APRIL 1978

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AA113	10p	BA138	16p	BC168B	14p	BC548C	14p	BF123	45p	BF336	35p	BY164	50p	OC140	150p	TIP35A	230p	2N1305	30p
AAZ17	30p	BA148	16p	BC168C	15p	BC549B	13p	BF125	45p	BF337	35p	BYX94	8p	OC171	40p	TIP35C	280p	2N1306	38p
AC121	30p	BA154	12p	BC169C	15p	BC549C	14p	BF127	50p	BF363	60p	C1120	30p	OC200	80p	TIP36A	350p	2N1308	50p
AC126	19p	BA157	15p	BC171	12p	BC557	13p	BF166	30p	BFS94	30p	C1164	20p	ORP12	70p	TIP41A	70p	2N1711	22p
AC127	19p	BA173	15p	BC172C	12p	BCY34	80p	BF167	25p	BFW58	20p	E100	42p	R1039	150p	TIP41B	75p	2N2219A	25p
AC127/01	25p	BA216	16p	BC178A	16p	BCY70	15p	BF173	25p	BFX29	30p	E300	47p	TIP29	45p	TIP41C	80p	2N2483	30p
AC128	18p	BA316	16p	BC182	10p	BCY71	20p	BF179	35p	BFX81	130p	E430	125p	TIP29A	47p	TIP42A	80p	2N2906	18p
AC151	25p	BAX13	5p	BC182L	12p	BCY72	15p	BF179C	40p	BFX84	25p	MJE340	45p	TIP29C	75p	TIP42B	85p	2N2907	20p
AC153K	40p	BAX16	5p	BC183	10p	BD121	85p	BF180	30p	BFX85	30p	MPSA06	25p	TIP30	55p	TIP2955	70p	2N3053	20p
AC176	20p	BB105A	35p	BC183L	12p	BD123	100p	BF181	35p	BFX87	25p	OA10	40p	TIP30A	58p	TIP3055	55p	2N3054	50p
ACY17	35p	BB110	45p	BC184	10p	BD124	85p	BF182	30p	BFX88	25p	OA47	15p	TIP30B	65p	TIS90	25p	2N3055	60p
ACY21	30p	BC107	10p	BC184L	12p	BD131	36p	BF183	30p	BFY50	20p	OA90	6p	TIP30C	80p	TIS91	25p	2N3439	50p
AD149	60p	BC108	10p	BC186	24p	BD132	39p	BF186	25p	BFY51	20p	OA91	6p	TIP31	55p	IN914	5p	2N3702	11p
AD161	40p	BC108C	15p	BC205	14p	BD133	45p	BF194	10p	BFY52	20p	OA202	8p	TIP31A	58p	IN3754	20p	2N3703	12p
AD162	40p	BC109	10p	BC212	11p	BD135	40p	BF195	10p	BFY90	125p	OC23	200p	TIP31B	65p	IN4001	5p	2N3704	11p
AD161/2MP	90p	BC109C	14p	BC212L	12p	BD136	40p	BF196	10p	BR101	35p	OC25	100p	TIP31C	70p	IN4002	5p	2N3705	12p
AF114	22p	BC113	12p	BC213L	12p	BD137	40p	BF197	10p	BRY39	35p	OC28	75p	TIP32	60p	IN4003	5p	2N3706	11p
AF115	22p	BC117	19p	BC214	13p	BD139	38p	BF198	25p	BRY56	35p	OC35	75p	TIP32A	65p	IN4004	5p	2N3711	12p
AF116	22p	BC125	20p	BC214L	14p	BD140	40p	BF199	25p	BSX20	20p	OC42	35p	TIP32B	85p	IN4005	5p	2N3715	300p
AF117	22p	BC126	15p	BC258	13p	BD181	80p	BF200	30p	BSY40	25p	OC43	35p	TIP32C	90p	IN4006	6p	2N3772	175p
AF118	50p	BC146	12p	BC294	35p	BD182	80p	BF224	20p	BSY95	20p	OC45	35p	TIP33	100p	IN4007	7p	2N3819	25p
AF125	25p	BC147	10p	BC303	55p	BD207	70p	BF225	20p	BT100A	80p	OC71	25p	TIP33A	105p	IN4148	4p	2N3866	95p
AF139	35p	BC148	10p	BC317	15p	BD233	50p	BF241	16p	BU105	150p	OC72	30p	TIP33B	115p	IS44	4p	2N3904	15p
AF239	45p	BC148C	14p	BC323	60p	BD263	65p	BF244B	35p	BU133	75p	OC75	30p	TIP33C	130p	2N456A	90p	2N4062	14p
ASY26	40p	BC149	10p	BC328	13p	BDY10	100p	BF257	26p	BU208	220p	OC81	30p	TIP34	115p	2N697	15p	2N4126	20p
BA114	9p	BC157	10p	BC338	12p	BDY62/01	80p	BF258	28p	BY100	20p	OC81D	25p	TIP34A	118p	2N929	20p	2N5061	35p
BA121	9p	BC158	10p	BC547	12p	BF120	50p	BF259	30p	BY126	15p	OC83	50p	TIP34B	145p	2N930	20p	2N5163	35p
		BC159	10p	BC547B	13p	BF121	45p	BF274	15p	BY127	15p	OC84	50p	TIP35	225p	2N1302	25p	2N6027	50p
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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
12V	10p
13V	10p
15V	10p
18V	10p
20V	10p
22V	10p
27V	10p
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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		

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Mullard or Erie
µF

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·0022	5p
·0033	5p
·0047	5p
·0068	5p
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4012	20p	4030	60p	4081	20p
4013	55p	4032	150p	4082	30p
4015	80p	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		

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2A 100V	50p
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CA3130	100p	SN76228N	180p
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LM307N	65p	TAA350	190p
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LM308DIL	130p	TAA661B	140p
LM309K	180p	TAA700	390p
LM310TO5	160p	TAD100	160p
LM311TO5	260p	TAD110	130p
LM317K	325p	TBA120S	80p
LM324N	350p	TBA120T	125p
LM348N	200p	TBA520Q	240p
LM380N	110p	TBA530Q	215p
LM555	35p	TBA540	230p
LM710TO5	60p	TBA540Q	240p
LM710DIL	65p	TBA550Q	335p
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ISSUE 854

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UCC35†	0·50*
UCF80	0·75*
UCH42	1·20*
UCH81†	0·50*
UCL82†	0·50*
UCL83	1·44*
UF41	0·75*
UF80†	0·50*
UF85†	0·50*
UF89†	0·50*
UL41	1·00*
UL84†	0·60*
UM80	1·00*
UY41†	0·75*
UY85†	0·65*
1B3GT†	0·55*
1R5†	0·55*
1S5†	0·40*
1T4†	0·40*
2AS15	10·00
2D21†	0·55
3A5	1·35
3CX100A5	20·00
3S4†	0·75*
3V4†	1·00*
4CX250B	17·50
5R4GY†	1·00*
5U4G	1·52*
5U4GB	1·00*
5V4G†	0·65*
5Y3GT	0·85*
5Z3	1·50*
5Z4G	1·12*
5Z4GT	1·00*
6-30L2	1·00*
6AB7	0·75*
6AC7	0·75*
6AF4A†	0·70*
6AG7	0·75*
6AH6†	0·70*
6AK5†	0·30
6AK6	0·95*
6AL5†	0·30*
6AM4	2·30*
6AM5	3·85*
6AM6†	0·65*
6AN5	2·50*
6AN8A†	0·70*
6AQ5†	0·75*
6AR5	0·70*
6AS6†	0·80*
6AS7G†	1·50*
6AT6†	0·65*
6AU5GT	4·26*
6AU6†	0·55*
6AV5GT	3·74*
6AV6†	0·50*
6AW8A†	1·00
6AX5GT	3·10*
6B7	0·75
6B8	0·75
6BA6†	0·50*
6BA7	5·12*
6BA8A	3·75
6BC4	3·71
6BE6†	0·45*
6BH6†	1·20*
6BJ6†	0·80*
GBK4	4·21*
6BL6	85·00
6BL7GT	3·86*
6BN6	0·80*
6BQ7A	1·55*
6BR7	4·00*
6BR8†	1·20*
6BS7	4·00*
6BW6	3·75*
6BW7	1·12*
6BX7GT	4·96*
6BZ6	1·78*
6C4†	0·40*
6CB6A†	0·50*
6CD6GA	4·00*
6CG7	1·72*
6CH6	4·42*
6CL6†	0·75*
6CW4	4·72*
6D2†	0·30*
6DK6	2·49*
6DQ6B	3·04*
6EA8	2·21*
6EB8	2·12*
6EW6	0·80*
6F6	0·75
6F23	1·60*
6F28	1·60*
6H2N	0·75*
6H3N	0·75*
6H6	0·75*
6J4†	0·75*
6J6†	0·55*
6J7	0·75*
6K4N	0·75*
6K6GT	0·75*
6K7	0·75*
6K8	0·75*
6KD6	4·79*
6L6G	2·50*
6L6GA	1·50*
6L6GT	0·85*
6L6GC	1·75*
6L7	0·75
6N2P	0·75
6N3P	0·75
6N7	0·75*
6P25	3·60*
6Q7	0·80*
6R7	0·80*
6SA7	0·80*
6SC7	0·80*
6SF7	0·80*
6SH7	0·80*
6SJ7	0·80*
6SK7	0·80*
6SL7GT†	0·70*
6SN7GT†	0·70*
6SQ7	0·75*
6SR7	0·75*
6SS7	0·75*
6U5G	2·00*
6U8†	0·40*
6U8A†	0·55*
6V6GT†	0·60*
6X4†	0·45*
6X5GT†	0·55*
7B7	1·00*
7C5	1·75*
7C6	1·25*
7H7	1·00*
7R7	1·50*
7S7	2·25*
7Y4	0·75*
7Z4	0·75*
12AT6	0·45*
12AT7†	0·45*
12AU6	0·50*
12AU7†	0·45*
12AV6	0·60*
12AV7	2·84*
12AX7†	0·45*
12AY7†	0·82*
12B4A†	1·00*
12BA6	0·50*
12BE6	1·60*
12BH7†	0·60*
12BY7†	0·80*
12E1	4·00
30C15	1·20*
30C17	1·20*
30C18	1·44*
30F5	1·60*
30FL1/2	1·12*
30FL12	1·72*
30FL14	1·44*
30L1	0·84*
30L15	1·72*
30L17	1·72*
30P4	0·92*
30P19	1·12*
30PL1	1·32*
30PL13	1·72*
30PL14	1·68*
30PL15	1·72*
35W4	0·60*
50C5	0·70*
85A2	1·50
90AG	7·26
90AV	7·16
90C1	1·50
90CG	5·74
90CV	5·99
92AG	7·26
92AV	7·16
150B2	1·80
150C2	1·50
150C4	2·30
211	5·00
723AB†	8·00
807†	1·00
811A†	3·80
812A	7·25
813†	10·00
833A	30·00
866A	8·85
872A	11·40
931A	12·24
2050	2·50
5642	3·16*
5654	3·61*
5651	1·80*
5670	2·86*
5814A	2·60*
6080†	6·85*
6146A	4·27
6146B	4·65
6159	6·00
6442	15·00
6973	2·61
7586	6·79
7587	12·54
7868	2·93*
8068	5·50
8136	1·54

INTEGRATED CIRCUITS

Type	Price
7400	0·20
7401	0·20
7402	0·20
7403	0·20
7404	0·26
7405	0·23
7406	0·55
7407	0·55
7408	0·28
7409	0·28
7410	0·20
7412	0·26
7413	0·45
7416	0·40
7417	0·40
7420	0·20
7422	0·25
7423	0·35
7425	0·35
7427	0·35
7428	0·50
7430	0·20
7432	0·36
7433	0·37
7437	0·42
7438	0·37
7440	0·22
7441AN	0·92
7442	0·78
7447AN	1·20
7450	0·20
7451	0·20
7453	0·20
7454	0·20
7460	0·20
7470	0·35
7472	0·36
7473	0·36
7474	0·40
7475	0·59
7476	0·42
7480	0·60
7482	0·85
7483	1·00
7484	1·00
7486	0·40
7490	0·52
7491AN	0·85
7492	0·60
7493	0·70
7494	0·80
7495	0·80
7496	0·90
7497	3·67
74100	1·75
74107	0·45
74109	0·86
74110	0·57
74111	0·86
74116	1·89
74118	0·95
74119	2·00
74120	1·10
74121	0·45
74122	0·60
74123	1·00
74125	0·80
74126	0·80
74128	0·80
74132	0·80
74136	0·68
74141	0·85
74142	3·00
74143	3·00
74144	3·00
74145	1·00
74147	2·45
74148	2·00
74150	1·75
74151	0·90
74154	2·00
74155	0·90
74156	0·90
74157	0·90
74159	2·50
74170	2·60
74172	5·00
74173	1·75
74174	1·57
74175	1·00
74176	1·10
74178	1·65
74179	1·65
74180	1·65
74190	1·48
74191	1·48
74192	1·25
74193	1·25
74194	1·25
74195	1·10
74196	1·20
74197	1·00
74198	2·25
74199	2·25
76013N	1·75*
LM309K	1·50
TAA570	2·30*
TAA630S	3·50*
TBA480Q	1·84*
TBA520Q	2·30*
TBA530	1·98*
TBA540Q	2·30*
TBA550Q	3·22*
TBA560CQ	3·22*
TBA673	2·19*
TBA700	1·52*
TBA720Q	2·30*
TBA750Q	2·07*
TBA990Q	2·99*
TCA270Q	2·99*
TCA760A	1·38*

DIL Sockets

Type	Price
8 PIN	0·15
14 PIN	0·15
16 PIN	0·17

BASES

Type	Price
BG7 unskirted	0·15
B7G skirted	0·30
B9A unskirted	0·15
B9A skirted	0·30
Int Octal	0·20
Nuvistor	0·25
Loctal	0·55
8 pin DIL	0·15
14 pin DIL	0·15
16 pin DIL	0·17
Valve screening cans all sizes	0·30

CRT'S

Type	Price
1CP31	31·00
2AP1*	8·50
2BP1*	9·00
3BP1	8·00
3DP1*	5·00
3EG1*	7·00
3FP7*	3·00
3GP1	6·00
3JP1*	8·00
3JP2*	8·00
3JP7*	10·00
SKP1*	15·00
3RP1*	35·00
4EP1	25·00
4EP7	25·00
4EP11	25·00
5ADP1	35·00
5BP1*	10·00
5CP1*	5·00
5CP1A	40·00
5FP15A	5·00
5UP7*	5·00
DG7-5	25·00
DG7-32	36·00
DH3-91	31·00
DH7-11	68·00
VCR97*	5·00
VCR138*	10·00
VCR138A*	12·50
VCR139A*	8·00
VCR517A*	3·00
VCR517B*	3·00
VCR517C*	3·00
Tube Bases	0·75

*=Surplus
VAT 8%

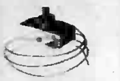
Terms of business: CWO. postage and packing valves and semiconductors 25p per order. CRTs 75p. Items marked* add 12½% VAT. Others 8%. † Indicates cheap quality version or surplus, but also available by leading UK and USA manufacturers. Price ruling at time of despatch. Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1 on credit orders. Over 10,000 types of valves, tubes and semiconductors in stock. P&P 8% VAT

QUOTATIONS FOR ANY TYPE NOT LISTED SAE.

Telephone 01-677 2424
Telex 946708

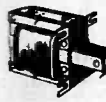
E & O.E.

THERMOSTATS

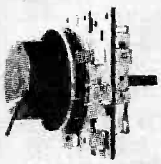


Refrigeration as illustrated with 36" capillary **£1·62.**
Limpet Stat must be mounted in close contact calibrated 90°–190°F 15 amp contacts **£1·62.**
Appliance Stat fix like a volume control—15 amp contact 30°–80°F **85p.**
ditto but for high temps **£1·25**
Over Stat—with Serson and capillary **85p**

MAINS OPERATED SOLENOIDS



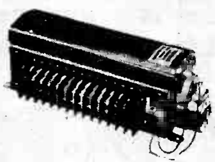
Model TT2—small but powerful 1in. pull—approx. size $1\frac{1}{2}$ x $1\frac{1}{2}$ x $1\frac{1}{4}$in., **£2.00**
Model 4001/—$\frac{3}{8}$in. pull. Size $2\frac{3}{4}$ x2 x 14in.**£2.50**
Model TT10—$1\frac{1}{4}$in. pull. Size 3 x$2\frac{1}{2}$ x 2in. **£4.50**
Prices include VAT & postage.



DELAY SWITCH

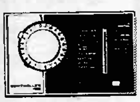
Mains operated—delay can be accurately set with pointers knob for periods of up to $2\frac{1}{2}$ hrs. 2 contacts suitable to switch 10 amps—second contact opens few minutes after 1st contact 95p.

MOTORISED DISCO SWITCH



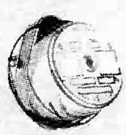
With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 200w's can be controlled and this would provide a magnificent display. For mains operating. 8 switch model **£5.25.** 10 switch model **£5.75.** 12 switch model **£6.75.**

SMITHS CENTRAL HEATING CONTROLLER



Push button gives 10 variations as follows: (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day (6) hot water and central heating on for 2 periods during the day time only—then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off. A handsome looking unit with 24 hour movement and the switches and other parts necessary to select the desired programme of heating. Supplied complete with wiring diagram. Originally sold we believe at over **£15.** We offer these while stocks last at **£6·95** each INCLUDING VAT and Postage.

LOW R.P.M. MOTORS

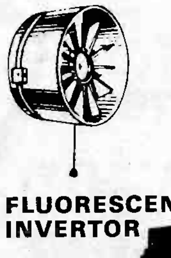


Made by Crouzet—Smiths—SAIWA—Venner and similar famous companies—all supplied ready for 230/240v 50hz mains working at **£2·75** each. Following speeds in stock when preparing this advert.

1 rev per day	6 rev per day
1 rev per hour	12 revs per hour
$\frac{1}{2}$ rev per min	1 rev per min
2 rpm	$1\frac{1}{2}$ rpm

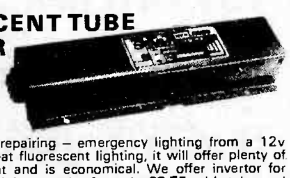
5 rpm 15 rpm 20 rpm 25 rpm 30 rpm

EXTRACTOR FAN



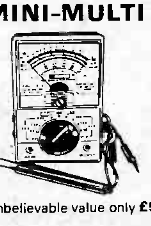
Cleans the air at the rate of 10,000 cubic feet per hour. Suitable for kitchens, bathrooms factories, changing rooms, etc. It's so quiet it can hardly be heard. Compact, $5\frac{1}{2}$in. casing comprises motor, fan blades, sheet-steel casing, pull switch, mains connector and fixing brackets. **£5·25** including post and VAT.
Monthly list available free send long stamped envelope.

FLUORESCENT TUBE INVERTOR



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

MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000opv—
11 Instant ranges measure:—
DC volts 10, 50, 250,1000
AC volts 10, 50, 150,1000
DC amps 0-1 mA and 0-100 mA
Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.
Unbelievable value only **£5·50** + 50p post and insurance.

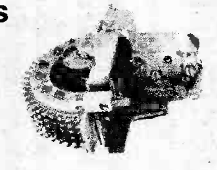
FREE

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

MULLARD UNILEX

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

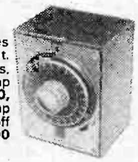
UNISELECTORS



These are pulse operated switches as used in automatic telephone switchboards etc. The pulse moves the switch arm through one position. Except where indicated the selectors are 25 position types and 50v Coil is standard, 24v or 12v operation extra at **£2** per switch.

3 pole	**£4·80**	4 pole	**£5·94**
5 pole	**£7·02**	8 pole	**£9·72**
10 pole	**£10·80**	12 pole	**£12·96**
3 pole 50 way	**£10·58**	4 pole 50 way	**£12·74**

24 HOUR TIMERS

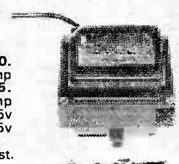


The one illustrated is 'E' controls this uses the Smiths mechanism as in their autoset. 2 On/off's per 24 hours, 13 amp contacts, override switch **£6·50.** Smiths 100 amp model one on/off per 24 hours **£10·50,** extra contacts **£1·00** per set. AEG 60 amp model with clockwork standby, one on/off per 24 hours **£9·50,** extra contacts **£1·00** per set.

INDUCTION MOTORS

One illustrated is our reference MM11 made for ITT $\frac{3}{4}$" stack $1\frac{1}{4}$" spindle **£2·25.** $\frac{1}{2}$" stack model **£1·75.** 1" stack **£2·75.** $1\frac{1}{2}$" stack **£3·25.**

MAINS TRANSFORMERS



20v $\frac{1}{2}$ amp 20w auto 230v **£1·50.** 18v $\frac{1}{2}$ amp **£1·75.** 6.3v 2 amp **£1·75.** 25v $1\frac{1}{2}$" amp **£2·25.** 24v 2 amp **£2·50.** 50v 2 amp **£4·50.** 9v 1 amp **£1·50.** 8.5v- 0-8.5v $\frac{1}{2}$ amp **£1·50.** 100w auto 230-115v **£2·00.** 8·5kv **£9·50.**
Many more, send for list.

WAFER SWITCHES

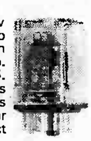
6 pole	2 way	12 pole	2 way	18 pole	2 way
5 pole	3 way	10 pole	3 way	15 pole	3 way
4 pole	4 way	8 pole	4 way	12 pole	4 way
3 pole	5 way	6 pole	5 way	9 pole	5 way
2 pole	6 way	4 pole	6 way	6 pole	6 way
2 pole	8 way	4 pole	8 way	6 pole	8 way
1 pole	10 way	4 pole	9 way	6 pole	9 way
1 pole	12 way	2 pole	10 way	3 pole	10 way
all **£1·32** each		all **£2·41** each		all **£3·12** each	

Multi bank switches up to 72 pole 2 way—to 12 pole 12 way quickly made to special order.

THIS MONTH'S SNIP

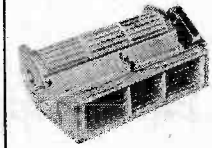
Japanese made FM tuner and matching decoder. Two items for less than average price of the tuner only – **£11·20** the two. Don't miss this – stocks will not last long.

RELAYS



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

TANGENTIAL HEATER UNIT



3KW MODEL
£5·95
+ £1·50 P & P

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

Terms. Prices include Post & VAT. But orders under £6.00 please add 50p to offset packing. Bulk enquiries – Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

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

IT'S FREE!

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

FM Tuner and decoder, 2 very well made (Japan) units, nice clear dial, excellent reproduction. **£11·20** the pair.
12 Volt Heavy Duty Relay, plug in type has three pairs of 10 amp changeover contacts. A transparent dust cover, price **£1·08** suitable 11 pin base 45.
4 Changeover Relay, upright mounting 4 sets of 10 amps changeover contacts, mains voltage coil **£1·72**
12 Volt 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 **£12·50.**
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 **£1·50** per pair. Size of clock approximately 8" x 5" x 5", totally encased but has lift up flap for ease of altering switching times. Price **£7·50.**
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 **£7·00.**
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 and instructions **£2.25**
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Band~Switch

THERE have been brief mentions recently in the national press of forthcoming changes in the wavelengths allocated to the various BBC programmes in the medium and long wavebands. These changes are due to take place on 23 November 1978, and will have a profound effect on the many listeners who have receivers which do not cover the long and medium wavebands and v.h.f.

Increases in the number and power of broadcasting stations in Europe over the years have been dramatic. Under the 1950 Copenhagen Plan, 620 transmitters with a total power of 20 megawatts were provided for in the medium and long wavebands. When the Geneva Plan comes into effect in November, these figures will be increased to 2700 transmitters and 214 megawatts. With channel spacings remaining at 9kHz, no new channels are available, so the result is a far greater degree of channel sharing. This is bound to worsen interference levels when reception ranges increase during the hours of darkness, especially in the medium waveband. Whilst this problem is not apparent on v.h.f., BBC research shows that fewer than 20 per cent of listeners make regular use of this band.

In bygone years, peak radio audiences were found in the evenings. Television has changed all that, and radio now has its largest audiences during the day, especially at breakfast time and around midday, although tea-time and the evening rush-hour is another popular listening period. The frequency planning engineers have therefore, understandably, concentrated mainly on the daytime situation in the new plan. Unfortunately, in the Northern latitudes, night-time conditions apply to the important early evening period during the winter months.

The United Kingdom was fortunate in being able to retain all its existing frequency assignments, and even gained a second channel in the long waveband, on 227kHz. Virtually all medium waveband assignments are being increased in frequency by 1kHz, to bring them up to multiples of 9kHz. This is expected to facilitate the design of future receivers incorporating synthesiser tuning.

The changes as they affect BBC programmes are that Radio 1 will be on two medium wave channels, 1053 and 1089kHz, while Radio 2 will be on 693 and 909kHz and Radio 3 moves to 1215kHz. Radio 4 is being transferred to the long waveband, where a new transmitter on 227kHz will provide coverage for Central Scotland. For the remainder of the UK, the established 200kHz channel will be used, with an additional transmitter in the North of Scotland.

The important question is how much all these changes are going to benefit the listener. Apart from increasing the service area of Radio 4, the answer is probably, regrettably, very little. Anyone without a v.h.f. or long waveband on his or her radio will be denied access to Radio 4—the principal information, news and weather forecast channel. It is certainly unlikely that there will be anv increased choice in programmes available, which is not good news for anyone with minority interests in music, hobbies or sport.

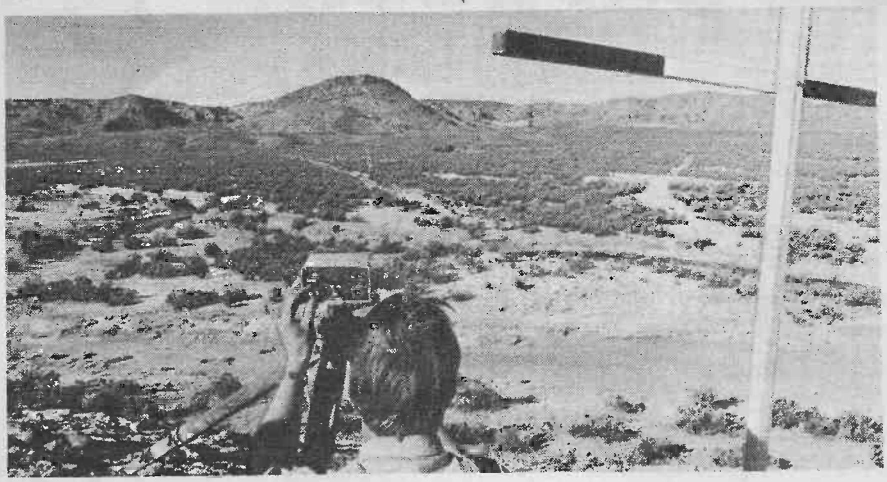
Geoffrey C. Arnold

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...

Marks of the Gods?



Tony Morrison seen using the specially assigned Tellurometer CD 6 portable infra-red distance measuring system while surveying one of a series of newly-discovered lines in the Central Andes during the making of the film, "Pathways to the Gods" which was recently shown on BBC TV.

Electronics has revolutionised the surveying profession with the introduction of high accuracy electronic distance measuring systems. Tellurometer was one of the earliest entrants into this field and their name has become almost synonymous with Electronic Distance Measurement (EDM)—the Hoover of EDM in fact.

EDM has been used successfully in the construction and positioning of North Sea oil rigs and production platforms as well as civil engineering surveying work.

In recent months, however, Tellurometer infra red EDM instruments have been helping to probe the secrets of the mysterious Nascan Lines—those strange straight lines which criss-cross the South American deserts high up in the Andes. Among the theories put forward for these strange patterns have been Erik von Daniken's prehistoric spacecraft landing site.

The BBC last year sent an expedition out to the Andes led by Tony Morrison with the aim of trying to unravel the mysteries of the lines. Tellurometer lent the expedition one of their CD-6 IR systems to enable the expedition to survey the lines with an accuracy never before applied to Nasça.

Armed with the results of the surveys, which showed that the lines were remarkably straight over incredibly long distances, Morrison enlisted the help of the man who decoded Stonehenge using a computer. Dr. Gerald Hawkins fed the results into a large computer to try to establish whether or not the lines had any astronomical significance. They did not, and Morrison had to look for other possible motives.

The expedition took plenty of film in the deserts and this was made into a film, "Pathways to the Gods" shown at the end of last year on BBC TV. Morrisons initial conclusions put forward at the end of the film were that the lines were nothing more than pathways showing the shortest distance between many hundreds of religious sites. This will not convince many "Chariots of the Gods" followers and doubtless the arguments will continue to rage for many years to come. Morrison is however keeping some of his secrets and theories for his book, due to be published this coming May.

The expedition also proved that electronic distance measurement is feasible under the intense heat and arid conditions of the high Andean deserts, where the portability and ease of operation of the Tellurometer CD-6 equipment really showed up.

Good News

We are pleased to announce the reintroduction of the publishers subscription service for *Practical Wireless.* The annual cost to either UK or overseas addresses is £10·60.

Application may be made to:
Practical Wireless,
Subscriptions Department,
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Perrymount Road,
Haywards Heath,
Sussex RH16 3DH.

Remittances should be made payable to IPC Services.

Remember "Going Back"?

All those readers who are interested in the vintage days of radio may now contact Colin Riches at his home address: *28, Chestwood Close, Billericay, Essex.*

Books

We are informed by Babani Press that their latest catalogue of radio and electronic books is available to readers of *Practical Wireless,* if they write enclosing an SAE to:
Babani Press & Bernards (Publishers) Ltd., The Grampians, Shepherds Bush Road, London W6 7NF.

Hello Sailor

The Royal Naval Amateur Radio Society are organising an activity period from 1800 hours GMT on 24-3-1978 to 1800 hours GMT on 2-4-1978. Location, HMS Belfast, Pool of London.

Three stations will be active using the call-sign GB3RN. Operation will be on ssb and cw in the 80, 40, 20, 15 and 10 metre bands, in addition to 1875kHz ssb and 1827/1837kHz cw.

All contacts will be acknowledged by a commemorative QSL.

HMS Belfast, the only surviving heavy cruiser of the Royal Navy is open from 1100 hours until 1600 hours in the winter and 1800 hours in the summer.

Sounds Good

The American Federal Communications Commission is to reconsider the feasibility of stereophonic sound channels for US television. First examined in 1964, the idea was abandoned some three years later on the grounds of lack of interest. The Public Broadcasting System however, have revived the question and the FCC is to hold an inquiry investigating the present feelings of manufacturers, broadcasters and the American public. At the same time, as in the UK, soundings are being taken to determine the interest in a.m. stereo and f.m. Quadraphonic transmissions.

'purbeck'

COVER PROJECT

OSCILLOSCOPE

IAN HICKMAN

For those taking a serious interest in electronics, an oscilloscope is the most important single instrument in the home workshop.

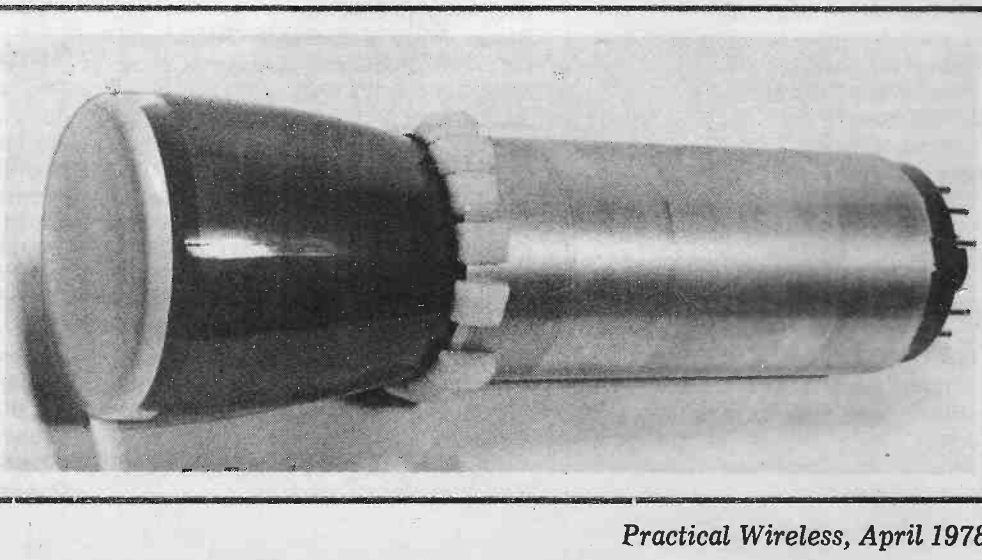
For the last ten years an all-transistor model has been in use by the author. However, lately this has been showing its age by deteriorating performance, poor reliability etc. When it was designed, there was no all-transistor oscilloscope on the market; now, of course, there are no valve types, apart from a few imports from the Communist Bloc.

It was an all discrete design, so when the time came that something just had to be done, it was clearly a better plan to start again from scratch using integrated circuits. A fresh start also provided the opportunity to incorporate a number of features which could prove valuable and which were not catered for in the previous version.

