tolerate input signals of the order of volts before becoming non-linear compared to the few hundred milli-volts of transistors. To the best of my knowledge nobody has yet come up with a practical design for a transistorised receiver front-end that can equal the performance of, say, a valve series-cascode circuit using a common ECC84 and conventional components. To listen round on a receiver so equipped is a revelation, the bands seem to go quiet as the spurious teletype and jamming stations disappear and weak stations can be copied in the presence of strong signals on adjacent channels.

Transmitting radio amateurs are well aware of the problem of cross-modulation, even more so now with the rapid increase in the use of imported transceivers which are generally solid state except for the odd valve or two in the transmitter section. It is interesting to see that one of the latest designs, the FT501, has resorted to a valved front-end using the old fashioned 6BZ6 and 6U8! Nuff sed!

It must be remembered that the mixer stage of a superhet is sometimes the culprit in cross-modulation problems especially if it is preceded by an RF amplifying stage. With an efficient mixer stage an RF stage should not be required. While pentodes and triodes can be used to advantage in front-ends there is another valve, the beam deflection valve, that is even better as a mixer. The 7360 appeared around 1960 but the later and current 6JH8 has better characteristics and is considerably cheaper.

Bill Squires W2PUL repeated (QST September 1963) the principles outlined by Goodman in 1957 that a receiver capable of preventing cross-modulation and overload should have:—

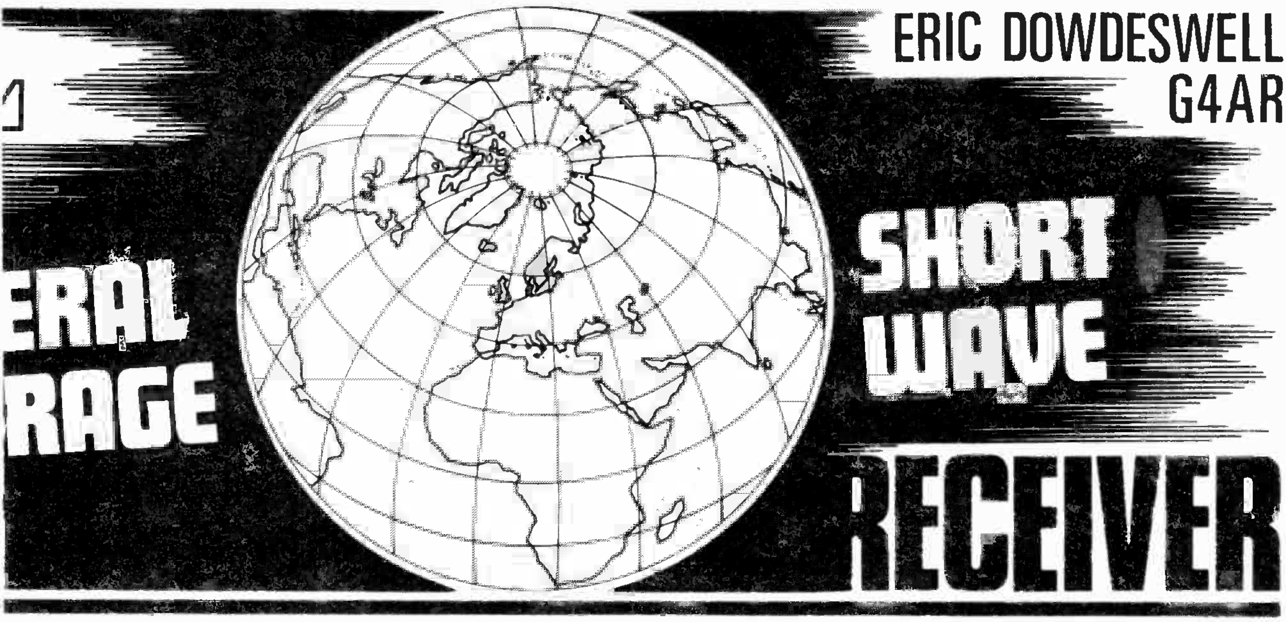
As little gain as possible before applying maximum selectivity.

Excellent linearity in any stage preceding the selectivity.

Squires therefore concluded that the ideal receiver should not have an RF stage, as few conversions as possible and that the mixer should be a linear device like a Class A amplifier . . . "conventional mixers perform only because they are non-linear . . . the local oscillator swinging the tube from nearly zero bias to nearly cut-off and no tube is linear near cut-off or near zero bias. As long as the signal is very small compared to the local oscillator voltage the mixer is quite linear but when the signal grows large violent cross-modulation occurs".

He went on to describe a mixer stage using the 7360 in which mixing takes place by switching the valve's electron stream between two anodes by means of deflector plates driven by the local oscillator voltage. See valve symbol V1 in Fig. 2. Up to the deflector plates the valve resembles a conventional pentode.

PW SUPER SEPARATES



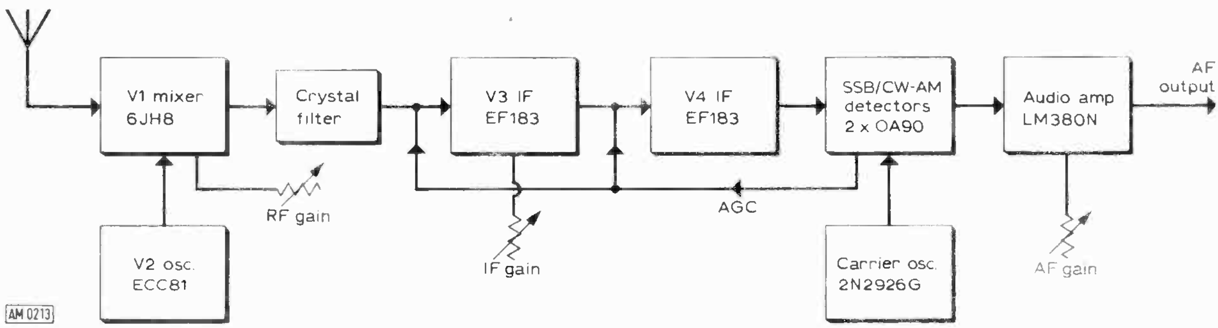


Fig. 1: Block diagram to show the functions of the various stages in the receiver.

W2PUL again . . . "since the two output anodes can be operated in push-pull the valve can be inherently balanced against the input signal frequency, hence good IF rejection".

No RF stage is used with the receiver described here but because of the problem of second channel interference (signals 2 × intermediate frequency from signal frequency) a much higher IF is required than the conventional 455kHz. In this design the IF is 5·5MHz, second channel now being 11MHz away from the signal frequency and adequately attenuated by two tuned circuits at signal frequency. Several circuits and much useful information on the 7360/6JH8 can be found in Pat Hawker's book, **Amateur Radio Techniques** published by the RSGB.

THE DESIGN

The circuit used in the "Epsom" is a hybrid one, using valves in the mixer and two IF stages, where linearity is important, and the first oscillator stage. Diodes are employed in the switchable AM or SSB/CW detector while the associated carrier insertion oscillator (CIO) uses a transistor. The single audio stage utilises an LM380N integrated circuit. The general arrangement is shown in Fig. 1.

In detail, it will be seen from Fig. 2 that the signal passes via the 5·5MHz IF signal trap L1/C1 to the two capacity coupled tuned circuits L2/VC1 and L3/VC2 which feed the signal grid of the 6JH8 mixer V1. Three pairs of plug-in coils cover the whole of the tuning range. The first oscillator V2, an ECC81, employs the very effective cathode coupled oscillator circuit, Fig. 4. Harmonic content is low and a minimum of components contributes to good stability.

The oscillator tuning range is 8 to 18MHz only, no bandswitching being required, the oscillator frequency being added to or subtracted from the input signal frequency in the mixer stage to produce the intermediate frequency of 5·5MHz thus:—

MHz Signal Tuning Range	Osc. Tuning Range MHz
2·5 to 12·5	+5·5MHz=8 to 18
13·5 to 23·5	−5·5MHz=8 to 18

The gap between 12·5MHz and 13·5MHz does not contain any broadcast or amateur band. There is also a gap in the tuning around the set's IF of 5·5MHz but again this is not an important part of the short wave spectrum. Another important aspect of this method of mixing is mentioned later when discussing sideband switching.

The oscillator voltage, approx. 3V RMS, is applied to the deflection plates of the mixer. A balanced circuit is desirable here but the practical difficulties

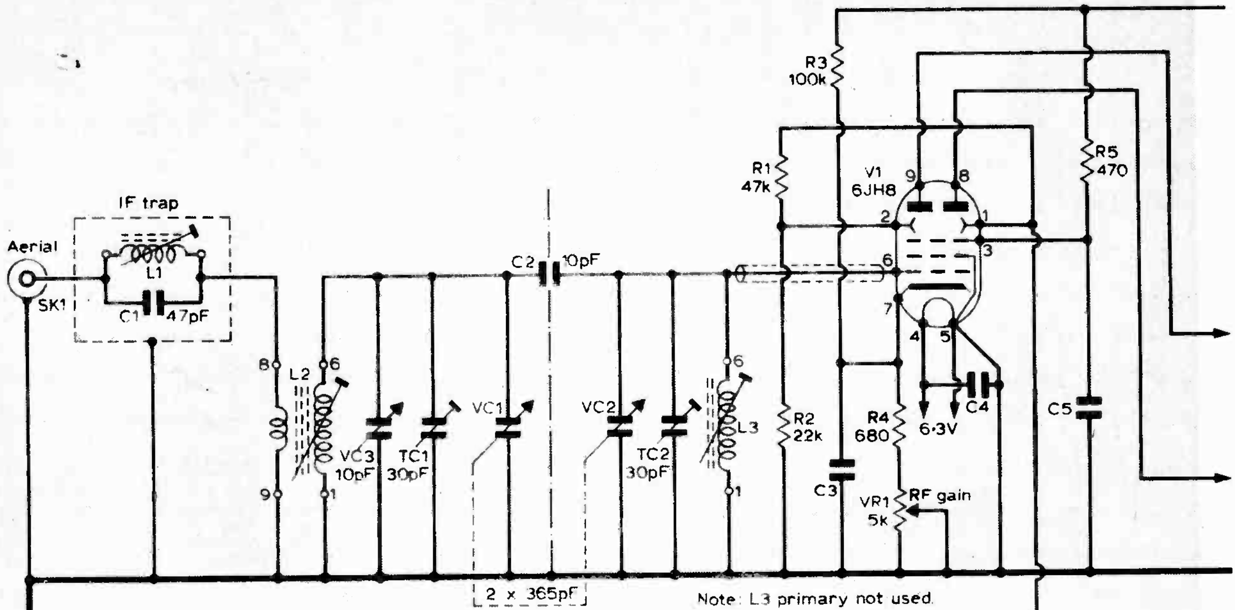


Fig. 2: The input signal is fed to the 6JH8 beam deflection mixer stage via an IF trap and two tuned circuits. The injection voltage applied to the deflection plates is derived from the first oscillator stage, Fig. 4.

AM 0214

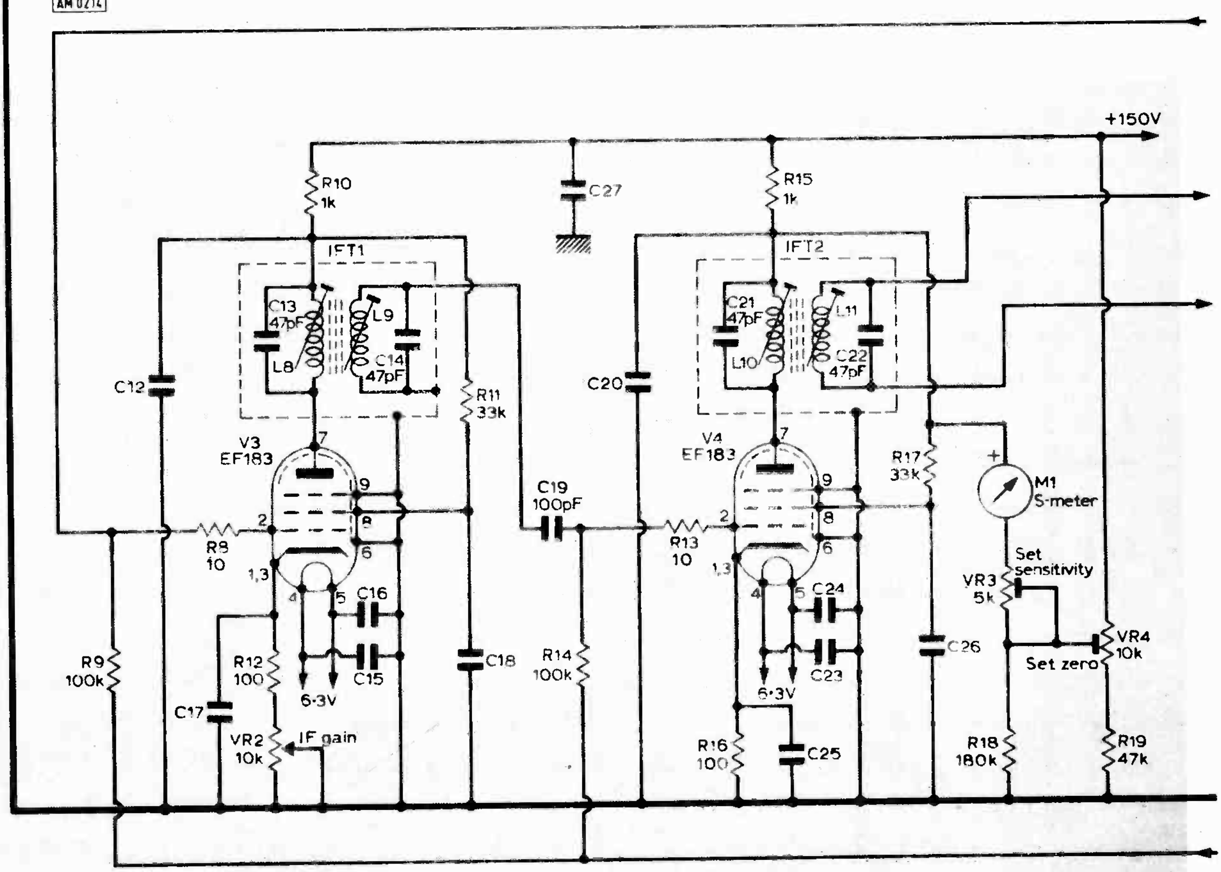


Fig. 3: The low-level signal from the filter is amplified by this two stage amplifier operating at 5·5MHz. Its gain can be controlled manually and by the AGC voltage on AM reception.

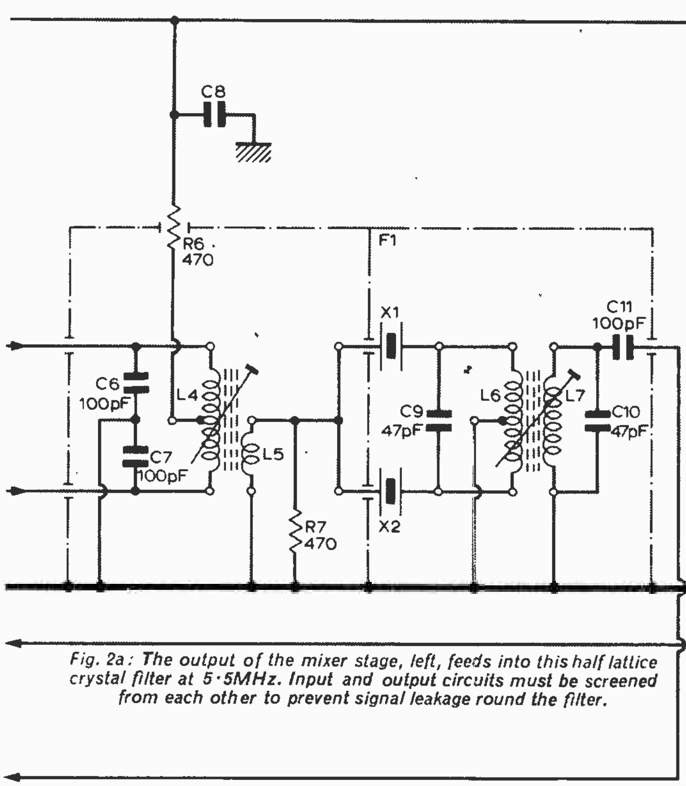


Fig. 2a: The output of the mixer stage, left, feeds into this half lattice crystal filter at 5·5MHz. Input and output circuits must be screened from each other to prevent signal leakage round the filter.

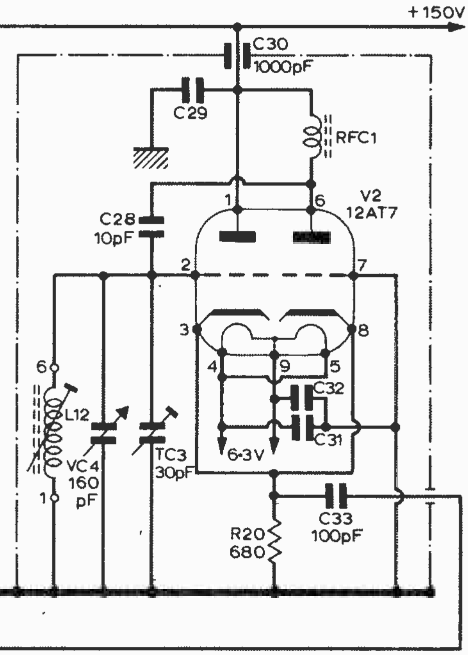


Fig. 4: The first oscillator stage uses very few components. Stability is improved by the absence of any bandswitching complications.

AM 0215

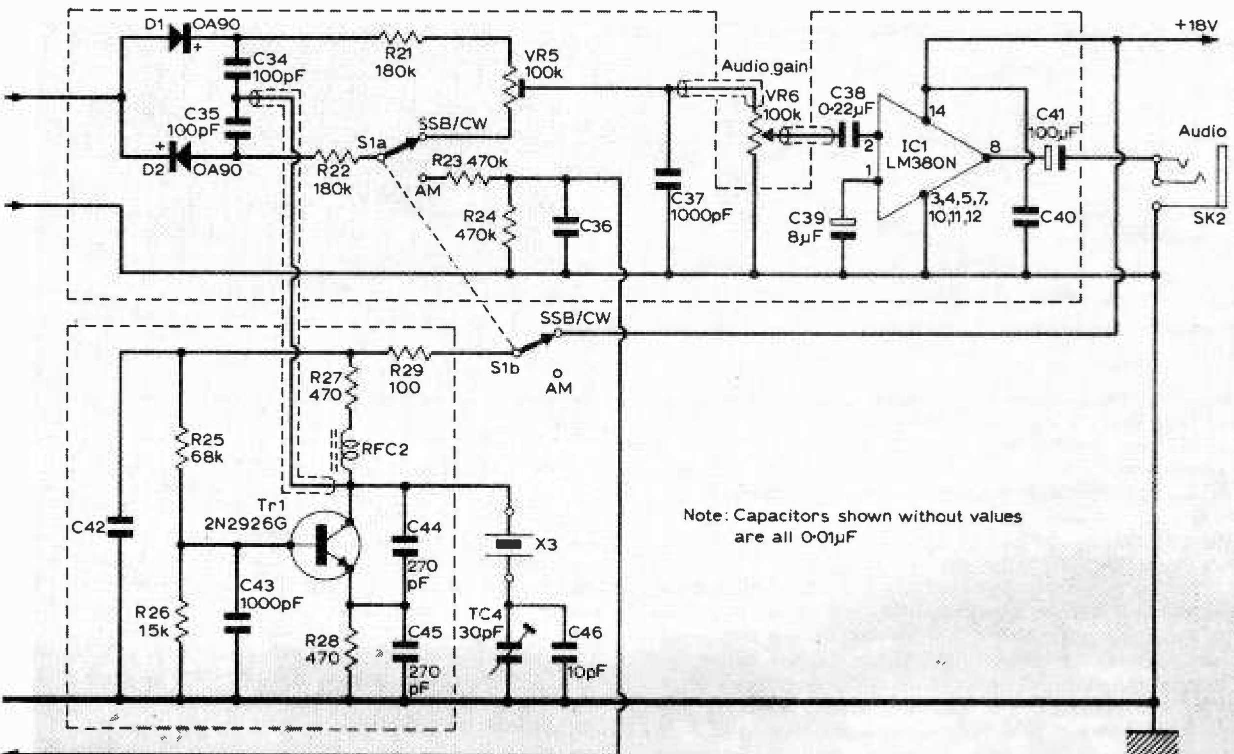


Fig. 5: The output of the IF amplifier, left, feeds a diode detector switchable for optimum operation on SSB/CW or AM reception. The resultant audio is amplified by the LM380N audio IC. The carrier insertion oscillator Tr1 operates only on SSB/CW.

★ components list

Resistors

R1 47kΩ	R11 33kΩ	R21 180kΩ
R2 22kΩ	R12 100Ω	R22 180kΩ
R3 100kΩ	R13 10Ω	R23 470kΩ
R4 680Ω	R14 100kΩ	R24 470kΩ
R5 470Ω	R15 1kΩ	R25 68kΩ
R6 470Ω	R16 100Ω	R26 15kΩ
R7 470Ω	R17 33kΩ	R27 470Ω
R8 10Ω	R18 180kΩ	R28 470Ω
R9 100kΩ	R19 47kΩ	R29 100Ω
R10 1kΩ	R20 680Ω	

All 5% or 10% and ⅓ or ½ watt

VR1 5kΩ lin.	VR2 10kΩ lin.	VR3 5kΩ lin. preset
VR4 10kΩ lin. preset	VR5 100kΩ lin. preset	VR6 100kΩ log.

