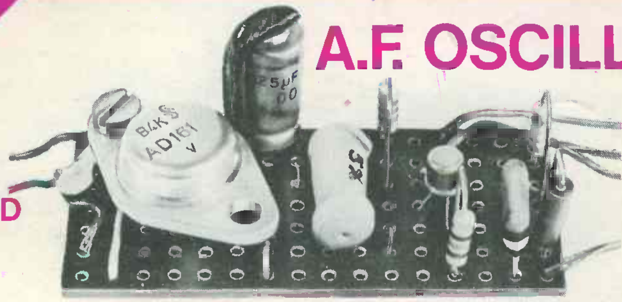
RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1973

20p

A.F. OSCILLATOR

VEROBOARD
PROJECT
ONE

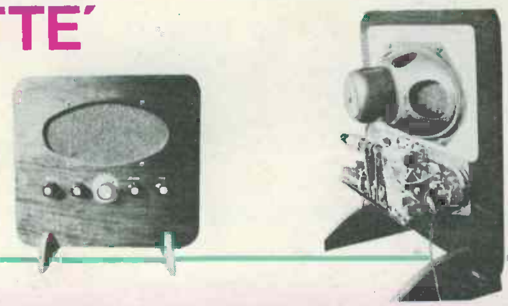


GRAM AMPLIFIER

VEROBOARD
PROJECT
TWO

THE 'BAFFLETTE'

A novel
superhet
receiver

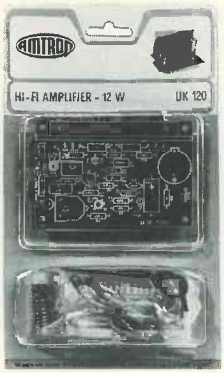


FREE PIECE OF VEROBOARD INSIDE

AMTRON
the big name in electronic kits

UK 595
Electronic Fuse
Up to 28v 1 amp. max.
£5.93 inc. VAT

Apart from the three items shown here there are nearly 200 other kits to choose from in the vast AMTRON range. A few examples are: Power Supplies; Pre-amplifiers; Amplifiers; L. F. Instruments, Amateur and Radio Control Transmitters and Receivers; Measuring Instruments; I.C. Digital Equipment, etc. All kits are sold in attractive blister packs and come with complete instructions plus solder.



UK 900
Crystal Oscillator
UK 910 RF Mixer
UK 925 RF Amplifier
£2.57 inc. VAT

UK 120 Hi-Fi Amplifier 12w in blister pack. £5.20 inc. VAT

Contact your local stockist for details.

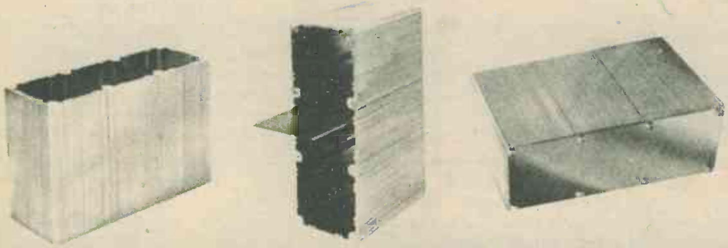
AMTRON® UK

AMTRON U.K. LTD. 4 & 7 CASTLE STREET, HASTINGS, SUSSEX. TEL: HASTINGS 2875

vero

products available from your local retailer

to assist with all types of home constructor projects

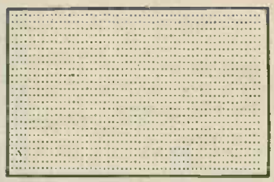


verobox ®

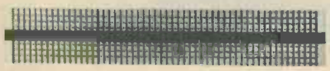
Six standard sizes of extruded box with built-in guide slots

Veroboard ®

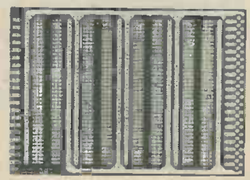
0.1" and 0.15" pitch
Single-sided, copper clad



Plain boards.
0.1" and 0.15" pitch.

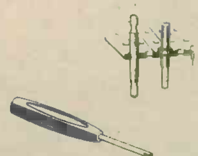


Group Boards for simple component mounting 0.1" and 0.15" pitch.



D.I.P. Breadboards are the easiest way of mounting your D.I.P's. 0.1" pitch.

Spot-face cutter to simplify cutting of copper track.



Terminal pins for 0.1" and 0.15" pitch boards together with pin insertion tool.

VERO ELECTRONICS LIMITED

Industrial Estate, Chandler's Ford, Hampshire SO5 32R

Chandler's Ford 2952 **Telex 47551**

SEMICONDUCTORS

Full spec. marked by Mullard, etc. Many other types in stock

AC127	10p	BCY71	18p	BFX29/30	25p
AC187/8	12p	BD115	67p	BFX84	22p
AD149	35p	BD131	40p	BFX88	20p
AD161/2	26p	BD132	49p	BFY50/1/2	13p
Matched pair	45p	BD135	36p	BSV64	40p
AF116/7	12p	BF115	23p	BSX21	20p
AF139	28p	BF167	18p	BU105/01	£1.70
AF178	30p	BF173	19p	OC35	28p
AF180	40p	BF178	25p	2N706	8p
AF239	30p	BF179	30p	2N2219	19p
BC107/8/9	7p	BF180/1/2	30p	2N2401 (ASY26-27)	15p
BC147/8/9	8p	BF183	40p	2N2904	17p
BC157/9	10p	BF184	17p	2N2905	21p
BC158	8p	BF185	17p	2N2906	15p
BC187	25p	BF195	12p	2N2907	18p
BCY40	25p	BF196/7	14p	2N3055	35p
BCY70	13p	BF262	60p	2N3053	15p

BRIDGE RECTIFIERS

Amp	Volt RMS		
½	1,600	BYX10	30p
1	140	OSH01-200	25p
1.4	42	BY164	35p
Plastic types			

Amp	Volt RMS		
2	30	LT120	30p
0.6	6-110	EC433	
Encapsulated with built-in heat sink			15p

1 AMP RECTIFIERS

IN4002	100 volt	4p
IN4003	200 volt	5p
IN4004	400 volt	6p
IN4005	600 volt	7p
IN4006	800 volt	7½p
IN4007	1,000 volt	8p

HIGH POWER RECTIFIERS

	Amp	Volt	
LT102	2	30	10p
BYX38-600	2.5	600	25p
BYX38-300	2.5	300	20p
BYX38-900	2.5	900	28p
BYX38-1200	2.5	1,200	30p
BYX49-600	2.5	600	25p
BYX49-300	2.5	300	20p
BYX49-900	2.5	900	28p
BYX48-300	6	300	27p
BYX48-600	6	600	32p
BYX48-900	6	900	40p
BYX48-1200	6	1,200	60p
BYX72-150R	10	150	24p
BYX72-300R	10	300	35p
BYX72-500R	10	500	43p
BYX42-300	10	300	40p
BYX42-600	10	600	45p
BYX42-900	10	900	55p
BYX42-1200	10	1,200	75p
BYX46-300*	15	300	£2.50
BYX46-400*	15	400	£2.90
BYX46-500*	15	500	£3.20
BYX46-600*	15	600	£3.80
BYX20-200	25	200	35p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.25

*Avalanche type

N50 ohm free plug (UG21D/U) 50p
N50 ohm square socket (UG58A/U) 50p

1" Terryclips black plastic coated, or chrome finish .. 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia .. 15p
Rubber Car Radio gasket .. 10p

DLI Pal Delayline £2.00

Relay socket 12p
Take miniature 2PCO relay

B9A valve can 2p

0–30 in ·5 segments, black pvc, 360° dial, silver digits, self adhesive, 4½" dia. 15p

OPTO ELECTRONICS

ORP12	43p
BPX40	25p
BPX42	£1
BPY10	75p
BPY68	75p
BPY69	£1
BPY77	75p

Diodes

Photo transistor
BPX29 80p
OCP71 30p

CQ11B Infra red transmitter £4

PNPN PROGRAMMABLE UNIJUNCTION

BRY39 30p

F.E.T's

BFW10 .. .. 25p
BSV79 .. .. 90p
BSV80 .. .. 80p

N. Channel
BSV81 M.O.S.T. .. £1
BFS 8 Dual M.O.S.T. 90p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	400 volt	15p
2MFD	250 volt	20p
2MFD	1.5 kv	50p
15MFD	150 volt	25p

ALL ORDERS OVER £3 POST FREE OVER £6 V.A.T. FREE

Phillips Iron Thermostat .. 15p

Bulgin 2-pin flat plug and socket 10p

McMurdo PP108 8 way edge plug 15p

300 ohm moving coil insert 4103D 1¾" diameter. Make ideal mike or speaker for communication work .. 25p

Tested unmarked or marked ample lead ex new equipment

AC128	6p	OC71/2	6p
ACY17-20	8p	OC200-5	6p
ASY28/9	8p	2G302	6p
ASZ21	8p	2N2926	5p
BCY70/1/2	8p	2N598/9	6p
BCY30-34	10p	2N1091	8p
BY127	8p	2N1302	8p
BZY88 series	6p	Germ. diode	3p
OA5/7/10	10p	GET111	20p
OA47/81	4p	GET120 (AC128 in 1"sq. heat sink)	20p
OA200-5	5p	100v 1 amp diode	3p
OC23	20p		
OC29	25p		
OC44	6p		

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 .. 20p

U.E.C.L. 20 way pin connector 2A60000A1P20 30p

U.E.C.L. 10 way pin socket 2B606001R10 20p

U.E.C.L. 20 way pin socket B260800A1R20 30p

BELLING LEE L1354 TV Aerial diplexer 10p

THYRISTORS

Amp	Volt		
1	240	BTX18-200	30p
1	240	BTX30-200	30p
5.6	700	BT106	85p
6.5	300	BT102-300R	42p
6.5	500	BT102-500R	60p
6.5	500	BT107	90p
6.5	500	BT108	90p
6.5	500	BT101-500R	68p
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£12

OTHER DIODES

Centercel	5p
IN916	5p
BA145	14p
BA182	16p

5 pin and 6 pin 240° (Type B) Metal Chassis Din Sockets 6p

TRIACS

Amp	Volt		
6	400	BT110-400 Plastic	75p
25	900	BTX94-900	£6.50
25	1200	BTX94-1200	£9

DIAC BRI00 30p

WESTINGHOUSE 28TIO 30 AMP 1000 VOLT THYRISTER WITHOUT NUT £5

PHOTO SILICON CONTROLLED SWITCH

BPX66 PNPN 10 amp £1

TAA30 T0-74 1 Watt A.F. AMPLIFIER I.C. 4·5 to 9v £1.50

WIREWOUND SLIDER

150 Ohm, 250 Ohm 5K 4p each

HANDLES

Rigid light blue nylon 6½" with secret fitting screws 5p

Rotor with neon indicator, as used in Seafarer, Pacific, Fairway depth finders 20p each

DEE PLUG

McMurdo DA15P 15 way chassis plug 20p

Fairway 18009 Coax. socket .. 5p

TIE CLIPS

Nylon self locking 3½" 1p; 7" 2p

CINCH 150

12 way edge socket 10p

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE
LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.
TOTAL GOODS PLUS CARRIAGE, ADD 10% V.A.T.

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday Phone 01-223 5016

THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	0.22	AD161 &		BC150	0.20	BD131	0.55	BF182	0.44	MAT121	0.22	2G304	0.27	2N2148	0.63	2N3055	0.55	2N4060	0.13
AC113	0.20	AD162(MP)	0.61	BC151	0.22	BD132	0.66	BF183	0.44	MJE2955	0.95	2G306	0.44	2N2160	0.66	2N3391	0.16	2N4061	0.13
AC115	0.22	ADT140	0.55	BC152	0.19	BD133	0.72	BF184	0.28	MJE3055	0.62	2G308	0.39	2N2192	0.39	2N3391A	0.18	2N4062	0.13
AC117K	0.32	AF114	0.27	BC153	0.31	BD135	0.44	BF185	0.33	MJE3440	0.55	2G309	0.39	2N2193	0.39	2N3392	0.16	2N4284	0.19
AC122	0.13	AF115	0.27	BC154	0.33	BD136	0.44	BF187	0.30	MPF102	0.46	2G339	0.22	2N2194	0.39	2N3393	0.16	2N4285	0.19
AC125	0.19	AF116	0.27	BC157	0.20	BD137	0.50	BF188	0.44	MPF104	0.41	2G339A	0.18	2N2217	0.24	2N3394	0.16	2N4286	0.19
AC126	0.19	AF117	0.27	BC158	0.13	BD138	0.55	BF194	0.13	MPF105	0.41	2G334	0.20	2N2218	0.22	2N3395	0.19	2N4287	0.19
AC127	0.20	AF118	0.39	BC159	0.13	BD139	0.61	BF195	0.13	OC19	0.39	2G345	0.18	2N2219	0.22	2N3402	0.23	2N4288	0.19
AC128	0.20	AF124	0.33	BC160	0.50	BD140	0.66	BF196	0.16	OC20	0.70	2G371	0.18	2N2220	0.24	2N3403	0.23	2N4289	0.19
AC132	0.16	AF125	0.33	BC161	0.55	BD155	0.88	BF197	0.16	OC22	0.52	2G371B	0.13	2N2221	0.22	2N3404	0.31	2N4290	0.19
AC134	0.16	AF126	0.31	BC167	0.13	BD175	0.66	BF200	0.50	OC23	0.54	2G373	0.19	2N2222	0.22	2N3405	0.46	2N4291	Q.19
AC137	0.16	AF127	0.31	BC168	0.13	BD176	0.66	BF222	£1,05	OC24	0.62	2G374	0.19	2N2368	0.19	2N3414	0.17	2N4292	0.19
AC141	0.20	AF139	0.33	BC169	0.13	BD177	0.72	BF257	0.50	OC25	0.42	2G377	0.33	2N2369	0.16	2N3415	0.17	2N4293	0.19
AC141K	0.32	AF178	0.55	BC170	0.13	BD178	0.72	BF258	0.66	OC26	0.32	2G378	0.18	2N2369A	0.16	2N3416	0.31	2N5172	0.13
AC142	0.20	AF179	0.55	BC171	0.16	BD179	0.77	BF259	0.94	OC28	0.55	2G381	0.18	2N2411	0.27	2N3417	0.31	2N5294	0.60
AC142K	0.28	AF180	0.55	BC172	0.16	BD180	0.77	BF262	0.61	OC29	0.55	2G382	0.18	2N2412	0.27	2N3525	0.83	2N5457	0.35
AC151	0.17	AF181	0.55	BC173	0.16	BD185	0.72	BF263	0.61	OC35	0.46	2G401	0.33	2N2646	0.52	2N3614	0.74	2N5458	0.35
AC154	0.22	AF186	0.55	BC174	0.16	BD186	0.72	BF270	0.39	OC36	0.55	2G414	0.33	2N2711	0.23	2N3615	0.82	2N5459	0.44
AC155	0.22	AF239	0.41	BC175	0.24	BD187	0.77	BF271	0.33	OC41	0.22	2G417	0.28	2N2712	0.23	2N3616	0.82	2N6211	0.75
AC156	0.22	AL102	0.72	BC177	0.21	BD188	0.77	BF272	0.88	OC42	0.27	2N388	0.39	2N2714	0.23	2N3464	0.10	2S301	0.55
AC157	0.27	AL103	0.72	BC178	0.21	BD189	0.83	BF273	0.39	OC44	0.17	2N388A	0.61	2N2904	0.19	2N3702	0.13	2S302A	0.46
AC165	0.22	ASY26	0.28	BC179	0.21	BD190	0.83	BF274	0.39	OC45	0.14	2N404	0.22	2N2904A	0.23	2N3703	0.13	2S302	0.46
AC166	0.22	ASY27	0.33	BC180	0.27	BD195	0.94	BFW10	0.66	OC70	0.11	2N404A	0.31	2N2905	0.23	2N3704	0.14	2S303	0.61
AC167	0.22	ASY28	0.28	BC181	0.27	BD196	0.94	BFX29	0.30	OC71	0.11	2N524	0.46	2N2905A	0.23	2N3705	0.13	2S304	0.77
AC168	0.27	ASY29	0.28	BC182	0.11	BD197	0.99	BFX84	0.24	OC72	0.16	2N527	0.54	2N2906	0.17	2N3706	0.13	2S305	0.86
AC169	0.16	ASY50	0.28	BC182L	0.11	BD198	0.99	BFX85	0.33	OC74	0.16	2N598	0.46	2N2906A	0.20	2N3707	0.14	2S306	0.86
AC176	0.22	ASY51	0.28	BC183	0.11	BD199	£1.05	BFX86	0.24	OC75	0.17	2N599	0.50	2N2907	0.22	2N3708	0.09	2S307	0.86
AC177	0.27	ASY52	0.28	BC183L	0.11	BD200	£1.05	BFX87	0.27	OC76	0.17	2N696	0.14	2N2907A	0.24	2N3709	0.10	2S321	0.62
AC178	0.31	ASY54	0.28	BC184	0.13	BD205	0.88	BFX88	0.24	OC77	0.28	2N697	0.15	2N2923	0.16	2N3710	0.10	2S322	0.46
AC179	0.31	ASY55	0.28	BC184L	0.13	BD206	0.88	BFY50	0.22	OC81	0.17	2N698	0.27	2N2924	0.16	2N3711	0.10	2S322A	0.46
AC180	0.22	ASY56	0.28	BC186	0.31	BD207	£1.05	BFY51	0.22	OC81D	0.17	2N699	0.39	2N2925	0.16	2N3819	0.31	2S323	0.62
AC180K	0.32	ASY57	0.28	BC187	0.31	BD208	£1.05	BFY52	0.22	OC82	0.17	2N706	0.09	2N2926(G)	0.14	2N3820	0.55	2S324	0.77
AC181	0.22	ASY58	0.28	BC207	0.12	BDY20	£1.10	BFY53	0.19	OC82D	0.17	2N706A	0.10	2N2926(Y)	0.12	2N3821	0.39	2S325	0.77
AC181K	0.32	ASY73	0.28	BC208	0.12	BF115	0.27	BPX25	0.94	OC83	0.22	2N708	0.13	2N2926(O)	0.11	2N3823	0.31	2S326	0.77
AC187	0.24	ASZ21	0.44	BC209	0.13	BF117	0.50	BSX19	0.17	OC139	0.22	2N711	0.33	2N2926(R)	0.11	2N3903	0.31	2S327	0.77
AC187K	0.25	BC107	0.10	BC212L	0.12	BF118	0.77	BSX20	0.17	OC140	0.22	2N717	0.39	2N2926(B)	0.11	2N3904	0.33	2S701	0.46
AC188	0.24	BC108	0.10	BC213L	0.12	BF119	0.77	BSY25	0.17	OC169	0.28	2N718	0.27	2N3010	0.77	2N3905	0.31	40361	0.44
AC188K	0.25	BC109	0.11	BC214L	0.16	BF121	0.50	BSY26	0.17	OC170	0.28	2N718A	0.55	2N3011	0.16	2N3906	0.30	40362	0.50
ACY17	0.28	BC113	0.11	BC225	0.28	BF123	0.55	BSY27	0.17	OC171	0.28	2N726	0.31	2N3053	0.19	2N4058	0.13		
ACY18	0.22	BC114	0.17	BC226	0.39	BF125	0.50	BSY28	0.17	OC200	0.28	2N727	0.31	2N3054	0.51	2N4059	0.11		
ACY19	0.22	BC115	0.17	BC301	0.30	BF127	0.53	BSY29	0.17	OC201	0.31	2N743	0.22						
ACY20	0.22	BC116	0.17	BC302	0.27	BF152	0.61	BSY38	0.20	OC202	0.31	2N744	0.22						
ACY21	0.22	BC117	0.20	BC303	0.35	BF153	0.50	BSY39	0.20	OC203	0.28	2N914	0.16						
ACY22	0.18	BC118	0.11	BC304	0.40	BF154	0.50	BSY40	0.31	OC204	0.28	2N918	0.33						
ACY27	0.20	BC119	0.33	BC440	0.34	BF155	0.77	BSY41	0.31	OC205	0.39	2N929	0.23						
ACY28	0.21	BC120	0.88	BC460	0.40	BF156	0.53	BSY95	0.14	OC309	0.44	2N930	0.23						
ACY29	0.39	BC125	0.13	BCY30	0.27	BF157	0.61	BSY95A	0.14	OCP71	0.48	2N1131	0.22						
ACY30	0.31	BC126	0.20	BCY31	0.29	BF158	0.61	BU105	£2.20	ORP12	0.48	2N1132	0.24						
ACY31	0.31	BC132	0.13	BCY32	0.33	BF159	0.66	C111E	0.55	ORP60	0.44	2N1302	0.16						
ACY34	0.23	BC134	0.20	BCY33	0.24	BF160	0.44	C400	0.33	ORP61	0.44	2N1303	0.16						
ACY35	0.23	BC135	0.13	BCY34	0.28	BF162	0.44	C407	0.28	P20	0.53	2N1304	0.19						
ACY36	0.31	BC136	0.17	BCY70	0.16	BF163	0.44	C424	0.28	P21	0.50	2N1305	0.19						
ACY40	0.19	BC137	0.17	BCY71	0.22	BF164	0.44	C425	0.55	P346A	0.22	2N1306	0.23						
ACY41	0.20	BC139	0.44	BCY72	0.16	BF165	0.44	C426	0.39	P397	0.46	2N1307	0.23						
ACY44	0.39	BC140	0.33	BCZ10	0.22	BF167	0.24	C428	0.22	ST140	0.14	2N1308	0.26						
AD130	0.42	BC141	0.33	BCZ11	0.28	BF173	0.24	C441	0.33	ST141	0.19	2N1309	0.26						
AD140	0.53	BC142	0.33	BCZ12	0.28	BF176	0.39	C442	0.33	TIS43	0.33	2N1613	0.22						
AD142	0.53	BC143	0.33	BD115	0.68	BF177	0.39	C444	0.39	UT46	0.30	2N1711	0.22						
AD143	0.42	BC145	0.50	BD116	0.88	BF178	0.33	C450	0.24	ZN414	£1.20	2N1889	0.35						
AD149	0.55	BC147	0.11	BD121	0.66	BF179	0.33	MAT100	0.21	2G301	0.21	2N1890	0.50						
AD161	0.37	BC148	0.11	BD123	0.72	BF180	0.33	MAT101	0.22	2G302	0.21	2N1893	0.41						
AD162	0.37	BC149	0.13	BD124	0.76	BF181	0.33	MAT120	0.21	2G303	0.21	2N2147	0.79						

DIODES AND RECTIFIERS

AA119	0.09	BY128	0.17	OA70	0.08
AA120	0.09	BY130	0.18	OA79	0.08
AA129	0.09	BY133	0.23	OA81	0.08
AAY30	0.10	BY164	0.55	OA85	0.10
AAZ13	0.11	BYX38/30	0.46	OA90	0.07
BA100	0.11	BYZ10	0.39	OA91	0.07
BA116	0.23	BYZ11	0.33	OA95	0.08
BA120	0.24	BYZ12	0.33	OA200	0.07
BA148	0.16	BYZ13	0.28	OA202	0.08
BA154	0.13	BYZ16	0.44	SD10	0.06
BA155	0.16	BYZ17	0.39	SD19	0.06
BA156	0.15	BYZ18	0.39	1N34	0.08
BA173	0.16	BYZ19	0.31	1N34A	0.08
BY100	0.17	CH62		1N914	0.06
BY101	0.13	(OA91 Eq)	0.06	1N916	0.06
BY105	0.19	CG651 (OA70-		1N4148	0.06
BY114	0.13	OA79)	0.07	1S021	0.11
BY124	0.13	OA5	0.39	1S951	0.07
BY126	0.16	OA10	0.15		
BY127	0.17	OA47	0.08		

LINEAR I.C's—FULL SPEC.

Type No.	Case		1	25	100 +
72702	DIL	14	0.50	0.48	0.45
72709	DIL	14	0.35	0.33	0.30
72710	DIL	14	0.45	0.43	0.40
72741	DIL	14	0.40	0.38	0.35
72741C	TO-5	8	0.45	0.43	0.40
72741P	DIL	8	0.38	0.36	0.34
72748P	DIL	8	0.38	0.36	0.34
SL201C	TO-5	8	0.50	0.45	0.40
SL701C	TO-5	8	0.50	0.45	0.40
SL702C	TO-5	8	0.50	0.45	0.40
TAA263	TO-72	4	0.80	0.70	0.60
TAA293	TO-74	10	£1.00	0.95	0.90
TAA350A	TO-5	10	£1.85	£1.80	£1.70
µA703C	TO-5	6	0.28	0.26	0.24
µA709C	TO-5	8	0.35	0.33	0.30
µA711	TO-5	10	0.45	0.43	0.40
EA1000	—	—	£2.00	—	—

DTL 930 SERIES LOGIC I.C's

Type	1	25	100 +
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.16	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.16	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP9093	0.45	0.43	0.40
BP9094	0.45	0.43	0.40
BP9097	0.45	0.43	0.40
BP9099	0.45	0.43	0.40

NUMERICAL INDICATOR TUBES

Type	Description	
3015F	Minitron 7 Segment Indicator	£1.50
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CD 66	Side Viewing 'Nixie Type' Tube 16 m m	£1.87
GR 116	Side Viewing 'Nixie Type' Tube 13 m m	£1.70

3 TERMINAL POSITIVE VOLTAGE REGULATORS

To3 Plastic Encapsulation O.P. 1.5 Amps.

µA7805	5V (Equiv. to MVR5V)	£1.76
µA7812	12V (Equiv. to MVR12V)	£1.76

RTL MICROLOGIC CIRCUITS

	Price each		
Epoxy TO-5 case	1-24	25-99	100 up
µL900 Buffer	39p	36p	30p
µL914 Dual 2I p gate	39p	36p	30p
µL923 J-K flip-flop	55p	52p	50p

Date and Circuits Booklet for IC's. Price 7p.

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14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL and NEW LOW COST.