Feeling that others might be interested in a design which is well engineered and suitable for the home constructor yet providing a high standard of performance, it was decided to use only components readily obtainable and in particular, in the interests of economy, the popular and reasonably priced surplus cathode ray tube type 3BP1, Fig. 1.

Where, in the interests of performance, special components are unavoidable, arrangements have been made with well-known firms advertising regularly in *PW* to stock them.

Fig. 1: In the interests of economy the 'Purbeck' uses the reasonably priced and readily obtainable 3BP1 cathode ray tube, seen here with the specially produced low cost mu-metal shield



Performance

The main performance features of the final design are as follows:

Y amplifier: 10mV per division to 100V per division (in 5 steps) with ×0·5, ×1 and ×2 multiplier, calibrated. 1MΩ and approximately 30pF constant input impedance. An uncalibrated "variable" gain control provides typically 2·5mV per division maximum sensitivity. Bandwidth d.c. (or 2Hz when a.c. coupled) to 5MHz full screen (21MHz for 1 division).

Timebase: 1ms, 100μs, 10μs, 1μs and 100ns per division with a multiplier switch giving ×0·5, ×1, ×2, ×5 and ×10 providing speeds from 50ns per division to 10ms per division. An uncalibrated "variable" control range, extending sweep range to about 25ms per division.

X amplifier: A "variable" gain control provides X1 (calibrated) to ×2·5 (approximate) gain range, extending sweep speed to about 20ns per division. a.c. coupled external X input, requiring approximately 4V peak to peak for 10 divisions for X deflection.

Trigger facilities: Internal or external triggering, a.c. coupled. On external, 200mV peak to peak required for triggering (20V if using the ×100 input). On internal, reliable triggering is obtained for an X deflection of less than ¼ of a division up to 10MHz. "Trig. level" control selects the point on the waveform at which triggering occurs. Brightline circuit causes the trace to free run in absence of an input or when "trig. level" needs adjusting. Trigger polarity selector gives a choice of triggering on positive or negative-going edges.

Power supplies: All voltage rails are fully stabilised, providing typically 3% measurement accuracy in both X and Y axes, independent of mains variations.

Other facilities: Brilliance and focus controls. X and Y shift controls. Timebase output socket. Sweep gate output socket. Alternate sweep gate output socket. Calibrator output socket. Probe/accessory power socket. 10×8 screen graticule of 0·225in squares.

It can be seen that a comprehensive range of facilities is provided. The instrument can be simplified somewhat by omitting some of these, but this is definitely not advised.

It is hoped in due course to publish details of various items for use in conjunction with the oscilloscope—probes, dual beam units, transistor curve tracers, panoramic receivers (even a *PW* Spectrum Analyser?)—and these between them will require all the 'scope's facilities. A dimensional panel layout is provided for the benefit of those with the necessary enthusiasm and metal-work facilities to make their own case.

However, a superb case, has been designed especi-

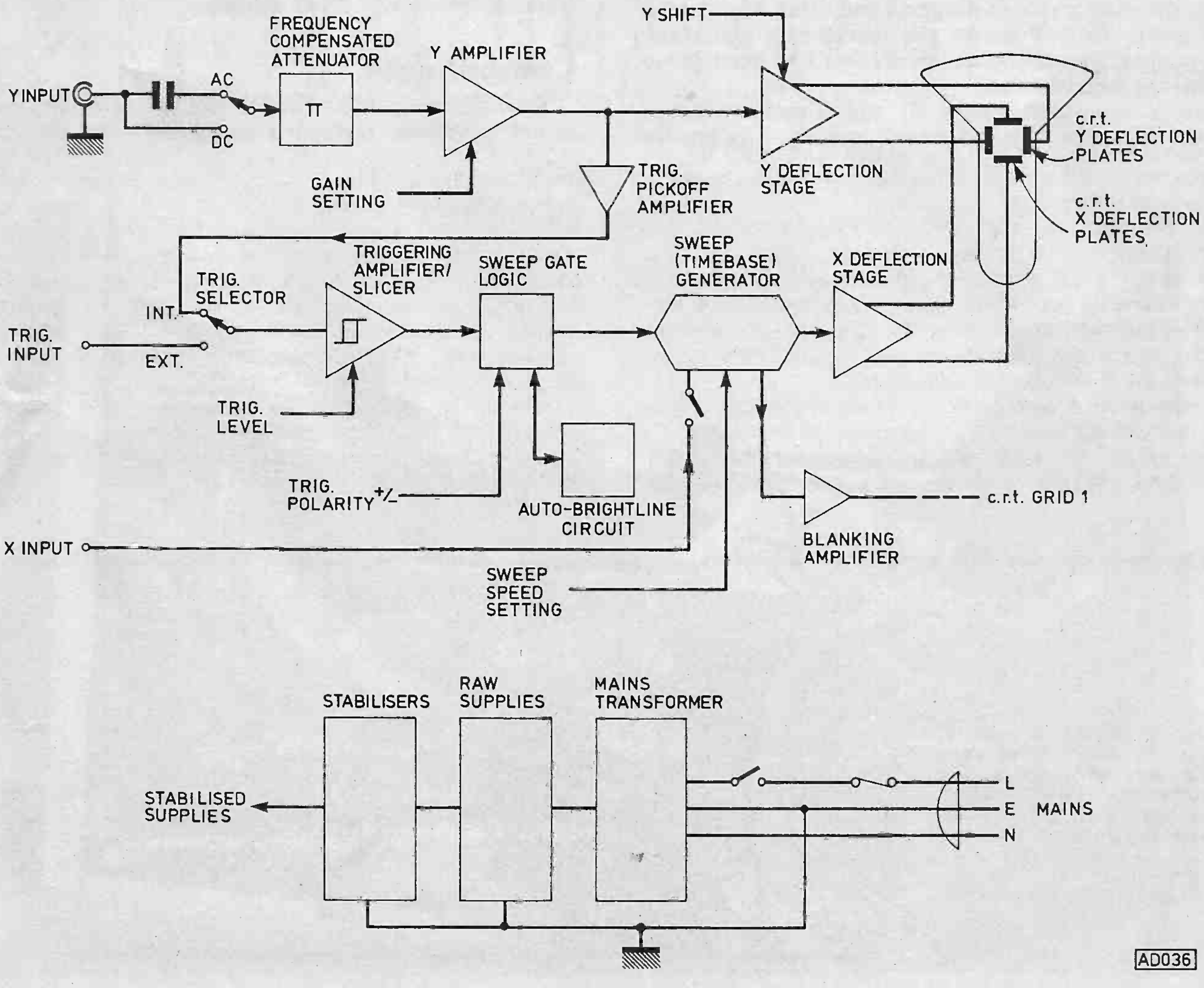


Fig. 2: Block diagram of the complete oscilloscope

ally for the "Purbeck" Oscilloscope and is very reasonably priced. The panel size is dictated by the facilities provided and the components used.

For example, in a commercially produced 'scope, the two Timebase speed controls would be combined in one switch with the "variable" control concentric with it and similarly for the Y sensitivity controls. Obviously a multiwafer 18 position switch is difficult to obtain and with a concentric pot. virtually unobtainable in small quantities. The present design uses single wafer switches with the exception of the frequency compensated input attenuator, S3.

Likewise, the depth of the case is determined by the need to mount the mains transformer to the rear of the cathode ray tube, to ensure no trace deflection from its stray magnetic field. The c.r.t. uses a simple low cost mu-metal shield designed and produced, like the mains transformer, specially for this project.

Is it only for advanced constructors?

The "Purbeck" Oscilloscope is a high performance fully stabilised instrument and therefore necessarily fairly complicated. Readers unfamiliar with valve circuitry should also realise that the high voltages used—particularly the 800V supply—are dangerous and should always be treated with caution and respect. It is not really a project to be undertaken by the beginner.

However, that said, anyone capable of reading and understanding a circuit diagram and using a soldering iron and a 20kΩ/V meter can confidently undertake this project, as special consideration has been given to ease of construction.

The Y amplifier (Board 3) and Timebase Board (Board 4) use a "ground-plane" technique to ensure stability in view of the high gain and wide bandwidth of the circuitry. (The gain-bandwidth product of the Y amplifier is 80GHz!!)

For economy, single sided boards are used with discrete wiring for the component interconnections. This also minimises stray capacitance, contributing to a bandwidth in excess of 20MHz for a deflection of one vertical division. Detailed drawings of all boards are given. All of the stabilised supplies are current limited, thus the odd incidental short circuit should cause no damage, but the heat sinks and components are *not* rated for an *extended* period in short circuit.

Fig. 2 shows a block diagram of the complete oscilloscope. This shows it to be a fairly conventional design of single channel measuring oscilloscope, i.e. calibrated gain and sweep speed with fully stabilised supplies. **Fig. 3** gives a general view of the internal construction, showing the use of plug-in boards for the Y amplifier and Timebase (Boards 3 and 4.

In each case, two controls are mounted actually on the board, with shaft extenders to the front panel. This not only substantially reduces the number of leads through the edge connectors (and simplifies the front panel wiring) but avoids problems which could arise if the high frequency signal leads associated with these controls were lengthy. Boards 1 and 2 (Raw Supplies and Stabilisers) are simpler and are therefore hand-wired rather than pluggable. A few components only are mounted in the main frame or behind the front panel.

Components

A single *component* list for the whole oscilloscope is not provided; instead a component list for each

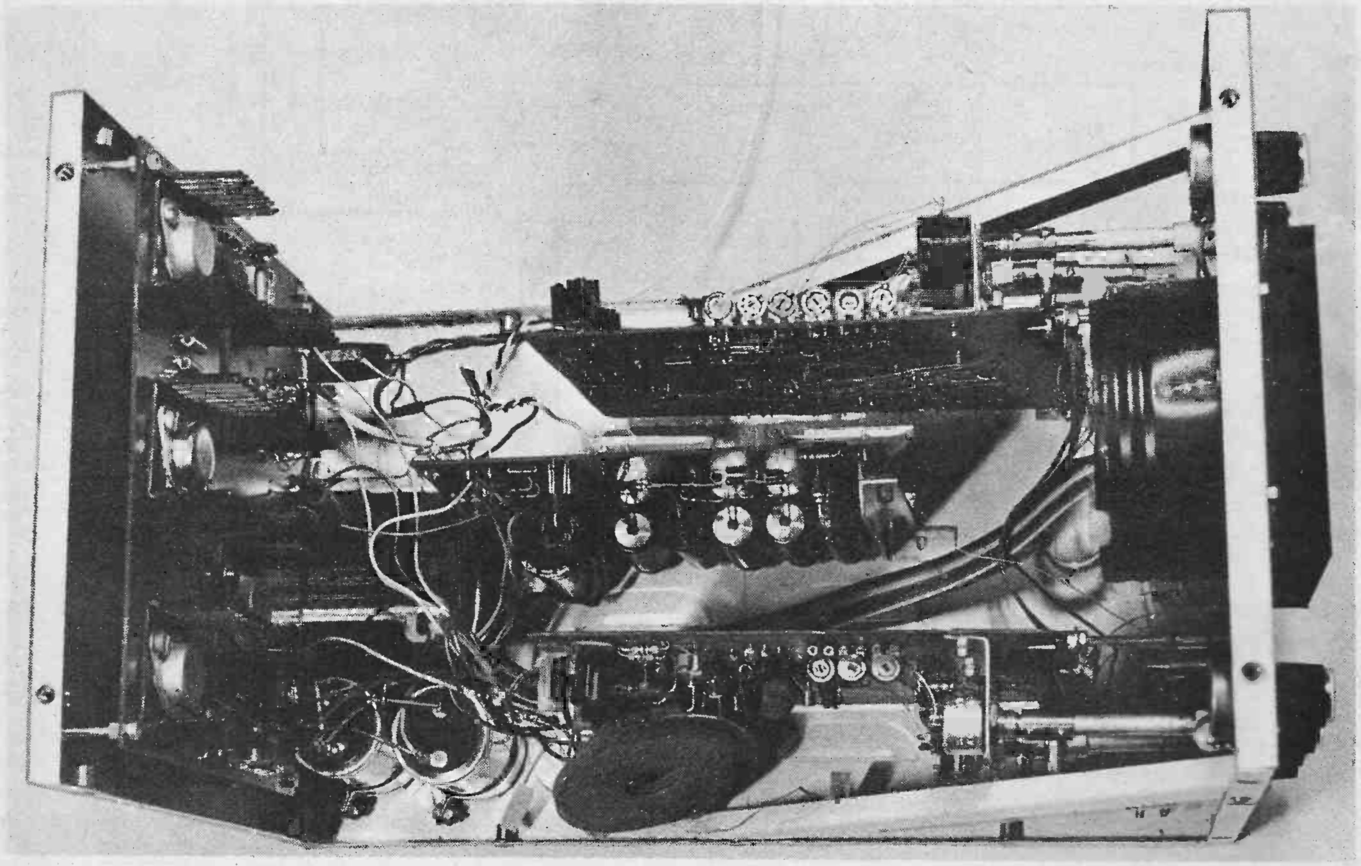


Fig. 3: General view showing the internal construction

Collated parts list

Resistors

¼W Carbon Film 5% tol. (10% above 1MΩ)

Value	No. Rqd.
2·2Ω	1
4·7Ω	1
6·8Ω	1
10Ω	2
47Ω	10
68Ω	1
100Ω	11
120Ω	1
150Ω	6
180Ω	2
220Ω	6
330Ω	2
390Ω	1
470Ω	3
680Ω	1
1kΩ	8
1·8kΩ	2
2·2kΩ	8
3·3kΩ	3
3·9kΩ	2
4·7kΩ	1
5·6kΩ	3
8·2kΩ	1
10kΩ	2
12kΩ	2
15kΩ	1
39kΩ	1
47kΩ	2
82kΩ	1
330kΩ	1
470kΩ	1
10MΩ	2

Various:—

Metal Film ½W 1%	
100Ω	1
1kΩ	1
10kΩ	1
100kΩ	1
910kΩ	1
1MΩ	4
Metal Oxide ½W	
4·7kΩ	1
10kΩ	1
2W	
180kΩ	1
Wirewound 5W 10%	
390Ω	1
1kΩ	3
3·3kΩ	2
6·8kΩ	2

Capacitors

Ceramic	
10pF	1
33pF	1
47pF	3
68pF	1
82pF	1
150pF	1
330pF	1
470pF	2
820pF	1
1nF 500V	2
0·1μF 30V	21
Variable	
2 to 22pF	8
5·5 to 65pF	2
Metallised Film	
1nF 63V*	1
4·7nF 63V	1
6·8nF 250V	1
10nF 63V*	1
47nF 63V	1
0·1μF 63V*	1
0·1μF 350V	2
0·1μF 1000V	1
1μF 63V*	1
* 1% or selected, see Pt. 5.	
Electrolytic	
4·7μF 25V	6
4·7μF 100V	1
8μF 15V	2
8μF 500V	5
47μF 500V	1
100μF 10V	1
2500μF 25V	2

Integrated Circuits

LM304	1
LM309	1
LM723	1
LM733	1
SN72710	3
SN7474	1
SN7486	1
SN74132	1

Switches

Min. Push Button (Make)	1
Min. s.p.c.o. Toggle	4
1p4w Rotary ¼in shaft	1
1p5w Rotary ¼in shaft	1
2p6w Rotary ¼in shaft	1
e.g. 2p 6w "wave change" with adjustable stop	
2p5w 2 Wafer	1
e.g. "Makaswitch" type	

Variable Resistors

Sub. Min. Vert. Preset 0·1W	
100Ω	2
220Ω	2
470Ω	1
1kΩ	2
4·7kΩ	1
22kΩ	3
47kΩ	1
100kΩ	1
Min. Hori. Preset 0·25W	
220kΩ	1
Linear 20%, ½W, ¼in dia. shafts	
470Ω	1
1kΩ	2
2·2kΩ	1
10kΩ	1
22kΩ	1
47kΩ	1
220kΩ	1

Inductors

15 Turns 38 s.w.g.	2
35 Turns 38 s.w.g.	2

Close wound on 100kΩ carbon composition resistors as formers

Diodes

BYX 94	5
BZX61C75	2
BZX61C160	5
BZY88C6V8	1
1N4148 (or 1N914)	7
50V 1A Bridge Rect.	1
L.E.D. (Hi Brightness)	1

Transistors

2N3055	3
BC108	13
BC109C	1
BC214K	3
E421 (Siliconix)	1
MJE340	1
BF336	4

Miscellaneous

Mains Transformer 250-0-250, 12·9-0-12·9, 6·3V Barrie Transformers type 7559	1
CRT 3BP1 plus Base	1
Mumetal screen for 3BP1	1
1¼in × ¼in fuse, 1A and holder	1
Edge connector 0·1in pitch, 36 way	2
4mm sockets Red, green	2 each
Blue, yellow, black, white	1 each
BNC round socket 50Ω (UG1094/U)	1
5 pin DIN socket type A (180°)	1
Knobs, Sifam 15mm collet type with nut covers and caps to fit	
K150 plain	2
K151 line pointer	4
W151 wing and line pointer	6
Case, complete, (Bazelli) Blue, with white panel, ready pierced with handle, feet and louvres	1
1mm plug and socket	6 each
Miniature 3 core mains lead	3 metre
10 way colour coded ribbon cable	1 metre
PW transparent front panel overlay with graticule.	

board is given in the instalment dealing with that board. A *collated parts* list for the complete project is given for those wishing to order parts in good time, so that each section can be constructed as the details are published.

The next instalment will deal with the main frame wiring, Raw supplies and Stabiliser boards. Further instalments will deal with the Y amplifier board and the Timebase board (with full description of the operation of these circuits), and a final instalment will deal with finishing off the construction, setting up and calibration and use, together with useful tips for any who may hit snags in getting it all going.

To minimise the possibility of this use only full spec. components from a reputable supplier. Don't use cheap or "outside the manufacturers very rigid spec. but all usable" components. These and gems from the junk box can cause disappointment and they can also damage other components when they fail.

Constructors are also advised not to substitute other component types for those listed, nor to depart from the contructional practice adopted in the article. In particular, if you don't use ground plane construction on the Y amplirier and Timebase boards—well, don't blame anyone but yourself for the results!

TO BE CONTINUED

DESIGN YOUR OWN PROJECTS

No. 6

TTL Interface

TOBY BAILEY & BOB WHITAKER

Regular readers will have noticed that circuits covered by this series have varied in their degree of immediate applicability. This month's project is one that few people will have an *immediate* use for, but it makes up for this by providing a detailed illustration of how to choose component values in an often-used circuit—as well as highlighting some problems of interfacing digital logic circuitry with the outside world. You may have a suspicion that we choose circuits for these articles solely on the basis that they haven't appeared in magazines recently. Actually this isn't true.

For example, the cassette power supply described in the October issue of *PW* was designed because one of us wanted such a device for a car which was being used as transport to do a job 25 miles away. The continuity tester described recently was born out of the desire to produce a simpler solution to a particular set of specifications accompanying a design published elsewhere.

As a contrast, this month's circuit was originally designed some while ago; part of a "suite" of test equipment that Toby needed at the time. Apart from power supplies, meters and things (all neatly housed in a surplus tank chassis) this magnificent device also contains a reasonably accurate frequency marker, which consists of a crystal oscillator, a waveform squarer, a series of TTL (Transistor—Transistor Logic, a particular way of fabricating digital integrated circuits) divide-by-ten counters and a pulse generator. The output from this can be switched to be 1MHz, 100kHz, 10kHz or 1kHz and the waveform shapes available are square wave, 20ns positive-going pulse or 20ns negative-going pulse. Now there is a very good reason for not connecting these outputs directly to sockets on the front panel, namely that an inadvertent short circuit will probably ruin the TTL circuits of the generator.

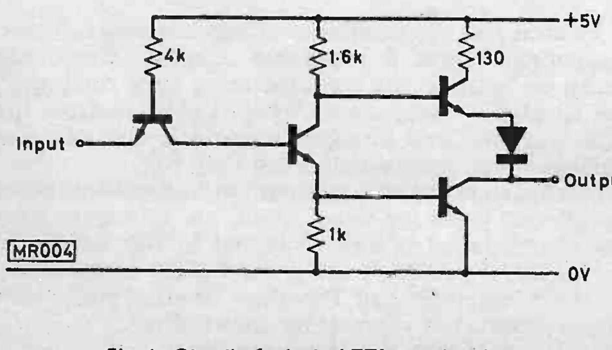


Fig. 1: Circuit of a typical TTL inverter stage.

As a digression, never underestimate the chances of doing something like this! Disaster struck recently when it was discovered that a strange combination of the metering switches caused the overload protection on the power supply to blow up. It's a good idea, when working out the design, to assume that some such mishap will occur.

Anyway, this month the circuit that we are going to design is an interface from TTL to the outside world.

Specification

Since we wanted to use this circuit in a particular piece of equipment it was fairly easy to produce a set of specifications. The circuit should run from the standard TTL power supply (5V). It should take as input the TTL waveforms produced by the frequency generator and give an output of 0V for a TTL low (or "0") input and an output of 1V for a high (or "1") input. The output impedance should be fairly low and we decided that 40 to 50 ohms would be adequate. Switching times should be as fast as possible to produce good, clean waveforms and finally the whole unit should be fairly "abuse-proof", paying particular attention to short circuits etc.

TTL Outputs

If you ever want to use TTL circuitry, and in particular if you want to connect other things apart from TTL to it, then it is essential to know what the actual TTL input and output circuits consist of, and what they are capable of driving. This is a bit of a diversion from our project, but we think that many people will find the information useful.

Figure 1 shows the circuit of a typical TTL inverter stage. A low input will form a current source for the emitter of the first transistor and so must supply a reasonable amount of current to it. On the other hand, if the input is high the input stage will draw appreciably less current. The output stages match the input conditions well: an output which is low will sink a considerable quantity of current (enough to supply ten TTL inputs connected to it simultaneously) whereas a high output can supply considerably less current (about 40 times less) which nevertheless, is still enough to drive at least ten other gates—this is what is meant when the manuals say that the gate has a "fan-out" of ten. It's useful to have the exact figures handy:

> Maximum voltage recognised as being a low input; 0·8V. Minimum voltage recognised as being a high input; 2·0V.

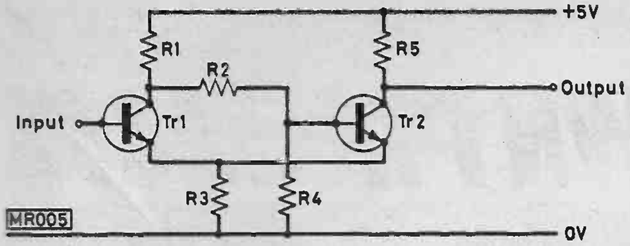


Fig. 2: A basic Schmitt trigger circuit using npn transistors.

Maximum current flow out of an input in the low state; 1·6mA.

Maximum current flow into an input in the high state; 40mA.

Maximum current into a low-state output without pulling it up to more than 0·4V; 16mA.

Maximum current out of a high-state output without pulling it below 2·4V; 400μA.

These figures show, for example, that if you want to drive a light-emitting diode from TTL then you should connect it (with a resistor in series!) between the TTL output and the +5V line, where 16mA is available, rather than connecting it to the 0V line where only 400μA is available.

The Circuit

Now, down to business! The best simple method of achieving fast switching is to use some form of Schmitt trigger—a circuit is shown in Fig. 2. How does it work? Well, suppose the input is low (near 0V), Tr1 will then be switched off and R1, R2 and R4 will form a bias network for Tr2—we choose the resistor values so that Tr2 will be turned on when the circuit is in this state.

Suppose now that we slowly increase the input voltage: when it reaches a value about 0·5V above the emitter voltage of Tr2, Tr1 starts to turn on and the voltage at its collector starts to drop. This has the effect of reducing the bias voltage to Tr2 which consequently starts to turn off, thus causing Tr1 to turn on even more quickly and soon the circuit will have flipped over into a state where Tr1 is on and Tr2 is off. If you go through the same process in reverse you will find that a similar sort of thing occurs and the circuit ends up where it started. Those of you who remember Part One of this series should recognise the process of regenerative switching here. What follows is a demonstration of how to choose component values for this particularly useful circuit.

Modifying the Basic Circuit

As it stands the circuit shown in Fig. 2 isn't quite what we want. The output varies between the positive line (when Tr2 is off) and something in between the positive line and ground when Tr2 is on. Furthermore, the input requires current driving "down to ground" which, as we mentioned earlier, is something that TTL doesn't particularly like to do. What happens if we turn everything upside down as in Fig. 3? We've now solved both of these problems. Note that we have labelled the negative power line 0V and the "ground" line "+5V" just so that we can keep track of what's going on: it will make the connection to the TTL circuitry clearer. (The Americans would probably just draw the transistors "emitter upwards" and draw the power lines all over the place but we have always found this habit very confusing).

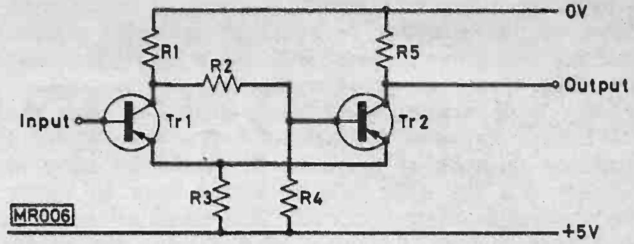


Fig. 3: The circuit of Fig. 2 modified to provide a greater "high" output drive capability.

Anyway, all we need to do now is choose component values so that with a low input (within 0·4V of the negative supply rail) Tr1 is turned on, and with a high input (i.e. at least 2·4V "below" the negative rail) the transistor is turned off.

Component Values

So where do we start choosing component values? We have a good base point here, since we require the output impedance to be about 40 or 50 ohms. As the output impedance is going to be roughly the value of R5 we can choose R5=47 ohms straight away. If you don't have a constraint like this, then start by deciding how much current you require and calculate R5 from that.

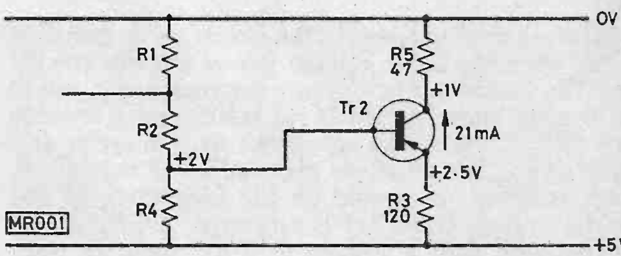


Fig. 4: The first steps in choosing component values.

When Tr2 is on we want an output voltage of about 1 volt "below" the supply line (bear in mind that this is 1V above ground from the point of view of the TTL). Hence the current flowing in R5 will be $\frac{1}{47}$ A= 21mA. The next thing to decide upon is the emitter voltage of the transistors when they are in this state, enabling us to calculate the value of R3. We don't want Tr1 to turn on with an input of 2·5V so we require the emitters to be at a voltage which is no more than 2·5V below the 0V line: the 0·6V drop across the base-emitter junction will then give us a safety margin. Since R3 will be passing 21mA and must drop 2·5V, its value must be at least:

$$\frac{2\cdot 5}{0\cdot 021} = 119 \text{ ohms; (say 120 ohms).}$$

Fig. 4 shows the bias circuit as it is when Tr1 is off (Tr1 has been omitted for clarity). Don't worry that the bias circuit here is part of a trigger circuit and not a simple transistor stage—we can just carry on our calculations as normal.

First, we have the standard problem of which transistor to use. Regular readers can probably predict that we will choose something like a 2N3702: these are good, cheap, general-purpose *pnp* devices and we usually have a number of them available. Now the 2N3702 has a stated d.c. gain of better than 60 for a collector current of 5mA so it should be safe to assume that the gain will be better than 40 under the conditions of our circuit. This gives us a maximum base current of about 0·5mA. We can use a rule-of-thumb, which states that "the current in the divider chain should be at least five times the base current", to decide that we want a divider current of 2·5mA. This means that the total resistance of R1, R2 and R4 should be $\frac{5V}{2\cdot 5mA} = 2{,}000$ohms. If we want the emitter of Tr2 to be 2·5V from the +5V line then the base will have to be around 3V from the line after we have allowed for the base-emitter junction. So: $R4 = (\frac{3}{5}) \times 2k = 1\cdot 2k$ and hence $R1 + R2 = 2k - 1\cdot 2k = 800$ ohms. We'll decide on the individual values of R1 and R2 in a moment.

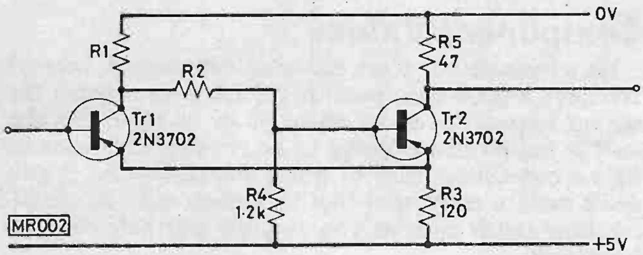


Fig. 5: The circuit of Fig. 4 with the input stage restored.

Let's see what happens to the circuit we've designed so far when the input voltage moves towards the 0V line. The circuit in Fig. 5 shows the component values we already know. As the input voltage goes towards zero volts, Tr1 will turn on and we want to arrive at a point where Tr2 takes no current, i.e. is turned off. Much is going to depend on the magnitude of the emitter voltage when Tr1 is saturated. Assuming this occurs again with a voltage of 2·5V, then we want $R1 = \frac{2\cdot 5}{0\cdot 021} = 120$ ohms. This ignores the current in R2 and R4, which will be much smaller than that flowing through R1, and the voltage drop between the collector and emitter of Tr1 (which is very small in a saturated transistor, say 0·3V or less). This means that R2=680 ohms: with these values Tr2 should be turned off since its base will be more positive than its emitter.

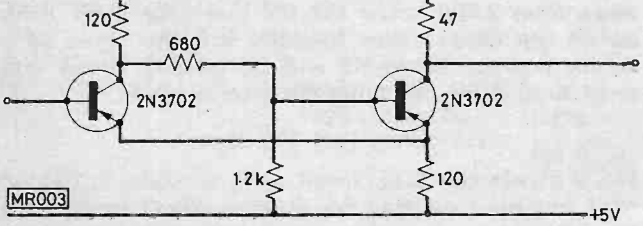
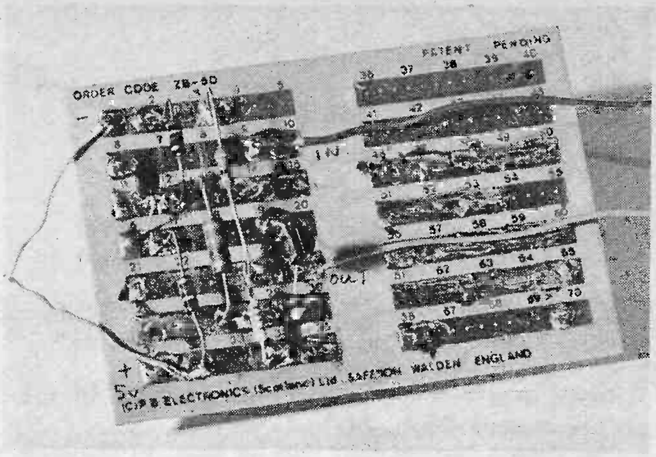


Fig. 6: The final circuit with all component values shown.



So we've arrived at the circuit shown in Fig. 6. We now have to make what we hope will be a final check to see if it works in practice. Since soldering up an untested circuit invariably causes huge amounts of trouble, we always make up the initial version of S-Decs or T-Decs (depending on the complexity). This circuit is no exception and it worked first time after all, the components having been plugged into an S-Dec. The final version shown in the photograph was constructed by transferring the components directly from the Dec to an S-Dec patterned Blob-Board. A stock of these can save a lot of time when making up "hard copies" of circuits constructed on Decs since it is not necessary to draw a layout diagram. ●

'SLIM JIM'
2-METRE AERIAL

F.C. JUDD FISTC, MIOA, Assoc. IPRE, A. Inst. E (G2BCX)

This is a vertically polarised omnidirectional free space aerial for two metres but which will operate in the same way for higher or lower frequency bands by scaling the dimensions accordingly. It has a radiation efficiency 50% better than a conventional ground plane due to its low angle radiation, is unobtrusive, has no ground plane radials, and therefore has low wind resistance. The name "Slim Jim" stems from its slender construction (it is only 60 inches long for 2 metre operation) and the use of a J type Integrated Matching stub (JIM) that facilitates feeding the aerial at the base, thus overcoming any problem of interaction between feeder and aerial. The feed impedance is 50 ohms.