Capacitors

C1 47pF SM	C16 0·01μF DC	C31 0·01μF DC
C2 10pF SM	C17 0·01μF DC	C32 0·01μF DC
C3 0·01μF DC	C18 0·01μF DC	C33 100pF SM
C4 0·01μF DC	C19 100pF SM	C34 100pF SM
C5 0·01μF DC	C20 0·01μF DC	C35 100pF SM
C6 100pF SM 5%	C21 47pF SM	C36 0·01μF DC
C7 100pF SM 5%	C22 47pF SM	C37 1000pF DC
C8 0·01μF DC	C23 0·01μF DC	C38 0·22μF DC 25V
C9 47pF SM	C24 0·01μF DC	C39 8μF 25V
C10 47pF SM	C25 0·01μF DC	C40 0·01μF DC
C11 100pF SM	C26 0·01μF DC	C41 100μF 25V
C12 0·01μF DC	C27 0·01μF DC	C42 0·01μF DC
C13 47pF SM	C28 10pF SM	C43 1000pF SM
C14 47pF SM	C29 0·01μF DC	C44 270pF SM
C15 0·01μF DC	C30 1000pF FT	C45 270pF SM
	C46 10pF SM	

DC=Disc Ceramic 250V SM=Silver Mica FT=Feedthrough
VC1/2 2 x 365pF (Jackson 02) VC3 10pF variable
VC4 160pF variable (Jackson Wavemaster 92/057/160)
TC1/2/3/4 30pF airspaced trimmers, beehive type

Semiconductors

D1/2 OA90 IC1 LM380N Tr1 2N2926G

Valves

V1 6JH8*	V2 ECC81 (12AT7)
V3 EF183	V4 EF183

* obtainable from Electronic Component Supplies, Thames Avenue, Windsor, Berks.

Crystals

X1 5·5008MHz X2 5·5024MHz X3 5·5000MHz

Nominal frequencies. A kit of the three crystals (Type HC6U) with holders is available from Senator Crystals, 36 Valleyfield Road, London SW16 2HR for £7·43 inc. VAT and P/P. Kit reference SC/PW/533

Inductors

L1 see text
L2/3 'Blue' Ranges 3, 4 and 5, two of each. (Denco miniature dual purpose)
L4/11 see text
L12 'Blue' Range 4 (Denco miniature dual purpose)
RFC1/2 RF choke 2·5mH miniature, ferrite core

Metalwork

Aluminium cabinet and panel (12 x 7 x 7in.) (Type W)

Chassis 9 x 6¾ x 2in. but see text

Aluminium box with lid 3 x 2 x 1in. (1 off) 4 x 2¼ x 1¼in. (1 off)

Screens from 18swg aluminium 15 x 1¾in. with ¼in. flange.

Panel bracket 4 x 4in.

The above metalwork is available from H. L. Smith & Co. 287 Edgware Road, London W2.

Miscellaneous

Valveholders B9A (ceramic or PTFE) with skirt and screen (4 off) without skirt (2 off). Switch S1 2 pole 2 way wafer switch. 14 pin DIL socket for IC1. Dial, Eddystone Type 898 or Jackson Type 4103 see text. Slow motion drive (Jackson Type 4511/4). Flexible coupling for ¼in. spindle.* Coil formers 1¾in. x ¼in. dia. with square base (Home Radio CR12) and screening cans (CR13) (5 off each). Dust cores (CR19) (7 off). Sk1 coaxial aerial socket. Sk2 stereo jack socket. S-meter 1mA Type MR52P (Henry's Radio). Calibrated knobs (3 off) (H. L. Smith Type F21). Plain knobs (3 off). Screened cable, 4 way. Stand-off insulators (12 off).*

Veroboard 5 x 1¼in. 0·1in. matrix, 2½ x 1¼in. 0·15in. matrix. Veroboard plain 2¼ x 1½in. 0·15in. matrix.

*Available from H. L. Smith & Co.

involved are not easy to overcome. The output circuit of the mixer is kept very carefully balanced however so that any input signal voltages present at the mixer output are cancelled out as far as is possible, as mentioned previously. A small trimming capacitor is sometimes added to one side or the other of the mixer anodes circuit to ensure best balance but it was not thought to be necessary here.

The IF filter unit Fig. 2a is full screened to prevent signal leakage across the filter and comprises two crystals X1 and X2 in a half lattice arrangement, with associated coils. Senator Crystals have agreed to supply a kit of these crystals plus the carrier insertion oscillator crystal X3 and three holders. The crystals are produced to close tolerances and it is hoped thereby that readers will be able to reproduce the results obtained by the author without too much difficulty. Commercial HF crystal filters are very expensive but perform better, of course, than the simple filter used here.

A feature of this particular receiver is that with a CIO crystal of precisely 5·5MHz and a single tuning range in the first oscillator the calibration problems are very considerably reduced, as will be seen later during the alignment procedure.

The filter output from L7 goes to conventional IF amplifying stages V3 and V4, Fig. 3, using EF183 frame grid valves. "Conventional" is perhaps not quite correct since the IF stages are operating at 5·5MHz! The signal grids are also connected to the AGC line and the gain of V3 can also be varied by the IF gain control VR2. The S-meter monitors signal levels on AM and is operated by V4, the AGC voltage being derived from the signal. IFT1 and IFT2 peak the 5·5MHz IF signal which is then fed from L11 to diodes D1 and D2, Fig. 5, which are switched

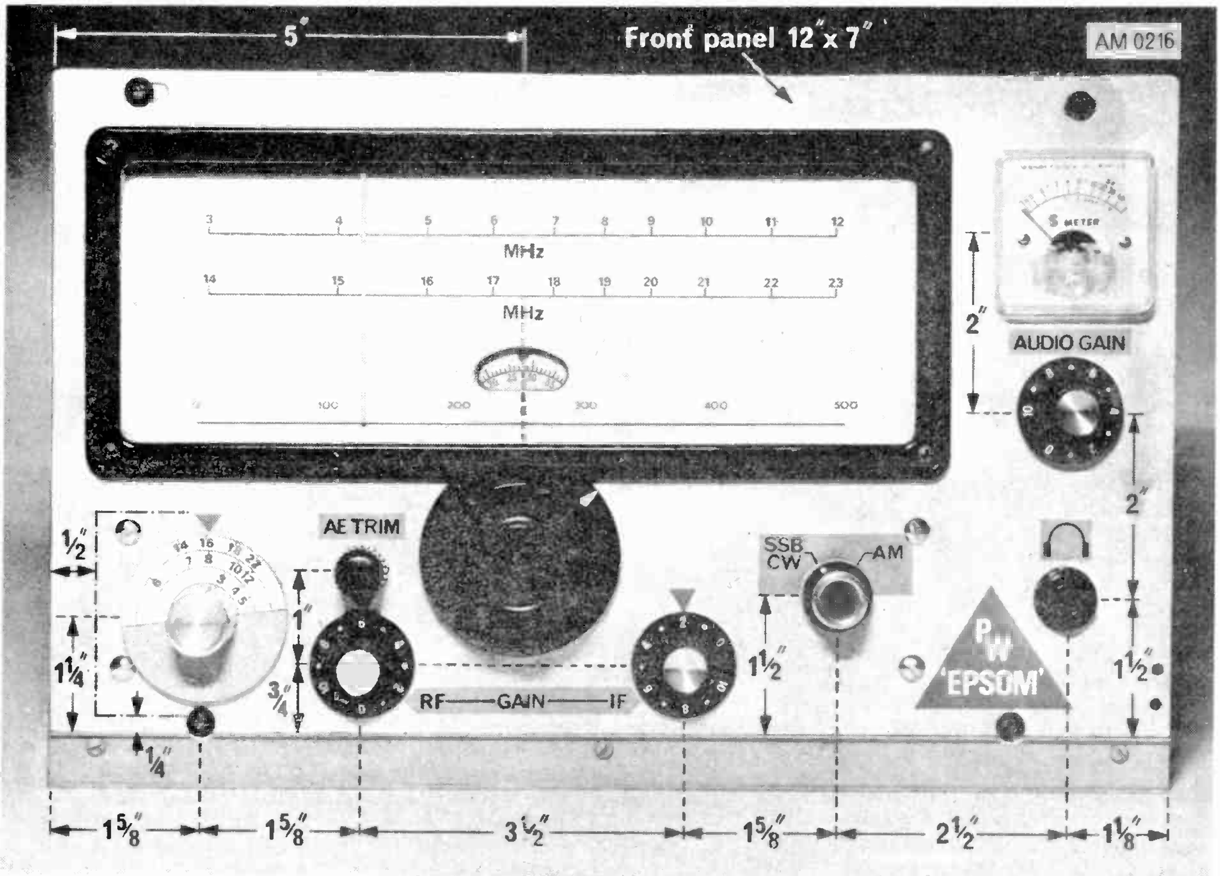
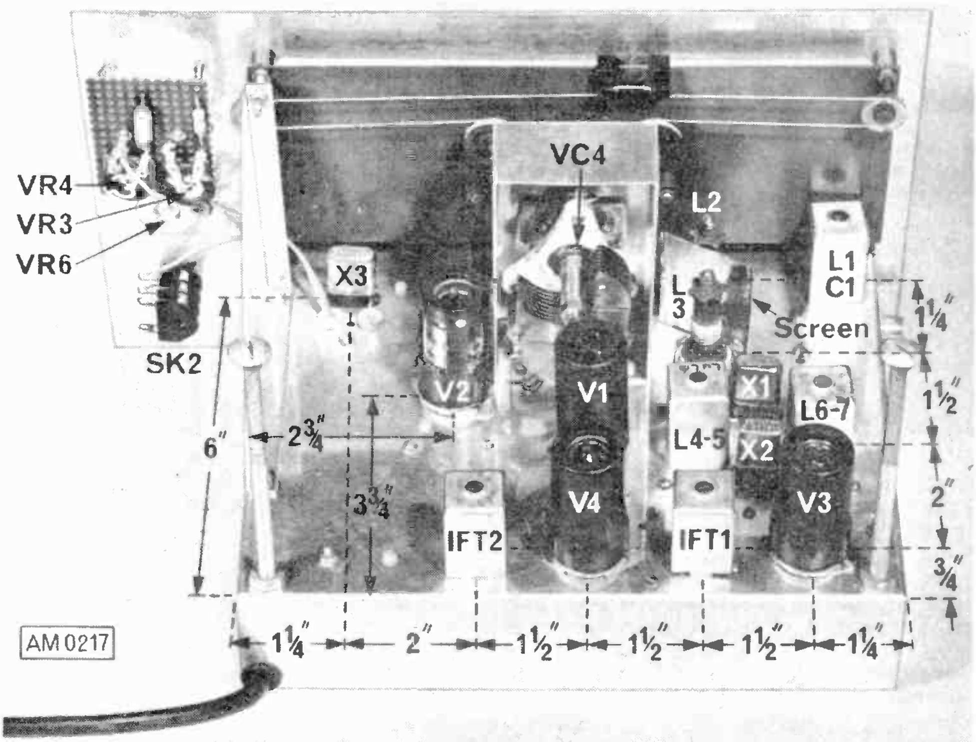


Fig. 6: above. Location of the components mounted on the panel is shown in this photograph. The left hand edge of the chassis is indicated to show its position on the panel. Fig. 7: below, identifies the components mounted on top of the chassis. The long bolts, subsequently removed, are of great assistance when working on wiring etc. inside the chassis.



Sinclair Cambridge kit. Was £27·45. Now only £14·95! (INC VAT) You save £12·50!

An advanced 4-function calculator in kit form
The Cambridge kit is the world's largest-selling calculator kit.

It's not surprising – no other calculator matches the Sinclair Cambridge in functional value for money; and buying in kit form, you make a substantial saving.

Now, simplified manufacture and continuing demand mean we can reduce even the kit price by a handsome £12·50. For under £15 you get the power to handle complex calculations in a compact, reliable package – plus the interest and entertainment of building it yourself!

Truly pocket-sized
With all its calculating capability, the Cambridge still measures just $4\frac{1}{3}$" x 2" x $\frac{11}{16}$". That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of normal use before replacement.

Easy to assemble
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

Total cost? Just £14·95!
The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £21·95 – so you're saving £7! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.

Features of the Sinclair Cambridge

- Uniquely handy package. $4\frac{1}{3}$" x 2" x $\frac{11}{16}$", weight $3\frac{1}{2}$ oz.
- Standard keyboard. All you need for complex calculations.
- Clear-last-entry feature.
- Fully-floating decimal point.
- Algebraic logic.
- Four operators (+, −, x, ÷), with constant on all four.
- Constant acts as last entry in a calculation.
- Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £15.
- Calculates to 8 significant digits.
- Clear, bright 8-digit display.
- Operates for weeks on four U16-type batteries

by S1 to operate either as a normal diode detector on AM or as a product detector on SSB and CW. In the latter modes the crystal controlled CIO, Tr1, is switched on and fed to the diodes via C34 and C35.

The CIO crystal X3 is 800Hz lower in frequency than X1 in the filter unit and it is important to note that the change from lower sideband (LSB) to upper sideband (USB) is automatically achieved by the additive and subtractive method of mixing mentioned previously. Thus only one CIO crystal is required. Generally LSB is employed below 10MHz and USB above. The precise frequency of X3 is adjusted by TC4 for best resolution of SSB signals.

The negative AGC voltage is obtained from the detector stage on AM only, being developed across R23 and R24 and fed to the IF stages V3 and V4. An SSB/CW the product detector output is switched across the preset resistor VR5 which can be adjusted to give virtually complete rejection of an AM signal, the null being quite sharp. This adjustment ensures correct operation of the PD on SSB/CW.

From VR5 the audio signal goes to the volume control VR6 before feeding the audio IC. Capacitor C39 on pin 1 of the IC helps to reduce hum and noise on the 18V supply line. (Further information on using the LM380N IC can be obtained from the December 1973 issue of *PW*). The output of the IC is fed via C41 to the panel stereo headphone socket Sk2. The output impedance is low, intended to operate a speaker of 4-16 ohms, but in this case a pair of stereo headphones is used, the units being connected in parallel at the socket. This may be a breakaway from the conventional high impedance headphones generally used with receivers but it is hoped that since stereo headphones are now very commonplace it will induce short wave listeners to use them instead of a loudspeaker!

Another point to note is that the AGC voltage is not applied to the mixer stage since it is very unlikely that it will ever be overloaded! In consequence the usual signal grid DC blocking capacitor and resistor are omitted which means that large blocking voltages cannot build up on the signal grid, such as can occur in the vicinity of a transmitter.

The number of components has been kept to a minimum, only 29 resistors in the receiver proper and 46 capacitors of which 21 are 0·01μF decoupling capacitors! With the exception of components comprising the various tuned circuits (RF and IF) the values of the resistors and capacitors generally are not very critical, an important point in a period of component shortages. Resistor R20 in the cathode circuit of the first oscillator V2 was adjusted carefully for maximum oscillator output to the mixer stage and the value of 680 ohms specified should be used. An attempt has also been made to reduce the number of different values required of resistors and capacitors.

CONSTRUCTION

Remember that the valves, S-meter and crystals are relatively fragile so do not undertake the drilling or cutting of any holes in the chassis when any of them are in position on the chassis, especially if a power drill is being used. In practice it is unnecessary to touch them at all until after all the wiring is completed and double checked.

When wiring the valveholders fit any old unserviceable B9A based valves into the valveholders. This will keep the pin sockets in their correct positions and prevent any soldering resin from entering them. Once the wiring to the holders has been completed don't forget to remove the old valves! If construction periods are limited it might be some while before the work is finished and the old valves could be easily overlooked. A short-circuited heater winding could result, or even worse!

The chassis as supplied by H. L. Smith to go with their cabinet and panel is 11 x 6¾ x 2in which is 2in longer than that used in the prototype. If this chassis is used it is only necessary to keep the various stages in the positions round the edges, as shown in the layout, increasing the length of the leads from the output of the IF strip, L11, to the product detector board. More space will be available in the centre of the chassis and a possible refinement could be the placing of the CIO board and its external components in a separate screened compartment.

The general layout of the components on the chassis and panel is shown in the photographs Figs. 6 and 7, but it is not necessary to copy it precisely provided the usual precautions are taken with screening between stages, short wiring in RF circuits etc. The dial used in the prototype, an Eddystone E898, has seen service on several other bits of equipment over the years and a new one today is rather expensive. The Jackson 4103 dial, available from H. L. Smith Ltd., is a suitable substitute having blank calibration scales as well as a two-speed drive mechanism.

Once the major cut-outs and holes have been made in them the panel and chassis can be bolted together, after ensuring that all burrs on holes have been removed. Then, two 5in bolts, about ¼in dia, are bolted temporarily to the rear of the chassis top. These are absolutely invaluable in keeping the chassis level when it is upside down for wiring and testing and they need only be removed when the set is finally installed in its cabinet.

The fitting of the main internal screens can be left to the end when all the wiring is finished, small cut-outs being made along the inside edges of the screens as required to clear wiring passing under the screens.

Part 2 will continue with the construction of the 'Epsom' and also deal with the power supply. The simplified alignment procedure will then be described.

★ components list

POWER SUPPLY UNIT

R1	33Ω ½W	C1	350μF 350V
R2	5kΩ 10W WW	C2	2000μF 30V
R3	100Ω ½W	C3	2000μF 30V
R4	22kΩ 2W	F1	Fuse 1A
R5	33Ω ½W	F2	Fuse 250mA

Miscellaneous

D1/2/3, 1N4007. S1, 2 pole on-off. S2, Single pole on-off. Fuseholders (2). Valveholders B7G (2). Cable plug B7G. Panel indicator lamp 6·3V. T1, Transformer 250-0-250V 80mA, 6·3V + 6·3V (Douglas MT1AT). Case 8 x 6 x 6 in. (H. L. Smith & Co. Type U). RV1, voltage stabiliser OA2. Speaker 6 x 4 in. elliptical 8Ω, with cable and jack plug. Speaker grill.

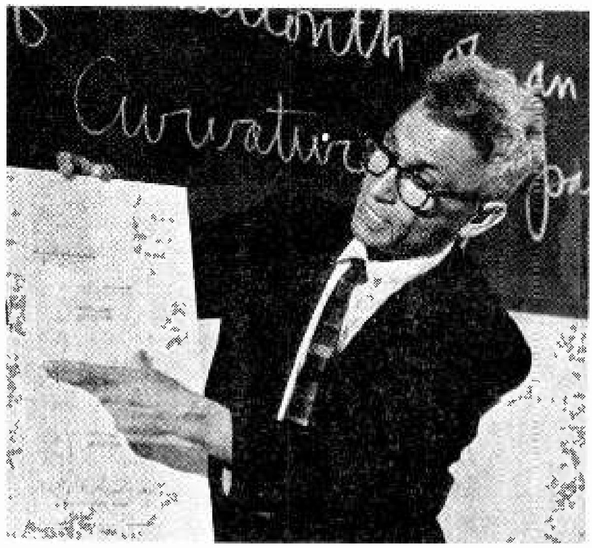
For convenience the components list for the power supply unit is given here. The unit will be described in Part 2.

J. B. DANCE M.Sc.

Gravitational waves

MAN has detected various types of waves arriving at the surface of the earth. Until recently all of these waves have been forms of electro-magnetic radiation (radio-waves, infra-red, visible light, ultra-violet rays and X-rays). However, Professor Joseph Weber of the University of Maryland has recently detected a completely new type of radiation known as 'gravitational waves'.

The gravitational waves detected by Weber appear to come from the centre of our galaxy and will doubtless bring us valuable scientific information. Like radio waves, they carry energy and move at the speed of light. Although gravitational waves were predicted by Einstein's work on general relativity, over half a century has elapsed before we have been able to make a practical detector which is sensitive enough to detect them.



Professor Weber lecturing on his work of detecting gravitational waves. Comparisons are made of charts taken from detectors 1000km apart.

GENERATION

If one wishes to produce an electro-magnetic wave, one must accelerate a charged particle. For example, an electron which is being accelerated in a radio aerial will generate radio waves, whilst an electron accelerated in an atom produces light or another form of radiation. Gravitational waves can be generated by accelerating large masses. It is not possible to generate detectable amounts of gravitational radiation in the laboratory, since one would have to accelerate objects at least as heavy as the earth. One can therefore only build suitable detectors and hope that gravitational waves of an adequate intensity reach the earth from astronomical sources.

Gravitational radiation shows very little tendency to interact with matter and is therefore extremely difficult to detect. A gravitational wave can pass completely through the earth almost unaffected!

WEBER'S WORK

Weber started his work on gravitational detectors in 1958 but few people thought he had any real chance of being successful. His equipment consists essentially of a large solid aluminium cylinder about five feet in length by two feet in diameter. It is suspended from a wire in a vacuum chamber in order to minimise damping.

When a gravitational wave of about the resonant frequency of the cylinder (1660Hz) reaches the equipment, the cylinder begins to oscillate with an amplitude of less than one hundred million millionth/cm. Although this is less than the diameter of a proton, Weber has used a system of piezo-electric transducers to convert the oscillations into electrical signals.

Unfortunately the cylinders pick up natural seismic vibrations of the earth and may be affected by other phenomena, such as cosmic rays. In order to eliminate such effects, Weber has set up two detectors 1000km apart; he records a signal only when both cylinders oscillate simultaneously. This occurs about once per day. Such simultaneous disturbances at large distances cannot be due to seismic effects.

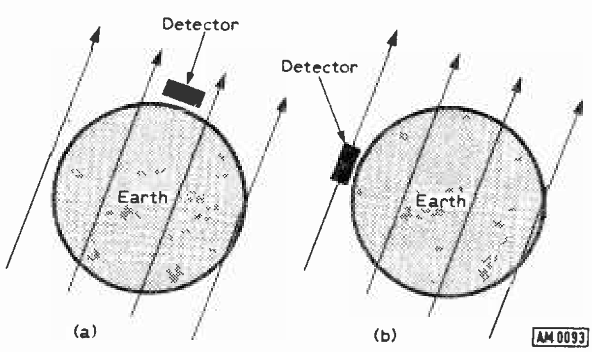
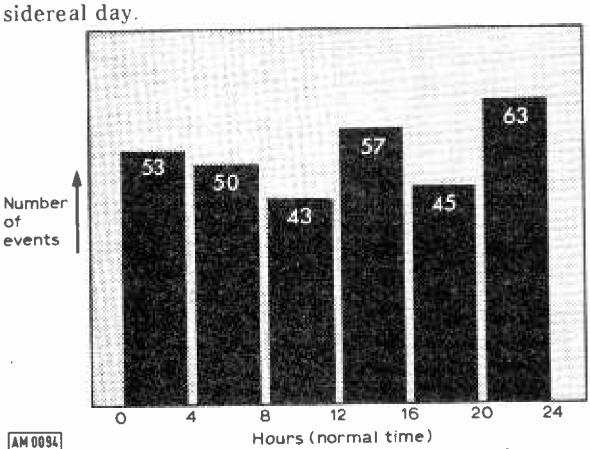


Fig. 1(a): The detector is sensitive to radiation in a direction perpendicular to axis of cylinder. (b) The detector is insensitive in this orientation.