TSO14	14 pin type	0.33	0.30	0.27
TSO16	16 pin type	0.38	0.35	0.32
BPS14	14 pin type (low cost) ..	0.16	0.14	0.12
BPS16	16 pin type (low cost) ..	0.17	0.15	0.13

74 Series T.T.L. I.C's

Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +
7400	0.18	0.17	0.16	7453	0.18	0.17	0.16	74153	£1.30	£1.20	£1.10
7401	0.18	0.17	0.16	7454	0.18	0.17	0.16	74154	£1.98	£1.90	£1.75
7402	0.18	0.17	0.16	7460	0.18	0.17	0.16	74155	£1.50	£1.45	£1.35
7403	0.18	0.17	0.16	7470	0.32	0.29	0.27	74156	£1.50	£1.45	£1.35
7404	0.18	0.17	0.16	7472	0.32	0.29	0.27	74157	£2.00	£1.90	£1.80
7405	0.18	0.17	0.16	7473	0.41	0.39	0.35	74160	£2.10	£2.00	£1.90
7406	03.9	0.34	0.31	7474	0.41	0.39	03.5	74161	£2.10	£2.00	£1.90
7407	0.39	0.34	0.31	7475	0.50	0.48	0.46	74162	£4.40	£4.15	£3.85
7408	0.20	0.19	0.18	7570	0.44	0.43	0.42	74163	£4.40	£4,15	£3,85
7409	0.20	0.19	0.18	7480	0.74	0.71	0.64	74164	£2.20	£2.10	£2.00
7410	0.18	0.17	0.16	7481	£1.30	£1.25	£1.20	74165	£2.20	£2.10	£2.00
7411	0.28	0.27	0.26	7482	0.96	0.95	0.94	74166	£3.20	£3.10	£3.00
7412	0.39	0.34	0.31	7483	£1.20	£1.15	£1.05	74174	£2.50	£2.40	£2.30
7413	0.32	0.31	0.30	7484	£1.10	£1.05	£1.00	74175	£1.75	£1.65	£1.55
7416	0.48	0.44	0.42	7485	£3.50	£3.40	£3.30	74176	£1.85	£1.75	£1.65
7417	0.48	0.44	0.42	7486	0.35	0.34	0.33	74177	£1.85	£1.75	£1.65
7420	0.18	0.17	0.16	7489	£4.00	£3.75	£3.50	74180	£1.50	£1.40	£1.30
7422	0.55	0.53	0.50	7490	0.74	0.71	0.64	74181	£5.00	£4.50	£4.00
7423	0.55	0.53	0.50	7491	£1.10	£1.05	£1.00	74182	£2.00	£1.90	£1.75
7425	0.55	0.53	0.50	7492	0.74	0.71	0.64	74184	£3.20	£3.10	£3.00
7426	0.50	0.46	0.44	7493	0.74	0.71	0.64	74190	£2.15	£2.10	£2.00
7427	0.50	0.46	0.44	7494	0.85	0.82	0.75	74191	£2.15	£2.10	£2.00
7428	0.55	0.53	0.50	7495	0.85	0.82	0.75	74192	£2.15	£2.10	£2.00
7430	0.18	0.17	0.16	7496	0.96	0.93	0.86	74193	£2.15	£2.10	£2.00
7432	0.50	0.46	0.44	74100	£1.50	£1.45	£1.40	74194	£2.98	£2.86	£2.75
7433	0.75	0.73	0.70	74104	£1.07	£1.04	£1.00	74195	£2.00	£1.95	£1.90
7437	0.70	0.68	0.65	74105	£1.07	£1.04	£1.00	74196	£1.95	£1.90	£1.85
7438	0.70	0.68	0.65	74107	0.44	0.42	0.40	74197	£1.95	£1.90	£1.85
7440	0.18	0.17	0.16	74110	0.60	0.55	0.50	74198	£5.00	£4.75	£4.50
7441	0.74	0.71	0.64	74111	£1.38	£1.27	£1.21	74199	£5.00	£4.75	£4.50
7442	0.74	0.71	0.64	74118	£1.10	£1.05	£1.00				
7443	£1.20	£1.15	£1.10	74119	£1.50	£1.40	£1.30				
7444	£1.20	£1.15	£1.10	74121	0.50	0.48	0.45				
7445	£1.98	£1.95	£1.90	74122	£1.50	£1.45	£1.40				
7446	£1.20	£1.15	£1.10	74123	£3.00	£2.90	£2.80				
7447	£1.10	£1.07	£1.05	74141	0.85	0.82	0.79				
7448	£1.10	£1.07	£1.05	74145	£1.65	£1.55	£1.45				
7450	0.18	0.17	0.16	74150	£2.90	£2.80	£2.70				
7451	0.18	0.17	0.16	74151	£1.10	£1.05	£1.00				

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Pak	No.		EQVT
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T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 55p each pak

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Suitable replacement for BSX 21, C 407, 2N 1893 120vcb.

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AD161 162 *PNP*

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Q 5	4	OC75 transistors	0.55
Q 6	5	OC72 transistors	0.55
Q 7	4	AC128 transistors *pnp* high gain	0.55
Q 8	4	AC126 transistors *pnp*	0.55
Q 9	7	OC81 type transistors	0.55
Q10	7	OC71 type transistors	0.55
Q11	2	AC127/128 Complementary pairs *pnp npn*	0.55
Q12	3	AF116 type transistors	0.55
Q13	3	AF117 type transistors	0.55
Q14	3	OC171 H.F. type transistors	0.55
Q15	7	2N2926 Sil. Epoxy transistors mixed colours	0.55
Q16	2	GET880 low noise Germanium transistors	0.55
Q17	5	*npn* 2 × ST.141 & 3 × ST.140	0.55
Q18	4	MADT'S 2 × MAT 100 & 2 × MAT 120	0.55
Q19	3	MADT'S 2 × MAT 101 & 1 × MAT 121	0.55
Q20	4	OC44 Germanium transistors A.F.	0.55
Q21	4	AC127 *npn* Germanium transistors	0.55
Q22	20	NKT transistors A.F. R.F. coded	0.55
Q23	10	OA202 Silicon diodes sub-min.	0.55
Q24	8	OA81 diodes	0.55
Q25	15	1N914 Silicon diodes 75PIV 75mA	0.55
Q26	8	OA95 Germanium diodes sub-min 1N69	0.55
Q27	2	10A 600 PIV Silicon rectifiers 1S425R	0.55
Q28	2	Silicon power rectifiers BYZ13	0.55
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0.55
Q30	7	Silicon switch transistors 2N706 *npn*	0.55
Q31	6	Silicon switch transistors 2N708, *npn*	0.55
Q32	3	*pnp* Silicon transistors 2 × 2N1131, 1 × 2N1132	0.55
Q33	3	Silicon *npn* transistors 2N1711	0.55
Q34	7	Silicon *npn* transistors 2N2369, 500MHz (code P397)	0.55
Q35	3	Silicon *pnp* TO-5, 2 × 2N2904 & 1 × 2N2905	0.55
Q36	7	2N3646 TO-18 plastic 300MHz *npn*	0.55
Q37	3	2N3053 *npn* Silicon transistors	0.55
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U 2	60	Mixed Germanium Transistors AF/RF	0.55
U 3	75	Germanium Gold Bonded Sub-Min. like OA5, OA47	0.55
U 4	40	Germanium Transistors like OC81, AC128	0.55
U 5	60	200mA Sub-Min. Silicon Diodes	0.55
U 6	30	Sil. Planar Trans. NPN like BSY95A, 2N706	0.55
U 7	16	Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0.55
U 8	50	Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0.55
U 9	20	Mixed Voltages, 1 Watt Zener Diodes	0.55
U10	20	BAY50 charge storage Diodes DO-7 Glass	0.55
U11	25	PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0.55
U12	12	Silicon Rectifiers Epoxy 500mA up to 800 PIV	0.55
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U15	25	NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0.55
U16	10	3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0.55
U17	30	Germanium PNP AF Transistors TO-5 like ACY 17–22	0.55
U18	8	6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0.55
U19	25	Silicon NPN Transistors like BC108	0.55
U20	12	1.5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0.55
U21	30	AF. Germanium Alloy Transistors 2G300 Series & OC71	0.55
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U24	20	Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0.55
U25	25	300MHz NPN Silicon Transistors 2N708, BSY27	0.55
U26	30	Fast Switching Silicon Diodes like 1N914 Micro-Min.	0.55
U27	12	NPN Germanium AF Transistors TO-1 like AC127	0.50
U29	10	1 Amp SCR's TO-5 can. up to 600 PIV CRS1/25-600	1.15
U30	15	Plastic Silicon Planar Trans. NPN 2N2926	0.55
U31	20	Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0.55
U32	25	Zener Diodes 400mW DO-7 case 3–18 volts mixed	0.55
U33	15	Plastic Case 1 Amp Silicon Rectifiers 1N4000 Series	0.55
U34	30	Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0.55
U35	25	Silicon Planar Transistors PNP TO-18 2N2906	0.55
U36	25	Silicon Planar NPN Transistors TO-5 BFY50/51/52	0.55
U37	30	Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0.55
U38	20	Fast Switching Silicon Trans. NPN 400MHz 2N3011	0.55
U39	30	RF. Germ.-PNP Transistors 2N1303/5 TO-5	0.55
U40	10	Dual Transistors 6 lead TO-5 2N2060	0.55
U41	25	Germanium Transistors TO-5, OC45, NKT72	0.55
U42	10	VHF Germanium PNP Transistors TO-1 NKT667, AF117	0.55
U43	25	Sil. Trans. Plastic TO-18 A.F. BC113/114	0.55
U44	20	Sil. Trans. Plastic TO-5 BC116/NPN	0.55
U45	7	3A SCR. TO66 up to 600PIV	1.10

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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ZENER DIODES
400mW (DO-7 Case), range 2–33V. **12p** each. 1.5W (Top-Hat), range 2–33V. **18p** each. 10W (SO 10 Stud), range 2–33V. **32p** each.

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 × 7400	0.55	UIC46	5 × 7446	0.55	UIC86	5 × 7486	0.55
UIC01	12 × 7401	0.55	UIC47	5 × 7447	0.55	UIC90	5 × 7490	0.55
UIC02	12 × 7402	0.55	UIC48	5 × 7448	0.55	UIC91	5 × 7491	0.55
UIC03	12 × 7403	0.55	UIC50	12 × 7450	0.55	UIC92	5 × 7492	0.55
UIC04	12 × 7404	0.55	UIC51	12 × 7451	0.55	UIC93	5 × 7493	0.55
UIC05	12 × 7405	0.55	UIC53	12 × 7453	0.55	UIC94	5 × 7494	0.55
UIC06	8 × 7406	0.55	UIC54	12 × 7454	0.55	UIC95	5 × 7495	0.55
UIC07	8 × 7407	0.55	UIC60	12 × 7460	0.55	UIC96	5 × 7496	0.55
UIC10	12 × 7410	0.55	UIC70	8 × 7470	0.55	UIC100	5 × 74100	0.55
UIC13	8 × 7413	0.55	UIC72	8 × 7472	0.55	UIC121	5 × 74121	0.55
UIC20	12 × 7420	0.55	UIC73	8 × 7473	0.55	UIC141	5 × 74141	0.55
UIC30	12 × 7430	0.55	UIC74	8 × 7474	0.55	UIC151	5 × 74151	0.55
UIC40	12 × 7440	0.55	UIC75	8 × 7475	0.55	UIC154	5 × 74154	0.55
UIC41	5 × 7441	0.55	UIC76	8 × 7476	0.55	UIC193	5 × 74193	0.55
UIC42	5 × 7442	0.55	UIC80	5 × 7480	0.55	UIC199	5 × 74199	0.55
UIC43	5 × 7443	0.55	UIC81	5 × 7481	0.55			
UIC44	5 × 7444	0.55	UIC82	5 × 7482	0.55	UICX1—25 Assorted 74's		1.65
UIC45	5 × 7445	0.55	UIC83	5 × 7483	0.55			

Paks cannot be split, but 25 assorted pieces (our mix) is available as **PAK UIC X1.**

NEW LOW PRICED TESTED S.C.R.'s

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0.22	0.27	0.39	0.39	0.52	0.55	0.58	£1.27
100	0.27	0.27	0.52	0.52	0.55	0.63	0.62	£1.54
200	0.27	0.32	0.54	0.54	0.62	0.67	0.67	£1.76
400	0.32	0.42	0.59	0.62	0.67	0.83	0.77	£1.93
600	0.42	0.52	0.75	0.75	0.84	£1.07	0.97	—
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50	0.05	0.06	0.05	0.08	0.15	0.21	0.60
100	0.05	0.07	0.06	0.10	0.17	0.23	0.75
200	0.06	0.10	0.07	0.12	0.22	0.25	£1.00
400	0.08	0.15	0.08	0.15	0.30	0.38	£1.35
600	0.09	0.17	0.10	0.18	0.36	0.45	£1.90
800	0.12	0.19	0.11	0.20	0.38	0.55	£2.10
1000	0.14	0.30	0.12	0.25	0.48	0.65	£2.50
1200	—	0.35	—	0.30	0.58	0.75	£3.00

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FOR USE WITH TRIACS
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10 Amp	0.83	0.99	1.21

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115 WATT SIL POWER NPN
55p EACH

2 Amp. BRIDGE RECTS.

50 v RMS	35p each
100 v RMS	41p "
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(Similar to 2N2060)

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Coils DRX1 Crystal set 56p; DRR2 Dual range 45p

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BA5	4"	x	2¼"	x	2"	41p
BA6	3"	x	2"	x	1"	34p
BA7	7"	x	5"	x	2½"	60p
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Model 42 £1.84

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Ref. 43	Record Care Kit	£2.35
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Ref. 32	Tape editing Kit	£1.54
Model 9	Wire stripper cutter	83p
Ref. P	Hi-Fi Cleaner	31p
Ref. 32A	Stylus Balance	£1.36
Ref. J	Tape Head Cleaning Kit ..	51p
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Model G 18 watt £2.15 SK2 Soldering kit £2.86

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ST1 .. .. £1.21 ST2 .. .. 77p

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18SWG Multicore 7 oz 82p 22SWG 7 oz. 82p
18SWG 22 ft. .. 28p 22SWG Tube 22p

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1101	For model CCN240 ⅛"	28p
1102	For model CCN240 ¼"	28p
1020	For model G240 ⅛"	28p
1021	For model G240 ⅛"	28p
1022	For model G240 ⅛"	28p
50	For model X25 ⅛"	37p
51	For model X25 ⅛"	37p
52	For model X25 ⅛"	37p

ELEMENTS
ECN 240 .. £1.16 ECCN 140 .. £1.16
EG 240 .. £1.16 EX 25 .. £1.16

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C 2	200	Capacitors mixed values approx, count by weight ..	0.55
C 3	50	Precision Resistors .1%, .01% mixed values	0.55
C 4	75	⅛th W Resistors mixed preferred values	0.55
C 5	5	Pieces assorted Ferrite Rods	0.55
C 6	2	Tuning Gangs, MW LW VHF	0.55
C 7	1	Pack Wire 50 metres assorted colours	0.55
C 8	10	Reed Switches	0.55
C 9	3	Micro Switches	0.55
C10	15	Assorted Pots and Pre-Sets ..	0.55
C11	5	Jack Sockets 3 - 3.5m 2 - Standard Switch Types ..	0.55
C12	40	Paper Condensers preferred types mixed values ..	0.55
C13	20	Electrolytics Trans. types ..	0.55
C14	1	Pack assorted Hardware – Nuts Bolts, Grommets etc.	0.55
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C16	20	Assorted Tag Strips & Panels	0.55
C17	10	Assorted Control Knobs ..	0.55
C18	4	Rotary Wave Change Switches	0.55
C19	3	Relays 6-24V Operating ..	0.55
C20	4	Sheets Copper Laminate approx. 10" × 7"	0.55

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19 and C20.

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PS39	Jack 2.5mm Switched ..	0.09
PS40	Jack 3.5mm Switched ..	0.10
PS41	Jack ¼" Switched	0.17
PS42	Jack Stereo Switched ..	0.26
PS43	Phono Single	0.06
PS44	Phono Double	0.10
PS45	Car Aerial	0.09
PS46	Co-Axial Surface	0.09
PS47	Co-Axial Flush	0.14

INLINE SOCKETS

PS21	DIN 2 Pin (Speaker)	0.13
PS22	DIN 3 Pin	0.17
PS23	DIN 5 Pin 180°	0.17
PS24	DIN 5 Pin 240	0.17
PS25	Jack 2.5mm Plastic ..	0.10
PS26	Jack 3.5mm Plastic ..	0.12
PS27	Jack ¼" Plastic	0.24
PS28	Jack ¼" Screened	0.28
PS29	Jack Stereo Plastic ..	0.22
PS30	Jack Stereo Screened ..	0.32
PS31	Phono Screened	0.14
PS32	Car Aerial	0.15
PS33	Co-Axial	0.17

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PS 1	DIN 2 Pin (Speaker)	0.11
PS 2	DIN 3 Pin	0.12
PS 3	DIN 4 Pin	0.15
PS 4	DIN 5 Pin 180	0.14
PS 5	DIN 5 Pin 240	0.15
PS 6	DIN 6 Pin	0.15
PS 7	DIN 7 Pin	0.15
PS 8	Jack 2.5mm Screened ..	0.10
PS 9	Jack 3.5mm Plastic ..	0.06
PS10	Jack 3.5mm Screened ..	0.12
PS11	Jack ¼" Plastic	0.13
PS12	Jack ¼" Screened	0.18
PS13	Jack Stereo Screened ..	0.29
PS14	Phono	0.06
PS15	Car Aerial	0.15
PS16	Co-Axial	0.10

CABLES

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CP 2	Twin Common Screen ..	0.08
CP 3	Stereo Screened	0.08
CP 4	Four Core Common Screen ..	0.23
CP 5	Four Core individually Screened	0.30
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CP 7	Three core mains cable ..	0.07
CP 8	Twin oval mains cable ..	0.06
CP 9	Speaker Cable	0.04
CP10	Low Loss Co-Axial	0.10

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Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC1	Single less Switch	0.14
VC2	Single D.P. Switch	0.26
VC3	Tandem Less Switch	0.44
VC4	1K Lin Less Switch	0.14
VC5	100K Log anti-Log	

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0.1 watt 0.06
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	Resistor Colour Code Disc Calculator	10p

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ACOS	GP91 1SC	200mV at 1.2cms/sec	£1.16
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	GP96 1	100mV at 1cm sec ..	£2.65
TTC	J-2005	Crystal/Hi Output ..	95p
	J-20 10C	Crystal/Hi Output Compatible ..	£1.10
	J-200 CS	Stereo/Hi Output ..	£1.60
	J-2105	Ceramic/Med Output	£1.64

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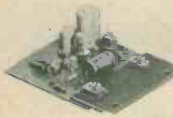
AL10 AL20 AL30
AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	Po=3 WATTS f 1 KHz	0.25%
LOAD IMPEDANCE	—	8 - 16Ω
INPUT IMPEDANCE	f=1KHz	100 KΩ
FREQUENCY RESPONSE ±3 dB	Po 2 WATTS	50 Hz - 25 KHz
SENSITIVITY for RATED O/P	Vs 25V. RL 8Ω f 1KHz	75mV. RMS
DIMENSIONS	—	3" × 2½" × 1"

The above table relates to the AL10. AL20 and AL30 modules.
The following table outlines the differences in their working conditions.

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL 8Ω f 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL10	3 Watts	£2.19
AL20	5 Watts	£2.59
AL30	10 Watts	£3.01

PRE-AMPLIFIERS

PA 12	(Use with AL10 & AL20)	£4.35
PA100	(Use with AL30 & AL50)	£13.15

POWER SUPPLIES

PS12	(Use with AL10 & AL20)	88p
SPM80	(Use with AL30 & AL50)	£3.25

TRANSFORMERS

T461	(Use with AL10) p&p 15p	£1.38
T538	(Use with AL20) p&p 15p	£1.93
BMT80	(Use with AL30 & AL50) p&p 25p	£2.15

FRONT PANELS PA 12 With knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response
20Hz–50KHz (-3dB)
Bass control
±12dB at 60Hz
Treble control
±14dB at 14 KHz
*Input 1.
Impedance 1 Meg. ohm.
Sensitivity 300 mV
†Input 2.
Impedance 30 K ohms
Sensitivity 4 mV

EA1000 AUDIO AMP MODULE

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Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

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The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer. Power supply and Power Amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (er.) 300mV into 1M
Freq. res. 25Hz–25kHz	Input 2 (Aux.) 4 mV into 30K
Harmonic distortion typically 0.25% at 1 watt	Bass control ±12bB at 60 Hz.
	Treble con. ±14bB at 14 kHz

£13.48

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50W pk 25w (RMS)
0.1% DISTORTION
HI-FI AUDIO AMPLIFIER
THE AL50

- ★ Frequency response 15Hz to 100,000 - 1dB.
- ★ Load - 3, 4, 8 or 16 ohms.
- ★ Distortion - better than .1% at 1KHz.
- ★ Signal to noise ratio 80dB.
- ★ Supply voltage 10 - 35 Volts.
- ★ Overall size 63mm x 105mm x 13mm.

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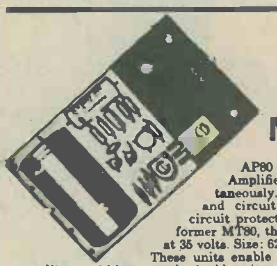
Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs. FULLY BUILT - TESTED - GUARANTEED.

STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 62mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Add ~~es, Intercom Units etc. Handbook available 10p.

PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques.

Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz — 20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50KΩ
2. Radio, Tuner	35 mV into 50KΩ
3. Magnetic P.U.	1.5 mV into 50KΩ

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.

Base Control	± 15dB @ 20Hz	Treble Control	± 15dB @ 20KHz
Filters: Rumble (High Pass)	100Hz		
Scratch (Low Pass)	8KHz		
Signal/Noise Ratio	better than — 65dB		
Input overload	+ 26dB	Supply	+ 35 volts @ 20mA
Dimensions	292mm × 82mm × 35mm		

Price £13.15

SPECIAL COMPLETE KIT COMPRISING
2 AL50's, 1 SPM80, 1 BMT80 and 1 PA100 ONLY **£25.30** FREE p & p.

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Assembly time is about 3 hours.

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5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
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If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

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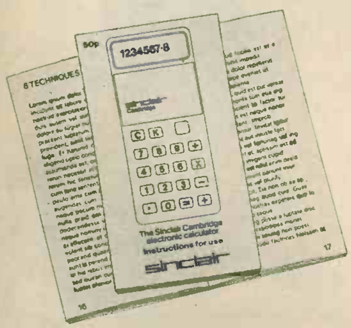

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Price fully built: £29·95 + £3·00 VAT. (Total: £32·95)

REC 1073

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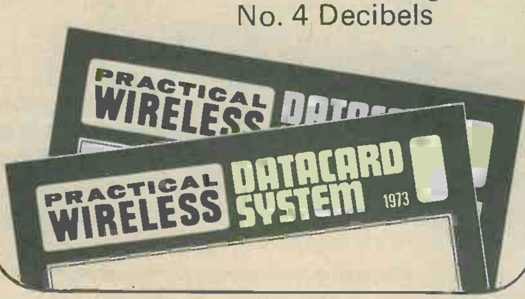

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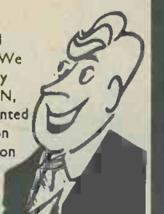

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RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER 1973

Vol. 27 No. 3

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141

Telegrams Databux, London

Annual Subscription: £2.70 (U.S.A. and Canada $7.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production.—Web Offset.

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Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London, W9 1SN

The *Radio & Electronics Constructor* is printed by Carlisle Web Offset.

NOVEMBER ISSUE WILL BE PUBLISHED ON NOVEMBER 1st

A. F. OSCILLATOR

by J. R. Davies

This simple oscillator offers a wide range of applications and may be readily assembled on the Veroboard panel which is given free with this month's issue.

We are presenting a free Veroboard panel in this issue for the benefit of constructors and experimenters. The board is of 0.15 in. matrix and has 7 copper strips, each with 16 holes. Readers may wish to assemble their own designs on the board but, for the benefit of those who prefer to work to published information, we are offering two different circuits, either of which can be assembled on the board. The first of these is a simple but versatile a.f. oscillator, and this is described in the present article. A more complex design, for a 200mW gram amplifier, appears elsewhere in this issue.

Readers who have not worked with Veroboard before will find that it is a product which allows very easy assembly to take place and which gives an impressive appearance to any project constructed with its aid. Soldering to the copper strips is extremely simple to carry out, as these are already pre-fluxed. A small soldering iron of around 15 to 20 watts rating is required and it is essential that a radio-type resin-cored solder be employed. Suitable solders are Ersin Multicore or Savbit. *Never* use a paste or liquid flux, as this will leave a harmful residue.

THE OSCILLATOR

The circuit of the oscillator appears in Fig. 1, and it consists of a 2N2646 unijunction transistor, TR1, which operates as a relaxation oscillator and is followed by an AD161 power transistor in the TR2 position.

The oscillator functions in the following manner. When points 'X' and 'Y' in the circuit are connected together, capacitor C1 commences to charge via R1, whereupon its upper terminal goes increasingly positive. At a certain voltage level the base material between the emitter and base 1 of the unijunction transistor suddenly exhibits a negative resistance effect and C1 discharges rapidly into the components connected in the base 1 circuit. The negative resistance effect ceases when C1 is nearly fully discharged, and no further current flows into the emitter of the transistor. Because of this, the capacitor commences to charge once more and the process is repeated again. As a result, a series of sharp high current pulses appear in the base 1 circuit of the transistor. With the values specified for C1 and R1 these pulses have a repetition frequency of around 400Hz and therefore constitute an audio frequency tone.