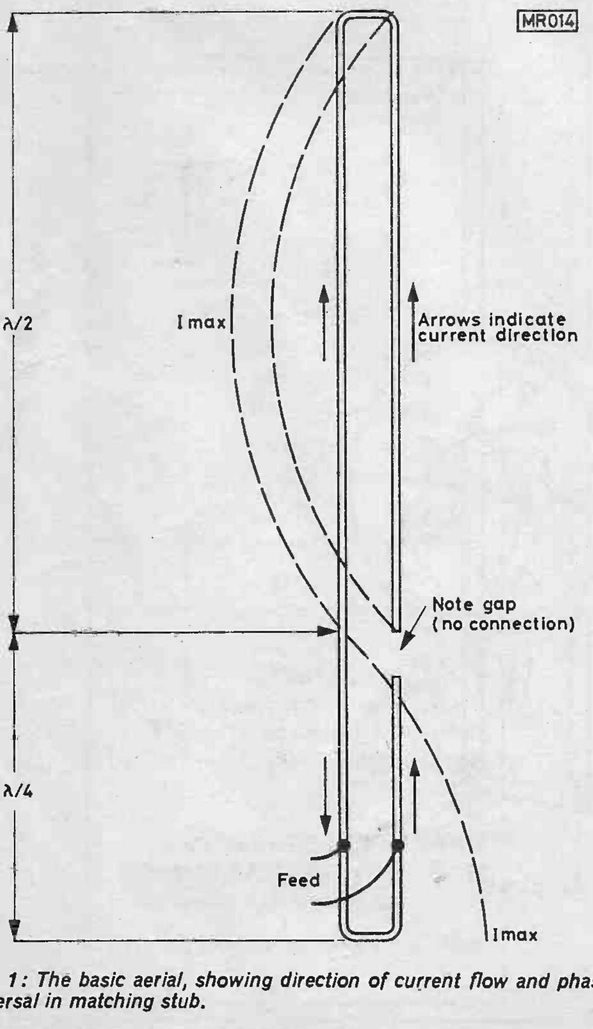
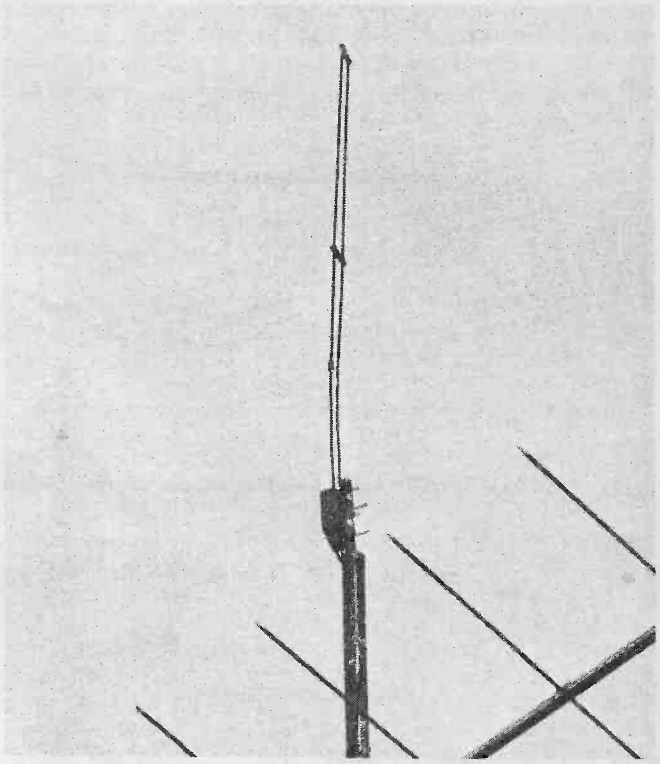


Fig. 1: The basic aerial, showing direction of current flow and phase reversal in matching stub.



How the 2BCX "Slim Jim" operates

Basically it is an end-fed, vertically operated, folded dipole (**Fig. 1**). As with all folded dipoles, the currents in each leg are in phase whereas in the matching section they are in phase opposition, so little or no radiation occurs from the matching stubs. Correctly matched the VSWR will be less than 1·5 to 1 and will remain so across the band. It can be constructed for use as a fixed home station "omni" or for portable operation, and the aerial has been used for mobile operation mounted on a short stub mast attached to a rear bumper; at sea a special version is used, completely enclosed in a plastic tube for protection against salt water.

Construction

The "Slim Jim" may be constructed from ¼ or ⅜ inch diameter aluminium tube, stiff coathanger (galvanised iron) wire or 300 ohm ribbon feed. The spacing between the parallel elements is not critical

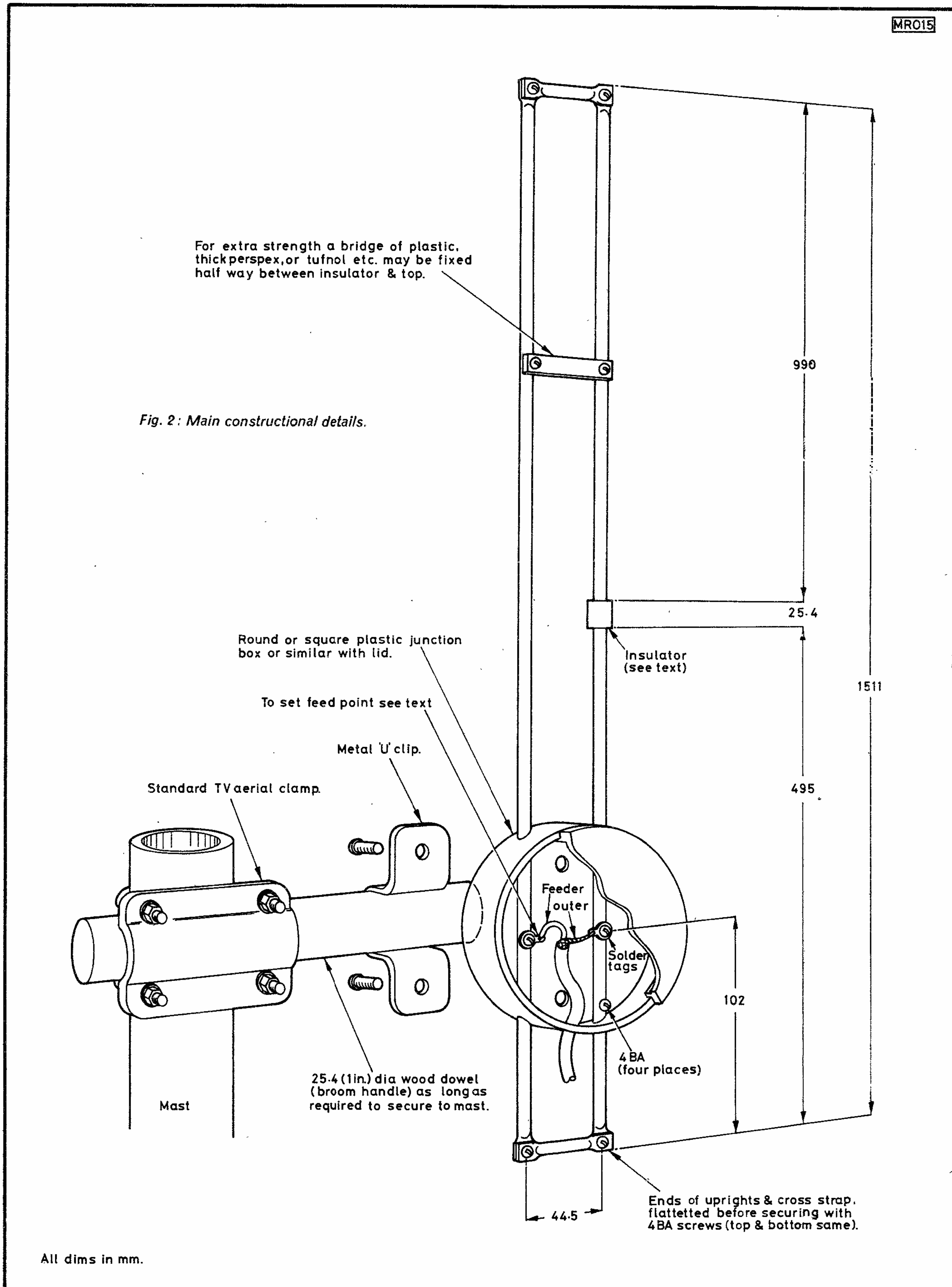
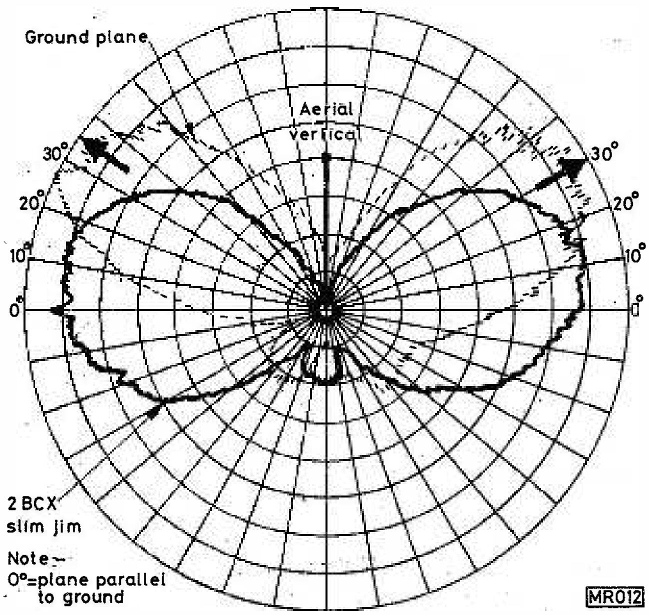


Fig. 2: Main constructional details.

and neither is the overall length, providing this is within $\pm \frac{1}{4}$ inch.

Details for a strongly made version for fixed station use outdoors are given in **Fig. 2**, in which the diagrams are self-explanatory and dimensions are included. The only comment called for is on the insulation between the return half of the folded radiator and the top of one side of the matching stub. This may be a piece of thick perspex, tufnol or p.t.f.e. drilled to take the rods (they must not touch), which can be set in with Araldite.



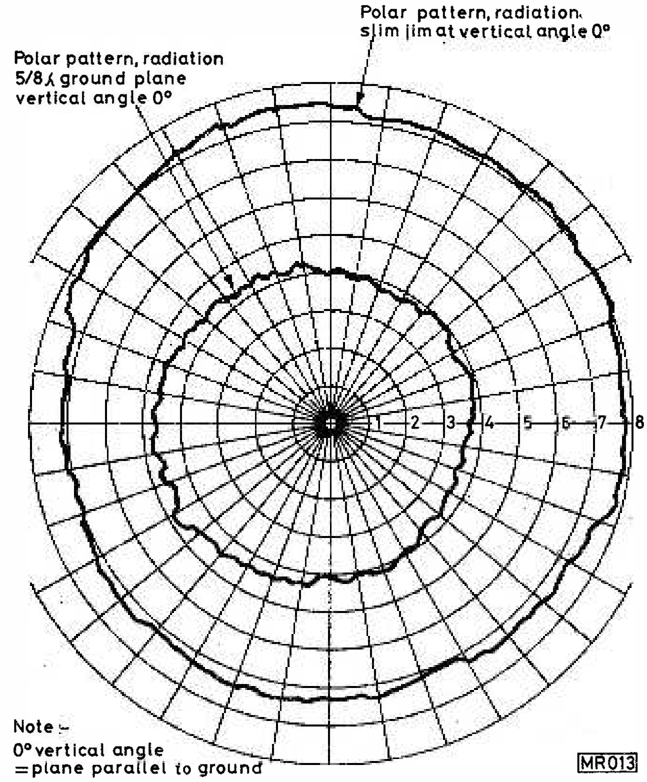


Fig. 3, above, where the 5/8 wavelength ground plane radiation angle is 30° or more (dotted line), and the "Slim Jim's" at virtually 0°. Fig. 4, top right, providing omnidirectional patterns of a 5/8 gr.p. at 0° vertical angle. Both patterns from models at 650MHz.

Response

The polar diagrams shown in **Figs. 3 and 4** explain the "Slim Jim's" improved efficiency over the 5/8 wavelength ground plane, in spite of its claimed 3dB gain over a dipole or similar ground plane. Fig. 3 shows that the "Slim Jim" vertical angle of radiation is almost parallel to ground, so maximum radiation is therefore straight out (and all round) which is what we want. With all ground plane aerials, including those with radials of more than $\frac{1}{2}$ inch length, radiation is tilted to an average angle of 30° or more. The dotted line in Fig. 3 is that from a 5/8 wavelength Gr.P aerial with 6 quarter-wave radials.

Now examine Fig. 4. The outer line is the (omnidirectional) radiation from the "Slim Jim" at a vertical angle of 0° e.g., on a plane parallel to ground. The inner line shows the loss of radiation, by comparison, from a 5/8 wavelength ground plane at the same angle and that loss can be around 6dB! This has been verified with full size 2 metre aerials as well as with UHF scale models on the writer's aerial test range. Many 2 metre operators already using the "Slim Jim" in place of a ground plane will confirm its efficiency.

Setting Up

The feed point may be protected from rain as shown in Fig. 2, by a circular plastic junction box, with a screw-on lid, but the correct feed point must be found first. The best way of doing this is to complete the construction of the aerial and stand it upright in the room near the transmitter but clear of other conductors. Use the full length of feeder required to reach the aerial when finally in situ. Clip on at about 4 inches up from the bottom as in Fig. 2. Adjust slightly up or down for minimum S.W.R. and maximum power into the aerial. Note points of contact and then fit solder tags as shown ready for the feeder soldered connections. The plastic box may now be fitted and the completed aerial and feed protector box can be given a coat or two of polyurethane varnish before final installation. Fig. 2 shows methods of mounting on a mast with a TV aerial claw clamp such as those made by Antiference.

Positioning of the "Slim Jim"

Ideally the aerial should be as high as possible and clear of other aerials or conductors. It will, however, operate quite well indoors in the loft, or even in a living room, but obviously with a lower range.

If the "Slim Jim" is constructed from coathanger wire, galvanised iron wire or 300 ohm ribbon feeder, while other considerations remain the same, the space between the elements may be reduced to about 1 inch. The whole of the aerial, made like this, could be housed in plastic water pipe. Being compact, the "Slim Jim" can be carried around quite easily for portable operation on holidays, etc. Please note the name "2BCX Slim Jim" is copyright and the design is exclusively that of the writer.

THE 5 METRE STORY part 3

Ron HAM BRS15744

G6DH

Denis Heightman G6DH began listening on 56Mc/s in 1936 but as he was located at Clacton-on-Sea he did not often hear any of the London stations. His first QSO was cross-band between 28Mc/s and 56Mc/s with YL2CD (Latvia)! At 0810 on June 3rd 1937 Denis asked the Latvian station (on 28Mc/s) to listen out for him on 56·1Mc/s. This he did and he gave Denis R5 to 7 for his 5 metre signal.

The first G contact that G6DH made on 5m was in 1937 with G8MU in Ipswich and then with G5LC. In May 1938 Denis received the auto transmissions on 56Mc/s from SM5SN of the Luma Lampworks in Stockholm. It was a pity that they were not listening on the band, because G6DH is sure that a QSO would have resulted. On July 24th 1939 another strong signal, this time from Lisbon, was received by G6DH; he heard the auto transmission at 1745 of CS3VA calling G6YL but again the Lisbon station was not receiving so Denis was unable to attempt a DX QSO.

Across the Border

For several years prior to 1935 a number of Scottish amateurs were carrying out experiments on 56Mc/s under the leadership of G6WL, who, before giving up owing to ill health, inspired Archie Brown, G6ZX with the 5m bug. Archie was very active on "five" from about 1933 and had carried out many tests with G5YG, between a fixed station and a moving vehicle, and vice versa. The birth of the Glasgow and District Radio Club, and its members' interest in 56Mc/s operation, gave G6ZX new incentives and Sunday morning schedules with the local radio club began.

On May 5 1935, members of the club set off with 56Mc/s receivers, batteries, and all necessary equipment for the top of Ben Lomond (2,500ft) which was about 33 miles NW of Archie Brown's location in Clarkston. For his part, G6ZX used a beam aerial and also a straightforward vertical half-wave system. When the expedition reached the top, one of the receivers was hooked up while a short aerial was being erected, and, to everyone's amazement, Archie's signal came pounding in before the aerial was connected.

Snowdon to England

The banner of amateur radio had been planted on Snowdon by another 56Mc/s enthusiast in 1933, but this did not deter Douglas Walters G5CV and his companion David Richards (director of radio communications in the previous Mount Everest expedition) from taking their 5m gear up this 3,500ft mountain in June 1935 for more experiments. Before leaving London, arrangements were made for a full description of the tests and schedule to be mailed to 56Mc/s enthusiasts throughout the country. Marchese Marconi very kindly promised to co-operate and the Marconi Company at Chelmsford set up two special 56Mc/s stations with directional aerials for Snowdon. The War Office and Post Office also co-operated and a watch was kept on these tests by the Royal Engineers at Woolwich and the P.O. Engineers at Dollis Hill.

The first contact from G5CV on Snowdon was with G5MQ (55 miles) in Liverpool, and the next with G2IN whose gear was installed in a car near Ormskirk (75 miles). After the tests were completed it was learnt that G5JU had received their signals in Bristol (140 miles) and a report from G6CJ at Stoke Poges increased the distance to 180 miles, and, finally, on arrival back in London, Douglas learnt that his 56Mc/s signal from Snowdon had been heard by G2NU near Romford, a distance of 207 miles.

An interesting fact emerged from these tests; the signal strength from all stations fell to a minimum between 1100 and 1400 hours, a phenomenon which had been observed on several occasions during the previous three or four years, and also by Mr. Dent of the *Wireless World*.

The low power transmitter used on Snowdon was the same one that Douglas Walters had used for his aircraft and glider experiments. Their larger transmitter employed two special PX25 valves in push-pull and a PT25B as modulator. For the occasion, Messrs Webbs Radio loaned them an Eddystone 56Mc/s

THE T. & R. BULLETIN, September 1939. 161

TRANSMITTING ENTRIES

Call	Location	Crystal Frequency	Transmitter Line-up	Receiver	Aerial Systems	No. of QSO's	No. of Stns. Hrd.	Max. Dist. Wrkd. Miles
G2ZVP	Bury Hill, Sussex	7	6L6/6L6	*Acorn* Superhet	½ wave beam two long wires	8	29	52
G8LYP	Near Basingstoke	14	6L6/RK39	0–v–2	½ wave beam	4	16	46
GW6AAP	Snowdon ...	28	6J5/807/35T	*Acorn* 1–v–1	½ wave zepp fed	25	31	124
G2NHP	Near Dorking ...	9·3	6L6/6N7	Superhet	½ wave dipole	20	39	—
G8JVP	Near Leek ...	28	RK34/RK34	*Acorn* 1–v–1	½ wave dipole	14	18	70
G5MAP	Near Storrington, Sussex.	14	6L6/6N7	Superhet	½ wave dipole	18	35	52
G2QYP	Near Elstree ...	7	6L6/6L6/T20	1–v–1	½ wave beam	10	32	—
G2RDP	Woldingham, Surrey.	ECO	6L6/6L6	0–v–1	½ wave	5	—	—
G2WSP	Woldingham, Surrey.	ECO	89/6L6	1–v–1	W8JK 4 × ½ wave dipole	9	—	—
G5CDP	Amersham, Bucks.	7	(*See* July BULLETIN)	*Acorn* Superhet	½ wave	3	18	—
G5CMP	Billingshurst, Sussex.	ECO	89/6V6	0–v–2	½ wave beam	7	—	—
G3CUP	Epsom	7	6L6/6N7	0–v–1	½ wave dipole	15	—	—
G3APP	Grays, Essex ...	7	3 stage	0–v–1	14 × ½ waves	4	7	61
G3BYP	Hartshead, Pike...	28	6J5/6V6	*Acorn* 1–v–1	2 × ½ wave in phase	7	11	—
G2JBP	Warlingham, Surrey	—	Long-line	0–v–1	½ wave reflector	7	12	35
G8AAP	Near Birkenhead	—	S excited	Transceiver	½ wave	2	6	—

A typical contest table of 1939, showing the type of gear which was in use at the time. All stations were operating portable, hence the final "P" on the callsigns.

Table courtesy of the RSGB

receiver, the GEC supplied the Osram valves, and the Chloride Electrical Storage Company supplied the Exide accumulators which provided their LT supply and powered the generators which in turn supplied the HT current for both transmitters. Which all goes to show how confident other people were in Douglas Walters and his amateur radio experiments.

On August 23rd 1936 another group comprising G6KY, 2AKD, G6YQ and G5YP set up station on the summit of Snowdon. Promptly at 0900, G6YQ/P was in operation and shortly afterwards contacted G5BY, from Croydon, who had journeyed by road to Fishguard with his gear and erected it at Strumble Head (85 miles). Early contact was made with G6AA/P at Holyhead and then with G6IA, assisted by G5SD who had hauled their rig to the summit of Snaefell, I.O.M. (87 miles). The best DX was made at 1530 when contact was made between Snowdon and EI8G/EI5F at Mount Merrion Estate, Dublin, a distance of 96 miles, and was the first QSO between EI and G on 56Mc/s.

One definite conclusion emerged as a result of the Snowdon tests and from subsequent portable operations elsewhere:—A horizontally polarised wave seemed more satisfactory for DX work and produced a better signal at the receiving end than did a vertically polarised wave.

After the GW 56Mc/s contest in September 1937 competitors realised that it is not always transmitter power that gets the most contacts. From 11 stations who sent in logs, one had a transmitter power of 25 watts, two of 5 watts, one of 4 watts, six of 10 watts, and the winner's power was a mere 1·8 watts! The success of the leading station operated by H. Jones G5ZT/P was due to his location on Parlike Pike, near Preston. In second place came GW6OK/P with 5·4 watts; he had 9 contacts compared with the winner's 15 but again his low power earned him points because he was located on top of Snowdon. To the third and fourth operators G6MX/P Snaefell, and G2DC/P near Buxton, went the joint honour of the then longest 56Mc/s QSO in the UK, 124 miles when both were using 10 watts.

During this event Barbara Dunn G6YL succeeded in contacting G5VQ using CW and, although the distance was only 27 miles, the intervening country was very hilly. Barbara was using a long lines transmitter with an LS5B valve.

Solar First

It was G6YL who made the very important observation on July 31st 1939, when she reported hearing the "hissing" noise from a solar burst in the 5m band, and her claim was supported by 2BIL. The "hissing" noise from solar activity (In the author's opinion, this was the birth of solar radio astronomy) was first discovered by Denis Heightman G6DH in 1935 when he was operating on the 10m band. Many other radio amateurs also heard it at 28Mc/s but Miss Dunn was the first on 56Mc/s.

Denis Heightman was again to the fore in the 1939 "GW Trophy" 56Mc/s contest, not as the winner, although he did take third place, but as the station which gave the longest distance contacts to both the leading contestants, G8JV/P in Staffs who won the trophy, and G2VZ/P assisted by 2DDD, who were runners up.

The apparatus used in this event was not only of a truly portable nature but also of the latest design. For instance, the winner, George Henderson, was pleased with the performance of the Mullard TV03/10 double-triode valves employed in his transmitter when four out of his 17 contacts were greater than 140 miles. The team in second place proved the superiority of the three-element beam over the long wire aerial. Of the 11 stations that submitted logs, five were using 954 Acorn valves in their receivers, three had superhets and the others had 0-V-1.

Aerials

Throughout his researches the author found that the enthusiasts had tried and tested a wide variety of aerials on the 5m band. Some used the Windom while others, like Ted Williams G2XC, back in 1935, used their already established 7Mc/s "Zepp", a 66ft horizontal wire fed by open wire tuned line, which of course accommodated eight half-waves.

Getting parts for aerials was not too easy. Eddystone marketed transposition blocks for dipoles but most amateurs used wooden dowel boiled in wax. George G2CIL can't remember seeing a coaxial cable in those early days, but both G2AKM and G6NK remembered 50ohm coax with a black substance for insulation, and a 50ohm flat twin feeder.

Rotating Beam

G8LY loved experimenting with aerials, and was grateful to her 60-year-old tree-climbing father who fixed her 56Mc/s vertical aerial some 70ft up in a fir tree! Unfortunately, the lossy feeders available then did not do justice to the height of her aerial. One day, A. E. Mitchell G8DF appeared, with G5LT, and on the roof of his car was a 5m beam for Constance to use. This beam was eventually mounted on a pole which had a unique (G8LY Special) rotating system. A metal pipe was placed in the centre of a ten-gallon oil drum which was filled with concrete, three bagatelle balls were dropped into the pipe to act as a bearing for the aerial mast, which slid down into this pipe. Constance carried out many directional aerial tests with other 5m operators using this beam.

During the late 1930s, Constance was the first YL to contribute an article to the *T & R Bulletin*, and her subject was "UHF Measurement by means of Lecher wires" and for some time she compiled the monthly 56Mc/s report for the journal.

Constance, a radio enthusiast since the 1920s, lived near Basingstoke in her 5m days, in a house which had no main electricity supply, so all her soldering was done in the kitchen with a large iron heated on the kitchen range. Her shack was in the attic and so accumulators were used for the filaments of her valves.

Unique Propagation Study

R. H. Hammans G2IG and J. L. Nixon G6XO had both experimented on 56Mc/s since 1931, and in May 1934 the *T & R Bulletin* published a lengthy article about their design, construction and testing of a 5m "manpack" outfit ("56 Megacycling on Foot"). The author was fascinated by the following extract and felt that this was just another example of the enthusiasm of the 5m brigade. "The initial step was to erect a transmitter at one of our stations, which were 300 yards apart in a crowded residential district. A "detector and one LF" receiver was built at the same time.

The first tests were carried out between two rooms at the same station, using an unmodulated carrier. Our ambition next was to receive the signal at the other station. As we could not do so, we set out to find where the signal was lost. The transmitter (consisting of two D.E.5 valves in a push-pull circuit with 120 volts HT) was mounted on a dinner wagon and hauled through the streets! The signal on this momentous occasion lasted 150 yards and then disappeared. Aerials were then fitted to the transmitter and receiver for the first time, and signals were at last received between the stations. The transmitter was then keyed and a signal received over 100 yards, acknowledgment being made by flash-lamp. During this test an unaccountable variation in signal strength was noted, which had considerable bearing on subsequent work. It was observed that reception on one side of a lamp standard was 60 per cent greater than on the opposite side." Screening by buildings was obviously a handicap, so tests were made in open country, signals being obtained at R7 over three-quarters of a mile and acknowledged by Klaxon horn.

The Curtain Came Down

The author has tried to show the great enthusiasm and co-operation that existed among the 5m brigade; it was as if there was a great sense of urgency about the whole affair. They never looked back, they shared their findings with others and were always willing to try something new. There was a feeling of sadness among the majority of 56Mc/s enthusiasts when the news came through on September 1st 1939 that their licences had been withdrawn. In November 1939 Constance Hall began her 56Mc/s Column (*T & R Bulletin*) with the following verse:—

Hang up your headphones on the old shack wall,
And cuss, cuss, cuss,
Hang up your headphones on the old shack wall,
But do not make a fuss.
What's the use of listening,
It hardly is worthwhile, so—
Hang up your headphones on the old shack wall,
But smile, smile, smile.

Well, they hung up their own headphones alright, and the majority of them took up His Majesty's headphones and gave all of their 5m experience and know-how, to the service of their country.

To prove that their efforts were not overlooked, the author turned to the book about the Battle of Britain, called *The Narrow Margin* by Derek Wood, and on Page 16 he found the following extract which for the author sums it all up.

"Throughout the operational, installation and development period of German Radar all branches of the service connected with it suffered from an acute shortage of skilled manpower. This was almost entirely due to Goebbels who had seen fit to ban all amateur radio operations shortly after Hitler's rise to power. The excuse given was that of countering subversive elements during the anti-communist purge. The order was never rescinded.

"Until the end of the war Germany was short of good quality radio and radar operators and engineers, *in complete contrast to Great Britain where literally thousands of radio hams with first class knowledge joined the services and the research establishments.*"

The author apologises to the many 5m enthusiasts whose names he has not used in this article, there are many parts of this story still to be told. ●

IC OF THE MONTH 68

Brian DANCE M.Sc

2N5777 PHOTO-DARLINGTON SENSOR

Silicon photodiodes are now in fairly extensive use, but in many applications difficulties occur because a comparatively high light level is required before such diodes pass a useful current. Silicon phototransistors are considerably more sensitive because the "photocurrent" is multiplied by the current gain of the transistor of which the photodiode forms a part.

The 2N5777

In the monolithic 2N5777 device the photosensitive junction is incorporated into a transistor which is internally connected to another transistor in the Darlington configuration. This enables the "photocurrent" to be amplified by an overall factor of at least 2,500 times. Thus this device is considerably more sensitive to light than any conventional phototransistor, but nevertheless very cheap.

The 2N5777 is encapsulated in a package of the standard TO-92 shape shown in Fig. 1, but instead of being manufactured from the normal black plastic material, the body of the 2N5777 is made of a clear epoxy compound which allows the incident light to reach the sensitive junction.

The internal circuit of the 2N5777 device is shown in Fig. 2. The incident light strikes the base-collector junction of the internal NPN transistor Tr1 and forms charge carriers (holes and electrons). These opposite charges are separated by the reverse bias applied across the junction and the resulting current is amplified in the phototransistor Tr1. The emitter current from Tr1 flows into the base of Tr2 where it is further amplified by this second transistor. Both transistors are silicon planar types.

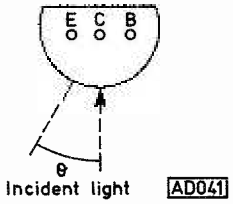
Connections

There are only three connections to the 2N5777, but in many circuits the base is left unconnected. A resistor may be connected between the base and the emitter to reduce the sensitivity somewhat or to reduce the effect of temperature on the "photocurrent".

The maximum permissible collector-emitter voltage is 25V. The maximum permissible values of the collector current and of the power dissipation are 250mA and 200mW respectively; the device may be damaged if these values are exceeded.

Response

The incident light should be directed towards the curved surface of the device as indicated in Fig. 1. As the angle of the incident light (θ in Fig. 1) increases, the response falls rapidly as shown in Fig. 3 until it is almost zero as θ approaches 90°. In practice, however, some light is usually reflected onto the junction whatever the angle.



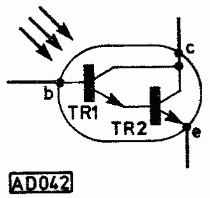


Fig. 1: (left): Encapsulation of the 2N5777. The device is most sensitive to light arriving along the direction of the arrow.

Fig. 2 (right): Internal circuit of the 2N5777.

The sensitive area itself is a very small square with length of sides 0·375mm. Greatly increased sensitivity can be obtained if the light is focused onto this small area.

The response of the 2N5777 to light of various wavelengths is shown in Fig. 4. As with all silicon devices, the peak response is in the near infra-red at a wavelength of about 0·85 microns. Nevertheless, the device is fairly sensitive throughout the visible region, although the sensitivity does fall off in the blue region of the spectrum.

When the device is in darkness, the collector current is less than 0·1μA when the base is not connected and the collector is at +12V relative to the emitter at 25°C. This dark current is roughly doubled for each 10°C rise in temperature and reaches about 10μA at 100°C (with a maximum about 10 times this figure).

TABLE 1

	Silicon Photodiode	Silicon Photo-transistor (BPX25)	2N5777 Photo-Darlington
Daylight (Dull winter day)	2μA	200μA	10mA
100W tungsten filament lamp at 1 metre	3μA	5mA	16mA
Circular fluorescent lamp at 1 metre	0·25μA	50μA	150μA

Sensitivity

One can use complex equipment to measure the "photocurrent" at various light intensities at specified wavelengths, but such data is not likely to be very useful to the home constructor. The 2N5777 collector current was therefore measured under the conditions stated in Table 1 and compared with that in a simple photodiode and in a phototransistor. It can be seen that the 2N5777 "photocurrent" is always greater than that of either of the other devices, but the table does not account for all factors.

The photodiode had a flat glass surface, whereas the BPX25 phototransistor has a small lens. This lens will focus the rays of light onto the junction, but this renders the sensitivity of the BPX25 critically dependent on the angle at which the light enters the lens. If one has a fairly small light source, such as a 100W bulb, the "photocurrent" of the BPX25 can be quite high. However, the 2N5777 not only passes a greater current, but this current output is far less dependent upon the position of the device.

Even a red light-emitting diode placed about 10mm from a 2N5777 device was found to produce a photocurrent of about 25μA in the latter.

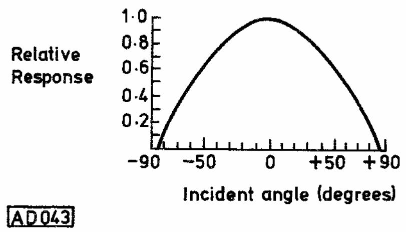


Fig. 3: Response relative to angle of incidence of light upon the device.

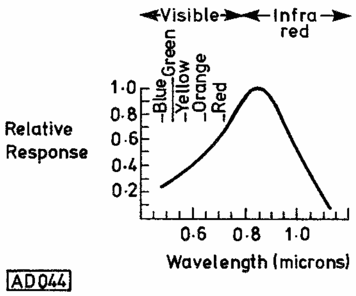


Fig. 4: Response relative to wavelength of incident light.

It should be noted that the tungsten filament lamp produces higher currents in all of these silicon devices than the fluorescent lamp, since it emits mainly in the red and infra-red where the sensitivity of silicon devices is greatest.

Circuits

The basic circuit for the use of the 2N5777 is shown in Fig. 5. When light falls onto the device, the output voltage falls from the V+ value to a low value. The value of R1 should be chosen according to the light level to be detected. If, for example, one expects from Table 1 that the light intensity will produce a current of about 2mA, R1 may have a value of about 3·3 kilohm so as to produce a voltage drop of about 6·6V.

