JAN 1978

practical WIRELESS

45p

PROPORTIONAL POWER CONTROLLER

also:

AERIAL PERFORMANCE TEST SET

HF DIRECT CONVERSION RECEIVER

T.T.L. 74 I.C's By TEXAS, NATIONAL, I.T.T., FAIRCHILD Etc

7400	14p	7413	30p	7432	25p	7454	15p	7490	35p	74121	25p	74139	100p	74156	70p	74174	100p	74189	350p
7401	14p	7414	60p	7437	25p	7460	15p	7491	75p	74122	40p	74141	60p	74157	70p	74175	75p	74190	140p
7402	14p	7416	30p	7438	25p	7470	30p	7492	45p	74123	60p	74142	270p	74160	90p	74176	100p	74191	140p
7403	14p	7417	30p	7440	15p	7472	25p	7493	40p	74125	50p	74143	270p	74161	90p	74177	100p	74192	120p
7404	14p	7420	15p	7441	65p	7473	30p	7495	60p	74126	50p	74144	270p	74162	90p	74178	140p	74193	120p
7405	14p	7422	20p	7442	65p	7474	30p	7496	70p	74130	130p	74145	75p	74163	90p	74179	140p	74194	100p
7406	40p	7423	25p	7445	80p	7475	30p	74100	95p	74131	100p	74147	230p	74164	125p	74180	100p	74195	100p
7407	40p	7425	25p	7446	85p	7476	30p	74104	40p	74132	65p	74148	160p	74165	125p	74181	200p	74196	100p
7408	20p	7426	25p	7447	75p	7483	85p	74105	40p	74135	100p	74150	120p	74166	125p	74182	75p	74197	100p
7409	20p	7427	25p	7448	70p	7485	100p	74107	30p	74136	80p	74151	65p	74167	325p	74184	150p	74198	185p
7410	15p	7428	40p	7450	15p	7486	30p	74109	50p	74137	100p	74153	65p	74170	200p	74185	150p	74199	185p
7411	20p	7430	15p	7451	15p	7489	250p	74118	90p	74138	125p	74154	120p	74173	150p	74188	350p		
7412	20p			7453	15p			74120	90p			74155	70p						

SEMICONDUCTORS
by MULLARD, TEXAS, MOTOROLA, SIEMENS, I.T.T., R.C.A.

AA113	10p	BA138	16p	BC168B	14p	BC548C	14p	BF123	45p	BF336	35p	BY164	50p	OC140	150p	TIP35A	230p	2N1305	30p
AA144	10p	BA148	16p	BC168C	15p	BC549B	13p	BF125	45p	BF337	35p	BYX94	8p	OC171	40p	TIP35C	280p	2N1306	38p
AAZ17	30p	BA154	12p	BC169C	15p	BC549C	14p	BF127	50p	BF363	60p	C1120	30p	OC200	80p	TIP36A	350p	2N1308	50p
AC121	30p	BA157	15p	BC171	12p	BC557	13p	BF166	30p	BFS94	30p	C1164	20p	ORP12	70p	TIP41A	70p	2N1711	22p
AC126	19p	BA173	15p	BC172C	12p	BCY34	80p	BF167	25p	BFW58	20p	E100	42p	R1039	150p	TIP41B	75p	2N2219A	25p
AC127	19p	BA216	16p	BC178A	16p	BCY70	15p	BF173	25p	BFX29	30p	E300	47p	TIP29	45p	TIP41C	80p	2N2483	30p
AC127/01	25p	BA316	16p	BC182	10p	BCY71	20p	BF179	35p	BFX81	130p	E430	125p	TIP29A	47p	TIP42A	80p	2N2906	18p
AC128	18p	BAX13	5p	BC182L	12p	BCY72	15p	BF179C	40p	BFX84	25p	MJE340	45p	TIP29C	75p	TIP42B	85p	2N2907	20p
AC151	25p	BAX16	5p	BC183	10p	BD121	85p	BF180	30p	BFX85	30p	MPSA06	25p	TIP30	55p	TIP2955	70p	2N3053	20p
AC153K	40p	BB105A	35p	BC183L	12p	BD123	100p	BF181	35p	BFX87	25p	OA10	40p	TIP30A	58p	TIP3055	55p	2N3054	50p
AC176	20p	BB110	45p	BC184	10p	BD124	85p	BF182	30p	BFX88	25p	OA47	15p	TIP30B	65p	TIS90	25p	2N3055	60p
ACY17	35p	BC107	10p	BC184L	12p	BD131	36p	BF183	30p	BFY50	20p	OA90	6p	TIP30C	80p	TIS91	25p	2N3439	50p
ACY21	30p	BC108	10p	BC186	24p	BD132	39p	BF186	25p	BFY51	20p	OA91	6p	TIP31	55p	IN914	5p	2N3702	11p
AD149	60p	BC108C	15p	BC205	14p	BD133	45p	BF194	10p	BFY52	20p	OA202	8p	TIP31A	58p	IN3754	10p	2N3703	12p
AD161	40p	BC109	10p	BC212	11p	BD135	40p	BF195	10p	BFY90	125p	OC23	200p	TIP31B	65p	IN4001	5p	2N3704	11p
AD162	40p	BC109C	14p	BC212L	12p	BD136	40p	BF196	10p	BR101	35p	OC25	100p	TIP31C	70p	IN4002	5p	2N3705	12p
AD161/2MP	90p	BC113	12p	BC213L	12p	BD137	40p	BF197	10p	BRY39	35p	OC28	75p	TIP32	60p	IN4003	5p	2N3706	11p
AF114	22p	BC117	19p	BC214	13p	BD139	38p	BF198	25p	BRY56	35p	OC35	75p	TIP32A	65p	IN4004	5p	2N3711	12p
AF115	22p	BC125	20p	BC214L	14p	BD140	40p	BF199	25p	BSX20	20p	OC42	35p	TIP32B	85p	IN4005	5p	2N3715	300p
AF116	22p	BC126	15p	BC258	13p	BD181	80p	BF200	30p	BSY40	25p	OC43	35p	TIP32C	90p	IN4006	6p	2N3772	175p
AF117	22p	BC146	12p	BC294	35p	BD182	80p	BF224	20p	BSY95	20p	OC45	35p	TIP33	100p	IN4007	7p	2N3819	25p
AF118	50p	BC147	10p	BC303	55p	BD207	70p	BF225	20p	BT100A	80p	OC71	25p	TIP33A	105p	IN4148	4p	2N3866	95p
AF125	25p	BC148	10p	BC317	15p	BD233	50p	BF241	16p	BU105	150p	OC72	30p	TIP33B	115p	IS44	4p	2N3904	15p
AF139	35p	BC148C	14p	BC323	60p	BD263	65p	BF244B	35p	BU133	75p	OC75	30p	TIP33C	130p	2N456A	90p	2N4062	14p
AF239	45p	BC149	10p	BC328	13p	BDY10	100p	BF257	26p	BU208	220p	OC81	30p	TIP34	115p	2N697	15p	2N4126	20p
ASY26	40p	BC157	10p	BC338	12p	BDY62/01	90p	BF258	28p	BY100	20p	OC81D	25p	TIP34A	118p	2N929	20p	2N5061	35p
BA114	9p	BC158	10p	BC547	12p	BF120	50p	BF259	30p	BY126	15p	OC83	50p	TIP34B	145p	2N930	20p	2N5163	35p
BA121	9p	BC159	10p	BC547B	13p	BF121	45p	BF274	15p	BY127	18p	OC84	50p	TIP35	225p	2N1302	25p	2N6027	50p
		BC167A	12p	BC548	12p			BF324	30p	BY133	22p							2SD234	50p

BZY88
400M.W.
Zeners

OV7	10p
2V4	10p
2V7	10p
3V0	10p
3V3	10p
3V6	10p
3V9	10p
4V7	10p
5V1	10p
5V6	10p
6V2	10p
6V8	10p
7V5	10p
8V2	10p
9V1	10p
10V	10p
11V	10p

BZY88

12V	10p
13V	10p
15V	10p
18V	10p
20V	10p
22V	10p
27V	10p
30V	10p
33V	10p

100 Mixed Zeners 850p
BZY88 Zeners 850p

SN76013ND	125p
SN76013N	180p
SN76023ND	125p
SN76023N	180p
SN76227N	160p
SN76228N	180p
SN76666N	100p
ZN414	120p

CA3090AQ	400p

TAA300	150p
TAA350	190p
TAA550	50p
TAA570	220p
TAA661B	140p
TAA700	390p
TAD100	250p
TAD110	200p
TBA120S	125p
TBA120T	125p
TBA540	300p
TBA540Q	400p
TBA550Q	400p
TBA560	400p
TBA641A12	250p
TBA720	230p
TBA800	100p
TBA820	100p
TBA990	250p
TCA270Q	250p
TCA270S	250p

LM301A	65p
LM307N	65p
LM308TO5	130p
LM308 8 DIL	130p
LM309K	180p
LM317K	325p
LM348N	200p
LM380N	110p
LM555	35p
LM710 TO5	60p
LM710 P	65p
LM723 TO5	60p
LM723 14 DIL	75p
LM741	25p
LM748	45p
LM1303N	155p
LM3900	90p

NE555	35p
NE556	100p
NE562B	400p

ELECTROLYTIC CAPACITORS

μF/V			
·47/25	5p	330/35	16p
1/16	5p	330/50	18p
1/25	5p	470/10	12p
1/50	5p	470/25	16p
2·2/25	5p	470/35	18p
2·2/35	5p	470/50	22p
3·3/25	5p	680/25	25p
4·7/10	5p	1000/16	25p
4·7/16	5p	1000/35	30p
4·7/25	5p	1000/63	50p
4·7/50	5p	2200/10	28p
6·8/25	5p	2000/35	50p
10/10	5p	2200/16	35p
10/16	5p	2200/63	75p
10/25	5p	2200/100	120p
10/35	5p	3300/16	40p
10/50	5p	3300/25	42p
22/6V3	5p	3300/63	80p
22/10	5p	4700/25	45p
22/16	5p	4700/40	50p
22/25	5p	4700/63	120p
22/35	5p		
22/50	6p		
33/6V3	5p		
33/16	6p		
33/25	6p		
33/40	6p		
33/50	7p		
47/10	6p		
47/16	6p		
47/25	6p		
47/35	6p		
47/50	7p		
100/10	6p		
100/16	6p		
100/25	6p		
100/50	8p		
100/63	10p		
125/15	6p		
220/16	10p		
220/25	12p		
220/50	20p		
330/25	15p		

POLY'TER CAP'ITORS
Mullard or Erie

μF	
·001	5p
·0022	5p
·0033	5p
·0047	5p
·0068	5p
·01	5p
·022	5p
·033	5p
·047	5p
·1	6p
·22	7p
·33	9p
·47	12p
1·00	20p
2·2	25p
4·7	35p
6·8	40p

SPECIAL OFFERS

BC147
BC148
BC149
BC157
BC158
BC159
BF194
BF195
BF196
BF197
100 ASSORTED FOR £7·50p

IN4148
100 for 150p

741 Op AMPS
100 for £20

555 TIMERS
100 for £30

RELAYS
24V 3 C.O. H.D. 11 Pin Plug 1N £1·00 Each

ASSORTED POLYESTER CAPACITORS
100 for £3·00

BYX94 DIODES
1250 PIV 1 Amp.
100 for £6·00

MULLARD
4500/64V C.432 Screw Terminal 75p

RESISTORS CARBON FILM 5%

·25 W
2·2Ω–4·7M 2p

·5 W
2·2Ω–4·7M 2·5p

1 W
2·2Ω 10 MEG 3·5p

POTENTIOMETERS

1K Lin	30p
5K Lin	30p
10K Lin	30p
25K Lin	30p
50K Lin	30p
100K Lin	30p
250K Lin	30p
500K Lin	30p
1 Meg Lin	30p
2 Meg Lin	30p
5K Log	30p
10K Log	30p
25K Log	30p
50K Log	30p
100K Log	30p
250K Log	30p
500K Log	30p
1 Meg Log	30p
2 Meg Log	30p

ROTARY SWITCHES BY LORLIN

1P 12W	40p
2P 6W	40p
3P 4W	40p
4P 3W	40p

MULLARD POT CORES

LA3	100–500 KHz	75p
LA4	10–30 KHz	100p
LA5	30–100KHz	100p
LA7	< 10KHz	100p

LA13 FOR W.W. OSCILLOSCOPE 200p

SPECIAL SCOOP OFFERS

LEDS ·125
OR ·2 RED ONLY
100 for £9·00
1000 for £60·00
SPECIAL QUOTATION FOR LARGER QUANTITIES

WESTINGHOUSE THYRISTORS

300 Volts 16 Amp 250p

CMOS

4000	20p	4023	20p	4055	140p
4001	20p	4024	100p	4056	145p
4002	20p	4025	20p	4060	130p
4006	120p	4026	200p	4066	55p
4007	20p	4027	85p	4069	30p
4009	70p	4028	155p	4071	30p
4011	20p	4029	130p	4072	30p
4012	20p	4030	60p	4081	20p
4013	55p	4032	150p	4082	30p
4015	90p	4043	220p	4510	145p
4016	55p	4046	150p	4511	200p
4017	110p	4047	115p	4516	140p
4018	250p	4049	70p	4518	110p
4020	140p	4050	50p	4528	130p
4022	180p	4054	130p		

BRIDGE RECTIFIERS

		V/REG.	
1A 50V	25p		
1A 100V	30p	7805	140p
1A 200V	30p	7812	140p
1A 400V	35p	7815	140p
1A 600V	40p	7818	140p
2A 50V	35p	7824	150p
2A 100V	50p		
2A 200V	55p		

SKELETON PRE-SET POTENTIOMETERS

0·1W 50N–5M mini vert & horiz 7p
·25W 100N–3·3M horiz. 7p
·25W 200N–4·7M vert. 8p

TANTALUM BEAD CAPACITORS

35V: 0·1μF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2, 3·3, 4·7, 6·8, 25V 1·5, 10, 16V 4·7, 10, 22, 10V 4·7, 15, 25, 33
Price 14p each

LEDS

RED ·125	15p
GREEN ·125	25p
YELLOW ·125	25p
RED ·2	15p
GREEN ·2	25p
YELLOW ·2	25p
DL747 Display	200p

DIL SOCKETS

8 Pin	13p
14 Pin	14p
16 Pin	15p

BZX61
Zeners 1·3W

6V8	15p
9V1	15p
11V	15p
13V	15p
15V	15p
22V	15p
30V	15p
39V	15p
43V	15p
47V	15p
51V	15p
56V	15p
68V	15p
72V	15p
160V	15p

XEROZA RADIO

306 ST. PAUL'S ROAD, HIGHBURY CORNER, LONDON, N.1

TELEPHONE 01-226 1489

Easy access to Highbury via Victoria Line (London Transport) British Rail

PLEASE NOTE ALL PRICES INCLUDE POSTAGE AND V.A.T. AT 8 OR 12½% AS APPROPRIATE

LARGE STOCKS OF NEONS, NUMICATOR TUBES, SINGLE AND MULTIPHASE HIGH CURRENT RECTIFIER STACKS, CAPACITORS OF ALL TYPES INCLUDING PHOTO-FLASH AND MOTOR START, TV TUNERS ALSO SOME HIGHLY TECHNICAL EQUIPMENT AND PARTS FOR INDUSTRIAL USERS AND SCHOOLS FOR PERSONAL CALLERS

Manufacturers (Large and Small) we welcome your enquiries. Overseas Buyers/Agents etc. let us know your requirements.

ISSUE 851

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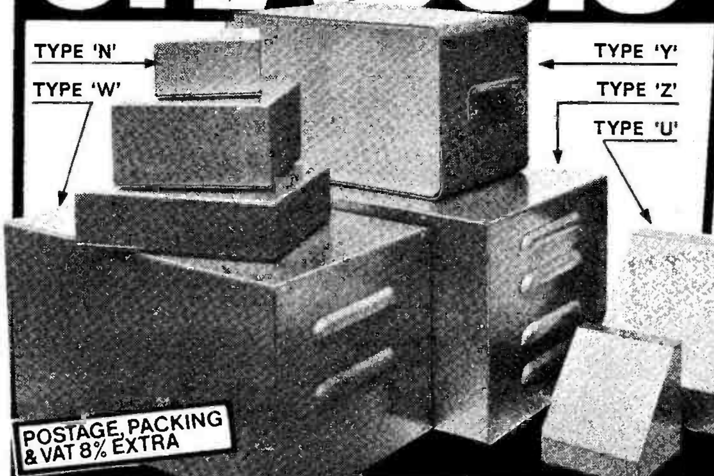
News and Views

For our Constructors

General Interest

CHASSIS & CASES



BLANK CHASSIS

FOUR-SIDED 16 SWG ALUMINIMUM

Size	Price	Base
6" × 4" × 2"	75p	34p
7" × 4" × 1½"	70p	37p
7" × 5" × 2"	85p	40p
8" × 4" × 2"	85p	40p
8½" × 5½" × 2"	£1·05	53p
9" × 7" × 2"	£1·10	59p
10" × 4" × 2½"	£1·05	46p
12" × 4" × 2½"	£1·15	52p
12" × 5" × 3"	£1·45	59p

Size	Price	Base
10" × 8" × 2½"	£1·45	70p
12" × 7" × 2½"	£1·50	74p
12" × 9" × 2½"	£1·70	88p
13" × 8" × 2½"	£1·65	86p
14" × 7" × 3"	£1·80	83p
14" × 10" × 2½"	£1·95	£1·08
15" × 10" × 2½"	£2·05	£1·15
17" × 10" × 3"	£2·45	£1·28

TO FIT OUR CASES

Size	Price	Base
7" × 5¾" × 1½"	80p	45p
7" × 5¾" × 2"	90p	45p
11" × 6¾" × 1½"	£1·10	69p
11" × 6¾" × 2"	£1·25	69p
12" × 6¾" × 2"	£1·35	74p
14" × 8¾" × 2"	£1·65	£1·00
15¾" × 9¾" × 2½"	£2·15	£1·22
17¾" × 9¾" × 2½"	£2·35	£1·35

PANELS: Any size up to 3ft. at 86p sq. ft. 16 s.w.g.
(18 s.w.g. 58p)

INSTRUMENT CASES

16 SWG ALUMINIUM, SILVER HAMMER FINISH

TYPE 'U'

*L	W	D	Price
3"	3"	3"	£1·40
4"	4"	4"	£1·75
5½"	4½"	4½"	£2·20
8"	6"	6"	£3·00
9½"	7½"	3½"	£3·25
12"	7"	7"	£4·20
16"	10"	6"	£6·15
15"	9"	9"	£6·45

TYPE 'W'

*L	W	D	Price
8"	6"	6"	£4·20
11½"	5"	7"	£4·70
12"	7"	7"	£5·40
15"	9"	8"	£7·45

TYPE 'Y' Louvres on back

*L	W	D	Price
8"	6"	6"	£4·65
12"	7"	7"	£5·95
13"	7"	9"	£6·90
15"	9"	7"	£7·40

TYPE 'Z'

*L	W	D	Price
17"	10"	9"	£8·80
19"	10"	8½"	£9·25

TYPE 'N' chassis with base plate

*L	W	D	Price
4"	4"	2"	£1·75
6"	6"	3"	£2·50
8"	6"	2"	£2·50

*L = side to side. W = back to front. D = top to bottom
Type "U" has removable bottom or back, type "W" removable front, type "Y" all-screwed construction, type "Z" removable back + front.

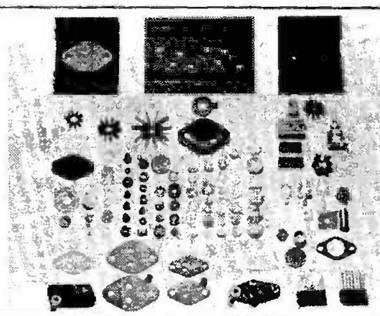
CHASSIS WITH BASE

Plain Aluminium

Size	Price	
5" × 4" × 2½"	£1·10	(16s.w.g.)
3" × 2" × 1"	55p	(18s.w.g.)
4" × 2¼" × 1¼"	65p	"
4½" × 3" × 2"	75p	"
3½" × 3½" × 2¼	75p	"
3¼" × 3¼" × 2½"	80p	"
6⅞" × 2⅞" × 1⅞"	80p	"

H.L.SMITH & CO.LTD.

287-289 EDGWARE ROAD, LONDON W2 1BE
TELEPHONE: 01-723 5891



LOW PROFILE DIL SOCKETS. TIN PLATED.

Prices Per	1	5	10	25
8 Pin	10p	45p	85p	£2·00
14 Pin	12p	55p	£1·05	£2·50
16 Pin	13p	60p	£1·15	£2·75
28 Pin	25p	£1·20	£2·30	£5·50
40 Pin	40p	£1·80	£3·50	£8·25

STANDARD PROFILE DOUBLE SIDED DIL-SOCKETS.

14 Pin	14p	65p	£1·25	£3·00
16 Pin	15p	70p	£1·35	£3·25

Mounting Pads	10/Pack	50/Pack
TO5 4 Hole	9p	40p
TO18 4 Hole	9p	40p

CONVERTERS

TO99 TO DIL	55p	£2·50
TO100 TO DIL	55p	£2·50
TO92/98 TO TO5	9p	40p
TO18 TO TO5	9p	40p
TO98 TO505	9p	40p
DIODE CRADLES	10p	45p

Larger range of transistor pads and insulating bushes in catalogue. All prices include V.A.T.

READY DRILLED BLACK ANODISED HEAT SINKS

TO3	1 @ 40p	5 @ £1·80
TO66	1 @ 40p	5 @ £1·80
TO3 ×2	1 @ 70p	5 @ £3·20

HEAT SINK COOLERS FITTING TO 5.

NP204	1 @ 14p	5 @ 65p
NF205	1 @ 12p	5 @ 55p
NF207	1 @ 13p	5 @ 60p
NF209	1 @ 15p	5 @ 75p

INSULATING KITS. 5 WASHERS 10 BUSHES

	Melinex	Mica
TO3	@ 28p/Kit	@ 30p/Kit
TO66	@ 25p/Kit	@ 30p/Kit

Bush shank length req:—·205, ·158, ·125, ·05, ·025 Please state req.

TRANSISTOR INSULATION COVERS

TO3	5 @ 35p	10 @ 70p
TO5	5 @ 15p	10 @ 25p
TO66	5 @ 35p	10 @ 70p

POWER SOCKETS

TO3	1 @ 14p	5 @ 65p
TO66	1 @ 16p	5 @ 75p

TO220 INSULATING KITS
5 Washer 5 Bushes
Melinex 20p/Kit Mica 25p/Kit

Post and Packaging 15p kits/pads/sockets/coolers. 45p for anodised heat sinks.

MOULDED ELECTRONIC COMPONENTS INT. LTD., 34D QUARRY HILL ROAD TONBRIDGE, KENT. PHONE: 0732 365910

Full Illustrated Catalogue . Send 30p For Post & Packing.

From ....

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**MOULDED ELECTRONIC
COMPONENTS INT. LTD.
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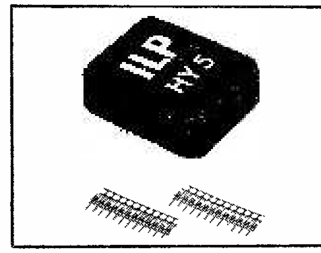
KENT
PHONE 0732 365910**

For the Professional Amateur

Vero can offer a complete package to help you build your product to a truly professional standard.
Full range of veroboards, accessories and housings.
Please send 10p plus S.A.E., size 7" x 9" for catalogue.
Vero Electronics Limited. Industrial Estate, Chandler's Ford, Eastleigh, Hampshire, SO5 3ZR.
Telephone: (04215) 2956 Telex 47551 VEROEL G
Available worldwide through 3 subsidiary Companies and 25 Agents.

15—240 Watts!

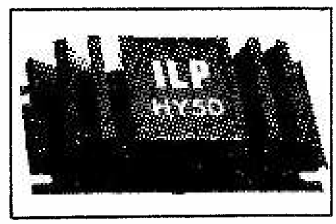
HY5
Preamplifier



The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.
APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address
SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £5·22 + 65p VAT P&P free.

HY30
15 Watts into 8Ω

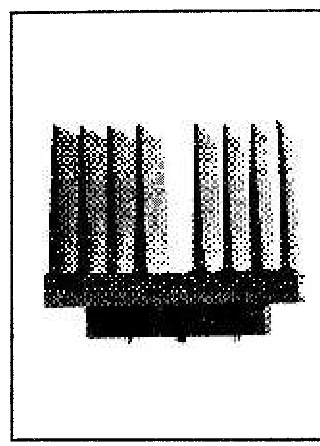
The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.
FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.
APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £5·22 + 65p VAT P&P free.



HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.
FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components
APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier
SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £6·82 + 85p VAT P&P free

HY120
60 Watts into 8Ω



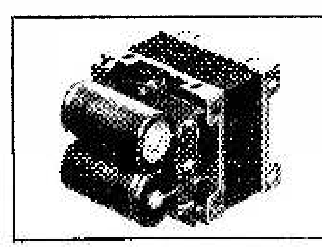
The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.
FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components
APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ
SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm
Price £15·84 + £1·27 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components
APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address
SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £23·32 + £1·87 VAT P&P free.

HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.
APPLICATIONS: Public address—Disco—Power slave—Industrial
SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz – 3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm
Price £32·17 + £2·57 VAT P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£5·22** plus **65p** VAT. P/P free.
PSU50 suitable for two HY50's **£6·82** plus **85p** VAT. P/P free.
PSU70 suitable for two HY120's **£13·75** plus **£1·10** VAT. P/P free.
PSU90 suitable for one HY200 **£12·65** plus **£1·01** VAT. P/P free.
PSU180 **£23·10 + £1·85** VAT.
B1 **£0·48 + £0·06** VAT.

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SAXON ENTERTAINMENTS LTD

SYSTEM 7000—GUARANTEED MODULES FOR ALL DISCO/PA APPLICATIONS

POWER AMPLIFIER MODULES 30—240 WATTS

- Fully tested & guaranteed.
- Full RMS Sine Wave output.
- Distortion typically 0·2%
- 10 Transistors, 4 Diodes.
- Response 30HZ-30KHZ.
- Fully short & open circuit proof.
- Sensitivity suits most mixers.
- Built-in surge suppression & compensation.
- Twin D.C. & output fuses.
- Top-grade components throughout.

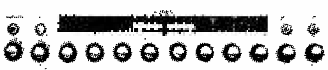
30 Watts rms	60 Watts rms		120 Watts rms		240W rms
SA308 30W rms/ 8 ohms £9·95	SA604 60W rms/ 4 ohms £13·25	SA608 60W rms/ 8 ohms £14·25	SA1204 120W rms/ 8 ohms £14·95	SA1208 120W rms/ 8 ohms £21·00	SA2404 240W rms/ 4 ohms £29·50

POWER SUPPLIES FOR THE ABOVE MODULES—READY WIRED & FUSED ON GLASS FIBRE PCB

PM301 For 1/2 SA308 £10·90	PM601/4 For 1/2 SA604 £13·50	PM601/8 For 1/2 SA608 £13·50	PM1201/4 For 1 SA1204 £13·50	PM1201/8 For 1 SA1203 £13·50	PM1202/4 For 2 SA1204 £22·50	PM1202/8 For 2 SA1208 £22·50	PM2404/1 For 1 SA2404 £22·50

SYSTEM 7000 COMPLETE DISCO MIXERS (With Autofade)

Mono or Stereo



- Ready to plug in & use
- Automatic Mic override
- Two tone panel
- Twin deck & mic & tape inputs
- Left/Right deck fader
- 20Mz–20kHz Noise—77 dB

The choice of the professional D.J.

Controls: Mic volume, Bass, Treble, A/Fade Depth, Tape, L/Deck, R/Deck volumes, Bass, Treble, Master, Headphone volume, Selector & On/Off.

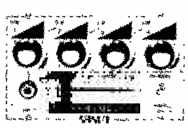
Mono 18v **£39·50** Mains **£45·75** Stereo 18v **£57·50** Mains **£63·75**

IN MODULAR FORM—All you require is front panel (see below) knobs & sockets etc. All electronics are assembled & tested.

- Specification as for complete mixer
- All Potentiometers supplied & fitted
- Low cost do it yourself with step by step easy to follow instructions.

Mono **£22·50** Stereo **£33·50** Panel **£3·95** Supply unit **£9·50**

SYSTEM 7000 LIGHTING CONTROL UNIT MK II (Four channel)



Has your light unit got?

- 4,000 W handling
- Sequence facility
- Smart 2 tone panel
- Advanced IC circuitry
- Top grade components
- Integral dimmers
- Automatic audio level

OURS HAS!

All your needs in one superbly designed unit

ONLY £44·50

IN MODULAR FORM—THE QUADRAFECT **£22·50** (Panel £2·95)

As with the mixers the Mk II L.C. unit may be purchased in module form with all controls, requiring only a panel, case & knobs etc. There are 13 simple connections

- 1-240w Audio
- 8A RCA triacs
- 0·5-20Hz Sequence
- Fully suppressed

CUSTOM MIXER MODULES (Complete or in printed circuit form only)

Make your own mixer, mono or stereo, up to 2 channels, with full monitoring facilities, and provision for echosend/return etc.

- Inputs for low and high 2 mic, ceramic & magnetic cartridge etc.
- Up to 20 input modules per single mixing module
- Feed most types of amplifier—accepts all inputs
- Professional low noise circuitry 20 Hz-30kHz
- Infinitely adaptable—Extremely economical

COMPLETE MODULES With facia panel, Knobs & sockets, Monitor buttons, Ready wired & tested

- 0·5W headphone circuit
- Full range bass/treble controls
- Noise—80dB

Mono input **£8·95** Mono mixing stage **£8·95**
Stereo input **£12·50** Stereo mixing stage **£12·50**

PRINTED CIRCUIT MODULES With controls fitted, requires only sockets, facia & knobs

Mono input **£5·95** Mono mixing stage **£5·95**
Stereo input **£9·50** Stereo mixing stage **£9·50**

Power supply for up to 20 channels—PPM18—**£8·50**.

SYSTEM 7000 SOUND—LITE (3-CHANNEL)

IN COMPLETE OR MODULAR FORM
(Modular form illustrated)

- Complete unit similar to Mk II unit above
- Long established & proven design
- 3 Channels—100W per channel
- RCA 8A Triacs—Individual channel fuses
- 1-240 W Input—master audio level plus Bass/Middle/Treble

COMPLETE UNIT—Fully cased with rear terminations—just plug in & go! **£26·75**

MODULAR FORM Facia & knobs etc. Needs only 11 simple connections **£19·75** (Panel £2·95)

COMPLETE DISCO SYSTEMS

WITH **TWO** YEAR GUARANTEE—LOW INTEREST CREDIT — FROM ONLY **£16·05** DEPOSIT

CENTAUR 100W **STEREO**

with TWIN LOUDSPEAKERS, SOUND to LIGHT SEQUENCER PLUS DISPLAY. **£225** + £10 carr. (Dep. £28·80, 12 months at £21·38 or 24 months at £12·01)

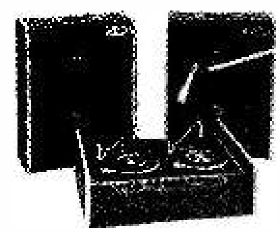
SUPER CENTAUR 200 W **STEREO**

As above but with 200 WATTS OUTPUT & larger TWIN CABINETS. **£275** + £10 carr. (Deposit £32·80, 12 months at £29·39 or 24 months at £15·21)

GXL CENTAUR 200W **STEREO**

As the SUPER CENTAUR but with extra large twin 200 WATT CABINETS, DECK LIGHTS, DECK STARTS & SUPERIOR DECKS. **£349** + £10 carr. (Deposit £42·72, 12 months at £36·58 or 24 months at £20·54).

- Cue Light + Head Phone monitoring
- Mic & Tape Inputs
- Crossfade & Override
- Logic Circuitry Lightshow
- Complete and ready to use
- Extremely Rugged construction
- Twin BSR Decks



Send today for Free Illustrated Leaflet on Saxon Complete Discos & Package PA Systems.

All Equipment subject to a Two Year Guarantee.

Deliveries in the UK by our own vans.

50W MINI DISCO £139·50 + £5 carr. (Dep. £16·06, 12 months at £13·30 or 24 months at £7·46)
100W MINI DISCO £159·50 + £5 carr. (Dep. £22·65, 12 months at £14·73 or 24 months at £8·27)

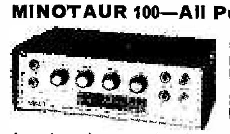
Two extremely compact mono systems complete with loudspeakers and leads.

- TWIN BSR DECKS
- HEADPHONE MONITORING
- MIC INPUT

100W PACKAGE P.A. £145 + £7·50 carr. with twin loudspeakers and PIEZO HORNS Dep. £19·70, 12 months at £13·70 or 24 months at £7·73.

SEND YOUR SPECIAL REQUIREMENTS FOR A CUSTOM DISCO QUOTATION

SYSTEM 7000 MINOTAUR 100—All Purpose Wide Range Amplifier



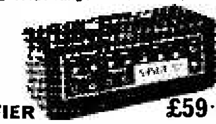
- 100W rms ± 1dB
- Standard 8 ohm output
- Twin mixed inputs accept a wide range of signals
- 30HZ-30KHZ ± 2dB
- 23dB bass/treble

An extremely compact and versatile amplifier with full protection and a clean, attractive appearance. Ideal for all groups, disco's & clubs

£49·50

A four input, high power amplifier which will deliver up to 150 watts output. An absolute must where multiple mixing & power are required

- Four individually mixed inputs
- Wide range bass/treble + master



- Vynide covered case
- Fully short proof
- Superb value for money

SAXON 150 HEAVY DUTY AMPLIFIER **£59·00**

STROBES & PROJECTORS (We stock the full Pluto range) Send for details

SUPERSTROBE £22·50

- 2-3 Joules
- 80W Tube for long life
- Compact 4" × 4" × 4"

PRO-STROBE £37·50

- 6-8 Joules
- External trigger
- Long Life tube timer circuit

150 WATT LIQUID WHEEL PROJECTOR

- Accepts all accessories
- C/w with wheel & motor plate
- Sturdy steel construction

Remarkable value—Sold elsewhere at £39·50 Our price is only: **£37·50**

ACCESSORIES Condenser mics ECM77 600 ohm **£15·00** ECM 81 Dual Impedance **£14·85**. Crown headphones **£7·50** Heavy duty boomstand **£14·50**

All prices subject to VAT @ 8% except SA303/PM301, mics. & headphones (12%)
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Stirling Sound

THE SCHEME

Choose from any of the 9 power amplifier (with heat sink if necessary) modules shown in our advt. and the Stirling Sound power supply unit best likely to suit. Refer to the published prices (which already include V.A.T. and post free in U.K.) Add the prices when you send the money, and

DEDUCT 5%

If you order UNIT ONE at the same time that you order a power amp. and power unit as above, when you send the money,

DEDUCT A FURTHER £1·00

If you order UNIT TWO at the same time that you order a power amp. and power unit when you send the money for the total order

DEDUCT A FURTHER £1·18

■ Britain's most go-ahead module manufacturers

CHOOSE THE ITEMS *YOU* WANT AND BUY THEM THE STIRLING SOUND BARGAIN WAY whether for a new system, to up-grade what you use now, to build a disco or P.A. outfit, perhaps even a domestic intercom or any other device where an amplifier could be used. Whatever it be, there's a Stirling Sound power amp for it up to 100 watts R.M.S. together with stereo tone control/pre-amps if required. Build with Stirling Sound now! See what you save and hear how good it sounds!

SS-1100

MADE IN OUR OWN ESSEX FACTORY AND SOLD DIRECT TO THE USER

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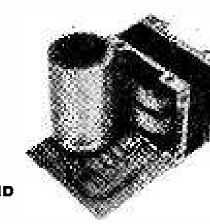
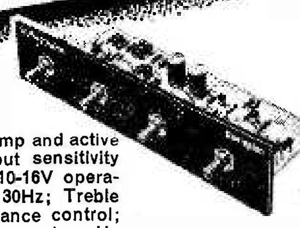


SS-370



UNIT ONE

Combined stereo pre-amp and active tone control unit. Input sensitivity 50mV for 200mV out. 10-16V operation. Bass ±15dB at 30Hz; Treble ±15dB at 10KHz; Balance control; Volume control. For ceramic p.U., radio or tape inputs. WITH FREE CONTROL PANEL FASCIA. **£9·00**

UNIT TWO

With control facilities similar to UNIT ONE but for magnetic cartridge input. Input sensitivity—5mV for 200mV out (can be varied) WITH FREE CONTROL PANEL FASCIA **£12·43**

CONTROL PANEL FASCIA FOR UNITS ONE OR TWO **0·50p**

SS.100

Basic active stereo tone control module to provide ±15db on bass at 30Hz and on treble at 10KHz. **£3·00**

SS.101

Stereo pre-amp suitable for ceramics, tape, radio, etc. **£2·75**

SS.102

Stereo pre-amp for mag, pick-ups **£4·45**

WHEN ORDERING

ALL PRICES QUOTED INCLUDE V.A.T. AND GOODS ARE SENT POST FREE IN U.K. Owing to time between sending our ad. to this journal and the time it appears, prices may be subject to alteration without notice. E.&O.E.

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AMPLIFIERS 3 to 100 WATTS R.M.S.

Ready assembled on P.C.Bs., tested and guaranteed. Easy to connect. With instructions. Output ratings ±1dB.

SS.103 Typically 3 watts R.M.S. using 14V/4Ω I.C. amp. Input 100mV £2·85
SS.103-3 Stereo version of above, 2 I.C.s £5·00
SS.105 5 watts R.M.S. into 3Ω using 13·5V. Sensitivity—30mV. THD—0·3% 3¼" × 2" × 1" £3·95
SS.110 10 watts R.M.S. into 4Ω using 24V. Sensitivity—60mV. THD—0·3% 3¼" × 2" × 1" £4·65
SS.120 20 watts R.M.S. into 4Ω using 34V. Sensitivity—80mV. THD—0·3% 3¼" × 2" × 1". £5·15
SS.125 25 watts R.M.S. into 8Ω using 50V. Sensitivity—140mV. Distortion—Less than 0·05% into 8Ω S/N better than 70dB. £7·25
SS.140 40 watts R.M.S. into 4Ω using 45V. Sensitivity—300mV. Distortion typically 0·1%. 5" × 3¼" × 1¼". £6·50
SS.160 64 watts R.M.S. into 4Ω using 50V. Sensitivity—350mV. Distortion typically 0·1%. 5" × 3¼" × 1¼" £8·50
SS.1100 100 watts R.M.S. into 4Ω using 70V/2A. Input sensitivity—500mV. Distortion at half-power, typically 0·1%. 5" × 3¼" × 1¼". £10·50
HS.160 Multi-finned heatsink for SS.140 or SS.160. £0·75p
HS.1100 Ditto for SS.1100 £1·50

POWER UNITS

Every unit is tested under working conditions before despatch, and guaranteed. All units except SS.312 include a stabilised low voltage take off point (13-15V) for pre-amp, tone control units etc. Outputs quoted are minimal unloaded ratings.