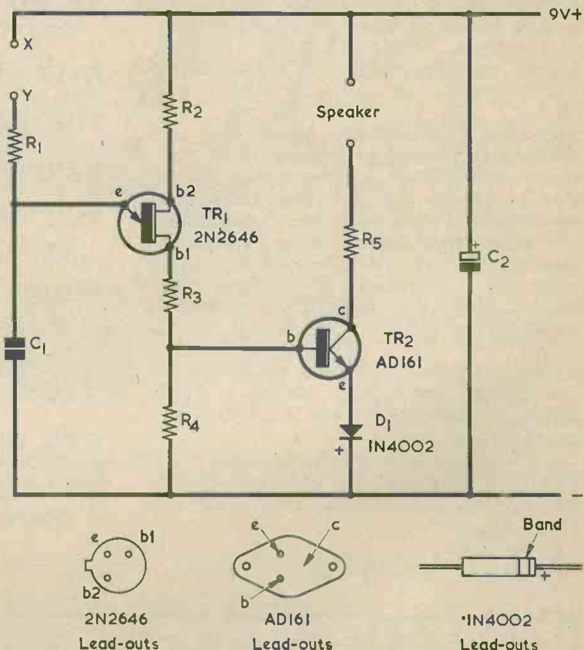


Fig. 1. The circuit of the a.f. oscillator unit. This consists of a unijunction transistor relaxation oscillator and a power switching transistor

The pulses at the base 1 of TR1 flow through the current limiting resistor R3, the base-emitter junction of TR2 and the silicon diode D1. TR2 is turned hard on for at least part of the duration of each pulse, whereupon it causes a relatively high current to flow in a speaker connected to the output terminals.

The function of R4 and D1 is to ensure that TR2 is nearly fully cut off between pulses, whereupon this transistor acts virtually as a switch which continually opens and closes at the frequency of 400Hz. A small standing current flows between the base 2 and base 1 of the unijunction transistor between pulses, and this causes a small voltage to be built up across R4. However, due to the presence of D1 no base current can flow in TR2 until the voltage across R4 is in excess of 0.75 volt, this figure being the sum of the 0.6 forward voltage drop in D1 and the 0.15 forward voltage drop in the base-emitter junction of TR2. Thus, TR2 is only made fully conductive when current pulses are fed to it by TR1.

TR2 is a germanium power transistor. A power transistor is employed here because the collector current passed at pulse peaks can be relatively high, and a smaller transistor might break down. The average dissipation in TR2 is low and there is no need for it to be mounted on a heat sink. It is because of the high peak currents in the collector circuit that R5 is specified as a wire-wound resistor. The average heat dissipated in this component is similarly low.

R1, R2, R3 and R4 are miniature ¼ watt resistors having a nominal body length of 8 mm. (0.32 in.) and a nominal body diameter of 2.8mm (0.11 in.). C1 is a Mullard Miniature Foil capacitor type C280 and C2 is a Mullard Miniature electrolytic capacitor.

The current drawn by the oscillator from the 9 volt supply is approximately 14mA when the output is coupled to a 3Ω loudspeaker, and is about 6mA when the output is coupled to a 25Ω loudspeaker.

COMPONENTS

Resistors
(All values ¼ watt miniature 10% unless otherwise stated)

R1	22kΩ
R2	470Ω
R3	100Ω
R4	680Ω
R5	2.7 or 3Ω wire-wound, 2½ or 3 watt

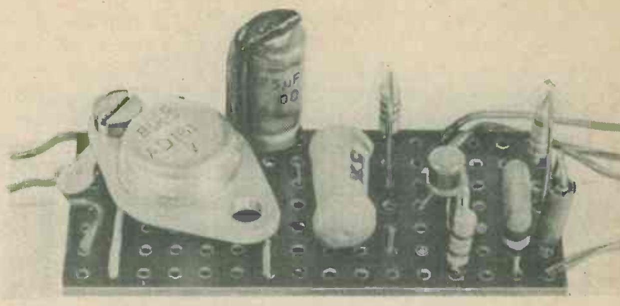
Capacitors

C1	0.1μF Mullard Miniature Foil type C280
C2	125μF 10V Wkg., Mullard Miniature electrolytic

Semiconductors

TR1	2N2646
TR2	AD161
D1	IN4002

Miscellaneous
Veroboard, 0.15 in. matrix, 7 strips by 16 holes
4BA solder tag
4BA nut and bolt
9 volt battery
Battery connector clips
Sleeving



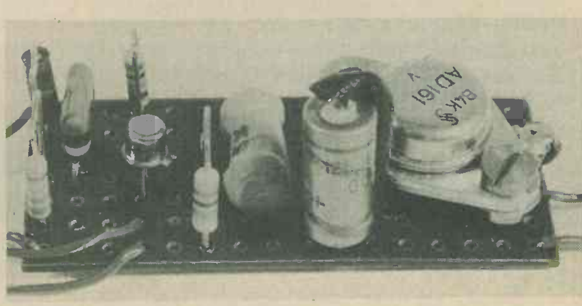
Side view of the completed oscillator unit. The 4BA solder tag secured to the case of TR2 is clearly visible here

APPLICATIONS

The oscillator can be connected to any moving-coil loudspeaker. The loudness of the audible tone varies with the impedance of the speaker, and decreases as the impedance increases. If a loud tone is required a 3Ω speaker should be coupled to the output. A quieter tone is given when speakers of 25Ω or 35Ω impedance are so connected.

The unit has a number of applications, some of which will next be discussed. These are illustrated in Figs. 2(a) to (d).

Fig. 2(a) shows the oscillator employed for Morse practice. The Morse key connects between points 'X' and 'Y'. A similar method of connection is used in Fig. 2(b) in which the oscillator is employed as an audible continuity tester. This enables complicated circuits to be traced through without the user having to deflect his eyes towards a meter needle. With the circuit of Fig. 2(b), some amusing and instructive effects can also be provided by connecting different values of resistance between points 'X' and 'Y', and it will be found that the frequency of oscillation falls as the resistance between these two points increases. With the prototype unit, oscillation was maintained for resistances up to 2MΩ across points 'X' and 'Y', the output with this value of resistance being evident as a series of discrete 'clicks' appearing at a frequency of approximately 3Hz. However, the performance given at very high values of resistance across points 'X' and 'Y' may vary somewhat with different specimens of the unijunction transistor specified. It should be found that oscillation at a low frequency is given when the bared



The assembled oscillator, as seen from the other side

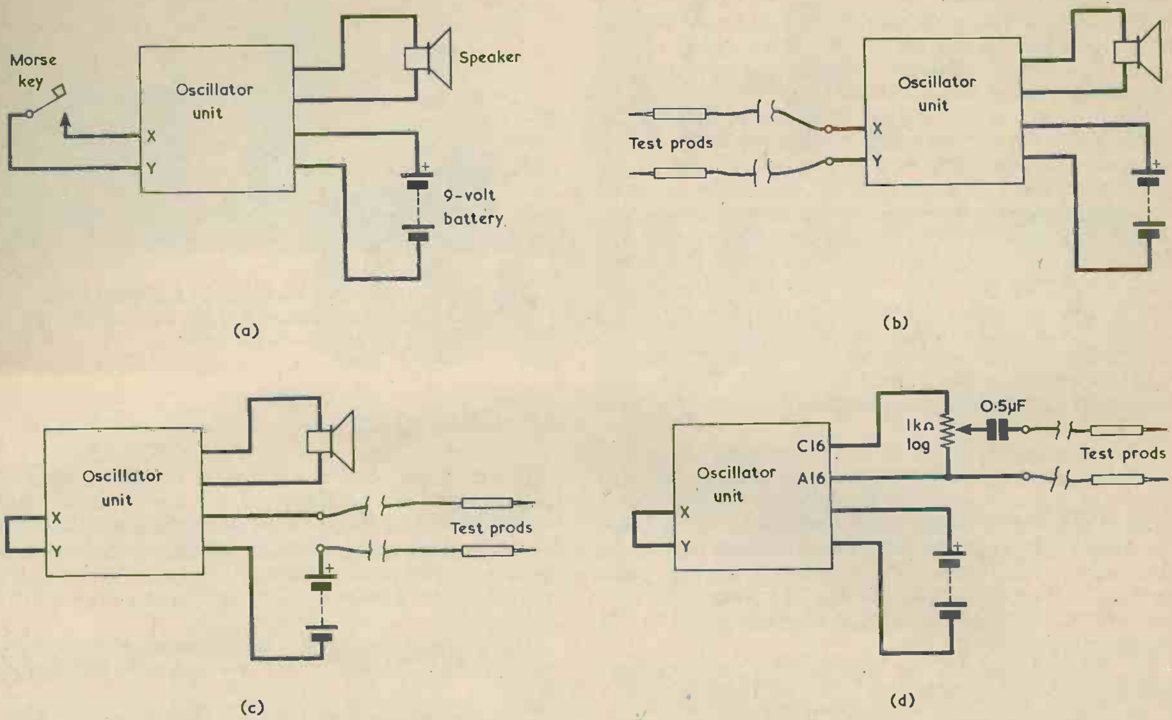


Fig. 2 (a). The unit lends itself readily to use as a Morse practice oscillator.
(b). Set-up for an audible continuity tester which is capable, also, of producing a number of interesting effects
(c). An alternative audible continuity test circuit which responds to lower values of resistance
(d). The oscillator employed as an a.f. signal injector. The external 1kΩ potentiometer functions as an attenuator and is connected to the Veroboard holes indicated

ends of the wires from points 'X' and 'Y' are held in the hands, the resistance here being given by the resistance of the body. If points 'X' and 'Y' are connected to a photoconductive cell type ORP12 the frequency of oscillation will vary according to the light level illuminating the cell.

The fact that the arrangement of Fig. 2(b) gives audible results when quite high values of resistance are applied to points 'X' and 'Y' may make it unattractive as an audible continuity tester for some constructors. An alternative approach consists of short-circuiting points 'X' and 'Y' and putting the test prods in series with the battery, as in Fig. 2(c). The oscillator will then operate, when used with a 3Ω speaker, for test resistances up to around 5kΩ, the amplitude of oscillation decreasing as resistance increases.

Yet a further application consists of employing the oscillator as an a.f. signal injector. In this case the speaker is replaced by a 1kΩ log potentiometer, which functions as an attenuator. The arrangement is shown in Fig. 2(d). Other uses will, doubtless, suggest themselves to the reader.

ASSEMBLY

Assembly is carried out following the layout diagram of Fig. 3, which shows the component and copper sides of the Veroboard.

First, using a Vero spot face cutter or a twist drill of suitable size, cut the copper strips at holes B5, B10, C7, D7, E5 and F7.

Next, fit a bare wire link between holes E6 and F6. Fit a second bare wire link between holes B9 and C9. Fit an insulated wire link between holes B15 and G15. Fit R1 to holes B1 and D1, R3 to holes E1 and F1, R4 to holes F4 and G4, and R2 to holes A6 and C6. All these components are fitted vertically. So also is C2, which comes next. It is necessary to pass a length of sleeving over the negative lead-out of C2, which passes through hole B11. The sleeving prevents this lead-out from coming into contact with the case of TR2 when the latter is, later, fitted. The negative lead-out of C2 is that which is common with its can. The positive lead-out of C2 passes through hole A10.

Next, fit capacitor C1 to holes D2 and G2, resistor R5 between holes B8 and F8 and diode D1 between holes D10 and G10. These last two components are mounted horizontally, and the positive lead-out of D1 is at hole G10. Follow by fitting transistor TR1 to holes C4, D5 and E4 in the manner illustrated. Fig 3 shows the position taken up by the locating lug of this transistor, and this point will assist in fitting it into circuit correctly.

Next connect two flexible insulated leads to holes A16 and C16. These will later connect to the speaker.

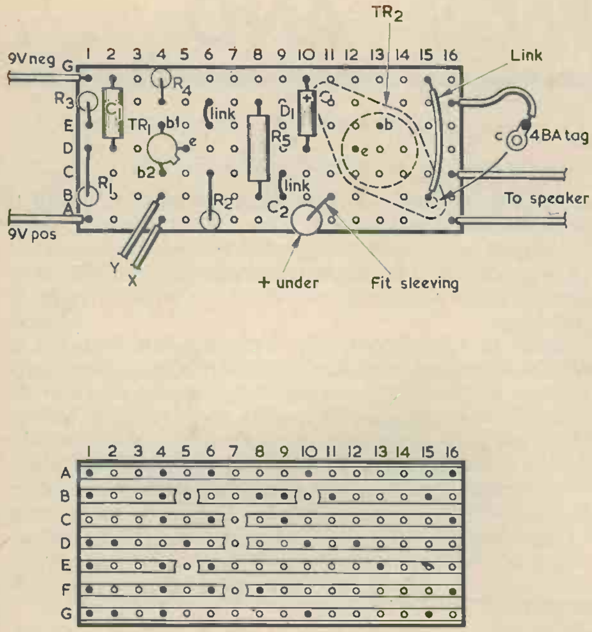


Fig. 3. The component and copper sides of the Veroboard assembly

Connect two more flexible insulated wires to holes A4 and B4. These provide the 'X' and 'Y' terminal points. Two more flexible leads connect to holes A1 and G1, that at A1 being the positive battery lead and that at G1 being the negative battery lead. All the flexible leads may have any convenient length. The two battery leads are next terminated in battery connector clips, observing correct polarity. The battery should not, however, be connected yet.

Take up a 4BA solder tag and solder a short length of thin flexible insulated wire to it. Secure this tag to transistor TR2 with a *short* 4BA bolt and nut at the end further away from the emitter and base lead-outs. Pass the base lead-out of TR2 through hole E13 and the emitter lead-out through hole D12. The transistor stands well off the upper surface of the board so that there is adequate clearance between the lower end of the 4BA bolt and the previously fitted link wire at hole B15. In most instances, it will be found best to pass the base and emitter lead-outs just sufficiently far through the board for their ends to be capable of being reliably soldered to the copper strips. The transistor will be held in position quite securely by this method of mounting.

Next, shorten the flexible lead from the 4BA solder tag as necessary, then fit its end at hole F16. For clarity, the 4BA nut and bolt are omitted in Fig. 3, but they are clearly visible in the accompanying photographs.

Assembly of the oscillator unit is now complete. Visually check both the component and copper sides of the board to ensure that component positioning is correct and that all solder joints have been reliably made. It is particularly important to ensure that no 'blobs' of solder have caused adjacent strips of copper to be short-circuited together.

The oscillator is now complete and ready for use. ■

RECENT PUBLICATIONS

SOLID-STATE PROJECTS FOR THE EXPERIMENTER. Edited by Wayne Green.
230 pages, 132 x 215 mm. (5¼ x 8½ in.) Published by Foulsham-Tab Ltd. Price £1.20.

This title is in the Foulsham-Tab list and consists of an American text with an added introductory chapter for the English reader. The address of the English publishers is Foulsham-Tab Ltd., Yeovil Road, Slough, Bucks.

The book consists of items which have already appeared in the American *73 Magazine,* and will in consequence hold greatest interest for the short wave listener and the amateur transmitting enthusiast. 60 projects are described in the book, these falling into the categories: receivers and converters, transmitters, test equipment, and power supplies. They are preceded by an introductory section devoted to solid-state principles and practice.

As each chapter in the book was originally a magazine article, or part of a magazine article, it remains an entity within itself. The more experienced amateur should find quite a lot of interest in this *pot-pourri,* and can dip into any section at will.

The following books, all with the same format, are also published by Foulsham-Tab Ltd.

125 ONE-TRANSISTOR PROJECTS. By Rufus P. Turner.
198 Pages. Price £1.30.

This book gives circuits incorporating a single transistor plus other components. The 125 projects described include a.f., r.f. and d.c. amplifiers, oscillators, control and alarm devices, test instruments, power supplies, receivers and transmitters.

104 EASY PROJECTS FOR THE ELECTRONICS GADGETEER. By Robert M. Brown.
166 Pages. Price £1.20.

The projects covered in this book are all in the simple category and take advantage of the properties of diodes, neon lamps, relays and similar passive components.

USING ELECTRONIC TESTERS FOR CAR TUNE-UP. By Albert Wanninger.
262 pages. Price £1.20.

Although the test equipment dealt with here is of American origin, similar instruments are, in general, available in the U.K. The tests themselves are, of course, applicable in all parts of the world, and this book covers the complete ground from checking battery acid specific gravity to advanced tune-up analysis.

NEWS . . . AND .

LABORATORY OSCILLOSCOPE

The Meteronic Type 201 dual trace 15 MHz Oscilloscope offers an unusually wide range of features for a portable instrument.

Plug-in time base and amplifier modules allow the user to select the configuration best suited to his needs and an internal voltage and time calibration signal is provided.

Sensitivity is 5mV/div at full bandwidth and the fastest sweep speed is 100 nS/div. TTL trigger circuits operate to 20 MHz and triggering may be from either channel or external. The display mode may be either A, B; A & B chopped or A & B alternate. A battery option is soon to be available.

The instrument weighs only 3.5 kgms and measures 111 mm × 260 mm × 222 mm. The U.K. list price is £170.

BRINGING SHAKESPEARE TO LIFE

The Royal Shakespeare Company's Theatre at Stratford-upon-Avon uses BASF tapes for all sound effects in its productions.

The complexity of sound cues needs sophisticated studio equipment.

For example, in a production of 'The Tempest' the audience was greeted upon entering the auditorium by the sound of waves gently lapping on a beach, to get them in the 'right mood'.

This was achieved by switching various banks of speakers, placed at strategic intervals, around the auditorium, in and out as directed by the cue sheet.

Within the theatre there are 46 speakers and 4 stereo decks which can all be played simultaneously. They are controlled by an 8 channel mixer which enables the sound controller to create the most realistic effects at the pull of a lever.

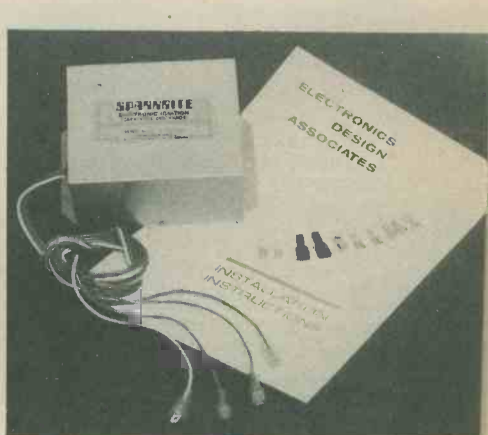
HOT PAINTS

A paint which will transform a wall into a heating panel radiating warmth is now available commercially here in Britain, and also in Denmark, Italy and Japan. France and Finland will have it soon.

The paint, explained the BBC, was invented several years ago by the Paint Research Association, a British-based organisation which has members in many countries.

The paint gives out warmth when an electric current is passed through it, and there is no significant risk either of electric shock (the voltage is very low) or of fire since the painted surface need only be a few degrees warmer than the room it heats.

EASY TO INSTALL ELECTRONIC IGNITION SYSTEM



From the makers of Gunton Electronic Ignition, comes a new product called SPARKRITE. This highly developed electronic ignition system incorporates a short circuit proof inverter to prevent SCR lock on, improved radio interference suppression filter and a trigger circuit with a positive feedback clamp circuit from output of the unit, as well as the usual benefits of electronic ignition, which when fitted (can be done in 15 mins) produces a higher energy spark and thereby creates more efficient combustion giving faster acceleration, higher top speed, continual peak performance, reduced fuel consumption, longer spark plug and contact breaker life etc. Designed for all petrol engines, the unit costs £11.55 incl. V.A.T. and carriage and is guaranteed for 5 years, or £9.35 incl. V.A.T. and carriage in kit form. For further details contact: Electronics Design Associates, 82, Bath Street, Walsall. WS1 3DE.

. . . COMMENT

RADIO COMMUNICATIONS –A 75TH BIRTHDAY

The BBC's station identification – based on the Morse code for the letter V – was, in fact, used much earlier in radio communication. Seventy-five years ago, a series of V's were received by a man sitting in a coal-merchant's yard in Ballycastle, a little town on the coast of Northern Ireland.

The man was George Kemp, senior assistant to radio pioneer Guglielmo Marconi, and the occasion was the first practical use of radio for communications.

The signals were being transmitted from Rathlin Island, four miles offshore, to inform shipping and insurance interests about the movement of vessels passing north of the island. The messages, which were sent on to London by telegraph, had previously been passed by flags, which proved difficult in bad weather.

To commemorate this occasion, radio amateurs operated a radio station in a local school.

A sculpture is also to be unveiled on the seafront at Ballycastle, but visitors wishing to see the site of the transmitter will have to travel by the same type of small open boat that was in use 75 years ago – the radio communications have improved vastly since those days, but the physical transport has hardly changed at all!

IN BRIEF

■ The complete range of Sinclair Radionics hi-fi equipment was displayed and demonstrated at Audio '73 held in Harrogate last month.

All Sinclair hi-fi equipment benefits from the full service facilities available at the company's headquarters in St. Ives, Huntingdonshire.

■ The Sheffield cablevision programme service was recently inaugurated by the Minister of Posts and Telecommunications.

This new local community TV service is run by British Relay Cablevision Ltd., and is the third of five stations licensed by the Minister to different companies to transmit locally initiated TV programmes on an experimental basis.

■ The Midland National Amateur Radio and Electronics Exhibition successfully launched last year, is again to be held at the Granby Halls, Leicester on 25th, 26th and 27th October.

Thursday and Friday from noon to 8 p.m., and on the Saturday from 10 a.m. to 6 p.m.

Admission is 25p. There are large car parks and there is a chance to win valuable equipment.

■ The Royal Television Society recently held its second Convention at King's College, Cambridge.

Nearly 200 delegates and speakers, representing all aspects of TV attended.

■ The Swiss Posts and Telegraphs Department has begun a major re-equipment programme for Switzerland's sound and television services, and has placed large orders with Marconi Communication Systems Ltd.

THE CONTIL-VOLL METAL DETECTIVE

This new device provides an accurate check for all hidden metals.

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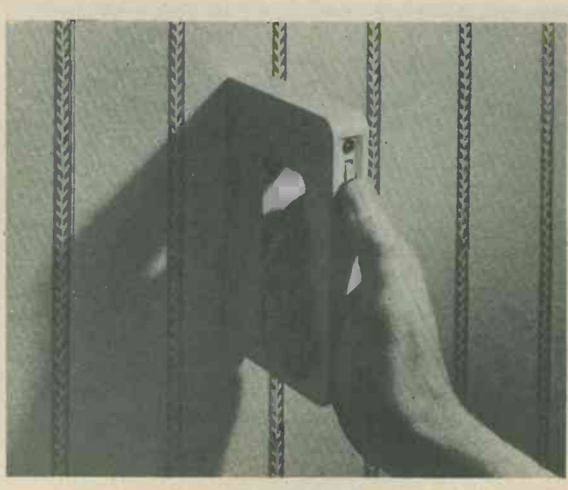

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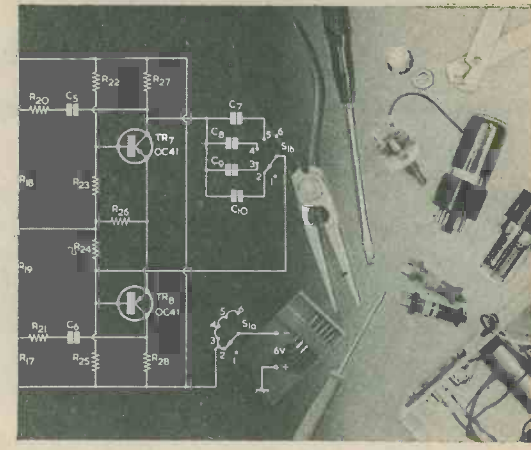


by G. A. French

The fact that a high gain transistor passes almost identical emitter and collector currents enables a number of interesting circuits to be made up. In the device described in this article the equal current factor is employed in the design of a simple high impedance a.c. millivoltmeter which gives useful readings from less than 10mV to 1V. Readings are peak values.

BASIC CIRCUIT

A BASIC CIRCUIT DEMONSTRATING THE equal emitter and collector current effect appears in Fig. 1. Here, a silicon transistor with a very high current gain has a 5kΩ resistor in its emitter circuit and a 15kΩ resistor in its collector circuit. A potential divider comprising a 3MΩ and a 620kΩ resistor couples to the base of the transistor and causes this to be about 6 volts positive of the lower supply rail. The emitter takes up a potential slightly lower than that at the base and we can say, for convenience, that this is of the order of 5 volts. In consequence 1mA flows through the 5kΩ resistor. The same current must also flow through the 15kΩ resistor, whereupon 15 volts is dropped across it. The remaining 16 volts (the 36 volt supply minus the sum of 5 and 15 volts) appears between the collector and emitter of the transistor.

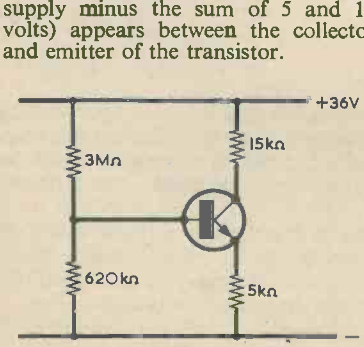


Fig. 1. Circuit demonstrating the effects of equal emitter and collector currents

If we apply an external voltage to the transistor base which causes it to go positive by 1 volt, then the emitter will similarly go positive by 1 volt. The voltage across the 5kΩ resistor then becomes 6 volts and the current which flows through it is raised to 1.2mA. The same current flows through the 15kΩ resistor, whereupon the voltage dropped across this resistor rises to 18 volts. This is an increase of 3 volts. Thus, it may be seen that a positive excursion of 1 volt at the base (and emitter) of the transistor results in a negative excursion of 3 volts at the collector, and it can be further argued that any voltage excursion within reason at the base will similarly result in an excursion at the collector which is three times greater.

The factor of 3 results from the fact that equal currents flow in the collector and emitter resistors and that the collector resistor has a value that is three times the value of the emitter resistor. If we set up a similar sort of circuit in which the collector resistor has a value which is ten times that of the emitter resistor, then voltage excursions at the collector will be ten times greater than those at the emitter. Summing up, the ratio of change in collector voltage to change in emitter voltage is the same as the ratio of the collector resistance to the emitter resistance.