Weber's detectors are sensitive to waves which arrive from a direction perpendicular to the axis of the cylinder, Fig. 1. As the earth moves, the direction of maximum sensitivity scans the universe.

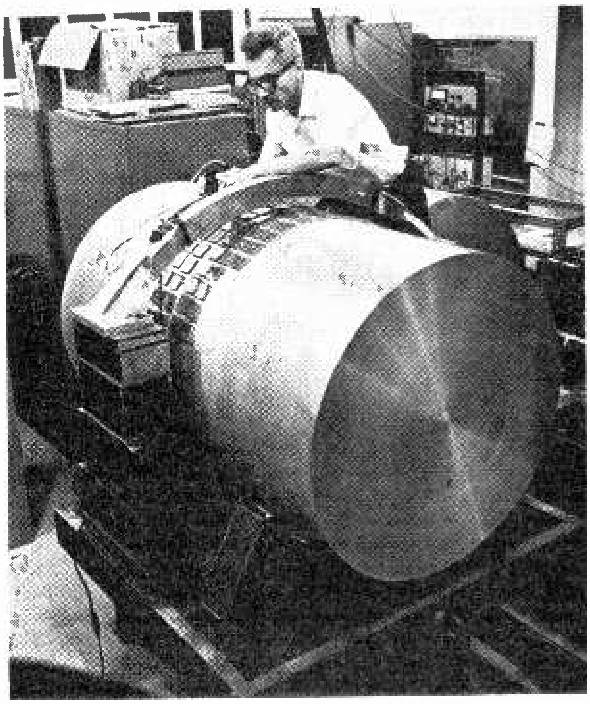
ORIGIN

Weber found that the detectors did not oscillate more frequently at any particular time of day when the results were averaged over a period, Fig. 2. If, however, the time of the simultaneous oscillations are plotted against sidereal time (that is, the time of the earth's rotation relative to the background of stars), then it is found that the oscillations occur most frequently when the direction of greatest sensitivity of the detector points towards (or away from) the centre of our galaxy. This is shown in the histogram of Fig. 3 where two peaks occur per sidereal day.



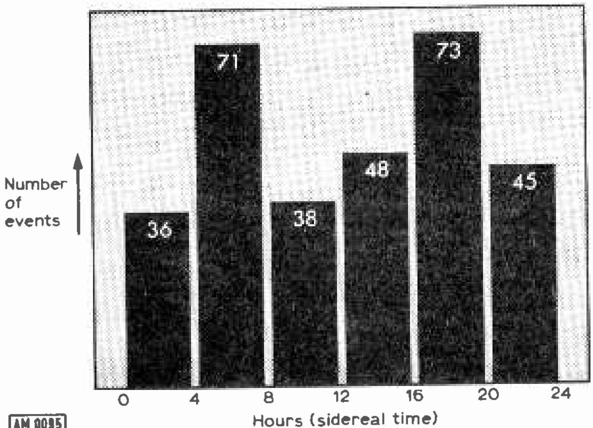
AM 0094

Fig. 2: The number of events plotted against time of day.



Professor Weber working on one of his detectors. A ring of piezo-electric transducers is mounted round the aluminium cylinder, the whole being suspended by a fine wire from the bridge. In use, the entire detector is mounted in a vacuum chamber. Readers may have seen the Horizon programme on BBC 2 TV which dealt extensively with Professor Weber's investigations and the work of optical astronomers seeking to confirm the existence of "black holes". More recently established gravitational wave detectors, using aluminium drums 12ft. long, have so far failed to confirm Professor Weber's findings.

If pulses detected by Weber originate at the centre of our galaxy, the amount of energy emitted in the form of the waves must be enormous; calculations show that waves of this intensity could be generated only by the acceleration of objects of a mass not less than that of the sun. In addition, the



AM 0095

Fig. 3: This time events are plotted against sidereal or star time.

objects must have a diameter of not more than one hundredth of that of the earth or the emitted waves will not be in phase. The sources must therefore consist of extremely dense matter.

NEUTRON STARS

Neutron stars are formed when a star collapses under its own gravitational field to the fantastic density of about one hundred million million grams per cubic centimetre. Neutron stars are almost certainly the 'pulsars' discovered by radio-astronomy; they emit pulses of radio waves spaced very regularly in time. However, it seems very doubtful whether they could emit enough energy as gravitational waves to explain Weber's results.

When a neutron star collapses, theory indicates that it can form a 'black hole' where matter has an infinite density and from which no light or matter can ever escape owing to the intense gravitational field. When a black hole is formed or when two black holes collide to form a single black hole, enormous amounts of gravitational energy may be radiated away which could account for Weber's pulses. Black holes have not yet been definitely identified, but their physics is far more fascinating than anything one can find in science fiction.

The new science of practical gravitational astronomy is being founded. Weber's first results have already had a profound effect on our ideas of cosmology. Other groups of workers in England and elsewhere are now setting up detectors for gravitational waves. It may be possible to use seismic detectors on the moon for the detection of very low frequency gravitational waves. ■

HOTLINES ON RECENT DEVELOPMENTS

OFF THE RECORD

Probably the major problem in the design of any machinery for recording and reproducing sound is the reduction of speed variations in the mechanical drive—cause of the dreaded wow and flutter. Indeed, it is safe to say that the man who invents a high fidelity recording system completely devoid of moving parts should make his fortune.

What could be the first step towards this goal has been taken at Pye TMC new products division. The secret is a novel system of analogue to digital conversion called delta modulation. Compared with conventional pulse code modulation, where the amplitude of regular samples of the audio waveform is encoded as a twelve-bit pulse train, delta modulation uses only two bits. These convey three "words"—"increase", "decrease" or "no change" —to describe the **change** in audio amplitude since the previous sample. Hence the name of the system.

The circuitry required to perform the conversion is based on four complex integrated circuits designed by Pye TMC. Storage of the modulated information is accomplished by circulating it through a series of shift registers.

The technique is currently being used in a unit which intercepts telephone calls addressed to discontinued numbers and informs the caller of the new number to dial. The Post Office telephone bandwidth of 300Hz to 3·4kHz can easily be handled using a 16kHz data rate and specially designed 4000 bit shift registers.

QUIET PLEASE

A new audio frequency noise reduction system has been developed by Pan Electronics, a recently formed R and D company with establishments in Germany and the United States.

Operating over the band 10Hz to 20kHz, the system compresses an input dynamic range of 100dB into 50dB before recording or transmission. Precision expanders restore the original range at the reproducing end, giving up to 50dB improvement in signal to noise ratio. The process is claimed to be suitable for all audio recording and transmission media and also for data links.

So, if any of you were waiting for one of the existing systems to gain universal acceptance before investing in some new hi-fi equipment, a little further patience might be advisable.

A NEW SAW

Quartz crystal controlled oscillators operating at a fundamental frequency of 720MHz are undergoing evaluation at the GEC-Marconi Electronics research labs.

Instead of the bulk acoustic waves used in traditional crystal oscillators, these devices employ surface acoustic wave (SAW) techniques on a quartz crystal substrate. Experimental devices have proved to be rugged and stable and can be tuned or frequency modulated over a bandwidth up to one per cent of the centre frequency.

The small size of the quartz element would permit complete oscillators to be constructed in a single TO8 transistor can.

Work is continuing to improve the long term stability and to extend the operating frequency range still higher.

KEEP IT COOL

The problem of preventing thermal runaway in power transistors has been approached in various ways in the past. Generally for full protection a resistor is inserted in the emitter lead and, though this may be very low in value, it inevitably causes some waste of power. Now, a new device called a byistor does away with the need for those emitter resistors.

The byistor contains two components, a diode and a resistor, both fabricated from silicon. The success of the device depends upon its thermal characteristics, which must be an accurate inverse match with those of the power transistor.

As the temperature of a power transistor is increased the collector current also increases, causing a further rise in temperature etc. The byistor reduces the bias current applied to the transistor as the temperature rises, thereby maintaining the collector current at a steady value. To obtain the accurate thermal match, the diode within the byistor is made using exactly the same material and process as that used for the power transistors it is designed to protect. In use, the device is mounted on the same heat sink as the power transistor, as close to it as possible

WHAT'S COOKING?

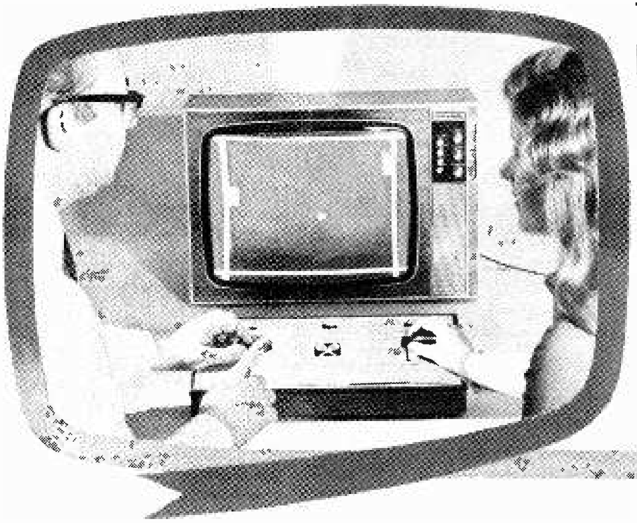
World wide increases in meat prices have prompted the US Army to embark on an investigation into the cooking of roasts. They reckon that home cooking techniques cause 20% less shrinkage than current large-scale methods.

A new oven has been developed having three separate heating systems. Microwave energy at 915 and 2450MHz is used for fast cooking of the interior of the meat whilst infrared elements are used to brown the outside. Pressurised steam is also available for cooking in a conventional hot environment.

Computer calculations of theoretical combinations of method, intensity and time for optimum cooking will be tested in the new oven. The whole procedure will be controlled by punched card.

The objective of the exercise is a saving of up to five per cent in the US government's requirement for roasting beef and comparable economies for other meats. This presumably represents quite a lot of money. If not, it seems an awfully expensive array of hardware to achieve something which millions of housewives do each weekend, almost without thinking about it!

Novus



THE POPULAR NEW ELECTRONIC GAME

TELE-TENNIS

PLAYED ON THE TELEVISION SCREEN

PART 3

M. J. HUGHES MA

This month we cover the construction and setting up of boards A and B which, between them, house the sync pulse generators and the ball and left and right base and bat waveform generators.

Sync generators

The complete circuitry for board A is shown in Fig. 9. IC1 is the Field sync oscillator which is a 555 timer operating in the astable mode. The nominal frequency of oscillation should be 50Hz and this is controlled by the resistor chain VR1, R1 and R2 together with C2. Field sync pulse-width is set by the value of R1 and should be in the order of 700μS.

Line sync is obtained in an identical fashion from IC2, the only difference being in the frequency of oscillation which is nominally 15·625kHz. VR2 gives a useful adjustment on this frequency to allow for component tolerances and the line sync width is set to approximately 4·7μS by R4.

Individual feeds are taken from the field and line sync generators to control the other waveform generators to be described in this and the next part. The two signals are also combined in an AND gate, IC7b and c, to give a mixed sync signal that is added to the video output just prior to modulation on Board E. Capacitor C1 provides heavy supply rail decoupling on the input pins to board A, as it is some way down the wiring loom from the power supply. The remainder of Board A's circuitry forms the ball waveform generator.

Ball generator

Monostable IC3 is triggered by the leading edge of the field sync pulse and provides a delay which controls the vertical position of the ball on the screen. This delay can be adjusted between approximately 2 and 18mS either by adjustment of VR3 or a voltage fed to pin 5. In practice VR3 is adjusted to position the ball approximately central on the screen when the ball control voltage ramp (generated on Board D) is in its mid-position.

Referring to Fig. 8 in conjunction with Fig. 9, the variable-width positive going pulse from IC3 is inverted by IC4b and then differentiated by C6 and R9, the negative spike being removed by D1. The value of C6 is fairly critical because it is the slope of the trailing edge of the resultant spike that controls the vertical duration (height) of the ball. This spike is fed to a straightforward trigger circuit (IC4d and c with D2 and R10) which is set to trigger at approximately 2·5V. The output of this is a sharp rectangular pulse, occurring at the pre-determined delay after field sync, with a width of about 300μS giving the ball a height equivalent to about 5 lines within one field. The ball's height can be increased by increasing the value of C6 and vice versa.

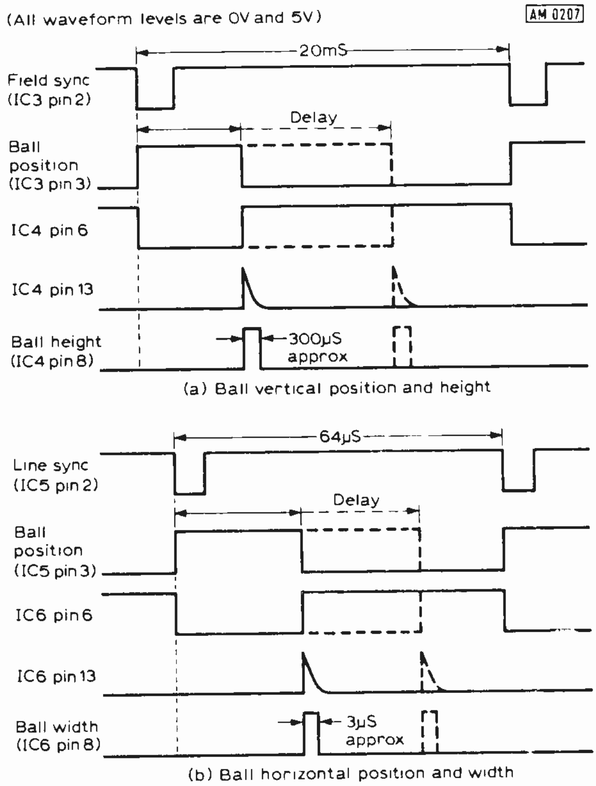


Fig. 8: Typical waveforms for the Sync generators and Ball-forming circuits on Board A.

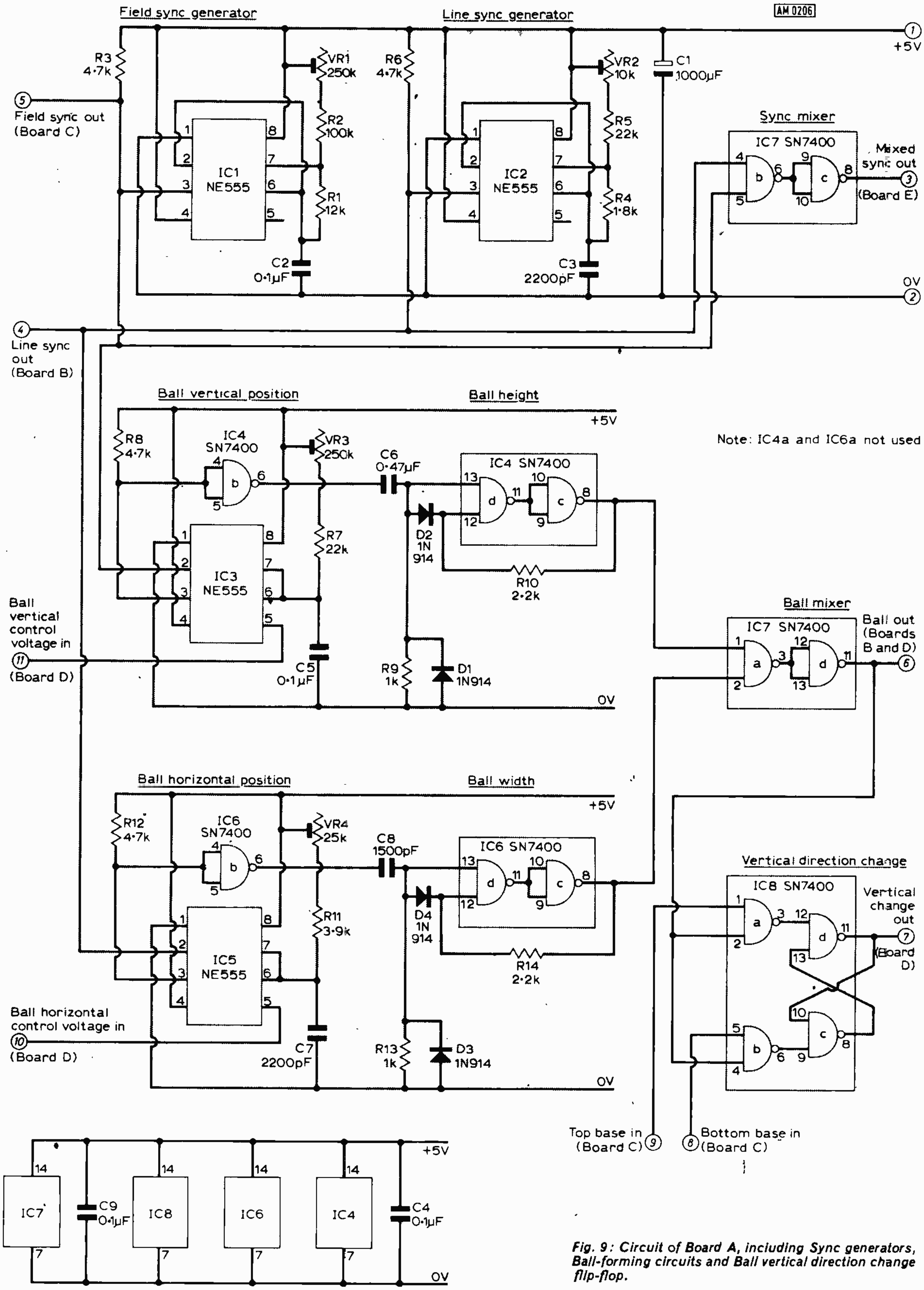
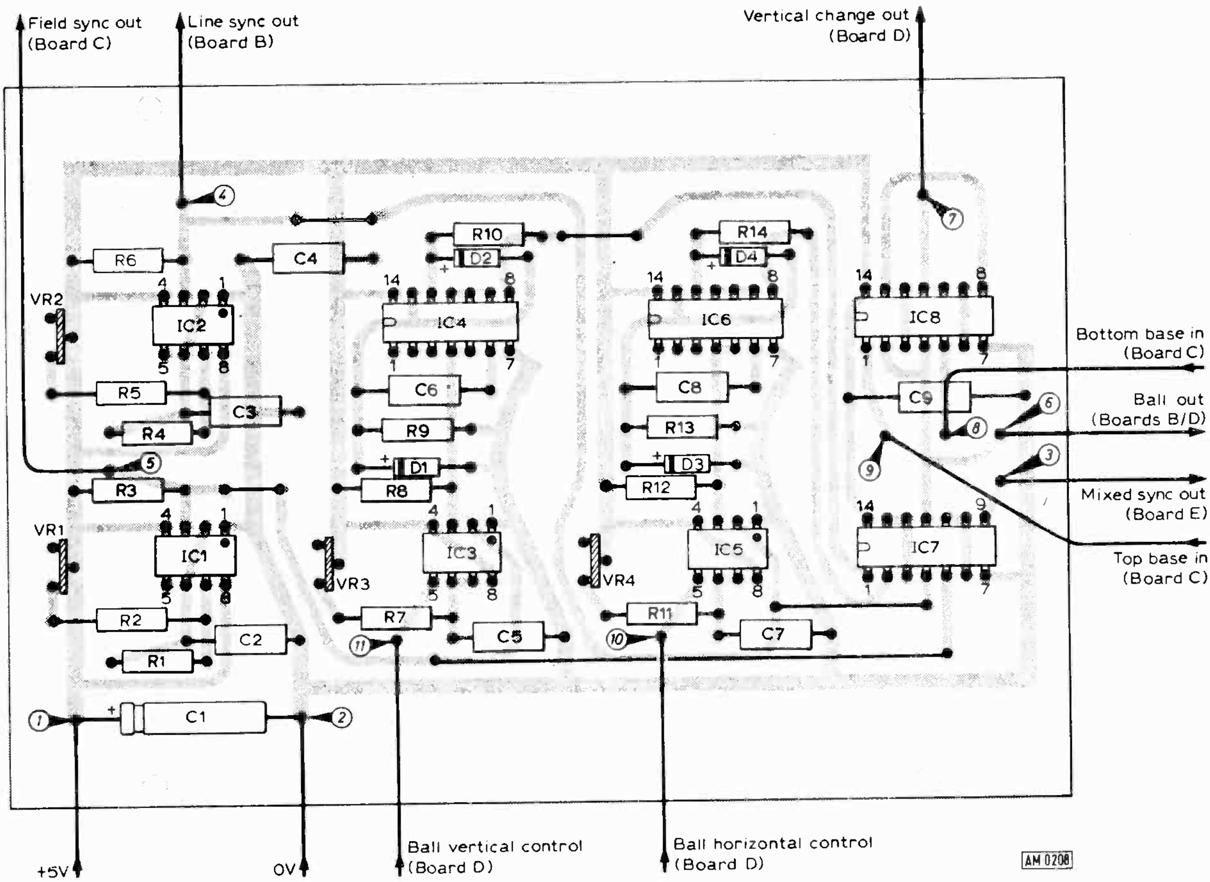


Fig. 9: Circuit of Board A, including Sync generators, Ball-forming circuits and Ball vertical direction change flip-flop.