The output from Fig. 5 can be fed into a suitable transistor circuit which may, for example, be used to operate a relay. If the power supply line has a potential of 5V, the output may be fed into a TTL circuit.

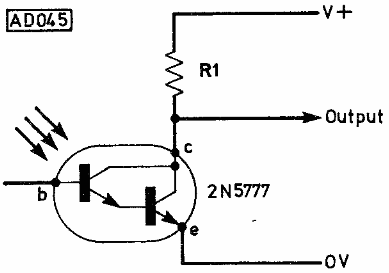
Triac control

An interesting circuit designed by the International General Electric Company is shown in Fig. 6. When the 2N5777 device is in darkness, current can flow from the mains through the load and the triac, but when a sufficient amount of light falls on to the 2N5777, the triac becomes non-conducting and little current flows through the load.

A small alternating current flows through R1 and this is rectified by the diode bridge, D1 and D4, so that the collector of the 2N5777 is always positive in relation to its emitter. If light falls onto the device, its resistance falls and the potential across C1 becomes small, since R1 and the 2N5777 act as a potential divider. When the potential across C1 is small, the diac does not break down and therefore the triac cannot be triggered in each half cycle. The triac used in this circuit should be selected for the requirements of the load employed.

Availability

The 2N5777 device is available from Arrow Electronics Ltd., Leader House, Coptfold Road, Brentwood, Essex CM14 4BN, at 70p (including VAT) plus a small order surcharge of 25p for packing and postage on orders under £5. This company also stocks various triacs and diacs suitable for the circuit of Fig. 6. ●



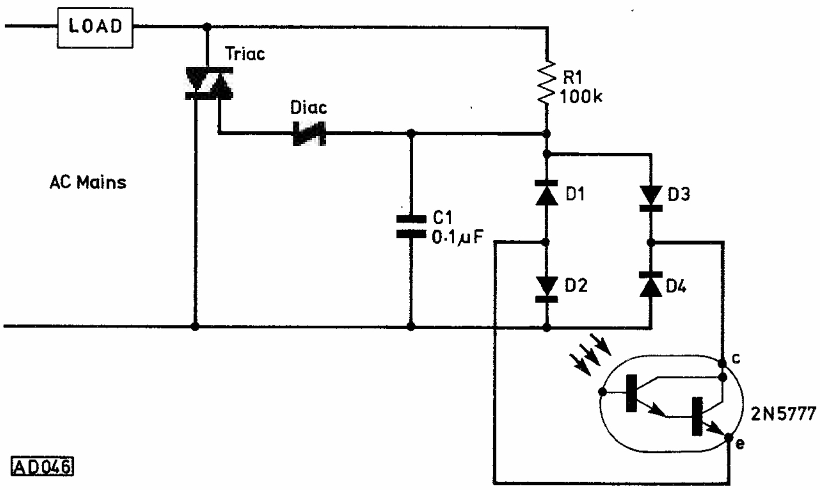


Fig. 5 (above): Basic operating circuit for the 2N5777.

Fig. 6 (right): A practical circuit for a light-dependent mains-voltage controller.

PRODUCTION LINES

alan martin

Miniature Crystals

Walmore Electronics Ltd., the exclusive UK agents for Toyo, have introduced a new range for ultra miniature crystals which are designed to meet the demand for high stability units with a low ageing characteristic.

Featuring a frequency range of 10-200MHz, the units are contained in the HC80/U resistance welded metal package which has a can height of just 8mm.

Also available is a range of high stability crystal units in the HC42/U and HC43/U cold weld miniature metal packages. Frequency range is 4-200MHz and, for both ultra miniature and miniature types, frequency stability is typically ±8ppm in the temperature range −20°C to +70°C, and ageing rate is as low as 1ppm/year.

Toyo's 12 page illustrated catalogue on their full range of crystal units contains both data and extensive descriptions of the characteristics of the devices. Copies are now available from: *Walmore Electronics Ltd., 11-15, Betterton Street, Drury Lane, London. WC2H 9BS.*

Patchboards

Vector Klip-Blok d.i.p. patchboards are ideal for fast convenient breadboarding for d.i.p.s, transistors and discrete devices.

Wire and component leads simply push into beryllium copper spring clips, each with four tie points, allowing experimental circuits to be built very quickly.

The beryllium copper clips accept leads of 0·015 to 0·032 inch diameter, making them compatible with most commercially available components. For larger leads (up to 0·050 inch diameter) adapter pins are supplied.

The patchboards are produced in three standard sizes from 67 × 114mm suitable for up to 3 d.i.p.s to 114 × 203mm (prices range from £4·50 to £21·00) which will accommodate up to 12 d.i.ps; all are mounted on a one inch aluminium frame.

There are also two inch high aluminium chassis into which patchboard panels (less frames) can be fitted to provide either two or four times the area of the largest board.

The system is sufficiently flexible to accommodate the very simplest circuits to complex l.s.i. packages and microprocessors.

Full details are available from: *Rhopoint Ltd., Eastman House, 98/102, Station Road East, Oxted, Surrey. RH8 0AY. Tel: 08833 7988.*

New from Casio

We have recently been fortunate in being able to examine some new Casio products kindly loaned to us by Tempus of Cambridge.

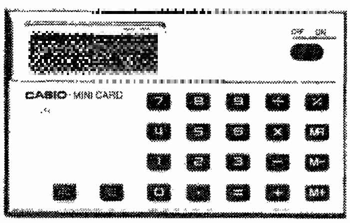
The versatile MQ-2 combines the best of digital clock and calculator abilities in a slim metallic case. A digital clock, alarm, alarm timer, time memory, calendar and 8-digit calculator, with a well-spaced easy to operate keyboard.

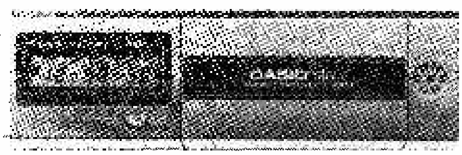
A truly pocket sized calculator is the LC-78 Mini card. Measuring only 4mm thick and weighing only 39g (1·4oz) it features all the normal functions including direct access to the memory. The read-out is an FE-type liquid crystal display. With power consumption at 0·0006W, the two silver oxide batteries, type G10 should give approx. 1000 hours continuous operation.

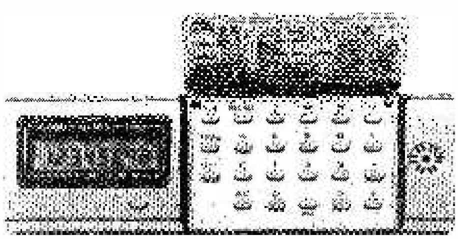
The fx-120, with digitron read-out, provides a really good balance between 'scientific' and 'everyday' functions. Fractions may be calculated without the need for figure conversions and the answers are also displayed as fractions.

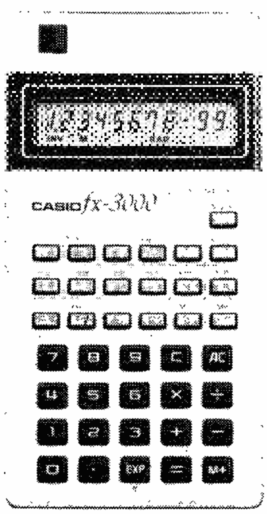
Last, but not least, the fx-3000, a pocket sized scientific calculator, which boasts a remarkable number of functions for a unit of its size and price. The liquid crystal display is unambiguous and the total weight is only 80g (2·8oz) including batteries.

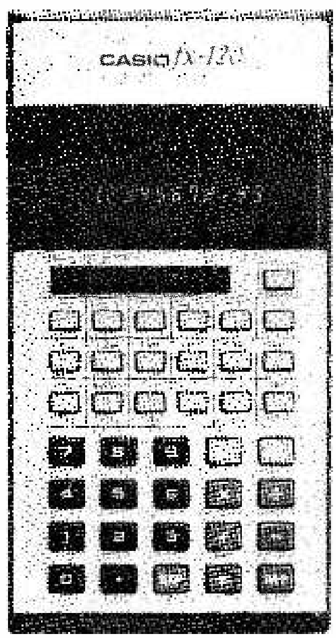
The units are available from Tempus at a discount price, which includes VAT and p & p (the RRP is shown in parentheses). MQ-2 £34·95 (£39·95), LC-78 £16·95 (£19·95), fx-120 £19·95 (£24·95), fx-3000 £25·95 (£30·95). *Tempus, Dept. P.W., 19/21 Fitzroy Street, Cambridge CB1 1EH. Tel: 0223 312866.*











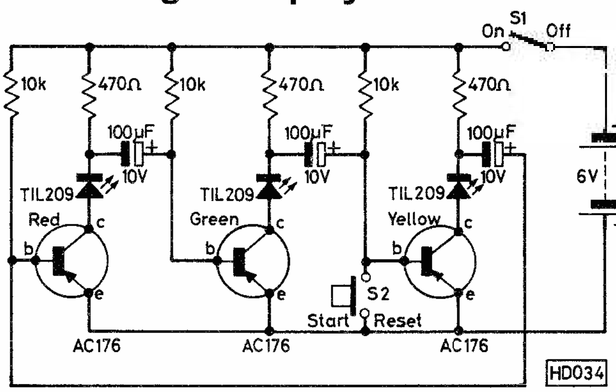
EXPERIMENTER'S CORNER

Some original circuit ideas provided by our readers. These designs have not been proved by us, and we cannot therefore guarantee their effectiveness. They should at least provide a basis for experimentation.

Why not send us your idea? If it is published, you will receive payment according to its merits. Articles submitted should follow the usual style of PW in circuit diagrams and the use of abbreviations. Diagrams should be clearly drawn on separate sheets, not included in the text.

Each idea should be accompanied by a declaration that it is the original work of the person submitting it, and that it has not been accepted for publication elsewhere.

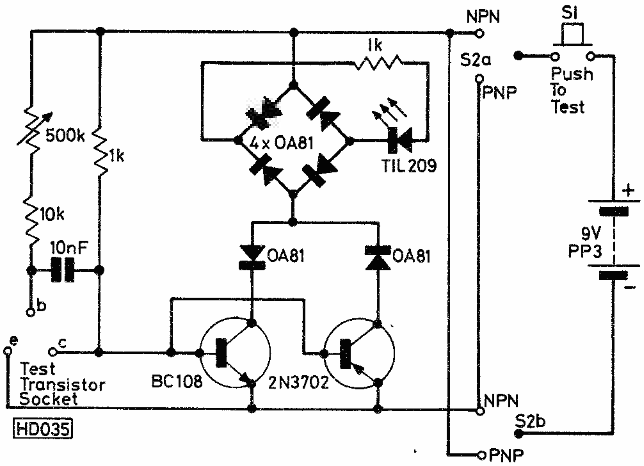
L.E.D. Light Display



A circuit without a frantically serious purpose, this is basically an astable multivibrator with an additional stage added. Each l.e.d. is switched on and off in sequence, with two being illuminated and one "off" at any one time. S2 acts as a start/reset in the event that all l.e.d.s stick in the "on" state. Each l.e.d. should of course be a different colour to increase the optical variety of the display The active area of the multivibrator uses the cheap and readily available AC176 germanium transistor, but any general purpose pnp type will suit.

A. Cooper, Wimborne, Dorset.

Transistor Gain Indicator



A transistor is plugged into socket 1, and "pnp" or "npn" selected; S1 is pressed, and l.e.d. 1 lights. VR1 is then rotated, anti-clockwise from the high gain end, until l.e.d. 1 is extinguished. The gain is then read off VR1 scale, indicating the minimum gain figure, in the range 10-500, which is related to a fixed collector current of approximately 8mA in the transistor under test.

The collector current is determined by R2, and base current is supplied via R1 and VR1. When the test transistor's collector/emitter voltage falls to 0·6V, Tr1 (for npn) and Tr2 (for pnp) will turn off since base current (via R2) is then taken by the transistor under test.

A bridge rectifier (D3-D6) supplies l.e.d. 1 with correct polarity regardless of supply changes. It is necessary to calibrate VR1 in terms of an approximate gain scale, and since R2 equals 1kilohm, then the scale is VR1+R1 expressed in units of 1k. Precise calibration can be effected via a Wheatstone bridge, using a multivibrator running at 1kHz, or other source, in concert with an earpiece to indicate the null point. When R1 is 10k this represents a reading of 10 on the scale.

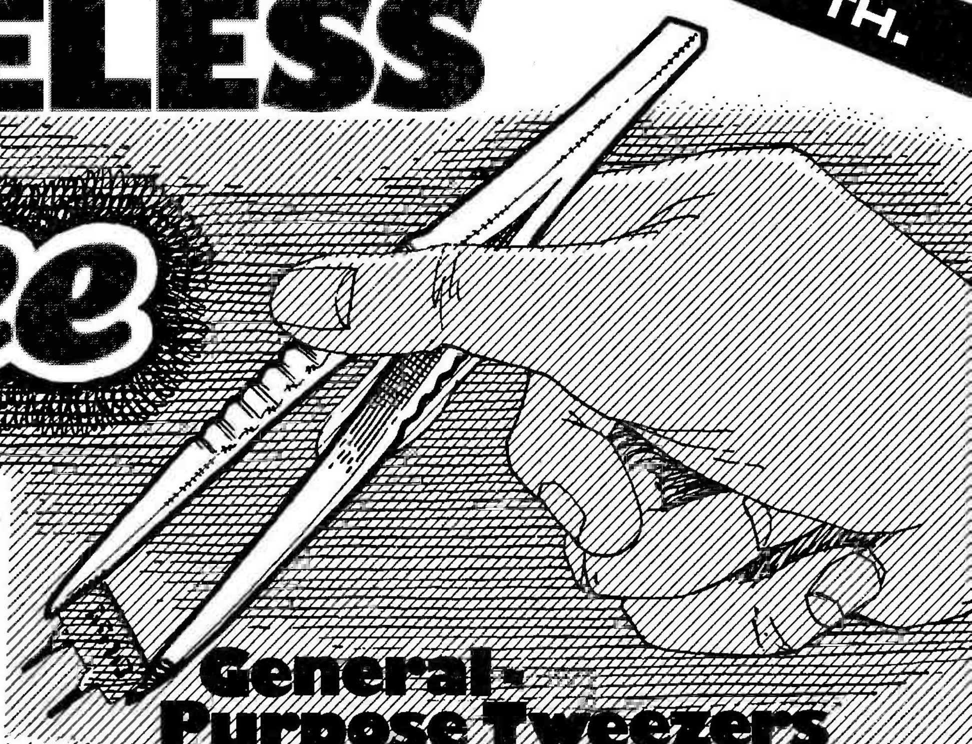
S. Lamb, Leeds, Yorks.

ON SALE APRIL 7TH.

NEXT MONTH IN...

practical WIRELESS

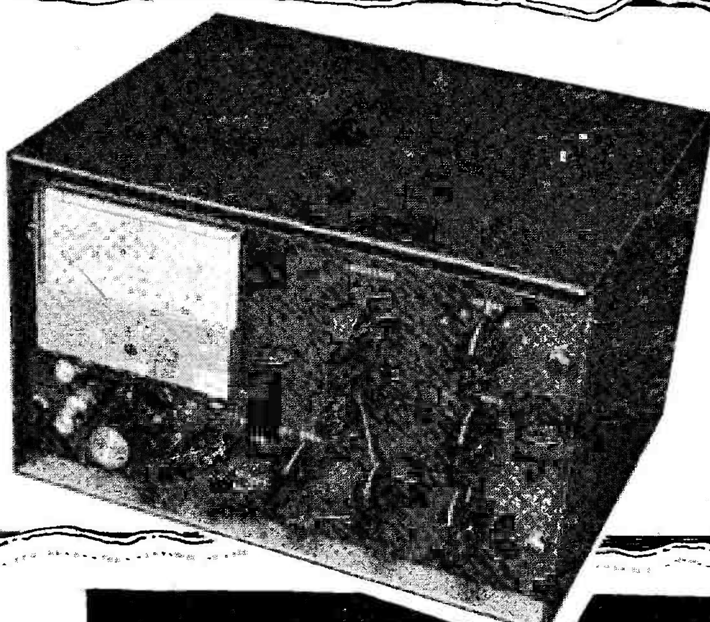
free



A pair of tweezers is an indispensable aid for anyone handling small parts or components. Ours, shown here life-size, have the added advantage of being made of ABS, a particularly tough grade of plastics. Don't miss this opportunity!

General-Purpose Tweezers

AUDIO DISTORTION METER



The dramatic improvements in hi-fi specifications have highlighted the need for equipment capable of testing audio systems. Our Audio Distortion Meter will enable you to carry out objective tests.

also:

2-METRE VSWR BRIDGE

Constructional details of an efficient 1-100 watt s.w.r. bridge, allowing constant 'on air' measurements to be made in order to obtain the maximum possible radiated power from a v.h.f. transmitter.

The bridge may be placed permanently in-line with the aerial feeder and indicates forward and reflected power levels.

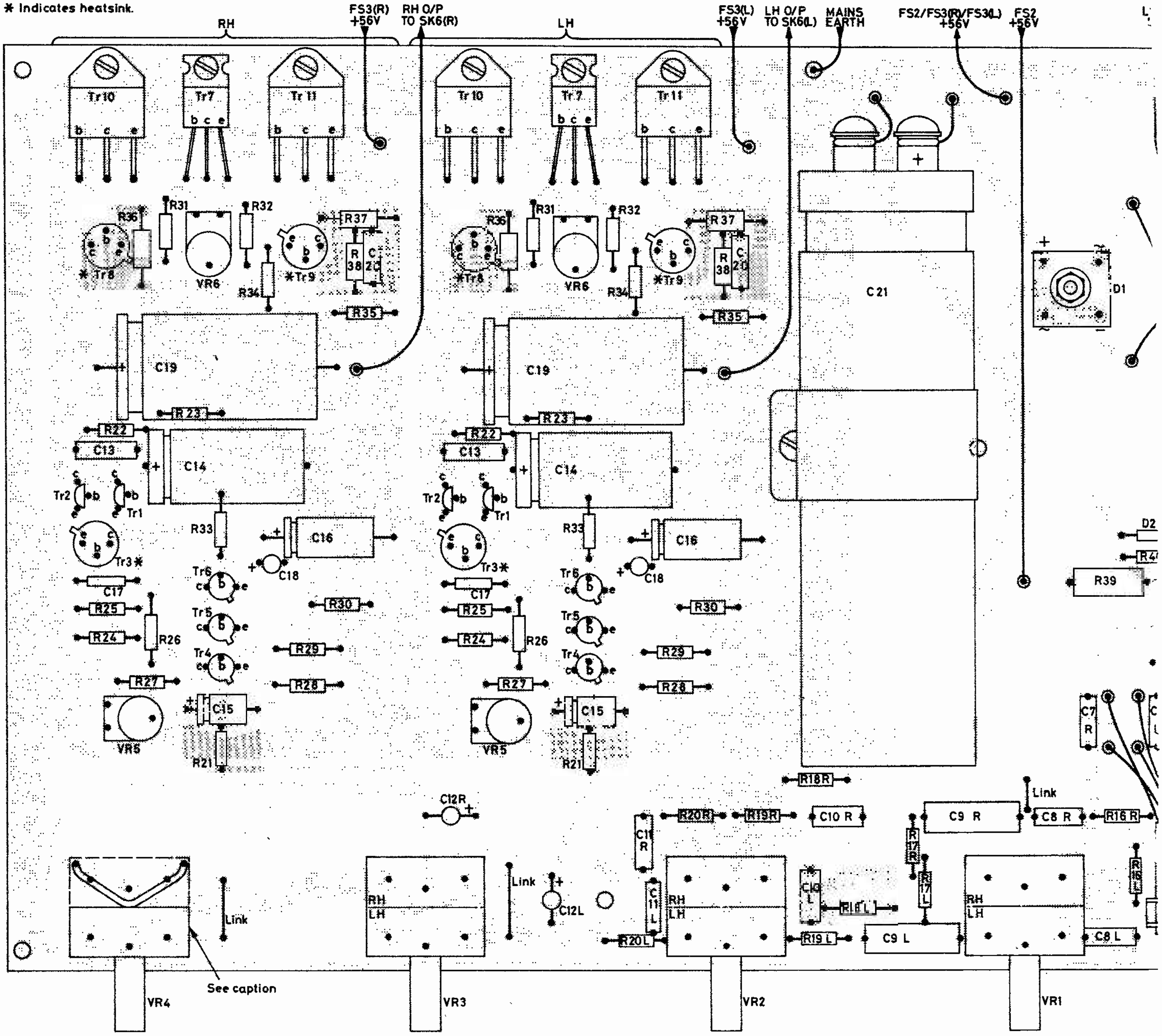
PHASE-LOCKED LOOPS

The principle of the phase-locked loop (p.l.l.) and its versatility in situations where immunity from noise is important, is covered in this "extended application note". This treatment provides data and applications for the NE561B "chip" as f.m. discriminator and a.m. demodulator.

'EUROPA' stereo amplifie[r]

Fig. 4(a): Location of components on the printed circuit board. Connections to the push-button switch assembly are detailed in Fig. 7. Note that the OV track on the p.c.b. is connected to earth and to the chassis only at the fixing point labelled "Mains earth". In the prototypes, the Balance control VR4 was a single potentiometer fitted with stiffening supports as shown in the photograph last month. Alternatively, a twin-gang potentiometer can be fitted, one half being unused. The p.c.b. will accommodate either arrangement.

* Indicates heatsink.



PA'

amplifier

C. Toms B.Sc

Part 2

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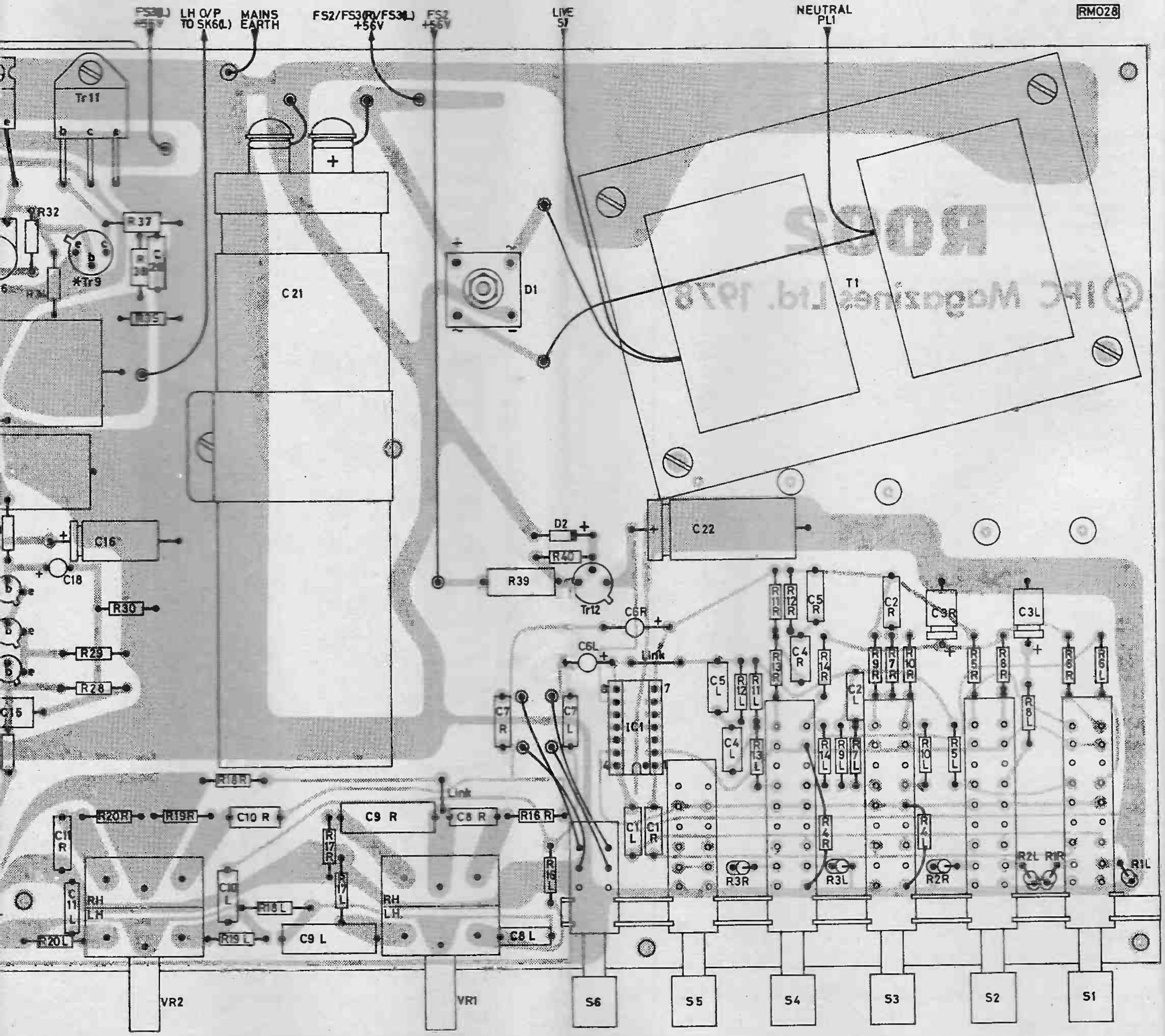
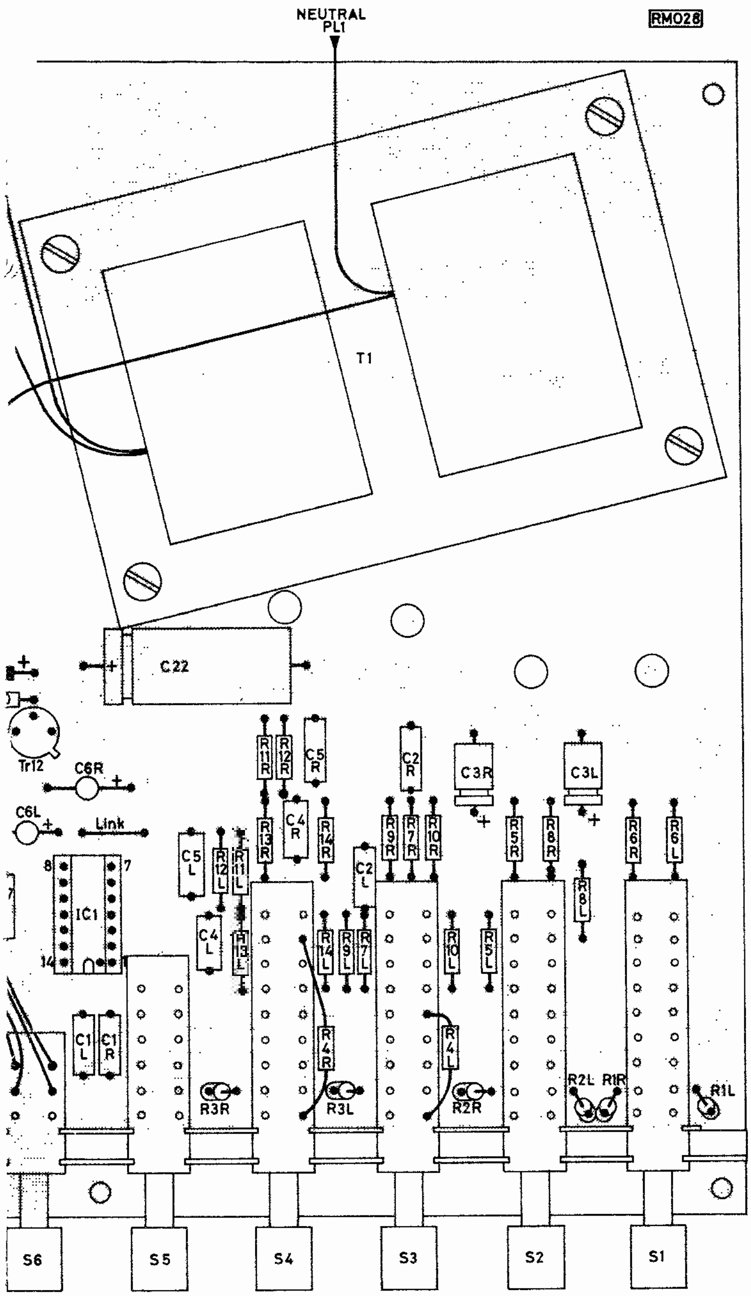


Practical Wireless, April 1978

C. Toms B.Sc

Part 2



Construction

Assembly of components onto the printed circuit board (see Fig. 4) should present no problems but it is suggested that they be fitted in the following sequence:

1. All resistors.
2. All capacitors excluding the main smoothing capacitor.
3. The switch assembly.
4. All semiconductors and socket for IC1 (see below).
5. The power supply bridge rectifier and smoothing capacitor.
6. The mains transformer.
7. Controls.
8. Connect the mains transformer secondary to the a.c. input of the diode bridge.

Before fitting the row of output transistors (Tr7, Tr10, Tr11) it will be necessary to make the heat-sink plate to fit under them. This should be cut from aluminium sheet and bent as shown in Fig. 6. Note that when assembling this it is sandwiched between the back plates of the individual transistors and the p.c.b. Make sure that isolation is provided with mica washers and plastic bushes for the fixing screws. Heat-sink compound should be used where shown in Fig. 6. Clip-on TO39 heat sinks are used on the driver transistors Tr3, Tr8 and Tr9. Before leaving the p.c.b. fit flexible speaker output leads of sufficient length to reach the output sockets but leave connection to the sockets until later.

The main chassis is formed from a single piece of aluminium sheet with dimensions as shown in Fig. 5. Drill all fixing holes for the heat sink and p.c.b., using the board as a pattern, and then drill holes for and mount the power input and output sockets and fuse holders. Bolt the p.c.b. into place using stand-off spacers. Ensure that the transformer bolts are long enough to protrude right through the chassis so that spacers can be inserted under them also. This gives the p.c.b. more support under the heavy transformer.

The p.c.b. 0V track should be connected to the chassis only at the main earthing point (the centre fixing screw at the back of the board). Insulating washers should be used between spacers and p.c.b. where necessary.

Carefully bolt the heat-sink down making sure there is good thermal contact and then connect the speaker output leads to their respective sockets after cutting to length. Connect both speaker leads in like manner, to preserve correct phasing.

The input sockets are wired to the front four terminals of their respective switches as shown in Fig. 7. It is advisable to use the DIN standard socket configurations so that standard interconnecting leads can be used. Screened wire must be used for the connections between sockets and switches and the positions of their earthing points followed exactly. Holes are provided in the p.c.b. for these leads to be routed through and under the board to the sockets at the rear.

Finally, wires should be connected between the p.c.b. and the fuses and the mains connectors as shown in Fig. 8.

Assembly should now be complete but before applying power re-check all connections and ensure that there is no chance of the p.c.b. wiring shorting to chassis through the fixing screws. It is just as well to check that the mica insulators under the output transistors have not been forgotten!

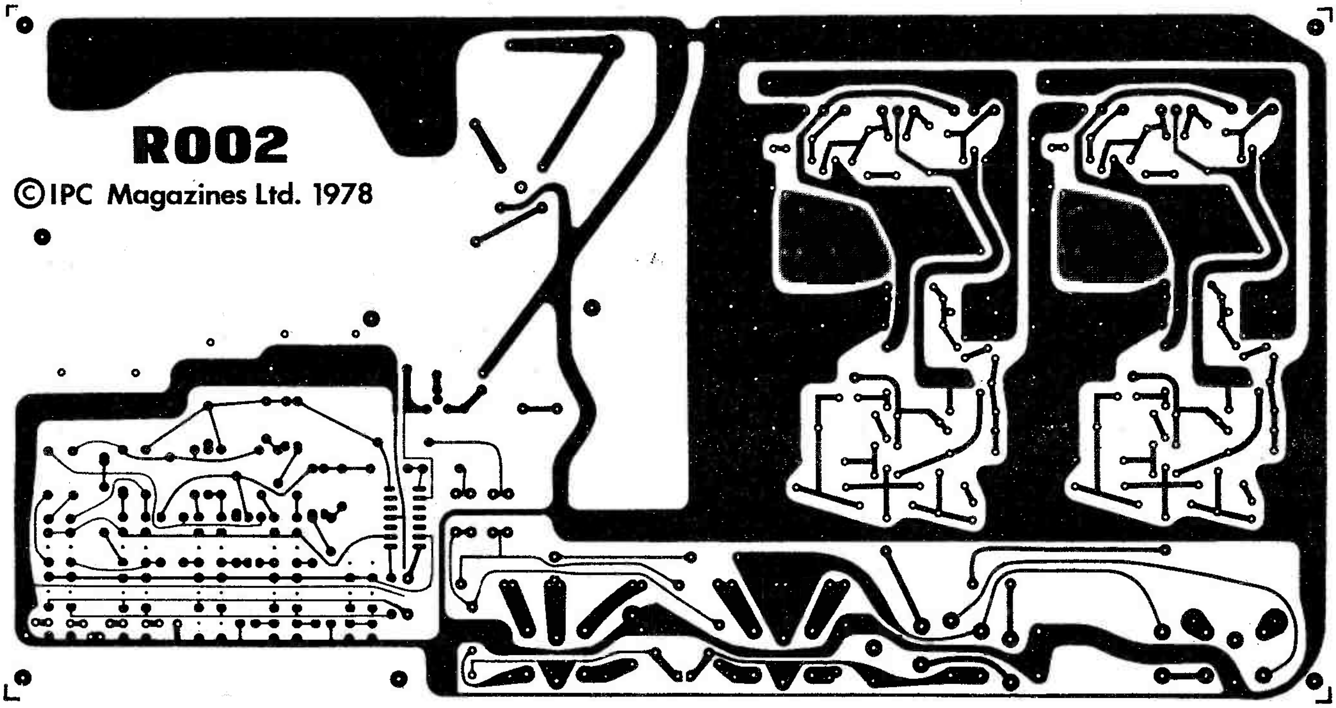


Fig. 4(b): Track pattern of the printed circuit board, shown half-scale. Full-size copies of this drawing will be available from the editorial address given at the front of the magazine, price 30p. Send a cheque/postal order for 30p together with a large stamped self-addressed envelope. Ready-made boards will be available from the Readers PCB Service as usual. See their advertisement.