We take the basic idea a stage further in Fig. 2, which illustrates a theoretical approach towards an a.c. millivoltmeter. The d.c. conditions for the transistor are the same as in Fig. 1, since the d.c. emitter load is 5kΩ and the d.c. collector load is 15kΩ. Again, about 5 volts is dropped across the 5kΩ resistor, and approximately 15 volts is dropped across the 15kΩ resistor. The conditions for alternating voltage are, however, different. Assuming that the 4,000μF capacitor has negligible reactance, the a.c. emitter load becomes 5kΩ and 3.3kΩ in parallel, giving an effective value at a.c. of 2kΩ. Similarly assuming negligible reactance in the 2.2μF capacitor, the a.c. collector load becomes 15kΩ and 30kΩ in parallel, offering a combined value of 10kΩ. In conse-

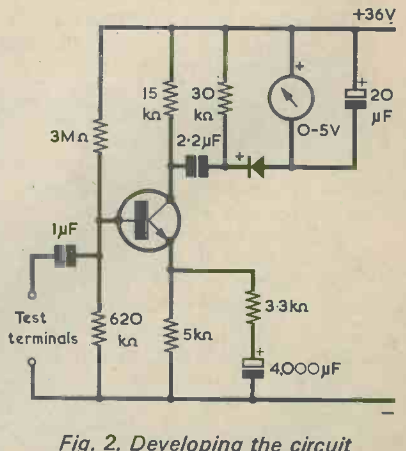


Fig. 2. Developing the circuit to produce a peak-reading a.c. millivoltmeter

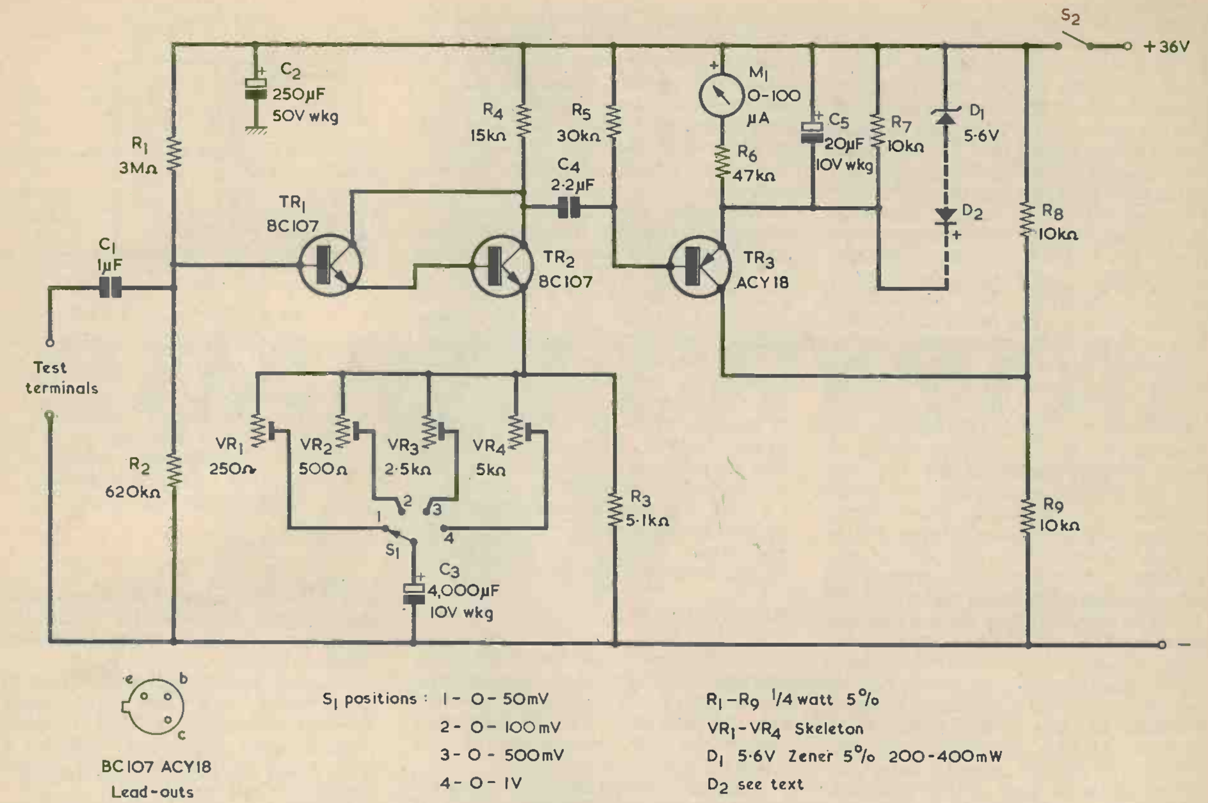


Fig. 3. Practical working a.c. millivoltmeter circuit with four ranges

quence, the a.c. collector load is five times the value of the a.c. emitter load. If we apply an alternating voltage of 1 volt peak to the base of the transistor via the 1µF input capacitor, there will be an alternating voltage of 5 volts peak at the collector. This voltage will cause the peak-reading voltmeter, provided by the diode, the 0–5 volt meter and the 20µF capacitor, to give a full-scale reading. Lower input alternating voltages at the input will produce proportionately lower readings in the meter, with the result that the circuit is potentially capable of functioning as an a.c. voltmeter.

If, next, we replace the 3.3kΩ resistor with one having a value of 208Ω, the effective a.c. emitter load falls to 200Ω. This is one-fiftieth of the 10kΩ a.c. collector load, with the result that any alternating voltage appearing at the collector will be fifty times that appearing at the emitter. The peak reading meter will now give full-scale deflection for an alternating voltage of 100mV peak at the test terminals. It follows that the theoretical a.c. voltmeter of Fig. 2 can be made to have any number of voltage ranges within reason by substituting suitable resistors for the 3.3kΩ component.

In practice, the number of voltage ranges which can be handled by the circuit is limited at the high voltage end by the maximum voltage swing which can appear at the collector of the transistor. The direct voltages across the transistor and across the 15kΩ resistor are both of the order of 15 volt whereupon it would seem reasonable to limit the maximum alternating voltage swing to 5 volts peak; and this can correspond to 1 volt peak at the test terminals. The limitation at the minimum end of the range is imposed by the maximum voltage gain which the transistor, with reduced values of a.c. emitter load, can provide. From experiment with the practical version of the circuit it was found that the voltage amplification available cannot produce an f.s.d. reading in the meter for input alternating voltages lower than about 20mV peak. It would seem prudent, in consequence, to have a minimum range of 0–50mV peak.

WORKING CIRCUIT

A complete working circuit is given in Fig. 3. Here, the high gain transistor of Figs. 1 and 2 is replaced by the Darlington pair, TR1 and TR2. R1, R2, R4 and R5 have the same values and appear in the same circuit positions as in Fig. 2, as also do C1, C3 and C4. R3, the d.c. emitter load, now has the preferred value of 5.1kΩ instead of 5kΩ, as it had in Fig. 2.

All the fixed resistors are 5% types, and each range is set up by adjusting one of the pre-set potentiometers, VR1 to VR4. It might be considered preferable to use close-tolerance resistors in all the positions which affect meter accuracy but it was found in practice that the ratio of collector alternating voltage to emitter alternating voltage varies slightly from the ratio between the load resistances at the lower voltage ranges. As a result, it is convenient to simply use 5% resistors throughout and provide a pre-set adjustment for each range.

The input impedance at the test terminals is approximately 0.25MΩ when S1 is at position 1, increasing to about 0.5MΩ with S1 at position 4. At 50Hz, C1 has a reactance of 3,180Ω and C4 has a reactance of 1,590Ω. These reactances are sufficiently low to ensure an adequately 'flat' response down to 50Hz and below. C3 has a reactance of 0.8Ω at 50Hz. This is sufficiently low to be considered negligible at 50Hz on Ranges 3 and 4, although it does cause a small fall in response of some 2% on Range 2 and of some 4% on Range 1 at this frequency. Thus, the instrument can be considered as offering useful results for all frequencies within the a.f. spectrum.

The peak-reading voltmeter section of Fig. 2 incorporated a series diode for purposes of explanation, but a rather more complicated circuit is employed in the practical version of Fig. 3. Due to the presence of C4, any alternating voltage appearing at the lower end of R5 swings both negative and positive of the upper supply rail. TR3 conducts on negative half-cycle peaks and causes C5 to charge up to very nearly the peak value. The voltage across C5 is then read by the voltmeter given by meter M1 and R6 in series. The meter is a 0–100μA movement, and it gives an f.s.d. reading when the voltage across C5 is a little less than 5 volts. R7 is included to reduce any meter deflection, with zero voltage input, which may result due to leakage current in TR3. A germanium transistor was chosen for TR3 because the reverse base-emitter voltage ratings of most silicon transistors are too low for the present application and, also, because the forward base-emitter voltage drop is much lower than with a silicon device. The use of a germanium transistor introduces the disadvantage that some transistors of the type specified may have a leakage current which causes an inconveniently high indication in the meter under zero input conditions, and it might be necessary to select a suitable transistor because of this. The writer tried several ACY18 transistors in the circuit, and they all caused a deflection of the order of 2μA on the 0–100μA meter scale, and this does not seem inordinately high. Suitable alternatives for TR3 are transistors type ACY17, ACY19 to ACY21, ACY39 to ACY41, and ACY44. The possibility of using alternatives may be of assistance if selection of a suitable device for TR3 is necessary and the constructor wishes to employ whatever stock he may have on hand.

The time constant in the peak-reading meter circuit is a little less than 0.2 second. This ensures that peak readings are given at frequencies down to 50Hz without excessive sluggishness of needle movement.

The purpose of the zener diode D1 is to protect the meter against the flow of excessive current. Such a flow could otherwise occur each time the instrument is switched on. Immediately after switching on a charging current flows into C3 and this causes the Darlington pair, TR1 and TR2, to conduct heavily. The consequent low voltage on the collector of TR2 is passed via C4 to the base of TR3, whereupon this transistor also becomes heavily conductive. Without the zener diode, a current well in excess of the f.s.d value would flow in the meter for a short period until C4 charged up. When the zener diode is in circuit, the meter needle still swings past f.s.d. on switch-on, but the current in its coil is limited to around 16% in excess of the f.s.d. value, and this should not cause any damage. Normally, the zener diode will be non-conductive up to and beyond the f.s.d. voltage. However, if it is felt that, due to R6 being at top tolerance and the diode being at bottom tolerance, the diode is limiting meter sensitivity near f.s.d., then silicon diode D2 may be added in series as shown. This will provide an extra 0.6 volt to the existing zener voltage. If D2 is not in circuit, the zener diode connects directly across R7.

The rather high supply voltage of 36 volts is required in order to allow an adequate alternating voltage swing at TR2 collector. The supply may be provided by four small 9 volt batteries connected in series. The current drawn is quite low, being 2.8 to 3mA only.

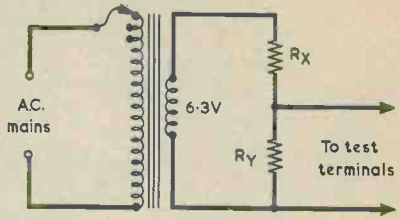
The transistors are readily obtainable types, and suitable alternatives for TR3 have already been discussed. If needed, diode D2 can be a small silicon rectifier, such as the 1N4002. The four pre-set potentiometers, VR1 to VR4, can all be small skeleton types. C1 and C4 can be metallised foil, polycarbonate or any other plastic foil capacitors. They do not need to be close-tolerance components.

SETTING UP

The instrument can be assembled in any manner preferred by the constructor. Layout is not at all critical and the size of the case will be governed mainly by the dimensions of the batteries and meter employed.

After assembly, it becomes necessary to set up the potentiometers VR1 to VR4. A series of known test voltages is required here and these may be conveniently provided by a mains 6.3 volt heater transformer. The calculated peak value of the 6.3 volts given by such a transformer is 8.8. volts and, since a heater transformer normally gives slightly higher than its nominal secondary voltage when it is off load, it can be assumed that the actual peak voltage is 9 volts. Constructors who have an accurate a.c. voltmeter available may use this to measure the r.m.s. voltage given and then convert this to the peak value by multiplying by 1.4. But the value of 9 volts just mentioned will be accurate enough for most requirements and we will assume that this is the voltage we are working to. Naturally, the correct primary tap of the heater transformer must be selected.

Initially, D2 is out of circuit, and D1 is connected directly across R7. All the four potentiometers are adjusted to insert *maximum* resistance into circuit. Range 4 is next selected. A known voltage is given by means of a potential divider connected across the secondary of the heater transformer, as in Fig. 4. Here, RX has a value which is ten times that of RY whereupon one-eleventh of 9 volts, or 0.82 volt, appears across RY. RX may have any value between 100Ω and 10kΩ and RY any value between 10Ω and 1kΩ, the only important point being the 10 to 1 ratio between the two resistor values. Ideally, the two resistors should be close tolerance types



$R_X = 10R_Y - V_{peak} = 0{\cdot}82V$

$R_X = 20R_Y - V_{peak} = 0{\cdot}43V$

$R_X = 100R_Y - V_{peak} = 90mV$

$R_X = 200R_Y - V_{peak} = 45mV$

Fig. 4. With the aid of a heater transformer, known alternating voltages may be obtained for setting up

and the wide range of suitable values may make it easier to make the requisite selection from whatever resistors happen to be on hand.

The test terminals of the instrument are connected to RY and the resistance inserted into circuit by VR4 is slowly reduced until the meter indicates a peak value of 0.82 volt. This corresponds to 82μA on the scale.

Range 3 is next selected and the potential divider across the heater transformer secondary changed for resistors which allow RX to be twenty times RY. RX may, again, have any value between 100Ω and 10kΩ and RY, this time, any value between 5Ω and 500Ω. The voltage across RY is now 0.43 volt and potentiometer VR3 is adjusted for the corresponding reading, 86μA, in the meter.

For Range 2 RY is one-hundredth of RX and may lie between 1Ω and 100Ω. The range for RX is the same as before. The voltage across RY is now 90mV and VR2 is set up for a reading of 92μA in the meter. This takes up the 2% fall in response at 50Hz on Range 2. Finally, Range 1 is dealt with and, here, the value of RY is one two-hundredth part of that of RX, causing the voltage across RY to be 45mV. The range of RX is still 100Ω to 10kΩ. VR1 is adjusted for a reading of 94μA in the meter, which takes up the 4% fall in response at 50Hz on this range.

S1 is returned to Range 4 and a new potential divider is coupled across the heater transformer secondary. This is illustrated in Fig. 5. RY is replaced now by a linear potentiometer having a value between 20Ω and 2kΩ, and the upper fixed resistor has a value which is approximately five times greater. Close tolerance components are not required here as it is merely required to have a continuously variable source of voltage having a range from zero to greater than 1 volt. The test

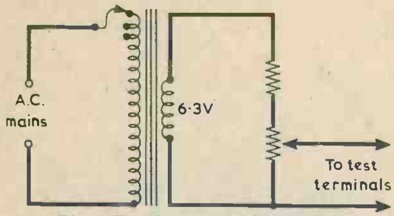


Fig. 5. A test circuit for checking final operation

terminals of the instrument are connected to the potentiometer as shown, and its slider is rotated from zero to slightly in advance of 1 volt, as indicated by the meter. Any evidence of 'cramping' at the f.s.d end of the range due to the zener diode will soon make itself evident as the potentiometer spindle is rotated. If such 'cramping' exists, diode D2 should be added to the circuit, as already discussed.

Should it be necessary to add D2, it would be advisable to set up Ranges 1 and 2 once more.

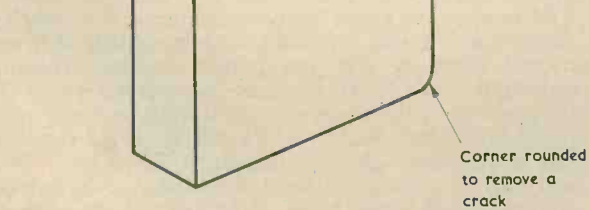
The instrument is then completed and ready for use. The only limitation in its operation occurs immediately after switch-on. Initially, the meter needle goes momentarily to f.s.d., and then returns to zero. After this, it is necessary to wait a few further seconds until capacitor C3 has become fully charged. ■

QUARTZ CRYSTAL REPAIR

by T. E. Millsom

Unserviceable crystals can often be brought back to working order again.

HAVING JUST COMPLETED THE REPAIR OF A DEFUNCT quartz crystal, it occurred to the writer that the subject might be unusual enough to be of interest to other readers. Before proceeding further, however, it must be pointed out that the process of bringing a crystal back to working order can possibly result in its being completely broken. Still, if the crystal is in the first place not working properly, the risk involved in attempting a repair would seem to be well worth taking.



Illustrating various conditions of a faulty crystal. This may have a crack at one corner or a ragged edge with flakes still adhering. Also shown is a corner which has been rounded off to remove a crack.

REFUSAL TO OSCILLATE

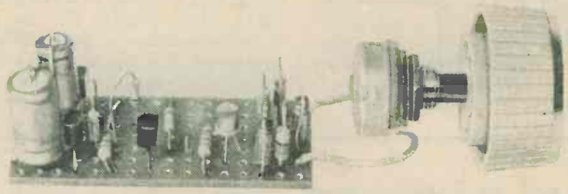
When a previously lively crystal refuses to oscillate it is reasonable to suspect mechanical damage. This may be caused by electrical overload or, more likely, by such things as dropping on the floor. A minute crack on one edge of the crystal can be sufficient to hinder the mechanical vibrations of oscillation. Sometimes, the presence of a crack of this nature is indicated by the fact that the crystal needs a much higher voltage than average to ensure oscillation.

Repair may be simple if the crystal holder can be taken apart. The quartz crystal is then examined for cracks, especially close to the corners, or for flaking along the edges. The cracks may be nearly invisible, and polarised light is a help here, thickening up the stressed areas to black pencil-like lines. Polaroid spectacles could be employed.

The repair consists of grinding the flaked areas smooth, and generally entails rounding one corner. As the quartz is brittle this should be done on a fine grindstone, holding the quartz in a paper handkerchief to avoid fingermarks. The work is quite quickly done. If no actual cracks can be seen it may still be worthwhile to run the edges over the grindstone, as this could detach cracked flakes which are still adhering to the main body.

So long as no material is removed from the large faces the frequency should be largely unaffected since it is mainly determined by the distance between electrodes; that is, by the thickness of the plate of quartz. Degrease the crystal before reassembly, to ensure good electrical operation.

The last crystal repaired by the author in this way had a 1mm. by 1mm. crack on one corner, and was brought into working order again by rounding off this corner. Although it was quite useless before the repair, it now works rather better than it used to do. ■



GRAM AMPLIFIER

By J. R. Davies

Capable of providing an output of 200mW, this amplifier has been specifically designed for assembly on the free Veroboard panel, presented with this month's issue.

THE AMPLIFIER TO BE DESCRIBED INCORPORATES FOUR silicon transistors and, with a 25Ω speaker, gives an output of 200mW. It may be fully loaded by a crystal or ceramic pick-up and it incorporates a high level of negative feedback. Current consumption under quiescent conditions is approximately 5mA from a 9 volt battery.

AMPLIFIER OPERATION

The circuit of the amplifier appears in Fig. 1. In this diagram the input from a pick-up, or similar source of signal, is applied to the volume control R1. The signal level tapped off by the slider of this control is then passed to the base of TR1 via R2 and the d.c. isolating capacitor, C1. TR1 operates as a common emitter amplifier and the amplified signal at its collector is fed to the base of TR2.

TR2 is an emitter follower and its emitter couples directly to the base of TR4 and, via R6, to the base of TR3. TR3 and TR4 are also emitter followers and they form a complementary output pair. The voltage dropped across R6 ensures that TR3 and TR4 receive a small bias current under quiescent conditions, and the presence of this current reduces the effects of crossover distortion. R7 is included to counteract any tendency to thermal runaway.

The two output transistors are in a standard Class B output stage, with TR3 conducting on positive half-cycles and TR4 conducting on negative half-cycles. The two output emitters couple to the speaker via C3. The slight asymmetry in the output circuit due to the presence of R6 and R7 in the base and emitter circuits respectively of TR3 does not introduce any significant distortion, as the values of these two resistors are relatively low. Also, any small distortion present is reduced in level by the negative feedback loop.

R5 is connected to the junction of C3 and the speaker, with the result that bootstrapping is provided and the effective load presented to the emitter of TR2 at a.f. is much higher than the physical value of R5. Bootstrapping is also given at the upper end of R4, the collector load of TR1.

D.C. AND A.C. FEEDBACK

A d.c. feedback loop from the output emitters to the base of TR1 is provided by R10, R8 and R3. These resistors form a potential divider in the manner shown in Fig. 2, and their values are such that approximately one-seventh of the voltage at the output emitters is applied to the base and emitter of TR1. The base of TR1 needs to be about 0.6 volt positive of the negative supply rail for this transistor to pass current and the overall effect is that the output emitters become stabilized at a voltage of approximately 4.5 volts. If, for any reason the voltage at the output emitters went positive, the bias current at TR1 base would increase and its collector voltage would drop. Since TR2, TR3 and TR4 are emitter followers, the voltage at the output emitters would similarly fall, counteracting the original positive excursion. A similar stabilizing effect is given if, for any reason, the output emitters went negative.

An output emitter voltage centred at 4.5 volts may seem a little high when the supply voltage is 9 volts and will reduce as the battery ages, but it was chosen for the following reasons. As the base-emitter junctions of TR4 and TR2 appear between the output and the

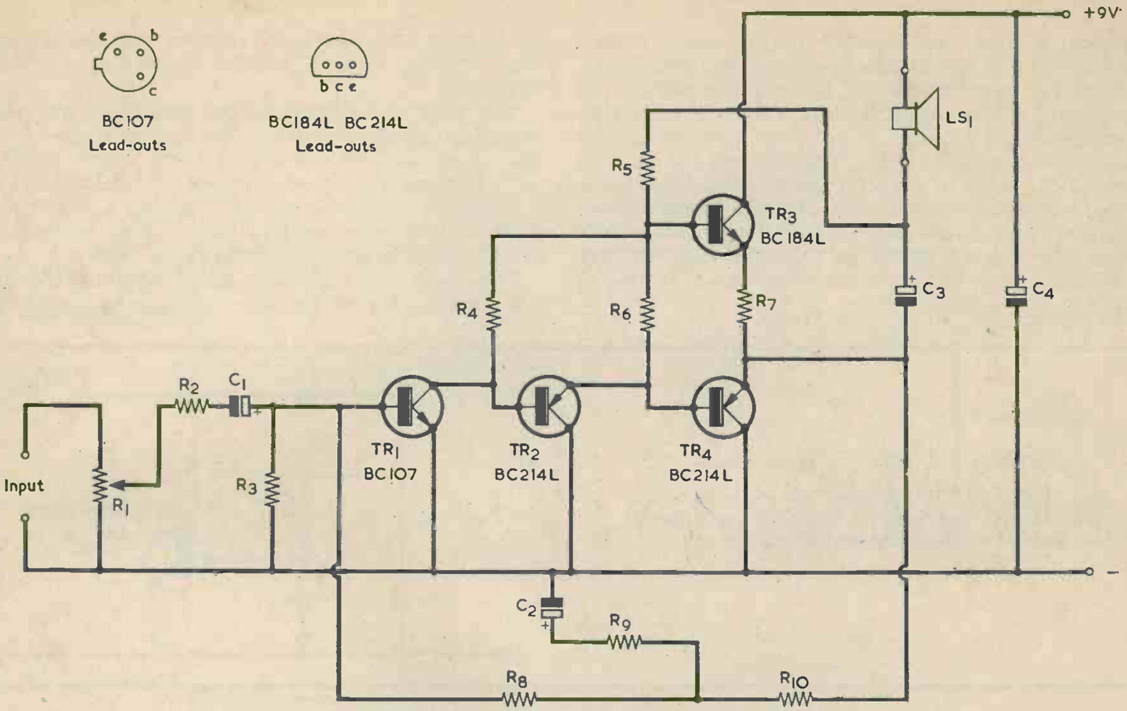


Fig. 1. The circuit of the 200mW gram amplifier

COMPONENTS

Resistors
(All fixed values ¼ watt miniature 10%)

R1	2 or 2.2MΩ potentiometer, log
R2	680kΩ
R3	33kΩ
R4	10kΩ
R5	560Ω
R6	180Ω
R7	2.2Ω (see text)
R8	220kΩ
R9	1.2kΩ
R10	10kΩ

Capacitors
(All Mullard Miniature electrolytic)

C1	4µF 10V. Wkg.
C2	4µF 10V. Wkg.
C3	125µF 10V. Wkg.
C4	200µF 10V. Wkg.

Transistors

TR1	BC107
TR2	BC214L
TR3	BC184L
TR4	BC214L

Speaker

LS1	25Ω speaker

Miscellaneous
Veroboard, 0.15 in. matrix, 7 strips by 16 holes
9 volt battery
Battery connector clips
Knob
Flexible screened wire

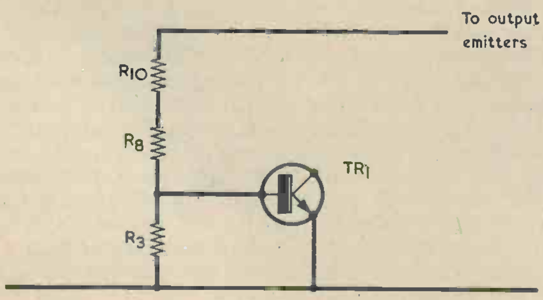


Fig. 2. Capacitor C2 has no effect at d.c., and the d.c. feedback loop is as shown here

collector of TR1, the negative output swing cannot pass beyond a potential which, with typical transistors, is about 1.3 volts positive of the negative supply rail whereupon, with a centre voltage of 4.5, the maximum negative swing is 3.2 volts. A positive swing of 3.2 volts takes the output to 7.7 volts. This permits a maximum swing of 3.2 volts in both directions until the battery voltage falls to around 8.3 volts. The positive swing then becomes progressively reduced as battery voltage falls further. An output swing of 6.4 volts peak-to-peak corresponds to an r.m.s. output power in a 25Ω load of almost exactly 200mW.

the output transistors. A speaker impedance higher than 25Ω may be used, but the output power will then be lower.