SS.312	12V/1A	£6·60
SS.318	18V/1A	£6·95
SS.324	24V/1A	£7·65
SS.334	34V/2A	£8·75
SS.345	45V/2A	£10·75
SS.350	50V/2A	£11·75
SS.360	60V/2A	£12·75
SS.370	70V/2A	£14·75

SS.310/50 Stabilised power supply; variable in output from 10V to 50V/2A and short-circuit protected £17·75

SS.300 Power stabilising unit variable from 10 to 50V/8A max. for adding to existing unstabilised supply units. £5·50

INFO. SHEETS—the new way to build a useful Stirling Sound Catalogue. About 15 (A4 size) are at present being planned and the first batch tell you about the modules you see here. Send LARGE S.A.E. stamped for 12½p for your free copies.

To STIRLING SOUND

Please supply ....
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PW178

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THE 'NUTS & BOLTS' OF THOSE PROJECTS

TRANSFORMERS

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280 0–6V, 0–6V RMS	£1·30*
2025	MT150 0–12V, 0–12V RMS	£1·30*

MINIATURE MAINS Primary 240V

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

1 AMP MAINS Primary 240 V

No.	Secondary	Price	
2026	6V–0–6V 1 amp	£2·70*	P. & P. 30p
2027	9V–0–9V 1 amp	£2·20*	P. & P. 30p
2028	12V–0–12V 1 amp	£2·60*	P. & P. 30p
2029	15V–0–15V 1 amp	£2·75*	P. & P. 30p
2030	30V–0–30V 1 amp	£3·45*	P. & P. 30p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V.
Voltages available by use of taps:
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 50, 25–0–25 V.

No.	Rating	Price	
2031	½ amp	£3·42*	P. & P. 30p
2032	1 amp	£4·40*	P. & P. 50p
2033	2 amp	£5·45*	P. & P. 85p

AUDIO LEADS

S127 5 pin DIN plug to 4 phono plugs length 1·5m £1·30*

S128 5 pin DIN plug to 5 pin DIN socket length 1·5m £1·05*

S129 5 pin DIN plug to 5 pin DIN plug mirror image length 1·5m £1·05*

S130 2 pin DIN plug to 2 pin DIN socket length 5m 68p*

S131 5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 length 1·5m 83p*

S132 2 pin DIN plug to 2 pin DIN socket length 10m 98p*

S133 5 pin DIN plug to 2 phone plugs connected to pins 3 & 5 length 1·5m 75p*

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All 7p each

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Type	No.	Type	No.	Type	No.
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All 7p each

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2A	637				

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BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

A Logical Step?

MICROPROCESSORS, as those of you who read our competitor magazines will know, are all the rage. As so often happens with modern developments in electronics (and, to a certain extent, in other fields) much thought has been devoted to finding new applications for this answer to all our problems.

The replacement of electro-mechanical control systems in things like cars, sewing machines, washing machines, etc., is a fairly logical step, giving great scope for improvement in reliability, and some reduction in cost. Other applications, such as the "computerised door-chime" reviewed last month, for things which were simply not practicable before, are also obviously valid.

When we get into the realm of the replacement of ranks of logic packages by a microprocessor and its memory, the advantages become more questionable. On a production line, considerable savings in assembly time are possible, though for the home constructor this is not quite so important. Systems can become more flexible, providing you can afford the memory required to store all the different programs—but what are you going to use this flexibility for? For control systems in a space capsule, or for some of the newer and more interesting TV games, all well and good. But for domestic control systems, I wonder.

If you are talking about central-heating controllers, burglar and fire alarms and the like, most of the cost and complexity is in the input/output devices and the sensors and controls, and these remain the same, by and large, whatever form the central processing unit takes. The idea of one box of electronics in a house, controlling a multiplicity of appliances and systems, doesn't really seem to be the answer. Even some microprocessor experts are now admitting that a separate processor in each application is likely to be a better solution. So what price flexibility? Each appliance and system will contain a single microprocessor chip with the necessary memory built in, dedicated to that one purpose and incapable of doing anything else.

For these reasons, we do not think that microprocessors have much application for the home constructor as yet, though obviously they are of interest, especially for anyone also involved professionally in electronics. We will not be ignoring them; one thing for sure, they aren't going to go away. But what do you, our readers, think about the subject? We would love to hear.

Geoffrey Arnold

PLEASE NOTE

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

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

Catalogue with a Plus

Available now from Plustronics, is their latest catalogue containing all the gen on the latest range of portable radios, radio/cassette recorders, tape decks, headphones, in-car units, digital watches and electronic calculators.

Many of the products in the catalogue are listed under the "Plustron" brand name, including the recently announced MC1500 Music Centre, which is featured on the front cover. Other brand names handled by Plustronics include Fair mate, Roxy, Aiko and Dansk.

For a copy of the Plustron catalogue which is called "A World of Entertainment", contact *Plustronics Ltd., Hempstalls Lane, Newcastle, Staffs. ST5 0SW. Tel: 0782 615131 or call at their London Showroom at 235-241 Regent Street, London, W1.*

Showtime

Aiwa, one of the fastest growing Japanese HiFi manufacturers have recently opened a new London Showroom. Growth of the company has continued since Aiwa were first marketed and distributed by Johnsons of Hendon, and continued growing when Aiwa decided to do their own marketing by opening up a new office, warehouse and distribution complex at Leeds.

Well known for their pioneering work in the compact cassette market, Aiwa were first with such innovations as automatic cassette loading; oil-damped ejection; full automatic stop; synchronised recording between cassette and turntable; and the first full HiFi music centre. Another 'First' by Aiwa, is a unique insurance scheme whereby the company offer, free of charge, insurance against fire, theft and accidental damage on every HiFi separate or music centre sold between November 1st 1977, and October 31st 1978. Insurance cover lasts for two years and costs purchaser absolutely nothing. The full range of Aiwa products can be seen, inspected, heard and whatever else you need to do, at the new showroom which is sited at the New Brunswick Shopping Precinct, a short step from Tottenham Court Road and an even shorter step from Russell Square tube station.

Aiwa Sales and Service (UK) Ltd., 56-58 Brunswick Centre in Bloomsbury, London WC1. Tel: 01-278 2081.

Stocking-up?

As the old saying goes "stock is as good as money", and by the look of the latest stock list published by Watford Electronics, they would appear to be potential millionaires considering the extensive and varied range of components included in the list. Now available to PW readers, this stock list contains just about everything for the electronic enthusiast, is clearly set out with components under headings and listed by type number. Ratings, where applicable are also shown, together with the type of package and the cost per unit. As the list is about 210 × 300mm, when ordering, please enclose an SAE.

Watford Electronics, 33 Cardiff Road, Watford, Herts. Tel: Watford 40588

Light work

A new family of Silicon Photovoltaic Cells are now available from National Semiconductors Ltd., and are accompanied by claims of good stability, high efficiency and excellent short circuit current linearity over wide ranges of illumination.

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National Semiconductors Ltd., Stamford House, Stamford New Road, Altrincham, Cheshire. Tel: 061 928-3417.

Keep-it-clean!

You've heard what they do to old warships to stop the elements getting to them—they 'mothball' them. Although the 'Mothballing' material differs slightly, you can now protect your records in a similar manner, with a new product called 'Sound Guard'. Originally developed for NASA, as a dry lubricant for the moving parts of space craft, it can now be obtained in a Hi-Fi form which is sprayed onto the surface of records. When buffed up immediately following application it leaves a five-millionth-of-an-inch thin-film solid lubricant of low shear strength bonded to the record groove. Other advantages are that while Sound Guard bonds to record surfaces, it will not bond to itself, so re-application will not cause a build-up of the coating. Also it contains an anti-static property, which all goes towards helping keep the groove clean and free from dust.

Marketed in the UK by Pyser Ltd. a 2oz bottle with a pump sprayer and buffer pad (sufficient for 25 LP's) costs around £4·99.

DIRECT CONVERSION receiver

M.H.TOOLEY B.A.G8CKT

Short wave listening can be an interesting and absorbing pastime. High performance SSB/CW short wave receivers do however tend to be very complex and rather expensive; it is unfortunate that the complexity of a receiver which has all the desirable features can be somewhat daunting to anyone but the most experienced constructor.

The basic receiver described here covers the popular 20m (14MHz) amateur band. This band offers a considerable long distance (DX) potential. This project is equally suitable for the beginner who requires a simple yet effective design, and the experienced short wave listener who requires a second, highly portable receiver. The unit may also be used in conjunction with a 2m converter having an intermediate frequency (IF) of 14 to 16MHz. The receiver will then cover the bottom end of the 2 metre band (144·0 to 144·4MHz) in which there is a great deal of VHF signal sideband (SSB) activity. Component changes and circuit modifications are also provided for coverage of the other amateur bands between 3·5MHz and 30MHz.

Single band design makes for considerable simplicity as regards coil winding and calibration; it also avoids problems associated with multi-band construction. Furthermore, the direct conversion technique ensures that the receiver is less prone to spurious signals, such as image channel interference, which can often be a problem with conventional superheterodyne receivers using single conversion and a low intermediate frequency.

The receiver uses a minimum number of semiconductor devices and is assembled using a single printed circuit board. The receiver may be built for a modest outlay of around £10 to £13 and alignment can readily be carried out using a signal generator or a second receiver.

Why direct conversion?

The vast majority of amateur activity in the HF bands is either single sideband (SSB) or morse (CW). Conventional receiver designs fall into two main categories. These are tuned radio frequency (TRF) and supersonic heterodyne (superhet). TRF receivers are relatively insensitive and unselective and thus some form of regeneration is needed. A TRF receiver cannot receive SSB or CW signals unless the regeneration is increased to a level which allows the receiver to oscillate continuously. This arrangement lacks frequency stability. The level of regeneration must also be frequently varied according to the strength of the incoming signal.

Superhet receivers, although selective and sensitive, tend to be complex and difficult to align. Furthermore, if SSB or CW signals are to be received using a superhet, it is necessary to incorporate a beat frequency oscillator (BFO) stage and a suitable detector.

The direct conversion receiver is halfway between a TRF receiver and a superhet. The incoming signal is mixed with a local oscillator signal operating on the same frequency. This should be clearly distinguished from the arrangement in a superhet where the local oscillator and signal frequencies differ by an amount equal to the intermediate frequency of the receiver. Thus the direct conversion receiver can be thought of as a superhet receiver with zero intermediate frequency. This may sound rather odd but it simply means that the incoming signal mixes with the local oscillator signal to produce an audible beat frequency. When SSB signals are to be received, the local oscillator is tuned to exactly coincide with the incoming carrier frequency. The result is correctly demodulated audio regardless of whether upper or lower sideband is being used. When a CW signal is to be received, the local oscillator is tuned to a very slightly different frequency from that of the incoming carrier.

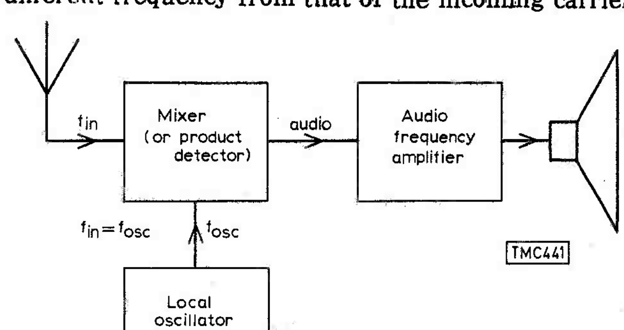


Fig. 1: Block diagram of simplest direct conversion receiver.

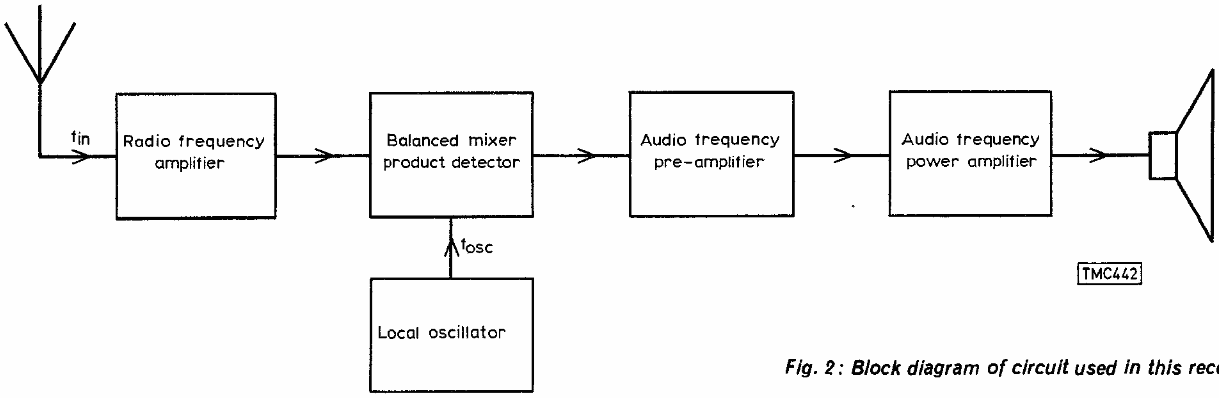


Fig. 2: Block diagram of circuit used in this receiver.

Thus the CW signal is converted to a beat note within the audio frequency range.

The basic form of direct conversion receiver is shown in **Fig. 1.** This incorporates a separate local oscillator stage. A worthwhile improvement in sensitivity can be achieved by the addition of a radio frequency amplifier stage. This offers the further advantage of providing a degree of isolation between the local oscillator stage and the aerial, thus helping to minimise the amount of local oscillator radiation from the receiver. The block schematic of the receiver is shown in **Fig. 2.** The AF amplifier has a tailored frequency response and is important in setting the selectivity characteristic of the receiver.

Balanced Detector

There is nothing new in the concept of a receiver which uses a phase synchronous detector. The technique is used in both colour TV receivers and in stereo decoders. In order to provide best results, the local oscillator (or reference) should be phase locked to the incoming signal carrier. This is necessary for the reception of AM signals where even a small phase error can be disconcerting due to the presence of an audio image which is unavoidable when a double sideband signal is demodulated. In advanced receivers, a frequency reference is derived from the signal by means of a threshold gate and PLL but this is not necessary for reception of single sideband and CW signals. Furthermore, provided that the detector exhibits a high degree of linearity, the selectivity of the receiver is determined solely by the frequency response of the audio stages. This eliminates IF filters which are found in superhet receivers.

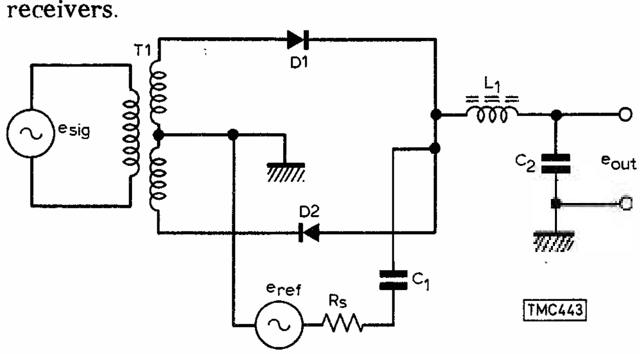


Fig. 3: Balanced detector circuit.

The simplified circuit of the balanced detector is shown in **Fig. 3.** It should be noted that, in practice, the reference provides a much greater voltage than that of the signal applied to the detector. D1 and D2 are effectively alternately switched "on" and "off" at the frequency of the reference oscillator. D2 conducts on positive going half cycles and D1 on negative half cycles. R_s represents the source impedance of the reference oscillator circuit amounting to a few hundred ohms. T_1 provides signal voltages which are supplied to D1 and D2 in antiphase. C_1 is chosen so that it has negligible reactance at the reference frequency and a very high reactance at audio frequency and thus behaves as a high pass filter. L_1 and C_2 form a low pass filter preventing both the reference output and signal input from reaching the audio stages.

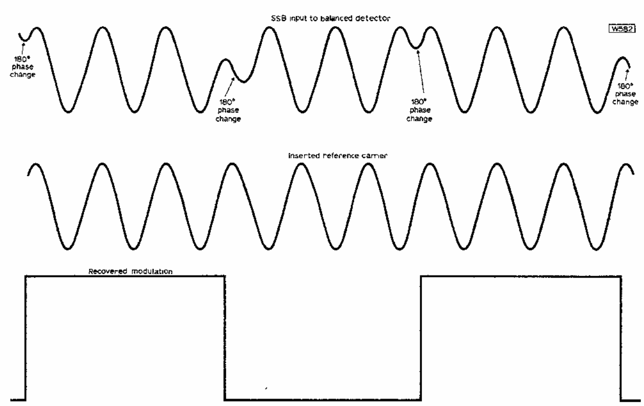


Fig. 4: The upper trace shows SSB signal 100% modulated by a square wave. Note the phase reversals. Without the reference carrier inserted by the receiver local oscillator (middle trace) speech would be received at double the natural frequency and hopelessly distorted. Square wave modulated SSB signals would not be resolved in any form. The lower trace depicts the recovered modulation from the upper trace.

When the signal and reference voltages are in phase, the balance of the detector is preserved and the output voltage after the low pass filter is zero. When a constant phase error exists between the signal and reference voltages the detector no longer remains balanced and a constant DC output voltage is produced. This may be positive or negative depending on the relative phase. When the phase error is not constant but changing, a corresponding alternating output voltage will be produced. Finally, if the signal and reference voltages differ by a constant frequency, say 1kHz, an audio signal is produced at this frequency. **Fig. 4** shows a 100% modulated SSB signal applied to the detector.

Circuit description

A dual gate FET is used as the RF amplifier. The gain of the stage is made variable by adjusting the bias voltage applied to gate-2 of the transistor. The input tuned circuit, L1/C1, is damped by means of

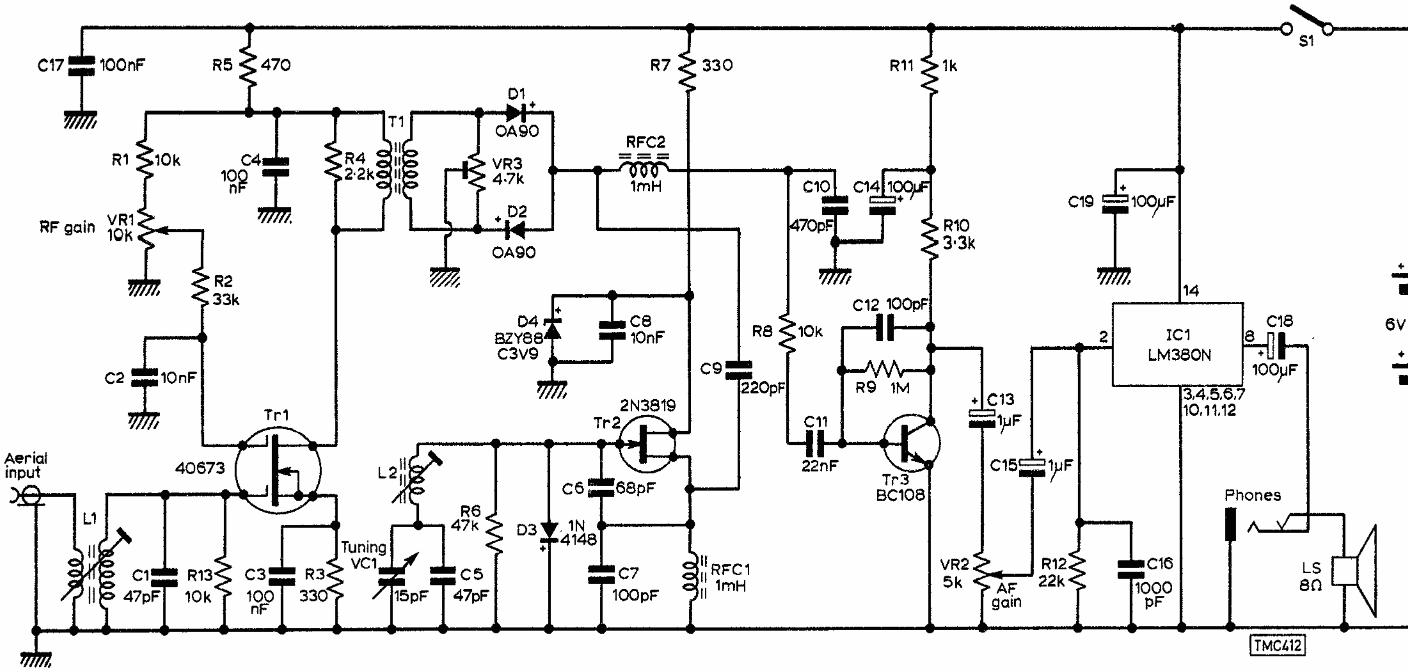


Fig. 5: Circuit diagram.

R13 to broadly tune to the 14MHz band. Its "Q" is however kept sufficiently high in order to reduce strong out of band signals. The RF stage is followed by a balanced detector arrangement using two germanium diodes, D1 and D2. Coupling from the RF amplifier stage to the detector is via a broadband transformer arrangement with damping provided by R4. Adjustment of the balance of the detector stage is provided by RV1. This compensates for any variation in the characteristics of the two diodes and is adjusted for maximum rejection of breakthrough from strong amplitude modulated signals which may otherwise be demodulated in a conventional manner.

The local oscillator uses a junction gate field effect transistor. Silicon diode, D3, provides automatic negative bias for the gate of the transistor. The supply voltage for the oscillator is stabilised by means of the zener diode, D4. The complete circuit diagram is shown in **Fig. 5.** The oscillator frequency is varied by means of VC1. The initial adjustment of operating frequency is carried out by means of the ferrite dust core of L2.

The demodulated audio signal is passed to the AF pre-amplifier. RFC2 and C11 operate as a low pass filter. C12 and C13 are used to define the operating frequency range of the pre-amplifier stage, Tr3. The audio power amplifier stage is straightforward and uses an LM380. It produces ample output from a 6V supply.

Construction and layout

With the exception of the controls, VR1, VR2, VC1 and S1, the battery holder and sockets SK1, all components are mounted on a printed circuit board. The component layout is fairly important and the use of a printed circuit board is highly recommended. Other forms of construction (matrix board, Veroboard or point-to-point wiring) may give rise to poor performance or instability unless great care is taken. Where a printed circuit board is not used, a good common earth connection to all parts of the circuit is essential.

The input circuit, comprising L1 and associated components, must be screened from the rest of the circuit. This is accomplished by using a small piece of 20 SWG tinplate cut out and bent as shown in **Fig. 6.** The printed circuit board (copperside) is

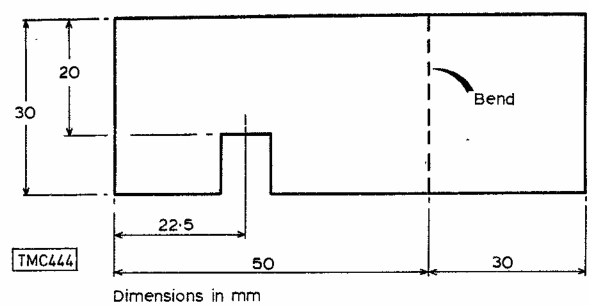


Fig. 6: This screen is essential for good stability.

shown in **Fig. 7**, the corresponding component overlay is shown in **Fig. 8.**

Care should be taken to keep all the internal connecting leads short. The leads to the volume control, VR2, should be screened. The loudspeaker is mounted on the lid of the case and, when the lid is in place, care should be taken not to trail the loudspeaker leads across the circuit board. The aerial and converter input socket, SK1, is mounted on the rear panel of the chassis. The tuning capacitor, VC1, is mounted on a small aluminium bracket. The bracket is secured to the front panel of the receiver by means of the same two screws and nuts which retain a vernier drive mechanism. The "live" connection from VC1 to L2 on the printed circuit board should be made using stiff wire, preferably 18 or 20 SWG; this helps improve the frequency stability. The earth tag of VC1 is returned to the common rail on the printed circuit board by means of a short length of copper braid. The outer conductor removed from a short length of 50 ohm or 75 ohm coaxial cable is ideal for this purpose. The lid of the case should also be earthed to the common rail. This prevents hand capacitance effects.

In the prototype, the printed circuit board is held in place by means of four 25mm spacers which are

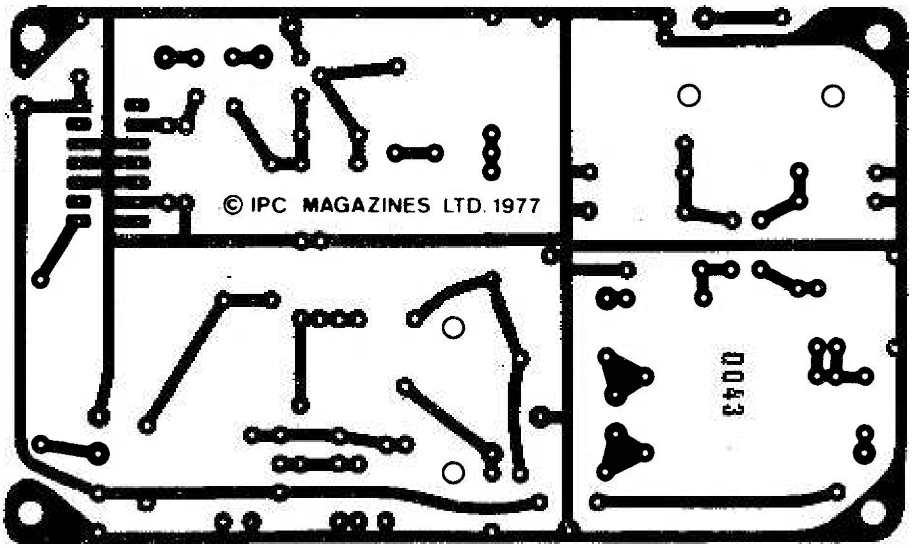


Fig. 7: The printed circuit board shown copper side. People are strongly recommended to use this board layout having been developed and checked with several prototypes. Boards may be obtained from the Readers' PCB Service (p 658) if required, quoting Ref. D043. The price is £1·85 + 15p p& p

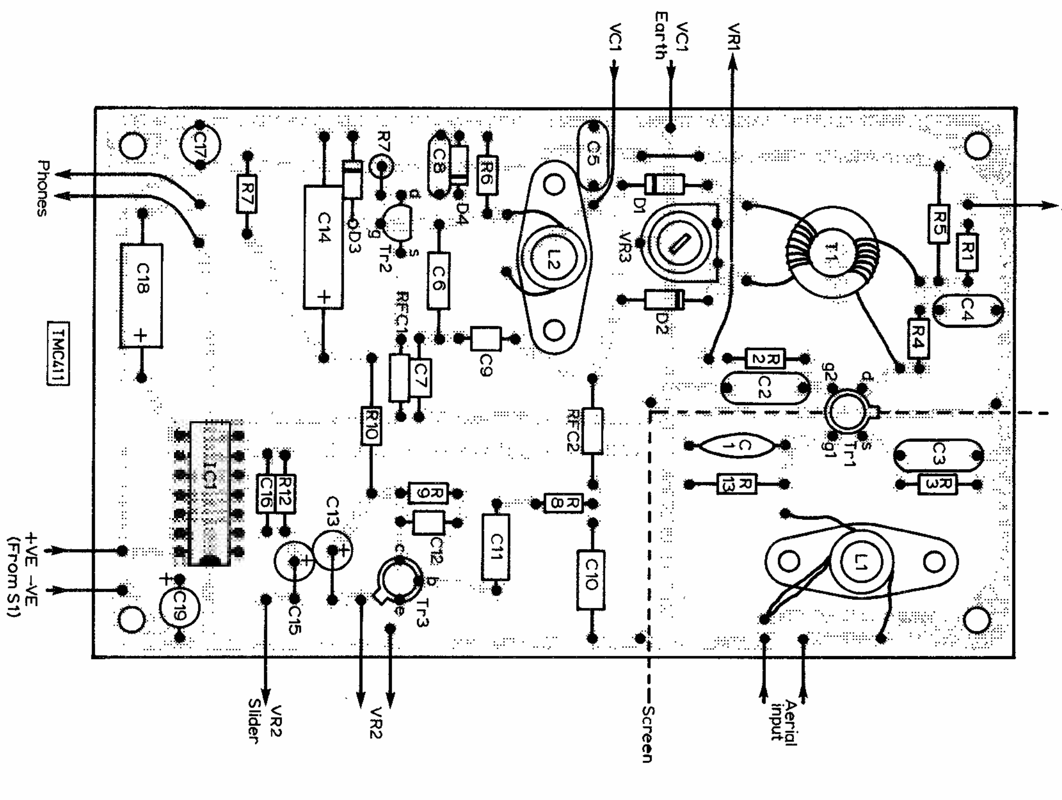


Fig. 8: The PCB overlay showing component locations.

secured to the bottom of the chassis by countersunk screws. The battery holder is made from suitably bent aluminium and then lined with a strip of foam rubber. The battery holder fastens to the back of the case by two nuts and bolts.

Coil winding details

Both coils, L1 and L2, are wound on 7mm diameter coil formers fitted with dust cores. L1 comprises a main tuned winding of 20 turns of 26 SWG enamelled copper wire closewound with an aerial winding of 4 turns 30 SWG enamelled copper wire as in **Fig. 9a**. A thin layer of PVC tape is used to hold the main tuned winding in place while the aerial winding is completed.

L2 consists of a single tuned winding of 24 turns of

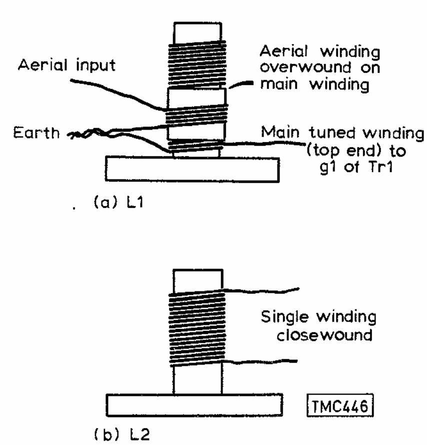


Fig. 9: Coil winding details for L1 and L2.

26 SWG enamelled copper wire closewound as in **Fig. 9b.** After winding, both coils are liberally coated with a quick setting epoxy resin adhesive. This seals the winding in place and provides a very effective protective coating.

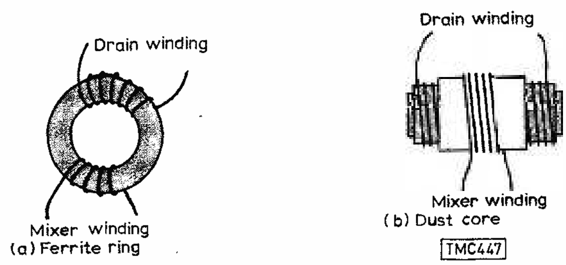
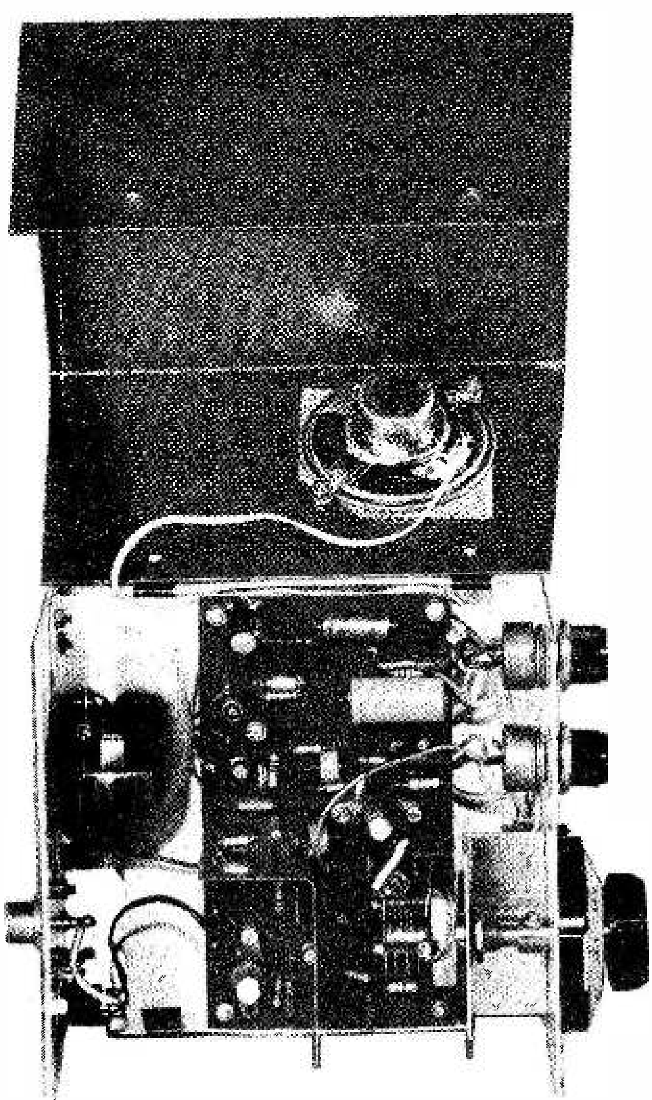


Fig. 10: Details of detector transformer (see text).

The interstage coupling transformer is wound according to **Fig. 10.** The transformer is wound on a miniature ferrite ring of approximate diameter 12mm. The drain winding (primary) consists of 10 turns 30 SWG enamelled copper wire. The mixer winding (secondary) consists of 5 turns 30 SWG enamelled copper wire. The transformer is similarly sealed with quick setting epoxy resin adhesive. If a ferrite ring is not available, the transformer may be wound using a 17mm x 8mm diameter dust core. The thread on the core facilitates a guide in which the transformer may be wound. The drain winding (primary) consists of 12 turns 26 SWG enamelled copper wire. The mixer (secondary) consists of 6 turns of 30 SWG overwound in the centre of the core. The transformer should be sealed with quick setting epoxy adhesive. The performance of the receiver is slightly better when a ferrite ring is used for the interstage transformer.



★ components

Resistors
R1 10kΩ
R2 33kΩ
R3 330Ω
R4 2·2kΩ
R5 470Ω
R6 47kΩ
R7 330Ω
R8 10kΩ
R9 1MΩ
R10 3·3kΩ
R11 1kΩ
R12 22kΩ
R13 10kΩ
All $\frac{1}{4}$W 5% carbon

Capacitors
C1 47pF
C2 10nF
C3 100nF
C4 100nF
C5 47pF silvered mica
C6 68pF
C7 100pF
C8 10nF
C9 220pF
C10 470pF
C11 22nF
C12 100pF
C13 1μF 63V
C14 100μF 10V
C15 1μF 63V
C16 1000pF
C17 100nF
C18 100μF 10V
C19 100μF 10V

Semiconductors
Tr1 40673
Tr2 2N3819
Tr3 BC108
IC1 LM380N
D1 OA90
D2 OA90
D3 1N4148
D4 BZY88 C3V9

Potentiometers
VR1 10kΩ lin
VR2 5kΩ log
VR3 5kΩ preset

Miscellaneous
VC1 15pF Jackson type C804. S1 SPDT miniature toggle switch. RFC1, RFC2 1mH RF chokes. T1 miniature ferrite ring or dust core, two coil formers 7mm diameter fitted with dust cores, vernier dia, 50mm, loudspeaker 50mm 8Ω $\frac{1}{3}$W. Case 127mm × 152mm × 89mm, 14 pin low profile dual-in-line IC socket, battery holder for 4 × HP7 1·5V cells plus snap connector to suit. Knobs. Mounting pillars. Double sided push fit pins. Coax socket for aerial and jack socket for 'phones.

Initial checks and alignment

After completing the wiring and assembly of the receiver, a careful visual check should be made for any faults. A 6V battery (4 x HP7) should be connected and the current consumption measured. If the receiver is working correctly, the supply current should be approximately 12mA. A slight variation should be noticed when the RF Gain control, VR1, is adjusted.

Alignment of the receiver can be carried out by using either an RF signal generator or an existing short wave receiver. The signal generator should be set for an unmodulated output at 14MHz. The tuning capacitor, VC1, should be set to maximum capacitance. L2 should then be varied until a beat note is heard. Carefully adjust L2 for zero beat (ie: the apparently dead spot at the centre of the two ranges in which an audible beat is heard). Note that it should not be necessary to have the signal generator directly coupled to the receiver for this purpose. Stray coupling, using a short throw-out aerial, should be sufficient to produce a strong beat signal. After locating the zero beat position corresponding to 14·0MHz, re-set VC1 to minimum capacitance. Vary the signal generator frequency until a zero beat is found and note the new frequency. This will be approximately 14·4MHz; it should extend to 14·35MHz if the whole of the 20 metre band is to be covered.

To align the RF amplifier stage, adjust L1. Switch the signal generator to give a modulated carrier at 14·2MHz but leave the setting of VC1 at minimum capacitance (do not search for a beat note). A tone should be heard in the receiver's loudspeaker. If this is not the case, increase the output level of the signal generator accordingly. Note that the tone should not vary in frequency as VC1 is adjusted. Now adjust L1 for maximum loudspeaker output. If necessary, reduce the output level of the signal generator as resonance is approached. Finally adjust VR3 for minimum output—it should be possible to null the tone out almost completely. The alignment procedure should be repeated once again after which the cores of L1 and L2 should be sealed. An antenna may then be connected to the receiver and its "on-air" performance can be checked.

Where a signal generator is not available, the frequency of the local oscillator can be set using a calibrated receiver. The receiver should be set to 14·0MHz and VC1 adjusted to maximum capacitance. L2 is then adjusted until a strong signal is heard in the main receiver, this will of course appear as an unmodulated carrier. The two receivers should be in fairly close proximity for this purpose and, if necessary, a short length of wire can be used to link the two aerial sockets so that sufficient coupling of the local oscillator signal is obtained. If more than one signal is heard on the main receiver (corresponding to two different positions of the core of L2) make sure that the stronger of the two is selected. This phenomenon is due to the image channel of the main receiver. Re-set VC1 to minimum capacitance and find the new local oscillator frequency by re-tuning the main receiver. This should be above 14·35MHz. Next connect an aerial to the unit and adjust VC1 to a signal which is fairly strong and continuous. A teleprinter signal is ideal for this purpose. Carefully adjust L1 for maximum output from the loudspeaker. If necessary, reduce the RF gain control accordingly. VR3 should be set to mid-position, but if break-through from strong amplitude modulated broadcast signals on adjacent frequencies is subsequently experienced, the pre-set should be adjusted for a null to minimise the effect.