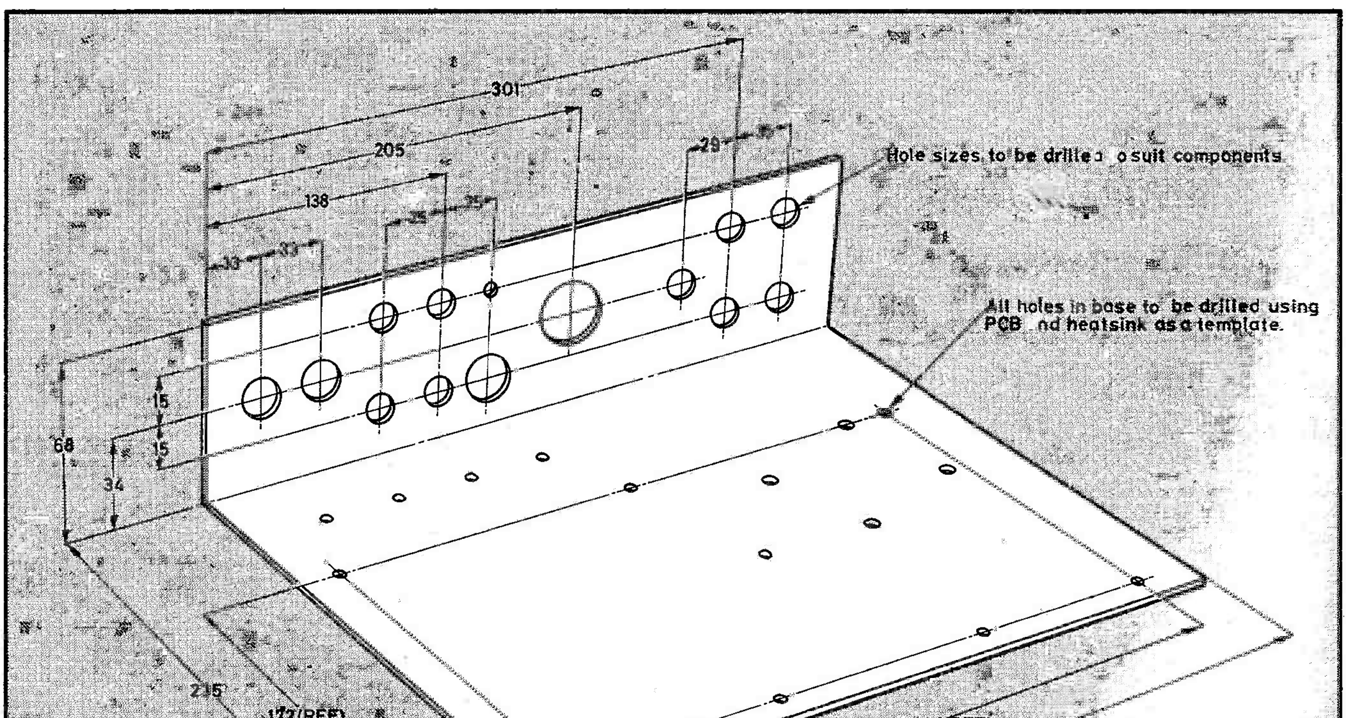


Fig. 5: Chassis dimensions and drilling details.

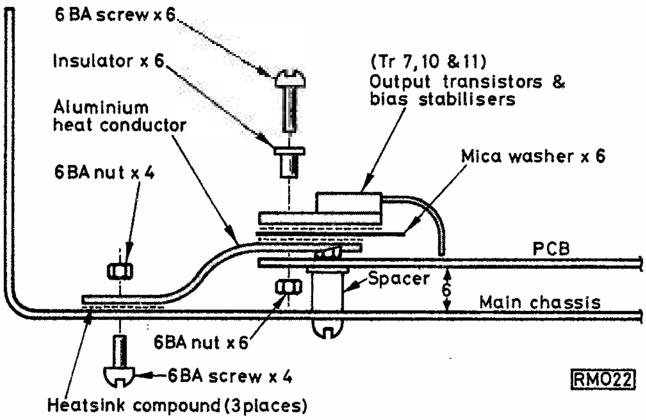
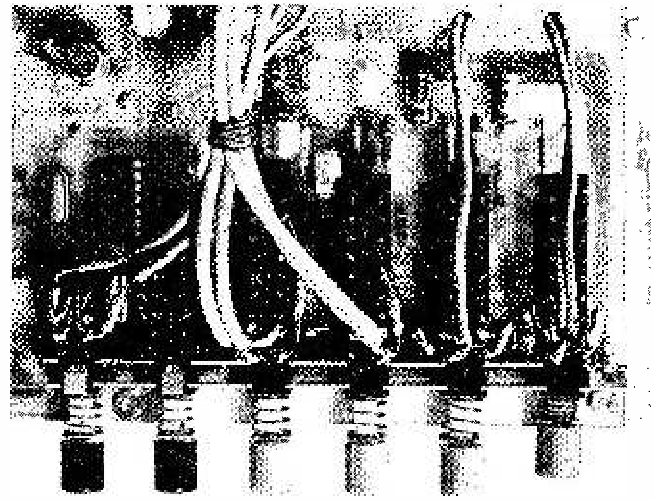


Fig. 6: Assembly details for output transistors and heat sink.



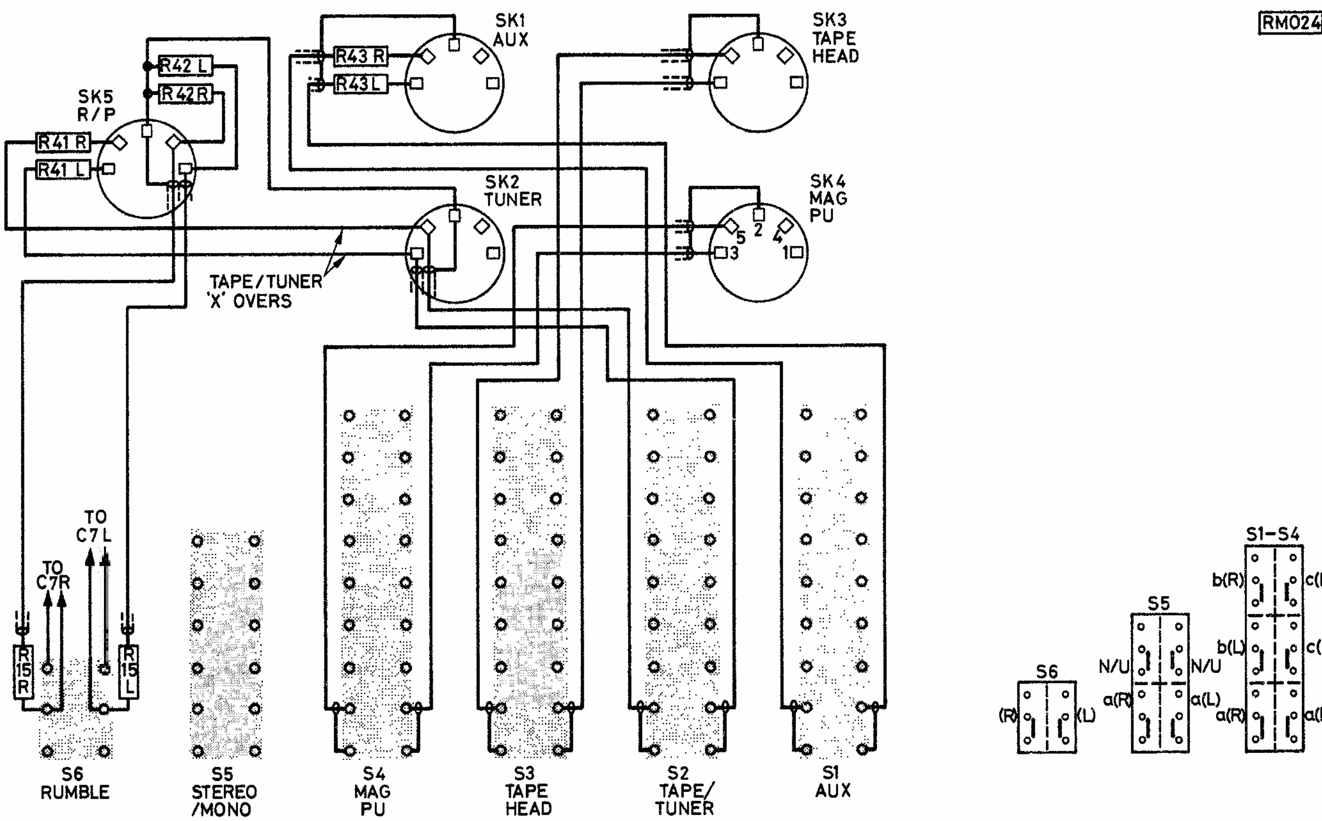


Fig. 7: Wiring details for the input sockets and push-button switch assembly. To avoid hum-producing earth loops, the cable screens must be connected only at the point shown. The photograph above shows the switch area in a prototype amplifier.

Testing

Before applying power set VR5 on both channels to a mid position and VR6 fully anticlockwise. Set the volume control to minimum and select the tuner input. The amplifier is now ready for test. At first do not connect loudspeakers but switch on the power and check that there is a nominal 56V supply at the fuses.

Now check the voltage at the positive end of the output capacitor (i.e. the junction of Tr10 emitter and Tr11 collector). This must be adjusted until it is exactly half the supply rail voltage, by carefully setting VR5. This procedure should be gone through for each channel. Leave the amplifier switched on for about 10 minutes and repeat the adjustment if necessary. If there is no voltage, or it is impossible to adjust it switch off immediately and check through the wiring for errors.

Having set VR5, switch off the amplifier, and for safety, disconnect the mains supply. The next step is to check the quiescent current of the power amplifier, and to set the standing current in the output stage so that crossover distortion is reduced to a minimum. This, again, must be done for each channel in turn.

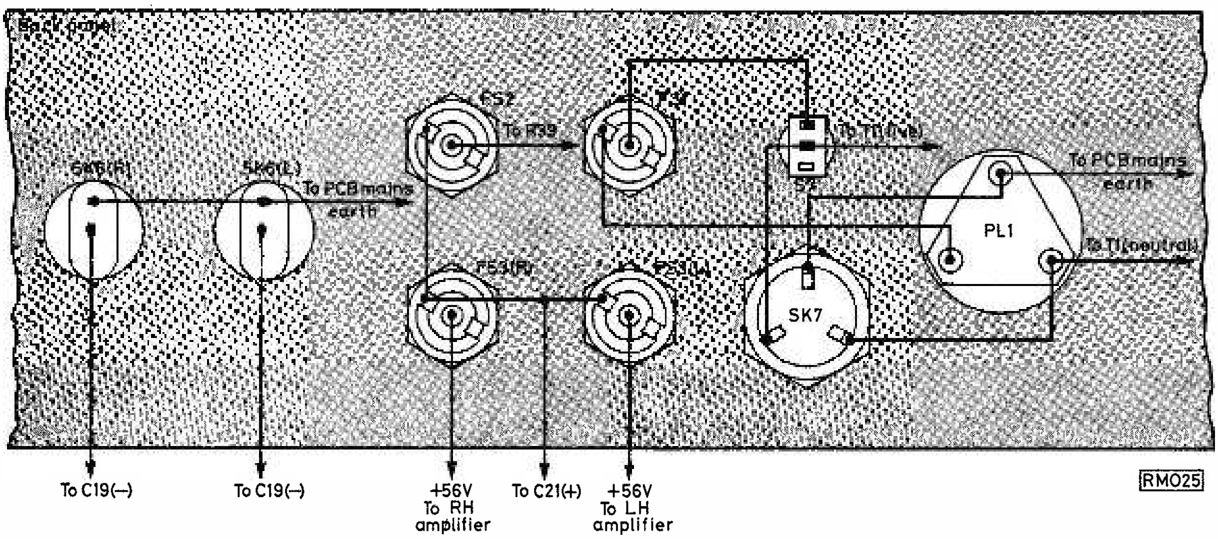


Fig. 8: Mains wiring and connections to the fuse-holders.

Remove the power amplifier fuse FS3 for one of the channels and connect a meter set to its 100mA d.c. range across the fuse-holder. Reconnect the mains supply and switch on the amplifier. Make a note of the quiescent current reading, which should be of the order of 8mA. Switch off and repeat this measurement for the other channel, which should be approximately the same.

The output stage standing current in each channel is set by turning up the appropriate VR6 until the current flowing *increases* by 25mA. The measurement should be checked again after about 15 minutes operation, and VR6 adjusted if necessary to regain the reading of quiescent current plus 25mA.

Mains Switching

The mains on/off switch S7 is mounted on the back panel of the prototype amplifiers. This has the advantage of keeping the hum field surrounding the mains wiring well clear of the amplifier input.

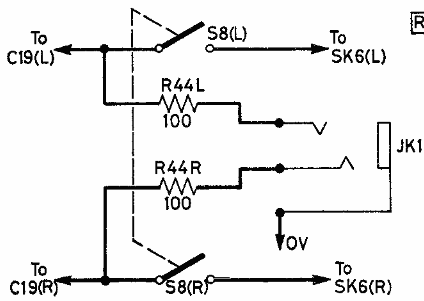
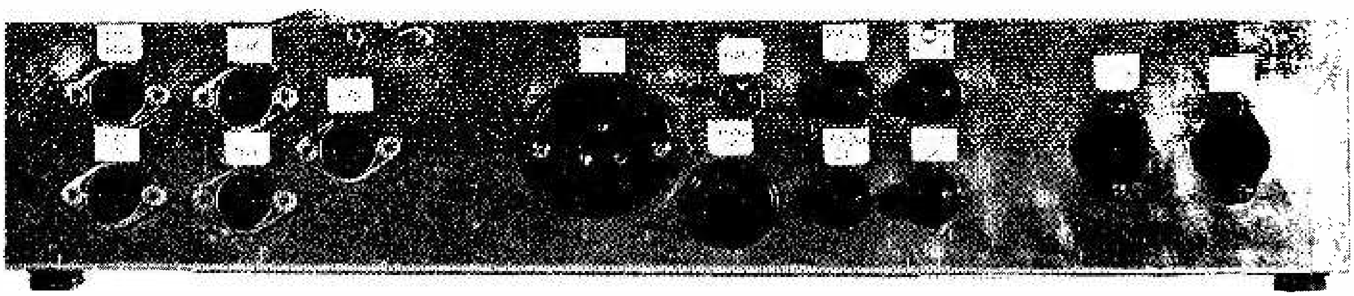


Fig. 9: Adding a stereo headphone socket.

Headphone Output

Constructors wishing to add a socket for the connection of stereo headphones may do so by inserting the circuit shown in Fig. 9 in the leads between C19 and SK6 of each channel. Resistor R44 attenuates the output signal to a level suitable for headphone listening. The switch S8 allows the loudspeakers to be muted when headphones are in use.



μ-DeCnology

DAVID GIBSON

2

THIS MONTH

'The Grip'n Grow'

Specification sheets on integrated circuits can be very frightening to the newcomer. Conversely, the prime aim of this series is to show how simple it is to use integrated circuits.

So let's take a peep at two of the terrible technicalities of our 741 operational amplifier (op amp) and see just how easy it is to understand them.

Two basic ways of using our op amp are the "open loop inverting d.c. amplifier", and the "closed loop inverting d.c. amplifier". It sounds very technical and off-putting, but you can see for yourself how simple it is by looking at Fig. 1.

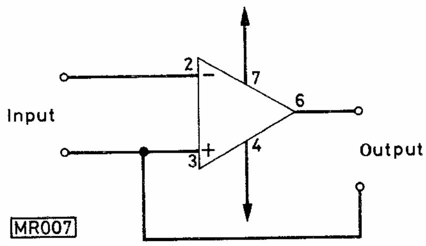


Fig. 1: The open-loop inverting amplifier circuit.

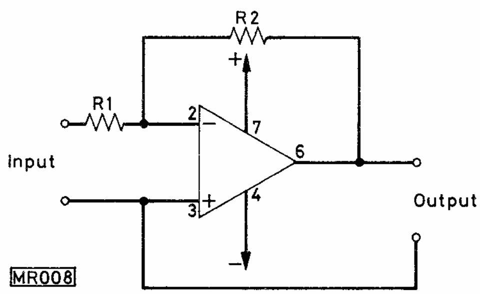


Fig. 2: The closed-loop inverting amplifier

The positive input terminal (pin 3) is connected to ground, and the input is applied between the negative input terminal (pin 2) and ground. In this mode the i.c. can have very high gain indeed, up to some 100,000, while the input impedance is around 1MΩ.

A problem with using the Fig. 1 circuit is that the practical performance is dictated by the parameters of the individual op amp used, and these parameters can vary quite a lot from one 741 to the next.

An alternative is to use the 741 in the closed loop mode and this is shown in Fig. 2. We've still grounded pin 3 and the input is still applied to pin 2, but we've added two resistors R1 and R2. Resistor R2 connects the output to the input and forms a feedback path. This is what is meant by "closed loop" i.e. "with feedback". In Fig. 1 there is no feedback resistor and thus the Fig. 1 circuit is called "open loop". See how simple it is—it's only the technical words which are hard!

Another useful feature of Fig. 2 is that the gain can be controlled by the ohmic ratio of R1 and R2. The mathematics are extremely simple: gain $= \frac{R2}{R1}$

Simplifying technical language is all very well, but let us now turn to the practicalities of putting the knowledge to work.

Figure 3 shows a 741 in a closed loop mode. You can make up this circuit very simply and quickly on

★ components

Resistors	
3·3MΩ	μDeC
100kΩ	μDeC DIL holder
1kΩ	12V battery
100Ω	μDeC jumper leads
741 op amp	meter 0-10mA (optional)

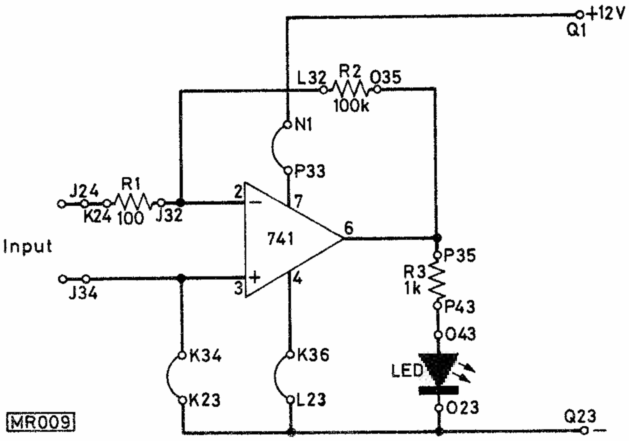


Fig. 3: A practical inverting amplifier for you to make up.

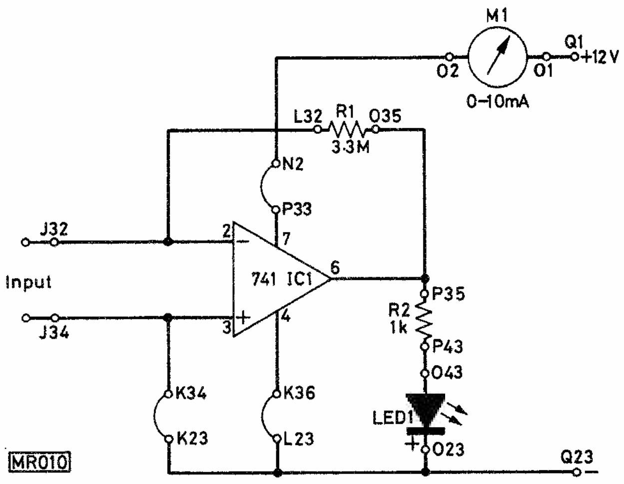


Fig. 4: A development of the circuit of Fig. 3.

your μDeC holes shown in Fig. 3. The op amp should be mounted into the μDeC d.i.l. carrier.

Resistor R2 has been made 100kΩ while R1 is 100 so the gain should be around 1,000 ($\frac{R_2}{R_1} = \frac{100,000}{100} =$ 1,000). The output circuit consists of R3 and the l.e.d.

If you now short together input points A and B you will effectively connect the negative input to ground or 0V and the l.e.d. will light. If you recall the last μDeCnology article you will know why this happens. If you don't know, then perhaps you might have a quick read of last month's *Practical Wireless* just to brush up?

We now know that shorting the negative input to earth will give us an output that will light the l.e.d. What happens if we connect (say) a 100kΩ resistor between pin 2 and ground? If you try this, you should find that the l.e.d. still lights, but less brightly. So we can now deduce that the resistance value between the input points A and B is proportional to the brightness of the l.e.d. and vice versa. Further, the brighter the l.e.d. is, the more current it must take, and we can therefore say that the current drawn by the circuit is also directly proportional to the value of resistance between points A and B.

In practical terms we can now not only understand our "closed loop inverting d.c. amplifier using an op amp", but we can transform this indigestible jargon into a circuit with some immediate uses.

Some applications, and the reasoning which led to them, are as follows—but before reading them try to think how you might use the effects you have already discovered from Figs. 1, 2 and 3, then read on and see if you came up with the same as I did.

Look at Fig. 4. This circuit is even simpler than the last one! It has an op amp, two resistors, a meter (optional) and a lone l.e.d. Resistor R1 is the feedback resistor, R2 and the l.e.d. form an output indicating device. The meter is simply inserted in the positive power lead and should read 0-10mA full scale deflection (f.s.d.).

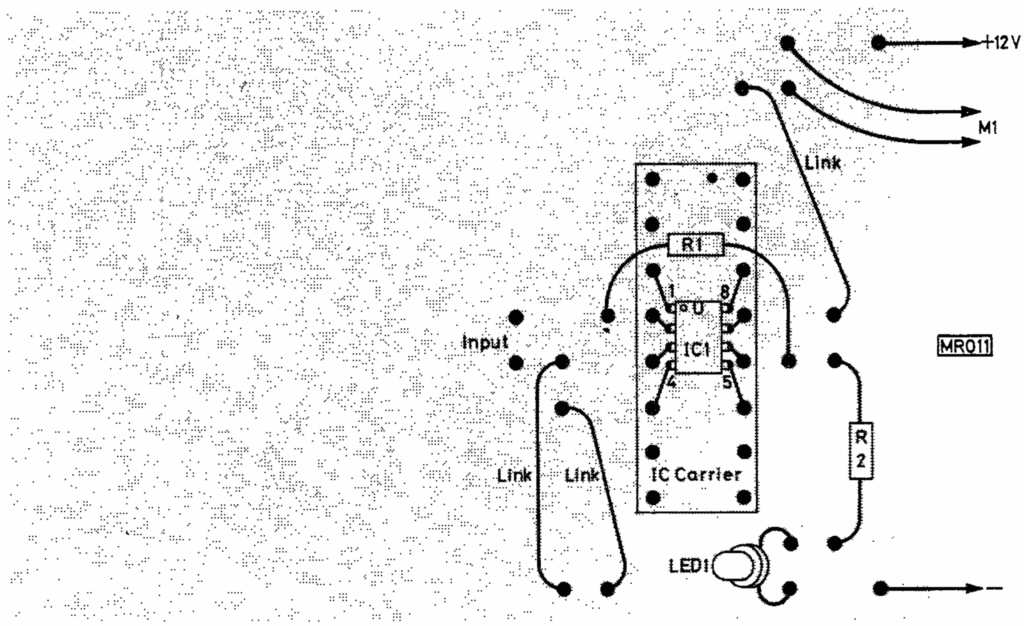


Fig. 5: The circuit of Fig. 4 laid out on the μDeC.

It was reasoned that small changes in resistance could give large changes in output current. Hence connecting a current meter in the power lead would confirm this. It was found that with 9V applied, the quiescent or standing current was 0·85mA. Shorting pin 2 to earth or ground caused the current to jump to 4·75mA quiescent and 7·25mA with pin 2 shorted to earth. The device would now give a considerable indication of the value of resistance between its input terminals. So it could be used (without the meter) as a plant watering indicator. Since soil has resistance, and since this resistance drops as the soil gets wetter it would be simple to make the device with two metal rod probes. These could be inserted into (say) the flower pot to see how brightly the l.e.d. lit. If it was clearly visible then no water would be needed. If the l.e.d. did not light, then the plant would require watering until the l.e.d. lit brightly. To test that the circuit is working, simply short the input terminal together momentarily and watch for the l.e.d. to flash.

The feedback resistor was increased to obtain greater gain. The series resistor was omitted since it was reasoned to be superfluous in this application.

Another use for the circuit might be in finding the values of unknown resistors. By using the meter as shown, a known resistor could be inserted and a definite value of current noted. Another, different value is then connected between the input points and again the current value noted. In this way, one could calibrate the meter. The unknown resistor might then be read off approximately. Alternatively, a potentiometer could be connected to the input terminals and its dial calibrated. The pot is then disconnected and the unknown resistor inserted. The current value is noted. The pot is then reconnected in place of the unknown resistor and adjusted to obtain the same current reading on the meter. The value of the unknown resistor is then read from the previously calibrated pot.

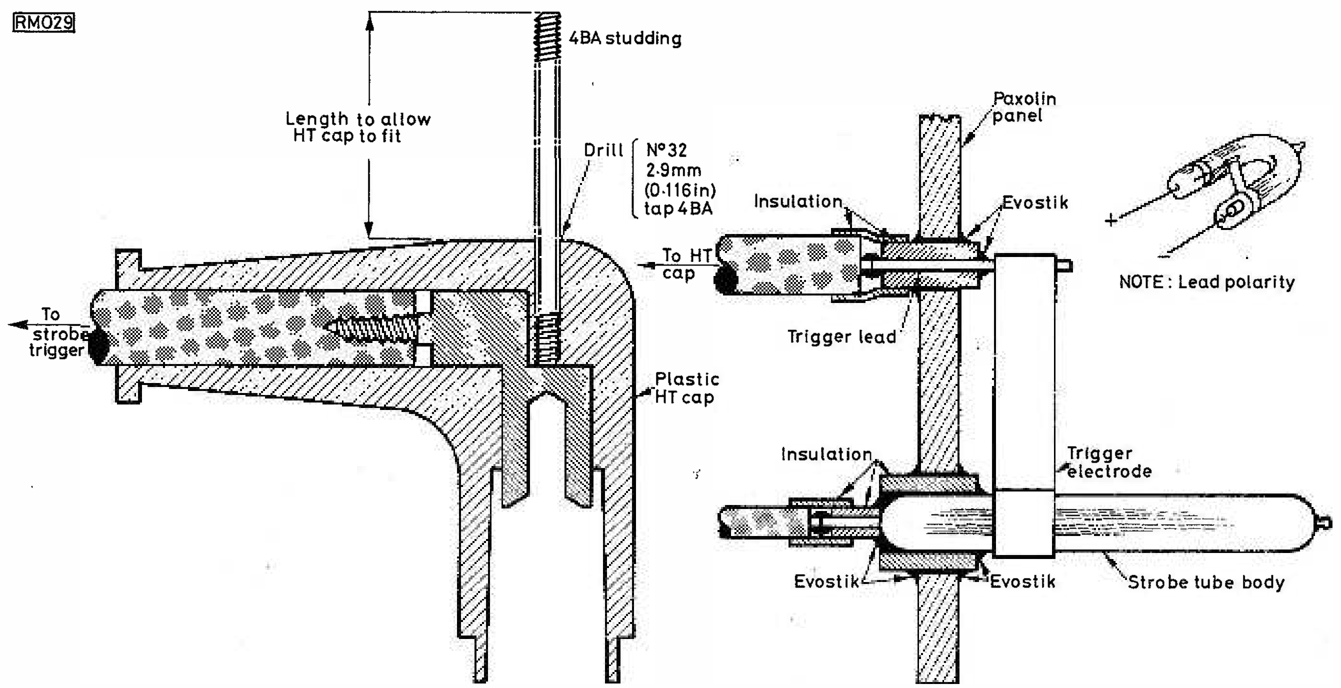
One last idea for using Fig. 4. It might be used as a party game of "test your strength". Since it measures resistance, then it should measure body resistance. On test this was found to be so, thus by using two rods, the contestant is asked to grip them as tightly as possible. The tighter these are gripped, the better the contact between the body and the rods and thus the lower the contact resistance and the higher the meter reading. The meter could be scaled from, say, 3·5mA as "nine-stone weakling" through 4·5mA ("ten stone weakling") up to the maximum reading of "get your cotton-picking bionic fingers off". For permanence, once the circuit has been proved on the μDeC, the components can be transferred directly to a single piece of "ZB1 IC Blob Board".

EXTRA DATA FOR THE ECONOMY TIMING STROBE

FEBRUARY ISSUE 1978

Readers constructing the Timing Strobe described in the February issue should take careful note of the following important information on the flash tube and the method of mounting it into the Paxolin panel. The wire leads from the glass tube must not be bent closer than 12mm from the glass and care must be taken to ensure that the correct polarity of the 300V supply is applied to the tube as shown in the drawing below. The drawing also shows how the tube is mounted and insulated using plastic sleeving and plenty of Evostik adhesive.

The left hand drawing shows an alternative spark plug adaptor using a standard plastic suppressor cap. The 4BA length of studding is screwed into the body of the cap until it makes contact with the metal connector moulded into the cap.



VHF Wavemeter

M. TOOLEY, BA

Introduction

The Home Office Amateur Licence requires that the holder provides equipment within the station that is capable of verifying that emissions are made only within the authorised frequency bands. The vast majority of modern VHF transceivers use crystal control (or crystal-controlled frequency synthesis) and hence only a relatively simple form of absorption wavemeter is required in order to comply with the licence regulations. The absorption wavemeter is used to confirm that the desired harmonic has been selected and that the output of the transmitter consists solely of the wanted signal with no unwanted radiation present.

It is essential that the wavemeter covers a sufficiently wide range, both above and below the desired band, and that the frequency coverage extends to at least the second harmonic of the desired frequency. Attention should also be placed on the scale length and accuracy of the instrument. The wavemeter described in this article was designed to meet the licence requirements for a station operating in the 2-metre band. The actual coverage is approximately 95 to 350MHz and the sensitivity is adequate for RF power levels of between 100mW and 100W. The wavemeter is designed so that it may be connected in the co-axial line between the transceiver and aerial and thus it can provide a continuous check on the output signal.

★ components

Resistors
R1 22kΩ ¼W 5%
R2 220kΩ ¼W 5%

Capacitors
C1 1nF disc ceramic. VC1 50pF, Jackson C804
Diode, D1 OA90.
Meter, 100micro-amp panel mounting (Maplin type "2in PAN")
Ferrite Beads, 2 off

Miscellaneous
S1, Miniature s.p. toggle switch with centre "off". SK1 and SK2, standard surface mounting co-axial sockets. Diecast box 120mm × 60mm × 44mm (Maplin type DC2). 140mm co-axial cable (Maplin type "low-loss"). 18s.w.g. tinned copper wire for L1. 200mm 26s.w.g. enamelled copper wire. Tag strip, control knob with pointer.