The four transistors in the amplifier are readily available standard types. The resistors are ¼ watt miniature, having a nominal body length of 8mm. (0.32 in.) and a nominal diameter of 2.8mm. (0.11 in.). If difficulty is experienced in obtaining a 2.2Ω resistor of these dimensions for R7, there is space on the board for a slightly larger component to be used.

The electrolytic capacitors are all Mullard Miniature components. Larger capacitors cannot be employed as there is insufficient space for them. It is important that C2 should have a low leakage current as, otherwise, the d.c. feedback operating conditions will be upset. A Mullard Miniature electrolytic capacitor will meet circuit requirements here. All the components, apart from R1 and, of course, the speaker, are mounted on the Veroboard.

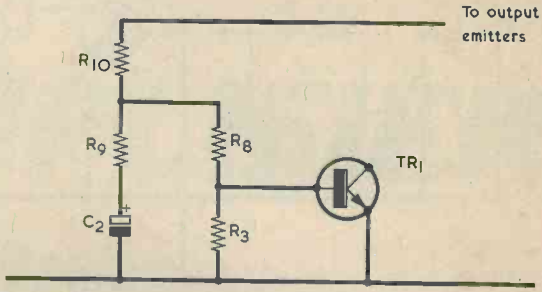
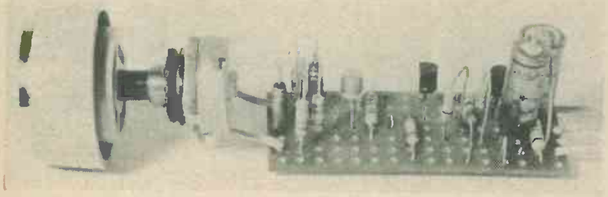


Fig. 3. At audio frequencies, C4 presents a low impedance, and the a.c. feedback path incorporates a different potential divider

There is also an a.c. feedback loop, this, as shown in Fig. 3, being given by R10, R9, C2, R8 and R3. C2 has no effect at d.c., but at audio frequencies it can be looked upon as providing a very low impedance. There is in consequence a different potential divider in the a.c. feedback loop, this being given by R10 and R9. The a.f. voltage at the junction of these two resistors is then applied to the network consisting of R8 and R3. The signal at the junction of R8 and R3 is passed to the base of TR1. The level of feedback is such as to allow the amplifier to be fully loaded by a crystal or ceramic pick-up.

The input impedance of the amplifier is 2 or 2.2MΩ (according to the value of R1) at minimum volume, this dropping gradually to 510kΩ at full volume. A crystal or ceramic pick-up can be coupled to these impedances.

The amplifier output stage is designed to work into a 25Ω speaker. A speaker with a lower impedance must on no account be used as this may result in excessive dissipation in the output transistors, which may become damaged as a result. Great care must be taken not to accidentally short-circuit the speaker leads whilst the amplifier is in operation, as this may similarly damage



Another view of the amplifier. The volume control is coupled to the Veroboard by screened cable if there is a possibility of hum pick-up

ASSEMBLY

Assembly is carried out as shown in Fig. 4, which shows the component and copper sides of the Veroboard.

First, cut the copper strips at holes B3, C11, C14, D4, D13, E6, E10 and G8. Next, solder in the four transistors. TR2, TR3 and TR4 are shown, for clarity, to one side of the holes at which they connect. In practice, these transistors stand directly over their holes, and it will be found an easy matter to slightly splay out their leads and insert them. The locating lug of TR1 and the flat surfaces of TR2, TR3 and TR4 are shown in Fig. 4, and this information will assist in fitting them correctly.

Next, fit two bare wire links, one between holes D7 and E7, and the other between holes B14 and C15. Carry on by mounting C1, R3, R2, C2 and R8. All of these are fitted vertically. Ensure that C1 and C2 are soldered in with correct polarity. The negative lead-outs of these capacitors are common with the cans.

R9 and R4 are now fitted horizontally, the bodies of these two resistors lying directly between the holes to which they connect. R6 follows. This is also mounted horizontally but its body is displaced slightly so that it lies between holes E11 and E12. Next fit R10 vertically, as shown. The lead-out which passes through hole E11 should be just clear of the body of R6. R7 comes next and this is also mounted vertically. Its body will need to be spaced away from the board slightly because of the presence of R6. The body of R7 and its lead-out at hole E12 should both be just clear of the body of R6.

Carry on by wiring in R5 horizontally. Its body should be spaced away from the board by about ⅛ in. to clear the link wire previously fitted, and also to allow

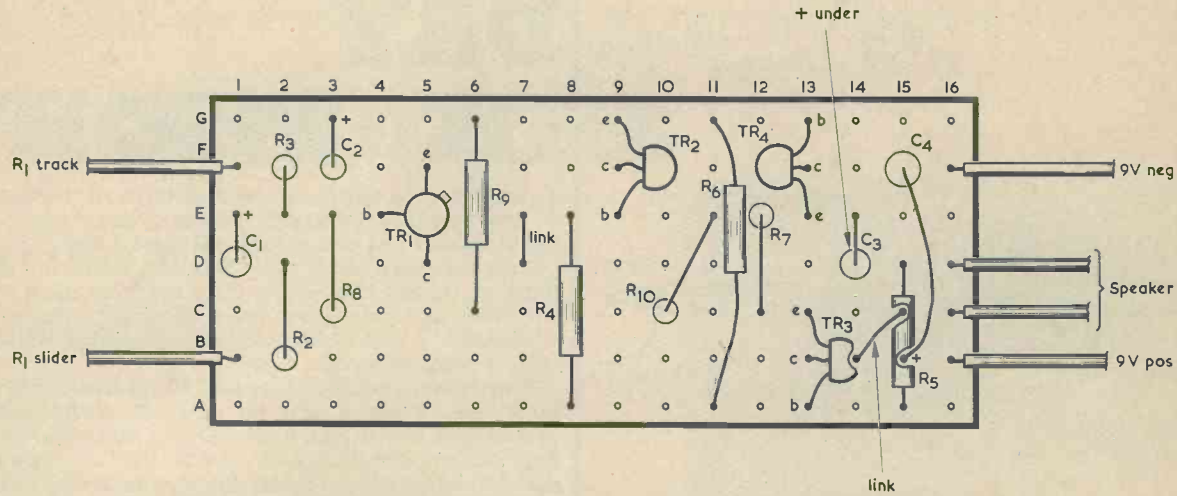


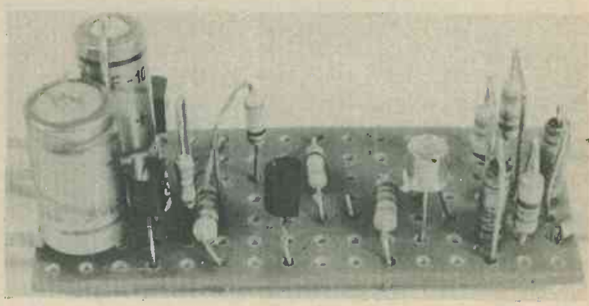
Fig. 4. The component and copper sides of the board

clearance for the positive lead-out of C4, which is wired in later. Next fit C3, with the polarity shown in Fig. 4.

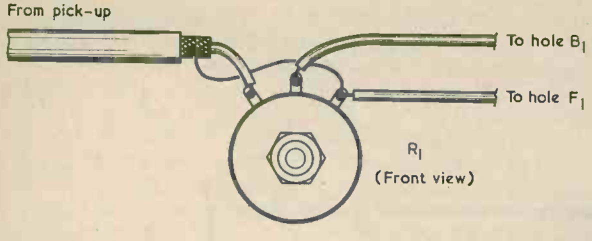
Solder in the four flying leads connecting to the 9 volt battery and to the speaker. These are thin p.v.c. covered flexible wires and may have any convenient length. Fit battery connector clips at the ends of the battery leads, observing correct polarity. Do not connect the battery yet.

The final component to be fitted to the board is C4. Its positive lead-out passes the side of R5 and connects at hole B15 underneath. The positive lead-out should be just long enough to enable this connection to be made. If not, a short extension length of bare tinned copper may be soldered to the lead-out. The lead-out, or extension wire, should be just clear of the body of R5.

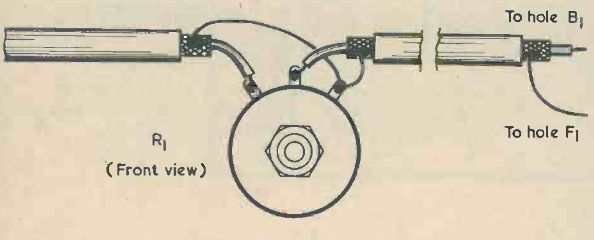
Volume control R1 is next connected to the board. If it is intended to have the connecting leads short, say 2 in. or less, and if the amplifier will be used well away from mains wiring where the input wire from R1 slider could pick up hum, these leads may be unscreened, as



A close-up view of the amplifier board



(a)



(b)

Fig. 5 (a). If there is no risk of hum pick-up, R1 may be connected to the board by two unscreened wires
(b). Alternatively, a screened lead may be used

shown in Fig. 5(a). If relatively long leads are to be used or there is a risk of hum pick-up, a screened wire must be employed. This is connected in the manner illustrated in Fig. 5(b). The pick-up or alternative source of signal connects to the two outside tags of the potentiometer, and the lead employed for this connection must be screened. The outer braiding of the screened wire from the pick-up is common to the zero-volume track tag of R1 and, hence, with the negative supply rail of the amplifier.

All connections to the board are now complete. Make a careful visual check of both the component and copper sides of the board, making sure that all parts are fitted correctly and that all solder joints appear sound. Check in particular that there are no 'blobs' of solder short-circuiting adjacent strips.

Taking care to avoid the possibility of accidental short-circuits, next connect up the speaker. It then only remains to connect the battery and check out the amplifier, whereupon the latter is complete and ready for use. It should be noted that, due to the presence of C4, there is no 'click' from the speaker when the battery is connected.

Before concluding, it may be mentioned that the constructor will possibly be employing a small or miniature 25Ω speaker with the amplifier. Speakers of this nature will give a good performance with the amplifier but it is desirable to provide them with some form of baffle. For test purposes a suitable baffle would be given by a flat piece of cardboard some 9 in. square with a hole having the same diameter as the speaker cone cut out in the centre. The speaker may be laid, cone upwards, on the bench, and the cardboard baffle placed over it. This rudimentary form of baffling can produce a surprising increase in bass response. Alternatively, of course, the speaker may be fitted in a proper cabinet. ■

THE DAY OF THE

I THINK IT WAS THE LATE P. P. ECKERSLEY OF THE B.B.C. who invented the word 'Whoppodyne'. Recently I was asked if I had ever seen one. Indeed I had.

Over forty-five years ago I saw and heard my first radio set. It had two valves, three engraved dials, and ten brass terminals. I was even allowed to make an adjustment. I was enchanted, and I decided without delay to become a *radio expert*.

Everything was in my favour: I was doing Euclid Book One, I had a new set of shiny mathematical instruments, and I was nearly twelve years old. So I went out and bought myself a book, the most formidable journal on sale, called 'Experimental Wireless'. This, alas, gave me a baffling and fruitless week-end.

MATHS MASTER

On Monday morning, having returned to school, I walked nonchalantly up to the Maths master's desk and laid my copy of 'Experimental Wireless' before him opened at an impressive article containing four pages of differential equations. I asked, 'could he explain this to me?' He looked at the article and said, 'No.'

'Perhaps,' I ventured, 'you don't understand it because it's wireless maths.'

Angus Stuart Fraser, M.A. Edin., shuddered then gathered himself up to his full five foot three and howled, 'Boy!'

'Sir?'

'Boy! if you continue for the next five years to wash behind the ears and do not perish from exposure whilst playing truant come back to me and I will crack your miserable ribs with differential equations. Meanwhile here is a problem on interest and proportion more in keeping with your immediate but alas meagre talents.'

There was no help for it. I could not invent it all by myself and I would have to join the local wireless club.

Now, the local wireless club requires some explanation. During the long Scottish winter nights the intelligentsia of the town had always to be doing and clubbing about one thing or another. Nearly always it was the same people who met in the same meeting place. Many years ago the club had begun as the Celtic Music and Drama Society, which in time thawed into the Antiquarian and Geological Society. This in turn was followed by the Photographic Society and the Astronomy Club. Now, 'wireless' was the current centre of interest.

From the moment of its application, my plea for admission divided the society; but this was as it should be, because as soon as the internecine clan wars in the club ceased there would have been little point in its continued existence. Eventually I was admitted on the promise that I kept quiet, asked intelligent questions, kept out of the way, and found three other members of my own age who (and this was *most* explicit) were in no way related to any present club member. I accepted

Radio construction in the '20s by no means consisted of the assembly of simple Crystal sets. The early valves had made their appearance and enthusiasts of that time made up multi-stage receivers which took up an enormous amount of space. Here, our contributor waxes nostalgic over his memories of the period of those "Whoppodynes".

WHOPPODYNE

by H. Ross McDonald

willingly because I had caught sight of the Club Set. It was unbelievable!

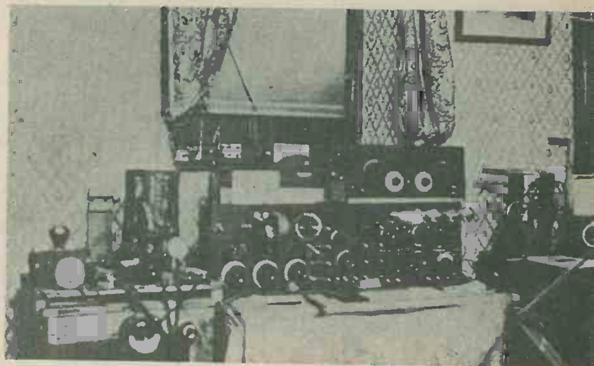
It was nearly five feet long with a vast quantity of tuning dials, two voltmeters, three 3-way coil holders, four 10-way rotary switches and their orbits of brass studs, six d.p.c.o. switches and nearly five dozen 2BA brass terminals. There were seven valves, three h.f., one detector and three l.f. This monster was connected to a small Amplion Dragonfly loudspeaker, which was meekly pouring out 80 milliwatts of 'Shepherd of the Hills'. The members were entranced – we were receiving Oslo.

I stood transfixed, yet a greater pleasure was to follow. Three operators simultaneously began to adjust the set. For to receive another programme the adjustments were so many, so interlocking and so overlapping, that three men was the minimum number required.

UNIT SYSTEM

The finances of the club were good and a new Club Set was on the agenda, and like the present one was to be constructed on the Unit System. But this set, unlike the existing one, was to have some elements of coherent design in its make-up. Also it was intended to be controllable by only one human being. (This last caused considerable contention.) Several members were allocated a unit, working to detailed instructions from a central plan drawn up by the local architect, who also drew up a series of layouts and calculated main dimensions and fixing centres, together with choice of materials. An almost dangerous degree of unanimity was setting in, and the members began to agree with, if not actually approve of, each other. 'Flexibility' was the thing; all the r.f. stages had to be capable of being series tuned, parallel tuned, aperiodic, tuned anode, etc., by means of a diabolical combination of switches. In the same way the three a.f., or as they were then called 'note magnifying', stages had to offer a choice of RC, choke or transformer coupling.

So we set to work. Cabinets were made, coils were wound and the four tuning capacitors were assembled vane by vane, spacer by spacer. I was impressed into the panel and terminal gang, and spent hours matting down the shiny surface of ebonite and burnishing terminals and lacquering them with a Fluxite lamp and warm shellac. The final scribing, drilling, and wiring was performed with all the profound solemnity of an involved religious rite.



Not quite a fully-grown 'Whoppodyne' but getting close to it. This is amateur station 6JJ which ran from 1922 to 1926. On the extreme left is a 120–180 metre transmitter with the filament voltmeter immediately below the oscillator valve. The long receiver on the ebonite panels was the main receiver, a 5 valve 2-V-2 which, with plug-in coils, tuned from 100 to 4,000 metres. Standing above it is a 40 to 80 metre receiver

But it was not all work, and nearly every evening we had discussions, lectures, and guest speakers inviting questions. Those questions! We juniors were only allowed one question each, and if the lecturer could give a coherent reply we fought each other afterwards in sheer mortification. What did we learn during these lectures? Really, quite a lot. Of course there was an enormous amount of nonsense talked. 'The Ether Theory' was proved so true and real that one could almost get a pen-knife out and carve one's initials on an adjoining chunk of it. One member even found a Biblical proof of it in Second Kings!

As the receiver neared completion we juniors were detailed to dig a sloping trench for the new earth connection. A length of perforated copper tube 5ft. long and 4in. in diameter was laid with all the solemnity of a municipal foundation stone. It is salutary to reflect that this piece of copper, which north of Inverness is still probably quietly mouldering away, is in view of today's exalted copper prices worth more than the entire club installation, were the latter available.

The new set worked moderately well; after its predecessor any change could only be for the better! I might add that the Chief Constable's wife had only to make two visits for the official 'switch on'.

But then, after eighteen months, the Radio Club slowly faded away and died. The day of the Whoppodyne was over and Numismatics was to be the new battle-ground. I just could not believe it – the Club to cease! But cease it did, and in ceasing it closed one chapter of my life. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Several times of late we have drawn attention in these columns to the subject of Clandestine transmissions and no apologies are offered for once again commencing with more news of these broadcasts. Many of these stations can easily be heard here in the U.K., whilst others represent real Dx in the accepted sense. The great majority of these transmissions are, of course, pro-communist and the locations claimed by the stations are invariably false.

● CLANDESTINE

The "Voice of Iranian Kurdistan" operates, in Kurdish, on **9630** (31.15 metres) from 1400 to 1420 and from 1710 to 1730 and is anti-Iranian government. According to the available information, this station is believed to be located in Iraq. We heard them at 1410 when short excerpts from classical music were interspersed with harangues in Kurdish. At 1418 the expected slogans, Arabic-type music and off at 1420. Identification is "Denge Kurdistani Erana".

The "Voice of Truth" can be heard on **7335** (40.91m) and on **9775** (30.69m) at various time periods through the day. During the evening they operate on **9775** from 1710 to 1730 and from 1830 to 1900; on **7335** from 1930 to 2000 and from 2030 to 2115. Identification is "Radiofonikos Stathmos i Foni tis Alithias". The station is believed to be located in East Germany. All programmes are in Greek. Logged here at 1858 on **9775**, six pips and a single gong at 1900 with clear station identification and off.

"Our Radio", announced as "Bizim Radio", with programmes in Turkish can be heard during various time slots daily on **5915** (50.72m), **6200** (48.39m), **9500** (31.58m) and on **9585** (31.30m). During the evening period they are on **9585** from 1740 to 1810 and from 1910 to 1925; on **5915** from 2000 to 2030 and from 2030 to 2100; on **6200** from 2005 to 2020 and from 2120 to 2155. According to the available information, these transmissions are believed to emanate from East Germany and Romania.

"Radio Pathet Lao" can, at times, be heard here in the U.K., and is regarded as a Dx "catch" when logged. Claiming to be situated in Laos, it is thought to be actually located in North Vietnam. The schedule is almost, but not quite, of 18 hours duration, the longest break being between 1600 and 2230. Operating on **4660** (64.37m), **6200** (48.38m), **7310** (41.03m), **7480** (40.10m) and on **8660** (34.64m), in French and a variety of local languages, they can probably best be heard here in the U.K., if conditions permit, from 1500 to 1515 in French, 1515 to 1530 in Cambodian, 1530 to 1600 in Laotian and from 2230 to 2400 in Laotian on **4660, 6200, 7310** and on **7480**. Identification is "Thi Ni Witayv Kachai Siang Fai Pathet Lao".

"Radio of the Patriotic Neutralist Forces", in Laotian, operates on **6273** (47.82m), **7250** (41.37m) and on **8606** (34.85m). Probably the best chance of hearing this one here in the U.K., would be from 2315 sign-on through to 0015 sign-off on **6273** or **8606.** Despite several attempts, we have not been able to log this one up to the time of writing. Claiming to be in Laos, it is thought to be located in North Vietnam. Identification is "Thi Ni Sathani Withayu Krachai Seing Heang Pathet Lao".

Or you could, if you wished to spend an evening chasing the Clandestines, try the PAIGC station on **6240** (48.07m) around 2100, or Radio Portugal Livre on **11505** (26.08m) around 1830 or, the next best to a Clandestine, something like –

● TANZANIA

The External Service of Radio Tanzania, Dar es-Salaam, operates from 1830 to 2000 on **15435** (19.44m) a schedule directed to ANC (African National Congress). Frelimo (Front for the Liberation of Mozambique), Molinaco (Movement for the Liberation of the Comoro Islands), SWAPO (South West African People's Organisation), ZANU (Zimbabwe African National Union) and ZAPU (Zimbabwe African People's Union) in English, Portuguese, Afrikaans and various African vernaculars, all according to their schedule.

CURRENT SCHEDULES

● AUSTRIA

The Short Wave Service of Radio Austria from Vienna has a service in English to Europe from 0830 to 0900 on **6155** (48.74m), **7245** (41.41m), **17850** (16.81m) and on **21720** (13.81m). Also from 1830 to 1845 on **6155, 15200** (19.74m), **15335** (19.56m) and on **17780** (16.87m).

● PORTUGAL

Radio Portugal radiates in English to Europe on **6025** (49.79m) from 2045 to 2130. Also of interest is the English service to South, East and West Africa from 1900 to 2000 on **11875** (25.26m) and on **21495** (13.96m).

● TURKEY

Radio Ankara, "The Voice of Turkey", can be heard in English for Europe, from 2200 to 2230 on **11880** (25.25m).

● **EGYPT**

Radio Cairo directs a programme in English to Europe from 2145 to 2300 on **9805** (30.59m). The General Service (Home Programme) in Arabic is intended for Europe also from 1700 as follows – on **9475** (31.66m), **11630** (25.80), **12005** (24.99m) and on **17670** (16.98m) until 1755. From 1800 to 1920 on **7075** (42.40m), **9475** (31.66m), **11630** and on **12005**.

● **KUWAIT**

Radio Kuwait Home Service operates an afternoon schedule in English also intended for listeners in Europe. From 1630 sign-on to 1900 on **9600** (31.25m) and on **15415** (19.46m).

● **NIGERIA**

The Nigerian Broadcasting Corporation (NBC) from Lagos, operates from 1500 to 2305 on **4990** (60.12m), listen from around 2000 onwards, and from 1800 to 2305 on **3986** (75.27m), many of the programmes are in English.

● **MEXICO**

Radio Mexico has an External Service in Spanish operating on several channels from 2300 to 0400, that offering the best chance of a logging being **11770** (25.49m), at least in theory!

● **IRAQ**

Radio Baghdad has an External Service to Europe from 1900 to 2000 which can now be heard on **9740** (30.80m).

AROUND THE DIAL

Tuning around the 15MHz area of the dial recently produced the following –

● **FINLAND**

OIX4 Pori with a programme in English from 1800, at 1810 some interesting information on workers choirs and music, **15185** (19.76m).

● **MALAYSIA**

BBC Far East Relay at Tebrau, 1815, full identification and parallel channels announced, followed by "Radio Newsreel". Sign-off at 1830 on **15310** (19.60m).

● **NIGERIA – 1**

NBC Lagos at 0720 with local poetry and music interspersed with announcements and explanations in English. Off channel on **15182.5** (19.75m) (listed **15185**).

● **CONGO**

R. TV Congolaise, Brazzaville, at 1750 with local songs and music, march at 1758, identification in French at 1800 on **15190** (19.75m).

● **ISRAEL**

Jerusalem at 2044 with station identification in English after programme in the same language, and sign-off, on **15165** (19.78m).

● **NIGERIA – 2**

NBC Lagos can also be heard at 1530, we logged them with identification and a newscast in English after time-check "4.30 Nigerian time", followed by "The Week in Africa" at 1545, on **15120** (19.84m).

On the 11MHz band the following stations were logged –

● **AUSTRALIA**

Radio Australia at 0738 in English with programme about the local political scene, at 0744 "Waltzing Matilda" and "Press Review" on **11765** (25.50m).

● **ASCENSION ISLAND**

BBC Relay at 2022 in English about Cambodian and Vietnamese current affairs on **11820** (25.38m).

● **CHINA**

Radio Peking at 2130 in English with news and comment on world affairs on **11675** (25.70m).

● **CZECHOSLOVAKIA**

Radio Prague at 0730 with a programme in English describing Czech advances in science on **11855** (25.31m), also at 0700 with newscast in English.

● **INDIA**

All India Radio (AIR) Delhi at 2100 with station identification, newscast in English, heard after Vatican signs-off (on same channel) also in English, at 2059, on **11715** (25.61m).

AIR Aligarh at 2038 with Indian music and songs in Hindi on **11810** (25.40m).

● **CANADA**

Radio Canada at 0702 with news of Canadian affairs in English on **11825** (25.37m).

● **ROMANIA**

Bucharest at 0705 with news of Romanian internal affairs on **11940** (25.13m).

● **LIBERIA**

VOA (Voice of America) Monrovia, world news in English at 0707 on **11925** (25.16m).

● **HOLLAND**

Radio Nederland at 0645 with identification and programme in English on **11730** (25.58m).

HERE AND THERE

● **MONACO**

Trans-World Radio, Monte Carlo, may be heard on **7102.5** (42.23m) at 0730 with a programme in English, identification at 0745. (Frequency as measured.)

Trans-World Radio also heard on **7295** (41.12m) at 1945 with a religious programme in English, identification at 1955, musical box interval signal and off.

● **SWITZERLAND**

Berne on **9590** (31.28m) at 0724 in English with a programme about the motor car and the resulting pollution in Switzerland, this transmission is intended for Australia and the Far East.