If the local oscillator frequency coverage is found to be too low even after adjustment of L2, C5 should be replaced by a 33pF silver mica capacitor. If the local oscillator frequency coverage is found to be too high, C5 should be similarly replaced by a 68pF silver mica capacitor or alternatively a 15pF silver mica capacitor can be wired directly in parallel with VC1.

If adequate screening is not used between the oscillator and RF circuits, a form of RF instability may occur. This is due to local oscillator radiation entering the RF amplifier and may only manifest itself when the RF gain control is turned fully up. Detuning L1 will usually cure this problem; however, the best solution is to ensure that a screen is fitted and that the lid of the case is adequately earthed (this is usually accomplished by the four securing screws).

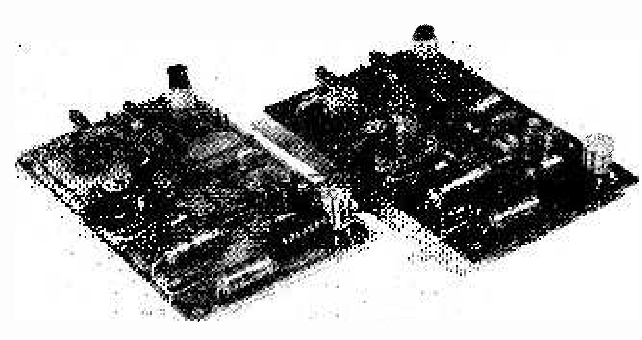
Should audio frequency instability be noticed, particularly when not using the recommended printed circuit layout, a 100nF miniature polyester capacitor in series with a 4·7ohm ¼W carbon resistor should be wired directly between pin 8 and the integrated circuit holder and the common earth rail. Also, when not using a printed circuit board, C19 should be wired as closely as possible between pin 14 of the integrated circuit holder and the common earth rail.

Instability may also occur which manifests itself as a howling at maximum gain settings when headphones are being used. This can be cured by using an RF choke, consisting of 6 turns 30 SWG (or 8 turns 26 SWG on a ferrite ring) wired directly between the loudspeaker output on the PCB and the headphone jack socket, SK4. However, few problems should be experienced if the recommended layout and printed circuit board is used.

Using the receiver

The performance of any short wave receiver depends greatly on the quality of the aerial system with which it is to be used and on the expertise of the user. This design gives acceptable results with a short "throw-out" aerial (15ft of flexible wire is ideal for this purpose). A good earth may improve performance further. If a dipole is available (this should be approximately 33ft in length and fed in the centre) results should be excellent.

Tuning an SSB receiver often presents difficulties to the uninitiated. The newcomer to short wave listening will however find that his ability to resolve SSB signals will improve considerably with practice. The



signal needs to be slowly tuned through until the speech appears normal. An incorrectly tuned signal will make you think that you are listening to Donald Duck. This is, of course, due to a shift in the frequencies of the speech components. With a little practice, the correct tuning point will easily be found. When incoming signals are very strong, the RF gain control should be backed off. This will assist in resolving signals.

In the first few days of use, and with a very modest aerial, over twenty countries were logged with the receiver. These included DK, EA, EI, F, G, GW, HB, I, K, OE, ON, PA, SM, UA, UB, VE, W, YU. Propagation conditions on 20 metres vary considerably during the day and night. Seasonal variations are also noticeable. Thus do not expect instant long distance (DX) reception! A few days listening will soon tell constructors when and where to listen.

This simple receiver was developed with low cost and portability in mind. It will not outperform a complex communications receiver. However, when used with an efficient aerial system, it gives an extremely good account of itself. ●

appendix

Table of component changes for alternative frequency coverage

RF TUNED CIRCUIT

Band	Turns on L1				C1
	sec.	SWG	pri.	SWG	
3·5–3·8 MHz	38	30	8	26	220 pF
7·0–7·1 MHz	30	30	6	26	100 pF
21·0–21·5 MHz	16	26	3	26	22 pF
28·0–30·0 MHz	12	26	3	26	22 pF

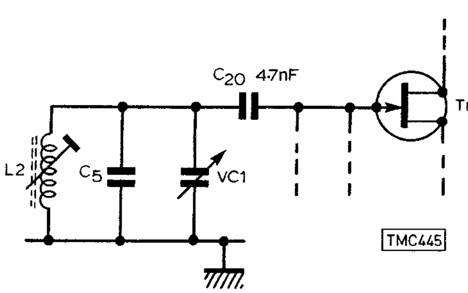


Fig. 11: Oscillator circuit modification for lower frequencies (see note below).

OSCILLATOR TUNED CIRCUIT

Band	Turns on L2	SWG	VC1	C5
3·5–3·8 MHz	30 *see note	30	100pF	220pF
7·0–7·1 MHz	22 *see note	26	15pF	100pF
21·0–21·5 MHz	16	26	15pF	47pF
28·0–30·0 MHz	10	26	15pF	47pF

*Note: Use modified circuit for oscillator shown in **Fig. 11.** Also increase the primary turns on T1 to 20 (30 swg) and secondary to 15 turns (30 swg). The use of a ferrite ring as the core of T1 is strongly recommended for the 3·5 MHz and 7 MHz bands.

So you want to pass the R.A.E. (Radio Amateurs' Examination)? No. 5

John Thornton Lawrence GW3JGA & Ken McCoy GW8CMY

Before we consider the behaviour of alternating current and voltage in circuits containing inductors and capacitors, we will have a look at the phenomenon of capacitance.

Capacitance

If we place two metal plates close to one another and separate them with a piece of insulating material, we have an arrangement which will store electricity in the form of a charge. The capacitance of the arrangement depends on a number of factors:—

i. Area of the plates
ii. Distance between the plates
iii. The nature of the insulating material occupying the space between the plates (specifically the Dielectric Constant or relative permittivity)

The unit of capacitance is the farad—an uncommonly large unit for the purposes we require—so that the values found in radio work are micro-farads (10^{-6}), nanofarads (10^{-9}) and picofarads (10^{-12}).

Dielectric Constant

If we measure the value of capacitance of two metal plates, separated by a certain insulating material, and repeat the measurement keeping area of plates and distance apart the same but having a vacuum separating them, then the ratio between the two values of capacitance will be equal to the dielectric constant of the insulating material. This constant is usually denoted by the letter K and the capacitance of a capacitor is given by the relationship:— C is proportional to $\frac{KA}{d}$, where A is the area of the plates and d the spacing between them.

A capacitor is classified by the material used as the dielectric and the table below shows some types of dielectric used together with their dielectric constants.

Material	Dielectric Constant
Air	1
Dry paper	2·5 approx
Polyester	5 approx
Mica	5-7 approx
Aluminium oxide (electrolytic)	7·5 approx
Ceramic (Lo K)	up to 20
Ceramic (Hi K)	up to 10,000

The Dielectric Strength is the voltage at which the dielectric breaks down and this and its thickness determines the maximum safe working voltage which may be applied to the capacitor.

Capacitor Ratings

The two most important practical ratings of a capacitor are its capacitance and its working voltage and these are almost invariably marked on the capacitor. The required value of capacitance depends on the purpose for which it will be used and the voltage rating on the maximum voltage that will be present across the capacitor under all operating conditions.

The required accuracy or tolerance of the capacitance value depends on how critical the circuit is to this. For example, the capacitance of an electrolytic capacitor, providing the smoothing in a power supply, could be greater or less by 20 per cent of its stated value without causing any significant change in performance, but a silvered mica capacitor in the oscillator tuning circuit of a communication receiver would cause serious tuning errors if its value was in error by this amount. In some applications therefore, the tolerance is also an important factor.

There are other factors too, such as insulation resistance, temperature stability, physical size, etc., which affect the suitability of a particular type of capacitor for a particular use.

Air Dielectric Capacitors

These are usually in the form of variable capacity tuning capacitors having a set of fixed plates with a set of moving plates that swing into mesh between the fixed plates. This enables the effective area of the plates, and so the capacitance, to be varied.

Air dielectric tuning capacitors for use in receivers, where the maximum voltage may be only a few volts, can have very close spacing between the plates, but types for use in transmitters where high voltages are present, must have significantly greater spacing to avoid voltage breakdown or flashover. The breakdown voltage of air is about 25,000V/cm and the spacing between the plates of a tuning capacitor for a receiver would be about 0·2mm (mainly limited by the mechanical accuracy) and for a 150W HF transmitter about 1·5mm.

Mica Capacitors

The mica capacitor uses thin sheets of mica as the dielectric and offers the best electrical properties possible but for a given capacity it tends to be large and fairly expensive. Mica is a very stable material naturally, after all it has been lying in the ground stabilising for millions of years, so the capacitor using it as a dielectric will also have excellent stability. The mica capacitor is therefore, ideal for use in tuning or other critical circuits.

The silvered mica capacitor has the electrodes deposited as a film of silver on the surfaces of the mica and so enables very thin blades of mica to be used. The blades are stacked with interconnecting foils and are then clamped or riveted together which gives them their characteristically flat "postage stamp" shape. Silvered mica capacitors are available in values from 1pF to about 10,000pF and usually have a voltage rating of 250 to 500V although higher voltage ratings are available for use in transmitters. They are very suitable for use in RF tuned circuits up to several hundred MHz and will carry appreciable RF currents in transmitter applications.

Some "compression type" trimmer capacitors use mica as a dielectric and in these the mica is sandwiched between spring foil electrodes. The capacitance is varied by squashing the sandwich with an adjusting screw and so changing the dielectric from partly air and partly mica to just mica. These capacitors, which were once seen only in radio receivers are now being used in transistor VHF and UHF transmitters where their very low inductance and low losses make them ideal.

Ceramic Capacitors

Ceramic capacitors are made in various forms, the most popular being the tubular and disc types. The tubular type consists of a small ceramic tube which has silver deposited on the inside and outside surfaces, the capacitance being determined by the area of the surface, the tube wall thickness and the ceramic dielectric constant. The disc type consists of a flat disc of ceramic with silver deposited on each side of the disc. Ceramic dielectric material can be made to have particular characteristics by adjusting the proportions of the ingredients.

The low K ceramic material usually used in the tubular capacitors provides good stability with a fairly low and a predictable temperature coefficient (change of capacitance with temperature) so that in some circumstances they can be used with advantage in a tuned circuit to compensate for the opposite temperature effects in other components in the circuit. Their small physical size and low inductance makes them suitable for use in receivers and low power circuits in the VHF and UHF range.

Tubular ceramic capacitors are also made in a lead-through form for decoupling supplies passing through a screening box or plate and they have a soldering flange or screwed bush for mounting. Variable tubular ceramic capacitors have the internal silvering replaced by a concentric adjusting screw and these are suitable for operation up to several hundred megahertz.

Disc ceramic capacitors are usually of the Hi K ceramic type and have the advantage of very high capacity with small physical size and very low inductance. Hi K ceramic material has a high temperature coefficient which makes these capacitors unstable in value and so unsuitable for use in tuned circuits. They suffer from losses at high frequencies but can be used successfully in bypass and decoupling applications up to 1,000MHz.

Wound Capacitors

Polystyrene, polyester, polycarbonate and paper capacitors are made by winding two strips of metal foil into a roll, insulated by two strips of dielectric film or paper. Connection strips or edges are brought out to form suitable lead-out connections. Polystyrene is a high-grade dielectric having characteristics approaching those of mica; polystyrene capacitors are used in LF, MF and HF circuits where stability is important. Polyester and polycarbonate capacitors are suitable for most LF and MF applications up to a few MHz. Paper capacitors are mainly used in LF applications and for high voltage power supply use where working voltages up to several thousand volts are available. Capacitors of this type are usually hermetically sealed in a can with special high voltage terminals.

Polystyrene capacitors are available in values from 10pF to 1μF and polyester, polycarbonate and paper capacitors from 1,000pF to 10μF approximately.

Now follows the last major theoretical section, but a very important one, leading up to the resonant tuned circuit, an essential part of every transmitter and receiver.

Inductors and Capacitors in series and parallel

(i) Inductors (not mutually coupled)

Series

$$L_{total} = L_1 + L_2$$

Parallel

$$\frac{1}{L_{total}} = \frac{1}{L_1} + \frac{1}{L_2} \text{ or } L_{total} = \frac{L_1 L_2}{L_1 + L_2}$$

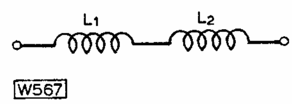


Fig. 20: Inductors in series.

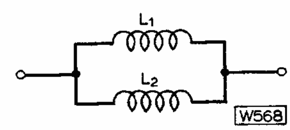


Fig. 21: Inductors in parallel.

The arithmetic is the same as for resistors, in series they add and in parallel the total value is less than the smallest. Whereas for capacitors it is just the opposite, as shown below.

(ii) Capacitors

Series

$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Parallel

$$C_{total} = C_1 + C_2$$

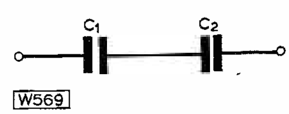


Fig. 22: Capacitors in series.

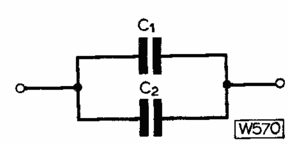


Fig. 23: Capacitors in parallel.

In parallel they add and in series the total value is less than the smallest. We are now in a position to look at the behaviour of resistors, capacitors and inductors in circuits where alternating currents are flowing.

AC Circuits

Resistors in an AC Circuit.

In this case both voltage and current are "in phase" with one another, i.e. they both reach maximum or minimum values at the same instant of time. When calculating current and voltage, the r.m.s. values are used, thus $I_{rms} = V_{rms}/R$

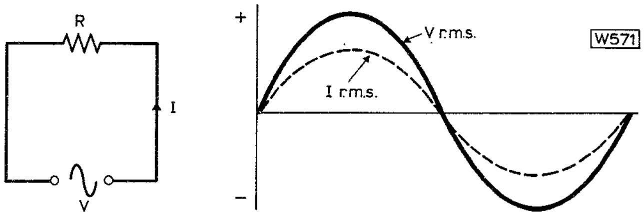


Fig. 24: The voltage and current in a resistive circuit are in phase.

Capacitors in an AC circuit (Capacitive Reactance).

When an alternating current is applied to a capacitor it will charge it, first in one direction and then in the other. The maximum current will be flowing in or out of the capacitor when the applied voltage is changing most rapidly (i.e. as it goes through zero volts) and the current will fall to zero when either peak of the cycle has been reached and the voltage is virtually steady for an instant.

Since the current is at a peak ¼ cycle before the voltage it is said to **"lead"** the applied voltage by 90° (one full cycle being 360°—see section on sine waves). The energy which is stored in the capacitor during the ¼ cycle charging period is returned to the circuit in the following ¼ cycle. The current flowing is known as Wattless Current as no power is dissipated in the conventional I^2R sense.

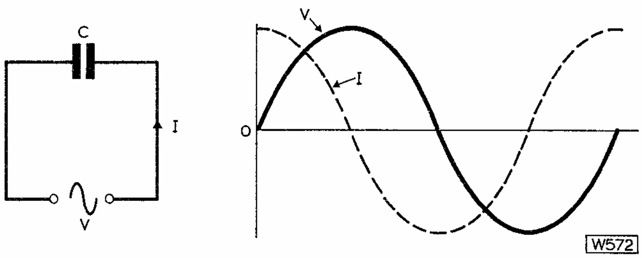


Fig. 25: In a capacitive circuit, the current which flows leads the applied voltage by 90°.

If the relationship between voltage and current is investigated, the frequency of the alternating current must be taken into account, together with the value of the capacitance in the circuit. In fact, the current flowing is proportional to capacitance, frequency and voltage. By arranging these factors we can extract a quantity which is akin to resistance in a DC circuit. This quantity is known as Capacitive REACTANCE and its unit is the ohm.

Capacitive REACTANCE (Xc) $= \dfrac{1}{2\pi fC}$ where f = frequency of alternating current, C = Capacitance and $\pi = 3{\cdot}142$.

Using Ohm's Law and reactance we can calculate the voltage or current in an AC circuit containing a capacitor:–

$$I = \frac{V}{X_c} \quad X_c = \frac{V}{I} \quad V = IX_c$$

(note that E and I are r.m.s. values)

Inductors in an AC Circuit (Inductive Reactance)

When an alternating voltage is applied to an inductor the resultant current causes a back or induced e.m.f. to be generated which is proportional to the rate of change of the current. In the inductor, as in the capacitor, the maximum current occurs when the voltage is changing most rapidly (as it goes through zero), except that in the case of the inductor the current "lags" the voltage by ¼ of a cycle or 90°.

It will be realised that if the frequency of the alternating current increases, so will the rate of change of current, thus the value of the e.m.f. generated in the inductance will be proportional to the frequency and the current flowing inversely proportional to the frequency. From this we can extract a quantity known as the Inductive REACTANCE, unit—again the ohm.

Inductive REACTANCE (X_L) = $2\pi fL$ where f = frequency, L = inductance and $\pi = 3{\cdot}142$.

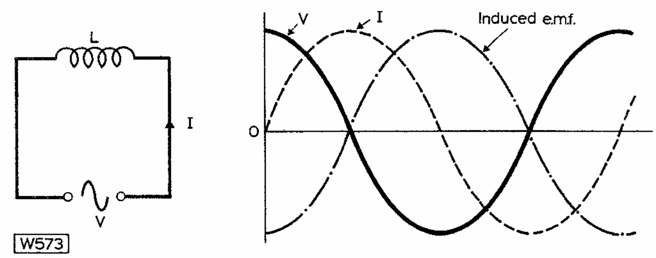


Fig. 26: In an inductive circuit, the current lags the applied voltage by 90°. The induced e.m.f. is in anti-phase (180° different) to the applied voltage.

Again we can use Ohm's Law and calculate current and voltage in the inductive circuit using REACTANCE in the place of resistance:–

$$I = \frac{V}{X_L} \quad V = IX_L \quad X_L = \frac{V}{I}$$

(note that V and I are in r.m.s. values).

Reactances in Series and Parallel

Reactances of the same kind, Inductive OR Capacitive can be treated similarly to resistors:—

Series $X = X_1 + X_2 + X_3$

Parallel $\dfrac{1}{X} = \dfrac{1}{X_1} + \dfrac{1}{X_2} + \dfrac{1}{X_3}$

Reactances of opposite kinds, Inductive and Capacitive:—

Series $X = X_L - X_c$

Parallel $X = \dfrac{-X_L.X_c}{X_L - X_c}$

This follows because when reactances of opposite kinds are combined in a circuit, the currents lag and lead the voltages, in the inductive and capacitive sections respectively, by 90° and consequently they must first be subtracted from one another to find the total reactance. For this purpose, Inductive reactance is normally considered 'positive' and Capacitive reactance 'negative'.

Impedance

In any circuit containing reactances there will be some resistive element in the wires, for example, in the inductor windings thus when we consider the resistance to current flow presented by reactances we must add that presented by the ohmic resistance of the circuit. When we consider all these elements together, inductive reactance, capacitive reactance and resistance, it is known as IMPEDANCE. The resistive element of the impedance may be either in series or in parallel with the reactance.

Series

The impedance Z in this case is $Z = \sqrt{R^2 + X^2}$ where Z = Impedance (ohms), R = Resistance, and X = Reactance (inductive or capacitive).

Parallel

$$Z = \frac{R.X}{\sqrt{R^2 + R^2}}$$

In circuits which contain impedances, Ohm's Law can be applied as follows:— $I = \frac{V}{Z}$ and $V = IZ$ and $Z = \frac{V}{I}$. (use r.m.s. values of V and I).

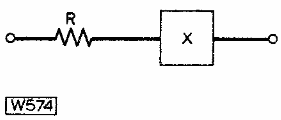


Fig. 27: Resistance and re- reactance in series.

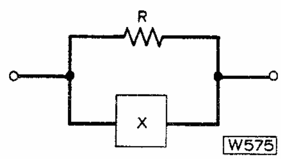


Fig. 28: Resistance and re- actance in parallel.

Resonance

The next characteristic of the AC circuit, that we are going to examine, is RESONANCE. This is a most importance effect which is employed many times over in every radio transmitter and receiver. As the AC frequency, applied to a circuit containing inductance and capacitance, is increased, the value of the inductive reactance increases, whilst that of the capacitive reactance decreases, as shown in the graph below:—

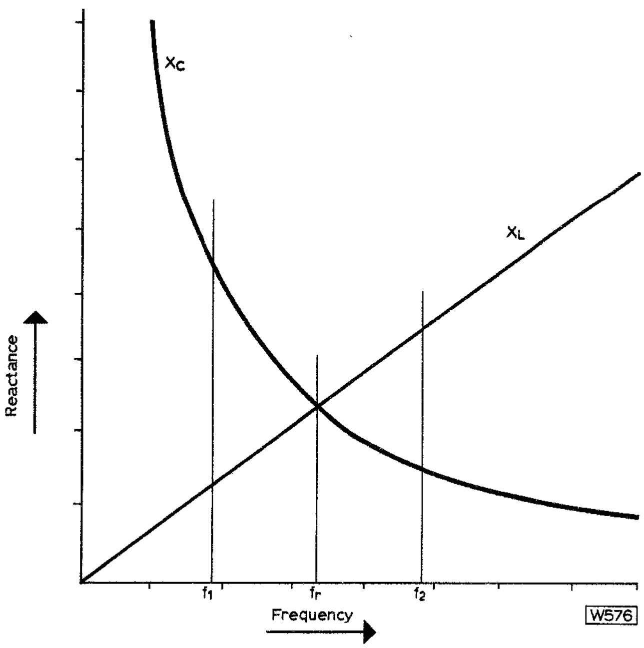


Fig. 29: Capacitive and inductive reactance plotted as a function of frequency. At the resonant frequency, fr, the two reactances are equal in value.

From this it is apparent that at a certain frequency, f_r, the capacitive reactance equals the inductive reactance.

Series Resonant Circuit (Acceptor Circuit)

If the frequency of V changes between f_1 and f_2 then the current flowing in the circuit will rise to a maximum at f_r. The impedance, on the other hand, falls to a value equal to R. To summarise this in an expression:—

$$X_L = 2\pi fL \text{ and } X_c = \frac{1}{2\pi fC}$$

$$\text{at } f_r \quad 2\pi fL = \frac{1}{2\pi fC}$$

$$\therefore f_r = \frac{1}{2\pi\sqrt{LC}}$$

Where f = frequency in Hz, L = Inductance in henries, C=Capacitance in farads and $\pi = 3{\cdot}142$.

The value of the current flowing in the circuit is found as follows:—

$$I = \frac{V}{Z} = \frac{1}{\sqrt{R^2 + (X_L - X_c)^2}}$$

Thus, at resonance, the impedance of a series resonant circuit is equal to the resistive component R, X_L and X_C having cancelled each other out.

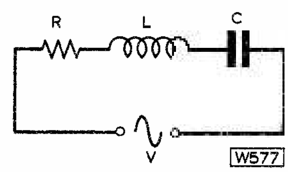


Fig. 30: A series resonant circuit.

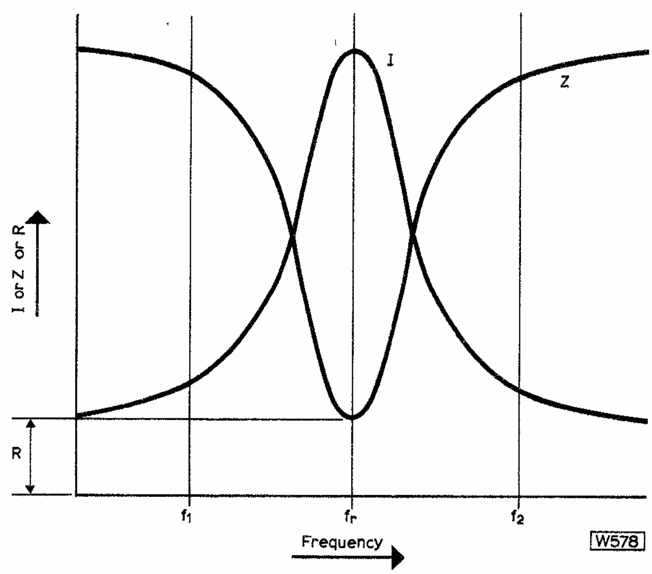


Fig. 31: When a series RLC circuit is at resonance, the impedance is at a minimum, and the current is at a maximum.

Parallel Resonant Circuit (Rejector Circuit).

This arrangement is awkward for the purposes of investigating the variation of current and impedance with frequency, so an equivalent parallel circuit is used in which a perfect inductor and a perfect capacitor are in parallel with an assumed resistance, known as the dynamic resistance R_D, R_D being equal to $\frac{L}{C_r}$ at resonance. The expression for the resonant

continued on page 669

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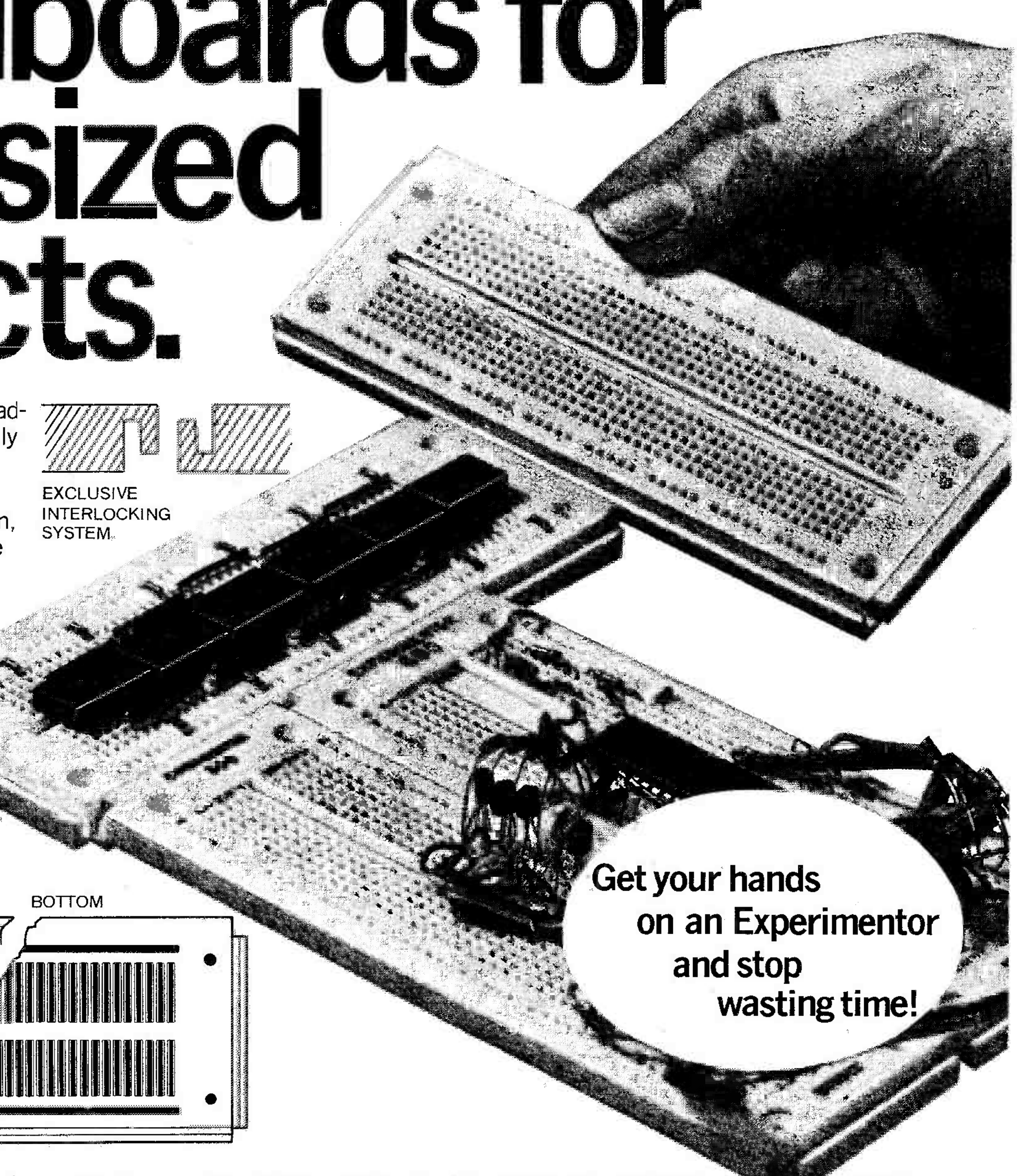

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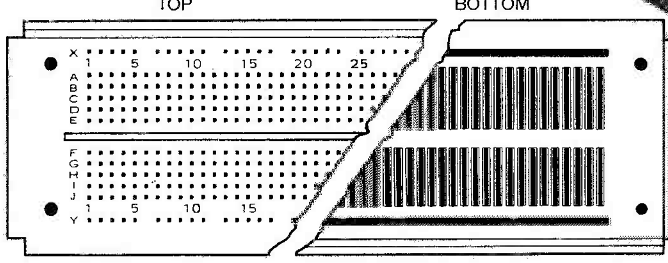
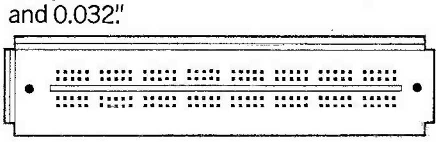


Contact resistance is a mere 0.4 mΩ and interterminal capacitance is typically less than 5 pF. The **Experimentor** is usable to over 100 MHz.

Experimentor 600 and 650 models are ideal for RAM's ROM's and PROM's (0.6" centre IC's) while the 300 and 350 models are for smaller DIP's (0.3" centres). All four models, of course, also take all standard components, the 0.1" grid being compatible with transistors, diodes, LED's, capacitors, resistors, pots — in fact any component with lead sizes between 0.015" and 0.032."



A useful quad bus strip (EXP4B) further expands the versatility of the system for the MPU user.

Model	Length"	Width"	Centre channel"	5-way tie points	Bus	Price	All units are 0.330" deep.
EXP300	6.0	2.1	0.3	94(470)	2(80)	**£6.77**	Prices include VAT (8%) and p&p for
EXP350	3.6	2.1	0.3	46(230)	2(40)	**£3.69**	UK Orders.
EXP600	6.0	2.4	0.6	94(470)	2(80)	**£7.35**	Add 5% to all orders outside UK.
EXP650	3.6	2.4	0.6	46(230)	2(40)	**£3.99**	All prices and specifications correct
EXP4B	6.0	1.0	N/A	N/A	4(160)	**£2.83**	at the time of going to press.

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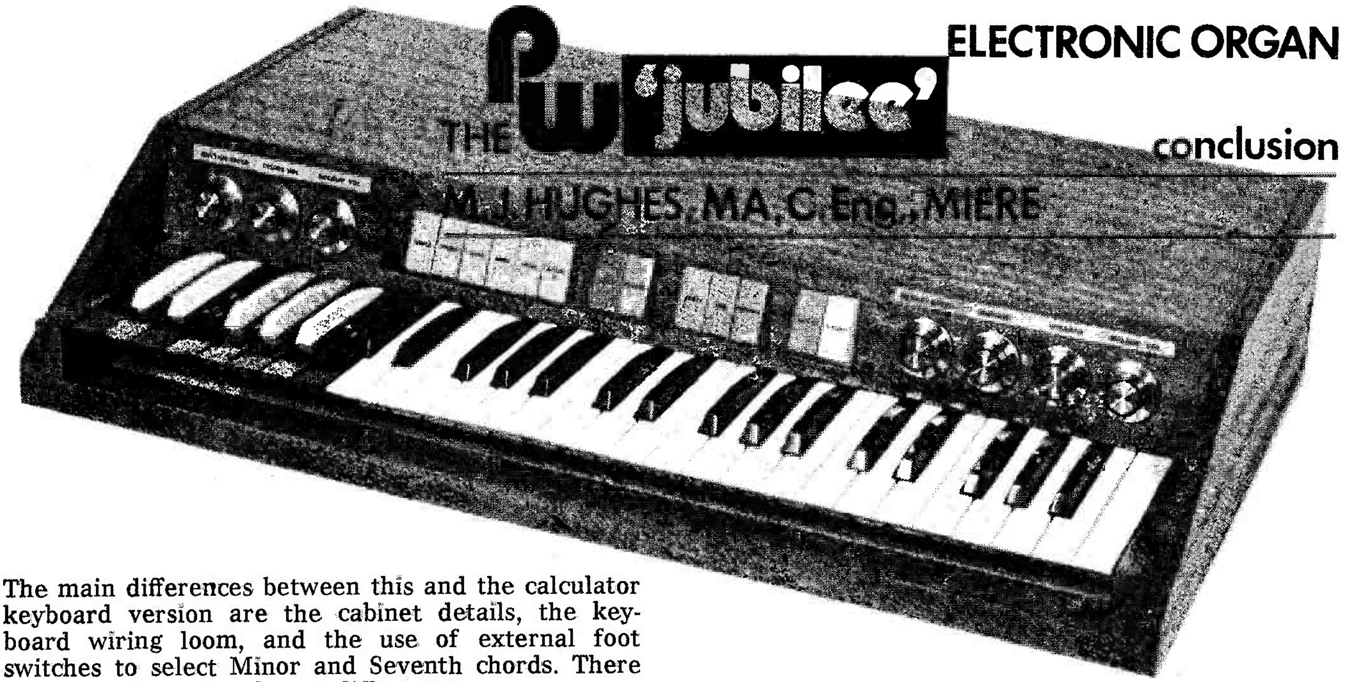


ELECTRONIC ORGAN

conclusion

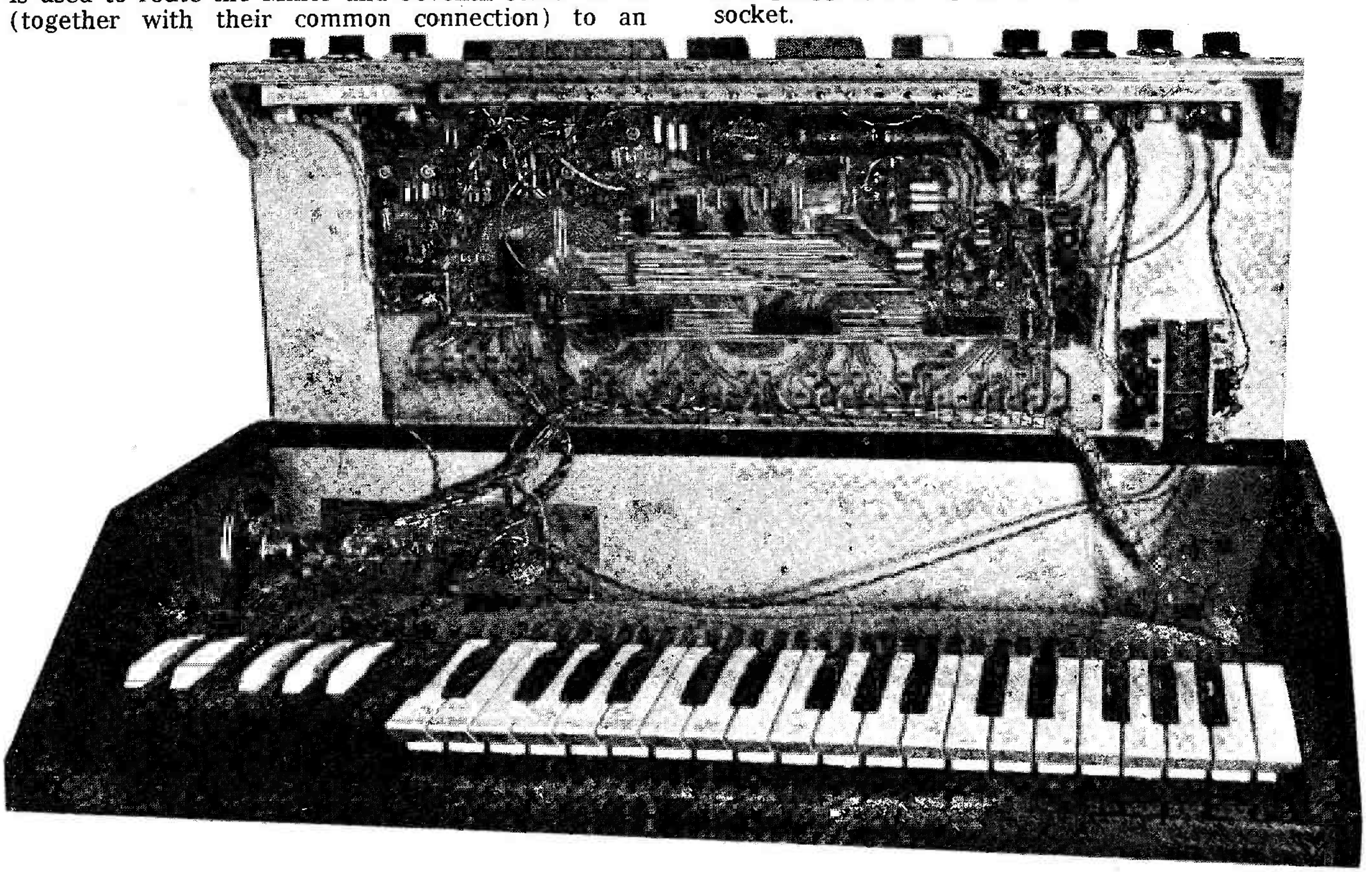
M. J. HUGHES, M.A., C.Eng., MIERE

The main differences between this and the calculator keyboard version are the cabinet details, the keyboard wiring loom, and the use of external foot switches to select Minor and Seventh chords. There are one or two minor layout differences.

The accompaniment keys (bottom octave of the 4 octave keyboard) require two separate busbars. One commons together the poles of C, C♯, D, D♯, E and F while the other commons F♯, G, G♯, A, A♯ and B. Use the wiring instructions shown in **Fig. 1** to connect between the board pins and the contacts of each key (note) switch—not forgetting the three busbar connections. Use lacing cord to neatly tie the keyboard loom into a bundle.

The rear panel wiring is slightly different from the calculator key version. A stereo jack plug and socket is used to route the Minor and Seventh select wires (together with their common connection) to an external "push to make" pair of foot switches. Although expensive, an electronic piano "Soft/Sustain" pedal pair worked well.

A single pole toggle switch was put in series with the internal loudspeaker connections so that the internal speaker can be muted. The output for the external Phono lead is connected via an extra stereo jack socket. This enables an external foot controlled volume control (swell pedal) to be used. The wiring is such that the control (which should be 10kΩ log) can be plugged into the jack socket if needed but, if unplugged, the signal is left unaffected at the DIN socket.