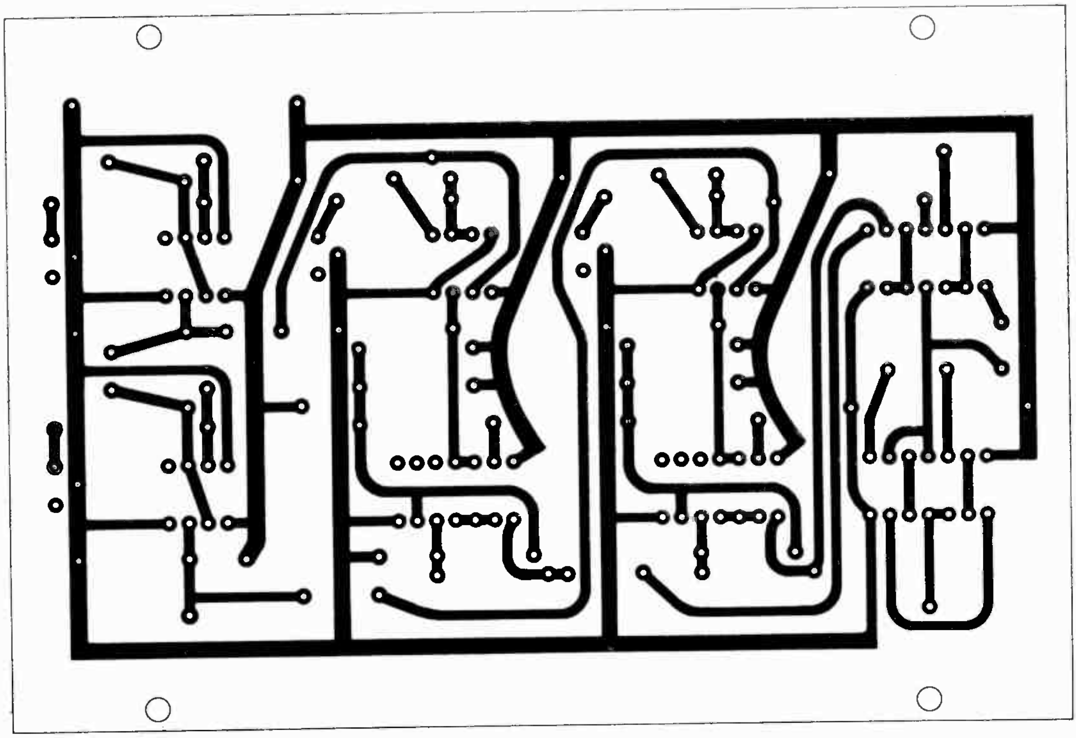


Fig. 10: Actual size layout of Board A and location of components.

The horizontal position and width of the ball is arrived at in like manner. The circuitry is identical and only the timing values differ. The delay is initiated relative to line sync which is fed to pin 2 of IC5. The ball's height and width waveforms are combined in an AND gate (IC7 a and d) which gives a +5V output only when the vertical and horizontal co-ordinates of the ball are coincident. This signal we designate "BALL" and we shall use this as a temporary test signal later in this part.

Vertical change

Concluding the description of Board A, IC8 forms a gated RS flip flop which provides an output signal at pin 11 to set the direction of the vertical control ramp for the ball's position. The inputs at pins 1 and 5 are the top and bottom base waveforms respectively and the output at pin 11 changes state whenever the ball's waveform is coincident with either of them. This appears subjectively on the television screen as if the ball rebounds on hitting either the top or the bottom base. Coincidence between BALL and TOP BASE sets a "1" at pin 11 which causes the ramp generator to produce a falling voltage. When fed to pin 5 of IC3, this ramp increases the delay on the ball's vertical position and the ball starts to move towards the bottom of the screen. Coincidence between BALL and BOTTOM BASE reverses the procedure.

It is worth mentioning, at this stage, that the ball must be high enough and the bases must be thick enough so that at the maximum speed of ball movement the ball cannot cross over a base line in less than 20mS. If this were to happen there is a fairly high chance that neither signal would be present to give coincidence—remember they only occur for a very short time during a single field! Without a coincidence the ball will appear to break straight through the base line without changing direction—hilarious to watch but making a mockery of a game of tennis!!

Testing board A

Assemble Board A and mount it on the sub frame. Connect the mixed sync output to Board E and take a temporary flying lead from the BALL output to one of the input diodes of Board E. Do not bother with any of the other connections yet apart from power supply leads. Set VR1 and VR2 to approximately mid positions and VR3 and VR4 to minimum resistance. Switch on the television set and allow it to warm up while receiving a broadcast picture. Adjust the vertical and horizontal hold controls to the centre of the range over which a stable picture is maintained.

Next apply power to the Tele Tennis, couple the output of the modulator to the receiver's aerial socket and tune the receiver for maximum signal. Do not expect a stable picture immediately because you must first adjust the line and field sync generators to their correct frequencies. Keep the brightness of the receiver up sufficiently to maintain a grey (not black) background and adjust VR1 until field lock is obtained on the receiver.

As it is approached you should see a dark horizontal bar (about 12 lines high) stabilise on the screen and then "snap" to the top of the field out of view. Carry on adjusting VR1 until you obtain frame roll in the opposite direction and then come back to a mid position. When you have done this you should be aware of the presence of the ball as a white dot flickering across the screen near the top. Next adjust VR2 until you obtain line lock; the ball should then appear clearly defined as a white square near the top left hand corner of the screen.

If field or line lock cannot be obtained, carefully check the soldering around ICs 1, 2 and 7 and make absolutely certain you have inserted IC1 and IC2 the correct way round—their orientation marks point in the opposite direction to the SN7400's. If you get lock but do not see the ball take the temporary lead off the BALL output and transfer it first to pin 3 of IC3 (you should obtain a bright band across the top of the screen) then to pin 8 of IC4; a thin bright line should appear across the top. Secondly check the horizontal waveform generator by touching the lead on to pin 3 of IC5 when a vertical bright band should

★ components list

BOARD 'A'

Resistors (all ¼ or ⅛W, 5%)

R1	12kΩ	R6	4·7kΩ	R11	3·9kΩ
R2	100kΩ	R7	22kΩ	R12	4·7kΩ
R3	4·7kΩ	R8	4·7kΩ	R13	1kΩ
R4	1·8kΩ	R9	1kΩ	R14	2·2kΩ
R5	22kΩ	R10	2·2kΩ		

Potentiometers (all sub-min. vertical presets)

VR1	250kΩ	VR3	250kΩ
VR2	10kΩ	VR4	25kΩ

Capacitors

C1	1000µF 12V	C4	0·1µF	C7	2200pF(P)
C2	0·1µF(P)	C5	0·1µF(P)	C8	1500pF(P)
C3	2200pF(P)	C6	0·47µF(P)	C9	0·1µF

Semiconductors

D1—D4 1N914 or 1N4148
IC1-IC3, IC5 NE555
IC4, IC6-IC8 SN7400

Miscellaneous

4 DIL8 IC sockets; 4 DIL14 IC sockets; pcb; 11 pcb pins

BOARD 'B'

Resistors (all ¼ or ⅛W, 5%)

R15	1·8kΩ	R19	15kΩ	R23	1kΩ
R16	4·7kΩ	R20	4·7kΩ	R24	1·2kΩ
R17	1kΩ	R21	1kΩ	R25	1·2kΩ
R18	1·2kΩ	R22	1·2kΩ	R26	1kΩ

Potentiometers (all sub-min. vertical presets)

VR5	25kΩ	VR6	5kΩ

Capacitors

C10	2200pF(P)	C13	2200pF(P)	C16	1000pF(P)
C11	2200pF(P)	C14	1000pF(P)	C17	0·1µF
C12	0·1µF	C15	1500pF(P)		

Semiconductors

D5-D12 1N914 or 1N4148
IC9, IC11 NE555
IC10, IC12-IC15 SN7400

Miscellaneous

2 DIL8 IC sockets; 5 DIL14 IC sockets; pcb; 16 pcb pins

NOTE—Capacitors marked (P) must be low-leakage polyester or polystyrene types.

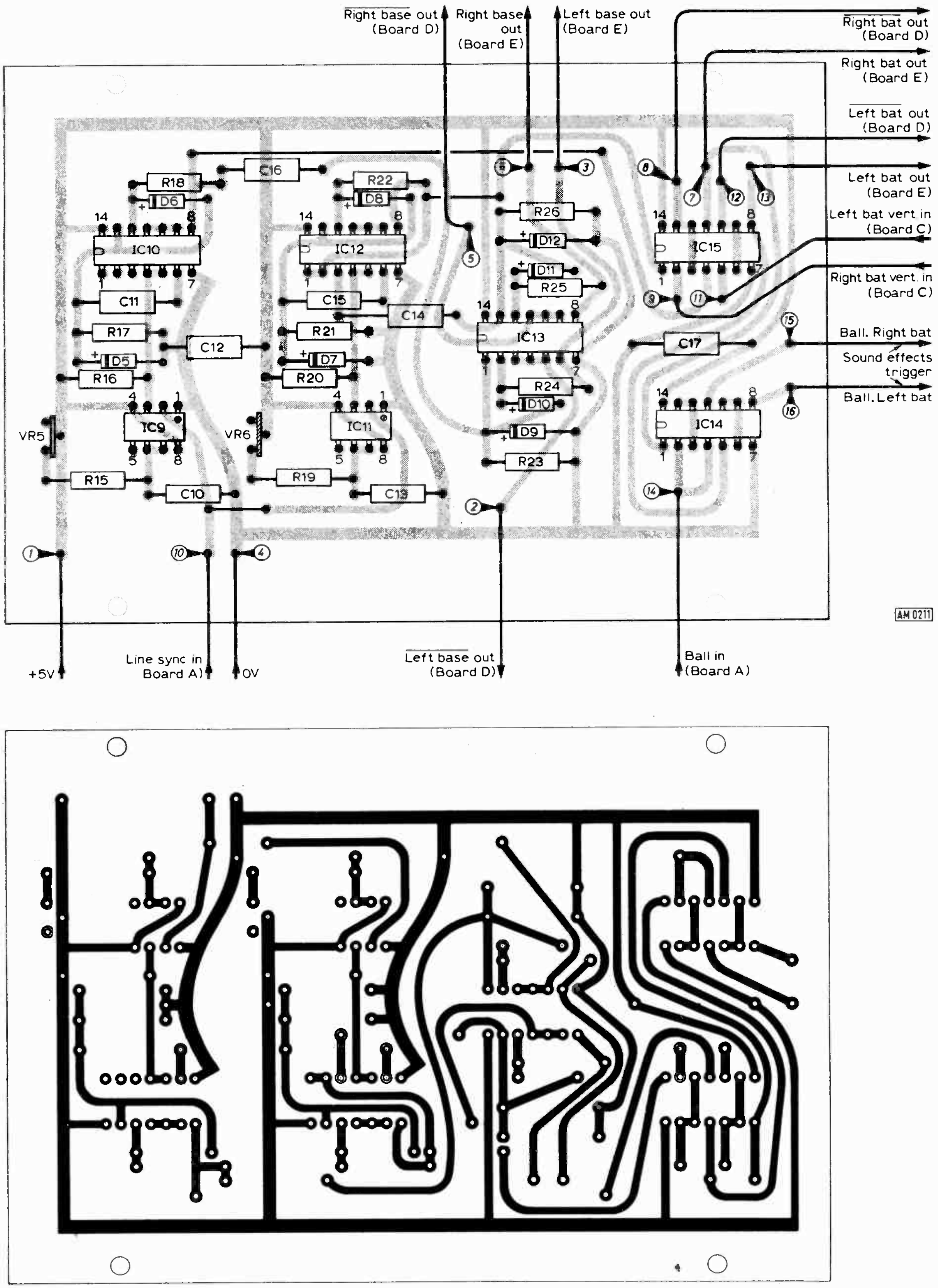


Fig. 11 : Actual size layout of Board B and location of components.

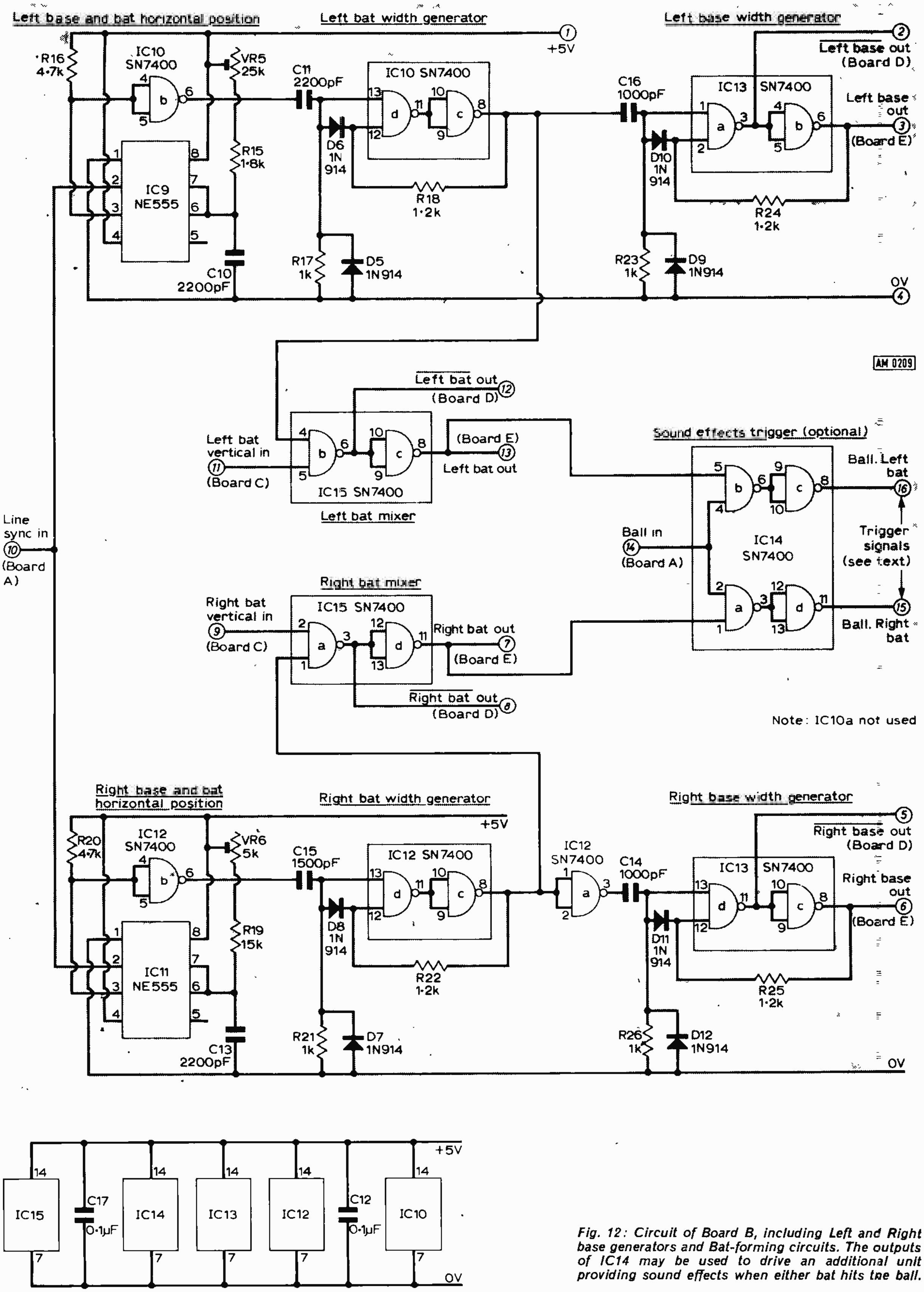


Fig. 12: Circuit of Board B, including Left and Right base generators and Bat-forming circuits. The outputs of IC14 may be used to drive an additional unit providing sound effects when either bat hits the ball.

be seen on the left of the screen. Finally check the output of IC6 (pin 8) and you should see a thin vertical line on the left.

Assuming all is well you should be able to position the ball somewhere near the centre of the screen by adjusting VR3 and VR4.

Bats & bases

Now to the circuitry of Board B which is shown in Fig. 12. Do not be put off by the apparent complexity; it is basically the same circuit repeated several times. IC9 provides the delay (relative to line sync) which positions the left base line and bat. The width of the left bat is set by the differentiating action of C11 with R17. The width signal for the left bat appears at pin 8 of IC10 and is a pulse approximately 5μS wide. The leading edge of this pulse is used to trigger the left base—generated by C16 with R23 and IC13 a and b.

The left base is approximately 2μS wide and starts at the same instant as LEFT BAT. Note that these two waveforms, Fig. 13, overlap. C11/R17 set the dimension from the left of the left base to the right hand edge of the left bat while C16/R23 control the width of the base. The former should, of course, always be larger than the latter! The bat width signal is combined with a height signal from Board C in IC15b to give both the horizontal and vertical co-ordinates of the bat. For later processing we need the true LEFT BAT signal and its inverse $\overline{\text{LEFT BAT}}$.

The right bat and right base are generated in like manner from the delay signal provided by IC11. Here, however, the bat width is narrower (it does NOT overlap the base) and is set by C15/R21. The trailing edge of the inverted right bat width signal is used to generate the width of the right base. The dimension is obtained by the differentiating action of C14 with R26. Again the right bat width is combined with its vertical coordinate in IC15a which, with IC15d, gives us RIGHT BAT and $\overline{\text{RIGHT BAT}}$ waveforms. Capacitors C12 and C17 are to suppress noise spikes.

The layout for board B allowed space for an optional extra which can be omitted without any other changes—this is IC14. Its function is simply to give a pulse output when there is coincidence between the ball and either the left or right bats. The outputs could be used to trigger a noise generator to produce a sound effect similar to a ball hitting a bat. We have not included this circuitry but the option is open to experienced constructors. The only point to watch is that under normal circumstances the pulse produced can be very narrow and may need stretching before much use can be made of it.

Testing board B

Having assembled Board B and mounted it onto the sub frame, complete the interboard wiring to boards A, E and F. Do not worry about the pins that have yet to be connected; these will be dealt with later. Set VR5 and VR6 to minimum resistance and apply power. You should now see the ball where it was before but you should also see two fairly wide vertical bars running down the left and approximate centre of the screen. These are the base lines

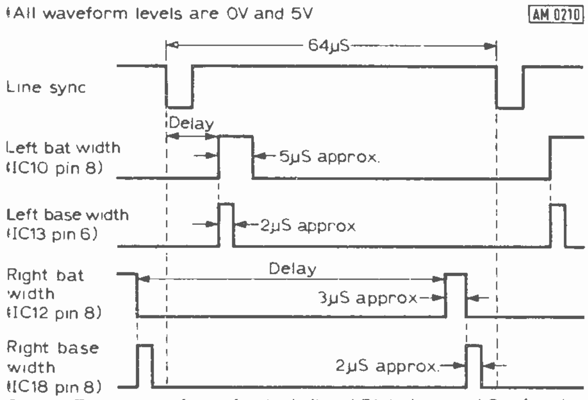


Fig. 13: Typical waveforms for the Left and Right base and Bat-forming circuits located on Board B.

with their immediately adjacent bats, but the vertical position and heights of the bats are not yet delineated—we need those signals from board C. It is sufficient to see the vertical bars and to check that their horizontal positions can be set by VR5 and VR6.

Should you have any trouble on this board we suggest you use the technique adopted on board A to check the waveforms. Work steadily through from the delay monostables to the output of the last gates. The only troubles you might encounter, provided you have used the specified components and have put them in the right way round, are dry joints and short circuits caused by solder blobs.

Next month we will describe the top and bottom base and bat height generators and the ball control logic (Boards C and D respectively).

ERRATA

Bench Stabilised Power Supply PW, Feb. 1974

(a) Fig. 8: The leadout connections shown for base and emitter of the 2N3055/2N3791 transistors should be reversed.

(b) Components List: D5 and D6 should be BZX61 C15 or equivalent with a rating of 1·3W or more.

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 ohm. 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 £12·00.** P. & P. 50p.

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5in 3 ohm £1·25, P. & P. 15p 7 × 4in 3 ohm £1·40 P. & P. 20p. 10 × 6in 3 or 15 ohm £3·10. P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet £1·70, P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8 or 15 ohm £3·50 P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network £4·65. P. & P. 30p. EMI CERAMIC MAGNET HEAVY DUTY TWEETER. approx. 3¼in. Av. 3 or 8 or 15 ohms. £1·25 plus 20p p. & p.

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Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.
AMP. KIT £11·55 P. & P. 25p (MIC 33p extra)
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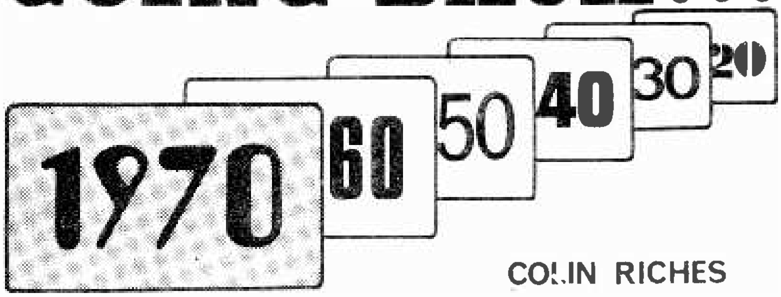


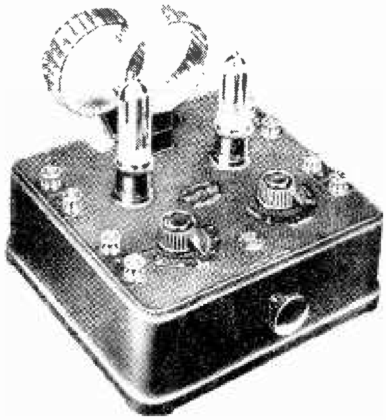
COLIN RICHES

THIS photograph of Marconi has just recently come to light. During preparations for the Science Museum's exhibition commemorating the centenary of Guglielmo Marconi, Mrs. Betty Hance, the Historian of GEC-Marconi Electronics Ltd. discovered this early portrait. The picture was taken by Lafayette Ltd. of Dublin, about 1901.

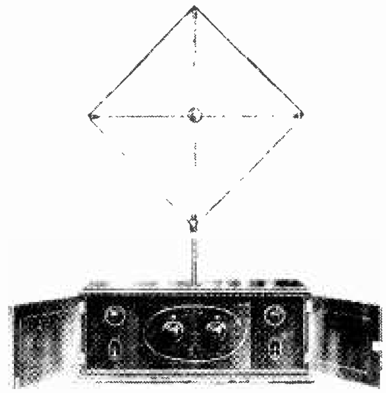
The existence of this portrait was known but no original print was thought to have survived. It shows Marconi as a very debonnaire young man and is one of the best of the early portraits.

Burndept 'Oldies'

Two Burndept receivers are shown here. The magnificent



specimen with two valves mounted on the top panel is a "Duplex" two-valve regenerative receiver said to be capable of operating a loud-speaker within 15-20 miles of a normal broadcast transmitter. Wave-length range was 250-5,000 metres depending upon which coils were plugged in. One of the valves used was a high-frequency amplifier and detector; the other was a "transformer-coupled note



frequency amplifier".