● **SWEDEN**

Radio Sweden on **6065** (49.46m) at 2100 with identification and current affairs programme in English "Panorama".

● **ZAMBIA**

Lusaka on **4962** (60.45m) at 1820 with a talk in English on the Vietnam conflict and Asian affairs in general. Station identification in English at 1830. Channel as measured.

New Products

8 TRACK STEREO TAPE PLAYER

Golding Audio announce a new 8 track, stereo tape player to add to their growing range of home tape equipment.

The Golding 602 will attract many new customers who will appreciate the excellent sound reproduction qualities for the size and price of the unit.

The main unit of the 602 measures approximately 11 in. $\times$ $5\frac{1}{2}$ in. $\times$ 9 in. and the speakers 8 in $\times$ 10 in $\times$ 5 in. The total cost of the unit is approximately £54 + V.A.T.

The solid state circuitry incorporates an isolation switch to make the amplification unit available for use with a record player deck. A full 5w per channel power output is developed in to a 2 $\times$ 4 ohm load.

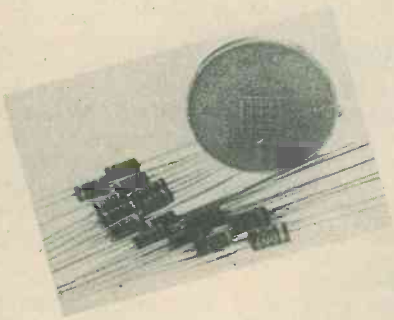
The front panel of the 602 is exceptionally well finished in black vinyl and chrome with an illuminated track indicator. The volume balance and tone controls are in the form of easy to operate, vertical slides which also give a positive indication of settings.

Requests for name and address of your nearest Golding Audio stockist should be addressed to: Golding Audio, Marks Tey, Colchester, Essex.

SPECIFICATION

Power output	5w $\times$ 2 rhms
Fidelity Bandwidth:	80–10,000 Hz
Transistors and diodes:	14 transistors and 3 diodes
Tape speed:	$3\frac{3}{4}$ inches per second
Tape speed deviation:	Less than 3%
Wow and flutter:	Less than 0.3%
Separation:	More than 40 DB
Speaker:	Air sealed air suspension system using two $6\frac{1}{2}$ inch dynamic speakers
Power source	117/220/240 volts AC 50/60 Hz
Dimensions:	Main unit: 11 in. w. $5\frac{1}{2}$ in. h. 9 in. d. Speaker: $7\frac{7}{8}$ in. w. $9\frac{7}{8}$ in. h. $4\frac{3}{4}$ in. d.

GENERAL INSTRUMENT'S RECTIFIER RANGE



GENERAL INSTRUMENT (U.K.) LIMITED, have announced a new family of miniature plastic fast-recovery rectifiers, THE R.P.1 series. Packaged in the popular DO–41 outline, the high current diffused-junction series is rated at 1.0 Amp, from 50 to 1000 Volts. Maximum reverse recovery time is 250nS for voltages up to 600V and 500nS for the 800V and 1000V types.

A major feature of the R.P.1 range is the low cost for quantity orders. 1000-up prices for these rectifiers range from £0.09 for the 50V type up to £0.16 for the 1000V type.

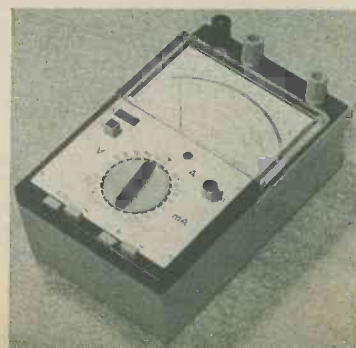
The introduction of this family now means a total package choice for fast recovery rectifiers including the glass DO–29 outline and the recently introduced glass passivated package. The rectifiers will be of particular interest to the TV market, where they are used in scan rectification circuits, and fast response power supply applications.

Further details from: General Instrument (U.K.) Ltd., Cock Lane, High Wycombe, Bucks.

'VENTURE' MULTIMETERS

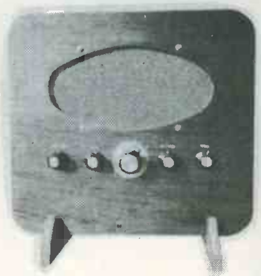
The three new 'Venture' multimeters launched recently by Smiths Industries Ltd., with great success, Multimeter 1 for electricians and power engineers, Multimeter 3 for general-purpose use (as illustrated), and Multimeter 4 for electronics engineers. Up to 52 ranges are offered on one instrument, and the taut-ligament movement is so sensitive that d.c. input resistance can be as high as 100 kohm/V.

For further information Smiths Industries Ltd., Instrument Division, Waterloo Road, Cricklewood, London NW2 7UR.



THE

'BAFFLETTE'



By

F. G. Raynor, Assoc. I.E.R.E., G30GR

This novel superhet receiver requires the minimum of carpentry, but it still offers a pleasant and stylish appearance. Construction is eased by the use of a ready-made a.f. amplifier module.

CABINET CONSTRUCTION PRESENTS DIFFICULTIES FOR those who are not interested in this kind of work, and it is not always easy to produce a case having a good appearance. So constructors in this category should find the receiver which is described here ideal – it has no cabinet at all! Instead, the components are mounted on a vertical baffle board which also forms the front of the receiver and carries the loudspeaker. The result is quite novel and likely to cause comment when seen. In addition, the components and wiring are at all times easy to reach, a factor which can be a source of further interest.

Wiring is simplified by using a ready-made Newmarket 'Packaged Circuit' a.f. amplifier type PC3. The complete receiver is capable of bringing in a good number of stations at excellent volume.

CIRCUIT

Fig. 1 gives the circuit, and it will be seen that this employs two transistors and one diode in addition to the ready-made a.f. amplifier.

L1 is the medium wave section of the ferrite rod aerial and, when S1(a) is set to position 1, is tuned by VC1 which is one section of the 2-gang tuning capacitor. Setting S1(a) to position 3 brings the long wave section, L2, into circuit, and also connects C2 and TC3 to the oscillator tuned circuit. The latter is given by the winding of L4 between pins 3 and 2, C4, TC2 and VC2, which is the remaining section of the 2-gang capacitor. VC1/VC2 is a Jackson type '00' 2-gang capacitor with trimmers and without an integral slow-motion drive. The two trimmers appear in Fig. 1 as TC1 and TC2.

TR1 couples to the ferrite rod aerial by way of L3 and the tapping at point '6' on L2. This part of the circuit thus requires no wave-change switching.

For maximum possible efficiency, a panel trimmer, VC3, is also provided. Normally, this needs little adjustment. It can, however, be peaked for maximum sensitivity with weak signals at any part of the bands covered, and so overcome the loss of efficiency which might otherwise exist due to slight errors in alignment.

A single stage of i.f. amplification is used and this provides a high degree of gain. The first i.f. transformer has two tuned windings and the second a single tuned winding, so selectivity in fact is comparable with that of many popular receivers having three single-tuned i.f. transformers. The second i.f. transformer is nominally a 470kHz component but it tunes down to 465kHz quite readily. The i.f. transformers are supplied prealigned and the cores should not be touched until the receiver has been completed and is ready to be aligned. The more selective first i.f. transformer then ensures that the i.f. signal used for alignment is at 465kHz.

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	56kΩ
R2	10kΩ
R3	3.9kΩ
R4	68kΩ
R5	10kΩ
R6	1.2kΩ
R7	680Ω
VR1	5kΩ potentiometer, log
VR2	1MΩ potentiometer, linear

Capacitors

C1	0.01μF plastic foil
C2	150pF 2%, silvered mica
C3	0.01μF plastic foil
C4	200pF 2%, silvered mica
C5	10μF electrolytic, 4 V.Wkg.
C6	0.047μF plastic foil
C7	2,000pF ceramic or plastic foil
C8	0.22μF plastic foil
C9	100μF electrolytic, 12 V.Wkg.
C10	0.01μF plastic foil
VC1/VC2	208+176pF 2-gang variable with trimmers, type '00' (Jackson Bros.)
VC3	25pF variable, type C804 (Jackson Bros.)
TC1/TC2	Part of VC1/VC2
TC3	60pF mica trimmer

Inductors

L1/L2/L3	Ferrite rod aerial type MW/LW5FR (Denco)
L4	Oscillator coil type TOC.1 (Denco)
IFT1	I.F. transformer type IFT18/465 (Denco)
IFT2	I.F. transformer type IFT14/470 (Denco)

Semiconductors

TR1	OC44
TR2	AF117
D1	OA81

Switch
S1(a)(b) 2-pole 3-way rotary

Amplifier
'Packaged Circuit' amplifier type PC3 (Newmarket)

Speaker
15Ω speaker, 7 by 4in. elliptical

Miscellaneous
7 by 2in. 'Universal' flanged chassis side, Cat. No. CU136 (Home Radio)
Insulated board, 6 by 2½in. (see text)
4 small knobs
1 large knob
Plywood, 6mm. or similar
9 volt battery
Battery connectors
Wire, sleeving, etc.

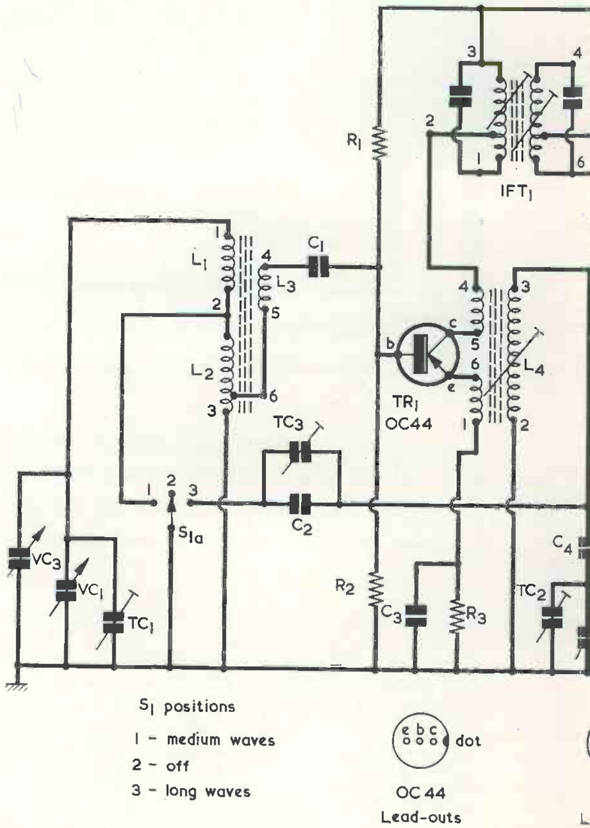


Fig. 1. The circuit diagram of the 'Ba

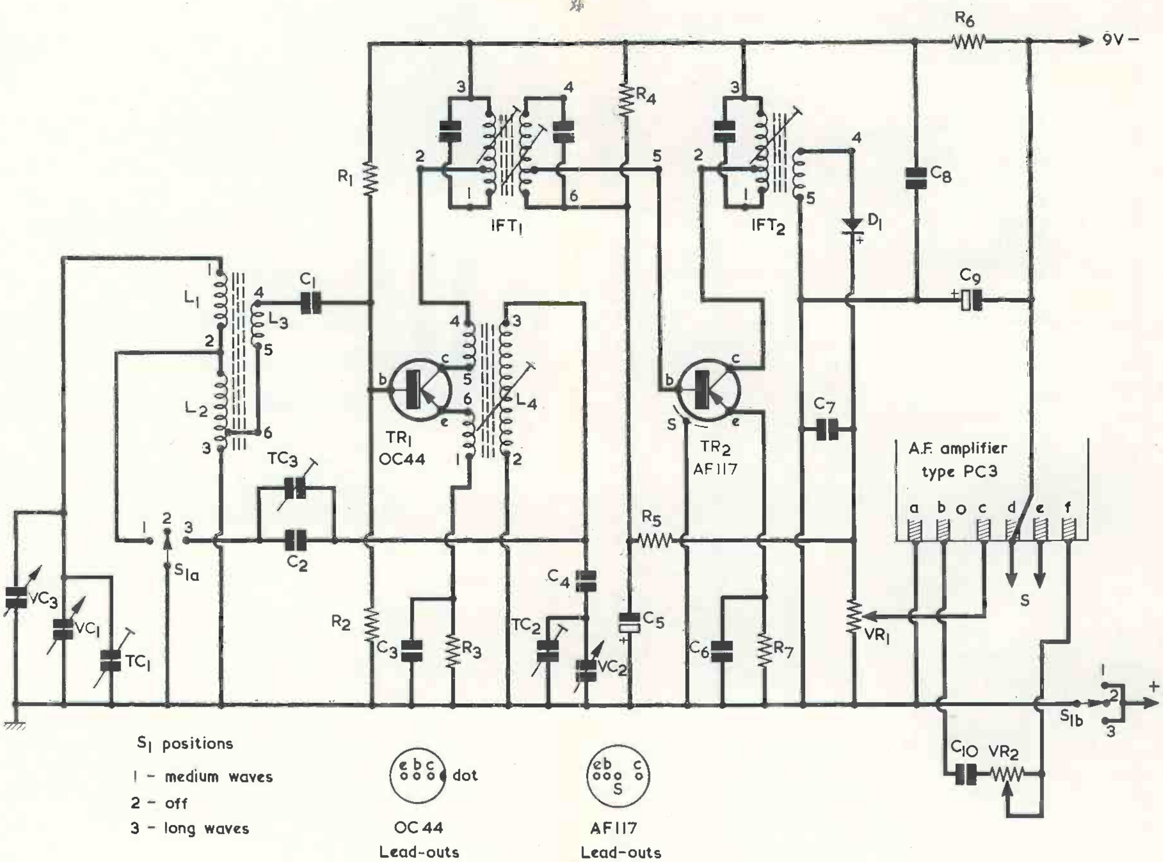
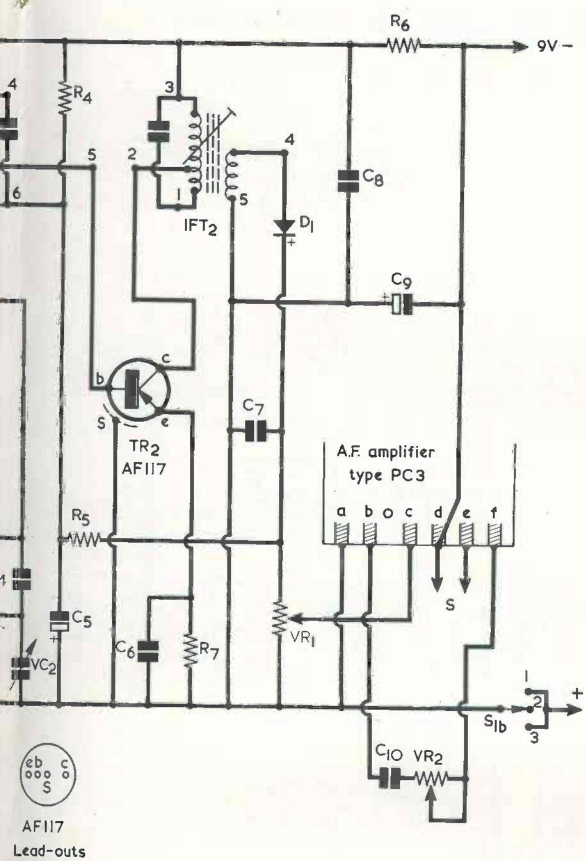
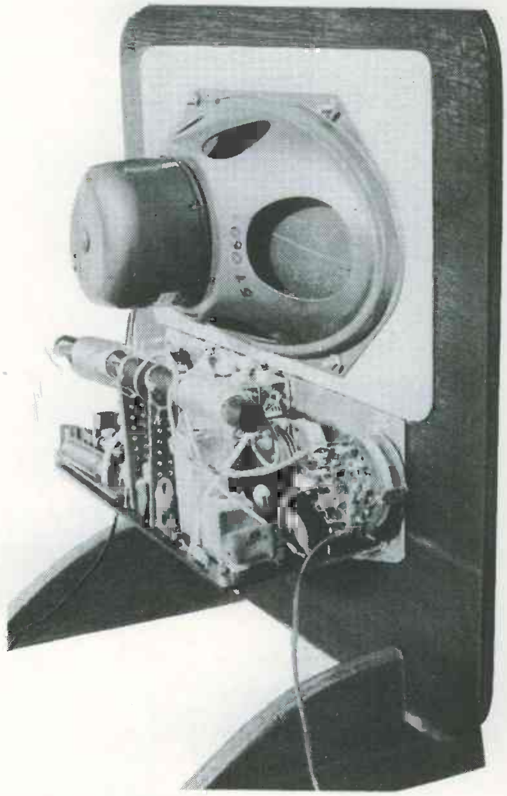


Fig. 1. The circuit diagram of the 'Bafflette' medium and long wave receiver



'lette' medium and long wave receiver*



A side view of the receiver. The only woodworking required is the cutting out of the baffle and its two feet

The r.f. and i.f. part of the circuit has, as will be seen, relatively few components. There is a corresponding simplification in wiring and assembly.

The a.f. amplifier is a high gain package incorporating five transistors, and it has a complementary output stage which connects directly to a 15Ω speaker. The maximum output is 400mW, which is quite adequate for ordinary purposes. In fact, the combination of mixer, i.f. stage and audio amplifier will be found to give excellent reception.

VR1 varies the input to the a.f. amplifier and thus functions as the volume control for the receiver. The amplifier has provision for a negative feedback tone control, this being given by VR2 and C10. VR2 is panel mounted and provides good control over the tonal balance of reproduction.

S1(a)(b) is a 2-pole 3-way rotary switch, wired so that the central position is 'Off'.

A.F. AMPLIFIER

The amplifier type PC3 is available from Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex. It has six printed circuit connecting strips located, as viewed from the copper side of its board, in the manner illustrated in Fig. 1. Small holes pierced at these strips

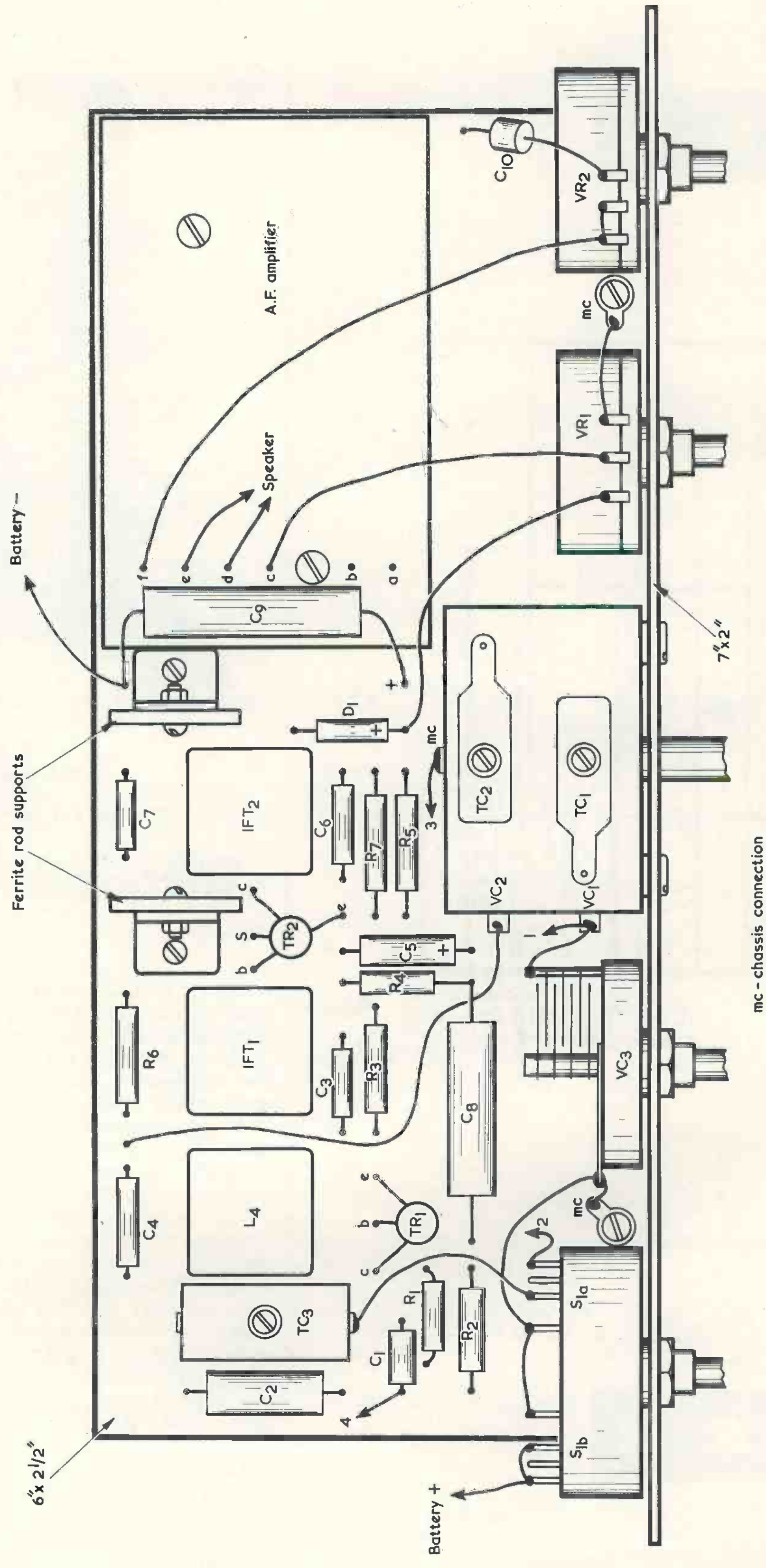


Fig. 2. Components and wiring on the top of the circuit board

allow connecting wires to protrude above the board, where desired. Connecting leads can be 26 s.w.g. tinned copper covered with sleeving or similar. For interest, the internal circuit of the amplifier is shown in Fig. 6.

Construction commences with the soldering of leads a few inches long and projecting below the amplifier board at connecting strips 'a' and 'b'. Next, solder leads about eight inches long, to project above the board, at 'c', 'e' and 'f'. Pass a wire through connecting strip 'd' and solder this so that there are several inches below the board and about eight inches above. All these leads will be shortened, as required, when they connect to the appropriate components in the circuit. These soldered connections should be made using a correct radio-type resin-cored solder, such as Multicore 'Ersin' or 'Savbit'. The same applies to all other solder joints made in the receiver. Paste or liquid flux must *not* be used.

CIRCUIT BOARD

The circuit board is 6in. by $2\frac{1}{2}$in., and may consist of plain $\frac{1}{16}$in. Paxolin drilled as shown in Fig. 2 for component lead-outs. Alternatively plain Veroboard (i.e. without copper strips) or perforated Eyelet Board may be employed, the component lead-outs passing through holes corresponding approximately in position to those indicated in Fig. 2.

Whatever board is used, it will be necessary to drill out holes for the pins and mounting lugs of L4, IFT1 and IFT2. These are located as illustrated in Fig. 3, which shows the underside of the circuit board. Drilling positions for the pins can be found by pressing these lightly against a piece of paper to form indentations, placing the paper over the insulated board, and marking through at the indentations with a pointed tool. If any of the holes are a little out of position, a very small round file can be used to enlarge them so that the components fit readily. Note that a central hole is needed under IFT1 to allow adjustment of its lower core. Be sure to position the pins as shown, so that the coil and i.f. transformers have correct orientation. Otherwise, the wiring will be incorrect.

Two 6BA clear holes are also drilled to match those in the a.f. amplifier, and three more to allow the passage of wires through the board from connecting strips 'a', 'b' and 'd'. A hole is also required for the lead to C10. This hole is shown in Fig. 2 only. Two further 6BA clear holes are required for the brackets which take the ferrite aerial supports. Further details on these brackets are given later in this article. Two 6BA clear holes are

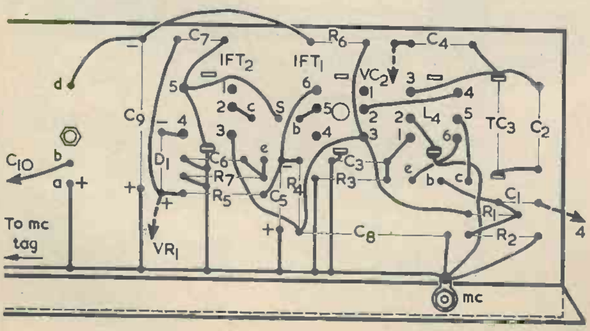
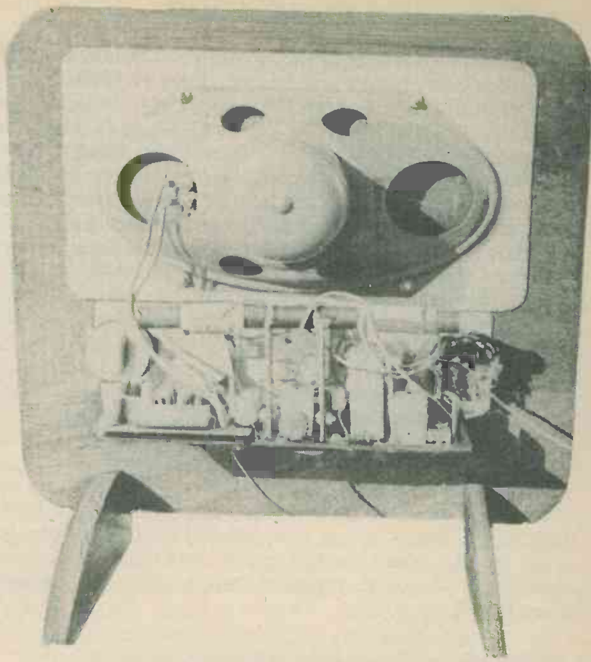


Fig. 3. The wiring below the board



The rear of the receiver. The layout of components is neat and compact

also required at the positions marked 'MC' in Fig. 2. (As is explained in the next section, these match up with two holes in the metal sub-panel.)