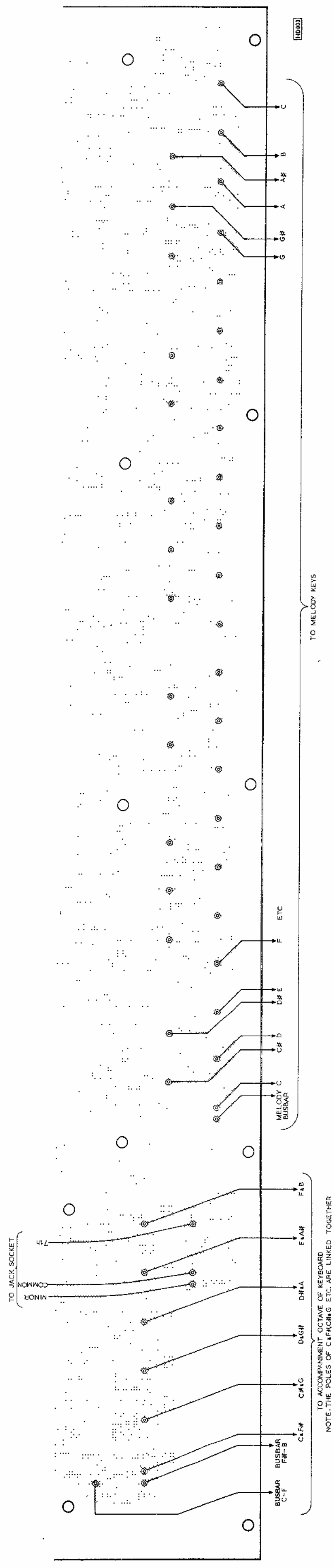


Fig. 1: Wiring between the PCB and an external keyboard.

Adjustments for both versions

The most obvious problem will be caused by constructors trying to get too much out of the internal amplifier. Remember—it is only capable of putting out about 1W (about the same total volume as a portable radio). When playing a single melody note, it is possible to turn up the gain of the melody pre-amp and produce a very loud sound but as soon as you introduce a chord from the accompaniment, the internal amplifier overloads and produces distortion. This is made even worse by the drums—particularly the bass drum. The secret is to turn all the front panel volume controls to maximum and then switch all the voicing switches to their "on" position. Put the vamp switch in the "off" position and select a rhythm—say "Waltz". With one hand, depress bottom "C" of the melody keyboard and the chord of "G" from the accompaniment. Adjust the preset gains of the three preamplifiers (VR8, 14 and 18) to get a good balance between melody, accompaniment and drums respectively and set the levels so that the sound is as loud as possible *without* distortion. It might be necessary to adjust VR15, 16 and 19 to get the best compromise between level and tonal quality of the cymbals, snare drum and bass drum respectively. Listen, particularly, to the bass drum sound. This is very low frequency and might not be very prominent when heard over a small loudspeaker but it could have a high electronic amplitude driving the drums preamplifier and the internal power amplifier into clipping. Having set the maximum level, do not expect very loud signals if you select the melody string voice unaccompanied.

The "brightest" cymbals sound is heard when VR15 is near its earthy end; likewise for the snare drum control (VR16). The best bass drum setting for VR19 is just before the onset of oscillation; take care, however, not to have too long a decay on the latter otherwise it will sound more like a percussive tone rather than a deep "thump".

Melody sustain length is increased by increasing the value of C6 by a small amount. Conversely reducing the value shortens the period. If you get no melody sustain, D2 may be short circuit. Check that D2 is in the right way round and the VR5 wiper is making good contact with the track.

Sustain length of the alternating bass is set by C16. Failure of the bass note to cut off completely is an indication that D3 is faulty, the wrong value or inserted the wrong way round.

Chord sustain is set by the value of C20 (which *must* be a polyester type). If the chords do not die away completely Tr5 probably has very low gain and it might be best to replace it. Alternatively you can reduce the value of R44 but if you do this you will have to increase the value of C20 to keep a reasonable sustain time constant. If the chords do not sound at all, D5 may be the wrong way round or Tr5 faulty.

Clicks on the attack of the bass note and melody notes can be removed by careful adjustment of VR10 and VR5 respectively. A hesitation on a cymbal stroke is caused by Tr8 having too high a gain and this can be rectified by reducing the value of R58 to 4·7k.

If you wish to alter the amplitude balance between the cymbals, snare and bass drum without changing their tonal quality (the two parameters are linked to some extent) you can change the values of R61, R75 and R86 respectively. Reducing the value by a small amount will increase the volume for that instrument.

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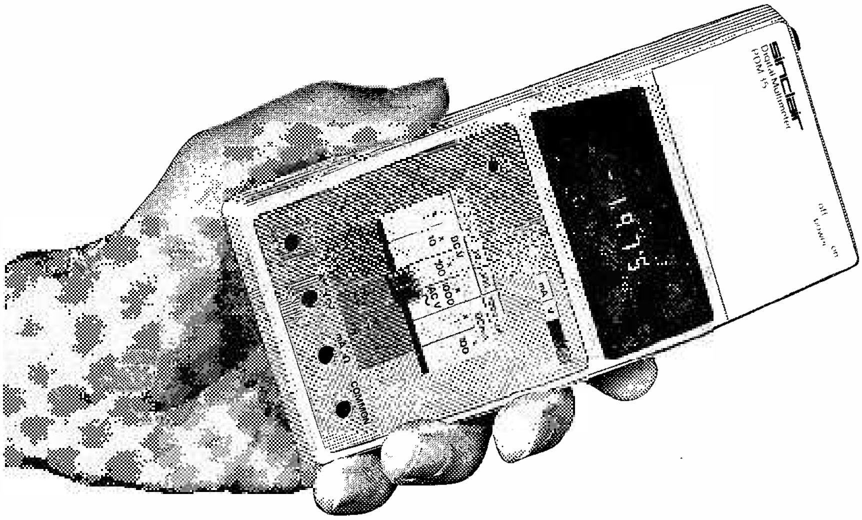

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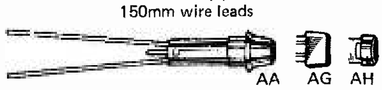

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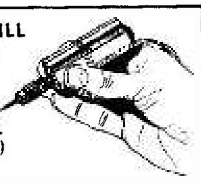

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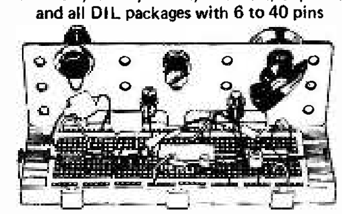

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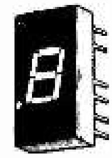

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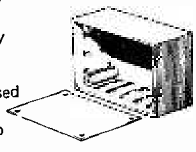

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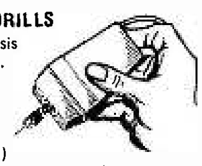

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2N29266 0·15*
2N3053 0·25
2N3054 0·58
2N3663 0·28
2N3055 0·60
2N3643 0·17*
2N3646 0·17*
2N3702 0·11*

2N3703 0·14*
2N3704 0·13*
2N3705 0·14*
2N3707 0·12*
2N3708 0·12*
2N3709 0·14*
2N3710 0·11*
2N3711 0·11*
2N3819E 0·25*
2N3820 0·45*
2N3823E 0·25*
2N4036 0·40
2N4058 0·16*
2N4059 0·10*
2N4061 0·12*
2N4124 0·20*
2N4126 0·30*
2N5298 0·50
2N5457 0·50
2N5458 0·40*
2N5459 0·40*
2SC1172 3·00*
40361 0·50
40363 0·88
40673 0·85

VARICAP I TUNER
ECL1043/05 £5*

TRANSFORMERS
6-0-6 100mA 1·20
9-0-9 75mA 1·20
9-0-9 ½A 3·20
12-0-12 50mA 1·30
12-0-12 1A 2·75
min O/P for OC71/2use 75p
06-06 280mA 2·40
12-0-12 150mA 2·40
MOT. 700 OP P-1K2 8Ω 200mW 50p

DISPLAYS
DL704 0·95
DL707 0·75

CAPACITORS Elec. MFD/V

1/25	0·10*		
1/53	0·10*	47/35	0·12*
1/75	0·10*	50/10	0·10*
2·2/25	0·10*	50/15	0·10*
2·2/63	0·10*	100/18	0·06*
2·5/64	0·10*	100/25	0·10*
4·7/16	0·08*	100/35	0·11*
4·7/63	0·10*	100/50	0·15*
5/10	0·10*	100/35	0·15*
5/16	0·11*	220/16	0·15*
6·8/25	0·10*	220/25	0·16*
6·8/40	0·10*	220/63	0·25*
8/70	0·10*	250/12	0·12*
10/16	0·09*	250/50	0·18*
10/25	0·09*	250/64	0·20*
10/35	0·10*	330/16	0·15*
10/64	0·10*	470/6V3	0·10*
10/250	0·18*	470/10	0·12*
15/40	0·10*	470/16	0·18*
15/400	0·35*	470/25	0·20*
16/10	0·10*	680/25	0·25*
20/15	0·10*	1000/16	0·25*
20/70	0·10*	100/25	0·30*
22/6V3	0·10*	1000/50	0·40*
22/16	0·10*	1500/25	0·35*
25/25	0·11*	2200/6V3	0·30*
33/50	0·12*	2200/40	0·60*
47/6V3	0·10*	2500/15	0·45*
47/10	0·10*	3300/30	0·45*
47/16	0·10*	5000/12	0·45*

POLY. R/Lead 100VDC

·001	0·06*		
·0022	0·06*	·068	0·07*
·0033	0·06*	·1	0·07*
·0047	0·06*	·15	0·08*
·0068	0·06*	·22	0·10*
·01	0·06*	·33	0·11*
·015	0·07*	·47	0·15*
·022	0·07*	·1 250V	0·10*
·033	0·07*	·1 600V	0·15*
·047	0·07*	1·0 400V	0·12*

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RED LED's ·125 10 for £1
RED LED's ·2 10 for £1
BC108C 11 for £1 100 for £8
2N3702 100 for £9
2N3704 100 for £9

POTENTIOMETERS
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5K, 10K, 25K, 50K, 200K, 250K, 500K, 1M, 2M, 25p* each.

CERAMICS 50V
2·2, 4·7, 6, 10, 22, 33, 39, 47, 100, 200, 470, 560, 1000, 1500, 2200, 3000, 4700, 10000, 47000pf; 1MFD 10V. All at 6p* each. 1MFD 63V 8p*.

RESISTORS 2p* each
One-third WATT E12 (5%)
1 ohm-10m ohm.

PRESET MIN. VERT. SUB MIN V & H.
100ohm, 220ohm, 470ohm, 1K, 2K2, 4K7, 10K, 20K, 50K, 100K, 250K, 470K, 1M, 2M2. 8p* each.

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100V 1A 0·38 TAG 1 100
200V 1A 0·60 TAG 1 200
600V 1A 0·80 TAG 1 600
700V 1A 1·40 BT 106
400V 4A 0·65 C106D1
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LED TIL 209/0·125; 0·2;
Red 20p 20p
Green 29p 29p
Clip for above 3p

NATIONAL SCOOP
SK 1122 TV GAME KIT
Colour and Sound Inc. PCB Semi-cons, Pots, Res, Caps, XTAL, Data
£21·00* (less cash discount)
MA 1003 CAR CLOCK MODULE
Built complete incl. Data £17·00
CAR INTERIOR LIGHT DELAY
4 to 40 seconds variable. Time to find keys and clunk-click. Complete, 2 wires to connect (protected). £5·25

I/C LINEAR
555 0·49
709 (TO99) 0·35
709 (8 PIN DIL) 0·40
741 (8 PIN DIL) 0·28
AY-5-1224 3·75
AY-3-8500 T.V. 6·00
CA 3130 0·87*
LM 301AN 0·55
LM 308 1·40
LM 309K 2·00
LM 324 2·05
LM 380/SL60745 1·29*
LM 381N 2·00*
LM 555 0·49
LM 723 0·59
LM 3900N 0·69
MC 1310/CA1310E 2·55*
MC 1327/SN76227 1·35*
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MC 1350P 0·75*
NE 555 0·49
SK 1122 T.V. Game 18·00*
SN 76003N 2·80*
SN 76013ND 1·60*
SN 76013N 1·75*
SN 76023N 1·75*
SN 76023ND 1·60*
SN 76033N 2·75*
SN 76660 0·90*
TAA 550 0·60*
TBA 120ASQ 1·30*
TBA 395 2·25*
TBA 480Q 1·25*
TBA 520Q 1·70*
TBA 530Q 1·90*
TBA 540Q 1·90*
TBA 550Q 3·40*
TBA 560CQ 2·30*
TBA 641 2·55*
TBA 750 1·90*
TBA 800Q 1·35*
TBA 810SQ 1·49*
TBA 820Q 1·20*
TBA 920Q 2·80*
TBA 990Q 2·50*
TCA 270Q 2·20*
TDA 2020 4·25*
U 14552 300mW Audio with data 0·35*
ZN414 1·40*

TTL DIGITAL
7400 15p
7401 20p
7402 18p
7403 18p
7404 23p
7407 40p
7408 24p
7410 18p
7411 24p
7412 25p
7413 38p
7414 72p
7416 36p
7417 36p
7420 18p
7421 25p
7427 32p
7428 38p
7430 18p
7432 28p
7437 42p
7440 18p
7442 68p
7443 1·00p
7444 1·00p
7446 1·00p
7447 98p
7448 98p
7451 18p
7460 18p
7470 32p
7472 30p
7473 30p
7474 35p
7475 49p
7476 32p
7480 65p
7481 1·00p
7485 1·30p
7486 43p
7490(A) 55p
7492 55p
7493 55p
7496 90p
74107 40p
74121 38p
74123 49p
74141 80p
74145 1·15p
74151 94p
74174 1·20p
74180 1·20p
74190 1·60p
74191 2·10p

Trouble shooting

We have already mentioned that the master oscillator operates from a lower supply rail than the dividers and during the constructional tests this was likely to give trouble. Generally the loading on the unstabilised +15V rail—when all the ICs have been inserted—will clear this problem but it is possible, in some instances, that some instability remains (diagnosed by an irregular or distorted quality of some notes. This can be overcome by increasing the value of +15V rail dropping resistor (R93) to 10 ohms. Remember this must still be a ½ watt device!

In the unlikely event of total failure you must check the system carefully in a systematic manner. Total failure is most likely to be associated with the power supply, internal amplifier, or master oscillator. Test procedures have been dealt with in previous issues.

It is difficult to decide whether the AY-1-0212 is faulty (IC2) without using an oscilloscope; if you can be certain that the master oscillator is working with no audio tones from the output pins of this IC, there is a high chance that the integrated circuit is faulty. In the absence of a 'scope there is a simple, but effective, test to check the master oscillator. Place a medium waveband transistor portable radio *very close* (within an inch or two) to Tr1 and Tr2. If you tune over the band, you should hear heterodyne whistles at several points. These may be identified as coming from the master oscillator by turning up the Vibrato Depth control. The whistles turn into chirrups.

Failure of the vibrato oscillator is most likely to be due to incorrect setting of VR2.

As with any printed circuit board project most problems are caused by poor soldering giving rise to dry joints, connections that have been missed—particularly under the large integrated circuits—solder blobs bridging conductor tracks, components put in the wrong holes and components inserted the wrong way round.

It is very unusual for components to be faulty—provided they have not been misused or abused. Remember that it is easy to damage MOS integrated circuits by handling them wrongly. In a complicated design such as the Jubilee Organ, there are bound to be occasions where a component on the extreme end of its tolerance can effect the final performance.

Postscript

Some people might wish to carry out a simple modification which enables the accompaniment section to memorise the last key that was depressed. If this is done, the rhythm and accompaniment sections will continue to repeat the same vamp without the player having to keep his finger on the key. To change the key of the vamp requires a single depression of the next key which is then memorised. Only major chords can be memorised. The modification requiries a two pole change-over switch and a break in the printed wiring on the pcb at pins 5 and 35 of IC13 (the Chord Generator). Normally both these pins are strapped to ground 0V. Connecting them to the +15V rail through the switch activates the latch circuitry associated with each chord select key. ●

SO YOU WANT TO PASS THE RAE?
—continued from page 662

frequency of the parallel tuned circuit is, in practical terms, the same as for the series tuned circuit,

$$f = \frac{1}{2\pi\sqrt{LC}}$$

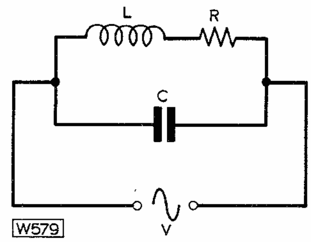


Fig. 32: A parallel resonant circuit.

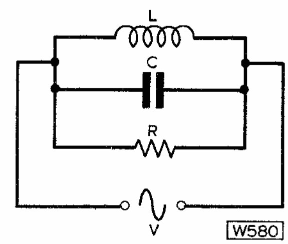


Fig. 33: The equivalent circuit of Fig. 32.

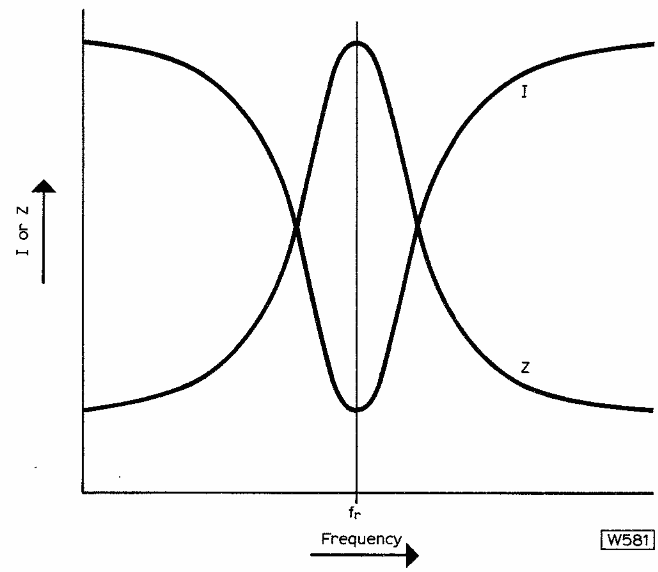


Fig. 34: In a parallel RLC circuit at resonance, the impedance is at a maximum, and the current is a minimum.

Magnification Factor "Q"

In the circuit shown in Fig. 30, at resonance, the voltage across the inductor (or the capacitor) can be considerably greater than the applied voltage V. As we have seen, the current at resonance is defined by the value of the resistor R, but the voltage across the inductor (or the capacitor) is given by the product of the current and the reactance in question, which is usually very much greater than R. The ratio of the voltage across the reactance to that across the resistor is called the Magnification Factor or "Q" of the circuit.

The "Q" of a practical tuned circuit depends mainly on the quality or "goodness" of the coil as the capacitor normally has very low losses associated with it. A high "Q" tuned circuit has the ability to respond to one frequency whilst rejecting others. In a receiver, this would imply "selectivity", the ability of the receiver to select a wanted signal and reject unwanted ones.

An example of the practical use of a simple resonant circuit is in an Absorption Wavemeter. In this device the resonant frequency of a tuned circuit is used to check the output frequency of a transmitter.

In the next section we will be dealing with diodes, transistors and valves, also block and circuit diagrams.

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS
In general, the author does not have any more information on products than appears in the article.

Pocket-it

With "in" words like Teletext and Oracle commonly in the news these days, one tends to be on the lookout for anything new in this field. The most exciting piece of news this month is that a manufacturer is concentrating its efforts on producing a Teletext receiver which will fit into the coat pocket. Although the company (in Germany) has primarily aimed at producing a portable radio size unit, the pocket version is hot on its heels. It is planned that the unit should be complete i.e. you do not need to plug it in or connect it to a TV receiver in any way. The coat pocket version (it is planned) will have its own aerial and tuner, IF amplifier and Teletext decoder. This will feed a display of LEDs (for the mains version) or liquid crystal cells (battery model) and thus avoid using a conventional cathode ray tube. For anyone following the stock market, this looks a good bet—as and when it becomes available.

After remembering using the old PO 3000 type relays for early model control, I am pleased to note that a new DPDT relay, housed in a dual in-line package and standing only 0·38in high, has appeared on the American market. It fits standard 16-pin DIL sockets which is very useful, constructionwise. Even nicer is the extreme sensitivity of these little beasties; the coil requires 200mW maximum to pull in. On the business side, the contacts will switch a resistive load of 1A at up to 28V DC and will carry 5A. It is amusing to note that the manufacturers of this little relay have the address; 100 Relay Road! Clearly an address which should click with those who are really switched on.

Smart alecs!

It seems that we will have to live with the word microcomputer for a while longer—until something even more wonderous takes its place, no doubt. The newest and most interesting development in this field comes from Japan. One of the electronics giants over there is to market a mini-computer-type kit which is aimed at school children between 12 and 14 years old. With a starting production schedule of producing some 4,000 kits a month, the company seems confident it can sell a large number. The price (converted very roughly) would be around £85—£95. Costly, perhaps, but the kit does contain quite a lot. There's a microprocessor (you know of a home without one?), a random access memory and a read-only memory, arithmetic/logic unit, 8-bit latch, audio amplifier, two static RAM chips, keyboard, displays and drivers, and even a loudspeaker. One of the exercises for users is to become an electronic composer. You can compose a tune and enter it into memory. At the touch of a button your masterpiece will be played back using oscillators (yes, these are included in the kit) Tunes of up to 127 notes are possible and are restricted to a maximum of three octaves. This takes in most if not all of the popular melodies for those who might prefer to stick to known tunes. I can see the time when a hush will descend on the Royal Albert Hall, and the soloist will emerge, tuck a 16-pin DIL under his chin and "give forth". Ah, come back Lionel Hampton, all is forgiven!

Valve size?!

New things are often labelled "best" or "biggest" etc. A new semiconductor just released looks as though it could fairly claim to be the biggest transistor in the world. It will handle a peak current of 200A with voltage rating of 550V. These devices have a gain of 15 at the 50A mark and could doubtless do nasty things to loudspeakers in disco systems where power is all. Transistors have certainly come a long way since those "red spot" semiconductors I bought in the Edgware Road many summers ago (and they cut off at about 800kHz).

Sunset strip

The recent Energy Exhibition in London highlighted (for me) just how sadly inefficient solar cells are. Manufacturers get excited at anything which exceeds 10% efficiency. While it is almost certain that newer and better materials and techniques will come, there is some work in hand to maximise what is already available. For example, one American company is aiming to get the costs down to fifty cents per watt of power produced. The approach here is to perfect further the technique of "pulling" a ribbon of silicon to get as wide a strip as possible. Up until now, 1in and even 2in wide strips have been produced. Now, the aim is to get 3in widths. The thickness involved is around half a millimetre but by using improved techniques it is hoped to get this down to less than 8 thou.

The strip itself is produced by touching the surface of a molten pool of silicon with a little "seed" bar of silicon. The seed is then very slowly withdrawn. As it rises it "pulls" silicon with it rather like pulling the surface layer of a bowl of hot chewing gum! The cooling length is pulled slowly through a die to form a strip and the silicon allowed to cool at a controlled rate from over 1,200°C down to 600°C. When it is completely cool, it is scribed and broken up into individual cell sizes.

A filter for all occasions

Readers interested in audio filters—particularly electronic music enthusiasts, will find the new SSM 2040 DIL device of interest. It comprises a voltage-controlled monolithic filter and it can be made to synthesize almost any kind of active filter from low-pass to high-pass, band-pass or notch. The manufacturer is offering samples only at the moment and these are quite expensive. Like most things, the price should drop once production increases and the devices would then probably become available to the home constructor. At present, I am waiting further information but it seems possible to use just the one, single filter and to "switch" it to get numerous effects in an electronic musical instrument. Watch this space.

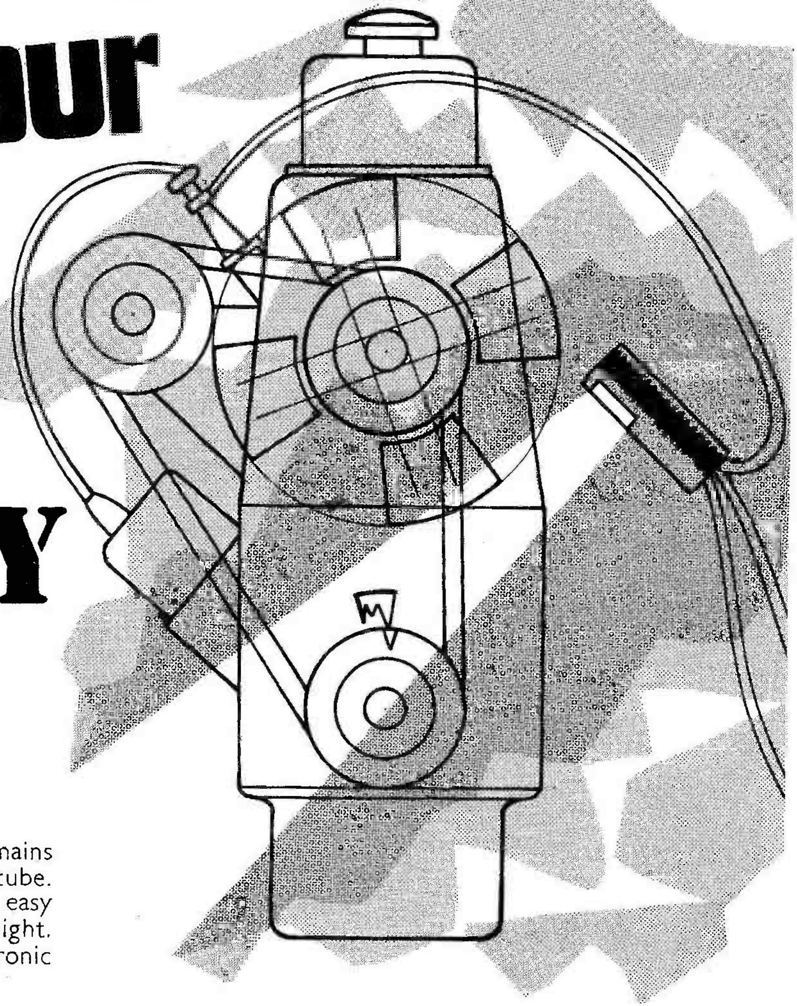
Ginsberg

ON SALE JAN. 6TH.

NEXT MONTH IN...

practical WIRELESS

tune up your car with the PW ECONOMY TIMING STROBE



A very simple design which uses an a.c. mains power supply to drive the Xenon strobe tube. This provides a really bright flash, allowing easy checking of ignition timing even in full daylight. This unit is suitable for conventional or electronic ignition systems.

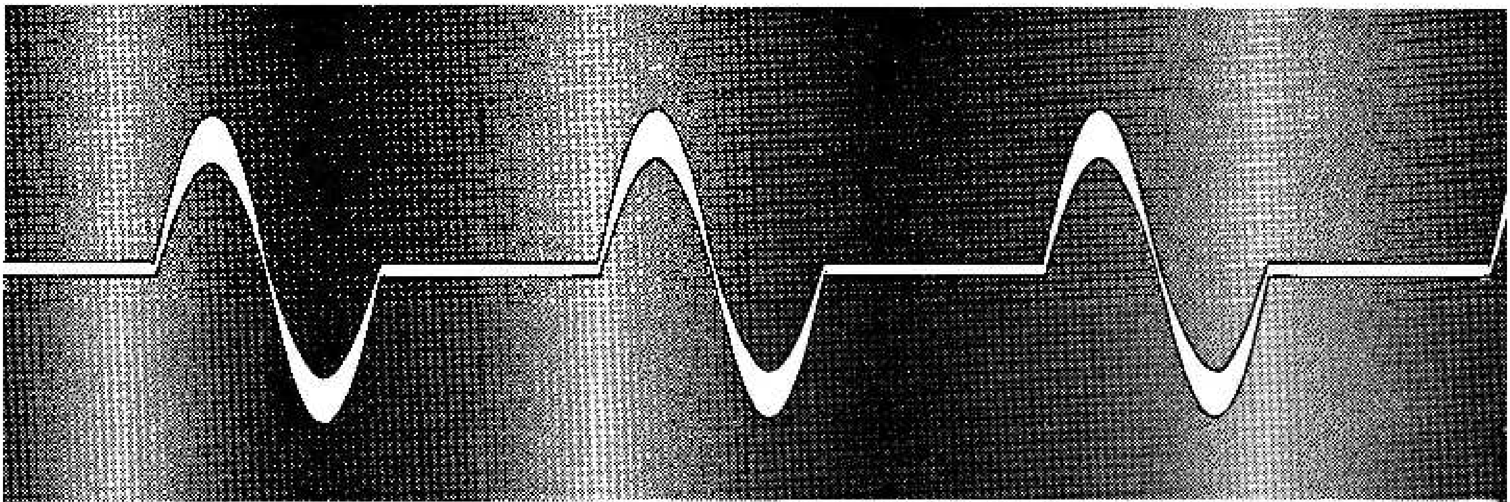
Also:

Active Tone Control

A three-transistor circuit based on the well-known Baxandall tone control, ideal for use in disco or public address systems. A wide variety of source and load impedances can be accommodated.

Medium Wave Tuner/Amplifier

This unit is designed to provide pre-amplifier input facilities plus medium wave AM broadcast coverage for feeding into an existing power amplifier, which also furnishes the necessary power supply. Prealigned IF transformers ease the setting-up procedure.



PROPORTIONAL POV

Due to the ever increasing cost of electricity the need was seen for a reliable and efficient method of controlling an electric fire by reference to temperature. It was thought that the control should be the same, if not better than, that of a gas fire. It should be proportional and automatic, i.e. adjusting to a preset level room heat. When switching large currents of 12-15 amps for up to 3 kilowatt fires, radio frequency interference can be a problem when using thyristors or triacs. With this in mind advantage was taken of the fairly new zero voltage switch integrated circuit, which will give very good proportional control with minimum interference. This is the basis of the circuit shown in **Fig. 1.**

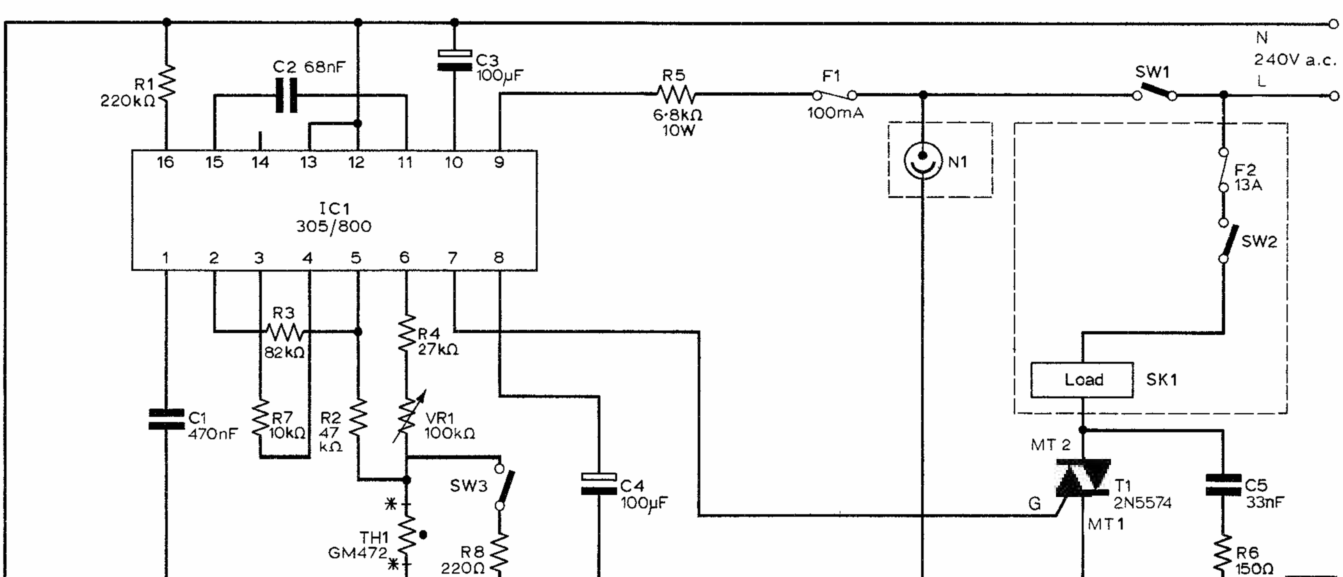
Zero Voltage Firing

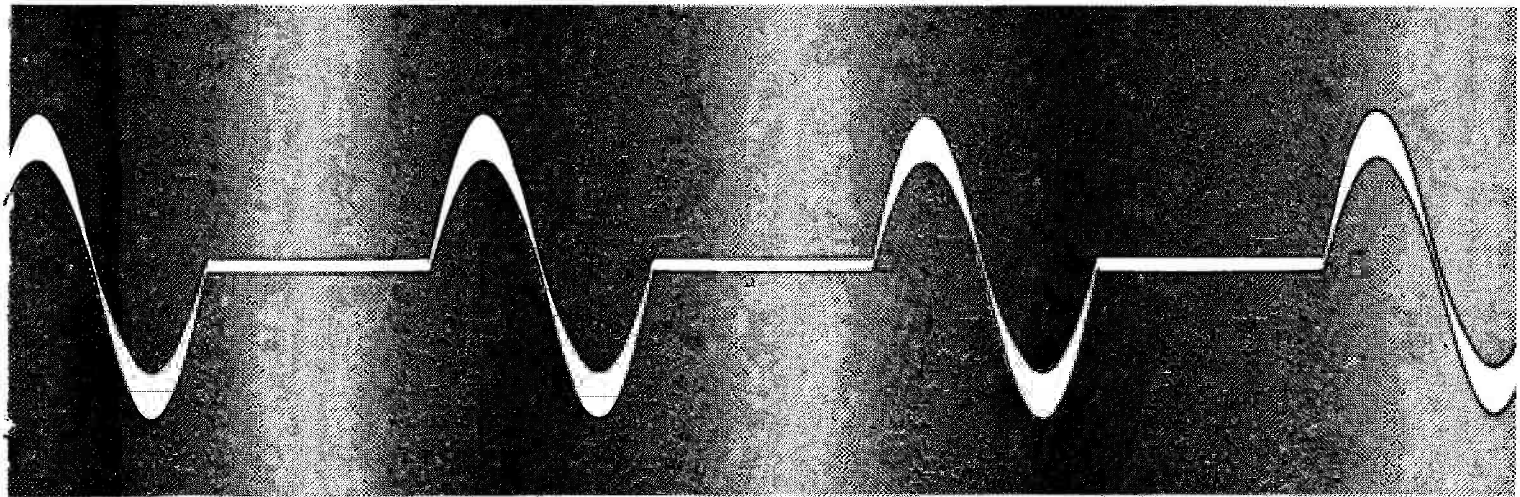
With zero point firing the current in the load is turned on at the zero voltage point; this has the effect of reducing radio frequency interference. The power in the load is controlled by the number of half cycles reaching the load in a given period. This technique can only be applied to certain loads, but is particularly suited to heater elements, which have a slow thermal inertia. The type of system described allows just sufficient bursts of power to reach the load, to make up system losses. This is achieved by using an internal generated ramp voltage (see **Fig. 2** diagram). The result is very accurate control of the power produced in the load and hence, in this case, the temperature of a room.

Circuit Description

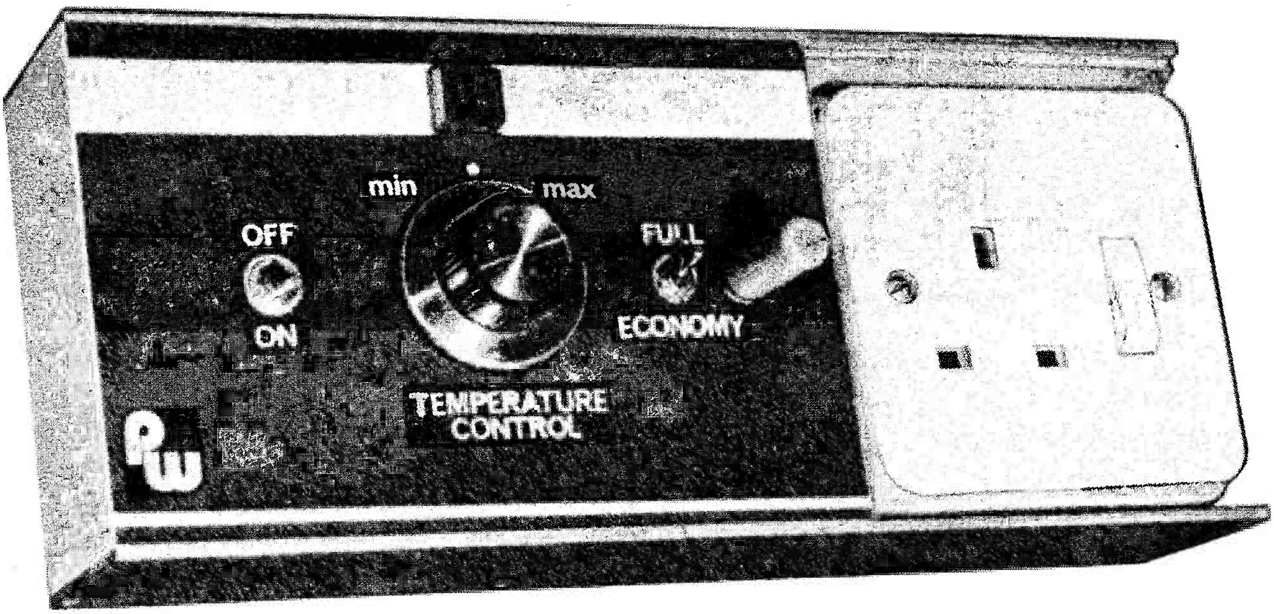
The principle of the operation of the zero voltage switch integrated circuit can be seen in Fig. 2. Here a ramp voltage is generated and used to turn on bursts of current in the load at the control voltage which is determined by, and related to, the temperature of the room, detected by the thermistor's resistance. This reference voltage, set up by the control circuitry, is fed into an operational amplifier. R1, R3, R4 and TH1 form the control circuit to give

Fig. 1: The circuit diagram of the power controller.