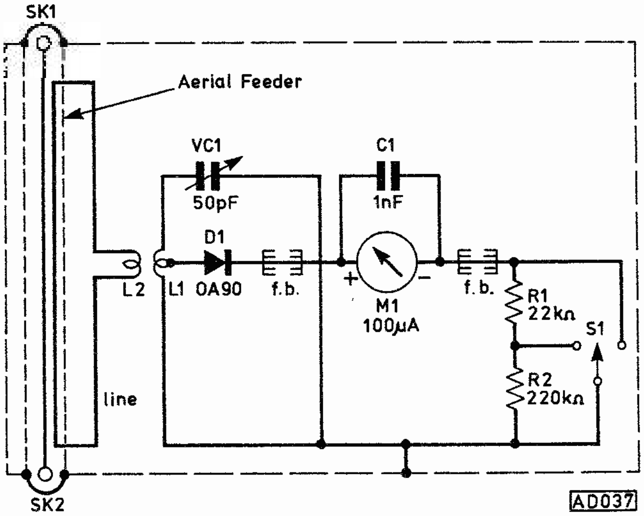
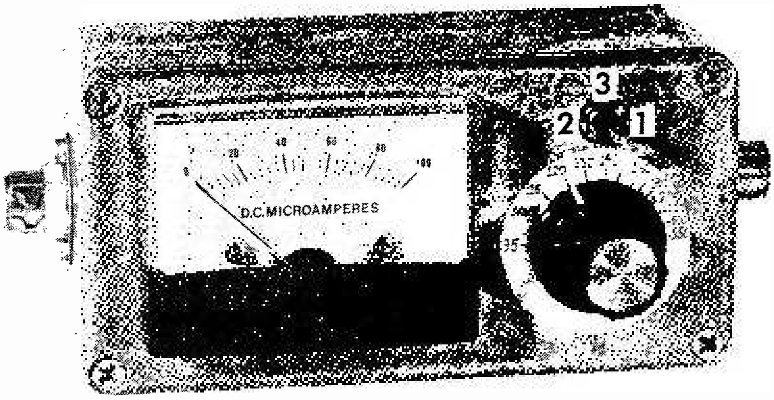


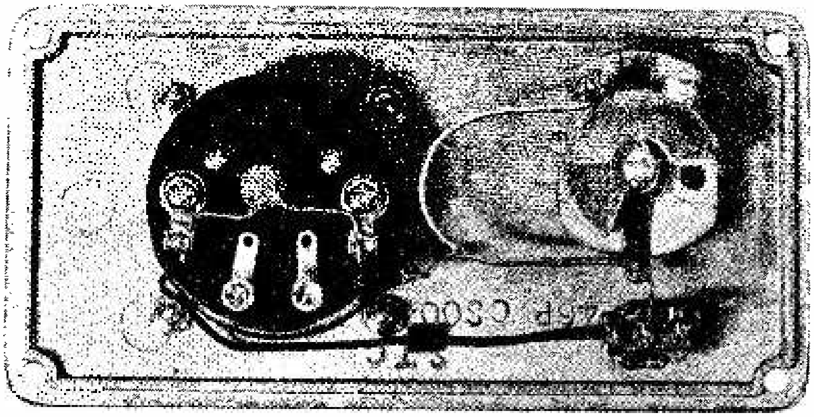
Fig. 1: Complete circuit diagram of the wavemeter.

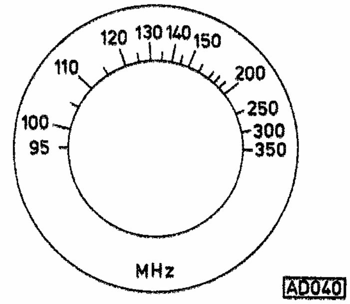
Circuit description

The wavemeter consists of a high-Q resonant circuit which is tunable by means of the variable capacitor, VC1. The resonant circuit is mounted on the underside of the lid of a diecast box and is inductively coupled, by means of a small pick-up loop, to the aerial feeder which is located in the base of the diecast box. The loop is, in turn, coupled to a sampling line inserted in the co-axial cable aerial feeder.

A detector diode, D1, is tapped well down the main inductor, L1, and a meter, M1 is used to measure the diode current. The current flowing in the diode is due to rectification of the signal voltage produced by the resonant circuit and this voltage is a maximum







The calibrated scale shown full size.

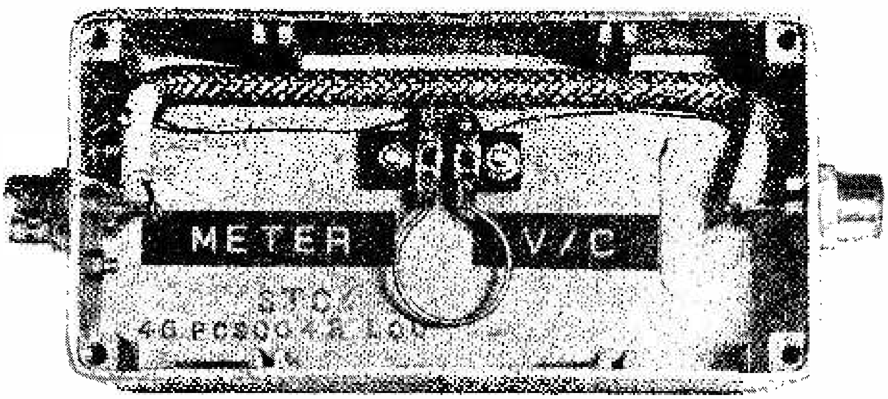
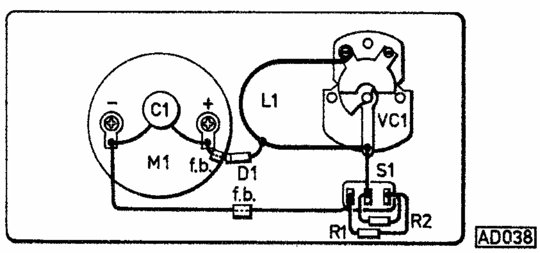
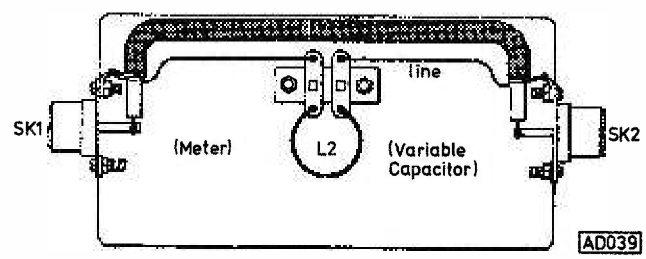


Fig. 2: (Left) The resonant circuit components mounted on the underside of the lid. (Right) The aerial feeder located in the base of the die-cast box. Note the lid must be orientated correctly to the box.





when the circuit is resonant at the frequency of excitation. Hence a maximum indication occurs at resonance and, since the tuned circuit is calibrated, it is possible to determine the frequency of excitation.

To reduce the sensitivity of the instrument a switch, S1, is used to introduce two fixed resistors in series with the meter movement. This facility is useful where high power exists in the co-axial feeder. By using a switch with a "centre off" position it is possible to provide three different sensitivities for the instrument.

The wavemeter may in practice be connected either way round in the aerial feeder due to the symmetry of the circuit. It is also possible to detach the lid of the wavemeter and use it as a conventional "loose-coupled" instrument by simply holding it in the proximity of a circuit where RF is present. The coupling arrangement in the base of the unit is then not required.

Construction

The instrument is built in a small diecast box, which also acts as an earth screen. In obtaining a suitable box it is important to ensure that it is deep enough to provide adequate clearance for the chosen meter movement. The component layout is shown in **Fig. 2.**

The co-axial line is made from a 140mm length of low loss co-aixal cable, see component list. The outer PVC sheath should first be carefully removed and the copper braid "bunched" to allow the sampling line to be introduced under the braid. The line should be run inside the braid, being careful to avoid kinking, and should exit at about 20mm from each end of the cable.

L1 is constructed using 76mm (3in) of 18 SWG tinned copper wire formed as shown in Fig. 2. The inductor is wired directly to the connecting tags of VC1. The inside radius of the bend in the inductor is 10mm. The diode tap is made at 25mm from the earthy end (earth tag of VC1).

L2 is constructed from 55mm of 18 SWG tinned copper wire. The inside radius of L2 is 9mm and it is supported by means of a miniature tag strip. The tag strip has two tags and is spaced 5mm above the base of the box using the two fixing screws and additional 8 BA nuts. ●

So you want to pass the R.A.E. (Radio Amateurs' Examination)? No. 8

John Thornton Lawrence GW3JGA & Ken McCoy GW8CMY

Transmitters Contd.

The previous section contained an example of an s.s.b. transmitter, shown in **Fig. 57.** In this arrangement, the upper sideband was selected by the relative placing of the 9MHz oscillator and the filter passband. Selection of the lower sideband could be obtained by moving the 9MHz oscillator to the high frequency side of the filter passband frequency so that the lower sideband would fit within the filter passband.

By convention, amateur transmissions use the lower sideband on the 1·8, 3·5 and 7MHz bands and upper sideband on 14MHz and above.

In practice, two quartz crystals would be employed in the 9MHz oscillator, having frequencies differing by about 3kHz, correctly placed each side of the filter passband and switched to give upper or lower sideband operation.

With regard to Class B and Class C r.f. amplifiers, remember that there are no essential physical circuit differences between the two types: the difference is in the operating conditions, namely, the bias supply voltage and the amplitude of the r.f. input signal. However, Class B (and Class A) amplifiers are more critical to any stray feedback which may be present in the device or wiring and therefore may need neutralisation, as described, before correct tuning and operation can be obtained.

Frequency Modulation

Frequency modulation is shown graphically in **Fig. 59**, where (a) represents an unmodulated r.f. carrier wave, (b) an a.f. modulating signal and (c) a frequency modulated carrier wave.

In this diagram it can be seen that the frequency of the carrier wave is increased and decreased in direct relationship with the modulating signal. The amount of frequency change (deviation) depends on the amplitude of the modulating signal, and the number of times per second the frequency changes is equal to the modulating frequency. For example, suppose that an r.f. carrier wave of frequency 1,000kHz is frequency modulated by a 1kHz signal, the deviation being 2·5kHz for full modulation. This means that the r.f. carrier is being deviated by 2·5kHz above and below the centre frequency, 1,000 times per second (1kHz rate). If the amplitude of the 1kHz modulation signal is reduced to half, then the deviation will be reduced to half, i.e. 1·25kHz above and below the centre frequency, but still 1,000 times per second (1kHz rate), as before.

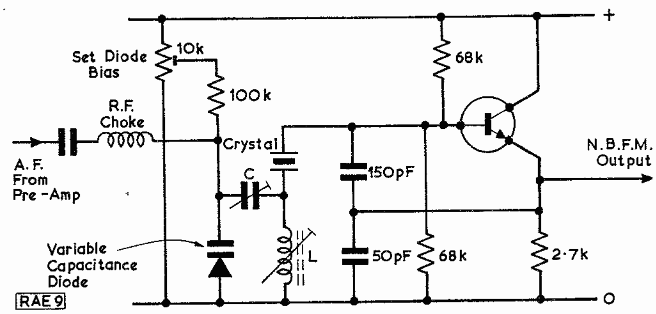


Fig. 60: A typical n.b.f.m. oscillator circuit.

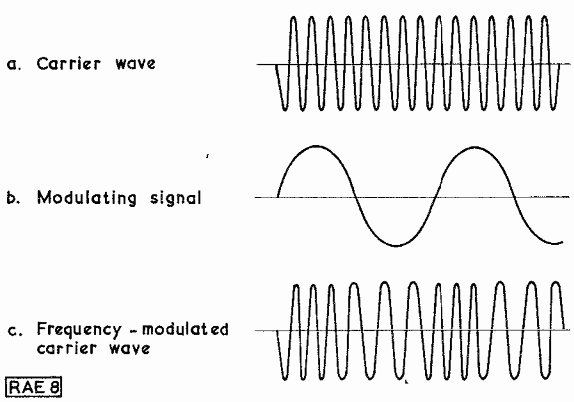


Fig. 59: Frequency modulation of a carrier wave.

Direct frequency modulation is performed in the oscillator circuit itself, usually by using a variable capacitance diode to modulate the oscillator frequency as shown in **Fig. 60.**

Phase Modulation

Indirect frequency modulation, or phase modulation as it is more popularly known, is performed by modulating the r.f. carrier such that the phase of the carrier is changed corresponding to variations in the amplitude of the modulating signal.

In this method the frequency remains fixed and modulation is applied using a phase shifting circuit, which can either be in the oscillator stage or following it. The *effect* is to either add to or subtract frequency variations from the fixed carrier.

For amateur radio purposes, particularly on the 2 metre band, narrow band frequency (or phase) modulation (n.b.f.m.) is frequently used. In this mode the deviation is usually restricted to about 2·5kHz. A block diagram of a typical 2 metre n.b.f.m. transmitter is shown in **Fig. 61.**

In this transmitter the crystal oscillator frequency is nominally 8MHz and the frequency is multiplied ×18 in three frequency multiplier stages, (×3, ×3, ×2) giving a final frequency in the 144–146MHz band. It follows from this that any frequency devia-

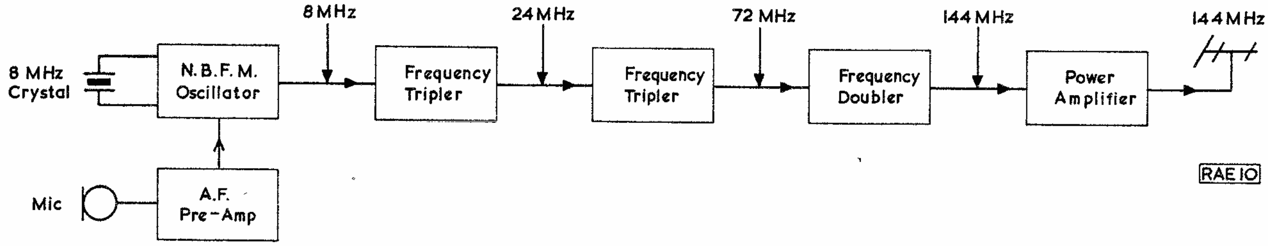


Fig. 61: Block diagram of an n.b.f.m. transmitter.

tion at the oscillator will also be multiplied ×18 and for a final deviation of 2·5kHz the oscillator deviation will only need to be $\frac{2500}{18}$ Hz=139Hz.

Basically, a crystal oscillator has good frequency stability but, by including in the crystal circuit a reactance which can be varied by the modulating signal, the crystal can be "pulled" off frequency and adequate deviation obtained for n.b.f.m. transmission. An example of this type of circuit is shown in Fig. 60. For further information see *RSGB VHF-UHF Manual.* Chapter 5.30(i).

The use of n.b.f.m. has several advantages,

(a) Modulation can be applied at low power; no high power modulator is required.

(b) The transmitter output stage operates at a constant power level which allows the use of lower rated components, e.g. transistors and capacitors.

(c) Any class of amplification can be used and chosen for best efficiency or low spurious emissions, etc.

(d) Interference with television broadcast and audio equipment is significantly reduced, as f.m. is not demodulated by the usual rectification methods.

Crystal Oscillators

Quartz crystal oscillators are employed in transmitters, receivers and frequency measuring equipment wherever a stable, accurate oscillator is required.

A plate, cut from quartz crystal has the property of generating an alternating voltage between its opposite faces when made to vibrate by mechanical means and conversely it will vibrate when an alternating voltage is applied across it. The natural mechanical resonant frequency of the quartz plate is determined to a large extent by its dimensions and when elec-

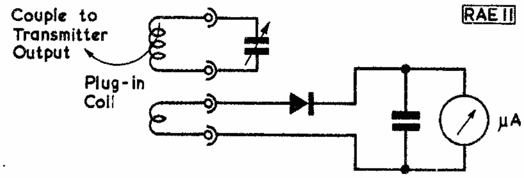


Fig. 62: An absorption wavemeter circuit.

trically connected in an oscillator it behaves as a series-tuned circuit having a very high L/C ratio and a very high Q(>10,000). See **Fig. 63.**

The crystal exhibits a series resonant frequency and a parallel resonant frequency; these are extremely close together: only a few hundred Hz apart at 10MHz. Crystals are calibrated in frequency for one or the other mode of resonance depending on the circuit requirements. An oscillator circuit for a crystal operating in parallel resonance is shown in **Fig. 64.**

Under normal room temperature conditions, the frequency of this oscillator would remain constant within a few parts per million (few Hz per MHz).

Crystals can be manufactured for very high frequencies (100MHz and beyond) using multiple vibration of the crystal; these are known as *overtone* crystals and are used in series resonance. A typical circuit is shown in **Fig. 65.**

TRANSMITTER MEASUREMENTS

Frequency Measurement

The licence requires that:—

1. A satisfactory method of frequency stabilisation shall be employed in the sending apparatus comprised in the station.

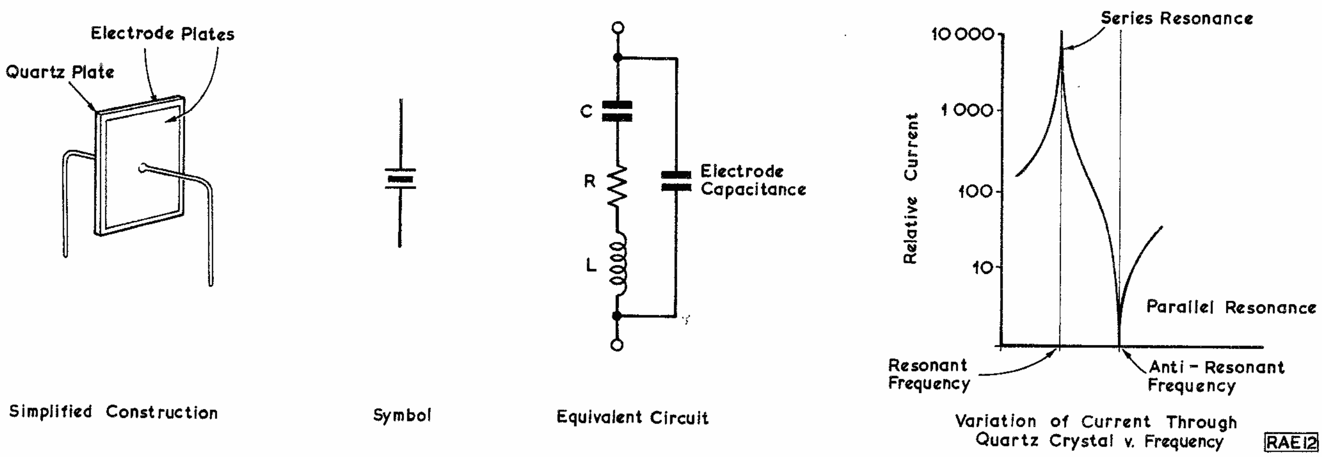


Fig. 63: Features of a quartz crystal.

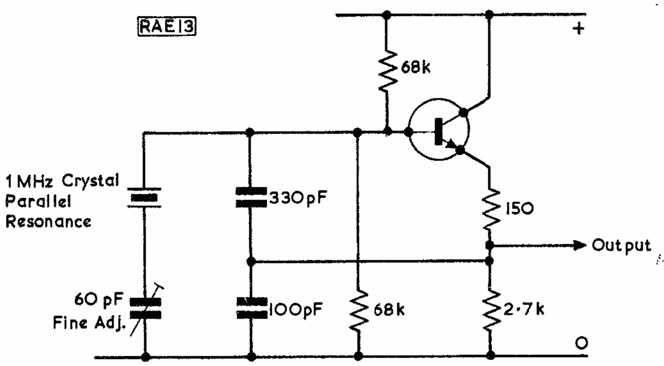


Fig. 64: A basic crystal oscillator circuit.

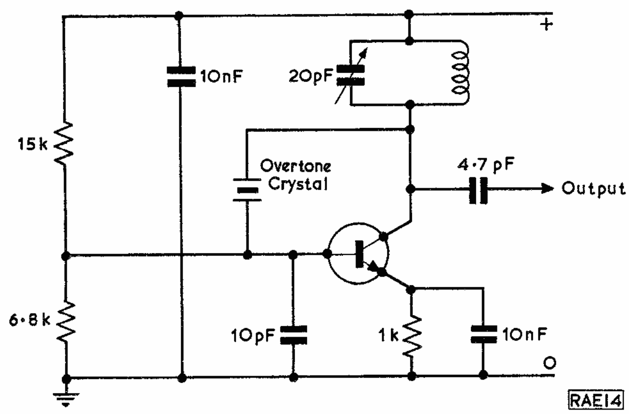


Fig. 65: An overtone crystal oscillator circuit.

2. Equipment shall be provided capable of verifying that the sending apparatus is operating with emissions within the authorised bands.

If the transmitter is crystal controlled, (the basic frequency-determining oscillator employs a quartz crystal) excluding bad design or a fault, the frequency stability will be satisfactory; also, if the crystal is of reputable manufacture and calibrated, then the oscillator frequency will also be known.

If the transmitter contains a variable oscillator (v.f.o.) then it must be of good mechanical and electrical design, employ stable components and be operated from stable supplies for the output frequency to have satisfactory stability.

WAVEMETERS

There are two main types of wavemeter: the absorption wavemeter and the heterodyne wavemeter.

Absorption Wavemeter

The absorption wavemeter consists of a coil and variable tuning capacitor with a calibrated dial. It absorbs power when the coil is held close to the transmitter circuit in question and the wavemeter is tuned to the same frequency. This is indicated by a dip in the grid or anode/collector current associated with the circuit under test. Sometimes a rectifier diode is coupled to the wavemeter circuit and a microammeter used to indicate power absorbed from the transmitter circuit. It is not very accurate, about 2-5%, but gives an unambiguous indication and is useful when checking transmitter outputs and frequency multiplier circuits. See **Fig. 62.**

When used with a crystal controlled transmitter, it satisfies the licensing requirement for determining that emissions are within the band and, if the wavemeter frequency range extends to the second and third harmonic of the highest frequency to be transmitted, the absorption wavemeter can also be used to check the output of the transmitter for harmonics and other unwanted frequencies.

Heterodyne Wavemeter

The heterodyne wavemeter uses a high stability variable frequency oscillator having a finely calibrated or *vernier* tuning scale. A mixer stage and headphone amplifier are included for comparing the incoming frequency with the variable oscillator and for checking the variable oscillator against a built-in crystal oscillator. The v.f.o. output can also be used to calibrate a receiver. A block diagram is shown in **Fig. 66.**

Initially the 1MHz crystal oscillator is set on frequency by zero-beating either its 5th harmonic with a standard frequency transmission (e.g., MSF on 5MHz) using a separate receiver, or alternatively, the second harmonic of the 100kHz signal with Droitwich (Radio 2) on 200kHz.

The v.f.o. is calibrated by tuning over the frequency range and recording the dial readings where each zero beat note with the crystal oscillator is obtained; 1MHz points first, then 100kHz points. Intermediate frequencies can be determined by interpolation or drawing a graph.

A transmitter frequency within the v.f.o. range, can be measured by loosely coupling the wavemeter

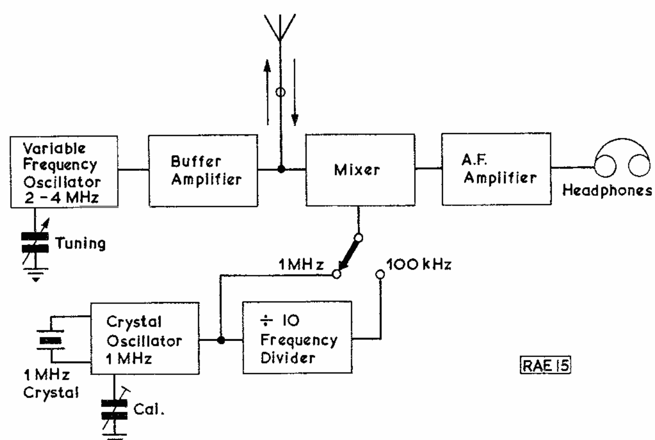


Fig. 66: Block diagram of a heterodyne frequency meter.

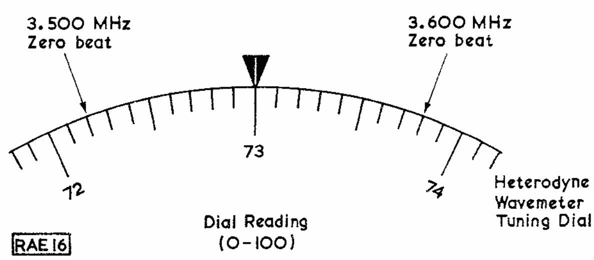


Fig. 67: Interpolating between crystal calibration points.

to the transmitter (a short length of wire laid near the transmitter is adequate) and tuning the v.f.o. for zero beat. The dial reading is recorded and the frequency determined from the graph or from the nearest crystal calibration points above and below the frequency, as shown on the example in **Fig. 67**.

If the wavemeter is used to measure a frequency higher than its v.f.o. coverage then a zero beat between a harmonic of the v.f.o. and the input signal is used. For example, if the input signal was 14·20MHz then a beat would be obtained at 2·85MHz (where the fifth harmonic is 14·20MHz) and at 3·55MHz (where the fourth harmonic is 14·20MHz).

To identify the actual harmonic, an absorption wavemeter should first be used to find the approximate transmitter frequency and the ratio of this to the v.f.o. frequency gives the harmonic number and so the exact frequency can be calculated.

$$\frac{\text{Approximate input frequency}}{\text{v.f.o. frequency}} = \frac{14\text{MHz}}{3{\cdot}55\text{MHz}}$$

$$\text{Approx. Ratio} = \frac{4}{1} = \text{4th Harmonic}$$

$$\text{Input frequency} = 3{\cdot}55\text{MHz} \times 4 = 14{\cdot}20\text{MHz}$$

In addition to the strong, primary, beat frequency signals there will be several other beat signals but these will generally be very much weaker.

A receiver can be calibrated by tuning it to the v.f.o. fundamental or harmonic frequency output.

Crystal Calibrator

The crystal calibrator employs a crystal oscillator and frequency divider(s) to generate a number of harmonically related "marker" frequencies, e.g. 1MHz, 100kHz, 10kHz as shown in **Fig. 68.**

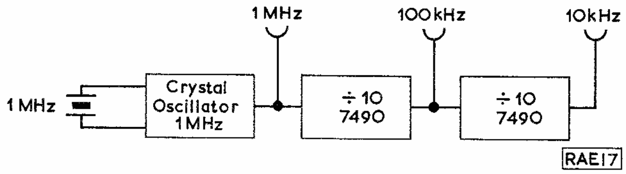


Fig. 68: Block diagram of a crystal calibrator unit.

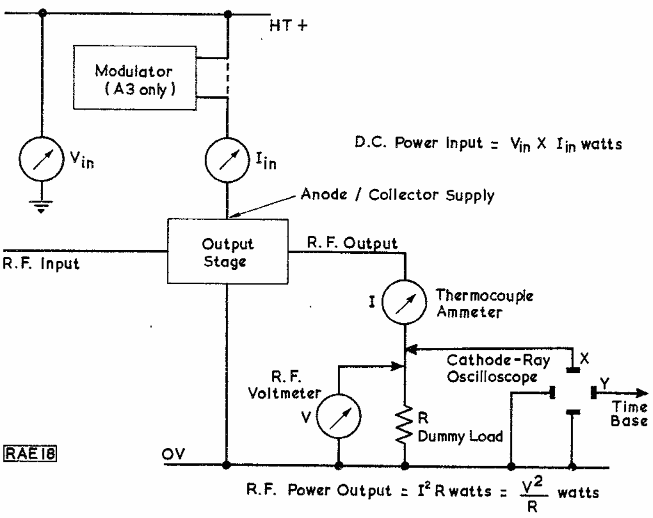


Fig. 69: Transmitter power measurement.

These output frequencies can be used to calibrate a receiver and this in turn can then be employed to check the frequency of a transmitter by noting the receiver tuning dial reading and interpolating between the nearest crystal marker points.

The 100kHz and 10kHz markers may conveniently be used up to a few MHz but at higher frequencies the spacing between the marker points is inconveniently small and the 1MHz marker should be used.

A crystal calibrator, used with a receiver having a suitable bandspread dial and an absorption wavemeter as described previously, would enable the frequency checking requirement of the licence to be met.

Power Input Measurement

For c.w., a.m. and f.m. emissions (A1, A2, A3, A3H, F1, F2 and F3), the Amateur Licence requires that the maximum d.c. power input to the valve(s), or any other device energising the aerial, shall not exceed the stated figure for the particular frequency band as given in the schedule (Appendix B) of *"How to become a Radio Amateur"* (ii).

The d.c. power input is the product of the supply voltage and the anode (or collector) current as shown in **Fig. 69.** The current meter is usually fitted in the transmitter but an external voltmeter may be required to measure the supply voltage.

Output Power Measurements

Transmitter output power can be calculated by measuring either the r.f. current into, or the r.f. voltage across, a non-inductive *dummy load* resistor connected to the transmitter output.

Suppose that a transmitter is operating with an input power to the final stage of 150 watts and that this stage is 66·6% efficient, then the output power would be $150 \times \frac{66{\cdot}6}{100} = 100$ watts.

A dummy load resistor of 100Ω connected to the output would have a current of 1 amp flowing through it and 100 volts r.m.s. across it.

$$\text{Power} = I^2 \times R = 1^2 \times 100 = 100\text{ W}$$

$$= \frac{V^2}{R} = \frac{100^2}{100} = 100\text{ W}$$

The current could most conveniently be measured by an r.f. ammeter of the thermocouple type and the voltage by an r.f. valve voltmeter.

Modulation Measurements

It is most important that a transmitter is not overmodulated as this will cause spurious signals to be radiated. Amplitude modulation, A3, can be checked using an oscilloscope with the vertical deflection plates connected across the dummy load as shown in Fig. 69.

In the unmodulated condition, assuming 100 watts output, the 100 volts r.m.s. will give a certain amplitude of deflection, as shown in **Fig. 70a.**

With sine wave modulation applied, the modulation envelope shows that the voltage across the load varies from zero to twice the 100 volts amplitude (200 volts r.m.s.).

The depth of modulation (per cent) is given by $\frac{a}{b} \times 100$, which in this case (as a=b) is 100%. Over-

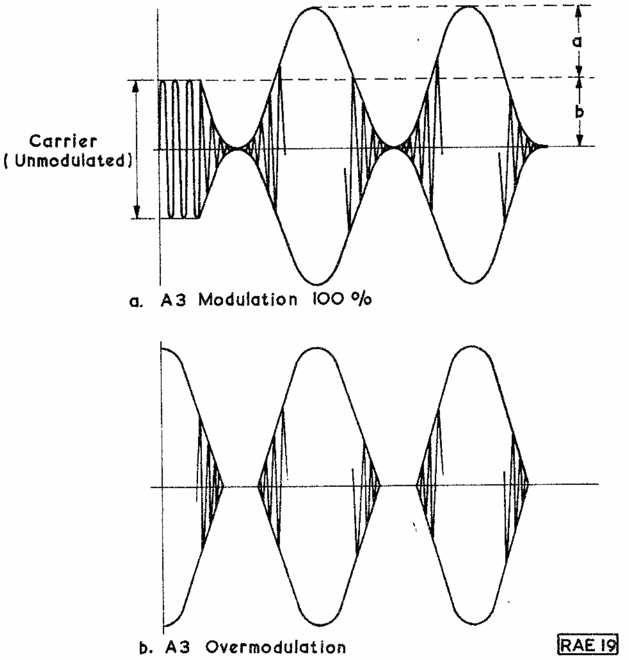


Fig. 70: Modulation patterns for an A3 signal. Note that in the overmodulated condition, flattening of the peaks will usually occur.

modulation will cause breaks in the carrier and "flat topping", as shown in **Fig. 70b.**

It will be seen that as the maximum r.f. amplitude is 200 volts r.m.s. and, as this is across 100Ω, then the *peak envelope power* is $\frac{V^2}{R} = \frac{200^2}{100} = 400$ watts.

Peak Envelope Power (p.e.p.)

A fully modulated A3 transmitter running 150 watts input (with an efficiency of 66·6%) produces an output of 400 watts *p.e.p.*

The licence requires that the *output* power of an s.s.b. transmitter (A3A, A3J), under linear operation, shall be limited to 2·667 times the d.c. input power, appropriate to the frequency band concerned.

To continue with our previous figures,

150 watts d.c. input ×2·667=400 watts p.e.p. So the *maximum p.e.p. output* allowed by the Licence is the same for a.m. (A3) or s.s.b. (A3A, A3J).

You will notice that the Schedule in Appendix B gives the d.c. power input and the equivalent p.e.p. output for A3A and A3J operation on the various bands. The most convenient way of measuring the p.e.p. output of an s.s.b. transmitter, is to use a two-tone test. This involves modulating the s.s.b. transmitter with two sinusoidal tones, of equal amplitude, simultaneously. The resultant modulation envelope, when displayed on an oscilloscope is shown in **Fig. 71.**

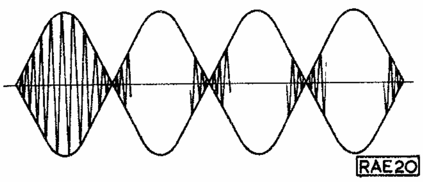


Fig. 71: Oscilloscope display of an s.s.b. signal modulated by two sinusoidal tones of equal amplitude.

The *mean power* output of an s.s.b. transmitter using a two-tone test is *half the peak envelope power.*

Returning to our transmitter, this means that when the output is 400 watts p.e.p. the mean power into the dummy load is $\frac{400}{2} = 200$ watts and the current indicated by the r.f. ammeter would be 1·41 amps.

$$\text{Power} = I^2R = 1{\cdot}41^2 \times 100 = 200\text{W}$$

Note. The value of 100Ω for a dummy load resistor was chosen to simplify some of the numerical examples; in practice 75Ω or 50Ω would be used.

To summarise the s.s.b. p.e.p. measurement (based on an extract from the UK Licence):

1. Apply two non-harmonically related sinusoidal tones of equal amplitude to the s.s.b. transmitter, with the carrier fully suppressed, and adjust the input power to give a mean radio frequency output power, under linear operation, of half the allowed peak envelope power, when measured into a resistive load by means of an r.f. meter. Under this condition, note the peak-to-peak deflection on the cathode ray oscilloscope.
2. Replace the tone by speech: the maximum vertical deflection on the cathode-ray oscilloscope shall not be greater than the previously recorded deflection obtained with the two-tone input.

Amateur Licence Conditions

Now is a good time to start reading, learning and inwardly digesting the Amateur Licence Conditions, ready for the R.A.E. on 18th May.