If plain Paxolin sheet is used, finally drill out all the remaining holes indicated in Fig. 2. Exact positioning of these holes is not essential, and it will be helpful to use the components themselves as a guide to hole positioning. All holes which take wires, including the three from the a.f. amplifier and that to C10, are made with a $\frac{1}{16}$in. drill.

METAL SUB-PANEL

A metal sub-panel is employed and the five controls are mounted on this. It consists of a flanged 'Universal Chassis' member measuring 7 by 2in. with the end flanges and one long flange cut off. The remaining long flange is drilled to match the two 6BA clear holes in the circuit board which are indicated as 'MC' in Fig. 2. The two items can then later be secured together with 6BA bolts and nuts, a solder tag being fitted under each bolt head and another under each nut. The circuit board is above the flange. The sub-panel is not, however, fitted to the circuit board until the panel control holes have been made and the controls mounted.

Five holes for the controls are cut out with the spacing indicated in Fig. 5. These are all at the same height on the metal sub-panel with the hole for VC1/2 on the vertical centre line of the panel. The height should be such as to allow clearance for the moving vanes of VC1/2 when the circuit board is in position above the flange. VC1/2 requires a $\frac{3}{8}$in. or $\frac{1}{2}$in. hole, whilst the other controls all fit in $\frac{3}{8}$in. holes. After the sub-panel holes have been cut out, the sub-panel may be used as a template to mark out the corresponding holes in the baffle. These holes are then cut out, at the height indicated in Fig. 5.

VC1/2 is mounted, with its trimmers uppermost, by three 4BA bolts passing through the metal sub-panel. The three holes needed in the panel are equi-spaced on a

1in. diameter circle with the capacitor spindle as centre. The 4BA bolts used must be *very short* so that they do not penetrate further than the thickness of the capacitor front plate. If the bolts are allowed to pass through the plate they can damage the fixed or moving vanes immediately behind the plate. If necessary, a washer or two can be put on each bolt between the capacitor front plate and the metal sub-panel, but the capacitor must not be spaced back too much or there will be insufficient spindle projection through the baffle to allow correct fitting of its control knob. The rear surface of the baffle is recessed with a drill or chisel to clear the three 4BA bolt heads. The metal sub-panel will then lie flat against the wood.

The whole receiver is wired with the sub-panel fitted to the circuit board, as in Fig. 2. Later, the securing nuts of S1(a)(b), VC3, VR1 and VR2 are removed, and the receiver is fitted to the baffle so that the bushes pass through the matching holes in the wood. The nuts are then replaced, holding the receiver assembly and baffle together. Correct fitting here should be readily obtainable as the holes in the baffle and sub-panel were accurately matched together before any components were fitted.

WIRING

When wiring, note the polarity of D1, C5 and C9, which should be as in Fig. 2. The points marked 'MC' in this diagram are chassis connections at the 6BA bolt heads which secure the sub-panel and circuit board together. There is also an 'MC' point at the rear frame lug of VC1/2. This connects to point 3 of the ferrite rod aerial assembly. However, it is advisable to fit this assembly, and the a.f. amplifier, later. Put insulated sleeving on connecting leads where necessary, as on the lead from the positive end of D1 and the lead from the fixed vanes of VC2.

Connections under the circuit board run approximately as in Fig. 3. In many cases the lead-outs of resistors and capacitors will be long enough to reach the connecting points. If not, extension lengths of 26 s.w.g. or similar wire can be soldered to them.

Insulating sleeving should be fitted on all leads which may touch other wires, tags or joints. It is helpful to use red sleeving for the positive ('MC') leads, black for the negative circuits, and a third colour for other connections.

If a mark with coloured ink is made on the appropriate diagram as every component and lead in Fig. 2 and every lead in Fig. 3 is fitted and connected, it is almost impossible for anything to be missed out or wrongly wired.

Numerous chassis returns are made to a bare wire which runs direct between the solder tags under the two 6BA mounting nuts. The metal can tags of L4, IFT1 and IFT2 must be connected to chassis, as shown in Fig. 3. The battery negative and battery positive leads are flexible wires coloured black and red respectively and should be long enough to pass to a battery standing behind the baffle on the same surface. They should be terminated with the requisite battery connector clips.

TRANSISTORS

It is as well to leave fitting the transistors until all the other joints in Figs. 2 and 3, apart from those to the a.f. amplifier and ferrite aerial, have been soldered. The transistor lead layouts are given in the inset in Fig. 1, where the transistors are shown in the conventional manner with the lead-outs pointing towards the reader. The wires can be more readily identified when the transistors are in position if thin coloured sleeving is put on them. This can be green for emitter, blue for base and orange for collector. The shield lead ('S') of TR2 can be left bare. If these pieces of sleeving are about ⅜in. long, they will ensure that the transistors are at a suitable height above the circuit board.

Solder the transistor lead-outs with the usual care that is taken with components of this nature. If the iron is correctly heated, it should only be necessary to hold it in contact with the joint for a few seconds, and it is removed as soon as the joint is made. Any excess wire can then be snipped off.

The a.f. amplifier can be fitted next. The wires from connecting strips 'a', 'b' and 'd' are threaded through the appropriate holes in the circuit board. The amplifier is held in place with two 6BA bolts and nuts. Extra nuts or washers are fitted on these bolts between the amplifier and the circuit board to give a little clearance.

The wires from 'a', 'b' and 'd' are connected up as in Fig. 3. Above the circuit board connect the lead from 'f' to VR2 and that from 'c' to VR1, shortening these as necessary. The leads from 'd' and 'e' are left for connection to the speaker later.

FERRITE AERIAL

Fig. 4 shows connections to the ferrite aerial and to S1(a)(b). The aerial rod is supported by two strips of Paxolin about 1¾ to 2in. long and ½in. wide. These are shaped as illustrated in Fig. 4 and are secured by the brackets shown in Fig. 2. The latter can be made from scrap metal and should be small enough to fit in the space available on the circuit board for them. The Paxolin strips are secured to the brackets with 6BA bolts and nuts and the brackets to the circuit board with similar bolts and nuts. A hole is required near the upper end of each Paxolin strip. The ferrite rod can then be tied to the top of each strip by thin string or thread passed through this hole. It is mounted with L1 at the S1(a)(b) end of the chassis.

The aerial connections should be left a little slack, to allow the windings to be moved on the rod. The connections required can be adjudged from Figs. 1, 2 and 4.

Point 1 of the aerial assembly is the beginning of the medium wave winding and it connects to the fixed

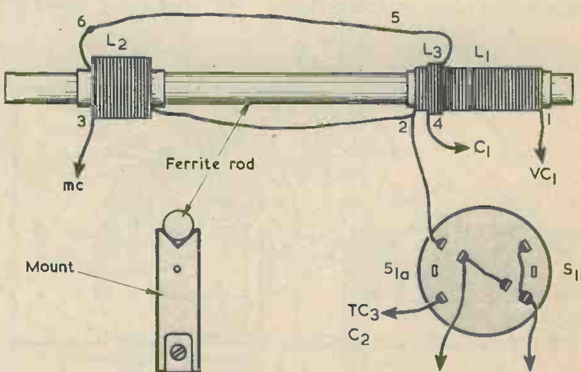


Fig. 4. Illustrating how the ferrite aerial is mounted and wired up

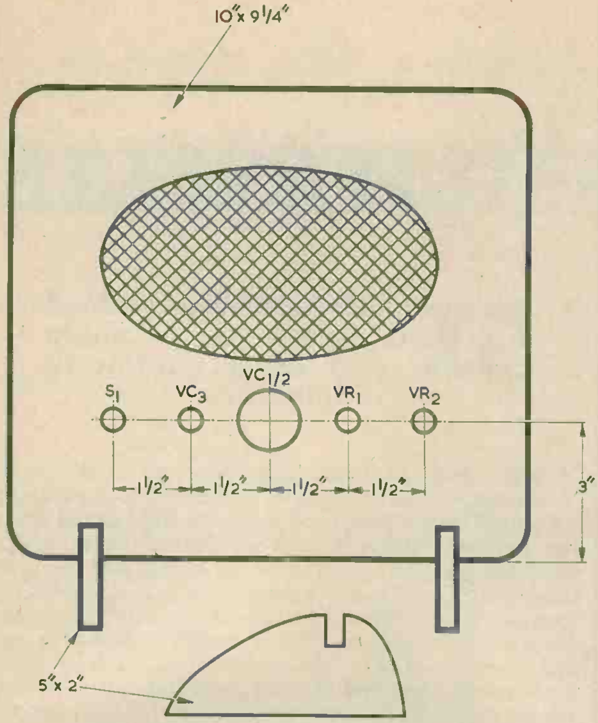


Fig. 5. Dimensions at the front of the receiver

vanes of VC1. Point 2 is the end of the medium wave winding and the start of the long wave winding and it connects to S1(a). Point 3 is the earthy end of the long wave winding and it connects to the frame tag 'MC' of VC1/2. Point 4 is the beginning of the medium wave coupling winding and it connects to C1. Point 5 is the end of this winding and it connects to the tap, point 6, in the long wave winding.

To avoid possible alignment difficulties on long waves, note that the windings L1 and L2 are put on the rod in such a way that the turns of L2 are in the same direction as those of L1, so that the inductance of L2 adds to that of L1. If this is not the case, proper long wave alignment is impossible, and it is necessary to slip L2 off the rod, turn it round and replace it. Also note that the tap in L2 at point 6 is electrically near end 3. If an ohmmeter is available, the resistance between points 6 and 3 will be found much lower than the resistance between points 6 and 2.

Thin sleeving can be passed over the ferrite aerial leads, which are themselves long enough to reach the various circuit points to which they connect.

BAFFLE

The baffle is about 10in. by 9¼in., as in Fig. 5. It will be found that 6mm. plywood is amply strong. If thicker material is used there will be some difficulty in fitting the control bush nuts and the knobs. The feet are each about 5in. by 2in. and are cut 1in. from the front to take the bottom edge of the baffle.

A speaker aperture is required and this should be cut out to match the speaker cone dimensions. It should be positioned such that the speaker will be comfortably clear of the receiver metal sub-panel when the latter is fitted. When the speaker aperture and all other holes in the baffle have been cut, the feet are glued in position and the assembly is then cleaned up with glasspaper and varnished.

The speaker can be secured with bolts and nuts, or with woodscrews which are short enough not to pass through the wood. A piece of speaker fabric is stretched over the aperture and glued in place before the speaker is mounted. In the prototype a piece of thick cardboard, with a hole to match that in the baffle, was placed between the speaker and the baffle to damp out possible resonances.

Finally, the receiver is fitted to the baffle as already described. The leads from connecting strips 'd' and 'e' of the a.f. amplifier are then connected to the speaker, the leads being shortened as necessary.

I.F. ALIGNMENT

As already stated, the i.f. transformers are supplied pre-aligned, and should not be touched before commencing alignment. A correctly shaped trimming tool, such as the Denco tool type TT5, must be used for adjusting the cores in the i.f. transformers and L4. A wedge-shaped blade can easily break the cores.

Set VR1 at or near maximum and correctly tune in a *weak* signal on the medium wave band. Give each i.f. transformer core a very slight turn, one way and the other, to find if this gives any improvement. Set each core in the position which gives greatest volume. The process is quite easy but it is essential that it be carried out with a weak station. If a strong signal were chosen, and VR1 turned back, the automatic gain control action would make the correct setting of the cores less obvious.

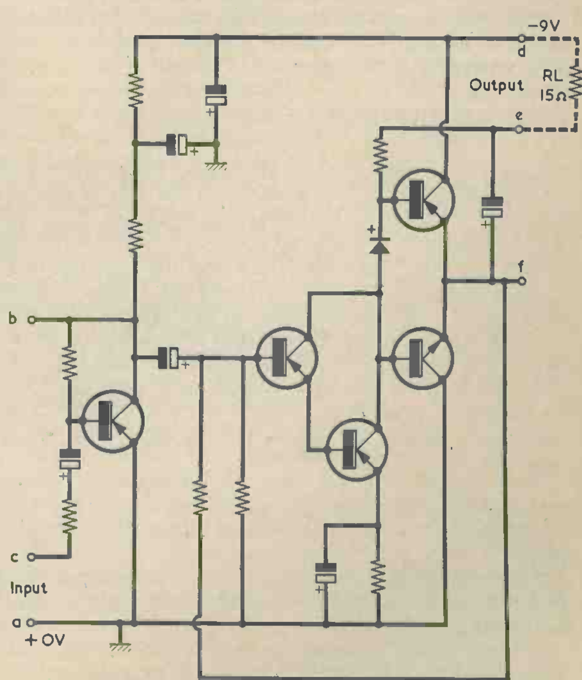


Fig. 6. The internal circuit of the PC3 a.f. amplifier

Once the i.f. transformer cores have been adjusted they need no further attention and should be left alone.

M.W. ALIGNMENT

The high frequency end of either band is reached with VC1/2 fully open. The low frequency end is reached when the vanes of VC1/2 are fully enmeshed.

Commence by unscrewing TC1 almost completely. (Due to the presence of VC3, TC1 should offer a low capacitance only.) Set VC3 at about half its maximum capacitance, screw TC2 about half-way down and switch to medium waves.

Tune in a signal near the high frequency end of the band. Rotating VC3 should enable this to be peaked to maximum volume. Tune in a signal near the low end of the band. Move L1 along the ferrite rod to the position which gives maximum volume. Repeat these two procedures a few times.

Maximum efficiency is obtained if VC3 can be peaked for best volume throughout the band, provided that this does not incur VC3 being either fully open or fully closed. The amount of adjustment required in VC3 can be reduced by slight re-adjustment of TC1 and TC2 at the high frequency end of the band and by moving L1 on the rod at the low frequency end.

If necessary, the wavelength or frequency reached at the high frequency end of the band can be altered by adjusting TC2, and the wavelength or frequency reached at the low frequency end of the band can be altered by rotating the core of L4. This allows medium wave coverage to be set up as wished, but if TC2 is adjusted, TC1 or VC3 must be set up for the new frequency being received. Similarly, if the setting of L4 core is changed, L1 has to be re-positioned on the rod.

Normally, it will be found that there is no difficulty at all in setting VC3 and L1 so that proper medium wave reception is obtained.

L.W. ALIGNMENT

Long wave alignment is similar to that for medium waves, except that L2 is moved on the ferrite rod and oscillator coverage is adjusted by means of TC3. If a signal generator is not available, set VC1/2 to the half closed position, and adjust TC3 and the position of L2 on the rod for best volume from the Radio 2 transmission on 1500 metres. Due to the presence of VC3, no long wave trimmer is provided across L2 for adjustment near the high frequency end of this band. If L2 is moved along the rod by a considerable amount it may be necessary to slightly readjust the position of L1 for maximum signal at the low frequency end of the medium wave band.

The position of the core of L4 does, of course, considerably influence long wave coverage. If, however, L4 is altered, re-alignment will be necessary on medium waves.

There is no slow-motion drive on the tuning control. If a reasonably large knob is used here, tuning will be found to be quite simple to carry out.

A final point is concerned with the a.f. amplifier. This should not be coupled to a load impedance lower than 15Ω, as dissipation in the output transistors may then become excessive. The amplifier output connections must not be allowed to short-circuit to each other.

Quiescent current consumption is approximately 12 to 14mA and a PP9 battery is suitable. ■

VERSATILE

A simple test instrument which functions both as a diode checker and as a continuity indicator.

THERE MUST BE MANY CONSTRUCTORS WHO HAVE invested in one or more of the inexpensive packs of 'untested' diodes which are available periodically from the popular semiconductor specialists. These packs represent extremely good value for money and can save the experimenter many times the initial expenditure. There follows, however, the task of selecting serviceable devices and ascertaining their polarity. Primarily all that is required is a 'Yes or No' indication of each diode's usefulness and in most cases this is carried out using a resistance range of a multimeter. Unfortunately this method suffers from being somewhat tiresome and time-consuming. It is also totally unnecessary if the simple unit to be described is at hand. This test unit is pocket-size, efficient in use, doubles as a continuity indicator, and is cheap and easy to build.

CIRCUIT

The circuit, shown in Fig. 1, was devised to provide a compact and economical unit capable of testing a wide

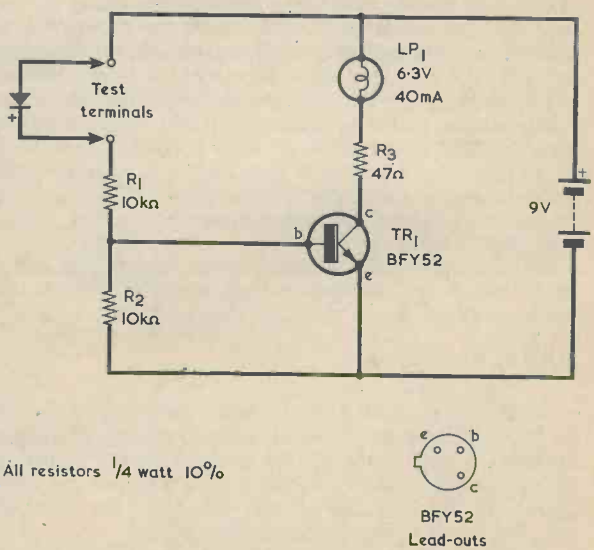


Fig. 1. The circuit of the diode tester

DIODE TESTER

by J. A. Nekrews

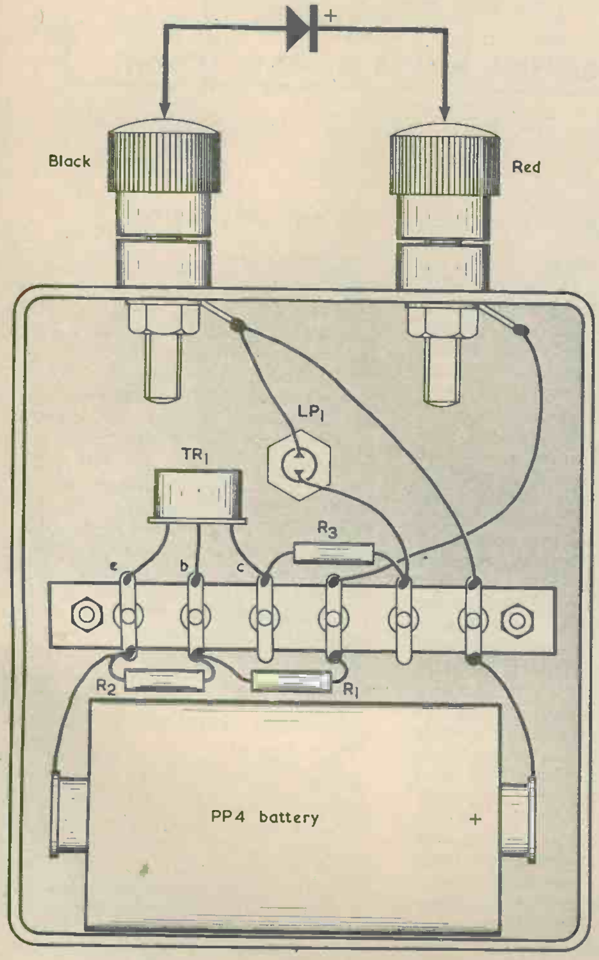


Fig. 2. How the author's tester was wired up

range of diodes and rectifiers without the risk of destroying the more sensitive signal type diodes by passing excessive current through them. The forward current passed by a conducting diode connected to the test terminals is only of the order of 0.8mA, which is the current required to 'switch on' the transistor. The latter is a type BFY52, which has a minimum current gain figure of 60.

CONSTRUCTION

The prototype was assembled in a small plastic box measuring 2$\frac{3}{8}$ by 2$\frac{3}{4}$ by 1$\frac{1}{4}$in. deep, using the layout and wiring shown in Fig. 2. Most of the components were mounted on a small 6-way tagstrip. A suitable tagstrip would be the Cat. No. BTS62 available from Home Radio. However, with a unit of this type layout is of no consequence and the constructor is free to build it in any form to suit available components. The prototype employed a PP4 battery, but any other small 9 volt battery can be used instead. No on–off switch was fitted, as it was felt that the drain on the battery is negligible when the tester is not in use. At room temperatures the leakage current in a BFY52 is 0.5μA maximum and 0.01μA typical.

The lamp used by the author was an R.S. Components Miniature Indicator, Filament, rated at 6.3V 40mA. This is a panel-mounting item available in amber, green or red, and it can be obtained from stockists of R.S. Components parts. However, 6V 40mA bulbs can be obtained from many suppliers as an m.e.s. item which screws into a bulbholder, and one of these could be employed instead.

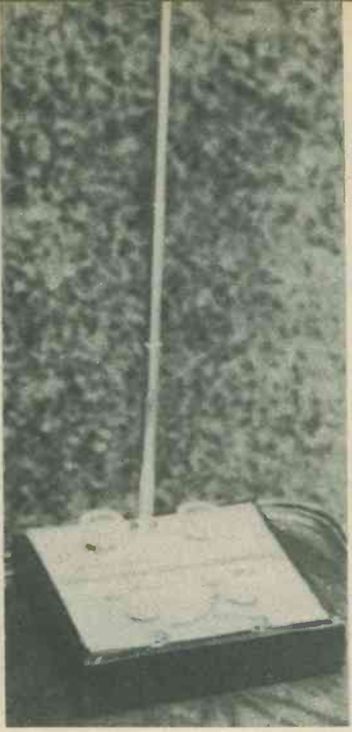
The test terminals used also accept 4mm. wander plugs and it is helpful to have the terminals coloured as indicated in Fig. 2. The bulb lights when the cathode of the diode connects to the red terminal and the anode connects to the black terminal. A pair of leads with small insulated crocodile clips were made up and these facilitate the execution of in-circuit tests which, in practice, were found to give reliable results in the majority of cases. The leads also permit the use of the tester as a continuity indicator.

OPERATION

In use, the lamp lights when a germanium or silicon diode is connected observing correct polarity. It will not light if the polarity is incorrect. So when checking an unmarked device it must be tried both ways; if the lamp remains lit regardless of polarity the diode is short-circuited. If the lamp remains unlit regardless of polarity the diode is open-circuit.

The tester is suitable for checking all types of germanium and silicon rectifier, switching and detector diodes, regardless of rating. After using this handy little unit for a few months the busy experimenter will wonder how he ever managed without it.

May all your diodes be good ones! ■



The 'DRC JUNIOR' SHORT WAVE RECEIVER

by

Sir Douglas Hall, K.C.M.G., M.A. (Oxon)

Using two transistors in a reflex circuit, this receiver covers the short wave bands from below 6MHz (50 metres) to higher than 18MHz (16.7 metres). It may be operated on its own as a personal receiver or in conjunction with the 'Sliding Junior' a.f. amplifier.

THE SPONTAFLEX DOUBLE REFLEX Colpitts short wave circuit was first introduced in *The Radio Constructor* in January 1968, though a basically similar circuit had been used in a design by the author in this magazine for August 1964. A silicon version of the DRC2 receiver was described in February 1970 and the circuit was used in an all-wave portable, the 'Export Spontaflex', which appeared in the issue for February 1971. The 'Spontaflex' DRC3, a very sensitive inductance headphone receiver using variable tuning appeared in June 1972.[1]

The present design uses most of the developments which have taken place plus a new modification which increases sensitivity. It is also considerably simplified, even though bandspread tuning is used. It is not intended to replace the DRC3, which is still recommended for serious DX listening. But even though only two transistors are used in the latest version, it has a sensitivity about half way between the earlier 2-transistor designs and the DRC3. It is made to the same dimensions as the 'Hiflex' medium and long wave personal portable and is equipped with switch contacts to allow it to be used immediately, and without modification, with the 'Sliding Junior' Amplifier.[2] It will be recalled that the 'Hiflex' uses a construction in which all parts are mounted on a plywood panel 5in. square, this having four 1in. 4BA bolts at the corners which project downwards and function as support 'legs'. Three of these bolts are used as contacts when the 'Hiflex' is employed with the 'Sliding Junior' amplifier, and they rest on corresponding springy brass strips on the top shelf of the amplifier. Two of the contacts enable the 'Hiflex' to take a 3-volt supply from the amplifier, whilst the third couples the receiver output to the amplifier input. The same system is employed with the present receiver, which may be used in conjunction with the 'Sliding Junior' or as a complete receiver on its own driving earphones. Thus, the 'Sliding Junior' amplifier is not an essential adjunct.

CIRCUIT OPERATION

The circuit is shown in Fig. 1. A telescopic aerial couples to the input control VR1, this being a 100Ω potentiometer which acts as a radio frequency gain control and which is also adjusted in conjunction with the reaction control to achieve the degree of selectivity required for different conditions. It may be found that when listening to stations on the higher wavelengths, such as the 41 and 49 metre bands, volume is not fully reduced as VR1 is turned back. This is because in these circumstances pick-up by the ferrite rod incorporated in the tuning coil is more efficient since, as will become clear later, a greater proportion of the ferrite rod is inside the tuning coil and it is more effective at the lower frequencies. Orientation of the receiver to reduce this direct pick-up can be carried out to advantage.

The aerial signal is now at the emitter of TR1 which acts as a common base radio frequency amplifier, the output appearing across the r.f. choke L2 and being applied to the tuned circuit given by L1, VC1 and VC2. The signal is then fed to the base of TR2 which, being a 'Spontaflex' amplifier offering common collector amplifications at radio frequencies, provides a very high impedance load. The signal next appears across the diode D1 and is automatically fed back as a.f. through TR2 which this time acts as a common base amplifier at audio frequencies. A much amplified audio frequency signal appears across the load given by R3 and VR2.

The collector of TR2 couples to the base of TR1, which now acts as a common emitter amplifier (not as a

1 Sir Douglas Hall, 'The "Spontaflex" Transistor Short Wave Receiver', *The Radio Constructor*, January 1968; '6-Stage 3-Transistor Short Wave Reflex Receiver', *The Radio Constructor*, August 1964; 'Developing The "Spontaflex" Short Wave Receiver', *The Radio Constructor*, February 1970; 'The Export "Spontaflex", A 13.8 to 645 Metre Portable', *The Radio Constructor*, February 1971; 'The DRC3 Bandspread Short Wave Receiver', *The Radio Constructor*, June 1972

2 Sir Douglas Hall, 'The "Hiflex" Personal Receiver', *Radio and Electronics Constructor*, May 1973; 'The "Sliding Junior" Amplifier', *Radio and Electronics Constructor*, June 1973. These issues are availabe at 20p each plus 6p postage for one issue or 8p postage for both issues.