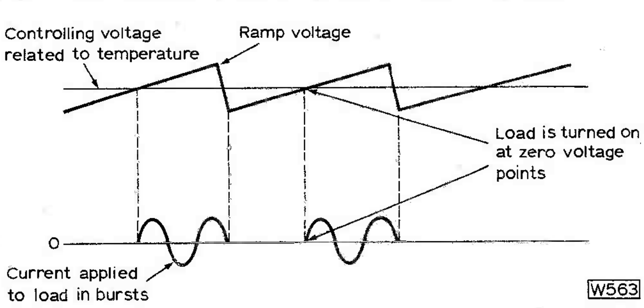


VER CONTROLLER C.TOMS



a means of controlling the related voltage. The width of the ramp voltage is set using the external components R1 and C1. When Pin 2 is at a lower voltage than the bottom of the ramp voltage, the heater is on, and when the voltage is higher than the top of the ramp the heater is off. Therefore voltages lying between the top and bottom of the ramp produce bursts of power to the load thus maintaining the

Fig. 2: Basic operational principle of the zero-switching device.



temperature set by the control. The values of VR1, R4, TH1 type, have been chosen to give a temperature range in the region 40°F to 80°F. The output pulse width is controlled by C2, and was chosen to suit the type of triac used, and is therefore fairly critical to ensure that the triac fires correctly. The economy part of the circuit is effected by R8 and S2, R8 being lower in value than the minimum resistance of the thermistor at the high temperature. This ensures a very low load current at low or high temperatures.

Practical Operation

The load can be any electric heater up to 3 kilowatts, with the exception of those using electric motors, i.e. fan heaters. Due to the values of R1, C1, used for good control of an element (bar type), the motor will operate in bursts, and not run smoothly. The 3 kilowatts could be extended using a larger triac and modifications to the gating circuitry. But 3 kilowatts was thought to be adequate. The sensing element is a miniature bead type thermistor, which in the prototype was mounted in a miniature jack plug, using epoxy resin.

When the room temperature is low the heater will be turned on. When the temperature of the room has reached the required level, that set by the position of VR1, just sufficient current is applied to the heater to maintain the temperature constant. When the temperature rises, the thermistor value drops and so the current is reduced. **Figs. 5** and **6** show some graphs of the performance. In Fig. 6 it can be seen that the temperature, with the control in the mid-position, was kept quite even over a period of some 3 hours. It was found, in fact, that once 70°F was reached, and the control left in the central position, the temperature varied only 1°-2°F in 8 hours.

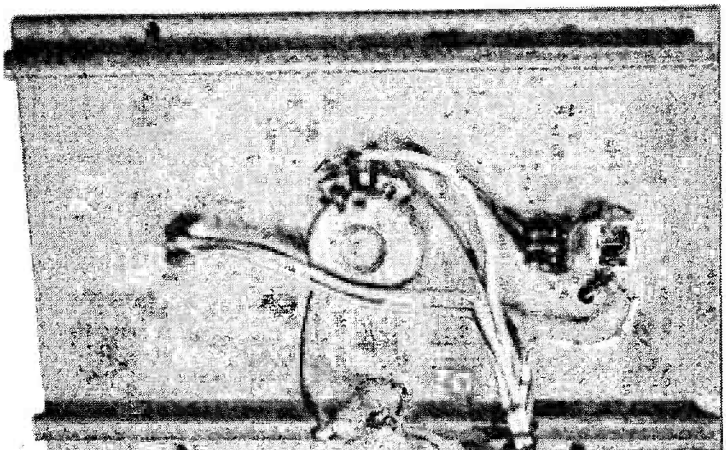
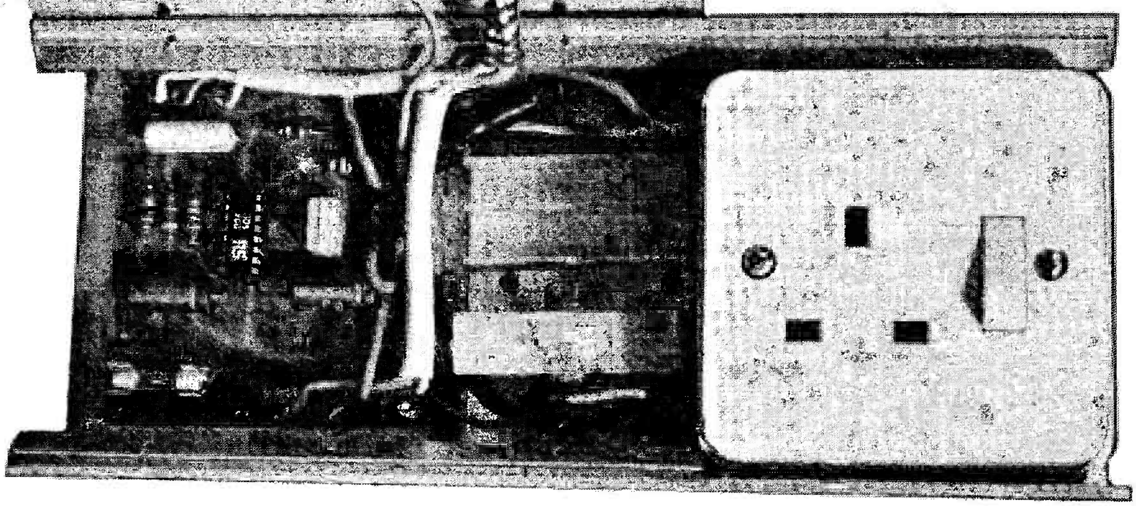



Fig. 3: A view showing the internal layout, and the fairly dense extruded aluminium casing.

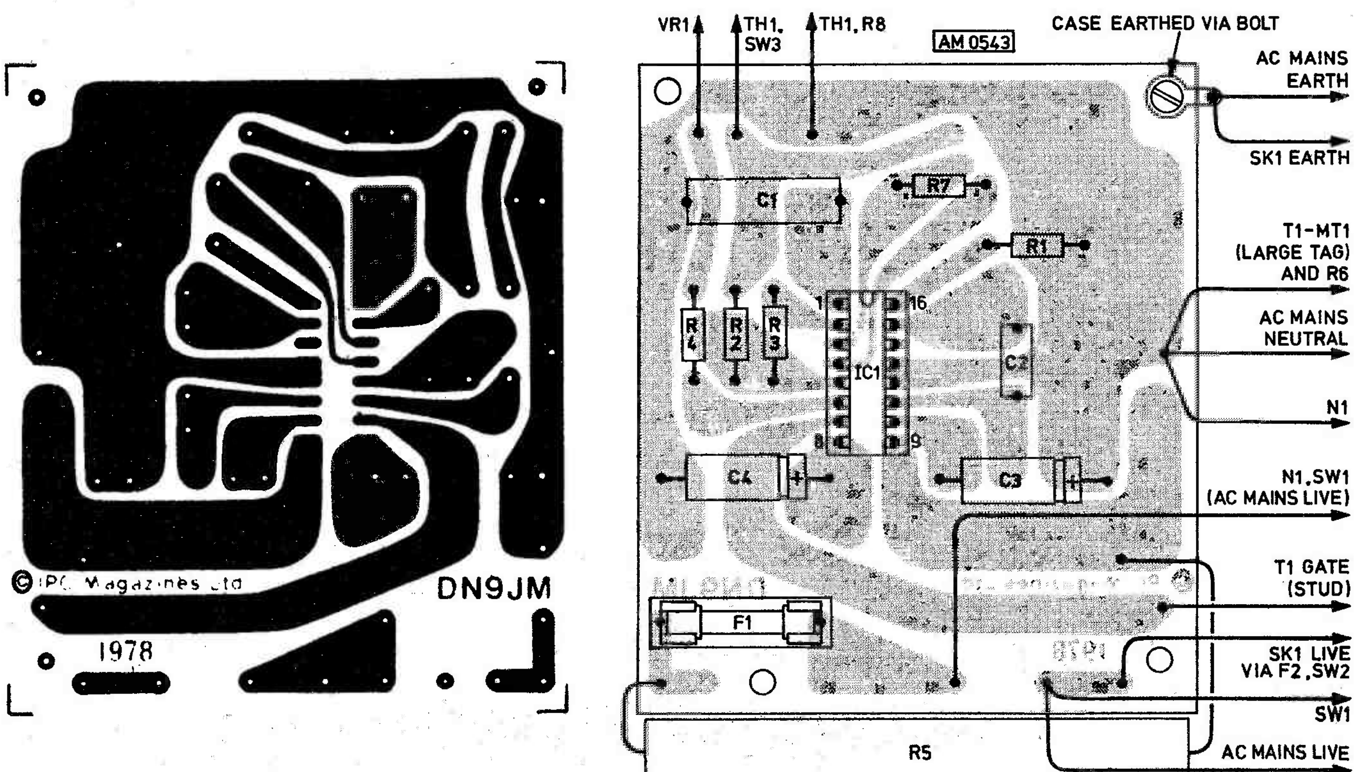


Fig. 4: Details of the PCB and overlay.

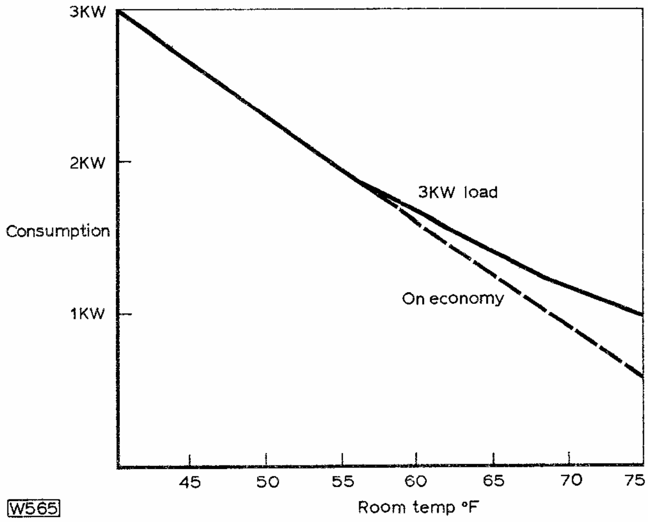


Fig. 5: Graph showing relationship between consumption and temperature.

★ components

Resistors
R1 220kΩ ¼W
R2 47kΩ ¼W
R3 82kΩ ¼W
R4 27kΩ ¼W
R5 6·8kΩ 10W
R6 150Ω ¼W
R7 10kΩ ¼W
R8 220Ω ¼W
VR1 100kΩ lin.
TH1 GM472

Capacitors
C1 470nF Polyester
C2 68nF ,,
C3 100μF 25V electrolytic
C4 100μF 25V electrolytic
C5 33nF Polyester

Semiconductors
T1 2N5574
IC1 305/800

Miscellaneous: mains voltage neon, 2 SPST miniature toggle switches, miniature jack plug and socket, 13 amp plug and socket, 13A fuse, fuseholder or fuse clips (20mm), 100mA fuse (20mm), PCB (Readers PCB Service), suitable case.

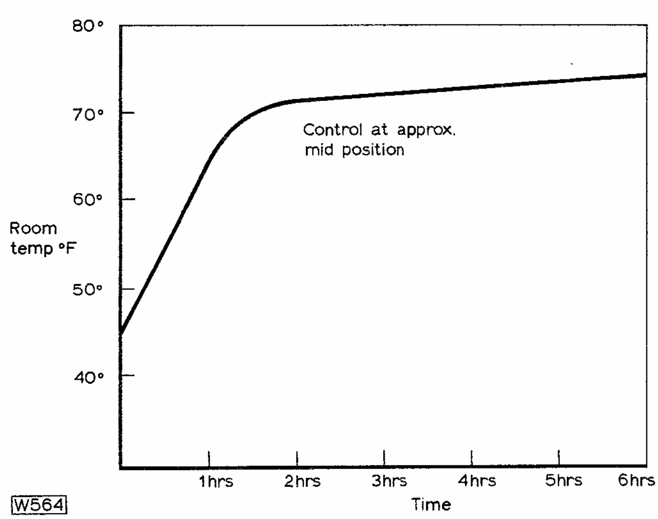


Fig. 6: Further graph indicating stable temperature level at mid-control position.

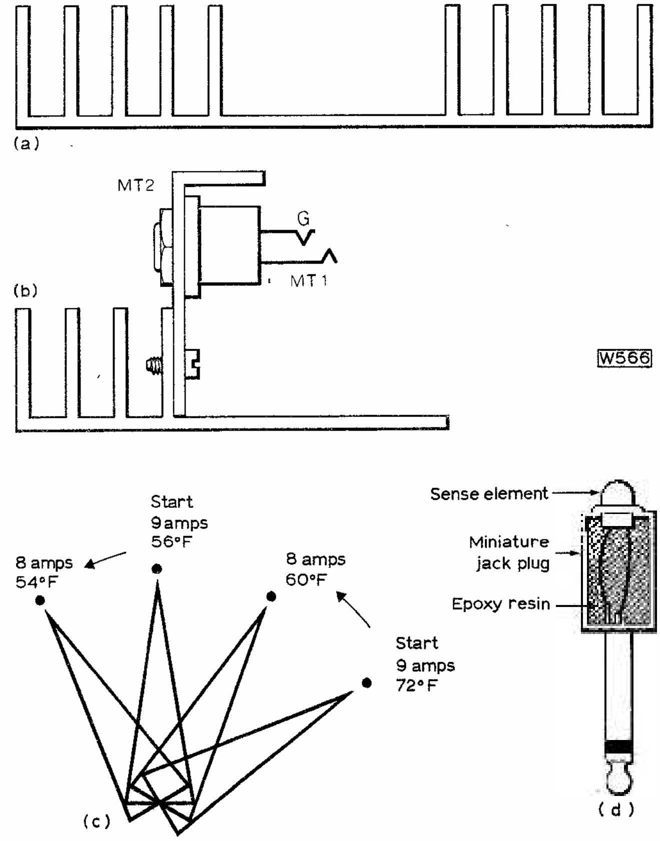


Fig. 7: Details of heatsinking for triac (7a and 7b), method of mounting thermistor (7d), and chart to show the approximate link between current and temperature conditions in the circuit environment (7c). C5 and R6 are mounted on T1, using the shortest possible leads.

Construction

Reference to **Figs. 3, 4** and **7** will show the method of construction. First and foremost it must be mentioned that mains voltages are being dealt with and a reasonable amount of care must be taken during construction. To ease the construction it is recommended that the approved P.C.B. is used i.e. Readers P.C.B. services, to minimise wiring errors. The assembly of the P.C.B. should be carried out first. The I.C. should be mounted in an I.C. socket. The case of the prototype was made out of aluminium extrusion, as used in shop fitting work, but any metal box of rigid construction and adequate size could be used. The unit could in fact be mounted flush to the wall, the brickwork giving added heatsinking to the triac. All leads should be kept away from the 6·8k 10 watt resistor. When mounting the triac, it should be fastened to its own heatsink, using the correct insulating kit. Figs. 7a and 7b show the mounting. The sense element in the prototype was mounted in a miniature jack plug. using epoxy resin, see Fig. 7d. There is no reason why the sense element should not be remote from the unit, say in its own small box. This however could possibly interfere with the fact that the unit is normally a portable accessory to an electric fire. If all the correct components are used there is no setting up of the unit to be done, but emphasis must be made here on checking wiring to the P.C.B. to eliminate damage to the I.C. Short circuits around the triac should be checked for, and also to make sure the case is adequately earthed.

stray signals

by POINT CONTACT

Were the summers sunnier, the blooms bigger and life more exciting when you were younger? Was the beer better, were the steaks juicier and the girls prettier? However that may be, I truly believe that the inhabitants of Research and Development Laboratories were more eccentric. In many instances the pranks they got up to were frankly crazy.

In his youth Point Contact spent varying amounts of time in laboratories which were only concerned with electronics in an oblique way, the immediate object of interest being some kind of material, a dielectric or semiconductor for example. Consequently, they were staffed by a motley mixture of Physicists, Chemists and that invaluable oddity, the Tame Mathematician, as well as the occasional Electronic Engineer. PhDs were two a penny, almost every other person had a higher degree except for yours truly and one or two other undergraduates. Whether as vacation students or student apprentices we were privileged for a period to participate in the work of this or that laboratory—and in the play too!

Some of the antics which people got up to were relatively harmless, some were fairly hazardous to the prankster and some potentially dangerous to others. In the first category I remember the Plasticene ploy. Plasticene (like Meccano) is a valuable laboratory aid with a thousand and one uses, like instant mounting for a specimen, plugging material for pipework etc. It was used again and again until it dried out and was thrown away and replaced. If you wanted some you had only to look around and there on the nearest shelf, in the cupboard, on the bench was a lump just waiting to be used. Of course, first of all it had to be well kneaded to make it soft and pliable again—and here care was necessary. The unwary were caught out by the prankster who had carefully fashioned a hollow lump and filled it with water, usually coloured with red ink, before smoothing over the hole and leaving it on the shelf.

Much more spectacular was the party trick of a certain Dr. K., which with a little prompting he would demonstrate. Pouring some liquid air from the Dewar flask of a vacuum-trap into a 50 ml beaker, he would then solemnly take a sip and roll it round and round his mouth. If one held up a smouldering taper he would breathe on it and it would burst into flame. (As liquid nitrogen boils at a lower temperature than liquid oxygen, it boiled off first, so unless replenished from a new delivery, vacuum-trap Dewars usually contained mainly liquid oxygen, as one could see at a glance from the pale blue colour.) He would then spit out the remainder, which vapourised in a flash on hitting the floor. Despite his assurances that it was quite safe if one kept the liquid on the move with one's tongue, I recount this stunt only to illustrate the statements in my first paragraph. Please DO NOT try it yourself!

Always interested in what components are available and what you can do with them, a colleague drew my attention a few days ago to the RCA fourteen-stage COSMOS ripple counter type CD4020. This divides by up to 2^{14}, so when clocked at 1MHz, produces an output frequency of 10^6 divided by 16384 or 61·03515Hz. A popular proprietary printed circuit board used for bread boarding digital circuits in our laboratory—it has supply rails running round and uncommitted pads for accepting i.c.s with up to 16 pins—accommodates 5 rows of 7 i.c.s. A board full of 35 CD4020s would therefore divide by 16384^{35}, which I am assured is $3{\cdot}196670156 \times 10^{147}$ (to the nearest 10 significant figures). Clock the board at 1MHz and one cycle at the output would reach completion in $1{\cdot}01296376 \times 10^{134}$ years.

This is a good bit longer than Point Contact is capable of imagining, in fact if just four CD4020s had been switched on in the year AD0, then given a long-life battery and assuming a rather good MTBF (mean time before failure) for all the components including the 1MHz clock oscillator, there would still be another 305 years to go before the output of the last i.c. clocked over!

The said colleague came back the next day with the further useful(?) information that there is a Motorola device number MC14521 which is a 24-stage ripple counter and that a boardful of 35 of these would have an output period (when clocked at 1MHz) of 10^6 divided by $7{\cdot}331559403 \times 10^{252}$ seconds or approximately $2{\cdot}3 \times 10^{239}$ years. A suitable long-life battery not being available, solar cells wouldn't help much either, he assured me, as the sun is expected to have burnt out in the odd 10^{10} years or so. Figures like these are so meaninglessly incomprehensible that the only thing to be said of them is that they do demonstrate the ample capacity of my informant's all-singing all-dancing scientific pocket calculator. ●

KINDLY NOTE!

Jubilee Organ Part 3—November 1977 issue.

Page 506: In describing the interim keying tests a mistake was made in the text. When the flying lead is connected to the +12V point (positive end of C8) the note is inhibited. It is when the lead is removed from this point that the note will sound and it is under this condition that VR5 should be adjusted. Re-applying the 12V will terminate the tone according to the sustain setting of VR6. When S2 is open the tone burst will occur when the flying lead is REMOVED from the 12V point. The same reversed logic would apply to testing the repeat percussion effect.

AERIAL PERFORMANCE TEST SET

F. JUDD Assoc. IPRE A. Inst. E. G2BCX

Transmitting and receiving aerial performance is difficult to measure with any degree of accuracy particularly when the operating frequency is low and the aerial is, of necessity, very large. At frequencies as high as 28MHz (10m band) one would find it physically impossible to plot the vertical angle radiation pattern, or indeed the plane polar pattern, with the aerial operating in either vertical or horizontal polarisation mode. At 145MHz (2m band) the problem is eased somewhat since the aerials are physically small but even then they need to be mounted very high in order to obtain true "free space" radiation patterns. Further, the transmitted signal source must be a large number of wavelengths away and/or the receiving point must be at a similar distance if the aerial being tested is radiating.

It is usual to test an aerial under receiving conditions; the final result is the same. The writer has in use a 60ft high mast that can be lowered to half way so that 2m aerials for testing can be mounted on a special rotator system that will turn the aerial through 360° as well as from horizontal to vertical mode. The system is remote controlled from the measuring instrument position and the distant transmitters normally used are GB3VHF for horizontally polarised signals and GB3PI, or local amateur stations for vertically polarised signals. Even so, the process of carrying out polar pattern and gain measurements is laborious to say the least, and indeed somewhat hazardous, especially when large beams (a recent one was a 12-element ZL Special) have to be hoisted to a small platform about 30ft above ground before being raised to full height for tests. On new designs there is the added problem of making modifications, so an aerial may have to be hauled up and down several times before the design can be approved.

The Theory of Similar Structures

It is well known that aerials scaled down in frequency behave in exactly the same way as they would at the original frequency. At one time the writer used a frequency of 10000MHz to operate a model aerial system capable of obtaining quite accurate polar patterns of both plane and vertical radiation fields. At such a high frequency however, impedance matching, with any degree of accuracy, becomes very difficult indeed.

The "theory of similar structures" is applied in many spheres of engineering. For example, for proving ship's hulls by using scaled-down models in wave tanks, models of aircraft in wind tunnels and models of bridge structures etc. It is readily adaptable to transmitting aerials and if we take a dipole for example, its familiar figure-of-eight radiation pattern is exactly the same whether the aerial is cut to operate on 2MHz or 200MHz, or any other frequency. This applies, of course, to aerials of all other configurations and to directivity, gain and polarisation as well.

The author's aerial measurement set-up, with aerial under test mounted on a turntable, plus a pen chart recorder.

Scaling down makes the aerials much smaller, easier to construct and handle, reduces the distance between the source of transmission and the aerial being tested, and brings the "free space" position much nearer the real earth. If the effect of earth is required as part of the measurement then a metal ground plane of several square wavelengths extent is no great problem. As mentioned however, if the scale frequency is too high matching the aerial to its feed point becomes a problem and to overcome this frequencies of between 600 and 1000MHz are commonly used.

Some years ago the writer used 800MHz for the original design of the "ZL Special" end-fire beam for operation on 14 and 28MHz and which was described in *PW* recently for 2m operation. At frequencies around those mentioned quite accurate matching is possible, materials for constructing the aerials can be scaled down, as can transmission lines, matching stubs and baluns etc. Even "miniature" co-axial cable, with little loss up to around 1000MHz, is readily available.

A Model Aerial System

A system recently built by the writer and described here operates at a frequency of 650MHz and, as with virtually all systems of this nature, aerials being tested are operated in receiving mode. The transmitter is normally placed at a distance of 10 wavelengths, in this case 4·6m, and it is equipped with a three-element (flat plane reflector) beam aerial to concentrate the radiation forward, to provide a sufficiently large illumination area and to reduce reflected signals to a minimum.

The "receiver" consists basically of a simple diode detector to provide a DC voltage from the RF signal picked up by the aerial being tested and which is used (a) to operate a pen chart recorder to obtain either polar co-ordinate or Cartesian co-ordinate plots of radiation patterns or (b) a continuous direct display of a radiation pattern in polar or Cartesian co-ordinates on an oscilloscope screen.

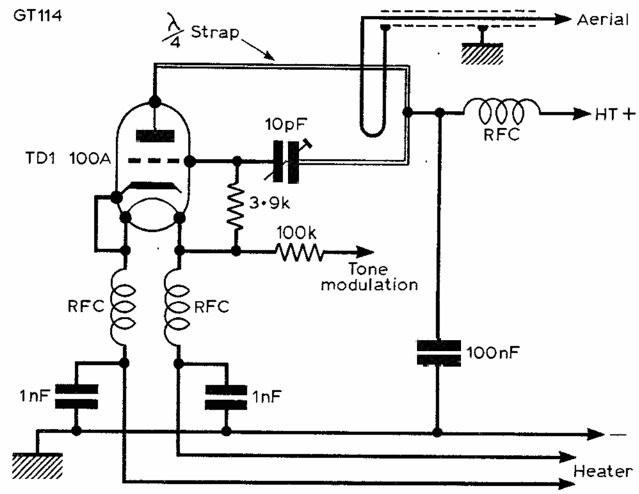


Fig. 1: Circuit diagram of the author's 650MHz transmitter.

The Transmitter

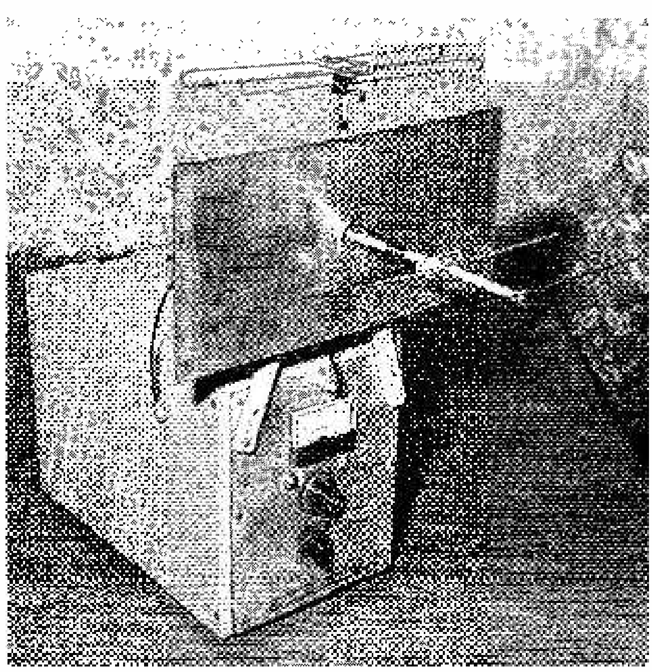
The transmitter is a simple self-excited oscillator using a Mullard TD1-100A valve to provide an RF output at 650MHz of about 2W. Any similar UHF valve would do and frequency stability is not critical provided drift is not more than a few MHz. Audio tone modulation can be applied for quick checks and for demonstration, in which case the model is made to radiate and the space around explored with a single dipole and diode receiver the signal from this being fed to an audio amplifier and speaker. The transmitter must, of course, be completely screened and its output (loop coupled) matched as closely as possible to the transmitting aerial. The circuit used is shown in **Fig. 1** and may serve as a guide to anyone interested in embarking on a similar project.

The Measuring System

This system is rather complex in view of the facilities it provides but could be simplified by using a meter to obtain readings for plotting patterns and checking gain, in which case the receiver need consist only of a diode detector, the DC output from this being fed to a micro-ammeter via a simple attenuator.

One of the most important factors in aerial performance measurement is the "reference" to be used and this is normally a dipole. For example, in gain measurement the dipole is first set up and the signal level from this noted. It is then substituted for the aerial to be tested and the level from this ascertained. If the readings are in terms of voltage then the usual formula $20 \operatorname{Log}_{10} \frac{V2}{V1}$ is used to obtain the gain in dB. In the system described here a rather more sophisticated reference system is employed, particularly in connection with continuous oscilloscope displays and this uses an "electronic dipole" to be described later.

The block diagram **Fig. 2** gives some idea of the complexity of the system, which begins at the aerial being tested, picking up the signal from the transmitter. This is coupled by a rotating loop to the detector and the received signal is rectified, the output being switched to obtain positive or negative (with respect to earth) DC which is fed to a calibrated attenuator. From here the signal goes to a pen-recorder for Cartesian or polar plotting, to a meter for making initial adjustments, or to the oscilloscope DC "Y" amplifier for direct display of Cartesian plots (see various photos). The aerial and polar plotting table are turned by either of two synchronous motors with suitable pulley and/or gear reduction to obtain (a) a slow rotation at about 1 revolution per 30 seconds for pen chart plots or a fast rotation for oscilloscope displays at between 5 and 8 revolutions per second. Directly coupled to the aerial turning shaft are (a) a system for obtaining a sync pulse for each 360° of rotation and pulses for each 10° of rotation which are used for Z modulation (scope "bright up") pulses and (b) the components for generating the electronic dipole signal. The sync and 10° marker pulses are obtained by a light shining through small holes in a perspex disc (painted black)



The 650MHz test transmitter with its 3-element aerial mounted above it.

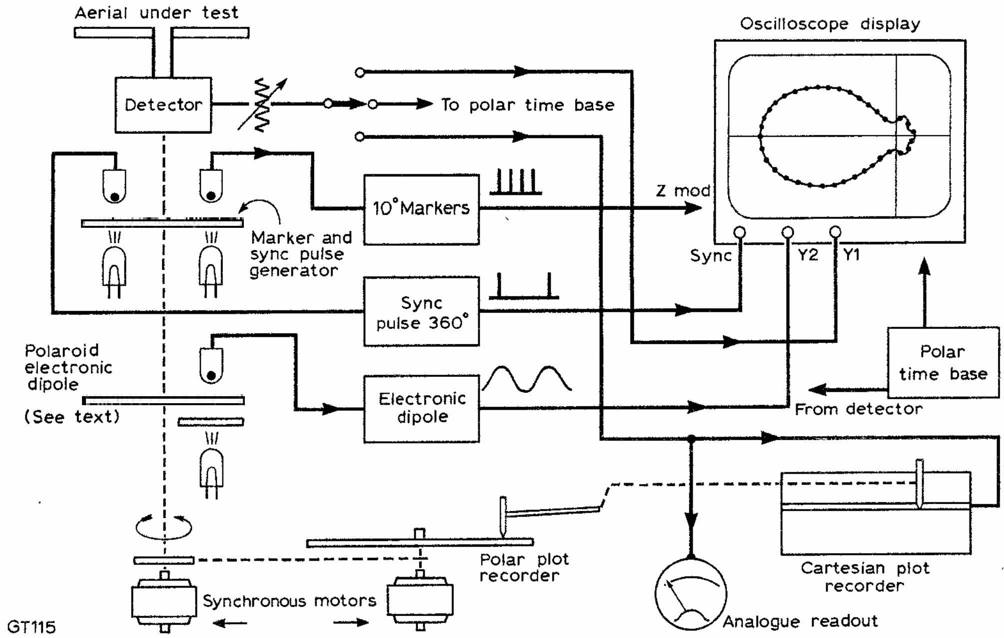
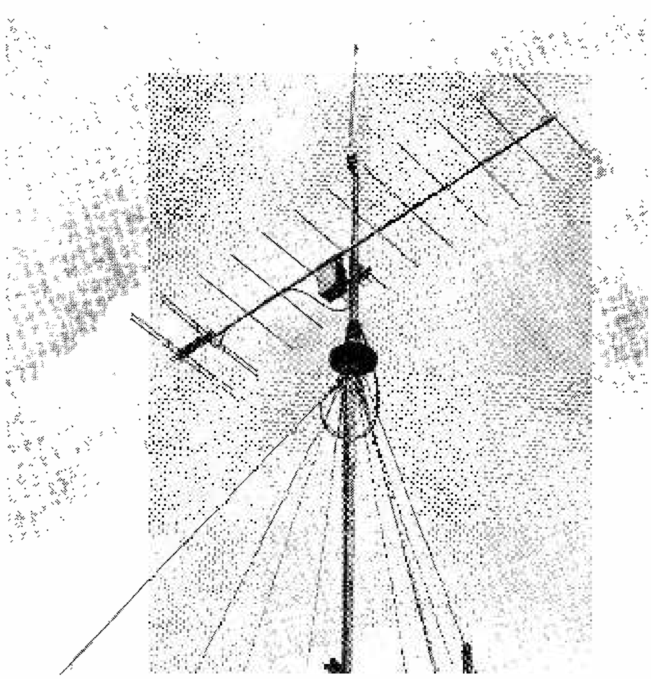


Fig. 2: Block diagram of the performance measurement system.

on to photo transistors, the outputs from which are amplified and shaped into short duration pulses. The disc contains 36 holes for the 10° markers and one for the 360° sync pulse.

The electronic dipole signal is obtained by shining light through a rotating disc of Polaroid material and a fixed piece of Polaroid simultaneously on to a photo transistor. As the light fluctuates sinusoidally the transistor generates two "sinusoidal" DC voltages per revolution, the equivalent of the radiation pattern from a dipole in Cartesian co-ordinates, see **Fig. 3.** The signal is coupled to the Y2 DC amplifier on the oscilloscope via an attenuator so that the level can be set against that from a real "reference" dipole and, of course, retained and displayed simultaneously whilst an aerial is being tested.



A 12-element "ZL Special" mounted on the rotator system atop the author's 60ft mast.

An additional feature in progress of being developed is to provide the oscilloscope (an Advance model OS250) with a controllable circular time base; controlled, that is, from the aerial signal to provide continuous display of patterns in polar form as depicted in the block diagram.

Examples of Pattern Plotting

First some examples of plots from the oscilloscope in Cartesian co-ordinate and, apart from the dipole, I have taken one or two of the aerials described in my articles in the *PW* July 1976 and May 1977. The pattern from a real dipole is shown in **Fig. 4** and, as can be seen, compares very favourably with the "electronic dipole" readout in **Fig. 3.** Each bright spot represents 10° of rotation, through 360°. Now examine the scope readout, **Fig. 5,** from the "ZL Special" end-fire beam described in *PW* May 1977, operating in horizontal mode. The two minor rear lobes are displayed to the right and left respectively. Compare this with the polar co-ordinate plot in **Fig. 6** taken from the same aerial and with the same equipment.

The $\frac{5}{8}\lambda$ ground plane is a very popular aerial but it is not as efficient as one would suppose due to its high-angle radiation. It is omni-directional and, ideally, maximum radiation should be parallel to the ground. As the vertical angle pattern **Fig. 7** shows, maximum radiation is at an angle of about 30° and although some gain is obtained from this aerial over a conventional $\frac{1}{4}\lambda$ ground plane it is wasted in an upward direction. In fact the "gain" on a line parallel to the ground is negative with respect to a vertical dipole. The oscilloscope readout **Fig. 8** shows the same pattern in Cartesian co-ordinate.

Performance Defects

With this system of testing all kinds of defects in performance can be seen readily. Taking again the $\frac{5}{8}\lambda$ ground plane, its normal omni-direction pattern

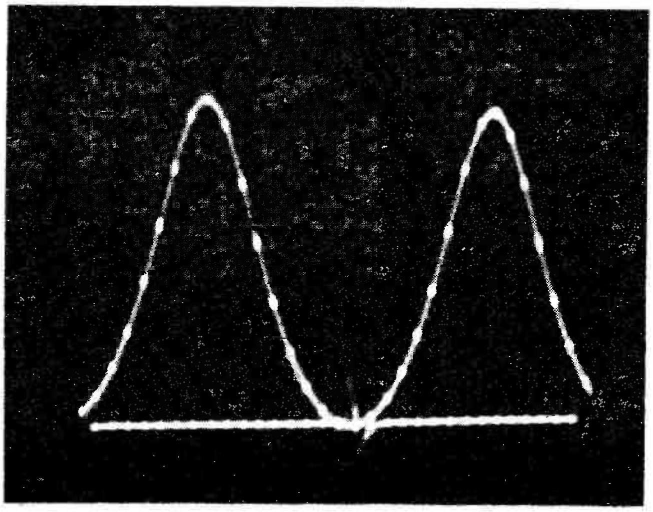


Fig. 3: Oscilloscope Cartesian plot of the "electronic dipole". (See text)

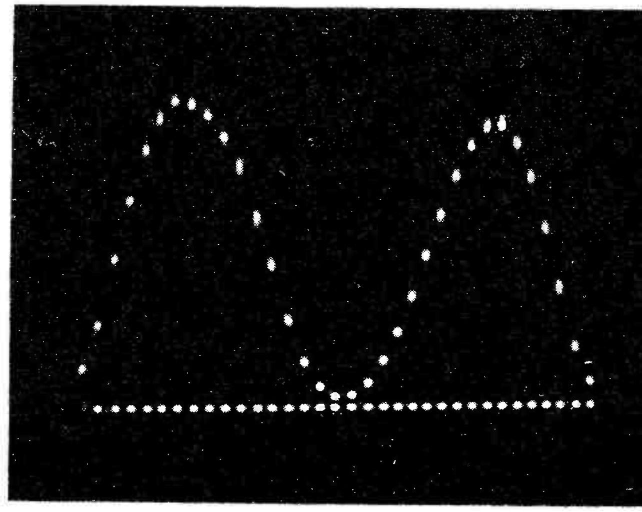


Fig. 4: A Cartesian plot of the response pattern of a real dipole.

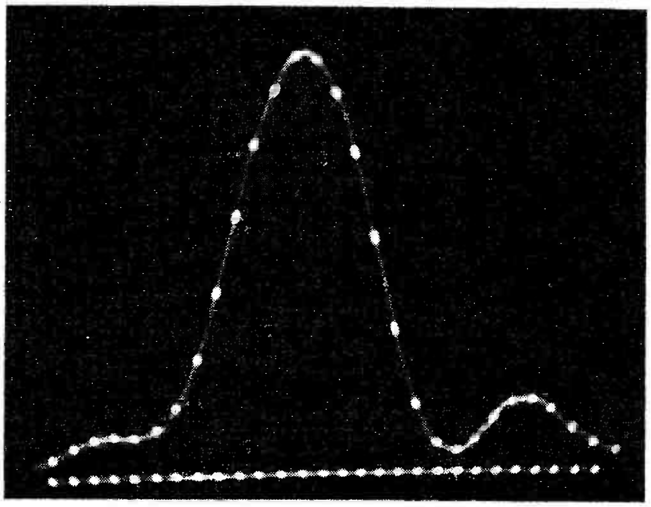


Fig. 5: Cartesian plot of the response pattern of a "ZL Special" array, operating in the horizontal mode.

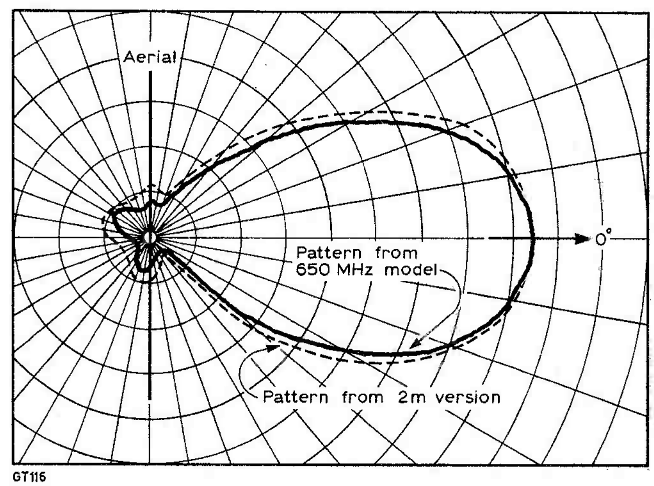


Fig. 6: A polar co-ordinate plot of the aerial of Fig. 5, plotted using the pen chart recorder.