My other picture is also of a Burndept receiver and, contrary to popular opinion, is *not* the one fitted with Charles Molloy's MW loop aerial and used for his MW DXing. It is in fact, a 7-valve superhet receiver operated from a frame aerial (would you believe!). No earth connection was needed. Two frame-aerials were supplied. One covering 250-550 metres and the other 1,000-2,000 metres. It operated from batteries and was designed for loudspeaker output.

Vintage CQ!

FOR DISPOSAL

...set of Harmsworth's "Wireless Encyclopedia", in excellent condition. Also c 1929 receiver which uses rheostats for control of the valve heaters. It is housed in a long metal box and looks like a kit of the time.—F. Cole, 69 High Street, Swanscombe, Kent.

...a set of Harmsworth's "Wireless Encyclopedias" —3 volumes. Also some other books of similar vintage.—R. A. Mansell, 50 Meadowhill Crescent, Redditch, Worcestershire.

.. vintage radio components—some new and unused. i.e. ebonite and nickel-cased condensers, plug-in coils etc. c 1923.—Griffith J. Jones, GW2HMO, 24 Walters Road, Llanelli, Wales.

...an Osram "Music Magnet 4" in immaculate condition and good working order.—R. Muir, G4AFC, 24 The Street, Boughton, Nr. Faversham, Kent.

INFORMATION WANTED

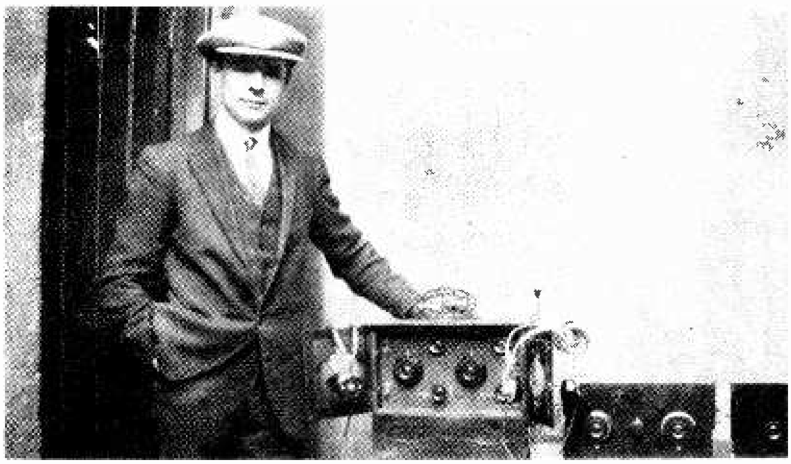
...any gen on McMichael Duplex Mains Four and a set with a lift-up lid box. The lid houses the speaker. All valves are 4-pin and one appears to be a P2. The only marking inside the set reads, "Empiric Ltd., Calthorpe Street, London, W.C.1." I'm no radio expert but spent many of my 75 years with cable ships of the Eastern Telegraph Co.—A. H. J. Bailey, 3 St. Mary's Terrace, Truro, Cornwall.

. .any information about ADEY wireless manufacturing company. I have one of their sets and require a full spec.—E. J. Hills, 41 Brays Mead, Harlow, Essex.

EQUIPMENT WANTED

.. diode valve (type unknown) wanted for a GECOPHONE B.C. 3000 radio. Also I require information about this set. Anything will help.—G. D. A. Brown, 16 Tranby Lane, Anlaby. HU10 7DS.

Hector Cole



The dashing young man pictured here is Hector Cole, G3OHK 25, Causeway Road, Seation, Workington, Cumberland, CA14 IPL. The receiver he has his hand on is a Popular Wireless "Continental Two". Reaction was by swinging coil and h.t. consisted of a lot of flashlamp batteries wired in series. The plug-in coils were home-made.

Picture taken c 1925

TAKE 20

DAVID ANDREWS

No. 63
I.F. SIGNAL GENERATOR

A series of simple transistor projects, using not more than twenty components.

WHEN lining-up a superhet receiver the amateur is often frustrated by the fact that he does not have a signal generator capable of producing a modulated carrier at the IF frequency. This project describes a very simple and easily made RF oscillator that can be modulated with an audio tone. It utilises a home-made coil and is designed to operate in the range of about 300kHz to 600kHz when used with a 300pF tuning capacitor.

If desired the circuit could be extended to cover a wider frequency range with switched coils but the object of this particular exercise was to design a project that can be quickly knocked-up on a piece of insulated board at very low cost.

The Circuit

The circuit, shown in Fig. 1, comprises a feedback oscillator tuned by L1 and VC1. The tuning capacitor is preset because it is envisaged that use of such a circuit will be limited to operation at a spot frequency. The feedback winding, L2, provides base drive to the transistor and the output signal is taken from a loosely coupled coil, L3. These three windings are made on an Aladdin type former, ¼in. in diameter, having a ferrite tuning slug. L1 consists of 300 turns of 40swg enamelled copper wire pile wound over about ⅜in. of the former and L2 is 5 turns of thin flexible insulated connecting wire wound over the top of L1. Take care to wind these coils in the same sense and note the start of each winding, a dot in the diagram, so that they are connected into the circuit with the correct phasing. L3 is simply a turn or two wound so that it loosely couples with the main coils and can be made from insulated connecting wire. Only one end of L3 is, in fact, used.

Should the output signal be too great the number of turns on L3 should be reduced and vice versa. There is nothing very critical about the coils but with the details given the circuit should oscillate at about 465kHz with VC1 in the centre of its capacitance range. Should there be need to alter the tuning range add or remove turns to L1 to decrease or increase the frequency respectively. When the coil is finished, hold the windings in place with a spot of adhesive.

★ components list

R1	470kΩ	C1	0·1μF
R2	100kΩ	C2	2200pF
R3	4·7kΩ	C3	0·022μF
R4	1kΩ	C4	0·22μF
R5	330Ω	VC1	300pF compression trimmer
R6	22kΩ		
R7	22kΩ	Tr1/2/3	BC108
R8	1kΩ	Former ¼" dia, with core	

If desired it is possible to use the circuitry built around Tr1 by itself as a simple Beat Frequency Oscillator (BFO), useful for picking up and detecting CW morse transmissions on any domestic radio set that has short wave coverage. All that is necessary is to supply the +6V at point A of the circuit and place a lead from the output of the oscillator close to the IF circuitry of the radio receiver. With a great deal of care and fiddling it is JUST possible to detect ssb received signals on a domestic receiver using the same technique and by careful adjustment of the oscillator's frequency.

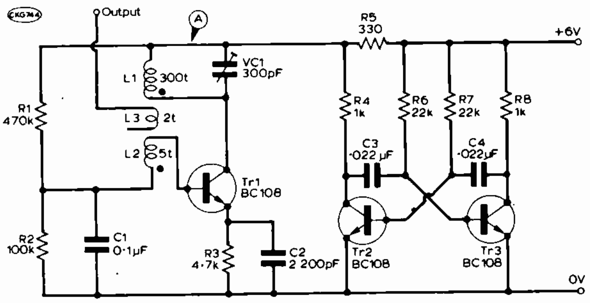


Fig. 1: A single transistor Tr1 generates the carrier which can be tone modulated by Tr2/3

Modulation

For radio alignment it is preferable to have a tone modulated carrier and this is provided by the multivibrator made up of Tr2 and Tr3. As this switches at audio frequency it modifies the supply voltage to the oscillator at point A thus providing a small degree of amplitude modulation. The frequency of the audio tone can be adjusted by altering the values of C3, C4, R6 and R7. To set the spot frequency of the oscillator it is best to use a radio of reliable performance (and known intermediate frequency) and simply adjust VC1 until the tone is received at its loudest.

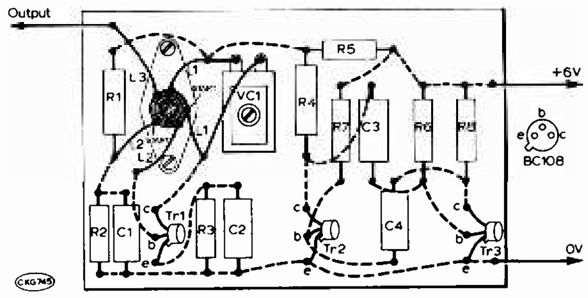


Fig. 2: Plain veroboard and pins, with wiring behind, was used in the prototype.

Dear Sir, letters

Extra Low Frequencies

I am 15 years old and recently found an advert in a newspaper. From it I understand that the IBA are broadcasting on the extremely low frequencies of 719Hz and 97·3Hz, the latter being on v.h.f. however they worked that out.

I don't know much about radio but surely, modulating such low frequencies must be extremely difficult and the engineers responsible must be congratulated!

In all fairness, later adverts have had the correct frequencies of 719kHz and 97·3MHz.—**D. Saul** *(Isle of Wight)*.

CR100 Mods

On reading through Practical Wireless, I noticed in the Short Wave article by Malcolm Connah references to the CR100 receiver.

Apparently, many readers wish to obtain details of particular mods and since I was fortunate enough to obtain these details some while ago, I feel I can be of help.

If I can get in touch with other CR100 owners I can help them out. I also have a complete handbook for the CR100 which I will willingly lend.—**P. R. Austin** *(3 Cunningham Way, Saltash, Cornwall, PL12 4HY)*.

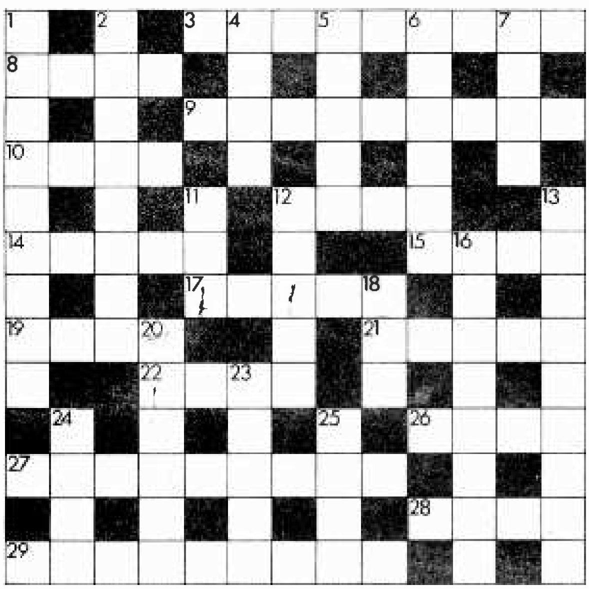
What It's All About

I read with interest, and considerable amusement, Mr. Watton's letter in the July issue of *Practical Wireless* telling me that I, and many others like me, need to be shown "what proper electronics is all about". While I appreciate his no doubt well intentioned desire to educate me I can't help feeling that he himself may be missing out on something.

The widespread availability of integrated circuits has certainly made the design and construction of certain circuits much more straightforward than that of their valved counterparts. What Mr. Watton perhaps fails to realise is that the design of far more advanced and complex systems, which would have been for various reasons highly impracticable in the "good old days", can now be considered. This undoubtedly requires every bit as much ingenuity and design ability as did the realisation of some earlier valved equipment.

The numerous advantages of semiconductor devices are well known so I shall not reiterate them here, and while admittedly valves are superior for a few purposes at the present time (I have actually used them myself in some circuits) it is to be hoped that due to the continued advances in semiconductor technology this highly unsatisfactory state of affairs will not persist for much longer. — **Peter Frazer** *(Angus)*.

PW TECHNICROSS PUZZLE No. 6



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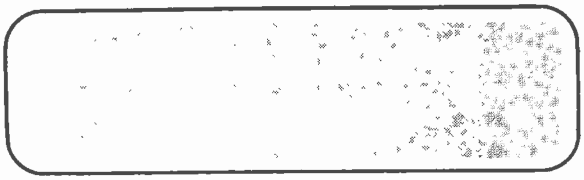
11 Through with cat sound reproduction! (3)
12 Such bad equipment unheard of! (5)
13 And such perfect reception! (5,4)
16 A speak-easy in the office! (8)
18 An example of 27 Across (3)
20 Game now played with TV sets? (6)
23 A pig of a sound to record! (5)
24 Had a tape full of information (4)
25 Telegram by radio less unused (4)

**FOR AMUSEMENT ONLY
ANSWERS NEXT MONTH**



VHF/FM DXING

by SIMON DAVID

VOLUPTUOUS Heart-rending Fidelity, believe it or not, should be the new interpretation of VHF, according to Lord Aylestone, Chairman of the IBA, who addressed the Radio Industries Club recently. As newcomers to this media, the IBA are obviously intent on selling commercial broadcasting in stereo terms, having already equipped their studios and transmitters to handle it. On the other hand the BBC have been experimenting with quadraphonic broadcasting (July 6th, 0005) for those lucky people with two stereo f.m. receivers tuned to Radio 2 (front channels) and Radio 3 (rear channels). Anyone hear these? If so I shall be interested in reporting the results. Although the BBC insists that it has no plans for regular quadraphonic broadcasting, one cannot help thinking of the similar attitude over stereo broadcasting sixteen years ago.

Two major DXing events were experienced in May, on the 9th/10th and 20th. **Julian Allen** of Hadleigh, Suffolk, reports BBC locals from London, Medway, Sheffield, Oxford, Humberside and Birmingham, IBA locals from London, French stations at Troyes 95·3, Rouen 96·5, Troyes 97·9, Lille 98·1, Niort 99·3, Boulogne 99·9MHz, and even Anglia television sound on 95·3, and 97·1MHz, BBC1 TV on 106·5MHz, BBC2 TV on 97·4 and 100·8. This seems to confirm my recent comments on unusual reception frequencies and is not uncommon during sporadic-E openings. Julian's receiver is an Audiosonic radio with telescopic aerial. He also says that he had another eight-piece telescopic "plugged" into the earpiece socket. Well, you never can tell, can you!

Igor Hájek is a student tucked away in a flat at the University of Lancaster. Between lecture periods he spends a lot of time listening and came up with a report for the 9th/10th May, aided and abetted by a Goodmans Module 90, a 4-element Yagi for the CCIR band (87·5 to 100MHz), and a 3-element wideband aerial for the OIRT band. What's that? The 65 to 73MHz band? This is used by East European countries! That's right, I find DXing on this band more satisfying, Igor writes. Sporadic-E openings are more frequent here and, with the exception of channel E4 television sound (67·75MHz), they all originate from Soviet controlled sources. His claims for the 20th are Lithuania, Latvia, Estonia, Byelorussia. Unfortunately the *World Radio and Television Handbook* identifies only a few. These were heard on 20th May.

On May 9th, Igor picked up several Polish and Soviet stations including Warsaw on 67·17 and 76·94MHz, Kiev on 71·77MHz.

Others listed are from Hungary on 66·8, 67·19, 69·38, 70·4, 70·6MHz; Poland 70·01; Czechoslovakia 69·2; Bulgaria 70·5, 72·0; USSR 68·5. Station locations are also listed, and these were heard on May 10th in the afternoon.

Coming back to the more usual band for UK listeners, Igor also picked up seven stations from Spain on 87·9, 95·3, 95·9, 96·9, 98·4, 99·0 and 100·2MHz. Also Bayonne in France on 96·1. He suffers from an overcrowded band between 95 and 98MHz, but during sporadic-E or tropospheric openings, the foreign intruders tend to suppress British stations.

You would think that Poole in Dorset would be a good venue for continental listening, and you would be right. **Colin Redwood** reports the following for the early evening of 20th May using the old Jason tuner and an indoor aerial made by modifying an old television aerial. From France he heard all three programmes from Cherbourg, Rennes, Caen and Rouen. BBC stations included North Hessary Tor, Rowridge, Wenvoe, Les Platons (Channel Islands), Mendip (R. Bristol). Results were variable, says Colin, but the best was from Rennes on 89·9, 93·55, 98·3.

Next on the list is **Jason Woodhead** from Bradford, who lists local stations of the BBC at Blackburn, Derby, Humberside, Leeds, London, Manchester, Sheffield and Stoke; IBA stations include Capital, Sheffield. His receiver is a Pioneer TX6-200 tuner with an SA-7100 amplifier and a two element Antiference aerial directed to Holme Moss.

We had some stormy weather over the weekend of 15th/16th June. For those who braved the storm the results were interesting and I shall be reporting next month. Because of the delay before reports appear in print, please write in promptly, stating the date of reception, equipment and aerial used and, of course, your location. Reports from overseas are particularly welcome.

Finally, turn your aerial round towards Ireland, listen on 89·7, 89·1, 90·4, 91·3, 91·9, 93·5, 94·1, 94·9, 95·3, 97·0MHz, and let me know what you get. If you are east of a line drawn from Carlisle to Southampton, you are sure to need high sensitivity and a large high aerial. If you are on top of Snowdon, you can't go wrong—he says!

MEDIUM WAVE BROADCASTS
by CHARLES MOLLOY

L. THOMPSON (Reading) asks "what about stations deep into Africa" and mentions that with his 17-transistor receiver, a 130ft long-wire aerial and aerial tuning unit he enjoys regular reception of Radio Dakar, Senegal on 764kHz (this station signs-off at midnight GMT). A number of Africans are heard regularly on the medium waves in the UK, the most conspicuous being Conakry in the Republic of Guinea on 1403kHz. Listen for African music after 2300hrs when the French chain on this frequency has signed off. Another regular is Bissau in nearby Portuguese Guinea which operates on 1070kHz and can be logged until 0200hrs. Radio Kinshasa in the Republic of Zaire is on the air all night on 692kHz, a frequency it shares with East Germany but a MW loop aerial will minimise interference. From Spanish Sahara, EAJ203 at El Aaiun is logged occasionally on 656kHz while further south in Nigeria, Radio Enugu on 1320kHz can be heard at 2300hrs GMT in English before it closes down at 2305hrs. Tenerife in the Canary Islands is often a strong signal at midnight on 620kHz with programming in Spanish.

John Porter who lives in Baslow, Derbyshire, has a Trio 9R59DS communications receiver and a MW loop aerial. His log includes Oran, Algeria on 548kHz; Voice of America relay at Kavalla, Greece on 791kHz; Agadir, Morocco on 935kHz; Algiers 980kHz; El Beida, Libya 1124kHz; Voice of Morocco, Tangiers 1232kHz; America Forces Network stations at Frankfurt 872kHz; Berlin 935kHz; Munich 1106kHz; Stuttgart 1142kHz; and BBC local radio stations at Blackburn 854kHz; Solent 998kHz; Leeds 1106kHz; Derby 1115kHz; Manchester 1457kHz; Birmingham 1457kHz; Stoke 1502kHz; Bristol 1546kHz; Teesside 1546kHz and Leicester on 1594kHz.

Julian Allen reports again from Hadleigh, in Suffolk. With his Audiosonic transistor portable he has pulled-in Beromunster in Switzerland on 527kHz; Ain Beida, Algeria on 533kHz; Oran, Algeria on 548kHz; AFN Stuttgart on 1142kHz.

A number of European stations on the medium waves carry programming in English. **Brian Robinson** (Belfast) has compiled a list of such transmissions heard on his Cossor 1506A radiogram and 20 metre longwire aerial. Radio Portugal on 755kHz at 2300hrs; AFN Frankfurt on 872kHz; Milan, Italy on 899kHz at 2200hrs; AFN Bremerhaven on 1142kHz; Radio Sweden 1178kHz at 2300hrs; Voice of America Rhodes, Greece on 1259kHz at 2235hrs; Dublin on 1250kHz; Deutschlandfunk 1268kHz at 1813hrs; Radio Prague 1286kHz at 2200hrs; Radio Tirana, Albania 1394kHz at 2200hrs; Trans World Radio, Monte Carlo 1466kHz at 2300hrs; Radio Warsaw 1502kHz at 2240hrs; Radio Berlin International 1511kHz at 2200hrs. All times in GMT. Brian reports hearing BBC local radios at Carlisle (Main) on 755kHz; Blackburn 854kHz; Leeds 1106kHz; Carlisle (Relay) 1457kHz; Merseyside 1484kHz; Manx Radio, Isle of Man on 1255kHz and on 1594kHz; IBA Radio Clyde on 1151kHz.

David Fitton of Oldham was in luck when he logged BBC Radio Blackburn. As well as sending in a reception report David replied to an on-the-air competition. His reward was an LP and a mention of his DXing activities over the air. Congratulations David.

SHORT WAVE DX
by MALCOLM CONNAH

THIS is the sixtieth article that I have prepared in this series representing the end of five years of work for *Practical Wireless*. Unfortunately, it must also be the last article.

I would like to take this opportunity to thank all those of you who have written to me during the last five years, some of the letters have been very interesting indeed. Reports, logs and letters should, in future, be addressed direct to the Editor (address on contents page).

I think that the most fitting way to end is by giving the last word to those of you who have contributed reports this month so here we go.

Brian Cox of Wimbledon has a Civic R4500 domestic receiver which when connected to 40 feet of wire via a 'PW' ATU produced the following:

6045 R. Nederland in English at 1000.
6055 R. Sweden in English at 1600.
6165 Swiss BC in English at 1100.
7230 Monte Carlo (TWR) in French at 1100.
11775 RNE, Spain in Spanish at 2200.
15092 R. Canada Int. in English at 1200.
15150 R. Finland in English at 2100.
15320 R. Australia in English at 2300.
15330 Austrian Radio in German at 0900.
15445 R. Nacional, Brazil in Portuguese at 2200.
17820 R. Canada Int. in English at 2000.

Albert E. Ord of South Shields will shortly be changing his QTH but one final fling with his Trio 9R59-DS, Hamgear preselector and Joystick antenna produced the following results:

4800 R. Lara, Venezuela in Spanish at 0300.
4955 R. Nacional, Bogota in Spanish at 0037.
4965 RSA, South Africa in English at 2130.
5038 Bangui, Cent. Afr. Rep. in French at 2215.
5047 Lome, Togo in French at 2223.
5075 R. Sutatenza in French at 0015.
6055 R. Australia in English at 1200.
9655 R. Damascus, Voice of the Arab Republic.
11915 HCJB, Quito, Ecuador in English at 0930.
15265 R. Afghanistan in English at 1130.
15400 R. Baghdad in English at 1415.
15520 R. Pakistan in English at 1300.