These are contained in Appendix A and B of the Home Office publication *"How to become a Radio Amateur"*. Questions on the licence are a vital part of the R.A.E. (just as the Highway Code is for a driving test), so even though you may not learn the Licence conditions by heart, you should be able to write down without much hesitation, the various conditions in Appendix A, the frequency bands and emission types in Appendix B and frequency checking in Appendix F.

The RSGB publication *"Radio Amateurs' Examination Questions and Answers"*, Part 1, Section 1, (iii) gives a good guide on how questions regarding the Licence should be answered.

Bibliography

(i) "VHF-UHF Manual." RSGB. Price £6·82 inc. p&p.
(ii) "How to become a Radio Amateur," free, from Home Office, Radio Regulatory Dept., Licensing Branch (Amateur), Waterloo Bridge House, Waterloo Road, London SE1 8UA.
(iii) "Radio Amateurs' Examination Questions and Answers." Price £2 inc. p&p. RSGB Publications (Sales), 35 Doughty Street, London WC1N 2AE.

NEXT MONTH
RECEIVERS
AND
PROPAGATION

HOTLINES

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

H.T. Supplies return

Great news for disco buffs. The Japanese have brought out a new stereo amplifier which gives 350W per channel. The interesting point is that the distortion at this level is only a miserly 0·003%.

The circuitry works in a new mode called "A plus". With Class A output stages the fidelity is extremely good but unfortunately the efficiency is low. Moving to Class B gives a well worthwhile increase in efficiency but the quality is not so good. The idea of the A-plus mode is to gain the best of both classes of amplification and from the figures out it seems that the Japanese have succeeded. The trick has been accomplished by using separate power supplies to drive the load (the loudspeaker) and the output transistors. The power supplies are floating and are at ±5V so there are no exotic voltages involved in the actual output stages, but I do note from the circuitry that the driving amplifiers both need a ±105V supply (funny, I thought, funny).

The amplifier will drive an 8Ω speaker load to full output and will also drive a 4Ω load to full rated power. The distortion figure of 0·003% is measured at full output power, over the frequency range from 20Hz to 20kHz. At half power, the distortion measured at 100kHz is still only 0·01% (that's at 175W) while at 1kHz at half power the distortion is so minute that it is unmeasurable. Not available in the UK as yet, but these amplifiers sound 'deafinately' good!

HP7 X-Rays

It all began with soldiers shooting at people in Vietnam. They used a "Starlight scope" which let them see in the dark. The Starlight scope was fitted to the rifles.

From this wartime application has come a development for peaceful uses called the Lixiscope. The device is a hand-held and completely portable X-ray machine. It is powered from a single pentorch-type battery.

The prototype consists of a small cylinder with a viewing screen in the centre. At the "back" of the cylinder (furthest from the holder) is a smaller cylinder which is mounted on an extendable rod. This smaller container holds a minute amount of radio-active source material which is completely shielded.

In use, the object under examination is put between the source and the main cylinder, and the device is triggered. When this happens, the radio-active material is exposed and the X-rays emitted pass through the object. The rays are then absorbed by a special phosphor screen and they are converted to visible light. These (very tiny) light values which, by their variation hold the X-ray image, are then picked up by fibre optics and amplified some 40,000 times and fed to the viewing screen for direct display.

This report is not very detailed—just the bare bones.

Frictionless Memory

Look out; there's a BEAMOS about. Basically a solid state memory in a vacuum tube, the device has certain advantages over other memories. The memory works by storing information in an oxide layer grown on a silicon substrate. The memory locations are small charges which are contained in this oxide layer. One advantage is that unlike magnetic tape or disc, the BEAMOS (Beam-Addressed Metal Oxide Silicon Memory) is contained within a vacuum tube (remember the old valves?) and so is protected from dust or other undesirable environmental baddies and it doesn't have any moving parts. The memory is scanned and read out by an electron beam from a "gun" something like a television tube. The same beam is used to "write in" or enter data. So it is frictionless and very fast. The latest BEAMOS device on the stocks will store something like 200 million bits of information and has a readout time of only 20 microseconds. If you haven't read a copy of the papers in the Proceedings of the 1977 International Microelectronics Symposium then you won't know how important it is to be kind to capacitors.

It seems that someone buried in the corner of some laboratory found that if you hit certain ceramic capacitors they would give out a voltage which could be as high as 40mV.

This phenomenon probably has no practical value for the home constructor, but the Ginsberg mind is already thinking of a miniature fairground-type test-your-strength and ring the bell device. A ceramic capacitor connected via a diode to a millivoltmeter—and a small hammer.

Microprocessor soup

Ever since I saw a man cleaning out one of those hot drink machines, I vowed never to sup from one again. Such a mass of cams and rods and other mechanical paraphernalia.

Well, the microprocessor has struck yet again. The newest machines are claimed by the manufacturers to be 20 per cent cheaper to run than their old mechanical counterparts. The microprocessor basically scans around to check if you've put enough money into its slot. If you have, then it has a quick scan of the selection buttons to see which one you want. Then it initiates the timing cycle and subsequent actions within the machine to give you that magnificent cup of Spring vegetable soup—with just a dash of hot chocolate!

The electronics (in the new machine) has replaced relays, solenoids and electric motors, hence the reduction in price,

I wonder when electronics will get round to replacing that little man in fridges who switches the light on and off every time we open and close the doors?

Free Energy

Talking about energy, a Japanese company is to market some solar cells which will provide just over 15V at nearly 0·5A. The panel of cells measures about 13in. square but the price is put at some £200. I also note that the reported efficiency of these cells is less than 7%. We still have a long way to go before we get all that "free" energy from the sun.

Ginsberg

ON THE AIR

by Eric Dowdeswell G4AR

Some readers have expressed interest in the Realistic DX150 receiver being used by some reporters to this column. This is a 16-transistor set covering the medium waves plus three s.w. ranges from 1·5 to 30MHz thus covering all the h.f. amateur bands. It has all the facilities one would expect on a communication receiver including an "S" meter and switchable a.g.c. for different modes, together with a separate r.f. gain control which can be most useful. Two transistors are used in the cascade r.f. stage which is a very sensible way of reducing cross-modulation. The set can be used on mains or 12V d.c. According to my information the receiver is available through the Tandy organisation.

In Worcester, **Brian Hughes** has been keeping an eye on the 10 and 15m bands. He tries to check 10m every day and at various times depending upon his work. His 15m catches include KC4AAC, KG6SW, TG9QK and VU2LQA, while 10m produced PJ2FR, S79DF, VP2MAA and 7P8BE. From Deeside, Clwyd comes a letter from newcomer **Vic Marland.** His HRO seems fair on 20m but on 80m he complains that the band "is always shut down to me". If he can't hear the racket there then there is something radically wrong! However, hopefully it is only a matter of tweaking the trimmers on that particular coil pack. Vic has a 66ft aerial and a.t.u. so he ought to do reasonably well with that HRO.

Brian Smith of Barry, Glam., got away from his domestic receiver and separate oscillator and built the *Everyday Electronics* f.e.t. receiver (March '75), including the coils. He found 80m and 160m easily enough but 20m was a bit trickier, but he managed it and with 40ft of wire on it he is starting to copy the DX.

An unusual bit of news concerns **J. Brooker** G3JMB of Hassocks in West Sussex. He was awarded the MBE in the New Year's Honours List. He is active on the h.f. and v.h.f. bands, a founder member of the Crawley Radio Club and currently a member of the Thanet ARS and of the Mid-Sussex ARS but strangely enough the award was given for his efforts in a completely different field, that of the National Savings movement, mainly in the Sussex and Kent areas. Congratulations OM!

Good news also from **John Hague** who has been writing to yours truly for some time. After taking the Morse test John became G4GOY and he intends to be active with 10W on 160m as a start. He'd welcome reports so if you hear him drop a line to 1 Chaloners Road, Dringhouses, York YO2 2TW. Congratulations to you, too, John. I know you will get a lot of fun as you will almost certainly have to make your own transmitter, at least, and with such low power you can go on the air at any time without having to worry about the neighbours' TV and possible QRM! **Mr. A. Cook** has been confined to bed for a while in Buckie, Banffshire, but he managed to borrow an Eddystone EC10 from GM3KHN and to take a listen around 20m. First catch was ZD8KG and wife ZD8MM talking to KC4USB in Antarctica so Mr. Cook now has the DX bug! He is thinking of getting a BC348 receiver of his own and wonders if any reader can help him with a circuit or manual? Drop a line to "Shielburn", Drybridge, Buckie, Banffshire, if you think that you can assist. Normally the BC348 is a very good set up to around the 20m band but it starts to fall off in performance after that. It is very well built and has an excellent dial mechanism and would make a very good tunable i.f. for the 10 and 15m bands, with a converter in front.

Geoff Cole G4EMN, Hon. Sec. of the Wessex AR Group would like to see a listing of club secretaries in this feature as he believes that such publicity can give a good boost to club membership. Unfortunately we do have space problems and I fear that if we did start to list them it would soon get out of hand. There is a list of course in the RSGB's Call Book but that is likely to be a bit out of date, naturally. Geoff knows of what he speaks! He now has 104 members to look after! The Wessex AR Group meets at the Dolphin Hotel, Holdenhurst Road, Bournemouth, so contact Geoff at 6 St Anthony's Road for details.

The Bury Radio Society has many activities for both the old-timer and the newcomer which means that their station G3BRS is put to good use. Meetings every Tuesday at Mosses Centre, Cecil Street, Bury at 1945hrs. March 14th sees a visit from RSGB Rep G3SMM so go and air your complaints! The 30th March is reserved for a visit to the Granada studios. More info from Hon. Sec. **E. Thirkell** G4FQE 59 Oulder Hill Drive, Rochdale or ring 32730.

CARA News, the news letter of the Cheltenham AR Association, is sent to me each month by **Edgar Janes** G2FWA and it generally contains several items of a constructional nature or similar hints and tips that one does not find in other club magazines. For instance, the January issue has a tester for op. amps, a multivib using a cheap i.c., values of resistors needed in a T-section attenuator for losses up to 50dB, simplified formulae for resonant circuits and a two-voltage PSU! Almost a handbook on its own!

I trust that you all heard or worked the Marconi commemorative station GB3MSA at Poldhu, Cornwall. The QSL card ought to be a very interesting souvenir. For a change, the event of the 75th anniversary of the first spanning of the Atlantic by two-way radio got a lot of coverage on the radio, TV and the press.

A note from the Derby and District ARS for your nice new diary! Their 21st annual rally will be held on Sunday 13th August. For the moment this is a provisional date.

Reports are few and far between at the moment. If you want to report some choice DX I can supply log sheets if you will send a request to me at my home address, see panel. Remember "choice" means half-a-dozen entries in the course of a month. Routine log entries are not required!

Log extracts

A. Cook:— **20m** A9XCC WA4UAZ/HC1 HK3AMV JY5US KC4USB KL7ITH VP2KC 9Y4FS

B. Hughes:— **15m** KC4AAC KG6SW TG9QK UM8FM VU2LQA XE2PL **10m** J3AAG PJ2FR S79DF VP2MAA W6BWZ WD9AKN 7P8BE

B. Smith:— **80m** EP3MK LX1PS **20m** FC2CD IT9WPO

All reports are for s.s.b.

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

From his QTH in Wrexham, **Jack Shone**, who uses a Realistic DX160 receiver and a Joystick antenna wonders if Radio Australia can really be classed as DX. He can listen to it virtually all day, starting on 21570kHz at 0755, changing to 15405 at 1000, to 9670 at 1200, then back to 15405 at 1300 until 1500 and then to either 11705 or 11900 to 1600 and on 11900 until 1645. Reception is sometimes possible on 5995 at 1700 though QRM is rather heavy at this time. It is also possible to hear Radio Australia on 11900kHz from 2100 until this frequency closes at 2230. All of the above are in English. Thanks very much Jack for such a comprehensive and useful report.

Clearly, reception of Radio Australia cannot be classified as DX when heard on a communications receiver and a good aerial. The same criteria would apply to major international broadcasters such as the VOA, Moscow, Radio RSA, the Voice of the Andes and others who pump high power into directional aerials in the hope that their transmissions will be received at programme value on domestic receivers. Reception of transmissions not beamed to the DXers, such as Radio Australia on 5995 would be classed as DX though. Incidentially, Radio Australia can also be logged on 7240kHz between 1500 and 1730.

From Waltham Cross, Herts comes a letter from **E. C. Adams** who has built the HAC one valve receiver which is advertised in kit form in *PW*. When connected to a 100ft long wire attached to a 3-element TV aerial it pulled in Monte Carlo, Berne and Turkey. HAC stands for Heard All Continents and covers a range of simple receivers that have been available for 35 years. **N. F. Morgan** is another one valve enthusiast. At the age of 71 he built a small 1-valve set which he uses with a 30ft long wire. Stations heard were Radio Canada, VOA, Kiev, Vatican Radio and Israel but no success has been had so far with stations south of the equator. Try Radio RSA on the 19m band (15155) and the 31m band (9589) between 2100 and 2150.

Has anyone tried s.w. DXing with a crystal set? One is on offer by an advertiser in *PW* for a modest sum. With an outdoor aerial a crystal set ought to pull in quite a few stations on the international bands and anyone hearing Australia would certainly be justified in calling it DX!

Any information about modifications to the MRC1 receiver would be welcomed by **Trevor Goodenough** who lives at Kilwinning in Ayrshire. This receiver, which is a valve portable, was supplied to the resistance movements in Europe during the last war so that they could listen to the BBC and to messages from the UK. A number of these receivers came onto the surplus market after the war and many of them should still be in private hands. Trevor goes on to ask for information about the SINPO code.

The SINPO code (and its variant SINFO) is an attempt to quantify the data in the reports that listeners send to broadcasting stations on the short waves. The terms Good, Fair or Poor are too vague to be of value. Other codes such as the Z, RST and QSA have been tried in the past but SINFO is now almost universally used in reports to broadcasting stations, many of whom will supply DXers with report forms or cards marked-out for SINFO ratings. The individual letters SINFO stand for Signal Strength, Interference (from other stations) Noise (static), Fading, Overall merit. The letter P in SINPO is for Propagation disturbance.

A five point rating using the digits 1 to 5 is used to assess each factor as follows:—

	S	*I*	*N*
5.	Excellent	Nil	Nil
4.	Good	Slight	Slight
3.	Fair	Moderate	Moderate
2.	Poor	Severe	Severe
1.	Just Audible	Extreme	Extreme

	F	*O*
5.	Nil	Excellent
4.	Slow (1-5 fades/min)	Good
3.	Moderate (5-20 fades/min)	Fair
2.	Fast (20-60 fades/min)	Poor
1.	Very fast (greater than 60)	Unreadable

Care should be taken not to over-rate the figure for overall merit. In my opinion the final digit should not be higher than the lowest of the others, though this might be debatable. Certainly it should not be the highest of the five and few would disagree that 22225 is impossible. An abbreviated version of SINFO is the SIO code which omits the N and the F, has been tried and is the one I prefer as it gives all the information that is required while remaining simple to use.

While on the subject of codes, reference should be made to some of the abbreviations which have become jargon among Radio Amateurs and are also used by broadcast band DXers. From the International Q code comes QSB=fading, QSL=a verification, QRM=man made interference, QRN=static, QTH=home address of the DXer. Other abbreviations in use are Rx=receiver, Tx=transmitter, shack=DXers radio room, condx=conditions. YL=young lady, XYL=wife (ex YL). DX originally meant distance, 73's means All the Best and is used by some DXers at the end of letters instead of the more usual Yours etc. There is also 88s which is one way of sending Love and Kisses.

Fourteen year old **Christopher Wather** would like to know if there is a DX club in his area or if there is anyone who lives near him who is interested in DXing. Replies to St Jude's Vicarage, Savile Park, Halifax, HX1 2HX, West Yorkshire. The Merseyside DX Club is now under new management. Regular meetings are planned, starting on the 28th January in Birkenhead with a talk on Propagation by **Gus Taylor** (G8PG), who for many years conducted the RAE course in Liverpool. Enquiries to go to the Secretary, Norman Monti, 66 Chesnut Grove, Birkenhead, Merseyside, L42 0MZ.

A nice log of Latin American DX, mainly on the 60m band, comes from **J. Edwards** of Bryn near Wigan, and should be of interest to DXers who have difficulty in logging this area. Using a Realistic DX160, a 50ft long wire and ATU he heard Radio Colosa, Colombia on 4945kHz at 0030; Radio Sante Fe, Colombia on 4965 at 0700; Radio Sutatenza, Colombia on 5095 at 0350; Radio Havana, Cuba on 17885 at 2155. **Harold Emblem** (Mirfield, with his Eddystone 730 pulled-in La Voz de Chile on 15150kHz with a good signal after 2335, also the African outlet at N'Jamana in Chad on 4905 at 0530.

A large mailbag this month has meant holding over some letters until next time. Apologies to all concerned.

MEDIUM WAVE DX

by Charles Molloy G8BUS

Jamming, which has been called the scourge of broadcasting by one DXer, is seldom mentioned in this column, although it is still widely practised. **Michael Irving** writes from Carlisle about a warbling noise on 719kHz heard at strength 4 with a Heathkit GR78 receiver and a loft aerial. Jamming is the name given to interference deliberately generated by one country to drown the broadcasts from another. There are various ways of doing this. A tape recording of a diesel engine was popular at one time though it is probable that more sophisticated methods are now in use. Jamming is not too much of a problem on the medium waves as the DXer can always null it out either with a loop or with a transistor portable by rotating the receiver to make use of the directional properties of the internal aerial. The snag of course is that the DX may be nulled-out as well. The noise on 989kHz together with the 300kW station in Berlin are easily nulled-out at this QTH to give untroubled reception of Madrid on the same channel.

Medium wave DXing in pre-war days is recalled by **George Rose** of Waltham Cross, Herts, who has dozens of veries of North American stations from Oregon to the Atlantic seaboard. George thinks that today this should be done with a crystal set! **Philip Rambaut** (Macclesfield) does not agree. He says that 40 years ago the air was uncluttered and DXing was easier and more pleasant. Such DX as KDKA Pittsburg and CBF Montreal were easily obtainable after midnight. The Lucerne Plan which came into operation in 1934 listed fewer than 200 stations, many of which were low power locals operating on common channels. Today there are about 1,500 stations in the European area which emit some 80 megawatts onto the m.w. band and a large increase is permitted under the new Geneva plan which comes into operation in November 1978.

Many DXers consider the medium waves to be the most difficult as well as the oldest DX band. A highly selective and sensitive receiver such as a communications type, together with a directional aerial such as a loop or Beverage, is essential in order to hear some stations but there are spaces in the band at night where much simpler gear will produce results. The best logging of the winter must go to Tudor Rees Vintage Services of Bristol who reported in their November bulletin, reception of WINS New York on 1010kHz at 2330 using a 1930 TRF receiver. It is the skill and patience of the DXer that really counts on the medium waves.

North American m.w. stations have certainly been conspicuous this winter. Highlights from a number of logs sent in are: WBT Charlotte in North Carolina on 1110kHz, WTIC Hartford on 1080, WOAI San Antonio Texas on 1200, from **John Faulkner**, Mansfield (Trio 9R59D plus longwire), CFRB Toronto 1010, KDKA Pittsburg 1020, KMOX St Louis 1120 (**John Morton**, Edinburgh, Homebrew receiver plus loop), WEAN Providence Rhode Island 790, WWL New Orleans 870, WWWE Cleveland 1100 (**David Sidebottom**, Fleetwood. Realistic DX160 plus longwire), WOR New York 710, WOWO Fort Wayne, Indiana 1190, WNCR Worcester, Mass 1440, WAXC Rochester NY 1460, WOKO Albany NY (**Derek Taylor**, Preston FRG7 plus loop).

Requests for help with unidentified stations come from a number of readers. **Steve Whitt** asks about a CBC outlet on 740kHz which would be CBNM Marystown in Newfoundland. **David Sidebottom** heard a North American behind the BBC World Service on 1088 with a call like WGIC. WTIC Hartford Connecticut is on 1080 and is heard sometimes in the UK. **Derek Taylor** is puzzled by a CBC station heard several times on 750. This would be the new CBGY Bonavista Bay in Newfoundland which has been heard by a number of DXers in the UK. **Malcolm Lougharne** refers to a Canadian station on 870 with a high power German on the low frequency side of it. Canada does not use 870kHz. It could have been CBH Halifax in Nova Scotia on 860, the German being Berlin on 854. **Martin Scholes** has picked up two stations on 1010, WINS and another with a call starting with the letter C. This is CFRB Toronto which is usually heard when conditions are good. **John Faulkner** heard Radio Populares on 700 in Spanish at 0205 which would be YVMH in Maracaibo Venezuela. He is also puzzled by a call like WFGT on 1330. There are two possibilities; WFTP Fort Pierce in Florida or WFBC Greenville in South Carolina.

A Trio 9R59D receiver, Codar Preselector and 100ft longwire is the set-up at **R. Calver's** QTH in Norwich and he would like to know what linkage is required between the three. The lead from the longwire goes to the terminal marked A at the back of the preselector. Terminal B goes to earth, if one is used. The co-ax socket is the preselector output, the inner goes to the receiver aerial input and the outer (screen) to receiver earth. A co-ax plug and length of co-ax cable is required here. Personally, I would not use a 100ft long wire plus a preselector with a communications receiver on the medium waves. The preselector may well cause overloading and cross-modulation. A m.w. loop used in place of the long wire and preselector would probably give better results.

A call for help comes from **M. J. Welch** of 35 Mercers Road, London N19 4PW who has built the *PW* loop aerial and differential amplifier but cannot get any joy out of it. He would like to contact any *PW* reader who lives near him and who might be able to help. Why not use the loop without the preamplifier? It should work very well this way with the CR100. The CR100 incidentally is an excellent receiver for m.w. DXing and does not need any modification to perform well on this band. Mods to the CR100 are usually done to improve its performance on the short waves.

Some DX from areas other than North America comes from several readers. **Derek Taylor** heard the 10kW outlet at Kingston, St Vincent in the Windward Islands on 750kHz at 0100, Radio Demerara, Guyana 760 at 0100, Radio America in Lima, Peru on 1010 at 0040. Derek also asks about the tentative logging of 4QD Emerald, Australia, on 1550. This was reported in the February 1977 edition of *PW* but no identification was possible as the signal was barely audible. **Roy Patrick** (Derby, Trio 9R59D plus loop) logged Freetown, Sierra Leone on 1205 and Radio Globo, Rio de Janeiro on 1220 at 0100. **Harold Emblem** (Mirfield, Eddystone 730 plus loop) heard Riyadh, Saudi Arabia on 587 signing off at 2300, Dakar, Senegal on 764 at 2330, YVRS Radio Margarita Venezuela on 1020 at 0100, EAJ25 Radio Terasa, Spain on 1412 which is usually dominant on this frequency. **John Faulkner** reports reception of Capital Radio Caracas, Venezuela on 710 at 0515; Radio Caracas 750 at 0115, Radio Sutatenza, Colombia 960 at 0306; ZDK Antigua in the Leeward Islands on 1100 at 0100, Radio Anzoategui, Barcelona Venezuela on 1210.

Finally, a couple of news items. Harold Emblem mentions that Bremen is on its new frequency of 935 and Roy Patrick has noticed Radio Moscow behind AFN on 1142. There is also the new station at Bonavista Bay in Newfoundland with the call CBGY on 750kHz.

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.

VHF BANDS

by Ron Ham BRS15744

Harold Brodribb, St Leonard-On-Sea, Sussex, using a CR100 and a long wire aerial noted the good 10m conditions from January 5 to 8, and, like myself, he heard, mainly in the afternoons, the very strong signals from a host of north-American stations working into many parts of Europe. Between us, on days 2, 5, 6, 7, and 8, we received strong signals from both North-American and Italian CB operators, around 27MHz, in QSO with their European counterparts. **George Hook,** G2CIL, Bognor Regis, also reported strong signals from the USA on the amateur and Citizen bands during the afternoon of the 2nd, and on the 9th, after completing a modification to the mixer stage of his HRO he heard a ZS1 on 10m.

Nigel Golds, BRS 36910, West Chiltington, Sx, heard the UA stations working into Germany and Spain around 0900 on the 14th and **Roy Bannister,** G4GPX, Lancing, now active on 10m, heard the Cyprus beacon, 5B4CY, among all the DX on the 5th. Beacon seeking is one of my daily jobs and I received reasonable signals from 5B4CY on 15 of the 24 days from December 26th to January 18th. I also kept watch around 28·300MHz for the project TESSA beacon, ZE2JV, and heard its signals on nine of those days. Around 1400 on the 5th and 6th I listened to both sides of the QSOs between W4s and 4X4 stations, in addition to 539 signals from the Bahrain beacon A9XC, 28·245MHz. Reports would be welcome from our overseas readers about the UK 10m beacon, GB3SX, I understand that it now has solid-state logic, keys its call-sign every minute and at 5-minute intervals, the station's bearings, QRA locator, and a 3-second tone follow the call-sign; all of which is then repeated in RTTY.

Perhaps the sun was responsible for the variable 10m conditions, because on January 3rd, **Cmdr Henry Hatfield,** Sevenoaks, **John Smith,** Rudgwick, Sx, and myself recorded a severe solar noise storm which continued into the following day. Fortunately, the Sevenoaks skies were clear on the 3rd and Henry, using his spectrohelioscope, saw 13 sunspots, including 2 groups (1×6 and 1×4 spots), 5 plages 21 filaments and several bright patches on the sun's disc. Henry was then in no doubt as to what caused the radio noise at 136MHz, and said that it was the most "active" sun he had ever seen. This information was quickly passed to **Charlie Newton,** G2FKZ, RSGB auroral co-ordinator who phoned back at 2215 to say that an aurora affecting v.h.f. radio signals had been reported over Scotland.

Another auroral manifestation, reported by **John Branegan,** Saline, Fife, occurred between 1230 and 1915 and briefly at 1940 and 2112 on the 4th, during which time he logged, by tone-A c.w., on 2m, 2 EIs, 7 GMs, 5 LAs, 1 OZ, 1 PA0 and 4 SMs. During the event, John heard signals from the RSGB 2m beacons in Angus, GB3ANG, Cornwall, GB3CTC, Lerwick, GB3LER, and Northern Ireland, GB3GI. Henry, John Smith, and myself recorded further solar radio noise on days 8, 9, 10, which I feel sure was responsible for the ionospheric disturbances reported by the BBC World Service on the 13th and 14th.

Another solar noise storm began on the 15th and was still, to a lesser degree, going on the 18th. John Smith's radio telescope is a home-brew, phase switched interferometer with a 90 metre base line which he also uses to observe the radio waves coming from Cassiopeia, Cygnus, and the Crab nebular. From Brighton comes news that the h.f. call-sign of the Brighton and District Radio Society is G4GQR and their v.h.f. call is G8OMR. Since January 1st, the 70cm repeater, GB3BR, has been fitted with new solid state equipment, a new style logic system, and it keys its call sign every five minutes. So far, good reports have come from G8LY in Hampshire, G4GPX in Lancing, and a mobile at Beachy Head.

Back in Fife, John Branegan has been testing his 70cm receiver by monitoring the telemetry beacon aboard OSCAR-7, 435·1MHz; John has passed it OK because he can hear the signal when the satellite is over Greenland. In his letter John says "the Doppler up to +8·2kHz approaching and −8·2kHz receding, must be allowed for by any would-be listener". Thanks for the tip John, I would also recommend that our satellite enthusiasts read Chapter 20, "Amateur Satellite Communication", in volume 2 of the RSGB's *Radio Communications Handbook*.

John gives thanks to GM8ARV and all who were responsible for the Edinburgh 70cm repeater, GB3ED, RB14, 433·35MHz, he says "the attractive feature is that it comes up every three minutes whether called or not and gives its call sign. So, it is as good as a 70cm beacon for me". Tropospheric disturbances affecting 70cm occurred on December 19, 20, and January 6, 7, 13 and 14, when, sometime each day, I received signals from the Sutton Coldfield beacon, GB3SUT, with only a dipole feeding the Modular Electronics converter in my FR101. The strongest signals came at 0910 on the 6th, (559) and 0103 on the 7th (599).

During the tropospheric opening of December 19th to 22nd, **Gordon Goodyer,** BRS 37345, Petworth, Sx, heard PA0s on 2m s.s.b., Roy Bannister heard the 2m beacon FX0THF and several French stations, **Pete Simmons,** G3XUS, Newhaven, worked DL, **Graham Kent,** G8HVD, St Leonards-On-Sea, Sx, worked a host of continentals on 2m s.s b. and **Constance Hall,** G8LY, Lee-on-the-Solent, using a 48-element array worked through GB3AW, RB10, the 70cm repeater at Ashmanworth, Berkshire. On the 21st, **Robert Dixon,** G8LZH, Heatherfield, Sx, after calling CQ Dx worked GM4DGC, GD, GU, GW, and northern G on 2m s.s.b. and heard GB3ANG and GB3LER.

The text-book opening in early January can be traced back to the 3rd when the atmospheric pressure climbed from 30·0in at noon to 30·55in by midday on the 5th, and, by midnight a gradual fall began and gave our readers something to shout about. The first sign of a v.h.f. opening came at 0005 on the 6th when **Alan Baker,** G4GNX, Newhaven, heard FX0THF and soon after he worked F1DGZ and F1EDM on 2m s.s.b. Later in the day, **Peter Penfold** was driving through Horsham and heard a station in Paris working through the Kent repeater, GB3KR, and from his home in West Chiltington, Sx, using an NR56 fed by a ground plane, he heard signals through the Bristol Channel, GB3BC, and Cambridge, GB3PI, repeaters.

Around 1300, G4GNX/M on Brighton sea front heard GJ3PRA/M working through the Hampshire repeater, GB3SN, and also on a direct path from Jersey. An hour later, situated on Devils Dyke, Nr Brighton, Alan had a multiway QSO with stations in Chigwell (who had heard an OE), Farnham, Whitstable and Worthing. Between 1700 and 1830, Alan was operating from Race Hill, Brighton, where he worked 20 French stations, (12 around Paris), through the repeater FZ3THF on R4. One station was only using 1 watt, and another, F1EVI, Caen, was running 4 watts to a 3-element beam.

In the middle of all this action, at 1800, Alan could not resist having a QSO with G8KLN, in nearby Worthing, when his signal came through this French repeater. Alan said there was chaos at that time because of the mix-up of signals between GB3KR and FZ3THF, both on R4. From 1957, Alan was at his home QTH, and on 2m s.s.b. he had a 59 contact with DK0VL, on the Swiss border and F1CFY in Douai. Some 30 minutes later, **Ern Hoare,** G8BDJ, Southwick, Sx, worked DK0VL on 70cm.

At 2230, **John Cooper,** G8NGO, joined G4GNX at his home and between them they worked DF5GX/P near the Swiss border, F1BBD/P and F1ECB. Earlier in the day, John, from his QTH in Scaynes Hill, Sx, using an FT221R and a 4-element home-brew beam in his bedroom, heard two DKs near Switzerland, several DLs, PA0s, ONs, some French stations in QSO with each other, and he worked four ONs and two French stations, on 2m s.s.b. At 2100 John heard a PE0 and an ON in QSO through the Ghent repeater ON0OV also on R4. At the same time I was receiving a strong picture from Lichfield on channel 8, 189MHz, using a dipole, and signals through the repeaters BC, BM, KR, and PO were all opening the squelch on my TM-56B.

During the early hours of the 7th, the 2m band was wide open, at 0046 I heard a mix up between a station in Rochester, one in Birmingham, and a Frenchman because they were not sure whether they were working through GB3BM or GB3SN, both on R5 and at 0200 I heard F6BSV, Paris, contact a G in Hull, through GB3KR.

On January 1st, the atmospheric pressure was falling and we started 1978 with a short-lived tropospheric opening. At 1315 I heard G3MCB, Cornwall, work a GW through GB3BC and signals from GB3KR was opening my squelch. During the evening **Angus McKenzie,** G3OSS, London, contacted F6CTW, F6DUD, and briefly received a signal from an OH. G4GNX worked five French stations and heard DB5UK/P, Bavaria, and F1BBD told Alan that he worked DL, G, HB, LX, and PA0 among the 200 QSOs he had during the opening.

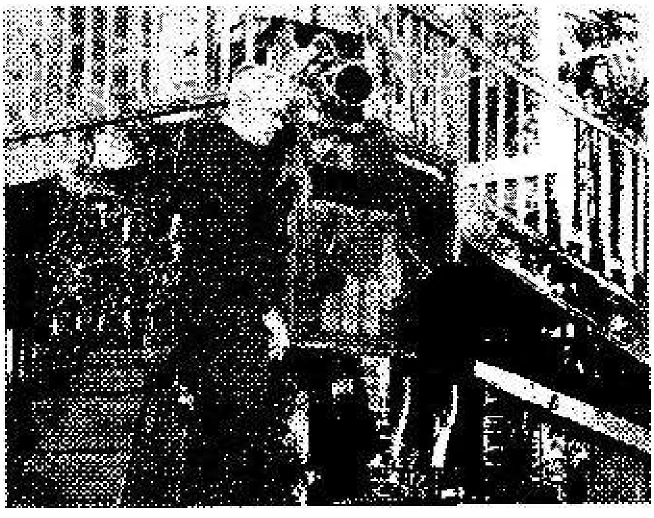
Many thanks for your reports and interest.