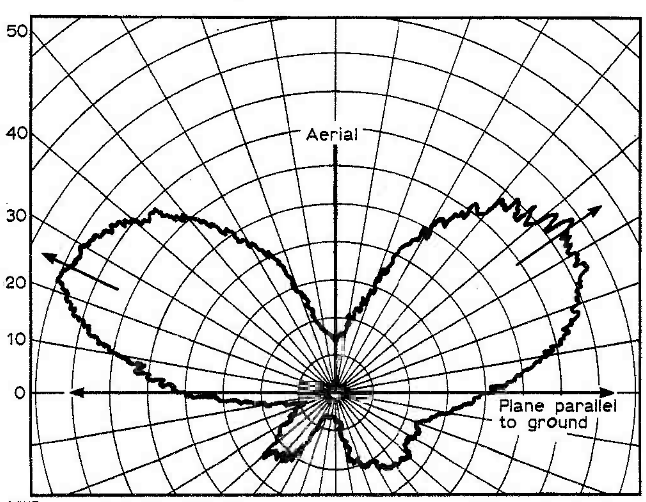


Fig. 7: Vertical radiation pattern of a $\frac{5}{8}$-wave ground plane aerial.

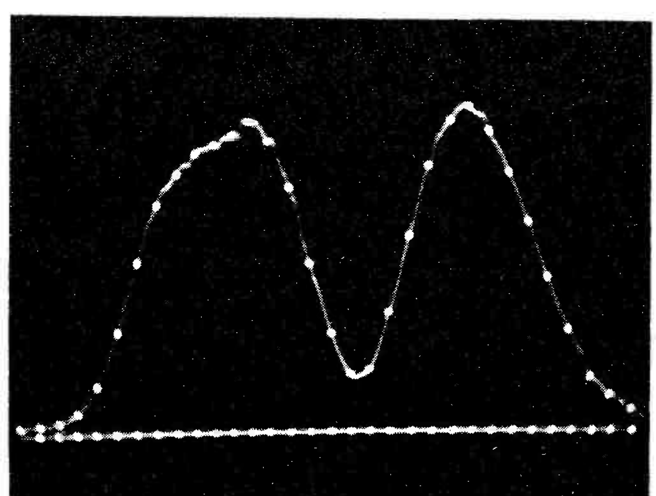


Fig. 8: Oscilloscope Cartesian plot of the response of the aerial of Fig. 7.

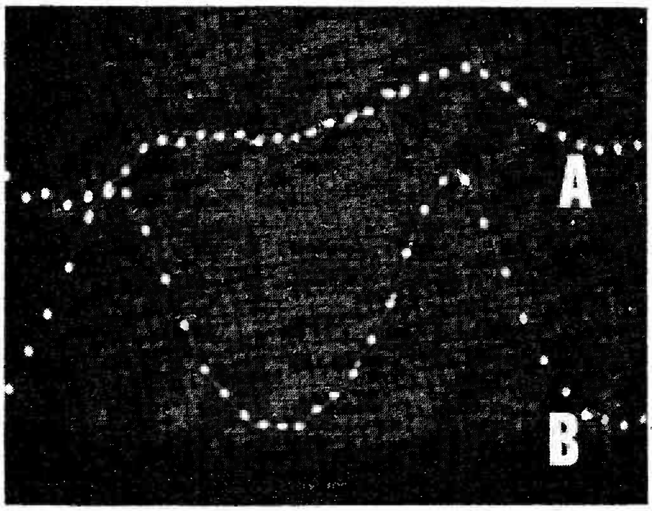
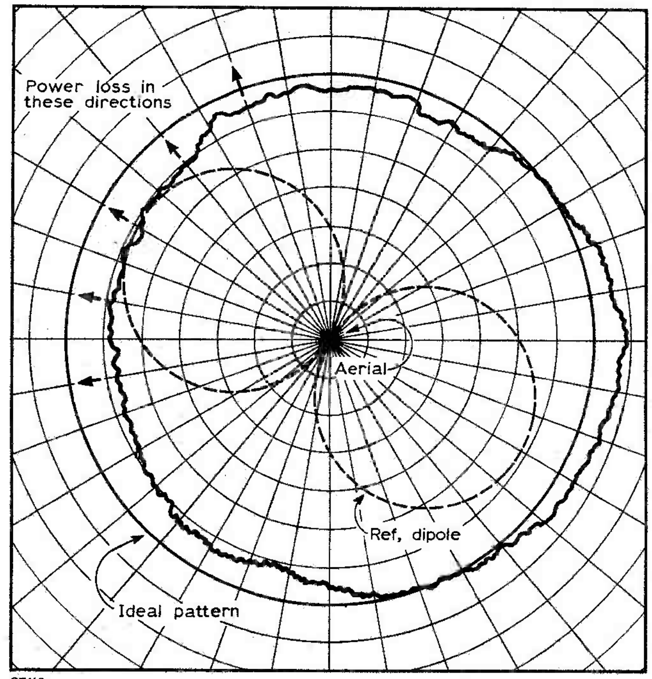


Fig. 9: Trace A shows the distortion of the radiation pattern of an omni-directional aerial due to a nearby resonant conductor. Trace B is a reference dipole.

Fig. 10 (right): The polar co-ordinate plot of the set-up of Fig. 9.



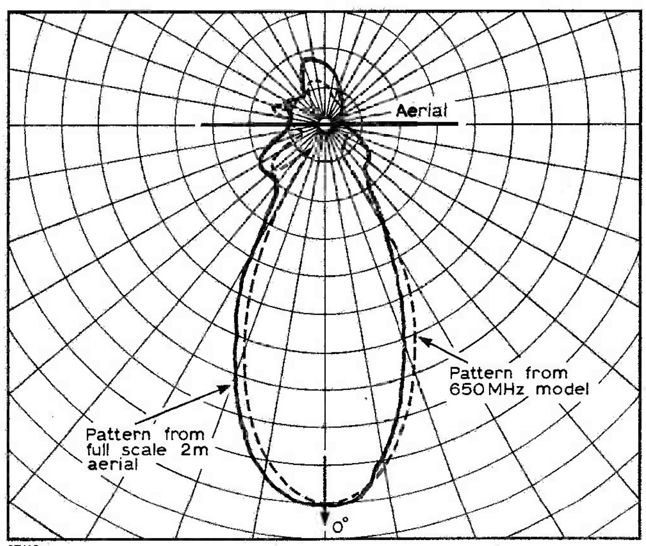


Fig. 11: Horizontal radiation patterns of two 12-element "ZL Special" aerials.

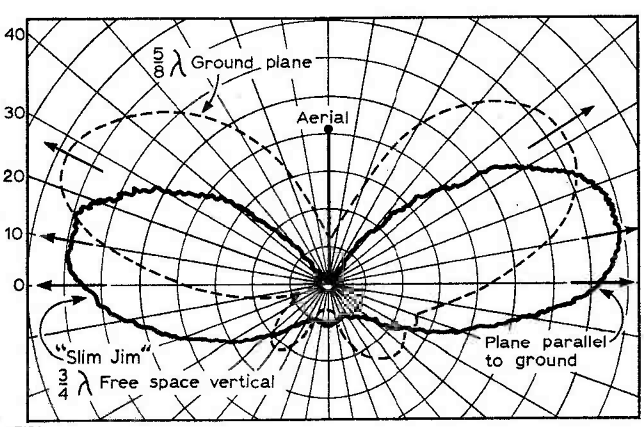


Fig. 12: Comparison of the vertical radiation patterns of a $\frac{5}{8}$-wave ground plane aerial and the $\frac{3}{4}$-wave "Slim-Jim".

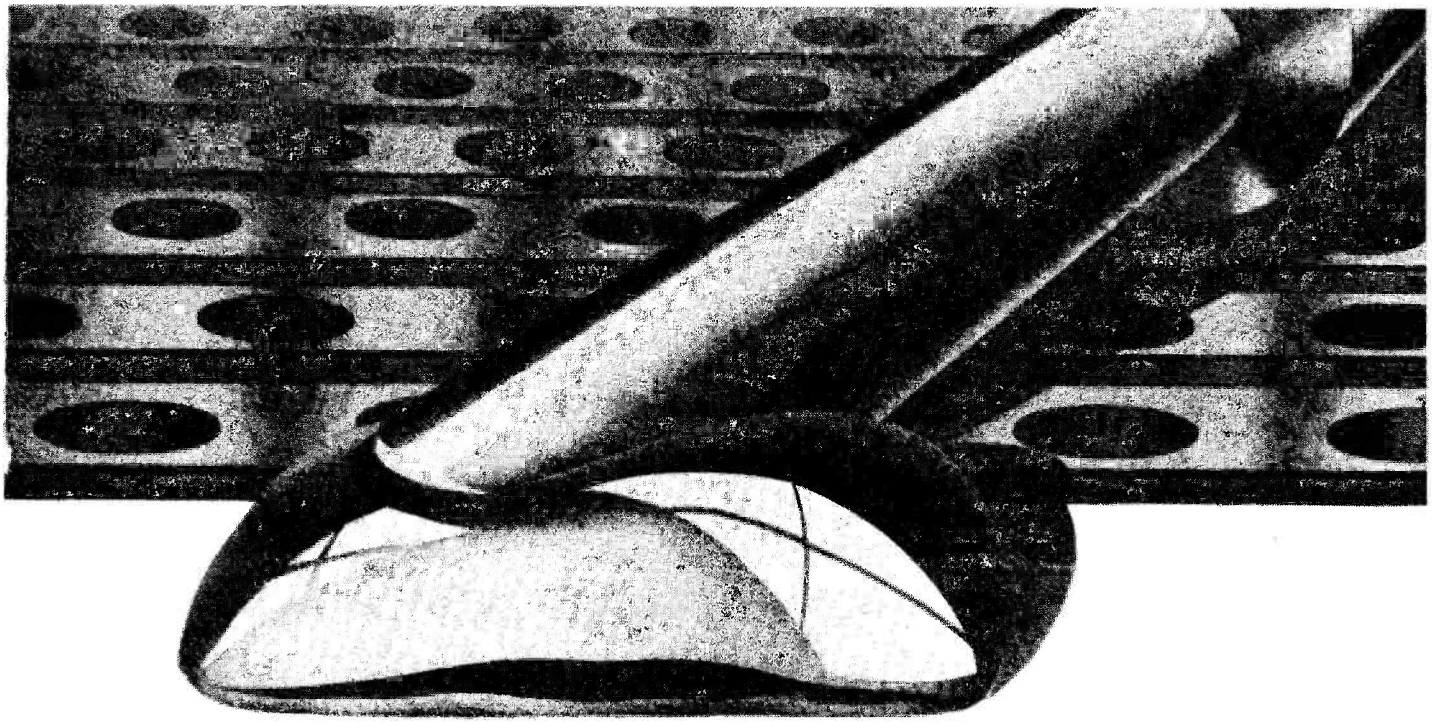
should be a circle if the aerial were behaving perfectly. If a mismatch exists, or the aerial is off resonance, the pattern can become distorted i.e., not a perfect circle. The presence of other resonant conductors will also produce this effect. The oscillogram **Fig. 9** shows this quite clearly. The lower trace (B) is a reference dipole pattern. The upper trace should be a straight line, therefore there is a loss of radiated power in some directions. The result is perhaps more clearly illustrated by the polar coordinate plot in **Fig. 10** of the same aerial with the dipole pattern again for reference.

A 12 element "ZL Special" mentioned earlier, has been developed for operation on 2m and is now operational at G2BCX, the home station. This aerial started out as a 650MHz model and after adjustment and a few modifications to director spacing and length, yielded a gain (over a dipole) of 14dB. The 2m version is physically much smaller than a Yagi array having the same gain. Its radiation pattern, actually plotted operating on 2m is shown in **Fig. 11** by comparison with the pattern obtained from the 650MHz model, which is shown dotted.

Slim Jim

Another aerial designed and developed with the aid of the model system is an omni-directional "free space" aerial for 2m known at the moment as the "Slim Jim". It has no ground plane radials and is vastly superior to a $\frac{5}{8}\lambda$ ground plane, due to the radiation being almost parallel to the ground. The vertical angle radiation from the full scale 2m version is shown in **Fig. 12.** Compare this with vertical angle radiation from a $\frac{5}{8}\lambda$ ground plane shown dotted in the illustration. Details of both these 2m aerials will be published in the not too distant future.

To anyone contemplating setting up a test system of this nature I must emphasise that the task is not an easy one, but the results, if they are reasonably accurate, are highly rewarding. ●



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DESIGN YOUR OWN PROJECTS

No.5

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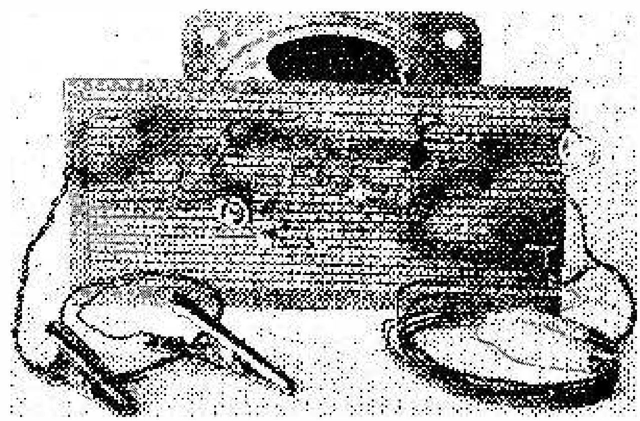
TOBY BAILEY & BOB WHITAKER



In part one of this series of articles we mentioned that many of the circuits that we would be describing were going to be "one off" affairs. By this we meant that every circuit built to our specification may not necessarily work first time, without some playing about with component values. In fact this is also true of designs which are far more "respectable" than our examples! The audio amplifier in part 4 should work every time whereas the courtesy light extender of the previous month probably needs different values of timing capacitor to cater for the spread in gains of the transistors.

In passing we would recommend that if you don't spend a reasonable amount of time experimenting with simple circuits like this one, then now is the time to start. It's one of the best ways of learning about electronics in practice, as of course is reading this series!

Perhaps it's time now to stop philosophising and get down to business. The circuit for this month stems from the problem of finding which wire is which in wiring harnesses and cables. Wires always seem to end up being coated with nasty mixtures of dust and gunge and usually end in the most inaccessible places. The result of this is that "colour coded" wires can appear identical to one another and that you sometimes need to be a contortionist to hold the meter probes and simultaneously look at the meter needle. To put an end to this ritual we are going to go through the design of an audible continuity tester as this month's project.

A little while ago we saw a design for such a device which pointed out the merit of using a low testing voltage (about 0·2V) so as to avoid seeing forward biased semiconductor junctions as short circuits. Although this seems a good idea the circuit was implemented with five transistors and a Zener diode—we felt that this was rather excessive so this month we will start from scratch and "design our own".

Specification

We want to use a 4·5/5V supply, so that we can either use batteries or the 5V supply which we use for driving most of the instruments on our test bench. The device should use a low testing current—certainly no more than about 5mA—and should treat a forward biased germanium junction as an open circuit. The standby current should be as low as possible so that when the tester is left on for a few hours/days/weeks it doesn't precipitate a major energy crisis.

Design

The major problem we have to deal with is the magnitude of the voltages we have to sense. To push three or four milliamps through a forward biased germanium junction is going to need around 0·4V—we realise that the "turn on point" is usually stated to be around 0·2-0·3V but at 4mA it will be a bit more. Now sensing 0·4V is going to be quite difficult and the best solution seems to be to use the sensitivity of a transistor, at the point where it is switching on, to "catch" the small voltages in which we are interested. By far the most convenient way to do this is to work out a way of converting the input signal of a fraction of a volt into a signal of several volts, which we can then use to switch an oscillator on or off.

Early ideas

Initially all our thoughts were directed towards putting the sensing circuit in the supply to the base of the transistor. **Fig. 1** shows one of our first circuits.

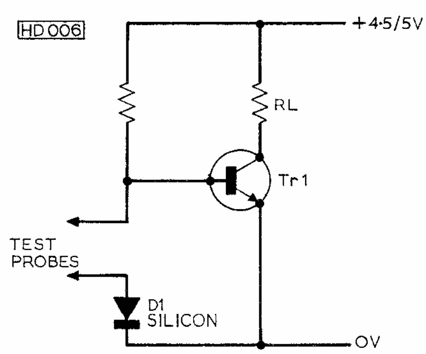


Fig. 1: The start of the design.

The idea is that the diode turns on a little before the transistor so that if the test probes are shorted together then the diode steals all of the base current from Tr1 and turns it off. If however there is a significant resistance or a junction between the probes then Tr1 will keep its base current and stay turned on.

Now this circuit has all sorts of problems in reality, but the one which caused us to abandon this circuit is that it will gobble up current at an alarming rate during standby. If the collector load resistor R1 is made large so as to reduce the quiescent current then Tr1 will be heavily saturated and hence difficult to switch off.

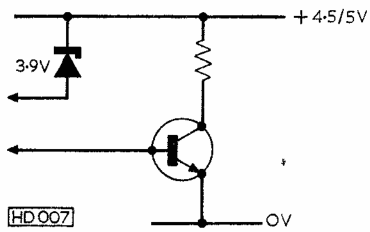


Fig. 2: A possible development using a Zener diode.

An alternative solution is to play around with Zener diodes, which alleviates the current problem (see **Fig. 2**). We don't like this idea since, by the time you have allowed for the +5% Zener tolerance (+0·2V) and for about half a volt difference between a full battery and a half empty one, the build up of tolerances will produce a bit of a mess.

Anyway, whilst we were thinking about this method, we had a bright idea: why not put the sensing element in the emitter and stabilise the base voltage—which can be done roughly with a couple of diodes? **Fig. 3** shows the sort of idea we are getting at—it seems altogether a lot better. The current consumption with

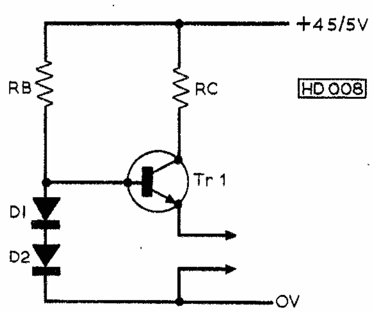


Fig. 3: A more effective modification involving two diodes.

the probes open circuit need be little more than the base current required to turn on Tr1—only a microamp or two. We will have to decide about the diodes by experiment but doubtless we can trim up the final circuit with a preset potentiometer. To check that this circuit is feasible suppose that we achieve an emitter voltage of 0·3V and that Rc is say 1kΩ: if we short the probes and ensure that Rb is sufficiently small then Tr1 will saturate, whilst if we connect a 200Ω resistor across the probes then a current of about 0·3/200=1·5mA will flow which means that Rc should drop only 1·5V. This all looks very promising.

At this stage in the proceedings we can make intelligent noises about how, since we want voltage gain and aren't particularly fussed about the current gain, a common base circuit (which this is in essence) is going to be at least as useful as a common emitter circuit (which the others were). We feel that whilst this sort of observation may be quite interesting it is not particularly useful and we certainly will not follow the scientific tradition of covering up the luck and inspiration involved by pretending that the circuit was arrived at in this way.

The Oscillator

Having got so far perhaps we should turn to the design of the oscillator. Some sledgehammer solutions spring to mind, such as using a transistor or two to amplify the current available and use this to supply a multivibrator or something. With a bit of thought we can do better than this. What about using the output of Tr1 to control the bias supply to a one-transistor oscillator—something like **Fig. 4**

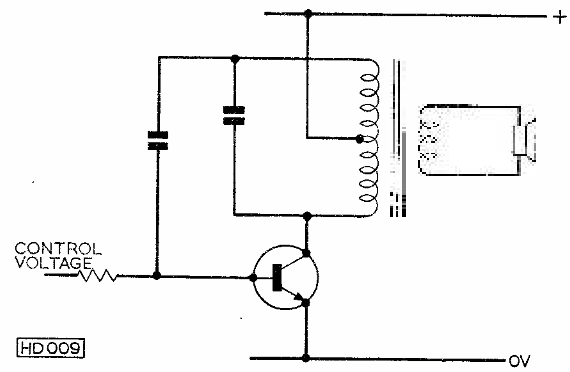


Fig. 4: Here the circuit has grown into a Hartley-type oscillator.

This may well work but we have a solution which we think is even better. The complementary pair type oscillator in **Fig. 5** works as follows. Assume that both transistors are turned off—then C will start charging up via R and the speaker. Soon Tr1 will begin to turn on; this turns Tr2 on and the current through the speaker raises the voltage at that end of C.

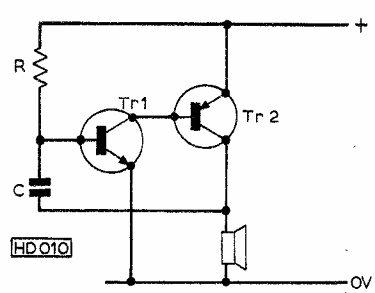


Fig. 5: An oscillator involving a complementary pair.

Now it is one of the fundamental principles of electronic circuitry that you cannot change the voltage across a capacitor instantaneously. This means that the voltage at the other end of C is pushed up even higher and so even more current flows. Eventually the capacitor loses all its charge and the current through the transistors starts to drop. Provided that the component values are within a certain range (which is very wide and we won't worry about it here) the capacitor will drag the base of Tr1 down sufficiently far to turn off both transistors again. The cycle can then be repeated. The current through the loudspeaker, which should be a low impedance type, flows in short pulses but is of sufficient magnitude to make a fair noise.

The major point of interest that this circuit holds for us is that the resistor acts merely as a charging source for the capacitor. If we take the supply-rail end of R and connect it to a variable voltage source, the oscillator won't run when the voltage is zero and will oscillate as before when the voltage is equal to that of the supply rail. Somewhere in between these two extremes it will struggle into life and a little experimentation with the circuit on a T-Dec showed that this occurred with R=1MΩ and C=1800pF at around 1·5V.

If we connect R directly to the collector of the sensing transistor in Fig. 3 we will in fact have produced a resistance tester which will make a noise only when we haven't got continuity. Although this works it is not what we wanted when we drew up our specifications. Never mind, we can turn the circuit of Fig. 5 "upside down" if we reverse the polarity of both the transistors—the two circuits can then be fitted together as shown in **Fig. 6.** We have tapped the resistor to the oscillator from the potential divider of R2 and R3 so that we can arrange for Tr1 to be near saturation before the oscillator switches on. We have also put a preset potentiometer in the base of Tr1 to trim the circuit for maximum sensitivity. We could have put it in series with the probe leads, but let's leave it where it is for the time being.

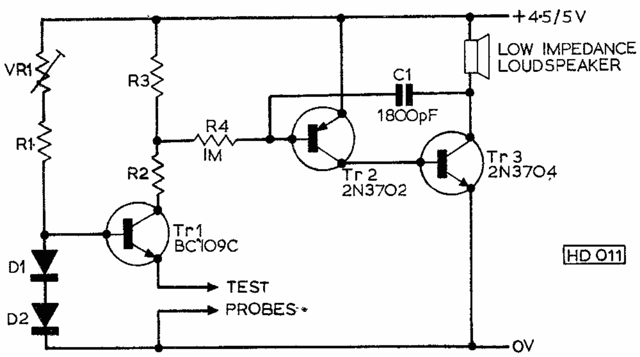


Fig. 6: The "combination" oscillator circuit.

Component values

Perhaps we should justify some of the component values in Fig. 6 which have already been decided. R4 was chosen as 1MΩ because our experiments with the oscillator showed that this value worked well. C1 is 1800pF because this value made a nice noise. As for the transistor types: the 2N3702 and 2N3704 are simply cheap general purpose types and we chose a BC109C for Tr1 because it has high gain which will mean that we need less current in the R1-VR1 circuit and this in turn means lower standby current. What now? Well the best thing to do is to build the circuit on a T-Dec and experiment with the values of the other components.

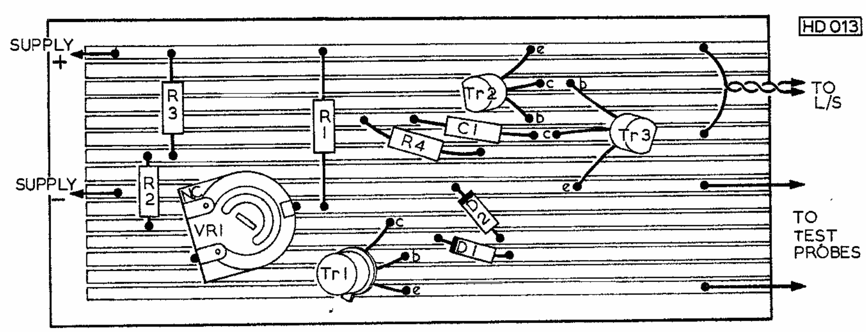


Fig. 8: A practical layout for the continuity tester.

Where do we start? We wanted a sensing current of three or four milliamps maximum so we want R2+R3 to be in the region of 1·5kΩ. We already know that we want about 1·5V drop across R3 when Tr1 is saturated, to drive the oscillator. A little experimentation showed that when R3=470Ω and R2=1kΩ the voltages were about right. Then we dug out a 500kΩ preset and soldered a couple of leads to it so that we could plug it into the Dec. R1 was chosen to be 270kΩ on the grounds that we can't possibly want more than about 70µA of combined base and diode current. The circuit was then tried without any diodes to make sure that the oscillator oscillated when the probes were shorted and stopped when they were open circuit.

We then experimented with the diodes. It turned out that with one silicon and one germanium diode in series the transistor could not be persuaded to turn on significantly at all, even with the VR1 on minimum. With two silicon diodes in series we couldn't turn the oscillator off when the probes were shorted. This is a disadvantage, as maximum sensitivity is obtained by adjusting VR1 so that the oscillator is just turned

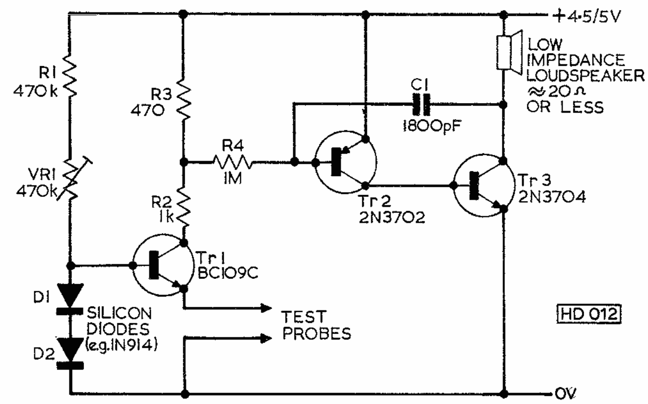


Fig. 7: The circuit of the completed design.

on when the probes are shorted. Increasing the value of R1 to 470kΩ rectified this deficiency.

Having set the circuit to the correct operating point with a 4·5V supply we found that resistances of more than about 20Ω did not register as shorts, neither did a selection of germanium junctions in diodes and transistors. The 20Ω figure was rather better than we dared expect and even when the supply voltage was increased to 5V there was little degradation in performance. The complete circuit diagram is shown in **Fig. 7.**

Flushed with success we transferred the whole circuit directly from the Dec to a piece of Blob Board. A practical layout is shown in **Fig. 8.** If the transfer is done component by component then the whole process is very fast and you don't have the problem of losing the components among the general chaos of the work bench. We then attached a pair of old probes to the unit along with two leads for the battery.

How you house the finished unit is very much up to the individual constructor, and will depend on whether you want to carry it around in your tool-box or mount it permanently somewhere on the work bench. ●

POTENTIAL BREAD or WRITING FOR PW!

In the January 1976 issue of *PW* we published an article entitled "Want Some Lolly"? which laid down the guidelines for budding authors. The response at the time, and for some time afterwards, was most encouraging so we feel that another similar, but updated, article could be of profit to magazine and readers alike.

First of all, don't imagine that just because you are a genius at developing and constructing electronic circuits you cannot possibly write them up as well. If you go about it in the right way, you can, and get paid for it! You have only to look at any copy of *PW* to see the style we use for technical articles and then copy that. What could be simpler? The secret is to keep an accurate account of what you are doing, from the word "go". Use a notebook and not odd bits of paper which are easily lost or used, inadvertently, for lighting your pipe!

We can sometimes arrange to help an author by providing him with a prototype board, if he can supply a rough foil pattern. A project built on stripboard can be eminently suitable for conversion to a PCB, and, again, we can usually assist. It is, perhaps, pertinent to point out here that we normally accept articles for publication on a "sole rights" basis. That is, IPC Magazines retain full copyright in the article on publication and payment of the appropriate fee to the author. Note that this includes the design of any PCB in the article. PCB layouts published elsewhere and possibly already the subject of copyright, cannot be accepted as part of an article submitted for publication.

When experimenting with a circuit you are bound to make voltage or current measurements so put these values on the circuit diagram in your notebook. If using an oscilloscope to check waveforms draw these in at the appropriate points, together with their amplitudes, if these have been measured.

If you think that your brainchild is likely to be of interest to the readers of *PW* then drop a line to the Editor with a brief resumé of what it is and what it does. If its appearance is important then a colour snapshot of it can be very informative to the Editor. DO NOT SEND THE PROTOTYE UNTIL REQUESTED!

Assuming that an article is requested what does the Editor want to receive from you? Briefly, the manuscript (MS), components list, plus circuits and constructional drawings. So let us look at these requirements in detail.

1. The MS. This should start with a brief introduction describing how the project came into being and what it achieves. If a technical specification is warranted put this on a separate sheet of paper. Next, a description of the circuit/s and how they work, with references to components linked to the circuit diagrams. Adequate constructional information comes next and this should not be skimped. Refer to your drawings as necessary, remembering that we shall be adding our own photographs to assist the reader. Finally, information on the alignment or adjustments that are needed to get the project working properly, together with any notes on snags that may have arisen.

To get a good, clean and presentable MS it is imperative to write it all out beforehand, checking and correcting it as necessary before typing it. A lot of work? Maybe, but then, that's what you are going to be paid for, you hope! Type the MS using double line spacing with wide margins at both sides. Here's a useful hint. Type out a whole line from a technical article in *PW* (September 1977 onwards) and use that as a guide to the length of a line when typing the MS. Type on one side of the paper only and number the pages. Add a cover sheet with your name and address, name of article and approximate number of words.

2. The Components List. This is very important and it must be accurate. Component values and references must agree with the circuit diagrams. All components should be readily available to the home constructor, but any "difficult" ones should have at least one source of supply quoted. Look at *PW* to see the required form of the components list. When working on a project see if the relatively unimportant components, such as decoupling components, cannot be rationalised to reduce the number of different values used. Because you have used odd values from your junk box these should not be carried on into the components list. In a big project, a reader can save money by buying similar values of resistors, capacitors etc. in bulk. When you come to reference the components as R1, C1 etc. start at the left and work across to the right. Look at *PW* for our style of numbering and, in particular, note that an IC my be split up on the circuit diagram and shown as IC2a, IC2b and so on but in the component list IC2 is sufficient.

3. The Drawings. All circuit diagrams, constructional drawings, graphs and the like must be on sheets of paper separate from the MS. Circuits only need to be clear and accurate and not works of art. We re-draw them anyway, so don't waste time on unnecessary elaboration. Avoid small, crabby circuits with hard-to-read component values. Naturally, circuits should agree with the working prototype but if you do make any last minute alterations don't forget to amend the circuits! If you are not too happy about your draughtsmanship then try using graph paper, it can be a great help, though sometimes poses problems when photo-copied.

Comes the day when all the bumph is ready but there is just one more very important job to do! Get it all photo-copied! The Editor, or whoever is handling the article, may, almost certainly, want to raise a point or two at some time or other but it will be a waste of time if you haven't got a copy of everything. When you post it to the Editor it is a good idea to send it Recorded Delivery.

General notes

If you don't want to have your name shown on the article when published then tell the Editor in your covering letter and suggest a nom-de-plume. If you happen to have a string of letters after your name don't be modest, we like to print them. It's good for our ego!

Ah, yes, payment! When the Editor gets the first copies of the issue containing your epic he will sit down and assess all the contributions for payment. In a couple of weeks you will get a docket to sign and return to our Accounts bods. When they get it they will issue a cheque in payment and suddenly you will realise that it has all been worthwhile. In the meantime, of course, you will have been working on yet another project for *PW*!

When working on the MS avoid the use of colloquial expressions such as "7 megs" (7MHz), "mike" (microphone), "amp" (amplifier) etc., it is much better to spell them out properly.

Measures should be in the Metric System but it helps to put the equivalent Imperial figures in brackets, especially for items such as boxes, cabinets and the like. There are many people around who, understandably, have not yet been able to come to terms with the Metric system.

If you are clever enough to supply photos, ensure that they are half-plate, black and white and properly identified but, frankly, we much prefer to take our own! ●

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

Quite a few reports have accumulated since last month but pride of place must go as usual to a reader who has just got his nice new callsign. **Andrew Work** of Beverley, E. Yorks, often wrote to the column as A9091 but now he is G8NPT and has already been on the air on 2m with some borrowed gear. Regretfully, Andrew has quite rightly decided to forget the code test until his "O" level exams are out of the way next year. Andrew is full of praise for our new RAE series in PW and feels sure it will bring on a new batch of licencees in due course.

Chas. Mason, subject of my November editorial is now GW4GJD and active with a KW Vanguard on CW using a 132ft wire, plus an AR88. Chas. is in a very isolated spot in Pembroke, W. Wales, so the DX potential ought to be excellent. **Simon Robinson** (Stocksfield, Northumberland) was on holiday on the Isle of Mull where he met local GM4EHB. Simon's DX is still not too good, being stuck with an inside aerial around the lamp fittings!

Alan Doherty BR34968 of Portrush, Co. Antrim has not had too much time for DXing but nevertheless found something on all the HF bands. WB6NCO/VQ9 on Diego Garcia was a good find on 15m and FK8CR on Noumea (Box 544) on 20m will be hard to beat. From Farnham, Surrey, **Paul Pasquet** reports that fellow listener Iain is now radio cadet with BP and away on a course, but Paul seems to have managed quite well on his own! Weirdest call of all time was 4079WARC which turned out to be in YU-land! Another of Paul's weirdies was Z44N reported to be on an island near ZC4. A more familiar prefix was KS6 in the shape of KS6FL a pretty good catch on 15m SSB.

It was good to hear from **Dave Peck** BRS37621 of Cambridge once again with a short list of his RTTY finds on 20m. Dave happened to find out that his neighbour is an Ex-RAF radio op so Dave can now do about 12wpm! Better get him into the local club OM! In Braunton, N. Devon, **Paul Bradbeer** now has a new FRG7 to feed from his V-3jr vertical aerial. Wisely, he has added earth radials rather than rely upon the natural earth. His favourite band is 15m although 20m and 40m get their share of his attention. First time writer **John Stephen** of Glasgow recently bought a Hallicrafters SX140 and is very pleased with results so far but would like to get hold of a manual for it, so if anyone can help write to John at 74 Shakespeare Street, Glasgow G20 8TJ.

Up in Dringhouses, York, some CW has been copied by **John Hague** but he hopes to do better soon with a DX160 which is on the way. John mentions that he is taking his code test very soon but I am not sure that this is very wise. As far as I know the code test certificate is only good for a year so unless John gets his RAE in that time he might have to take the code test again. With the astronomical rise in the cost of taking the code test and the RAE it behoves every candidate to make quite sure that he is 100% ready for the exams before entering.

An interesting letter from 16-year-old **Kevin Jones** in Nuneaton, Warks, who is shortly entering the Navy as an electrician. He has been busy on communications in the Sea Cadet Corps where he has been able to play around with some of the gear. From Rotherham comes a first letter from **Neil Clarke** who has succeeded in copying SSB on 40m with two domestic receivers, using one as a BFO! Anyway I think that the bug has bitten Neil hard enough to ensure that he will be getting a set soon that is better suited to the job in hand! One callsign, a G8, caused Neil to ask why he was operating on 40m as he thought G8's were confined to VHF and up. Well, this G8 was G8RY, an old-timer licenced around 1937/38, the other G8's have three letters popularly known as G8+3's. Similarly, my own call G4AR was issued in January 1939, the new licencees are G4+3's.

Old-faithful **Robin Bayley** keeps going up in Shropshire with his EC10 and long wire aerial. Even in summer he still logs DX like HK0 and FP8 on 80m and a VK9 on 40m, with KH6 on 20 and 15m. From Redruth in Cornwall, **Bill Caulfield** tells me he has been reading PW for years but only now has taken the plunge and bought some gear for the SW bands. It is only what I would call a "glorified" domestic receiver but, like Neil Clarke mentioned earlier, I hope it will lead to better things before long. Bill admits to being 58 which gives him plenty of time to get his ticket and settle down to the greatest of all hobbies!

CLUB NEWS A new radio club for those of you in Devon, namely the Exmoor Radio Club which meets on the second and fourth Thursday each month at the South Molton Community College. They plan to start RAE courses based on the new PW series. Thanks for the compliment, hope it leads to a lot of new tickets. Contact Chairman Dave Stone, 47 Oakford Villas, North Molton, Devon or Secretary Ted Bruns, Loughrigg, East Street, South Molton, Devon.

Log extracts

R. Bayley:— 80m AP2AD CT2AP EA9CR FP8DA HK0COP **40m** DU1DBT FP8DH JA1JRK JW7BK VK9XI **20m** KH6BB TG9AD **15m** HK0CAT KH6PP TG9TL

P. Bradbeer:— 20m VP2DLF VP8PM **15m** HM1JA HR3JJR KG6SS P29JS VP2GAH YB3KA 5T5JD **10m** FM7AV VP8NO 8P6FX 9J2BO

A. Doherty:— 80m JA6BSM 5Z4NI 8P6GN 9G1ARS **40m** KA2BAY TU2EF **20m** FK8CR KS6FL KX6BU ST2SA VP8MX VS5XU YB7AAA ZK1DR 3B8DS **15m** P29JW WB6NCO/VQ9 (Diego Garcia) ZD7PV 7P8BC

P. Pasquet:— 20m KA6KN 9N1MM **15m** J28AM KS6FL VP8NO ZD7SD 8Q7AD (Maldives)

D. Peck:—RTTY 20m A9XCC EA8IY EA9FJ FP8DF KH6FKG LU9CN PY2BXA SL6A VE3FQD YV7DU 7X4MD

J. Stephen:— 20m CP1BP HR3JJR TR8JVC TU2GO **15m** VP2SAG

B. Harrison:— 80m VP2LDD **20m** KC6BS **15m** S88TH VR4DN 8Q7AD **10m** VP8CZ VP8LP

All reports are SSB.