Over to Australia now for a report from **Grahame Manns** of Balgownie who used an HMV Multiband 4710 and 14 feet of wire to pick up the following:

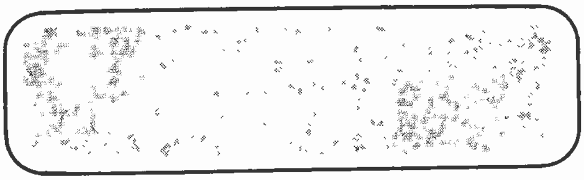
6030 FEBC, Manilla noted at 2040.
9625 R. Canada Int. noted at 1925.
9950 R. Nederland at 1830.
15115 HCJB, Quito, Ecuador, at 1900.
15235 NHK, Japan noted at 1948.
17850 R. Rumania noted at 1650.
21520 Swiss BC noted at 2106.

Mr. T. Lewis of Worcester rounds things off with this report obtained from his 10 transistor domestic receiver and 75 foot end-fed:

9590 R. Norway in English at 1412.
9690 R. Pakistan in English at 1745.
9770 R. Australia in English at 1705.
11755 R. Finland in English at 2047.
11980 R. Vilnius in English at 2230.
15085 R. Tehran, Iran in Farsiat at 1855.
15150 La Voz de Chile in Spanish at 2145.
15185 WINB, Red Lion, USA in English at 2130.

In conclusion I wish you all the best of luck and good DX for the future.

ON THE AIR



by Eric Dowdeswell G4AR

PROBLEMS, problems! The delays in our publishing dates, a month for our July issue, make rather a nonsense of the idea of providing any up-to-date station information on this page. Still, as we do not have any control over these matters let's press on and hope to catch up 'ere long.

Reports

Michael Crimes BRS34885 (Exeter) takes me to task, in a pleasant way, for neglecting the VHF bands! I can only print reports that I receive, so let me appeal to readers who spend their time on these bands to help me out. Michael, who lives at 7 Mount Pleasant Road, Exeter, Devon would like to correspond with other VHF types with a view to exchanging reports and information. He suggests the formation of a VHF/UHF Listeners Club, given sufficient support, so get out the 4½p stamps lads and go to it! I'd be glad to help in any way I can. Michael has a Microwave Modules 2m converter into a Trio 9R59DS and, at the moment, an indoor dipole. Such a set-up deserves a better signal 'putter-in' and Michael has promised an outside array very soon.

Derek Harding (Godstone, Surrey) joins our merry band with an interesting log but bemoans bad manners by operators on 80m SSB. However, the example he quotes is detergent-white compared to some things I've heard on that band, so be prepared for shocks, Derek! Unfortunately, bad manners are commonplace today but I don't think that there are many amateurs who would deliberately offend and thus threaten the existence of their hobby. Following a motor accident Derek has had more time to use his rig, a modified Codar MB6, PR40 and home-made ATU all fed from a G5RV aerial which is mostly at 30 ft. Get well soon, even if it means fewer reports!

Michael Rump (Brighton) has an 1155 (ugh!) and a Codar CR70A with the option of 132ft of wire 20ft up or a 20m quarter wave vertical. Terse?? but that's all I have! I'm sure Michael will relent and relax now that he has some of my log sheets!

Keith Ranger (Colchester) ex 9M2RK (shouldn't it have been KR??) is "now more interested in the receiving side" Peculiar fellow! However his efforts have produced a very small three transistor receiver covering six amateur bands and which, with ATU, aerial and earth wires and headset still weighs less than 4lbs. and only takes 5mA at 9V! (Article on the way, don't worry!)

John Porter is with us again and is obviously picking out the juicy ones as requested, judging by his log fed from his Trio 9R59DS and multiband dipole. He's pleased with his 2m receiver, from the design published in the Nov. 73 issue of PW. Mainly G8 + 3's in the log at the moment but I'm sure he will soon be reaching out to more exotic calls.

Looks like my free log plan may backfire on me! They are coming back thick and fast and hardly a single run-of-the-mill call among them from 10 to 160m. Let's not hear any more about bad conditions! In my experience too much is blamed on 'conditions' when so often it is just plain lack of activity. Listen to the 'silence' before a major contest on 15 or 20m and then to the bedlam as it begins!

All of you out there with receivers designed to copy SSB have a very easy life compared to **Simon Dabbs** of Birmingham who uses the time-honoured HAC one-valver! He feeds it into a transistor amplifier but that doesn't reduce the finesse required to get those SSB stations. Things are made a bit harder for Simon by restricted space for aerials and at the moment a folded dipole intended for 10m use is used on all bands. I'm sure Simon will now be sufficiently enthusiastic to want to expand his equipment to get maximum efficiency on all bands.

Log extracts

M. Crimes:- 2m GC3YIZ GC8AAZ/M F1COF F5XA ON4PB **all AM.**

D. Harding:- 20m HV3SJ M1D VE3CPJ/SU ZD9BT 6W3AU **15m** AC3VC (nice!) TR8VE **10m** XQ3CZ.

M. Rump:- 40m VK2AVA VK7GK **20m** OX9RJ VP2DM WA5KGH/AM (at 31,500ft) ZL1ON ZP7ZE 5X5JS (brave man!) **15m** ZS3AW 8P6CG 9X5KD.

K. Ranger:- 20m FG7XC JW1SO 9M2FK EP2RM FC0UH/M UL7FA VE8DC **15m 6W8DW** VQ9NC ZP5VO **10m ZE8JJ** CP6BS.

J. Porter:- 20m AP2KS (1700) EA8IP (2330) JA9JAI (1730) KA6DE XW8GB (1700) 9Y4VV LX1GM TI2WB VU2DK (1330) WA6EVX/P/KG6 (Guam 1730) 3A2CP 7Q7LB **15m** C21CI (Nauru 2230) CP1DN ((2130) CX6AM (2100) HC1HK (2200) HP1DD VP2MHK VP2SQ YS1GMV 5U7AZ 6W8AAD 9Y4CR **10m** HV3SJ ZS3AW (1060).

S. Dabbs:- CX6AM (2030) FL8OM (1900) OY1M ZB2A ZB2BL 9G1AZ.

CW stations in bold, remainder SSB.

BROADCAST BANDS

Short Wave Reports by 15th of the month to Malcolm Connah, 27 Lismore Road, Highworth, Swindon, Wiltshire, SN6 7HU.

Medium Wave Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

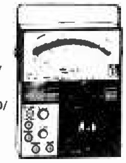
VHF/FM Reports to Simon David, c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.

AMATEUR BANDS

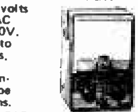
Logs covering any amateur band/s in band/alphabetical order by the middle of the month to **Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.**

ASK LASKYS

and make no mistake

KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels –20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with test leads etc.

OUR PRICE £17.50 P & P 40p

TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5–1500V. AC volts 1.5–1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.

OUR PRICE £17.50 P&P 50p

Additional probes available: RF £2.12, HV £2.50

L83 TRANSISTOR TESTER

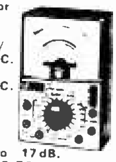
Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

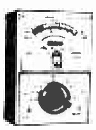
TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4¼" mirror scale. Size: 149 x 117 x 60mm. 0.3–12000V DC. 3–300V RMS AC. 8–800V P-P. DC current 0.12–12mA. Resistance up to 2000MOhms. Decibels –20 to +51dB. Supplied complete with leads and instructions.

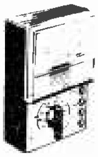
OUR PRICE £18.50 P&P 20p

MODEL AF.105 VOM

50,000 opv. Mirror scale. Meter protection. 0/3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. 20 to 17dB.

OUR PRICE £12.50 P&P 30p

AUDIOTRONIC Model ATM1

Top value 1,000 opv pocket multimeter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

OUR PRICE £3.25 P&P 15p

AUDIOTRONIC Model ATM5

Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC. (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.95 P & P 20p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. –20 to +50dB.

OUR PRICE £5.95 P&P 30p

HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0–50uA/250mA. 0–20k/2 Megohms.

OUR PRICE £5.97 P&P 30p

MODEL PL436

20,000 opv DC. 8000 opv AC. Mirror scale 6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. –20 to 46 dB.

OUR PRICE £6.97 P&P 30p

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.00 P&P 30p

MODEL HIOKI 730X

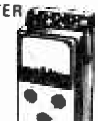
30,000 opv. Overload protection. 6/30/60/300/600 1200V DC. 12 60 120/600 1200V AC. 60/μA/30mA 300mA. 2K/200K/2 Meg Ohm. 10 to 63dB.

OUR PRICE £7.50 P&P 30p

U4324 MULTIMETER

High sensitivity, over load protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £8.00 P&P 30p

U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

OUR PRICE £8.75 P&P 30p

U4312 MULTIMETER

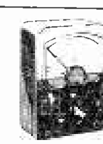
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

OUR PRICE £9.75 P&P 50p

U91 Clamp VOLT AMMETER

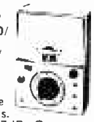
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

OUR PRICE £10.50 P&P 30p

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms

OUR PRICE £13.95 Carr. paid

Leather case for above £1.75

HIOKI 750X VOLT-OHM-MILLIAMETER

43 ranges. 0–0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0–3/6/15/30/60/120/300/600/1,200V AC. Current. 0–30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence 0–3/300k/3/30Mohms. Decibels: –10 to +17dB. Output.– 0–3/6/15/30/60/120/300V. Accuracy ± 3% DC ± 4% AC. Sensitivity: 50,000 opv DC, 5,000 opv AC. 4 inch meter. Built in protection. Size 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence 10k/100k/1 Meg/10 Meg ohms. –20 to +81.5dB.

OUR PRICE £12.50 P&P 20p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.

OUR PRICE £14.95 P&P 30p

Model HT100B4 MULTIMETER

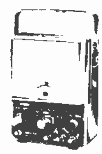
Overload protected, shock proof circuits 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistence 0–20/200k/2/20 Meg. ohms. DC current:– 10/250uA/2.5/25/250 mA/10A. AC current. 0–10A. –20 to +62dB. Operates from 2 x 1.5V batteries. Size. 180 x 134 x 79mm.

OUR PRICE £17.50 P&P 40p

MODEL AS.1000 VOM

100,000 opv Mirror scale. Built-in meter protection 0 3 12 60 120 300 600/1200V DC. 0 6 30 120 300 600V AC 0 10μA 6 60/300mA 12 Amp. 0 2K/200K/2M/200 Meg Ohm 20 to 17dB

OUR PRICE £17.50 P&P 30p.

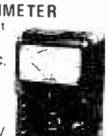
KAMODEN TT35 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.

OUR PRICE £17.50 P & P 40p

TMK 100K LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistence. 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER

Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.

OUR PRICE £19.95 P&P 30p

KAMODEN 72.200 Multitester

High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:–0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work. Knife edge pointer. 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

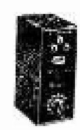
OUR PRICE £15.00 P&P 40p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC Accuracy 0.5% DC. 1% AC Scale length 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

OUR PRICE £49.00 P&P 50p

ALL PRICES EXCLUDE VAT

L84 TRANSISTOR TESTER

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester

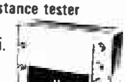
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

OUR PRICE £10.50 P&P 30p

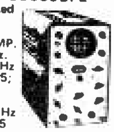
S100TR MULTIMETER TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2MFD Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

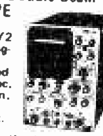
OUR PRICE £19.95 P&P 25p

KAMODEN HMG500 insulation resistance tester

Range 0–1,000 Megohms, 500V. Battery operated. Wide range clear meter 4"x4¾". Complete with deluxe carrying case, batteries and instructions.

OUR PRICE £19.95 P&P 30p

C15 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth. 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.

OUR PRICE £39.00 Carr. paid

RUSSIAN C116 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base. 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

OUR PRICE £87.00 Carr. paid

Also see following pages

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £19.95 P&P 30p

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedance 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 30p

TRANSISTORISED L.C.R. A.C. BR/8' MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance: 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1/1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7¾" x 5" x 2".

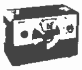
OUR PRICE £25.00 P&P 30p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.

OUR PRICE £8.97 P&P 30p

MODEL TE20 RF SIGNAL GENERATOR



Six bands. 120kHz–260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105–125V, 220–240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.

OUR PRICE £17.50 P&P 50p

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R.F. attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions. Size 140mm x 215mm x 170mm.

OUR PRICE £17.50 P&P 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/ Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

OUR PRICE £37.50 P&P 50p

SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER

complete with printed circuit mounting board.

OUR PRICE £1.50 P & P 15p.

PS200 Regulated POWER SUPPLY UNIT

Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P 50p

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating.

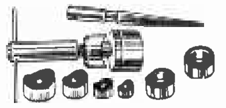
Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/500/1000/2500 ohms. **£1.15** P&P 10p

50 WATT 10/50/100/250/500/1500/5000 ohms. **£1.62** P&P 10p

100 WATT 1/5/10/25/50/250/500/2500 ohms 500 Ohms **£2.34** P&P 15p

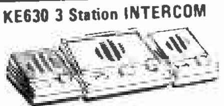
CP110 CHASSIS PUNCH SET



Carefully machined top grade steel. Contains 1/2", 5/8", 3/4", 1" and 1 1/8" punches complete with gripper and accessories.

OUR PRICE £3.00 P&P 40p

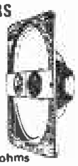
KE630 3 Station INTERCOM



Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

OUR PRICE £5.25 P&P 50p

EMI LOUDSPEAKERS



Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.50 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 35p

SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers

8 ohms 30 watt Heavy duty, ideal for Hi-Fi P A Group

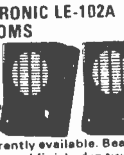
OUR PRICE £12.50 P&P 50p

SPECIAL BARGAIN!- FERGUSON 3406 HI-FI SPEAKERS

High quality 2 way speaker systems. 25 Watts. 4–8 ohms. 40Hz–18kHz. Size: 560 x 340 x 255mm. approx. Wood grain finish with black fronts

OUR PRICE £22.50 PR. P&P £1

AUDIOTRONIC LE-102A INTERCOMS



This new exclusive compact intercom offers the finest "2-station" value currently available. Beautifully made and finished in two-tone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker/mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt Approx. 60ft lead

OUR PRICE £3.95 P & P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

OH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.

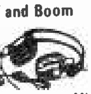
OUR PRICE £2.60 P&P 30p

SDH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.

OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone



Moving coil. Ideal for language teaching, communications etc. Headphone impedance 16 ohms. Microphone impedance 200 ohms.

OUR PRICE £5.95 P&P 30p

HANIMEX HRC 3075 CASSETTE RADIO

Covers Medium and FM wave-bands. Slider volume and tone controls Battery/Mains operation Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette

OUR PRICE £25.00 P & P 50p

TRITON CT.555 CASSETTE RECORDER

Battery Mains Piano key and slider controls Automatic level control. Complete with mike and earphone

OUR PRICE £10.50 P & P 50p

ZEPHYR TC1500B CASSETTE RECORDER

Battery/ Mains Complete with mike, cassette, earphone

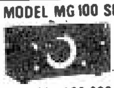
OUR PRICE £9.95 P & P 50p

TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO

Will play 8 track stereo cartridge monaurally Channel selector switch Covers medium and long wave bands Volume and tone controls Earphone socket. Battery Mains operation

OUR PRICE £11.95 P & P 50p

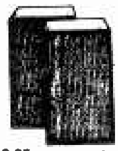
MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR



Range 19-220,000Hz Sine Wave 19–100,000 Hz Square Wave Output Sine or Square wave 10v P. to P Size 180 x 90 x 90mm Operation 220/240v A C

OUR PRICE £19.95 P&P 50p

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 PAIR P&P 50p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £8.95 P&P 20p

Stereo Multiplex Adaptor £5.95 extra.

Model A1018 FM TUNER

6 transistor high quality unit– 3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

OUR PRICE £13.50 P&P 30p

Stereo multiplex adapter £5.95 extra.

SINCLAIR CALCULATORS

Cambridge Ready Built. List £19.95 Our Price £17.95 P & P 25p.

Cambridge Kit Our Price £13.50 Post Free.

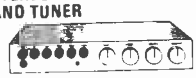
Executive. List £39.00 Our Price £35 45 P & P 25p

Executive Memory List £49.00 Our Price £44.50 P & P 25p.

Scientific List £49 00 Our Price £44 50 P & P 25p.

MANY OTHER CALCULATORS IN STOCK FROM AS LITTLE AS £9.95

SINCLAIR SYSTEM 2000 STEREO AMPLIFIER AND TUNER



AMPLIFIER

Amplifier output 8 watts per channel RMS. Distortion less than 0.06%. Silicon transistors. Two pick-up plus radio and tape inputs, tape output and scratch filter. Excellent Value.

OUR PRICE £27.50 P & P 60p.

FM TUNER

Excellent selectivity and sensitivity. Twin dual-varicap tuning. 4 pole ceramic filter. 19 transistor stereo demodulator giving 40 dB separation. Distortion 0.2% output. Fantastic Value.

OUR PRICE £27.50 P & P 60p.

SINCLAIR Project 80 Modules

Z40 Power Amp	£5.45	P & P 15p
Z60 Power Amp	£6.95	P & P 15p
Stereo 80 Pre-Amp	£11.95	P & P 15p
Active Filter Unit	£6.95	P & P 15p
Project 805	£26.95	P & P 50p
PZ5 Power Supply	£4.98	P & P 30p
PZ6 Power Supply	£7.98	P & P 30p
PZ8 Power Supply	£7.98	P & P 30p
Transformer for PZ8.	£4.05	P & P 50p

SINCLAIR Project 80 Packages

2 x Z40/Stereo 80/PZ5	£25.00
2 x Z40/Stereo 80/PZ6	£27.75
2 x Z60/Stereo 80/PZ8	£30.45

POST & PACKING 35p each.

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beautiful walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 30p

JOSTY KIT HIGH QUALITY CONSTRUCTION KITS

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£4.80
AF25 Mixer	£3.60
AF30 Mono pre-amplifier	£2.61
AF35 Emitter amplifier	£2.27
AF80 0.5W mic. amplifier	£4.22
AF305 Intercom	£9.52
AF310/2 Mono Amplifier	£7.56
AT5 Automatic light control	£2.56
AT25 Window wiper robot	£5.82
AT30 Photo cell switch unit	£5.70
AT50 400W triac light dimmer/speed control	£4.80
AT56 2,200W triac light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
GP304 Circuit board	£4.94
GP310 Stereo pre-amplifier for use with 2 x AF310	£21.27
GP312 Circuit board	£11.45
GU330 Tremolo unit	£7.50
HF61 Diode detector	£3.32
HF65 FM transmitter	£2.70
HF75 FM receiver	£2.87
HF310 FM tuner	£15.81
HF325 Deluxe FM tuner	£24.12
HF330 Decoder (HF310/325)	£9.96
HF380 lw/vhf aerial amplifier	£4.94
HF395 broadband aerial amp.	£1.77
LF380 Quadraphonic device	£11.36
M160 Multi-vibrator	£1.71
M191 VU Meter	£4.55
M192 Stereo balance meter	£4.97
M1302 Transistor tester	£8.45
NT10 Stabilised power supply 100mA, 9V	£6.15
NT300 Stabilised p. supply	£12.51
NT305 Voltage converter	£4.50
NT310 Power Supply 240 V AC or 2 x 18 V D.C. at 2 amps	£4.80
NT315 Power supply 240V AC to 4,5/15V DC, 500mA	£9.57

Amateur Electronics by Josty-Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

OUR PRICE £3.30 (No VAT)

P&P 25p plus VAT.

AE1 100mW output stage	£1.50
AE2 Pre-amplifier	£1.15
AE3 Diode receiver	£1.82
AE4 Flasher	99p
AE5 Astable multi-vibrator	95p
AE6 Monostable multi-vibrator	93p
AE7 RC generator	97p
AE8 Bass filter	90p
AE9 Treble filter	90p
AE10 CCIR filter	90p

1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

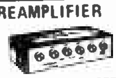
TYPE	5	10	25
C60	£1.57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

AUDIOTRONIC 8 TRACK CARTRIDGES

TYPE	Each	5	10
40M	85p	£4.00	£7.50
80M	£1.15	£5.40	£10.25

P&P Cassettes 3p, Cartridges 5p each OVER 10 of either POST FREE!

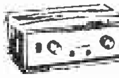
MP7 MIXER-PREAMPLIFIER



5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

AUDIOTRONIC AHA101 Stereo Headphone Amplifier



All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 30p

Also see previous page

ALL PRICES EXCLUDE VAT

SEW CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

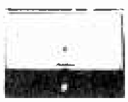
Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm

50uA	£3.80
100uA	£3.75
200uA	£3.70
500uA	£3.65
50-0-50uA	£3.75
100-0-100uA	£3.70
1mA	£3.65
5mA	£3.65
10mA	£3.65
50mA	£3.65
100mA	£3.65
500mA	£3.65
1A DC	£3.65
5A DC	£3.65
10A DC	£3.65
5V DC	£3.65
10V DC	£3.65
20V DC	£3.65
50V DC	£3.65
300V DC	£3.65
15V AC	£3.75
300V AC	£3.75
VU Meter	£3.90

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



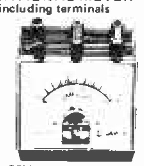
50uA	£4.60
100uA	£4.50
500uA	£4.30
50-0-50uA	£4.50
100-0-100uA	£4.45
1mA	£4.30
1A DC	£4.30
5A DC	£4.30
20V DC	£4.30
50V DC	£4.30
300V DC	£4.30
150V AC	£4.45
300V AC	£4.45
VU Meter	£4.90

EDGWISE MODEL PE70
Size: 90 x 34mm

50uA	£4.15
100uA	£4.10
200uA	£4.05
500uA	£3.90
50-0-50uA	£4.10
100-0-100uA	£4.05
1mA	£3.85
300V AC	£3.95
VU Meter	£4.30

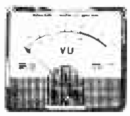
MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.