VHF PERSONALITY

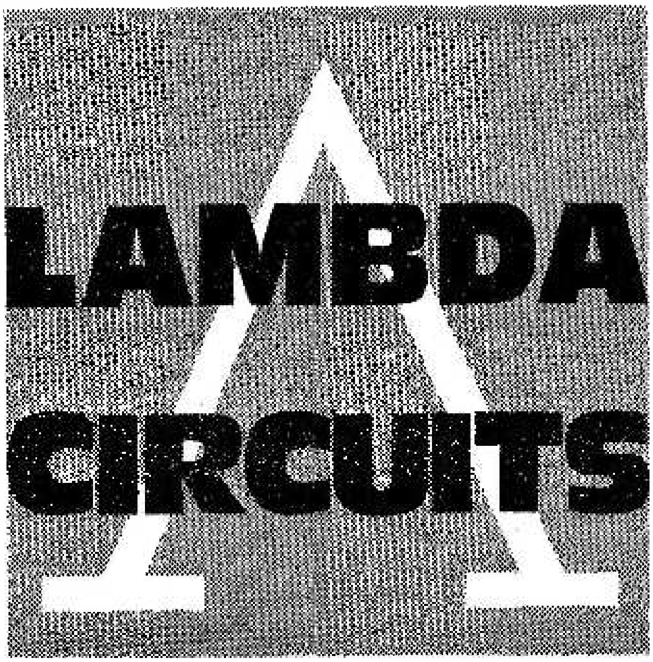
HENRY HATFIELD *by Ron Ham*

Commander Henry Hatfield, RN (retd.) having spent most of his professional life as a Navigator and Hydrographic Surveyor has now built a unique observatory at his home in Sevenoaks, Kent, which combines his long-standing interests in astronomy, engineering, photography and radio.

In 1963, Henry built a 6in Newtonian reflecting telescope which he used for his first regular observations of Jupiter, and a couple of years later, he made a 12in mirror for a new telescope which he used to make a detailed photographic survey of the moon, the results of which can be seen in his book, *Amateur Astronomers Photographic Lunar Atlas*, published by Lutterworth Press in 1968. Another of his photographic achievements was given centre page treatment by *The Daily Mirror* newspaper,



Henry Hatfield adjusting one of the mirrors of his spectroheliscope, another mirror is housed in the building (bottom right) and an electrically adjusted lens is mounted under the shingle cover (bottom left).



BRIAN DANCE

Although modern electronic circuits have an extremely impressive performance, many of them are so complex that it is not easy to understand how they operate. The home constructor often finds it especially satisfying when he meets a new type of circuit which appeals to him, not only because of its performance, but also because of its simplicity.

Lambda Circuit

One such circuit is the so-called *lambda circuit* in **Fig. 1.** This requires a pair of complementary junction field effect transistors; in other words, one of the two transistors must be an n-channel and the other a p-channel type. The writer has found that almost any pair of complementary f.e.t.s will give satisfactory results but, for economy, readers may decide to use a pair of plastic-encapsulated devices, such as the readily-available 2N3819 n-channel type and the equivalent 2N3820 p-channel type.

Both the n-channel and p-channel types have gate, source and drain electrodes, but the arrow of the circuit symbol of the n-channel type points into the gate electrode, as shown in Fig. 1, whereas the arrow of the p-channel type points away from it.

In order to make a lambda circuit, it is only necessary to connect the two source electrodes together and the gate of each device to the drain electrode of the other, as shown in Fig. 1. It is essential that the applied voltage should have the polarity shown or the circuit will not operate in the lambda mode.

Operation is dependent on the shape of the characteristic curve, illustrated in **Fig. 2**. This shows how the current passing through the circuit varies with applied voltage. It can be seen from Fig. 2 that as the voltage applied across the circuit in Fig. 1 starts to increase from zero, the current passing through it increases. This passes from the positive line, through the channel of the n-type device and then to the source of the p-type device, progressing through its channel to the negative line.

When the applied voltage exceeds a certain value, the current passing through the circuit actually decreases with increasing voltage. This region of the curve, shown in Fig. 1, is known as the negative resistance region, since the circuit behaves as if it had a negative resistance to small changes in applied voltage. It is only the a.c. or incremental resistance which is negative; indeed, it is not possible for the d.c. resistance to be negative or the circuit would produce more power than it consumes!

A further increase in applied voltage above the negative resistance region brings the circuit into the

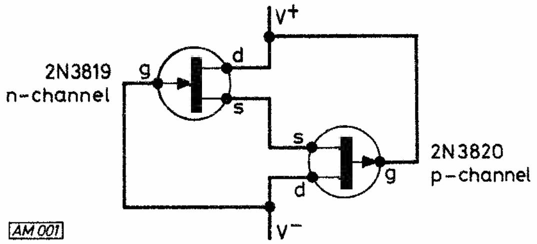


Fig. 1: The basic lambda circuit configuration.

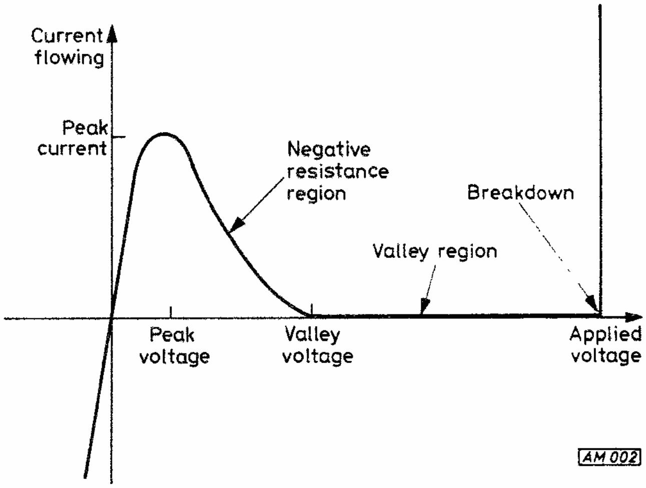


Fig. 2: Characteristic curve of the lambda circuit.

valley region, where the current passing is very low indeed—typically in the order of 1 nanoamp (1 nanoamp=1 millimicroamp). The valley region extends over a relatively wide voltage range, but as the applied voltage is increased, the circuit will eventually break down as the gate to the channel junction of one of the f.e.t. devices reaches its critical point: the current then rises very rapidly indeed with any further increase of applied voltage.

The type of characteristic shown in Fig. 2 resembles the Greek capital letter "lambda" (λ) and hence this type of circuit is usually known as a "lambda circuit". The Matsushita Electric Company of Japan have manufactured miniature two-terminal devices which have the internal circuit shown in Fig. 1 under the name "lambda diodes", but as far as is known these are not generally available in Europe. However, readers can easily make the circuit shown with almost any pair of complementary f.e.t.s.

The peak voltage is typically just under 2V and the peak current in the order of 1mA; the peak occurring when the applied voltage becomes equal to the lesser of the pinch-off voltages of the f.e.t.s: that required to bring the circuit into the valley region is usually in the order of 7V. Although the characteristic curve bears some resemblance to that of a tunnel diode, the lambda circuit has the advantage that its valley current is far smaller. However, the tunnel diode can oscillate at extremely high frequencies, whereas the gate-to-channel capacitances of the Fig. 1 circuit limit its maximum frequency of operation to some tens of MHz.

Applications

The negative resistance part of the lambda characteristic enables this circuit to be used in fast switching modes, as a simple oscillator, etc. The range of application is limited only by the ingenuity of the circuit designer, but we shall be able to consider only a few possibilities here.

Protection Circuit

The circuit of **Fig. 3** can act like an "electronic fuse"; when the current in the load exceeds a certain value, preset by VR1, it is suddenly reduced to a very low level. The switching action is rapid and takes place within about a microsecond, this being swift enough to prevent damage in most cases.

When the voltage across VR1 is relatively small, that across the lambda circuit will also be small. The lambda circuit will therefore be fully conducting and a bias current will pass through it to the base of Tr1. This transistor is connected in the Darlington configuration with Tr2, so as to provide high gain. The current from the emitter of Tr1 is fed to the base of Tr2; the latter therefore conducts and passes current to the load.

If the load current rises, the voltage across VR1 rises and eventually the lambda circuit will be biased into the valley region. The current passing to the base of Tr1 is now of the order of 1nA and this is too small (even after amplification by the Darlington pair) to allow much to pass to the load.

Tr1 may be a BC108, whilst Tr2 must be selected so that it can handle the load current. If Tr1 is omitted and the output from the lambda circuit is connected directly to the base of Tr2, the current at which the load normally operates can be reduced.

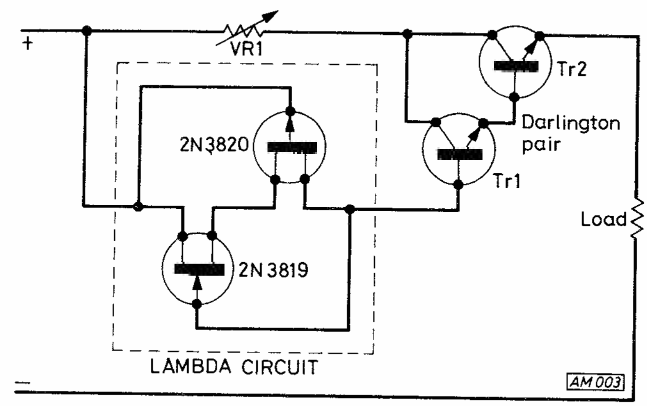


Fig. 3: A protection circuit using a lambda circuit as its over-current sensor.

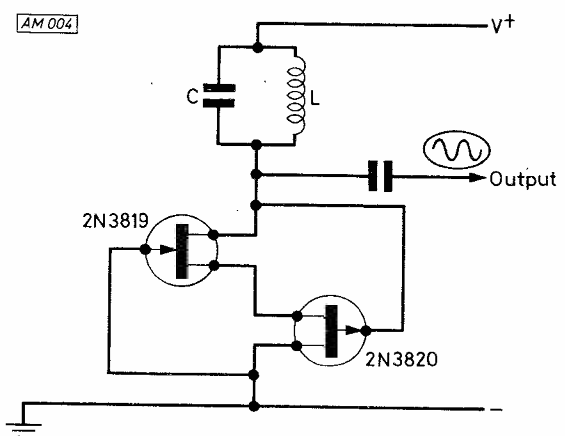


Fig. 4: A sinusoidal oscillator based on the lambda circuit.

Signal Generators

The circuit of **Fig. 4** shows the use of the lambda circuit in a very simple sinusoidal oscillator. The frequency is equal to $1/(2\pi\sqrt{LC})$, that is, the resonant frequency of the parallel-connected tuned circuit. If L is a radio frequency coil and C is a suitable capacitor, the output will be an unmodulated radio-frequency signal. Similarly, L may be an iron cored choke of, perhaps 0·5H and C a capacitor of about 50nF if one requires an output at an audio frequency. Thus one can choose any desired operating parameter from the lowest possible frequency (limited only by the size of the inductance and capacitance values which it is convenient to employ) up to a maximum of some tens of MHz.

This type of circuit can therefore be used either as a simple radio frequency signal generator or as an audio generator. For aligning radio receivers one often requires modulated radio frequency waves. The circuit of **Fig. 5** shows how a lambda circuit can be used to provide an audio frequency output or an unmodulated radio frequency output or a radio frequency output modulated by the audio frequency.

When S3 is closed, the radio frequency circuits are shorted out and the output is provided by the audio frequency determined by C1 and L1, provided that S1 is open. If S1 is closed and S3 is opened, the audio frequency circuits will be shorted out, whilst the radio frequency circuits will be brought into operation. The frequency range switch S2 is used to select one of the coils L2, L3 and L4 which resonate with C2.

Although three radio frequency coils are shown in Fig. 5, the constructor may use any reasonable number to obtain the ranges required. Any standard type of radio coils are suitable or they can be self-wound.

When both S1 and S3 are open, the audio and the radio frequency circuits are brought into operation and the output consists of a modulated radio frequency wave. Thus the circuit of Fig. 5 forms a very basic signal generator ideally suited for the alignment of simple receivers.

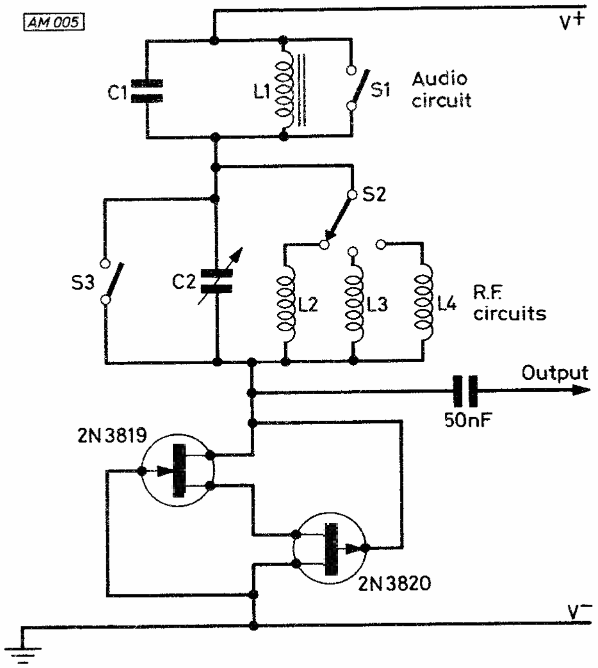


Fig. 5: An r.f./a.f. signal generator using the lambda circuit.

In the diagrams of Figs. 4 and 5, the signal voltage across the tuned circuit off load is equal to twice the steady power supply voltage applied. Thus such a circuit can be very useful when an output whose amplitude is accurately related to the power supply voltage is required. The circuit shown in Fig. 4 has occasionally been used for radio control.

Conclusion

We have seen that lambda circuits can be used as simple oscillators and we have examined one type of switching circuit. Many varieties are possible, for example the Matsushita Company have published a circuit which uses one of their lambda diodes in a battery voltage indicator. When the battery voltage is satisfactory, a green light-emitting diode is illuminated, but when the battery voltage falls the lambda diode switches so that a red light-emitting diode is illuminated and the green one is extinguished. If the battery voltage is very low indeed, neither device is lit. Another example would be circuits which are controlled by a phototransistor and cause rapid switching as the intensity of illumination passes through predetermined levels.

Lambda diodes can be integrated onto the same monolithic chip as other components and it has been forecast that lambda circuits may be attractive in certain memory applications. ●

who published his picture of the fluorescent glow as the Apollo-8 spacecraft jettisoned its surplus fuel when it parted company with the launch vehicle some 25,000 miles above.

Readers of my v.h.f. column will know about Henry's spectroheliscope, a complex instrument for observing the sun, which he built, and subsequently modified. As one of the General Secretaries of the British Astronomical Association he is often called upon to give lectures to both astronomical and radio societies and, when talking about his solar equipment he refers to his working frequency at 457 million megahertz. In fact, the tuning range of his spectrohelioscope is measured in angströms and it can tune across the spectrum of sunlight. Apart from overcast skies, a busy man like Henry cannot observe all day, and knowing that solar events emit radio waves he added a simple radio-telescope to his observatory which rings a bell when the sun becomes "active", calling him to the optical equipment.

Throughout the day, two electrically driven wave collectors, one a mirror and the other a 5-element Yagi, follow the path of the sun; the light waves pass through a series of mirrors and lenses to the solar observatory in a garden room below his house, and the radio waves are fed to a Microwave Modules 136MHz converter followed by an AR88 communications receiver situated near the spectrohelioscope. The detector voltage of the AR88 feeds a d.c. amplifier which, in turn, drives the alarm bell relay and a pen recorder. This is possibly the first amateur observatory in the world that can receive radio noise from the sun and then photograph the event which caused it.

In recent years Henry's observatory has been the subject of a BBC *Sky at Night* programme and an extensive write up in the *Amateur Photographer* magazine.

KINDLY NOTE!

Jubilee Organ, Part 2, October 1977 PW
Please ignore the amendment published on page 837 of our March 1978 issue. The connections to ICs 3, 4, 5 and 6 are correct as originally shown.

"Mystery Train Tour" March 1978 PW
A wire link connecting the top end of R10 to IC1 pin 10 was omitted from the Veroboard layout (Fig. 4) on page 824. Readers should also note that the track to which R10 is connected is broken beneath R14.

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70	6	3	5·35	0·96
108	8	4	6·98	1·14
72	10	5	7·67	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	26·82	OA

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105	3·0	8·45	1·32
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107	6·0	14·62	1·64
118	8·0	17·05	2·08
119	10·0	21·70	OA

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152	250	12·79	1·84
153	350	16·28	1·84
154	500	19·15	2·15
155	750	29·06	OA
156	1000	37·20	OA
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3	2·0	5·27	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	9·92	1·45
88	8·0	11·73	1·64
89	10·0	13·33	1·84

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127	2·0	7·60	1·14
125	3·0	10·54	1·32
123	4·0	12·23	1·84
40	5·0	13·95	1·64
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

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4	150	0-115-200-220-240	5·35	0·96
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
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1500	26·02	OA	93W
2000	37·65	OA	95W

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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	1·99	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	0·96
203	500, 500	0-15-27-0-15-27	3·99	0·96
204	1A, 1A	0-15-27-0-15-27	5·39	0·96
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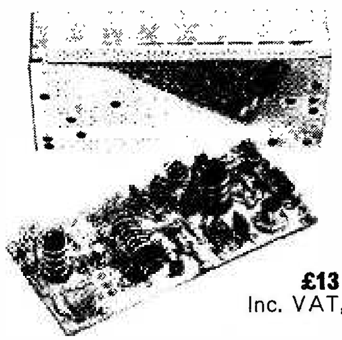

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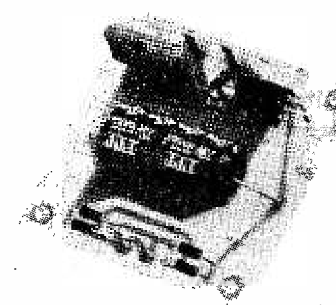

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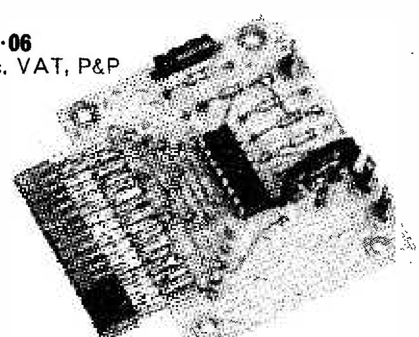

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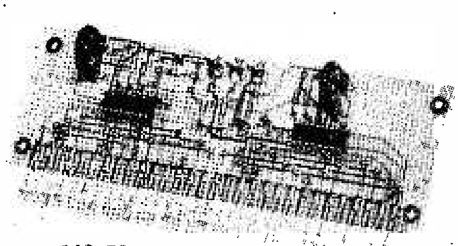

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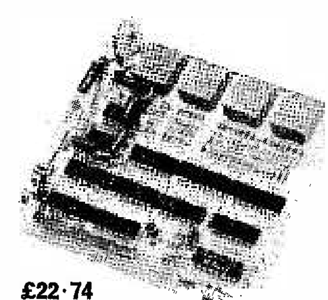
ILLUMINATED POINTER
Station finder



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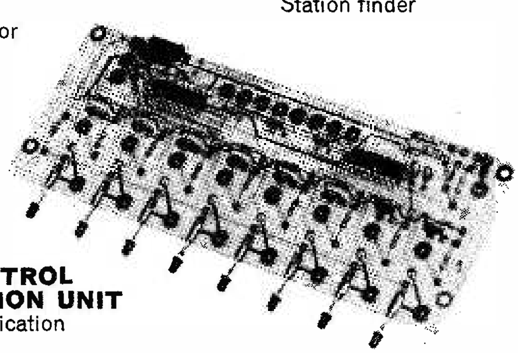
Digital display of received station frequency



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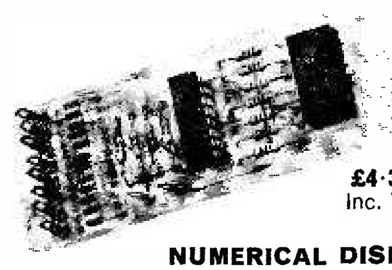

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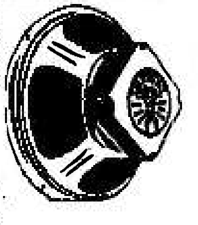

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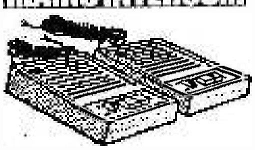

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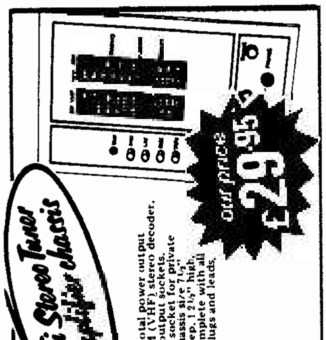

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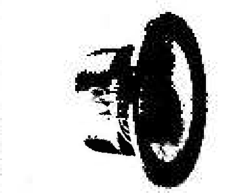
19 (1·5 mm) 20 (3·0 mm)
21 (4·5 mm) 22 (6·0 mm)

Trade Enquiries Welcome

From your Local Dealer or Direct from the Manufacturers:
S. & R. BREWSTER Ltd.
86-88 UNION ST · PLYMOUTH Tel 0752 65011



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SWAN WORKS, BANK SQUARE, WILMSLOW, CHESHIRE SK9 1HF
Discount HiFi Etc. at 5 Swan Street and 10 Swan Street
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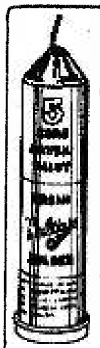
ERSIN Multicore 5 CORE SOLDER

Handy size Reels & Dispensers

OF THE WORLD'S FINEST CORED SOLDER TO DO A PROFESSIONAL JOB AT HOME

Ersin Multicore Solder contains 5 cores of non-corrosive flux that instantly cleans heavily oxidised surfaces and makes fast, reliable soldering easy. No extra flux is required.



SAVBIT handy solder dispenser

Contains 2.3 metres approx. of 1.22 mm Ersin Multicore Savbit Solder. Savbit increases life of copper bits by 10 times.

Size 5 58p

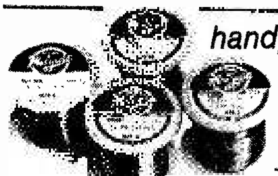
For soldering fine joints

Two more dispensers to simplify those smaller jobs. PC115 provides 6.4 metres approx. of 0.71 mm solder for fine wires, small components and printed circuits.

PC115 69p

Or size 19A for kit wiring or radio and TV repairs. 2.1 metres approx. of 1.22 mm solder.

Size 19A 63p



handy size reels of SAVBIT, 40/60, 60/40 & ALU-SOL solder alloys

These latest Multicore solder reels are ideal for the toolbox. Popular specifications cover all general and electrical applications, plus a major advance in soldering aluminium. Ask for a free copy of 'Hints on Soldering' containing clear instructions to make every job easy.

Ref.	Alloy	Diam. mm	Length metres approx.	Use	Price
Size 3	40/60 Tin/Lead	1.6	10.0	For economical general purpose repairs and electrical joints.	£2.16
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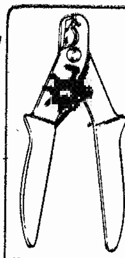
Size 12	SAVBIT	1.2	13.7	For radio, TV and similar work. Increases copper-bit life tenfold.	£2.29



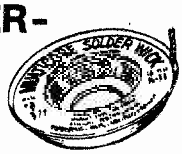
BIB WIRE STRIPPER & CUTTER

Fitted with unique 8-gauge selector and handle locking device. Sprung for automatic opening. Strips flex and cable in seconds.

Pat. No. 1443913

Model 8B 97p

SOLDER-WICK



Absorbs solder instantly from tags, printed circuits etc. Only needs 40–50 Watt soldering iron. Quick and easy to use. Non-corrosive.

Size AB10 97p

Sole U.K. Sales Concessionaires:
Bib Hi-Fi Accessories Limited,
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Prices shown are recommended retail, inc. V.A.T. From Electrical and Hardware Shops. In difficulty send direct, plus 20p P&P. Prices and specifications subject to change without notice.

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A Microcomputer, programmed to challenge you at one of THREE levels to match and improve your game. With this unique game, there is no need to find an opponent! You simply enter your moves, then 5-40 seconds later, after analysing the new position, the computer will respond! This amazing microprocessor computer is supplied complete with Chessmen, comprehensive instructions, and mains adaptor; and is fully guaranteed. You can now play chess when your are ready, day or night, without the bother of finding a chess partner.

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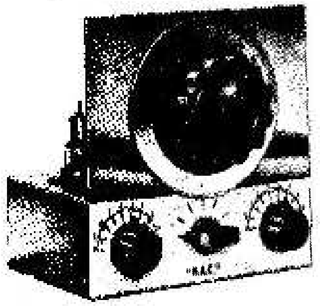
Callers welcome by appointment only

H.A.C. SHORT-WAVE KITS

WORLD-WIDE RECEPTION



Famous for over 35 years for Short-Wave Equipment of quality. "H.A.C." were the Original suppliers of Short-Wave Receiver Kits for the amateur constructor. Special offer AR8 valves—70p each.

1978 "DX" RECEIVER Mark III
Complete kit—Price £9·00 (incl. p. & p. and V.A.T.).

Customer who sent us five QSL cards, one from each continent writes: "Other countries of interest which I have heard are Korea, Japan, Sri Lanka, Liberia and many others. I was very surprised at the simplicity of the set, compared to its efficiency."

This kit is ready to assemble and contains all genuine short-wave components, drilled chassis, valve, accessories and full instructions. Full range of other S.W. kits, including the famous model "K plus" (illustrated above). All orders despatched within 7 days. Send now for free descriptive catalogue of kits and components.

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ALL PRICES INCLUDE VAT, POST AND PACKING.

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The prepaid rate for classified advertisements is 20 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £6·80 per single column centimetre (minimum 2·5 cms). All cheques, postal orders etc., to be made payable to Practical Wireless and crossed "Lloyds Bank Ltd". Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Practical Wireless, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London, SE1 9LS. (Telephone 01-261 5846)

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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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3. Although every care is taken, the Publishers shall not be liable for clerical or printers' errors or their consequences.

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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.

Receivers and Components

LED's. Mixed bags of 4 different sizes and 4 different colours. 50 at £5·25, 100 at £9·25 including VAT and post and packing. CWO. Michael Williams Electronics, 47 Vicarage Avenue, Cheadle Hulme, Cheshire, SK8 7JP.

COMPONENTS FOR P.W. PROJECTS. Components lists with prices available for P.W. projects from October 1977 onwards. Send SAE stating project and month of publication (maximum four projects per SAE). Lists sent by return together with ACE order form/catalogue. ACE MAILTRONIX, Tootal Street, Wakefield, W. Yorks WF1 5JR.

TIRRO ELECTRONICS the mail order division of Ritro Electronics UK offers a wide range of components for the amateur enthusiast. Large SAE or 20p brings list. Grenfell Place, Maidenhead, Berks. SL6 1HL.

GAMMA ENTERPRISES for transistors, resistors, capacitors, ICs, hardware etc. Large SAE for catalogue. 18 Landale Road, Peterhead, Aberdeenshire AB4 6QP.

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BASIC ELECTRONICS Timesaver Program. 30-stage speedilearn, easilearn program. Unique Timesaver breadboards, terminals, plans and circuit know-how. Ideal for beginners, students, schools, colleges. Limited period intro-offer £4·75. Money back if not delighted. TECHNOCENTRE, (PW) PO Box 33, 54 Adcott Road, Middlesbrough.

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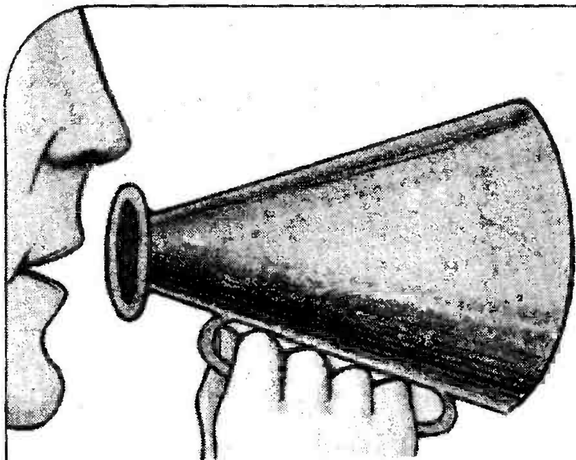
MULTIBAND RADIOS. 12 band . . . Marine, Aircraft, LPSB, HPSB, UHF (430/470), SW1/4, MW, LW, FM, RF gain. BFO. £150. GRUNDIG SATERLITT £199. BFO Units, £16·50. SHARP MW/Aircraft, £13. Langtons, High Street, Rocester, Staffordshire. SAE lists.



Calling all professional electronics engineers and amateur electronics enthusiasts

The Electronics Industry has always been a breeding ground of professional talent, particularly within the specialist areas. At EMI, we have always attracted talented people, graduates and specialist engineers with valuable experience to contribute.

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Your role with EMI Electronics will be to advise engineers, production personnel, buyers and Q.A. staff on various aspects of semi-conductor and micro-processor products, to liaise with suppliers and initiate/draft standards. You will also be expected to undertake laboratory testing, evaluate devices and be responsible for seeking out new products.

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For further information, please contact Neil Robotham, Personnel Department, EMI Limited, 135 Blyth Road, Hayes, Middlesex. Telephone 01-573 3888 or Record-a-call anytime on 01-573 5524.

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EMI

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NEW ISSUES of "Practical Wireless" available from April 1974 edition up to date. Price 65p each post free. Bell's Television Services, 190 Kings Road, Harrogate, N. Yorkshire. Tel: (0423) 55885.

550ft of Triple Play tape (ex-recording studio) on 3in unbreakable reel. Ideal for messages. Bargain at 25p each p&p 30p. 10½in metal spool (NAB) in sturdy box, 80p, p&p 30p. R. Southern, 551 Chorley Old Road, Bolton, Lancs BL1 6AE.

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SEEN WHISTONS CAT? 5000 odds and ends. Mechanical/Electrical Cat free. WHISTON (Dept. PW), New Mills, Stockport.

14 VOLS. PRACTICAL WIRELESS, March 1956-April 1970, also other Radio periodicals. £3·00 per vol. Buyer collects. Tel: 06755 2342.

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AUTOMATIC ELECTRONIC Time Delays, 1kW output kit £6·10, PCB/Details £1·20. Information—SAE. L. O. Green, 4 Gurney Road, Costessey, Norwich NR5 0HA.

PW Sept. 72 to Apr 77. Offers. Curson, 18 Heslop Road, Balham, London.

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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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Chassis only **£94** carr. £5

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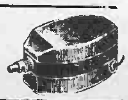

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Cueing Device, Bias Compensator, Balanced Arm, All Post 75p

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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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With aluminium presence dome.

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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. **£75** Carr. £1·50

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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.

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Complete kit of parts with R.C.S. printed circuit. Three channels. 600 to 1,000 watts each. Will operate from 20MV. to 100 watts signal source. Cabinet extra £4. Price **£17**

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw Fitting 75p. Each.

MAINS TRANSFORMERS

Post 50p

6 VOLT ½ AMP. £1·00 3 AMP. £1·40 9 VOLT 3 AMP £2·75
12 VOLT 300 MA. £1·00 750 MA. £1·30
30 VOLT 5 AMP. AND 34 VOLT 2 AMP. C.T. £3·45
20 VOLT 1 AMP. £2·00 2 AMP. £2·20 20-0-20 VOLT 1 AMP. £2·95
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GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at

2A, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V	£5·30
1A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£5·30
2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£8·50
3A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£11·00
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.
12 watts rms. 8 ohms

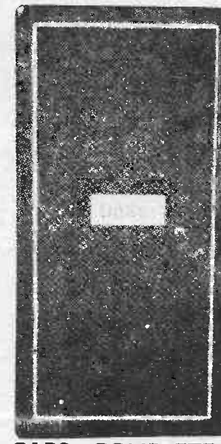
£19 pair Post £1·30

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
With one horn £60
With two horns £68
Carr. £3

80 WATT R.M.S. £56
With one horn £64
With two horns £72
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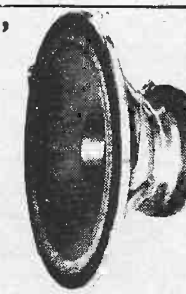
100 WATT R.M.S. £69
With one horn £78
With two horns £86
Carr. £5

SINGLE 12inch CABS COMPLETE
30 WATT R.M.S. £32. WITH HORN £40.
40 WATT R.M.S. £34. WITH HORN £42.
60 WATT R.M.S. £41. WITH HORN £49.
CARR £3 EA.

"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.

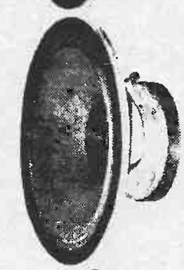
Bass Resonance	25cps
Flux Density	16,500 gauss
Useful response	20-17,000cps

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

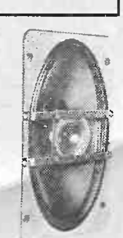
8 or 16 ohms models.

£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. Rubber cone surround. **£9.95** Post 65p

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