MEDIUM WAVE DX

by Charles Molloy G8BUS

A useful log of MW DX comes from **John McFadden** of Belfast who has recently acquired a Yaesu FRG-7 communications receiver. When connected to a 35ft longwire aerial it pulled in CJCH in Halifax, Nova Scotia on 920kHz, CJYQ (ex-CJON) on 930 and three broadcasts from New York City, WINS on 1010, WNEW on 1130 and WQXR on 1560, all heard between 0100 and 0230 GMT. Other DX logged includes Ain Beida in Algeria on 529 at 0014, Istanbul on 1016 at 0216 and an unidentified CBC Radio discussion programme on 630 at 0205. This could be CFCY in Charlottetown, Prince Edward Island which is occasionally heard in the UK. Although privately owned, CFCY may well have been relaying a programme from the CBC (Canadian Broadcasting Commission). Privately owned stations do this, a practice which can easily mislead the DXer.

John says he is interested in US medium wave stations and asks if it is a good idea to concentrate on one area or just to browse around for anything that happens to be on. Surprise and the unexpected await those who browse around the medium waves. New stations are always appearing and propagation is sometimes favourable to quite unexpected parts of the world. On the other hand, DXing North Americans has an attraction of its own.

There are large numbers of stations, over 4000 in the United States. There is no trouble with identification or language and the majority of stations will QSL. Propagation as usual is the deciding factor on the medium waves. The North American specialist will sometimes find the band alive with stations that interest him while at other times not a single North American will be heard. When this occurs he will have to "browse around" or pack in DXing until the North American path picks up again.

Neal Cartwright (London) who uses a Ecko A239 valve receiver, would like to know how to immobilise its AGC (automatic gain control). Locate the AGC line and connect it to the chassis via a switch. The AGC can then be switched on or off as required. Although the AGC is useful when turning across the band, as it prevents the receiver from being overloaded by strong signals, it can be a disadvantage when one is trying to listen to a weak station that is close to a strong one. The AGC will respond to the strong signal, reducing the receiver gain and the weak station now appears to be weaker than it really is.

The usual technique to use when the AGC is ON, is to set the RF gain control to maximum and adjust the volume by means of the audio gain control. With AGC switched OFF then a different procedure is called for. Adjust the audio gain for a comfortable volume from the loudspeaker and follow the signal with the RF gain control, backing it off on strong signals to avoid overloading and crossmodulation.

Is there a book giving details of radio stations in North and South America including powers of transmitters, callsigns, identifications and addresses, asks **John Faulkener** from Mansfield. The World Radio and TV Handbook, published annually and distributed in the UK by Billboard Publications, contains this information for the majority of broadcasting stations on the long, medium and short wave bands, throughout the world. The 1977 edition cost £5·50. John already possesses a copy of the World's Short Wave, Medium and Long Wave, FM and TV Listing which covers 1500 medium wave stations in the United States and another 300 in Canada. This paperback, which is published by Babani, costs 60p and is available from bookshops in the UK.

John does his DXing with a Trio 9R59D communications receiver, a Codar PR40 preselector and a 100ft longwire. North Americans heard with this set-up are CFRB in Toronto on 1010kHz, KMOX St Louis on 1120, WHAM Rochester NY on 1180, Ft Wayne Indiana on 1190 and WOAI San Antonio Texas on 1200. DX from other parts of the Americas include ZDK St Johns in Antigua on 1100, Rio de Janeiro on 1180 and Radio el Mundo in Buenos Aires on 1070.

Jim Robinson of Selby in Yorkshire is building a loop aerial. He has an unmarked variable capacitor and asks if is possible to find out its value. An indication of the value can be obtained by substituting it for one of known value in a tuned circuit, such as the tuning capacitor in a radio receiver, though this may not be too easy to do in practice. The unknown capacitor will be lower in value than the known one if the tuned circuit resonates at a higher frequency than before, with the vanes fully meshed.

Why not try the unknown variable on the loop? With the vanes unmeshed, adjust the number of turns on the loop so that it resonates not lower than 1600kHz. When the vanes are fully closed the loop should tune to 540kHz. If it tunes to a higher frequency then the capacitor is too low in value. It can be increased by using a fixed capacitor (try 220pF) in parallel via a switch, and the band can now be covered in two ranges. DXers who find it difficult to cover the whole band even when using a 500pF variable, should try this method.

Harold Emblem (Mirfield, Yorkshire) has been busy during the evening with his Eddystone 730/4 and loop. Stations heard include Riyadh in Saudi Arabia on 597kHz at 2145, Ouagadougo, Upper Volta on 746 at 2330, Enugu in Nigeria on 1320 at 2240 and Conakry, Guinea on 1403 at 2245. No need to stay up late to DX on the medium waves!

Harold mentions that all the stations in the CJON network, (610, 670, 680, 930, 1350) are now using the call CJYQ which is abbreviated at times to "CJ Radio". He has sent a reception report to St John's (930) which increased power recently to 50kW and the reply should indicate whether the callsign too has been changed from CJON to CJYQ.

Robin Harvey of Halesworth, Suffolk has heard the medium wave outlet of Mebo 2 under the Spanish station on 733kHz. It is on the air nightly between 1900 and 2300, in parallel with 6205 in the 49m band. Announcements are in English between non-stop music and the broadcast is from a ship anchored in the harbour of Tripoli in Libya. During the day it relays the programmes of Libyan Radio. Reception was with a Telefunken TS101 portable and a telescopic aerial.

T. Cridge of Farndon, Cheshire recently purchased a CR100 and has a great deal of pleasure from it. "I have been experimenting with different aerials and at present have a half folded dipole. I don't really know what I am doing but it is great fun finding out". A loop is now under construction which should give some direction to the experiments!

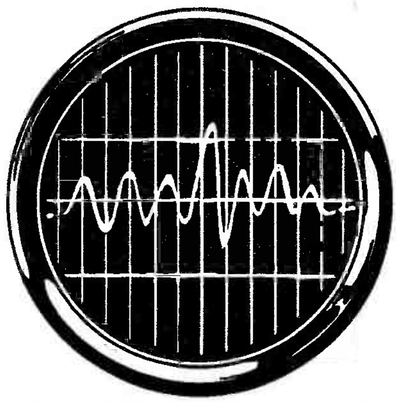
SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

The reference in the October issue of *Practical Wireless* to Radio Australia's transmission on 21570kHz in the 13m band has brought an interesting reply from **George Hew-**

LOOK! Here's how you master electronics.

....the practical way.



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

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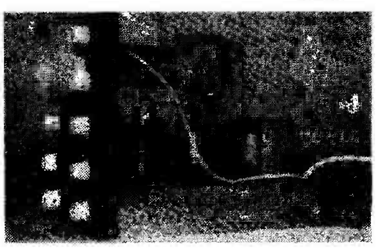

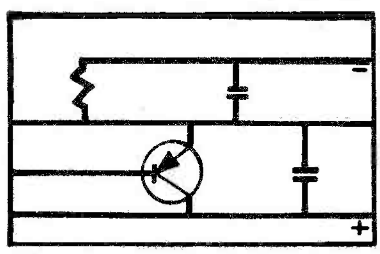

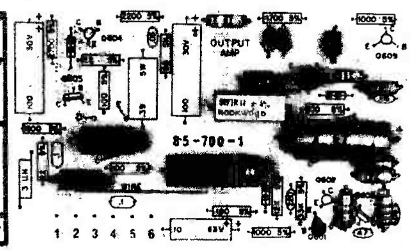

1 Build an oscilloscope.

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

2 Read, draw and understand circuit diagrams.

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

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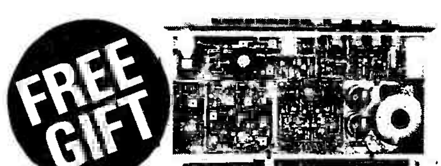

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lett of Torquay who is a Monitor to the Broadcasting Branch of Telecom Australia (Radio Australia and VNG). He refers to the antenna bearings which appear in Radio Australia's transmission schedule and in the World Radio Handbook. For British listeners, bearings of 308 and 325, both across the short route, offer the best reception while 110, 118 and especially 128 give the best reception over the long route across the Pacific. Reception of transmissions on other bearings can occur but are more difficult with much depending on time of year and day.

George refers to the Australian Time and Frequency station VNG which can be heard on 12·0 and 7·5MHz between 0600 and 0800 and on 7·5 and 4·5MHz between 1600 and 2000. Reception is possible throughout the year, the morning times being latest and the evening times earliest, in mid-winter. Station announcements are given a few seconds before each hour, quarter hour, half hour and quarter to the hour. The transmission on 4·5MHz, which appears 30 minutes later than the one on 7·5 should be of interest in Tropical Band DXers as an indicator of propagation conditions across S.E. Asia.

The International Short Wave Club is offering to send a free sample copy of their monthly bulletin to readers of *Practical Wireless*. The bulletin presents news and highlights of the short wave world and there is also a section covering the amateur bands. The October issue gives details of the well known ISWC short wave station popularity poll. The voting, for 1977, favoured Radio Nederland in all six continents. Request should go to the President, Jim Malone, 19 Seventh Avenue, Manor Park, London E12 and return postage, although not asked for, would no doubt be appreciated.

Brian Steele (Sheffield) has recently purchased a Sony ICF 5900W receiver with which he pulled in the Voice of Turkey on 9515 and 11880kHz, Radio South Africa on 11900 and Radio Canada on 15325. Brian is very pleased with his new receiver which has a military style cabinet, a crystal calibrator and has DX/Local, BFO and bandspread controls.

Harold Emblem (Mirfield, Yorkshire) has been trying his Eddystone 730/4 on the short waves and he reports hearing Trans World Radio, Bonaire on 15275kHz (19m band) at 2215, Sri Lanka on 15425 at 0400, AFRTS on 15430 at 2255. On 16 metres he logged WINB Red Lion on 17720 signing off at 2000 with announcement of this frequency which is not listed in the WRH, and WYFR Family Radio on 17845 at 2025. **Harold Brodribb** (St Leonards) has been busy again on the higher frequencies with his CR100 and longwire. On the 11m band he heard Radio Israel in Russian and Yiddish on 25605kHz between 1430 and 1630. On 13 metres, Radio RSA was heard on 21535 at 1435, Radio Australia on 21570 at 0840 with DXers Calling (also on 9570), Radio Israel on 21625 at 1640, BBC World Service on 21710 at 1403 and Radio Norway with Listeners Choice on 21730 at 1345.

Derek Taylor (Preston, Lancs) has been trying out his new Yaesu FRG-7 on the short waves. When connected to a 30ft longwire via an aerial tuning unit, it pulled in Radio Pyongyang on 9420 at 2000, The Voice of Vietnam on 10040 (out of band) at 1820, Bangladesh 11650 at 1830, ELWA Liberia on 11950 at 0625, Tokio, Japan on 15310 at 0610 and Kinshasa, Zaire on 15350 at 2115. **John Hill** (Swindon) has a Realistic DX160 receiver which he uses either with a 40ft longwire or connected to the bedspring (not to be recommended with a mains operated receiver!) Stations logged include Radio Australia on 9570kHz at 0830. John, who is new to the short waves is not sure whether his conversion from MHz to kHz is correct. It is very easy to do, just shift the decimal point three places to the right; 9·57MHz is the same as 9570kHz.

Newcomers to the short waves may be confused by the reference to "bands" which are expressed in metres and to individual frequencies which are in kHz or MHz. The conversion between the two is simple, especially if a pocket calculator is available. Divide 300,000 by the frequency in kHz to obtain the wavelength in metres, and vice versa e.g. Radio Australia on 9570kHz has a wavelength of 31·35 metres. The limits of the international short wave bands are:-

49 metre band from	5950kHz	to 6200kHz
41mb	7100	to 7300
31mb	9500	to 9775
25mb	11700	to 11975
19mb	15100	to 15450
16mb	17700	to 17900
13mb	21450	to 21750
11mb	25605	to 26095

and this table should help readers whose receiver is marked in metres, to locate stations mentioned in this column which are in kHz.

Roy Patrick (Mackworth, Derby) sends news of WYFR Family Radio who expect to start testing the first 100kW transmitter from the new transmitting site at Okeeshobee, Florida soon. The Scituate station will continue to broadcast until the middle of 1978 when it is scheduled to close down and all Family Radio programmes will then come from Florida. Roy used a Joystick antenna with ATU connected to a Trio 9R59D or a National 1400 portable. With this set-up he logged Radio Rumbos on 4970kHz at 0600, Malta on 5990 on Saturdays only, Radio Nova (Mebo 2) on 6205 with test transmissions in the evening, Radio Andorra on 6280 in French during the morning, the Voice of Iran 9022 from 2000 to 2030 in English, Voice of Turkey on 9515 at 2200 with DX tips nightly at 2230, WYFR on 11805 in Spanish at 1800, Kuwait on 12095 with a good signal from 1800 onwards, WINB 15270 with a good signal at 2130 and the Voice of Greece on 17780 in English at 1200. Thanks Roy for a very useful log.

The last word this month is from **John Faulkener** of Mansfield who mentions that the World DX Club has its own weekly programme in Adventist World Radio, broadcast over the 100kW station at Sines in Portugal. The programme is on a Sunday from 0835 to 0945 on 9670kHz on the 31m band and was received by John at a SINPO rating of 55555 with his Trio 9R59D receiver and 150ft longwire.

VHF BANDS

by Ron Ham BRS15744

Despite many overcast periods, **Cmdr, Henry Hatfield,** Sevenoaks, continues to produce valuable information about the sun's behaviour with his spectrohelioscope and his radio telescope. Frequently, during the latter part of September, **John Smith,** Cranleigh, Henry, and myself recorded radio noise from "active" events on the sun which were no doubt responsible for the widespread ionospheric disturbance, reported by the BBC World Service on the 24th, the auroral openings on the 22nd, 24th and 26th observed by **John Branegan,** Saline, Fife, and **Charlie Newton,** G2FKZ, London, and the good 10m conditions.

Henry identified 3 sunspot groups on October 2, 4 groups on the 3rd and 5th, witnessed 6 bright plages on the 2nd, a spray of gas and a pillar prominence on the 5th, 2 "Enormous" filaments on the 9th, and 4 plages and 16 filaments on the 18th. In view of this it is not surprising that John Smith, Henry and myself often recorded strong solar noise, (136MHz), from the 1st to the 15th and severe noise on the 16th, 17th, and 18th. An ionispheric disturbance was reported by the BBC World Service during the early hours of the 19th.

During the auroral events, John Branegan heard 2m signals from DL, EI, GM, GW, LA, and the UK beacons from Lerwick, GB3LER, to Cornwall, GB3CTC. Like other observers in the UK, confirmed by G2FKZ, RSGB auroral co-ordinator, John uses GB3LER, 144·955MHz, for early auroral warning. Readers reports will be passed on to G2FKZ and Ron Livesey, Co-ordinator for the British Astronomical Association.

It's good to hear the DX from both hemispheres on 10m again. On October 5, **Henry Hatch**, G2CBB, told BBC World Radio Club listeners that VK stations were currently being worked from the UK and at 0930 on the 8th I heard YB0ACP, and VK8CC/M. During the early mornings of the 10th and 14th I received strong signals from Japanese stations working into Europe. John Branegan heard stations from Italy, Portugal, South Africa, South America, Japan, both coasts of the USA and the USSR on the 8th and 9th, and at 1600 on the 9th the US Citizens Band was wide open and tuned to 27·155MHz, USB, John heard signals from Brazil, California, Louisiana, Novia Scotia, Ontario and Texas.

Harold Brodribb, St. Leonards-on-Sea, **Nigel Golds**, BRS 36910, West Chiltington, Sussex, **Lawrence Hobden**, Brighton, and myself frequently heard strong signals from the Cyprus beacon, 5B4CY, 28·220MHz, between the 8th and the 18th. At 0843 on the 10th I heard, amid QSB, the Bahrain beacon, A9XC, 28·245MHz, and on the 11th, 14th, 16th, 17th and 18th I received signals around 28·330MHz from an experimental propagation beacon ZE2JV. On the 13th, Lawrence Hobden heard the Florida beacon, N4RD, 28·207MHz, on his 1937 receiver which is still going strong, and Nigel heard several VP stations.

Around 1600 on September 27 and 28, **Anthony Mann**, Applecross, Australia, heard strong signals from the Bahrain beacon on 10m and on October 2 there was a strong opening toward UK and western Europe. During the early morning of October 4, and on several days after, the 10m band was open between Australia and the USA and some of the American CBers on 27MHz were almost at local strength.

Frank Luman, Donald Bassnet, John Thorburn, John McCarra, from Glasgow and **Fred Dinning**, Dunlop, have formed a club called, The Scottish VHF AND SW DXers, and currently meet every first and third Saturday afternoons at Frank's home, 2, Ormonde Drive, Netherlee, Glasgow. New members are welcome, enquires to Frank Luman. Frank, Donald and Fred have an early warning arrangement which was used on September 22 when 7 Norwegian stations, some in good stereo, were heard in Band II via what may have been the last event of the 1977 sporadic-E "season".

While on a hill some 600ft ASL Nr Dumfries, using a beam aerial 16ft AGL, **Mark Deutsch**, G3VJG, Kettering, could not make any contacts on 2m SSB, so he moved down the hill, about 1 mile away, at 250ft ASL and worked G2HFC, Wigan, via the Welsh repeater, GB3MP, with a 5/8 whip aerial on his car. Mark could also hear the Central Scotland repeater, GB3CS, where there was no trace of its signals at the 600ft level.

Congratulations to **George Zitterstein**, G8ITS, who, from his difficult location in the City of London, with his beam aerial fixed south on his balcony, has received his Four Metres and Down Certificate from the RSGB for 70cms. His achievement includes contacts with stations in northern G and his best DX was GW8CFQ, Wrexham. George now plans to do the same on 23cms.

On September 21, **Alf Lee, G4DQS, Brighton, worked** a G8 station on 2m via the Bristol repeater, GB3BC, from his car in Haywards Heath car park. At 0930 on the 30th, **Alan Baker**, G8LGQ, Newhaven, heard F1CIX working DC1WO via the German repeater, DB0UT.

Around 0800 on October 12 the atmospheric pressure began a gradual rise reaching 30·2in by noon on the 13th and at 0400 on the 14th it started to fall. True to form, a tropospheric opening occurred which lasted until late afternoon on the 15th when the AP was levelling off at 30·05in. The event covered a wide range of frequencies. **Derek Knight**, Storrington, and Harold Brodribb, both reported co-channel interference on UHF-TV and that both the BBC and IBA warned their viewers about the prevailing disturbance.

From midday on the 14th to mid-morning on the 15th I received strong signals from the Sutton Coldfield, GB3SUT, and Emley Moor, GB3EM, beacons on 70cms, a good picture on Channel 8, 189MHz, from Lichfield, and several continental broadcast stations in Band II, with only dipole aerials feeding the respective receivers. At 2035 on the 14th, Harold Brodribb, using a 2 element beam into his Bush VHF-80 heard French and Dutch stations in Band II and at noon on the 15th he counted 20 French stations between 88 and 101MHz, strong enough to obliterate the BBC signals.

During the morning of the 14th, Alan Baker worked several German stations on 2m via the Stuttgart repeater, DB0WR, and F1CIX, ON5QL/M, and DJ2HH/M via DB0UT on R7 while located on Beachy Head where both repeater signals were consistently 58. At 1700, Alan called on **Ern Hoare**, G8BDJ, Brighton, and they both watched Kojak on French TV via Ern's 70cm beam. Around 0200 on the 15th, Alan worked G8LCK, London, via both the Birmingham, GB3BM, and Hampshire, GB3SN, repeaters on R5, at the same time. Alan suddenly realised what was happening when the Birmingham repeater signal faded out and he could still hear the 1½ watt signal coming from G8LCK. At 1600 he heard the signal from a GM/M through the Kent repeater, GB3KR, and during the event he worked DC6TY, Cologne, about 500km on 2m SSB.

From 1800 until midnight on the 14th, **John Heys**, G3BDQ, Hastings, proved the value of a morse key and worked a host of DMs, 3 SPs, 4 OEs, 1 OZ, and in a half hour stint between 1935 and 2005 he contacted 6 OKs on the trot, all on 2m. His best DX was more than 1000km, on a mainly overland path with OK3CDI/P. John said it was his best evening for 20 years and looks forward to another tropo-opening when he can go for YU, YO, HA, and I1.

During the August leg of the RSGB 3cm Cumulative Contest, **Sam Jewell**, G4DDK, Stone, worked G8AXE/P on Winter Hill, Bolton, from Brown Clee, Shropshire, a distance of 124km with torrential rain at both ends which had little effect on the signals. Several days later, encouraged by this, G8AXE and G8AFC wanted to try for their Microwave Awards by working over 150kms. Sam set up his gear on the Long Mynd, Shropshire, and G8AXE, G8AFC, G3SMU and G4BBU climbed to the top of Fair Snape Fell in the Calder Fells, Lancs, to establish their stations. The two groups used their TR2200s for talk-back over the 151km path.

A signal on 3cms was received quickly from G8AXE/P but only a weak signal was received from G4DDX. The contact began at 1930, and as the sun set around 2045, a temperature inversion occurred and the signals came up at both ends allowing them to complete the formalities in relative comfort. On October 2, G8AFC and G4DDK set up their 3cm equipment on Axe Edge in the Derbyshire Peak District and exchanged signals over a 149km path with GW4BRS/P on Pumlumon Fawr, near Aberystwyth.

My thanks to you all for your fascinating reports, best wishes for Christmas, and let us look forward to another interesting year above 28MHz.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands must be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

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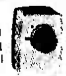
Vary speed of your wiper to suit conditions. All parts and instructions to make. £3·75 post and VAT paid.

ROOM THERMOSTAT



Famous Satchwell, elegant design, intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month £3·00 post and VAT paid.

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Rated at 5 amps 250 volts. Ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for £1·00, VAT and post paid.

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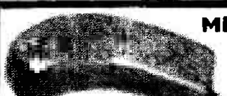

Ex behind the ear deaf aids, complete with volume control £2·16.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·45 including post & VAT. Made up model £1·00 extra.

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Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼" diameter and approximately 1" long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2" dia. × 5" long. Price £2·00 including Post & VAT.

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With triple 10 amp changeover contacts—operating coil wound for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment 60p each, 10 for £5 post and VAT paid.

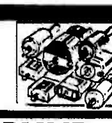
SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £1·90 —crystal earphone 55p including VAT and postage.

HUMIDITY SWITCH

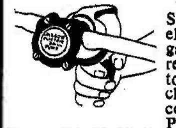
American made by Ranco, their type No. J11. The action of this device depends upon the dampness causing a membrain to stretch and trigger a sensitive microswitch adjustable by a screw, quite sensitive—breathing on it for instance will switch it on. Micro 3 amp at 250v. AC. Overall size of the device approx. 3⅛" long 1" wide and 1¼" deep. 65p.

8 POWERFUL BATTERY MOTORS



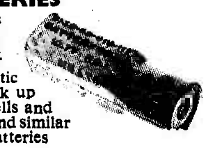
For models, Meccano's, drills, remote control planes, boats, etc., etc. £2·00.

ROTARY PUMP



Self priming, portable, fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertiliser, chemicals, anything liquid. Hose connectors each end. £2·00 Post Paid.

MERCURY BATTERIES



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

AMPLIFIER PANEL

6 photo sockets and d.p. changeover slide switch all mounted on insulating board. Glossy black finish size 2" × 8½" approx.—silly price 35p, or £1 for six.

THIS MONTH'S SNIP

is a miniature sealed relay 12v dc operated with two sets of change over contacts. The unique feature of this relay is its heavy lead out wires, these provide adequate support and therefore the relay needs no fixing; on the other hand there is a fixing bolt protruding through one side so if you wish you can fix the relay and use its very strong lead outs to secure circuit components—an expensive relay; but we are offering it for only 87p each. Don't miss this exceptional bargain!

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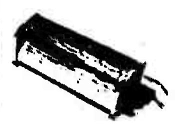
All in module form, each ready built complete with heat sinks and connection tags, data supplied. Model 1153 500mW power output £1·50 including Post & VAT.

Model 1172 1W, power output £1·85 including Post & VAT. Model EP9000 4 watt power output £2·90 including Post & VAT. EP 9001 twin channel or stereo pre-amp. £2·90 including Post & VAT.

TANGENTIAL HEATER UNIT



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+ £1·50 P. & P.

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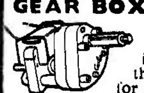
For camping—car repairing—emergency lighting from a 12v battery you can't beat fluorescent lighting, it will offer plenty of well distributed light and is economical. We offer Philips invertor for 12" 8 watt miniature tube for only £2·75 with tube and tube holders as well.

SPIT MOTOR WITH CARTER GEAR BOX



Probably one of the best spit motors made. Originally intended to be used in very high priced cookers however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. £4·32 including POST & VAT.

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IT'S FREE

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

Starlet 9" T.V. Mains Battery Model time based tested and in our opinion repairable. Complete except for small knobs, telescopic aerial and plug for mains/battery input. Price £16·87 each + post and special packing £2 + 16p.

Spares for Starlet. Tuners £3·50p, loud speaker £1·50p complete power unit (base unit) £6, printed circuit board panel £4. EHT Unit £4·50p.

9" T.V. Tubes for the Rigonda Starlet. £9·00. Post and special packing £2·75p.

12 Volt Heavy Duty Relay. Plug in type has three pairs of 10 amp change over contacts. Transpararent dust cover, price £1 + 8p. Suitable 11 pin base 27p + 2p.

4 Changeover Mains Relay. Upright mounting with perspex type dust cover, the really interesting feature is 4 sets of 10 amp changeover contacts. Price £1·62p + 12p.

12Volt Pump. Designed we believe as a bilge pump, this is 12 volt AC/DC motor coupled by a long enclosed shaft to a submersible pump. Suitable for water or most any fluids. Price £11·75p. Post 80p.

Just Arrived. Fruit Machines—working order—very impressive, choice of several but very heavy so you must collect. £50.

High Load 24 Hour Clock Switch. Made by the famous AEG Company for normal mains but with clockwork reserve has load capacity of 80 amps at 240v 50hz. Therefore suitable for dealing with large loads of say shop lighting, water heating, storage heaters etc. etc. Has triggers for on and off once per 24 hours but extra triggers will be available. Price £1·50p per pair. Size of clock approximately 8" × 5" × 5", totally encased but has lift up flap for ease of altering switching times. Price, new and unused £10·65p or used but guaranteed o.k. £6·50p.

Enclosed 24 Hour Clock. With contacts for breaking 10-12 amps at 240 volts. This one has two sets of on/off per 24 hours. Price £7·60.

Smiths 24 hr. Timers—Heart only with over-ride similar to those used in the auto set etc. £4·75p + 38p.

Ditto but in grey plastic wall mounting case, with leads ready for attaching to plug and socket. price £6·98.

Light Dimmer. Our timer module with small mods makes an excellent light dimmer. Contains a 4 amp 400v SCR so it should be suitable for loads approaching 1kw Price of module with variable resistor and instructions £2·25p.

Push Pull Solenoids. For mains operated solenoid which will push as well as or instead of pull. Very heavy duty, we estimate this at 20lbs push or pull. 1¼" × 3⅛" × 4" made by Magnetic Devices Co. £7·50.

Flashing Lights, chasing lights, random flashes, strobe effects etc. etc. can easily be achieved using our disco switches and with Christmas just around the corner you can do something special for your home or business. These switches are offered at approximately one-fifth of their proper price, are ex-equipment but guaranteed perfect and supplied with an adaptor suitable for mains working. To get some idea of the loading number, each switch is 10 amp which is approx. 2½ kw so the 6 switch model could handle over 12 kw's. For the light pipe or Catherine Wheel effect we suggest 12 switch model, interconnecting the switches to give fastest speed. 6 Switch model £5, 9 Switch Model £9·75, 12 Switch model £6·20. Also add 50p per switch. If you want the light pipe diagram please request this.

Always in Stock. Turntables with pick up lift, ideal for disco's at £11·95, post £2·25. We are also expecting some professional belt drive type at £25. Call or ring us for more information.

Reed Switches, standard 60 watt glass type. Normal open contacts glass lengths 2" diameter 3/16", 10 for £1 + 8p, 100 for £8 + 64p, 1000 for £65 + £5·20p.

Flat Reed Switches for stacking, greater quantity in confined space. Price 50p each + 4p.

F.M. Tuner and Decoder—two very well made (Japan) units—nice reproduction—£9·95 the pair.

Single Ended Types for jobs where it is not easy to bring a lead to each end. 75p each.

All these switches are normally open but can be biased to a normally closed position by fitting a magnet adjacent. The reed switch would then be opened by a magnet of opposite polarity being bought up to it

Ceramic Magnets suitable for operating reed switches, central fixing hole. 10 for £1·62p.

Music Centre Transformer 12–0–12 at 1 amp and 9 volt at ½ amp. Normal primary, upright mounting, impregnated and varnished for quiet operation. Price £2·95p. Post 54p.

'W' Shaped Fluorescent Tubes for porch light, box signs or where you want light evenly spaced over a confined area of approx. 10" × 10", 30 watts, made by Phillips price £1·62p. Post 54p.

Plinth for BSR Record Player still available at the record price of 95p + 12p. This is excellent value but unfortunately being a bulky and delicate item the postage has to be £1·50p + 12p so this is obviously only a bargain for callers.

(2) A similar model also available at the same price, this is somewhat larger and has a cut out for an amplifier.

Our Smokey Cover can be used with the above plinths, four small locating pins are fitted to the motor board. Size approx. 12½" × 14½", price £2·50p + 32p. Post £2·00 + 16p.

Extension Speakers 8 ohm 4-5 watts handling power. We have 5 or 6 different models in stock, cheapest being the Partytime at £3·95p each, again only really a bargain for callers as postage is £1·50p per speaker.

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12 AND 24 VOLT OR 12-0-12V
PRIMARY 220-240 VOLTS

Ref	Amps 12V	Amps 24V	£	P & P
111	0·5	0·25	2·20	0·45
213	1·0	0·5	2·64	0·78
71	2	1	3·41	0·73
18	4	2	4·42	0·96
70	6	3	5·35	0·98
108	8	4	6·98	1·14
72	10	5	7·47	1·14
116	12	6	8·99	1·32
17	16	8	10·39	1·32
115	20	10	13·18	2·08
187	30	15	17·05	2·08
226	60	30	26·62	OA

50 VOLT RANGE
Prim 220/240V Sec 0-20-25-33-40-50V
Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40, 50, 25-0-25 or 20-0-20.

Ref	Amps	£	P & P
102	0·5	3·41	0·78
103	1·0	4·57	0·96
104	2·0	6·98	1·14
105	3·0	8·45	1·32
106	4·0	10·70	1·50
107	6·0	14·42	1·64
118	8·0	17·85	2·08
119	10·0	21·79	OA

MAINS ISOLATING (SCREENED)
PRIM 120/240 SEC 120/240 CT

Ref	VA (Watts)	£	P & P
*07	20	4·40	0·78
149	60	6·20	0·86
150	100	7·13	1·14
151	200	11·16	1·60
152	250	12·78	1·84
153	350	16·30	1·84
154	500	19·19	2·15
155	750	29·08	OA
156	1000	37·30	OA
157	1500	45·60	OA
158	2000	54·30	OA
159	3000	79·05	OA

*115 or 240 sec

HIGH VOLTAGE MAINS ISOLATING
Prim 200/220V or 400/440V
Sec 100/120V or 200/240V

Va	Ref	£	P & P
60	243	5·89	1·32
350	247	14·11	1·84
1000	250	35·65	OA
2000	252	54·25	OA

30 VOLT RANGE
Prim 220/240V Sec 0-12-15-20-24-30V
Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V 15-0-15V, 12-0-12

Ref	Amps	£	P & P
112	0·5	2·44	0·78
79	1·0	3·57	0·96
3	2·0	5·37	0·96
20	3·0	6·20	1·14
21	4·0	7·44	1·14
51	5·0	8·37	1·32
117	6·0	9·82	1·45
88	8·0	11·73	1·84
89	10·0	13·33	1·84

60 VOLT RANGE
Prim 220/240V Sec 0-24-30-40-48-60V.
Volts available 6,8,10,12,16,18,20,24,30, 36,40,48,60V or 24-0-24V or 30-0-30V.

Ref	Amps	£	P & P
124	0·5	3·88	0·96
126	1·0	5·58	0·96
127	2·0	7·80	1·14
125	3·0	10·54	1·32
123	4·0	12·23	1·84
40	5·0	13·95	1·84
120	6·0	15·66	1·84
121	8·0	20·15	OA
122	10·0	24·03	OA
189	12·0	27·13	OA

AUTO TRANSFORMERS

Ref	VA (Watts)	Volts	£	P & P
113	20	0-115-210-240	2·48	0·71
64	75	0-115-210-240	3·95	0·96
4	150	0-115-200-220-240	5·35	0·96
66	300	0-115-200-220-240	7·75	1·14
67	500	0-115-200-220-240	10·99	1·64
84	1000	0-115-200-220-240	18·76	2·08
93	1500	0-115-200-220-240	23·36	OA
95	2000	0-115-200-220-240	34·82	OA
73	3000	0-115-200-220-240	48·00	OA

CASED AUTO TRANSFORMERS
240V cable in & 115V USA 2 pin outlet

VA	£	P & P	Ref
20	4·98	0·86	113W
150	6·48	1·14	4W
200	9·92	1·45	65W
250	10·49	1·45	66W
350	12·53	1·84	53W
500	15·72	1·64	67W
750	18·55	1·76	83W
1000	22·58	OA	84W
1500	26·02	OA	93W
2000	37·05	OA	95W

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	1·99	0·55
212	1A, 1A	0-6, 0-6	2·85	0·78
13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1·99	0·38
207	500, 500	0-8-9-, 0-8-9	2·59	0·71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·88	0·38
214	300, 300	0-20, 0-20	2·56	0·78
221	700 (DC)	20-12-0-12-20	3·41	0·78
206	1A, 1A	0-15-20-0-15-20	4·63	0·95
203	500, 500	0-15-27-0-15-27	3·99	0·95
204	1A, 1A	0-15-27-0-15-27	6·39	0·99
239	50	12-0-12	1·39	0·38
S112	500	12-15-20-24-30	2·84	0·78

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400V	4A	£0·80	0·29
400V	6A	£1·05	0·29
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BCY71	£12	74121	£26
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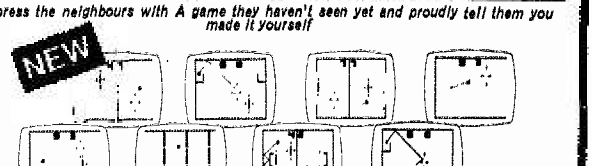
7475	40p*		
7476	39p*		
7480/2/5	10p*		

QUOTE THIS AD FOR SPECIAL PRICES SHOWN

Impress the neighbours with A game they haven't seen yet and proudly tell them you made it yourself

NEW



8 GAME T.V. PROJECT

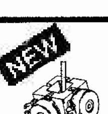
BASED ON AY-3-8600

★ Basket-ball ★ Grid-Ball ★ Hockey ★ Tennis ★ Squash ★ Football + Two — One-Player Games ★ Horizontal and Vertical Bat Coverage ★ Automatic Ball Speed-Up ★ Players Colour Coded ★ Three Tone Sound-Effects ★ Sound from T.V. ★ Ball Colour Coded to indicate turn in Squash-Game ★ All Components supplied guaranteed including sound and vision modulator C.H. 36 UHF. ★ Power requirement 9v battery ★ Just add controls and case.

Basic AY-3-8600 Paddle II Kit B + W only **£15·00**
Colour only **£20·90**

B+W Mini-Pack Chip + P.C.B. only **£12·90**
COLOUR Mini-Pack Chip + P.C.B. only **£13·90**

NEW



JOY STICK CONTROLS

DESIGNED FOR T.V. GAMES
(AY-3-8550-AY-3-8600) Subminiature Size

UNBEATABLE LOW PRICE

One off £1·90 Two off £3·50

TELETEXT DECODER

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TEXAS TIFAX — XM11

Tested and Guaranteed Only **£99·90**

Full Colour Display **ORACLE AND CEEFAX**
Simple to interface with most TV's.
Keyboard and power supply extra.
Also in stock NEW Colour TV's complete with Teletext FROM **£399·00**

All Projects supplied with easy to follow assembly instructions.

All prices include VAT + Postage. Orders under £10·00 — Add 20p p & p.
Make all Cheques or Postal Orders payable to

TELECRAFT

Retail Shop and Demonstrations — 14 Station Road, New Barnet, Herts.
For further Details and Technical Help — Phone 01-440 7033
(French and German spoken) Quantity discount negotiable.
For extra speed phone your order on Barclay-or-Access Cards.

WIRELESS TIME:

12:34.

approx. ¾ full size digits shown here

National's MA1012 LED digital clock module is a complete clock & alarm unit, operating from 50 or 60 Hz mains, and offering all the features you would expect: Hours-minutes display in bright 0.5" leds with optional seconds, sleep and snooze alarms, fast and slow setting, AM/PM indicator, switched alarm outputs - but best of all no RFI. Thus the MA1012 is suitable for use in any radio/tuner applications, and requires just 1.75 x 3.75 x 0.7" total. (Ex. transformer). £9.45 per module, isolating mains transformer £1.50 each. (*8% vat) Two modules, and two transformers for £20.00 (+8% vat)

In the latest Ambit catalogue: more TOKO coils, chokes, filters etc., data on the short wave coil sets, a revised price list, micro-microphone inserts, special offer lines etc.

DETECKNOWLEDGEY

Metal locator principles and practise, including some of the facts and information manufacturers of £100+ detectors would rather you didn't know. £1.00 each.

The Bionic Ferret 4000 - a VCO metal locator based on the PW seekit, including all parts, plasticwork, ready wound coil etc. Inc. free copy of detecknowledgey. £34.26 in pp and VAT at 8%.

Special announcement. The Bionic Radiometer metal locator is at last to be released. A full VLF discriminator, with simultaneous display of ferrous, non-ferrous and foil objects. With a little practise, you can actually find objects obscured by junk. Outperforms units costing £150+. Digital control. Demo available at Brentwood, on sale soon for less than £75.SAE info:

COMPONENTS

Herewith the list of first quality parts and modules for wireless, inc. Europe's largest range of signal coils and inductors. ½m in stock !