50uA	£8.50
100uA	£7.90
50-0-50uA	£7.90
1mA	£7.60
1-0-1mA	£7.60
1A DC	£7.60
5A DC	£7.60
5V DC	£7.60
10V DC	£7.60
15V DC	£7.60
20V DC	£7.60
50V DC	£7.60
300V DC	£7.60
500mA/5A DC	£8.60
5V/50V DC	£8.60
5V/15V DC	£8.60
1/5A DC	£8.60
1A/15A DC	£8.60

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm



50uA	£5.45
100uA	£5.40
200uA	£5.35
500uA	£5.25
50-0-50uA	£5.40
100-0-100uA	£5.35
500-0-500uA	£5.20
1mA	£5.20
1-0-1mA	£5.20
5mA	£5.20
10mA	£5.20
50mA	£5.20
100mA	£5.20
500mA	£5.20
1A DC	£5.20
5A DC	£5.20
15A DC	£5.20
30A DC	£5.40
10V DC	£5.20
20V DC	£5.20
50V DC	£5.20
150V DC	£5.20
300V DC	£5.20
15V AC	£5.30
300V AC	£5.30
S Meter 1mA	£5.20
VU Meter	£5.55
1A AC	* £5.20
5A AC	* £5.20
10A AC	* £5.20
20A AC	* £5.20
30A AC	* £5.20

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm

50uA	£4.30
100uA	£4.25
200uA	£4.20
500uA	£4.15
50-0-50uA	£4.25
100-0-100uA	£4.20
1mA	£4.10
5mA	£4.10
10mA	£4.10
50mA	£4.10
100mA	£4.10
500mA	£4.10
1A DC	£4.10
5A DC	£4.10
10A DC	£4.10
5V DC	£4.10
10V DC	£4.10
20V DC	£4.10
50V DC	£4.10
300V DC	£4.10
15V AC	£4.20
300V AC	£4.20
VU Meter	£4.40

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm

50uA	£3.20
100uA	£3.15
200uA	£3.10
500uA	£3.00
50-0-50uA	£3.15
100-0-100uA	£3.10
500-0-500uA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50mA	£2.95
100mA	£2.95
500mA	£2.95
1A DC	£2.95
5A DC	£2.95
10V DC	£2.95
20V DC	£2.95
50V DC	£2.95
300V DC	£2.95
15V AC	£3.05
300V AC	£3.05
S Meter 1mA	£2.95
VU Meter	£3.40
1A AC	* £2.95
5A AC	* £2.95
10A AC	* £2.95
20A AC	* £2.95
30A AC	* £2.95

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm

50uA	£3.10
100uA	£3.05
200uA	£3.00
500uA	£2.85
50-0-50uA	£3.05
100-0-100uA	£3.00
500-0-500uA	£2.80
1mA	£2.80
1-0-1mA	£2.80
2mA	£2.80
5mA	£2.80
10mA	£2.80
20mA	£2.80
50mA	£2.80
100mA	£2.80
150mA	£2.80
200mA	£2.80
300mA	£2.80
500mA	£2.80
750mA	£2.80
1A DC	£2.80
2A DC	£2.80
5A DC	£2.80
10A DC	£2.80
3V DC	£2.80
10V DC	£2.80
15V DC	£2.80
20V DC	£2.80
50V DC	£2.80
100V DC	£2.80
150V DC	£2.80
300V DC	£2.85
500V DC	£2.85
750V DC	£2.90
15V AC	£2.90
50V AC	£2.90
150V AC	£2.90
300V AC	£2.90
500V AC	£3.00
S Meter 1mA	£2.80
VU Meter	£3.20

CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm

50uA	£3.50
100uA	£3.45
200uA	£3.40
500uA	£3.35
50-0-50uA	£3.45
100-0-100uA	£3.40
1mA	£3.30
5mA	£3.30
10mA	£3.30
50mA	£3.30
100mA	£3.30
500mA	£3.30
1A DC	£3.30
5A DC	£3.30
10A DC	£3.30
5V DC	£3.30
10V DC	£3.30
20V DC	£3.30
50V DC	£3.30
300V DC	£3.30
15V AC	£3.45
300V AC	£3.45
VU Meter	£3.65

POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

50uA	£3.95
100uA	£3.85
200uA	£3.80
500uA	£3.75
50-0-50uA	£3.85
100-0-100uA	£3.80
500-0-500uA	£3.70
1mA	£3.70
1-0-1mA	£3.70
5mA	£3.70
10mA	£3.70
50mA	£3.70
100mA	£3.70
500mA	£3.70
1A DC	£3.70
5A DC	£3.70
10A DC	£3.70
15A DC	£3.70
20A DC	£3.80
30A DC	£3.85
50A DC	£4.05
5V DC	£3.70
10V DC	£3.70
15V DC	£3.70
20V DC	£3.70
50V DC	£3.70
150V DC	£3.70
300mV DC	£3.70
15V AC	£3.80
50V AC	£3.80
150V AC	£3.80
300V AC	£3.90
500V AC	£3.80
S Meter 1mA	£4.10
VU Meter	£3.70
1A AC	* £3.70
5A AC	* £3.70
10A AC	* £3.70
20A AC	* £3.70
30A AC	* £3.70
50mA AC	* £3.70
100mA AC	* £3.70
200mA AC	* £3.70
500mA AC	* £3.70

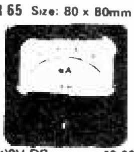
BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm

50uA	£4.50
100uA	£4.45
500uA	£4.20
50-0-50uA	£4.45
100-0-100uA	£4.40
1mA	£4.20
1A DC	£4.20
5A DC	£4.20
20V DC	£4.20
50V DC	£4.20
300V DC	£4.20
300V AC	£4.30
VU Meter	£4.70

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£3.70
100uA	£3.50
500uA	£3.35
50-0-50uA	£3.50
100-0-100uA	£3.45
1mA	£3.30
5mA	£3.30
10mA	£3.30
50mA	£3.30
100mA	£3.30
500mA	£3.30
1A DC	£3.30
5A DC	£3.30
10V DC	£3.30
20V DC	£3.30
50V DC	£3.30
300V DC	£3.30
15V AC	£3.40
300V AC	£3.40
S Meter 1mA	£3.30
VU Meter	£3.80
1A AC	* £3.30
5A AC	* £3.30
10A AC	* £3.30
20A AC	* £3.30
30A AC	* £3.30

BAKELITE MODEL MR 65
Size: 80 x 80mm



25uA	£5.25
50uA	£4.00
100uA	£3.95
500uA	£3.65
50-0-50uA	£3.95
100-0-100uA	£3.90
500-0-500uA	£3.60
1mA	£3.60
1-0-1mA	£3.60
5mA	£3.60
10mA	£3.60
50mA	£3.60
100mA	£3.60
500mA	£3.60
1A DC	£3.60
2A DC	£3.60
5A DC	£3.60
10A DC	£3.60
15A DC	£3.60
30A DC	£3.60
50A DC	£3.60
5V DC	£3.60
10V DC	£3.60
15V DC	£3.60
20V DC	£3.60
50V DC	£3.60
150V DC	£3.60
300V DC	£3.60
30V AC	* £3.60
50V AC	* £3.60
150V AC	* £3.60
300V AC	* £3.60
500V AC	* £3.60
VU Meter	£4.10
1A AC	* £3.60
5A AC	* £3.60
10A AC	* £3.60
20A AC	* £3.60
30A AC	* £3.60
50A AC	* £3.60
500mA AC	* £3.60
50mV DC	£3.75
100mV DC	£3.75

240° Wide Angle 1mA METERS

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10A	£33.75	£1.00
12A	£36.40	£1.00
20A	£85.00	£1.50
25A	£87.50	£1.50
40A	£99.95	£1.50

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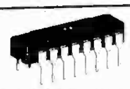

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7401	20p	18p	7451	20p	19p	74150	£3·30	£2·75
7402	20p	18p	7453	20p	19p	74151	£1·21	£1·15
7403	20p	18p	7454	20p	18p	74153	£1·32	£1·15
7404	21p	19p	7460	20p	18p	74154	£2·20	£1·87
7405	21p	19p	7470	33p	27p	74155	£1·65	£1·21
7406	54p	49p	7472	33p	30p	74156	£1·65	£1·21
7407	54p	48p	7473	46p	42p	74157	£1·54	£1·43
7408	29p	24p	7474	44p	40p	74160	£2·18	£2·05
7409	29p	24p	7475	63p	57p	74161	£2·18	£2·05
7410	20p	18p	7476	55p	51p	74162	£4·84	£4·54
7411	23p	21p	7480	£1·10	99p	74163	£4·84	£4·54
7412	40p	33p	7481	£1·37	£1·26	74164	£2·73	£2·63
7413	31p	29p	7482	£1·10	99p	74165	£2·73	£2·63
7416	49p	47p	7483	£1·32	£1·29	74166	£4·28	£3·94
7417	57p	53p	7484	£1·32	£1·21	74174	£2·78	£2·66
7420	20p	18p	7485	£2·75	£2·64	74175	£1·94	£1·81
7422	60p	58p	7486	49p	41p	74176	£1·99	£1·87
7423	60p	58p	7489	£4·95	£4·29	74177	£2·75	£2·64
7425	60p	53p	7490	82p	71p	74180	£2·75	£2·64
7426	85p	31p	7492	84p	65p	74181	£6·49	£6·05
7427	55p	51p	7493	82p	66p	74182	£2·16	£2·02
7428	85p	79p	7494	£1·04	93p	74184	£2·69	£2·42
7430	20p	18p	7495	£1·14	£1·03	74190	£3·08	£2·69
7432	42p	33p	7496	£1·25	£1·15	74191	£2·30	£2·24
7433	87p	81p	74100	£2·75	£2·58	74192	£2·53	£2·30
7437	77p	74p	74104	£1·18	£1·14	74193	£2·53	£2·30
7438	77p	74p	74105	£1·18	£1·14	74194	£3·27	£3·15
7440	20p	18p	74107	48p	46p	74195	£2·42	£2·30
7441	81p	78p	74110	67p	65p	74196	£2·18	£2·06
7442	81p	78p	74111	£1·52	£1·40	74197	£2·18	£2·06
7443	£1·40	£1·32	74118	£1·10	80p	74198	£6·65	£6·05
7444	£1·57	£1·52	74119	£1·64	£1·54	74199	£6·65	£6·05
7445	£2·31	£2·18	74121	47p	42p	74200	£26·40	£21·12

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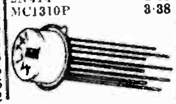
301	8 PIN DIL	46p
301A	DIL	69p
301A	TO99	69p
301A	8 PIN DIL	66p
307	DIL	69p
307	TO99	69p
307	8 PIN DIL	66p
308	TO99	6·45p
308A	TO99	6·40p
709c	DIL	35p
709c	TO99	31p
723c	DIL	99p
723c	TO99	95p
741c	8 PIN DIL	38p
741c	14 PIN DIL	39p
741c	TO99	41p
747c	DIL	86p
748c	DIL	39p
748c	TO99	41p
2N414		1·38
MC1310P		3·38



Resistors

½ watt 5% carbon	1p
⅓ watt 5% carbon	1p
1 watt 10% carbon	2½p
range 10 ohms to 4·7 megohms.	
⅓ watt m/o 2 %	4p
range 10 ohms to 1 megohms.	

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2½ × 3¾	24p	19p
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3¾ × 3¾	27p	23p
3¾ × 5	31p	31p
17 × 2½	82p	63p
17 × 3¾	£1·10	87p
17 × 5 (Plain)		90p
Pin insertion too	57p	57p
Spot face cutter	46p	46p
Pk 36 Pins	20p	20p

Electrolytic Capacitors

4 VOLT		16 VOLT		40 VOLT	
47µF	6½p	15µF	6½p	47µF	6½p
100µF	6½p	33µF	6½p	100µF	9p
220µF	6½p	150µF	6½p	68µF	10p
330µF	6½p	150µF	8p	220µF	11p
1000µF	13p	220µF	9p	470µF	19p
4700µF	29p	680µF	17p	680µF	25p
		1000µF	17p	1000µF	25p
		1500µF	25p	2200µF	44p
		2000µF	43p		

6·3 VOLT		25 VOLT		63 VOLT	
33µF	6½p	10µF	6½p	1µF	6½p
68µF	6½p	22µF	6½p	2·2µF	6½p
150µF	6½p	47µF	6½p	4·7µF	6½p
470µF	11p	100µF	8p	6·8µF	6½p
680µF	13p	150µF	8p	10µF	6½p
1500µF	18p	220µF	10p	22µF	6½p
2200µF	18p	470µF	13p	68µF	10p
3300µF	26p	680µF	20p	100µF	11p
		1000µF	22p	150µF	13p
		2200µF	39p	220µF	19p
		5000µF	68p	330µF	22p
				470µF	26p
				1000µF	44p

10 VOLT		40 VOLT	
22µF	6½p	6·8µF	6½p
47µF	6½p	15µF	6½p
100µF	6½p	33µF	6½p
220µF	8p		
330µF	10p		
470µF	10p		
1000µF	11p		
1500µF	20p		
2200µF	24p		

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Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	P & P £	p
07	20	1	8	7·0 × 6·0 × 6·0	2·55	30
149	60	3	12	9·9 × 7·7 × 8·6	3·79	36
150	100	5	8	9·9 × 8·9 × 8·6	4·17	52
151	200	8	0	12·1 × 9·3 × 10·2	7·39	52
152	250	13	12	12·1 × 11·8 × 10·2	9·25	67
153	350	15	0	14·0 × 10·8 × 11·8	11·35	82
154	500	19	8	14·0 × 13·4 × 11·8	13·20	–
155	750	29	0	17·2 × 14·0 × 14·0	21·20	
156	1000	38	0	17·2 × 16·6 × 14·0	27·40	–
158	2000	60	0	21·6 × 15·3 × 18·1	49·25	–

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P & P £	p
113	20	1	0	5·8 × 5·1 × 4·5	0-115-210-240	1·34	22
64	75	2	4	7·4 × 6·7 × 6·1	0-115-210-240	2·64	30
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	3·18	36
66	300	6	4	9·9 × 9·6 × 8·6	,,	6·19	52
67	500	12	8	12·1 × 11·2 × 10·2	,, ,,	9·20	67
84	1000	19	8	14·0 × 13·4 × 14·3	,, ,,	13·50	82
93	1500	30	4	14·0 × 15·9 × 14·3	,, ,,	17·50	–
95	2000	32	0	17·2 × 16·6 × 14·0	,, ,,	25·35	•
73	3000	40	0	21·6 × 13·4 × 18·1	,, ,,	32·80	•

CASED AUTO TRANSFORMERS

115V 500W enclosed transformer, with mains lead and two 115V outlet sockets. £9·49, P & P 67p. 20 Watt version £2·02 P & P 27p.

TRANSFORMERS

PRIMARY 240-250 VOLTS 12 AND OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P & P £	p
111	0·5	0·25		8	4·8 × 2·9 × 3·5	0-12V at 0·25A × 2	1·34	22
213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·58	22
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·09	22
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·95	30
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·52	42
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	3·96	52
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·67	52
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·61	52
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	7·22	52
115	20	10	11	8	14·0 × 9·6 × 11·8	0-12V at 10A × 2	9·20	67
187	30	15	15	8	14·0 × 12·1 × 11·8	0-12V at 15A × 2	16·94	82
226	60	30	32	0	17·2 × 15·3 × 14·0	0-12V at 30A × 2	22·50	•

30 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1	4	6·1 × 5·8 × 4·8	0-12-15-20-24-30V	1·56	22
79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	2·11	36
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·18	36
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	3·96	42
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·67	52
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	5·83	52
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	6·94	52
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	9·00	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	11·36	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	2·09	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	3·08	36
104	2·0	5	8	9·9 × 8·9 × 8·6	,, ,,	4·26	42
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·79	52
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	7·69	52
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	11·38	67
118	8·0	18	0	14·0 × 12·7 × 11·8	,, ,,	12·40	97
119	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	18·62	•

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60	2·12	36
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	2·97	36
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·67	42
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	7·11	52
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	9·20	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	10·83	87
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	13·35	82
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	15·01	•
122	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	19·60	•
189	12·0	29	00	17·2 × 14·0 × 14·0	,, ,,	21·60	•

MINIATURE TRANSFORMERS WITH SCREENS

Ref.	MA.	Weight		Size cm	VOLTS	P & P £	p
238	200		2	2·8x2·6x2·0	3-0-3	1·44	10
212	1A 1A	1	4	6·1x5·8x4·8	0-6 0-6	1·67	22
13	100		4	3·9x2·6x2·9	9-0-9	1·23	10
235	330,330		4	4·8x2·9x3·5	0-9, 0-9	1·67	10
207	500, 500	1	00	6·1x5·4x4·8	0-8-9, 0-8-9	2·23	22
208	1A, 1A	1	12	7·0x6·4x6·1	0-8-9,0-8-9	3·00	30
236	200, 200		4	4·8x2·9x3·5	0-15, 0-15	1·67	10
214	300, 300	1	4	6·1x5·8x4·8	0-20, 0-20	1·76	22
221	700 (D.C.)	1	8	7·0x6·1x6·1	20-12-0-12-20	1·55	30
206	1A, 1A	2	12	8·3x7·7x7·0	0-15-20, 0-15-20	4·05	36
203	500, 500	2	4	8·3x7·0x7·0	0-15-27, 0-15-27	3·10	38
204	1A, 1A	3	4	8·9x7·7x7·7	0-15-27, 0-15-27	3·15	38

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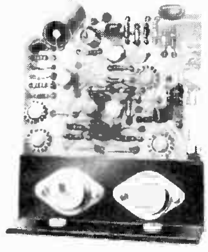

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PS70	Suits 2 SA100	£4·90	Carriage free
MT70	Transformer for above	£4·90	Carriage 40p

N.B. PS70 is not suitable for the SA50

Mk II STEREO DISCO MIXER £19·75
Carr. 30p

This well tried unit mixes two decks, handles any ceramic cartridge, and features mic over-ride plus separate full range bass and treble controls on both mic and deck inputs. Ample headphone power is available for P.F.L. May be used for mono and is mains operated. Fitted with sturdy screening case. Controls: Mic vol, bass, treble. Left/Right fade, deck volume, bass, treble, h/phone select, vol, Mains. Size 17½in × 3in × 4in deep.

DISCO MODULE £8·00 Carr. 20p

Thousands sold of this extremely popular mono version. A mic input may be fitted using the VA30 (see below). Low consumption from a 9V battery. Features the same high standards of reproduction as the Stereo version. Controls: H/phone select, vol, Left deck vol, Right deck vol, bass, treble, master vol. Size 12¾in × 3in × 2in deep.

3-CHANNEL SOUND-LITE £22·50 Carr. 30p

Only SAXON can supply such incredible value for money. This unit features 3kW power handling, full-wave control, bass, middle, treble AND master controls. Twin loudspeaker jacks for "through" connections. It may be used free standing or will panel mount next to either of the above. Also features unique CUT-BACK circuitry for extra wide range response. Size 12in × 3in × 2½in deep. Professional standards at a price you can afford!

SINGLE CHANNEL VERSION £7·50 Carr. free — Recently reduced in price due to increasing sales, handles 1kW. Full wave operation

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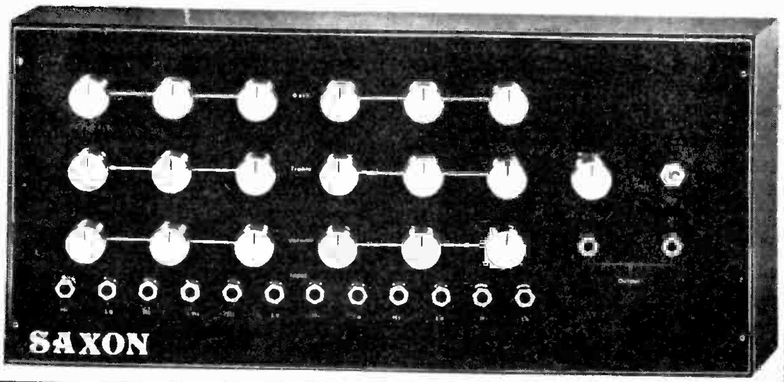
MULTI-PURPOSE MIXERS

M4HL £18·50 Carr. 50p — **M6HL £27·50** Carr. 50p

Featuring multiples of our VA30 module, the M4HL and M6HL fulfil the requirements of all clubs, groups, etc. where a high quality mixer is required. Each channel has one high and one low impedance input, plus volume, treble and bass controls. Input impedances may, if required, be easily changed. The M4HL has four channels, and one output, and the M6HL six channels (12 inputs) and a master control and two outputs. Either unit may be used free-standing or panel mounted. These mixers will feed all types of amplifier. Recommended for their versatility and high performance, and excellent value for money.