CA3089E	FM IF	1.94	BC413	lo noise	0.18
KB4402	FM IF	1.94	40238	shld RF	0.25*
HA1137W	FM IF	2.20	BF224	6ghz RF	0.22
TBA120	FM IF	0.75	BF274	.7ghz RF	0.18
TBA120S	FM IF	1.00	ZTX212	50v/.3w	0.17
sn76660n	FM IF	0.75	ZTX213	30v/.3w	0.16
ua720	AM rad	1.40	ZTX214	30v/.3w	0.17
CA3123E	AM rad	1.40	ZTX451	60v/1w	0.18
HA1197	AM rad	1.40	ZTX551	60v/1w	0.18
TBA651	AM rad	1.81	BD515	45v/10w	0.27
MC1350	agc gain	1.00	BD516	45v/10w	0.30
ua753	fm gain	1.80	BD535	60v/50w	0.52
LM1496	Bal mix	1.25	BD536	60v/50w	0.53
MC1310P	mpx dec	2.20	BD609	80v/90w	0.70
KB4400	as above	2.20	BD610	80v/90w	1.20
ca3090aq	mpx dec	4.35			
HA1196	mpx dec	4.20	BF256	1ghz fet	0.34
LM380	2w AF	1.00	E176	p ch swt	0.38
LM381	preamp	1.81	MEM614	(40822)	0.38*
tda2020	15w AF	2.99	MEM616	(40673)	0.67*
tca940E	10w AF	1.80	MEM680	lo noise	0.75*
tba810as	7w AF	1.08	BA102	vhf varic	0.30
LM301an	op amp	0.39*	BA121	vhf varic	0.30
ua741	op amp	0.34*	BB104	dual var.	0.45
LM3900	op amp	0.68*	BB105	uhf varic	0.40
7805uc	5v/1amp	1.55*	mvam2	dual AM	1.48
tda1412	12v/½A	0.95*	mvam115	15v/AM	1.05
78M20	20v/½A	1.20*	mvam125	25v/AM	0.90
78M24	24v/½A	1.20*	**TOKO Coils & Filters**		
ua723cn	variable	0.80*			
NE550a	as above	0.80*	10mm & 7mm (rad cont)		
taa550b	32v ref	0.50*	AM IFts with cap		0.30
icl8038cc	sig gen	4.50*	FM IFts with cap		0.33
NE555v	timer	0.70*	eg		
NE566v	vco	2.50*	YHCS11098AC2		0.30
NE567v	tone dc	2.50*	YHCS12374AC2		0.30
NE560B	hf pll	3.50*	YHCS11100AC2		0.30
NE561B	hf pll	3.50*	KALS4520A		0.33
NE565K	lf pll	2.50*	KACSK586HM		0.33
MC1312	quad	1.50	LLC238	7mm	0.33
11C90	650mhz	14.00*	LLC4827	7mm	0.33
			LLC4828	7mm	0.33
ZTX107	50v/.3w	0.14	CFS10.7 ceramic		0.50
ZTX108	30v/.3w	0.14	BLR3107N mpx		1.90
ZTX109	30v/.3w	0.14	BBR3132 6pole fm		2.25

MFL 2.4 kHz ssb mech. filter for ssb gen/IF 455kHz with matching transf's. 9.95
MFH series 4/5/7kHz bandwidth @ 455kHz 1.95
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Modules/tunerheads etc.

EC3302 3cct v/cap fm 7.50
EF5600 5cct v/cap fm 12.95
EF5800 6cct v/cap fm 15.25
EF5801 (5800+osc op) 17.45
8319 4 v/c, mos mixer 11.45
7252 complete fm mono tunerset.afc,agc,mute 26.50
7253 complete fm stereo tunerset. afc, agc, mute 26.50
7020 10.7MHz fm if 6.95
7030 linear phase fm if 10.95
93090 ca3090aq dec 8.36
92310 1310 decoder 6.95
91196 ha1196 decoder 12.99
91197 mw/lw v/cap tun11.35
7122 3 v/c mw(OR lw) tuner KIT 15v tuning 9.00
810k 7w af kit comp. £3
940k 10w af kit 3.95
tda2020k pr. tda2020 ics, pcb, heatsinks for pa 9.35
All mpx decoders feature TOKO pilot tone filters.

Tuners: complete

Larsholt signalmaster Mk 8 Best fm tuner kit under £100 Looks as good as it sounds. Full instructions 86.95
Audiomaster amp. Matching 25+25w rms amp. 79.00
carriage on above £3 extra ea.

Misc.

FX1115 beads 10/0.25
MW/LW ferrite rod ant 0.90
min. foil trimmers (see pl)
22t 100k pots for tuning .45
RFchokes: 1uH to 120mH

VAT is extra at 12½%, except where otherwise shown (*8%). PP now 25p per order. Catalogue 45p (inc). Pse send A5 or larger SAE with enquiries. Price lists free with an SAE. Full range of components etc available to callers at our new easy-to-get-to premises.

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Our new premises are only 200 yards from Brentwood station - with parking facilities outside the door !! *

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1. Advertisements are accepted subject to the conditions appearing on our current advertisement rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any Act of Parliament nor is it an infringement of the British Code of Advertising Practice.

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When replying to Classified Advertisements please ensure:

(A) That you have clearly stated your requirements.
(B) That you have enclosed the right remittance.
(C) That your name and address is written in block capitals, and
(D) That your letter is correctly addressed to the advertiser.

This will assist advertisers in processing and despatching orders with the minimum of delay.

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Books and Publications

Ladders

Service Sheets

SERVICE SHEETS — COLOUR TV SERVICE MANUALS

Service Sheets for Mono TV, Radios, Record Players and Tape Recorders 75p. Please send large Stamped Addressed Envelope. We can supply manuals for most makes of Colour Television Receivers by return of post.

B.R.C. PYE ECKO PHILIPS ITT/KB SONY G.E.C. HITACHI BAIRD ULTRA INVICTA FERGUSON H.M.V. MARCONI AND MANY MORE

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G. T. TECHNICAL INFORMATION SERVICE
10 DRYDEN CHAMBERS, 119 OXFORD ST., LONDON WIR 1PA

BELL'S TELEVISION SERVICES for Service Sheets on Radio, TV, etc., 75p plus SAE. Colour TV Service Manuals on request. SAE with enquiries to BTS, 190 Kings Road, Harrogate, N. Yorkshire. Tel: (0423) 55885.

SERVICE SHEETS for Radio, Television, Tape Recorders, Stereo, etc. With free fault-finding guide, from 50p and SAE. Catalogue 25p and SAE. HAMILTON RADIO, 47 Bohemia Road, St. Leonards, Sussex.

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MULTIBAND RADIOS. 12 band . . . Marine, Aircraft, LPSB, HPSB, UHF (430/470), SW1/4, MW, LW, FM, RF gain. BFO. £150. GRUNDIG SATERLITT £199. BFO Units, £16·50. SHARP MW/Aircraft, £13. Langtons, High Street, Rocester, Staffordshire. SAE lists.

For Sale

NEW ISSUES of "Practical Wireless" available from April 1974 edition up to date. Price 65p post free. Bell's Television Services, 190 Kings Road, Harrogate, N. Yorkshire. Tel: (0243) 55885.

Wanted

WANTED. New Valves, Transistors. Top prices, popular types. Kensington Supplies (C), 367 Kensington Street, Bradford 8, Yorkshire.

SURPLUS??? Turn it into cash. Phone 0491 35529 (Oxon).

WANTED. Rank Bush mono cassette recorder model TP 66. Working P.C.B. case, manual. Denis, 749 3524 after 6 p.m., or write 103 Fitzneal Street, W12 0BA.

WANTED NEW Valves, transistors, I.Cs, amplifiers, receivers, televisions (Anything Useful) any quantity. Stan Willetts, 37 High Street, West Bromwich. Tel: 021-553 0186.

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STYLI, CARTRIDGES, AUDIO LEADS, etc. For keenest prices send SAE for free list to: Felstead Electronics (PW), Longley Lane, Gatley, Cheadle, Cheshire SK8 4EE.

TIMESWITCHES. CHEAP TIMESWITCHES. Sangamo 20 amp reconditioned, guaranteed for one year. Only £3·70. Also electric eyes. Write:—J. Donohoe, 1 Upper Norfolk Street, North Shields, Tyne & Wear.

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Individually designed by Ex-B.B.C. Transmitter and Aerial Engineer. All custom built for the transmitter or S.W.L. G5RV's, G2DYM's, Wideband S.W.L. types, Design and Advisory Service. Details—7" × 10" 12½p S.A.E. + 3 × 9p stamps.

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COURSES—Radio Amateurs Examination, City & Guilds. Pass this important examination and obtain your G8 licence, with an RRC Home Study Course. For details of this, and other courses (GCE, Professional examinations, etc.), write or phone: THE RAPID RESULTS COLLEGE, Dept. JX1, Tuition House, London SW19 4DS. Tel: 01-947 1102 (24hr recording service).

Amateur Club

THE BRITISH AMATEUR ELECTRONICS CLUB for all interested in electronics. Four Newsletters a year with help and special offers for members. Major projects sponsored by the B.A.E.C. designed and made by members, currently the B.A.E.C. Z-80 Computer. Membership fee for 1978: £3·50 UK, overseas £4·50 surface and £5·50 airmail, payable in sterling. S.A.E. for details and application form to the Hon. Sec. J. G. Margetts, 42 Old Vicarage Green, Keynsham, Bristol.

Miscellaneous

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Cassette A: 1-12 w.p.m. for amateur radio examination.
Cassette B: 12-24 w.p.m. for professional examination preparation.
Morse by light system available. Morse Key and Buzzer Unit for sending practice.
Prices each Cassette (including booklets) £4; Morse Key and Buzzer £4.
Prices include postage etc., Overseas Airmail £1·50 extra.

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IMMEDIATE BY RETURN DELIVERY. Large range of miniature synchronous motors, many speeds 1 rev per hour to 1 rev per 2 days. £1·10 to £2·50 each. 3 and 4 digit mechanical counters, 45p to 85p. 10 amp micro switches at 20p. SAE for list. WALES (ELECTRICAL) LTD., Queen St., Newton Abbot.

100 Resistors 75p

¼W 5% c/FILM 2·2 Ω-2·2M Ω (E12)
10 each of any value
Send stamped envelope for **FREE SAMPLE**

C60 CASSETTES 30p
C90 CASSETTES 45p

Quantity Discounts
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All prices include VAT.

All Cassettes in Plastic Case with Index and Screwed Assembly.
Add postage 10p in £1.

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H. M. ELECTRONICS
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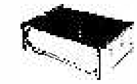
SEC. CABINETS (illus'd)



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Send 15p for leaflets (Refundable)
Trade enquiries invited

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swg	1 lb	8oz	4oz	2oz
14–19	2·40	1·20	·69	·50
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SAE brings Catalogue of copper and resistance wires in all coverings.

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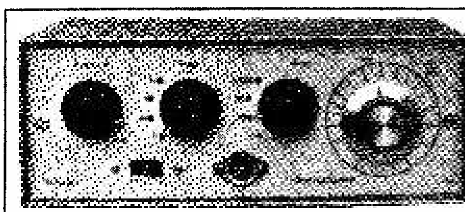

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Very Low Distortion
Audio Signal Generator

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A J. Linsley Hood design

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Specification. Frequency range: 10 Hz-100 kHz in 4 steps. Output: 10mV-1 volt in 3 steps. Sine- and Square-wave forms: Dist. below ·02%. Attenuator: Powered by 9V battery.

Other instruments: Millivoltmeter, Frequency Meter, Reg. P.S. Units. THD Analayser. Also Hi-Fi Amp kits 10-100 F.M. Tuners, Kef Speaker Units.

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325, Fore Street, Edmonton, London, N.9. Telephone: 01-807-3719.

FREE DX

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ADD 100-600 MHz with an LF Converter. Antenna tuning, feeds 3·5-4 MHz receiver, only £8·80.

EXPLORE 10-150 KHz with a VLF Receiver, only £9·70. FIND DX with a Crystal Calibrator. Switched 1MHz, 100, 25 KHz markers to VHF for only £13·80.

Make SURE your ANTENNA is OKAY with an Antenna Noise Bridge, 1-150 MHz, only £8·20.

Each easy-assembly kit includes ALL parts, printed circuit, case, battery, etc., instructions, postage, money back assurance. Get more DX, SEND TODAY.

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ARMATURE & COIL WINDING ENAMELLED COPPER WIRE

Only top quality materials supplied.
All orders dispatched within 24 hrs.

S.W.G.	1 lb reel	½ lb reel
10 to 19	£2·95	£1·60
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All prices are inclusive of P. & P. in U.K.

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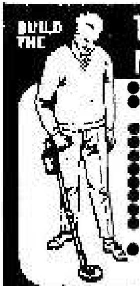
3½ DIGIT DVM MODULE kit. Autozero, autopolarity only £37·50. SAE details. MLC, 116 College Road, Southwater, Horsham, Sussex.

BUILD THE

TREASURE TRACER MK III Metal Locator



- Varicap tuning
- Britain's best selling metal locator kit;
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- Knocks down to only 17in.
- Prebuilt search coil assembly
- Thoroughly professional finish
- As seen on BBC1 and BBC2 TV
- You only need soldering iron, screwdriver, pliers and snips
- Five transistor circuit

Send stamped, addressed envelope for leaflet

Complete kit **£15·95** Built & tested **£20·95**

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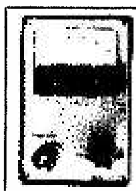
OUTSTANDING 2200 Hi-Fi FM Tuner. Full coverage 88-102MHz. Varicap tuning. Latest silicon superhet design. Ideal for push button/manual tuning, only £9·95. Unique 3300 stereo class A Amplifier, power 32 watts peak, complete stereo Pre-Amplifier/ 2 Power Amplifiers, all inputs accepted. Only £10·95. 5500 Tuner Amplifier plus specification as above 2. Only £19·95. All equipment built, tested and guaranteed with full instructions. (P&P 50p.) GREGG ELECTRONICS, 86-88 Parchmore Road, Thornton Heath, Surrey.



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- ★ Complete kit £29·50
- ★ Linear scale
- ★ 6 ranges up to 100 KHz
- ★ Easy to calibrate—quartz standard supplied on loan

Send SAE for details to:
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Whilst prices of goods shown in classified advertisements are correct at the time of closing for press, readers are advised to check with the advertiser both prices and availability of goods before ordering from non-current issues of the magazine.

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Any 5-64p, 10-£1·20, 50-£5·00. Your choice from the list below.

ECC82, EF80, EF183, EF184, EH90, PCF80, PCF802, PCL82, PCL84, PCL85, PCL86, PCL805, PL504, PY81/800, PY88, 30PL14, 6F28, PFL200.

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Aerial boosters can produce remarkable improvements on the picture and sound, in fringe or difficult areas.

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All boosters are complete with battery with Co-ax plugs and sockets. Next to the set fitting. £4·20

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Values from ·01uF to 1·5uF, 250v/w. Price **£1·50** (mixed packs).

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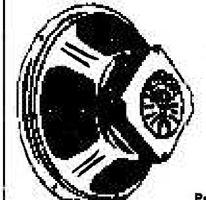
From 1uF to above 500uF. Mixed voltages. Price £2·00 (mixed packs).

All prices include VAT. P&P 30p per order. Please send uncrossed P.O. or cheques for returning if we are out of stock of capacitor bargain packs. Exports welcome at cost.

ELECTRONIC MAILORDER LTD.
62 BRIDGE STREET, RAMSBOTTOM, BURY, LANCS.
TEL: RAMS (070 682) 3036

Please mention Practical Wireless when replying to Advertisements

Sonic
HI-FI DISCOUNT CENTRES



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Imp 8 or 15Ω as app.
Guarantees:
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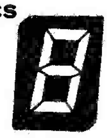

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POLYESTER CAPACITORS: Axial lead type. (Values are in µf). **400V:** 0·001, 0·0015, 0·0022, 0·0033 **8p**; 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p**; 0·022, 0·033, **10p**; 0·047, 0·068, **14p**; 0·1, **15p**; 0·15 0·22, **22p**; 0·33, 0·47 **39p**; 0·68 **45p**. **160V:** 0·039, 0·15, 0·22 **11p**; 0·33, 0·47 **19p**; 0·68, 1·0 **22p**; 1·5 **29p**; 2·2 **32p**; 4·7 **36p**. **DUBILIER: 1000V:** 0·01, 0·015 **16p**; 0·022 **18p**; 0·047 **16p**; 0·1 **34p**; 0·47 **43p**.

POLYESTER RADIAL LEAD (Values in µf). **250V:** 0·01, 0·015 **6p**; 0·022, 0·027 **7p**; 0·033, 0·047, 0·068, 0·1 **8p**; 0·15 **12p**; 0·22, 0·33 **14p**; 0·47 **16p**; 0·68 **20p**; 1·0 **24p**; 1·5 **27p**; 2·2 **31p**.

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). **63V:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8, 10, 15, 22, **9p**; 47, 32, 50, **12p**; 63, 100, **27p**; **50V:** 1·0, **7p**; 50, 100, 220, **25p**; 470, **50p**; 1000, **62p**; 2200, **68p**; **40V:** 22, 33µF, **9p**; 100, **12p**; 3300, **62p**; 4700, **64p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; 1000, **49p**; **25V:** 10, 22, 47, **6p**; 80, 100, 160, **8p**; 220, 250, **13p**; 470, 640, **25p**; 1000, **27p**; 1500, **30p**; 2200, **34p**; 3300, **52p**; 4700, **54p**; **16V:** 10, 40, 47, 68, **7p**; 100, 125, **8p**; 470, **16p**; 1000, 1500, **20p**; 2200, **34p**; **10V:** 4, 100, **6p**; 640, **10p**; 1000, **14p**.
TAG-END TYPE: 70V: 2000, **98p**; 4700, **121p**; **50V:** 3000 **75p**; **40V:** 2500, **65p**; **25V:** 4700, **48p**; 2000, **37p**; **40V:** 2000+2000, **95p**; **350V:** 32+32, **185p**.

TANTALUM BEAD CAPACITORS
35V: 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8. **25V:** 1·5, 10. **20V:** 1·5µF **13p** each. **10V:** 22µF, 33, **6V:** 22µF, 47, 68, **3V:** 100µF **20p** each. **10V:** 100µF **35p. 16V:** 100µF **45p**

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF **5p**
0·015, 0·02, 0·03, 0·04, 0·05, 0·056µF **6p**
0·1µF, 0·15, 0·2 **7p.** **50V:** 0·47µF **10p**

CERAMIC CAPACITORS 50V.
Range: 0·5pF to 10nF **3p**
15nF, 22nF, 33nF, 47nF, **4p.** 100nF **6p**

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

POTENTIOMETERS (AB or EGEN)
Carbon Track, 0·25W Log & 0·5W Linear values
1KΩ & 2KΩ (LIN. ONLY) Single gang **26p**
5KΩ–2MΩ single gang **26p**
5KΩ–2MΩ single gang D/P switch **55p**
5KΩ–2MΩ dual gang stereo **70p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm
5KΩ–500KΩ single gang **70p**
10KΩ–500KΩ Dual gang **80p**
Self-Stick graduated Alum. Bezels **20p**

PRESET POTENTIOMETERS
0·1W 50Ω–2·2M Mini. Vert. & Horiz. **8p**
0·25W 100Ω–3·3MΩ Horiz. } larger **10p**
0·25W 250Ω–4·7MΩ Vert. } **10p**

JACKSONS VARIABLE CAPS.
Dielectric
100/300pF **105p**
500pF **125p**
DILEMIN
300pF/500pF **185p**
4832/2K 2 speed Drive Unit complete with knobs and coupling **350p***
6:1 Ball Drive 4511/DAF **107p***
Dial Drive 4103 6:1/36:1 **520p**
Drum 54mm **30p***
0-1-365pF **268p**
00 2 365pF **275p**
0 2 365pF with slow motion Drive **305p**
00 208/176 **285p**
" " with slow motion drive **305p**
C804–5pF; 10; 15; 25; 50pF **150p***
100, 150pF **215p***
'L' 3x310pF **428p**
00-3x25pF **386p**

RESISTORS–Erie make 5% carbon Miniature High Stability, Low Noise

	RANGE	Val.	1–99	100+
0·25W	2·2Ω-4·7M	E24	1·5p	1p
0·5W	2·2Ω-4·7M	E12	2p	1·5p
1W	2·2Ω-10M	E12	5p	4p
2% Metal Film	10Ω–1M		6p	4p

SILVER MICA (pF)
3·3, 4·7, 6·8, 10, 12, 18, 22, 27, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 200, 250 **9p** each.
300, 330, 360, 390, 600 & 820pF **16p** each.
1000, 2200pF **20p** each.

CRYSTALS
100KHz **365p**
1MHz **323p**
1·6MHz **395p**
3·2768MHz **380p**
4·433619MHz **165p**
Holder HC6U **18p**

HEAT SINKS*
TO92 **8p**
TO5 **9p**
TO18 **8p**
TO88 **22p**
TO3 **22p**
TO66 **22p**
Silicon Grease 5ml. **48p**
20ml. Syringe **125p**
Insulation Kit for TO3; TO66 or TO220 **5p** per Kit

DENCO COILS
Dual Purpose 'DP' VALVE TYPE
Range 1-5 B,Y,R,W **80p**
6-7 B. Y, R **70p**
1-5 Green **85p**
'T' Type (Trns. tuning)
Rng. 1-5 B, Y, R, W **86p**
B9A Valve Base **23p**
RDT2 **85p**
RFC 5 chokes **84p**
RFC 7(19mH) **90p**
IFT 13/14/15/16/17 **79p**
IFT 18/1·6 or 465 **95p**
TOC1 **80p**
MW 5FR **76p**
MW/LW 5FR **96p**

CERAMIC TRIMMER CAPACITORS
2–7pF; 4–15pF; 6–25pF; 8–30pF **20p**

MINIATURE TYPE:
2·5–6pF; 3–10pF;
3–30pF; 10–40pF **22p**
6–25pF; 65pF; 86pF **30p**

COMPRESSION
3–40pF; 10–80pF **22p**
25–200pF **33p**
100–800pF 1250pF **38p**

AUDIBLE Warning Devices 12V **179p***

REVERB AMP
Short spring-line Unit **448p**

S-DEC **185p***
T-DEC **340p***
U-DEC 'A' **375p***
U-DEC 'B' **655p***
16 DIL Adaptor **170p***
TO5 Adaptor **160p***
Single end lead with 1mm plug **9p***
Double ended lead with 1mm plugs **16p***

EARPHONES
Magnetic
2·5mm **18p**
3·5mm **18p**
Crystal **33p**

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Types: 109, 308, 812 or 813 **355p each**
Sockets **20p**

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12-0-12V 0·5A **240p+**
0-12 0-12 0·5A **240p+**
15-0-15V 0·5A **220p+**
24-0-24V 0·5A **260p+**
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30-0-30V 1A **295p+**
20-0-20 2A **320p+**
6-0-6V 1·5A **345p+**
0-18 0-18V 1·5A **379p+**
9-0-9V 2A **270p+**
12-0-12V 2A **320p+**
30-25-20-0-20-25-30 2A **497p+**
0-6 0-6V 6VA **240p**
0-12 0-12A 6VA **240p**
0-15 0-15V 6VA **240p**
0-20 0-20V 6VA **240p**
LT44 **54p**
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60 x 46 x 35mm
0–50µA 0–100mA
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0–500µA 0–1 Amp
0–1mA 0–50V DC
0–5mA 0–300V DC
0–10mA "S"
0–50mA "VU"
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0–50µA
0–100µA
0–500µA
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with Cores 4mm; 6mm; 10mm **20p** each

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X25 25W **340p**
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TRANSISTORS

	p
AC107	23
AC117	35
AC125*	19
AC126*	19
AC127*	18
AC128*	18
AC141*	24
AC141K*	38
AC142*	24
AC142K*	38
AC176*	18
AC187*	20
AC188*	20
ACY17	35
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
ACY40	48
ACY41	39
ACY44	39
AD149*	70
AD161*	42
AD162*	42
AF114*	20
AF115*	20
AF116*	20
AF117*	22
AF118*	55
AF121*	48
AF124*	55
AF125*	35
AF127*	35
AF139*	35
AF178*	70
AF180*	70
AF186*	50
AF239*	42
ASY26*	40
ASY27*	45
ASY50	95
ASY76	95
ASZ21	60
BC107*	9
BC107B*	10
BC108*	9
BC108B*	12
BC108C*	12
BC109	9
BC109B*	12
BC109C*	12
BC113	17
BC114	20
BC115	20
BC116	20
BC117	20
BC118	20
BC119*	28
BC134	20
BC135	20
BC136	18
BC137	20
BC140*	35
BC142*	28
BC143*	28
BC147	7
BC148	7
BC149	8
BC153	27
BC154	27
BC157	10
BC158	11
BC159	11
BC160*	42
BC167A	11
BC168C	12
BC169C	14

	p
BC170	18
BC171	11
BC172	10
BC177*	18
BC178*	16
BC179*	18
BC182	10
BC183	10
BC184	11
BC182L	13
BC183L	12
BC184L	14
BC186	24
BC187*	28
BC212	11
BC212L	13
BC213	11
BC213L	14
BC214	14
BC214L	15
BC307B	20
BC308	20
BC328	15
BC338	15
BC441*	45
BC461*	38
BC462*	45
BC547	12
BC548	12
BC549C	13
BC557	20
BC558	30
BCY30*	57
BCY34*	75
BCY39*	80
BCY40*	78
BCY42	48
BCY43	85
BCY58	90
BCY59*	90
BCY70*	15
BCY71*	20
BCY72	15
BCY78	35
BCZ10	145
BCZ11	145
BD106	125
BD112	95
BD115*	62
BD124*	115
BD131*	38
BD132*	38
BD133*	43
BD135	38
BD136	36
BD137	36
BD138	50
BD139	34
BD140	36
BD142	59
BD144*	198
BD145*	198
BD181	85
BD205	110
BD434	42
BD378*	65
BD517*	65
BDY11	220
BDY17*	195
BDY60*	110
BDY61*	165
BF115*	22
BF154*	23
BF156*	29
BF160	30
BF161	60
BF167	30
BF173*	25
BF177*	24
BF178*	25

	p
BF179*	30
BF180*	30
BF181*	30
BF182*	30
BF183*	30
BF184*	20
BF194	10
BF195	10
BF196	12
BF197	15
BF198	18
BF199	18
BF200	30
BF224A	18
BF244B	30
BF256*	50
BF257*	29
BF258*	29
BF259*	30
BF594	40
BF595	38
BFR39	25
BFR40	28
BFR79	28
BFR80	28
BFX29*	28
BFX81*	130
BFX84*	24
BFX85*	28
BFX86*	28
BFX87*	23
BFX88*	28
BFY18*	50
BFY50*	17
BFY51*	17
BFY52*	17
BFY53*	28
BFY55*	45
BFY64*	40
BFY71*	47
BSX20*	18
BSX26*	75
BSX29*	45
BSX78*	55
BSY95A	18
BU105*	140
BU205	190
BU208	228
MD8001	158
ME1120	25
ME4102	15
MJ400*	90
MJ491*	160
MJ2955*	120
MJE340*	45
MJE370*	80
MJE371*	80
MJE520*	65
MJE521*	74
MJE2955*	115
MJE3055*	60
MPF102	36
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	32
MPSA06	32
MPSA55	30
MPSA56	30
MPSA70	34
MPSU02	58
MPSU05	50
MPSU06	56
MPSU52	85
MPSU55	55
MPSU56	60
MPU131*	39

	p
OC23*	150
OC25*	120
OC26*	150
OC28*	105
OC29*	160
OC35*	100
OC36*	170
OC41*	48
OC42*	40
OC43*	65
OC44*	35
OC45*	35
OC70*	30
OC71*	30
OC72*	30
OC74*	45
OC75*	45
OC76*	76
OC77*	76
OC79*	76
OC81D*	28
OC82D*	48
OC83*	48
OC84*	44
OC122*	99
OC123*	115
OC139*	140
OC140*	125
OC141*	157
OC170*	40
OC171*	40
OC200*	70
OC201*	125
OC203*	150
OCP204*	150
SJE5039*	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	52
TIP30A	52
TIP30B	64
TIP30C	70
TIP31*	50
TIP31A*	50
TIP31B*	58
TIP31C*	66
TIP32*	55
TIP32A*	60
TIP32B*	75
TIP32C*	77
TIP33*	85
TIP33A*	85
TIP33B*	100
TIP33C*	110
TIP34*	95
TIP34A*	95
TIP34B*	120
TIP34C*	140
TIP35*	219
TIP35A*	225
TIP35B*	240
TIP35C*	270
TIP36*	280
TIP36A*	280
TIP36B*	300
TIP36C*	325
TIP41A*	66
TIP41B*	73
TIP42A*	72
TIP42B*	82
TIP2955*	65
TIP3055*	52
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50

	p
TIS49	50
TIS50	47
TIS74	47
TIS90	24
TIS91	24
ZTX107	22
ZTX108	20
ZTX109	25
ZTX212	28
ZTX300	16
ZTX301	16
ZTX302	25
ZTX303	25
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	30
ZTX341	20
ZTX500	17
ZTX501	15
ZTX502	19
ZTX503	19
ZTX504	25
ZTX531	28
ZTX550	25
40250	85
40251	97
40311*	56
40313*	125
40315	55
40316*	95
40317*	52
40319	71
40320	56
40323	60
40324	99
40326*	52
40327*	62
40347*	99
40348*	116
40360*	43
40361*	45
40362*	48
40406	65
40407	56
40408	75
40411*	285
40412*	65
40467*	129
40594*	98
40595*	125
40603*	113
40636*	165
40673*	87
2N697*	21
2N698*	39
2N699*	50
2N706A*	19
2N707*	50
2N708*	19
2N914*	32
2N916*	27
2N918*	30
2N920*	51
2N930*	18
2N961*	61
2N1131*	22
2N1132*	22
2N1303*	50
2N1304*	50
2N1305*	28
2N1306*	35
2N1307*	50
2N1308*	46
2N1613*	20
2N1670*	150
2N1671B*	195
2N2160*	105
2N2217*	48
2N2218A*	35

	p
2N2219A*	22
2N2220A*	26
2N2221A	25
2N2222A*	20
2N2303*	50
2N2368	25
2N2369A*	15
2N2483*	28
2N2484*	30
2N2646*	48
2N2784	55
2N2904*	22
2N2905A*	20
2N2906*	18
2N2907*	20
2N2907A*	22
2N2926G	10
2N3011*	30
2N3053*	17
2N3054*	49
2N3055*	60
2N3108	60
2N3442	142
2N3563	32
2N3614*	169
2N3615*	135
2N3663	26
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	11
2N3709	11
2N3710	16
2N3711	12
2N3772*	170
2N3773*	288
2N3819	22
2N3820	38
2N3823*	65
2N3824*	70
2N3866	90
2N3903	20
2N3904	18
2N3905	18
2N3906	17
2N4037*	52
2N4041*	80
2N4058	17
2N4061	17
2N4062	13
2N4064*	120
2N4069	45
2N4236	145
2N4288	20
2N4289	20
2N4859	65
2N4922*	55
2N5135	42
2N5136	42
2N5138	20
2N5179	60
2N5180	60
2N5191	65
2N5305	40
2N5457	35
2N5458	35
2N5459	38
2N5485	38
2N5777	58
2N6027	40
2N6109	45
2SD234*	50
3N128	85
3N140	85

Matched Pair 10p extra

TTL 74* (TEXAS)

7400	14
7401	14
7402	16
7403	16
7404	20
7405	22
7406	38
7407	38
7408	20
7409	20
7410	15
7411	70
7412	23
7413	37
7414	74
7416	35
7417	30
7420	16
7421	33
7422	24
7423	32
7425	30
7426	36
7427	38
7428	38
7430	16
7432	32
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	76
7450	17
7451	17
7453	17
7454	17
7460	17
7470	32
7472	28
7473	32
7474	32
7475	42

7476	36
7480	50
7481	97
7482	82
7483	93
7484	95
7485	110
7486	36
7489	320
7490	36
7491	80
7492	53
7493	35
7494	85
7495	70
7496	82
7497	262
74100	128
74104	82
74105	82
74107	33
74109	64
74110	64
74111	74
74116	188
74118	90
74120	115
74121	28
74122	48
74123	70
74125	95
74126	60
74128	77
74132	73
74141	72
74142	280
74143	314
74144	314
74145	85
74147	175
74148	143
74150	118
74151	75
74153	75
74154	140
74155	82
74156	80
74157	80
74159	225
74160	116

74161	118
74162	116
74163	118
74164	121
74165	130
74166	161
74167	198
74172	625
74173	175
74174	113
74175	98
74176	120
74177	118
74180	142
74181	299
74182	127
74184	225
74185	146
74188	650
74190	146
74191	140
74192	140
74193	140
74194	140
74195	95
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74197	118
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4013	55
4014	99
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4016	52
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4018	99
4019	60
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4021	99
4022	90
4023	20

4024	78
4025	19
4026	180
4027	55
4028	90
4029	109
4030	58
4031	230
4032	100
4033	145
4034	196
4035	120
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4050	52
4051	89
4052	89
4053	89
4054	120
4055	134
4057	2570
4059	480
4060	115
4063	110
4066	58
4067	380
4068	22
4069	22
4070	32
4071	21
4072	21
4073	21
4075	23
4076	129
4077	40
4078	21
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4093	85
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4516	128
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4520	108
4528	98
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M253AA*	950
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Suitable carrying cabinet £16. Carr. £2. Price **£94** carr. £2·50

ANOTHER R.C.S. BARGAIN !

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This famous unit now available, 10 watts, 8 ohm.
Price **£3·45** Post 40p

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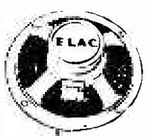

Large ceramic magnet.
Response: 50-18,000 cps.
Bass resonance 55 cps.
16 ohm impedance
10 watts. Post 40p **£4·50**

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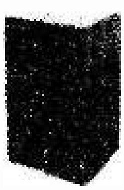

MODEL "A". 20 × 13 × 12in. For 12in. dia. or 10in speaker. Illustrated. **14·50** Post £1·60
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3½in. diam. 18,000 C.P.S. 25 WATTS 8 Ω **£3·25**
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5in. EMI mid range £5.
10in. 30 watt GOODMANS woofer 4 ohm £10·95.

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Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/249V.
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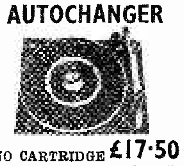

Plays 12in. 10in. or 7in. records Auto or Manual. A high quality unit backed by BSR reliability with 12 months guarantee. A.C. 200/250V. Size 13½ × 11¼in.
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Below motor board 2½in.
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BSR P128 with Ceramic Cartridge £19·50

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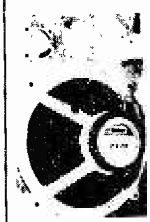
Post £1



90-14,500 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 25 watts. NOTE: 4 or 8 or 16 ohms must be stated.

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30-17,000 c/s with tweeter, crossover, baffle 19 × 12½in. Please state 4 or 8 or 16 ohms. **£19·00** Post £1·60

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Bass resonance 55 cps.

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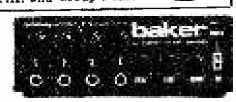

Professional amplifier using advanced circuit design. Ideal for disco, groups, P.A. or musical instruments. 4 inputs 4 way mixing. Master treble, bass and volume controls. 3 speaker output sockets to suit various combinations of speakers. 4-8-16 ohm. Slave output. A/C mains. Guaranteed. Details S.A.E. **£72** Carr. £1·00

100 WATT DISCO AMPLIFIER

MADE BY JENNINGS MUSICAL INSTRUMENTS **£59**
4 Speaker outputs volume, treble, bass, controls
CAN BE USED AS 100 WATT SLAVE Carr. £1

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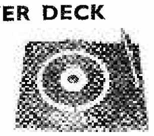

3 speed. Plays all size records, Stereo Cartridge. Cueing device, Ideal Disco Deck.
£13·50 Post 75p

DRILL SPEED CONTROLLER/LIGHT DIMMER KIT. Easy to build kit. Will control up to 500 watts AC mains. Post 35p **£3·25**

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

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6 VOLT ½ AMP. £1·00 3 AMP. £1·40
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2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£8·50
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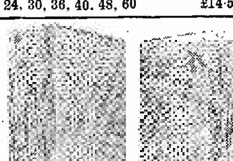
5A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40. 48, 60	£14·50

R.C.S. BOOKSHELF SPEAKERS



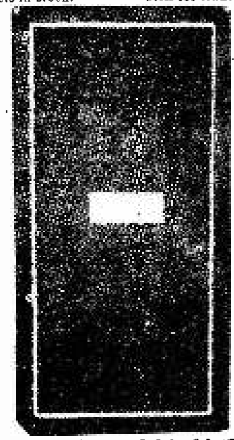
13 × 10 × 6in.
50 to 14,000 cps.
8 watts rms. 8 ohms
£16 pair Post £1·30

BAKER DISCO SPEAKERS

HIGH QUALITY—BRITISH MADE

2 x 12" CABINETS

For Disco or PA all fitted with carrying handles and corners. Black vynide covered. Other cabinets in stock. SAE for leaflet

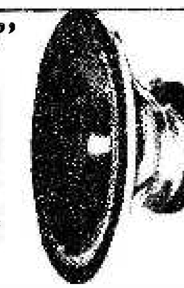


60 WATT R.M.S. £52 Carr. £3
80 WATT R.M.S. £56 Carr. £3
100 WATT R.M.S. £69 Carr. £4

1 x 15" + 1 x 12" 100 WATT CABINET
Size 36" x 24" x 15" £75·00. Carr. £5
Ideal for Disco, Organ or PA work.
High quality. Full range.

"SUPERB HI-FI"

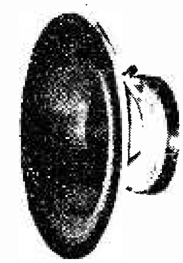
12in 25 watts



A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.
Bass Resonance 25cps
Flux Density 16,500 gauss
Useful response 20-17,000cps
8 or 16 ohms models.
£22·00 Post £1·60

"AUDITORIUM"

12in. 35 watts



A full range reproducer for high power, Ideal for Hi-Fi and Discotheques. Electric Guitars, public address, multi-speaker systems, electric organs.
Bass Resonance 35cps
Flux Density 15,000 gauss
Useful response 25-16,000cps
8 or 16 ohms models.
£21·00 Post £1·60

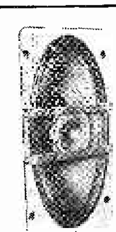
"AUDITORIUM"

15in. 45 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home Hi-Fi.
Bass Resonance 35cps
Flux Density 15,000 gauss
Useful response 20-14,000cps
8 or 16 ohms models.
£26·00 Post £1·60

Loudspeaker Cabinet Wadding 18in wide, 20p per ft.
Hi-Fi Enclosure Manual containing plans, designs, crossover data and cubic tables, 68p.

E.M.I. 13½ × 8in SPEAKER SALE!



With tweeter. And crossover. 10W. State 3 or 8 ohm. **£7.95** Post 45p
15W model 8 ohms. **£10·50** Post 65p
GOODMANS 20W Woofer Size 12 × 10in 4 ohms. **£9.95** Post 65p

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