VA30 CHANNEL MODULE £3·50 Carr. free

This is the basic channel module in the above mixers and may also be used for extra inputs on either the mono or stereo mixers. Fitted with volume, bass and treble controls, requires just a jack and supply (9–100V)



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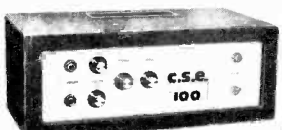

CSE 50 £29·50 Carr. free

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ECL82	0·61	EZ81	0·40
ECL83	0·68	GY501	0·90
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DAF96	0·50	EF95	0·40	PCC89	0·50
DCC90	1·35	EF98	0·75	PCC189	0·60
DF91	0·30	EF183	0·30	PCF80	0·40
DF96	0·50	EF184	0·35	PCF82	0·35
DK91	0·45	EL32	0·60	PCF86	0·60
DK92	0·70	EL33	1·75	PCF801	0·50
DK96	0·60	EL34	0·60	PCF802	0·50
DL92	0·40	EL36	0·50	PCF805	0·90
DL94	0·48	EL37	2·50	PCF806	0·75
DL96	0·55	EL41	0·90	PCF808	0·90
DY86/7	0·36	EL42	0·90	PCL82	0·35
DY802	0·37	EL84	0·28	PCL83	0·66
EABC80	0·38	EL95	0·40	PCL84	0·45
EAF42	0·75	ELL80	1·25	PCL85	0·60
EB91	0·22	EM80	0·40	PCL86	0·45
EBC33	1·00	EM81	0·60	PCL805/85	
EBC41	0·75	EM84	0·35		0·50
EBC81	0·33	EM85	1·00	PD500	1·30
EBF80	0·40	EY51	0·40	PEN45	0·75
EBF83	0·40	EY86	0·40	PL36	0·63
EBF89	0·32	EZ40	0·75	PL81	0·50
EBL31	1·50	EZ41	0·75	PL82	0·45
ECC81	0·40	EZ80	0·28	PL83	0·45
ECC82	0·33	EZ81	0·29	PL84	0·40
ECC83	0·33	GY501	0·90	PL500	0·80
ECC84	0·30	GZ30	0·45	PL504	0·80
ECC85	0·40	GZ32	0·50	PL508	0·90
ECC88	0·40	GZ34	0·65	PL509	1·55
ECH35	1·25	GZ37	1·25	PL802	0·95
ECH42	1·00	HN309	1·50	PX4	3·50
ECH81	0·30	KT61	1·75	PX25	3·50
ECH83	0·45	KT66	2·50	PY33	0·63
ECL80	0·55	KT81 (7C5)		PY81	0·50
ECL82	0·35		1·30	PY82	0·35
ECL83	0·70	KT81	1·75	PY83	0·38
ECL86	0·40	KT88	2·90	PY88	0·40
ECLL800	3·20	KTW61	1·00	PY500	1·05
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U25	0·85	6K7M	0·45
U26	0·85	6K7G	0·35
U191	0·75	6K8M	0·70
UABC80	0·40	6K8G	0·45
UAF42	0·75	6K25	1·00
UBC41	0·75	6L6G	0·55
UBC81	0·45	6Q7M	0·50
UBF80	0·40	6Q7G	0·50
UBF89	0·40	6SL7GT	0·48
UCC85	0·45	6SN7GT	0·48
UCH42	0·75	6SQ7GT	0·50
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UL41	0·85	6X5GT	0·45
UL84	0·42	7B6	0·75
UY41	0·48	7B7	0·70
UY85	0·40	7C5	1·30
VR105-30	0·40	7C6	0·75
VR150-30	0·40	7H7	0·70
OA2	0·40	7R7	0·75
OB2	0·40	7S7	2·25
1R5	0·45	7Y4	0·75
1S5	0·30	12AT6	0·40
1T4	0·30	12AT7	0·40
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6AM5	1·00	30F5	1·10
6AQ5	0·45	30FL1	0·80
6AS7G	0·85	30FL2	0·75
6AT6	0·45	30FL14	0·90
6AU6	0·30	30L15	1·05
6BA6	0·28	30L17	0·95
6BE6	0·35	30P4MR	1·30
6BH6	0·75	30P12	1·05
6BJ6	0·55	30P19	1·00
6BQ7A	0·55	30PL1	0·95
6BR7	1·00	30PL13	1·20
6BS7	1·35	30PL14	1·25
6BW6	0·90	35W4	0·50
6BW7	0·90	35Z4GT	0·70
6C4	0·35	50CD6G	1·20
6CD6G	1·30	807	0·50
6CH6	1·40	813 ITT	£13
6CW4	1·00	813 USSR	
6F23	1·05		£5·75
6F25	1·00	866A	1·00
6F28	0·70		
6J5M	0·65		
6J5G	0·45		

TRANSISTORS-INTEGRATED CIRCUITS

EXPRESS POSTAGE
4p for first Transistor, for each additional add 1p.

All transistors, I.C's offered are new and branded. Manufactured by Mullard, Texas, RCA, Ferranti, Motorola, ITT, Fairchild, Lucas, etc. Quantity discounts on application. Send SAE for full lists.

AA119	0·7	BD132	0·50
AAZ13	0·10	BF115	0·22
AAZ15	0·10	BF167	0·25
AC107	0·35	BF173	0·28
AC126	0·25	BF179	0·33
AC127	0·25	BF180	0·35
AC128	0·20	BF181	0·35
AC176	0·25	BF194	0·13
AC187	0·20	BF195	0·13
AC188	0·20	BF197	0·15
ACY21	0·22	BF200	0·32
ACY39	0·65	BFS61	0·25
AD140	0·50	BFS98	0·25
AD149	0·50	BFX29	0·28
AD161	0·39	BFX88	0·22
AD162	0·39	BFY50	0·20
AF115	0·25	BFY51	0·20
AF116	0·25	BFY52	0·20
AF117	0·20	BFW10	0·61
AF186	0·40	BY100	0·15
AF239	0·44	BY126	0·14
ASY27	0·30	BY127	0·15
ASY28	0·25	BZX61 series	
BA102	0·25		0·20
BA115	0·10	BZY88 series	
BC107	0·12		0·10
BC108	0·12	CR81-05	0·30
BC109	0·12	CR81-40	0·45
BC113	0·16	CR83-05	0·40
BC117	0·21	CR83-40	0·55
BC143	0·30	MJE340	0·50
BC147	0·12	MJE370	0·68
BC148	0·10	MJE520	0·65
BC169C	0·14	MJE2955	1·10
BC182	0·12	MJE3055	0·75
BC182L	0·12	MPF102	0·40
BC184L	0·13	MPF103	0·36
BCY32	1·20	MPF104	0·35
BCY33	0·38	MPF105	0·46
BCY34	0·45	NKT404	0·60
BCY70	0·15	OA5	0·60
BCY71	0·20	OA10	0·40
BCY72	0·15	OA79	0·10
BCZ11	0·65	OA81	0·10
BD121	1·00	OA91	0·7
BD124	0·80	OA200	0·08
BD131	0·45	OA202	0·10

OC16	1·00	ZTX501	0·15	2N2904	0·20
OC20	2·00	ZTX503	0·16	2N2904A	0·25
OC23	1·25	ZTX531	0·25	2N2905	0·32
OC25	0·40	ZTX550	0·18	2N2905A	0·25
OC28	0·70	1N914	0·06	2N2906	0·20
OC35	0·55	IN4001	0·6	2N2926	0·10
OC36	0·65	IN4002	0·7	2N3053	0·20
OC42	0·40	IN4003	0·8	2N3055	0·60
OC44	0·18	IN4004	0·8	2N3525	0·80
OC45	0·18	IN4005	0·10	2N3614	0·59
OC71	0·15	IN4006	0·12	2N3615	0·65
OC72	0·25	IN4007	0·12	2N3702	0·11
OC76	0·30	1N4009	0·06	2N3703	0·12
OC77	0·55	1N4148	0·06	2N3704	0·14
OC81	0·28	1S921	0·07	2N3705	0·12
OC81D	0·28	1S2033	0·20	2N3706	0·10
OC81Z	0·45	1S2051A	0·10	2N3707	0·13
OC83	0·25	1S2100A	0·20	2N3708	0·07
OC140	0·65	1S3010	0·25	2N3709	0·10
OC170	0·25	2N696	0·15	2N3710	0·11
OC171	0·30	2N697	0·15	2N3711	0·11
OC200	0·55	2N706	0·10	2N3819	0·35
OC201	0·80	2N706A	0·12	2N3820	0·60
OC202	0·90	2N1131	0·25	2N3823	0·60
OC203	0·55	2N1132	0·25	2N3903	0·15
OCP71	1·00	2N1302	0·18	2N3904	0·20
ORP12	0·55	2N1303	0·18	2N3905	0·25
ORP60	0·45	2N1304	0·22	2N3906	0·16
T1005	0·20	2N1305	0·22	2N4058	0·15
TIC44	0·29	2N1306	0·28	2N4059	0·10
TIC226D	1·50	2N1307	0·28	2N4060	0·13
TIL209	0·25	2N1308	0·28	2N4061	0·13
ZTX107	0·12	2N1309	0·30	2N4062	0·14
ZTX108	0·10	2N1613	0·20	2N4289	0·20
ZTX300	0·14	2N1614	0·45	3N141	0·81
ZTX301	0·14	2N2147	0·75	40360	0·40
ZTX302	0·20	2N2160	1·00	40361	0·45
ZTX304	0·24	2N2369A	0·16	40362	0·40
ZTX500	0·15	2N2646	0·50	40430	0·85

SN7400	0·26	SN7425	0·37	SN7473	0·44	SN74107	0·51	SN74157	1·09
SN7401	0·20	SN7427	0·37	SN7474	0·48	SN74110	0·57	SN74170	2·88
SN7402	0·20	SN7428	0·43	SN7475	0·59	SN74111	0·86	SN74174	1·80
SN7403	0·20	SN7430	0·20	SN7476	0·45	SN74118	1·00	SN74175	1·29
SN7404	0·20	SN7432	0·37	SN7480	0·80	SN74119	1·92	SN74176	1·44
SN7405	0·20	SN7433	0·43	SN7482	0·87	SN74121	0·57	SN74190	2·30
SN7406	0·40	SN7437	0·43	SN7483	1·20	SN74122	0·80	SN74191	2·30
SN7407	0·40	SN7438	0·43	SN7484	1·00	SN74123	1·44	SN74192	2·30
SN7408	0·25	SN7440	0·20	SN7486	0·50	SN74141	1·00	SN74193	2·80
SN7409	0·33	SN7441AN		SN7490	0·75	SN74145	1·44	SN74194	1·72
SN7410	0·20		0·85	SN7491AN		SN74150	2·30	SN74195	1·44
SN7411	0·28	SN7442	0·85		1·10	SN74151	1·15	SN74196	1·58
SN7412	0·28	SN7450	0·20	SN7492	0·75	SN74154	2·30	SN74197	1·58
SN7413	0·30	SN7451	0·20	SN7493	0·75	SN74155	1·15	SN74198	3·16
SN7416	0·30	SN7453	0·20	SN7494	0·85	SN74156	1·15	SN74199	2·88
SN7417	0·30	SN7454	0·20	SN7495	0·85				
SN7420	0·20	SN7460	0·20	SN7496	1·00				
SN7422	0·28	SN7470	0·33	SN7497	4·32				
SN7423	0·40	SN7472	0·38	SN74100	2·16				

DIL SOCKETS 14 pin **15p** 16 pin **17p**

VAT

10% to be added to all orders including POSTAGE!

THIS MONTH'S

OSCILLOSCOPE TUBE TYPE VCR 139A

Price £8·00 p & p 25p

SPECIAL OFFER

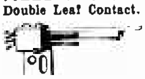
TERMS OF BUSINESS: C.W.O. A/c's available to approved companies on application. Telephone and telex orders accepted. Export and trade enquiries welcomed. Lists, etc. on application. Open daily to callers 9 a.m.–5 p.m. Mon.–Sat. Closed Sat. 1–3 p.m. Prices correct when going to press.

RST VALVE MAIL ORDER CO.

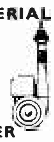
16a Wellfield Rd., London, SW16 2BS

Tel: 01-677 2424 Telex: 946 708.

RECORD PLAYBACK HEADS (TRUVOX)
Individual prices of these are:
2 track record playback heads **50p** each.
4 track record playback heads **72p** each.
Erase heads are also available separately—
2 track **33p**—4 track **55p**.
MU metal mounting shields **39p** each.
2 track-heads already fixed on heavy mounting plate with shield **£1·22p**.

NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. **8p** each, 10 for **60p** Plastic pushrod suitable for operating. **6p** each, 10 for **54p**.

1 R.P.M. MOTOR+GEAR BOX
Made by the famous Chamberlain & Hookham Ltd. These could be made to drive clock or similar. Really robust reliable unit. Price **£1·10** each.

AUTO—ELECTRICAL CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£6·35** plus **25p** post and insurance.

MAINS TRANSISTOR POWER PACK
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **£1·10**, plus **20p** postage.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at **25p** each.

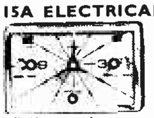
MULTI-SPEED MOTOR.

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price **97p** plus 23p postage and insurance.

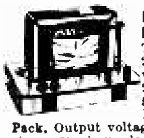
MIGHTY MIDGETS
Probably the finest possible radio, as described in Practical Wireless January 1973. All electronic parts **£2·20** post paid.

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. **8p** each. 10 for **73p**. Ditto as above but for printed circuit **6p** each 10 for **63p**. **Sub Miniature Slide Switch.** DPDT 19mm (⅜in approx.) between fixing centres. **20p** each or 10 for **£1·90**. SP Change over spring return 250v 1 amp. **11p**.

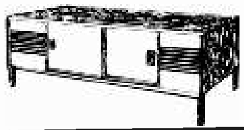
15A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you awake — switch on lights to ward off intruders — have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£2·15** + 20p p. & p. or with glass front, chrome bezel, **83p** extra.

BALANCED ARMATURE UNIT
500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, **37p** each.

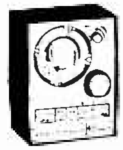
12 VOLT 1½ AMP. POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mF smoothing. Price **£2·20** plus 20p post & packing. **Heavy Duty Mains Power Pack.** Output voltage adjustable from 15-40V in steps—maximum load 250W—that is from 6 amp at 40V to 15 amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price **£6·33** plus 63p post.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1·10 each or £12 per dozen, specify 5, 10 or 15 amp—*simply fit in place of switch.*

STEREO RADIO CABINET

Long, Low and Modern. Teak veneered with sliding front and tapered legs. Speaker spaces each end. Size approx. 4ft. 2in × 15in × 15in. Probably cost over **£20** to make. Our Price **£8·10** each, or **£5·50** each if ordered with BSR Record Changer below.

THIS MONTH'S SNIP ULTRA MODERN RECORD CHANGER.
Famous BSR deck with stereo cartridge **£6·95** + **£1·00** post.
Famous GARRARD SP 25 with ceramic stereo cartridge **£12·00** + £1·00 post and insurance.
SAVE OVER £2·00 IF YOU ALSO BUY THE STEREO CABINET ABOVE.

HORSTMANN 24-HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:—

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated. Size 3in. × 3in. × 2in. deep. Price **£3·85** as illustrated but less case.

PORTABLE RADIO CASE DE-LUXE

A similar size to the above but a more expensive design. Used with the Good Companion de-luxe model. **£2·20** plus 50p post and insurance.

KETTLE ELEMENTS
Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1⅛in (approx.) suitable for Swan and other similar models—1⅜in (approx.) suitable for G.E.C., Hotpoint, etc. All quick boil 2¼kW elements at 240V, Price **£1·88**.

MULLARD UNILEX STEREO SYSTEM

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this:—

1 Unilex Amplifier	Ref. EP.9000	**£1·60**
1 Unilex Amplifier	Ref. EP.9000	**£1·60**
1 Unilex Pre-Amp	Ref. EP.9001	**£1·98**
1 Unilex Power Unit	Ref. EP.9002	**£2·53**
1 Control panel kit with spun aluminium faced knobs	.. ..	**£3·30**

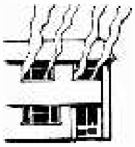
Or the complete outfit—**£11 30** post paid.
Pair of 15 ohm speakers made by Goodmans are also available if required, price **£3 30** the pair. No extra postage if ordered with the above, otherwise add 25p.

SWITCH TRIGGER MATS

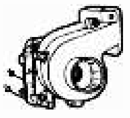
So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc.
24in × 18in **£1·69**
13in × 9in **£1·21**

HORSTMANN "TIME AND SET" SWITCH

(A 30 amp Switch). Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing.
Two models 15 amp **£1·98**, 30 amp **£2·58**. P. & P. 25p each

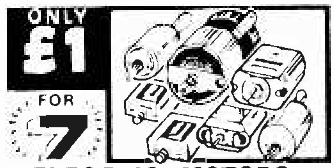
SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection against these killers.
Saga uses a fantastic electronic **sensor** which "smells" smoke and gas and sounds the alarm immediately. In a neat case measuring approx. 5" × 3¼" × 2¼", it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. **£6·99** plus 30p post.

OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS, NOW AVAILABLE. PRICE 30p POST PAID.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4¼" × 4¼" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when **soldering** etc., etc. A real bargain at **£2·05**.

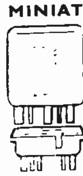
TERMS:—
ADD 10% V.A.T.
Send postage where quoted—other items, post free if order for these items is £6.00, otherwise add 20p.

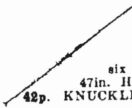
Sensational "once in a lifetime offer" because Mullard over-produced — definitely not repeatable once our stocks (now over half sold) are cleared. Hi-Fi 4 transistor amplifier complete in case ready to use. Batt., car or mains operated—freq. range 50hz-15Khz—distortion better than .2%. Comes complete with guarantee and data FREE to purchasers. Great handbook published by Mullard "tells all you need to know" to build your own stereo. Complete Unilex Stereo System **£11'30**, pair of speakers for same **£3.80**.



ELECTRIC MOTORS
7 powerful battery motors as used in racing cars and power models. Output and types vary to make them suitable for hundreds of different projects—tools, toys, models, etc. All brand new reversible and for 10 to 12v. Bats., wiring diagrams included. Post and VAT **30p**.
FREE Details of how to make miniature power station.

FERRITE RODS
For aerials, etc. The following types are in stock Dia. ⅜", 4" long **15p**, 5" long **18p**. Dia 5/16", 8" long **30p**. Dia. 3/8", 4" long **20p**, 5" long **25p**, 6" long **30p**, 8" long **40p**; Dia. ½", 6" long **35p**; Ferrite Slab 3" long x ⅞" x 1/8th"—**20p**.

MINIATURE SEALED RELAY

American made. Our Ref. No. REL A1. Measures only ⅞" wide × ½" thick and ⅞" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms. and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price **33p** including base.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw, **42p**. KNUCKLED MODEL FOR F.M. **55p**.

TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. **£3·30** plus 20p post and insurance.

MIDGET TWO GANGS
Tuning condenser as fitted to many Japanese and Hong Kong radios—probably 200pf each section with ⅛" spindle with terminal-less trimmers. Price **38p**. With trimmers **50p**.

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3 Price **99p** each, 10 for **£9**.

MAINS OPERATED SOLENOIDS

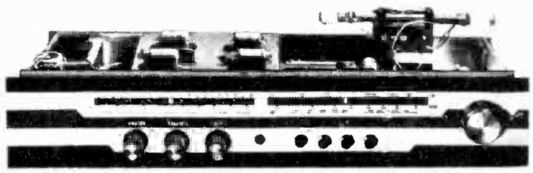
Model 2 — small but powerful 1in. pull—approx size 1¼ × 1¼ × 1⅛in. **66p. Model** 4001/—⅜in. pull. Size 2⅜ × 2 × 1⅛in. **83p. Model** TT1—1⅛in. pull. Size 3 × 2¼ × 2in **£1·98** plus 20p post and insurance

RADIO STETHOSCOPE
Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. **£2·20**, twin stethoset instead of earpiece **83p** extra—post and ins. 20p.

J. BULL (ELECTRICAL) LTD.
(Dept. PW), 102/3 Tamworth Road, CROYDON CRO 1XX

Why pay more - look at our Fantastic Bargain Offer!

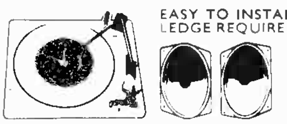
THE AVON AUDIO SYSTEM



The uncabineted system is ideal as an economical replacement for an outdated chassis. Stereo Amplifier for Stereo/Mono record reproduction. Tuner with medium, long and short wavebands provides Worldwide coverage, even the weakest continental stations can be received with superb clarity. Push button band selection, 10 watts total output. Frequency response 25-18000 Hz.

LATEST BSR STEREO/MONO RECORD CHANGER plays all types of 7in., 10in., and 12in. Mono or Stereo records. Manual or automatic play.

TWIN ELLIPTICAL SPEAKERS These low impedance, permanent magnet units have been specially selected to provide the fullest range of audio reproduction.



EASY TO INSTALL—NO TECHNICAL KNOWLEDGE REQUIRED. List Price £45·74. OUR PRICE £35·00. Credit Terms £3·50 deposit plus £2 Post & Packing followed by 9 payments of £4·10 (Total Credit Terms £44·40) Don't miss this bargain.

SEND £5·50 TODAY

ALL EQUIPMENT COVERED BY OUR 12 MONTHS FULL GUARANTEE

CALLERS WELCOME

LEWIS radio PW 9/74

100 Chase Side, Southgate, London N14 5PL
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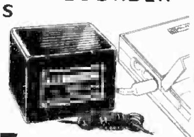

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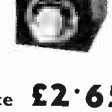

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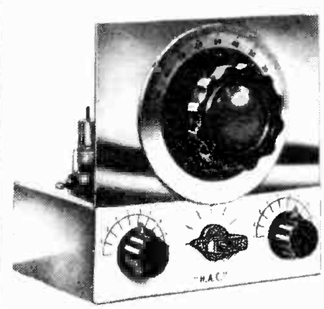

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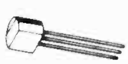

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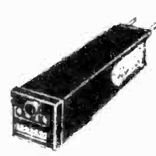

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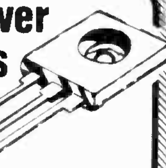

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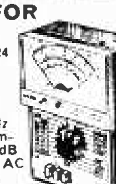

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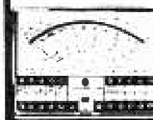

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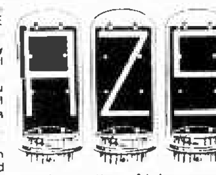

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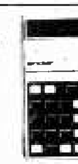

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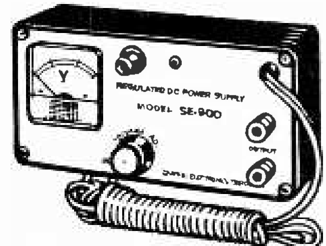

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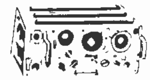

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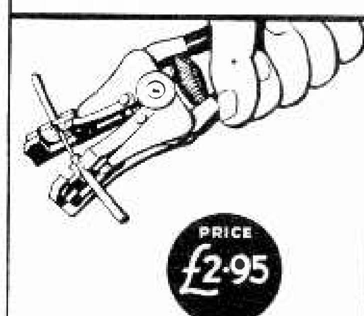

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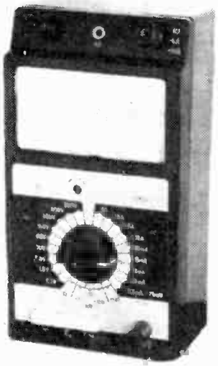

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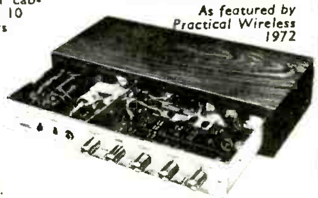

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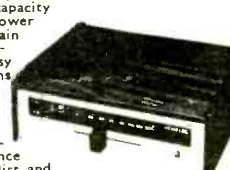

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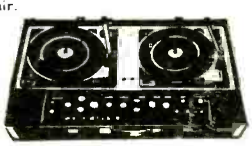

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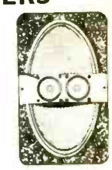

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