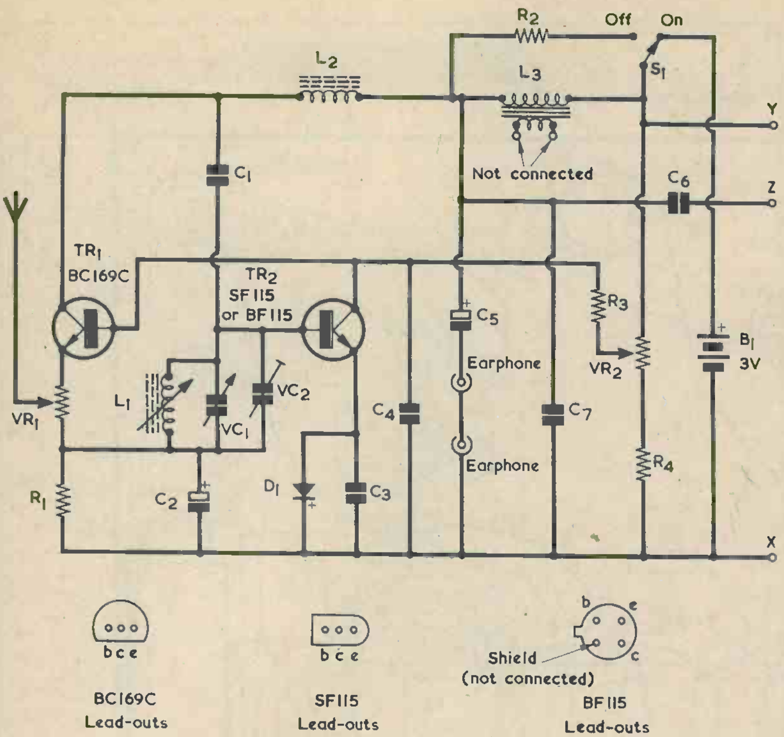


Fig. 1. The circuit of the 'D.R.C. Junior' short wave receiver. The letters X, Y and Z refer to connections made to the 'Sliding Junior' amplifier

common collector device as occurred with the first transistor in all earlier DRC circuits) and allows a further amplified signal to appear across the output choke, L3. This choke is the large winding of an interstage transformer. The r.f. choke, L2, offers negligible impedance to the audio frequency signal at TR1 collector. Because VR1, which is part of the emitter load of TR1, is not bypassed, some negative feedback of the audio signal takes place and the input impedance of TR1 is thereby increased. This means that it more closely matches the comparatively high output impedance at the collector of TR2. Matching is therefore catered for and, at the same time, a useful degree of voltage amplification is given by TR1. This provides some of the increased gain in the present circuit as compared with earlier DRC receivers.

A suitable bias current for TR2 becomes available due to the voltage drop across R1. TR1 is biased by the current made available by VR2 and R3, which also provide collector current for TR2.

Reaction takes place by the Colpitts capacitance tap method, the tap being provided by C3 which is, in series with C4, effectively between the emitter and collector of TR2. The degree of reaction available is adjusted by altering the amplification of TR2 by varying the current which can pass through it. It should be noted that although the radio frequency amplification falls as the current available for TR2 is reduced by adjusting VR2, the consequent increase in the collector load actually enhances the audio frequency amplification given by TR2, amplification at audio frequencies being far less affected by a reduction in current. This method of reaction control therefore gives efficient results. The presence of R4 ensures that a large proportion of VR2 track can be used for control of reaction, whilst R3 prevents the appearance of the rather heavy currents which could otherwise flow when VR2 slider is at the positive end of its track.

Tuning is carried out by altering the inductance of L1, this being effected by moving a length of ferrite rod in and out of it. A range from below 6MHz (50 metres) to higher than 18MHz (16.7 metres) is provided. Trimmer VC2 ensures that the correct range is covered, and VC1 is a panel control which provides bandspread. The use of variable inductance tuning gives a high inductance-to-capacitance ratio in the tuned circuit and this enables greater voltage gain to be obtained on most wavelengths than occurred with the earlier DRC designs which had variable capacitor tuning. A further advantage of employing variable inductance tuning is that the bandspread control offers an equivalent coverage at all settings of the main bandset tuning control. With normal capacitance bandset tuning the bandspread control offers an excessively large range at high frequency settings of the bandset tuning control and an undesirably small range at low frequency settings of the bandset tuning control.

TR2 may be either an SF115 or a BF115. When a BF115 is used, no connection is made to its shield lead-out.

Two separate Acos 1kΩ earphones are used for personal listening, these being fed by way of the 2μF capacitor, C5. These earphones, in series, offer an optimum load for output power. Low impedance magnetic earphones, or crystal types, will not prove satisfactory. When the receiver is used in conjunction with the 'Sliding Junior' amplifier, the output to the amplifier is fed via the 0.1μF capacitor, C6. In this instance S1 is set to 'Off', because the receiver is now powered by the large 3 volt battery in the amplifier, and it causes R2 to be connected across L3. This resistor prevents a tendency towards threshold howl, a condition which often appears when a fairly high a.f. inductive load is used following a regenerative circuit. Threshold howl shows itself as a grunt or growl as reaction is brought up to the oscillation point and it can, in practice, ruin sensitivity. When earphones are employed these provide the necessary damping across L3. Experimentally minded constructors may like to try different values for R2, but they will probably find that the 3.3kΩ value specified provides satisfactory results.

Note that only a 3 volt battery is used. The current drawn from this is a mere 0.7mA. With a power consumption of just over 2mW, this must be one of the most economical short wave receivers that has ever been described!

The components employed are generally available. The two Acos 1kΩ earphones are listed by Home Radio under Cat. No. TR23D. The 100kΩ moulded track linear potentiometer specified for VR2 may be an R.S. Components part, available from R.S. Components suppliers. The 100Ω wire-wound potentiometer must be a small 1 watt type. An R.S. Components 1 watt potentiometer may be used. The telescopic aerial is an Eagle type TA632, and may be obtained from Eagle stockists including G. W. Smith & Co. (Radio) Ltd., 11-12 Paddington Green, London, W.2. The ferrite tuning rod is cut down from a 4 in by ⅜ in. diameter rod obtained from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE. Rods obtained from other

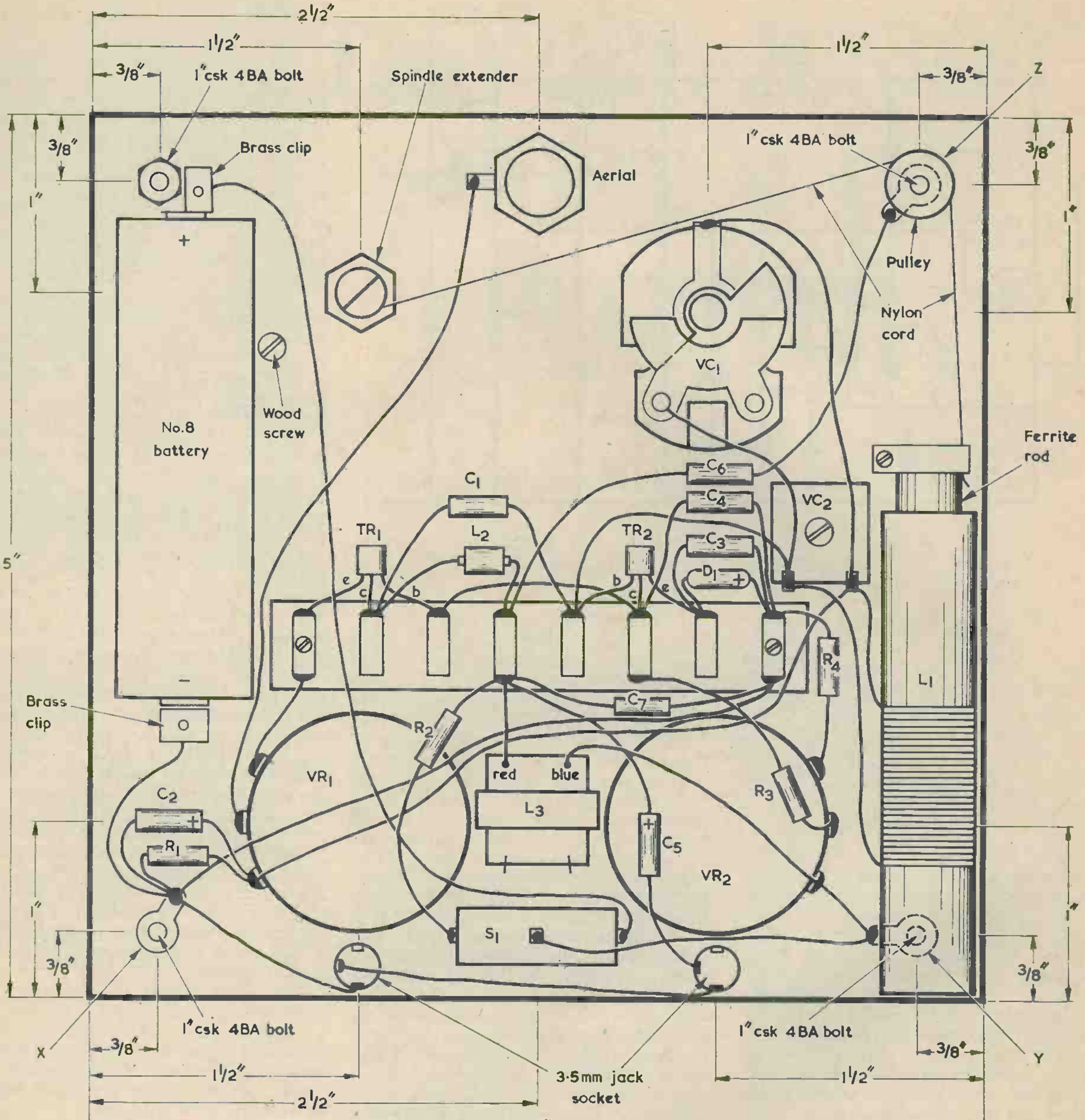


Fig. 2. Component positioning and wiring on the receiver panel

sources may have a different permeability and could give results different from those obtained in the prototype An 8-way tagstrip is employed, this being cut out from an R.S. Components 'standard size' 18-way tagboard, or from the tagboard available from Home Radio under Cat. No. BTS10.

Finally, there are some comments to make concerning the mechanical arrangement for the bandset control. This incorporates a spindle extender and a brass bush, which may be obtained under Home Radio Cat. Nos. DL52B and DL52C respectively. Further required is a pulley wheel (Home Radio Cat. No. DL62) and a length of nylon tuning drive cord. The assembly also employs two plain ¼ in. washers and a compression spring ¼ in. washer. The knob used for the bandset control should be a pointer type having a brass insert threaded to take grub screws. For the sake of appearance it will be desirable for the other three knobs to be of the same type.

CONSTRUCTION

Construction is quite simple, and all components are mounted on a piece of ¼ in. plywood measuring 5 in. by 5 in. If the receiver is to be employed with the 'Sliding Junior' amplifier and the latter has already been built, it should be remembered that the panel has to fit into the cavity at the top of the amplifier case. Should the inside dimensions of the cavity differ slightly from exactly 5 in. square, the outside dimensions of the panel should be modified accordingly.

The layout of components on the rear of the panel is shown in Fig. 2. Four 1 in. 4BA countersunk bolts are fitted at the corners with their ends pointing towards the reader. If the

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	1kΩ
R2	3.3kΩ (see text)
R3	22kΩ
R4	100kΩ
VR1	100Ω potentiometer, wire-wound
VR2	100kΩ potentiometer, linear, moulded track

Capacitors

C1	10pF silvered mica or ceramic
C2	100μF electrolytic, 2.5 V.Wkg.
C3	22pF silvered mica or ceramic
C4	1,000pF silvered mica or ceramic
C5	2μF electrolytic, 4 V.Wkg.
C6	0.1μF paper or plastic foil
C7	0.01μF paper or plastic foil
VC1	10pF variable air-spaced, type C804 (Jackson Bros.)
VC2	40pF trimmer, mica

Inductors

L1	See text
L2	2.5mH r.f. choke type CH1 (Repanco)
L3	Interstage transformer type TT49 (Repanco)

Semiconductors

TR1	BC169C
TR2	SF115 or BF115
D1	OA73

Switch

S1	S.P.D.T. toggle

Battery

B1	3 volt battery, No. 8 (Ever Ready)

Aerial
Telescopic aerial type TA 632 (Eagle)

Earphones
2 1kΩ earphones (Acos)

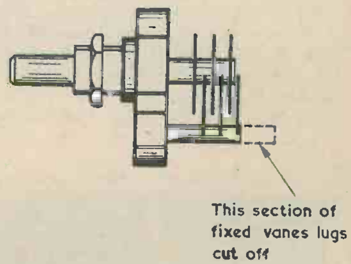
Miscellaneous
2 3.5mm. jack sockets
Tagstrip (see text)
Ferrite rod (see text)
Spindle extender (Home Radio Cat. No. DL52B)
Bush (Home Radio Cat. No. DL52C)
Pulley wheel (Home Radio Cat. No. DL62)
Nylon drive cord
4 knobs (see text)
Plywood, Fablon or Contact, etc.

receiver is used on its own, these act as 'legs' and enable it to stand on a flat surface with the components being clear of that surface. When the receiver is used in conjunction with the 'Sliding Junior' amplifier, the four screws rest on springy brass strips fitted to the amplifier shelf which supports the receiver. Automatic connection to the amplifier 3 volt battery and to its input is then provided by the screws designated X, Y and Z in Fig. 2. (The corresponding brass strips in the amplifier are similarly identified by the letters X, Y and Z.)

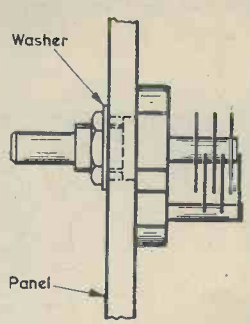
If both the 'Sliding Junior' amplifier, and the 'Hiflex' receiver have been built, and the latter is fitted with the optional switch which automatically cuts out its internal battery when it is inserted in the amplifier case, projecting upwards from the amplifier shelf will be a 6BA bolt whose function is to operate the switch. Components and wiring in the present receiver should be positioned such that they do not foul this bolt when the receiver is fitted in the amplifier case.

Cut out the four holes for the 4BA screws, countersinking these on the side of the panel which is away from the reader. Fit the bolts, securing solder tags under the nuts for those at X, Y and Z. Cut out $\frac{3}{8}$ in. diameter holes for VR1, VR2, VC1 and the bush for the spindle extender. The holes for the aerial and for S1 will need to be cut to suit. A fretsaw is useful here.

It will be necessary to ensure that the fixed vane lugs of VC1 do not project further back than the ends of the 1 in. 4BA bolts, and it will be necessary to cut these shorter, as indicated in Fig. 3(a). Great care must be taken to ensure that the capacitor is not damaged whilst cutting these lugs, and a good approach consists of securing the section to be cut off in a vice, holding the capacitor body with one hand and gently cutting through the lug with a small hack-saw. If the rearward projection of the capacitor is still too great, it may be mounted slightly further forward by enlarging its hole in the panel so that the wider part of its bush passes into the panel hole, as in Fig. 3(b). A washer is then fitted under its mounting nut to cover the wider panel hole. As this method of mounting puts some strain on the ceramic body of the capacitor, the mounting nut should not be over-tightened. In practice, excessive backwards projection of the capacitor, if it is encountered, will be of the order of a small fraction of an inch and it would also be in order to have the four 4BA bolts which act as 'legs' very slightly longer than 1 in. to take it up. None of the other controls will raise difficulties in mounting.



(a)



(b)

Fig. 3 (a). Capacitor VC1 has its fixed vane lugs reduced in length
(b). The capacitor may, if necessary, be mounted in the manner shown here

The 8-way tagstrip, cut as mentioned earlier from an 18-way tagboard, is secured to the panel as shown in Fig. 2. A piece of Fablon or Contact cut to the same outside dimensions is previously fixed to the panel so that it will be under the tagstrip when the latter is fitted. The tagstrip is held in place by two small woodscrews passed through the holes in its end tags. Springy brass clips are used to make contact with the terminals of the No. 8 battery. These clips were made from terminal strips taken from an old No. 800 battery. Note the woodscrew which is used to assist in holding the battery in position. L3 is secured in place with adhesive, a slot being cut in the plywood to accommodate its core.

Coil L1 is made as shown in Fig. 4. A piece of Fablon or Contact, 4 in. by 2¾ in. is cut out. All the backing paper is left on except for a strip ½ in. wide along one of the 2¾ in. edges. The Fablon is then rolled round the ferrite rod to make a tube which is a loose fit on the rod. The exposed ½ in. strip of adhesive should be at the end of the roll; this adheres to the Fablon already rolled on and fixes the tube. It is important that the fit on the rod be good. The rod should be able to slide freely inside the tube, but it should not be able to wobble. If necessary, make two or three tubes until one is achieved which is just right.

A piece of ⅜ in. wood dowelling ½ in. long is cut and slipped into one end of the tube, a turn or two of Sellotape having first been put on to ensure a tight fit. A 4BA clear hole is then

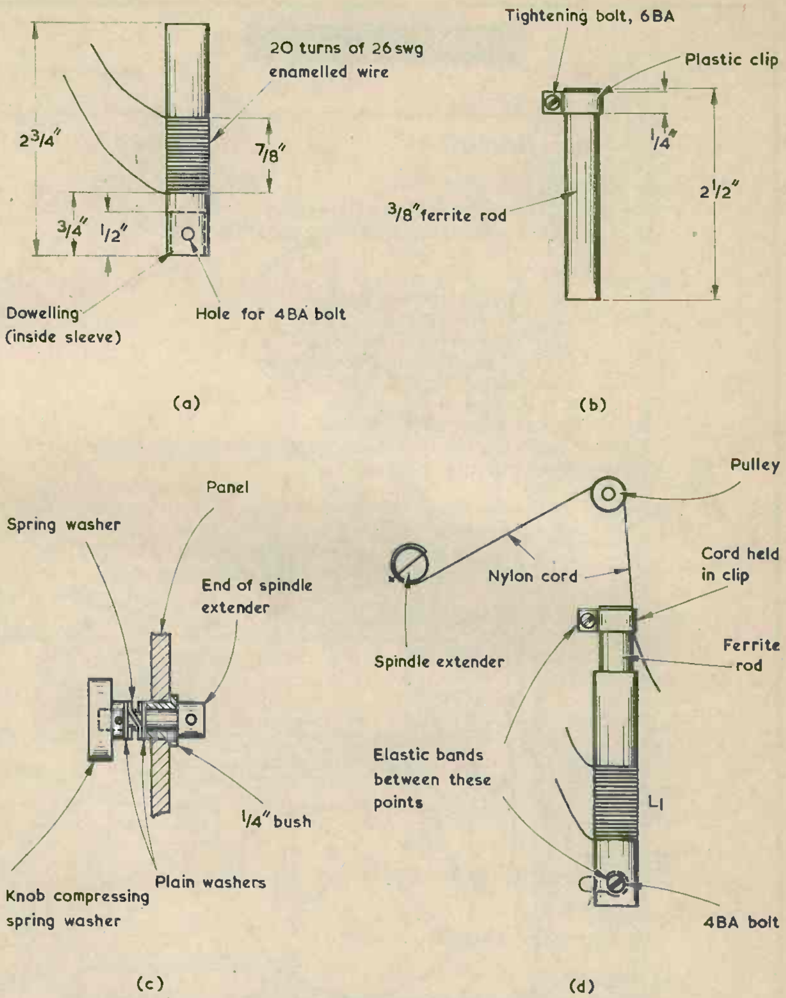
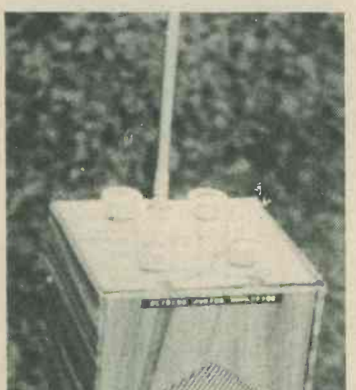


Fig. 4 (a). How coil L1 is wound
(b). The ferrite rod with its plastic clip
(c). The friction spring assembly at the bandset tuning spindle
(d). Illustrating the operation of the bandset tuning



The 'DRC Junior' receiver fitted to the top of the 'Sliding Junior' amplifier

drilled through the tube and dowelling whilst the dowelling is in position in the tube, as in Fig. 4(a). 20 turns of 26 s.w.g. enamelled wire are wound on, as illustrated in the diagram, to make a coil about ⅞ in. long. This will involve spacing each turn by about the diameter of the wire. Secure the winding with Sellotape.

A 2½ in. length of ⅜ in. diameter ferrite rod is required. This can be obtained from the 4 in. by ⅜ in. ferrite rod by filing a mark around the rod at the required place and snapping it off. A clip is made from pliable plastic material and is affixed to the end of the rod as shown in Fig. 4(b), using a 6BA bolt and nut to secure the clip ends. If one end of the rod has a rough edge as a result of snapping it from the longer piece, this end can be the one enclosed in the clip. The clip *must* be plastic, and a metal clip must not be used.

Fit the brass bush to the appropriate hole in the panel. The method of fitting the spindle extender to this brush is illustrated in Fig. 4(c). A spring washer and two plain washers are passed over the spindle and the knob is fitted so that it keeps the spring washer under compression. This is achieved by tightening the knob grub screws whilst the knob and spindle extender are pushed together. The resultant friction ensures that the spindle extender cannot rotate due to the tension exerted on it by the nylon cord which is attached to it. Cut the spindle extender to the desired length and then fit this, the three washers and the knob in the manner just described. The pulley wheel has its centre drilled out to fit the 4BA bolt at position Z, as shown in Fig. 2. The coil assembly is passed over the screw at position Y and is held firm with a nut on the outside. The grub screws of the spindle extender are removed and a length of nylon tuning drive cord with a knot at one end is passed through the grub screw holes. The cord is pulled through up to the knot, is passed round the end of the extender as shown, and then taken round the pulley and under the plastic clip on the ferrite rod. The clip is partially tightened only while the cord is adjusted so that its length is correct to allow full movement of the rod within the coil tube as the spindle extender is rotated. The rod moves into the coil when the tuning knob is rotated in a clockwise direction. When the desired length of nylon cord has been found the clip is tightened fully. An elastic band, or bands, is then fitted between the clip and the 4BA bolt at position Y so as to pull the rod into the coil when the tuning knob is turned clockwise. Two 4BA nuts can, if desired, be passed over the 4BA bolt at position Z to ensure that the pulley remains on this bolt. They are lock-nutted together.

It will be found that the bandset control, i.e. the spindle extender just fitted, will be turned through nearly 360° for the complete movement of the ferrite rod. It is a good idea to fit a small woodscrew at '12 o'clock' on the outside of the panel, and to use a tuning knob with a pointer which can be stopped by this screw. This will prevent the possibility of the control being turned too far in either direction. If the control is turned too far anti-clockwise the nylon cord can become loose and come off the spindle extender.

Wiring up and the fitting of small components is then carried out, as in Fig. 2.

THE RECEIVER IN USE

The only setting up adjustment required concerns VC2. This is adjusted such that the 49 metre band can be covered by the bandspread control, VC1, when the bandset control is set to insert the ferrite rod fully into the coil. This should ensure that the 16 metre band is covered when the bandset control is at or near the minimum wavelength end of its range.

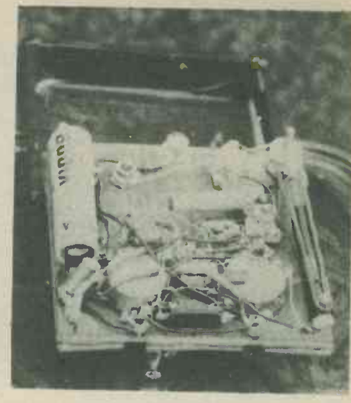
A piece of card with suitable holes for the controls, aerial base, the woodscrew adjacent to the bandset control knob and the earphone sockets can be used to cover the panel, and this may be marked with control functions and calibration figures. It is helpful to mark out a scale for the bandset control showing the main amateur and broadcast bands. This should be done with the bandspread control at a central setting. The card may be covered with translucent book covering cellophane, with a consequent very neat final appearance.

The receiver is operated in the normal manner, the bandset control being adjusted approximately to the signal frequency required, fine tuning then being carried out with the bandspread control. VR2 provides reaction and VR1 is adjusted for the desired gain and for optimum reaction conditions. The telescopic aerial can be extended to a length of about 32 in. When its sections are closed, its swivel base allows it to lay neatly across the top of the receiver.

RECEIVER CASE

If the 'Hiflex' receiver has been built, its case may be used for the present receiver when it is being used with earphones. Details of the 'Hiflex' case are given in Fig. 5 for the benefit of readers who do not have to hand the earlier issue in which the 'Hiflex' receiver was described. The case is made up of four pieces of plywood and a panel of Paxolin or Formica, as shown. The bottom edges of the plywood pieces are secured to the panel as indicated by the broken lines, the result being an open-topped box measuring $5\frac{1}{2} \times 5\frac{1}{2}$ in. with a height of $1\frac{1}{8}$ in. plus the thickness of the panel. This box is covered with Fablon or Contact. The receiver is dropped into the box and, provided there is a good fit, no further fastening should be necessary. The dimensions given in Fig. 5 assume that the plywood panel of Fig. 2 has been cut exactly 5 in. square. If this is not the case the dimensions in Fig. 5 should be modified to suit the actual size of the plywood panel.

When the present receiver is used with the 'Sliding Junior' amplifier no box is required, as it will be ensconced



The components and wiring behind the receiver panel

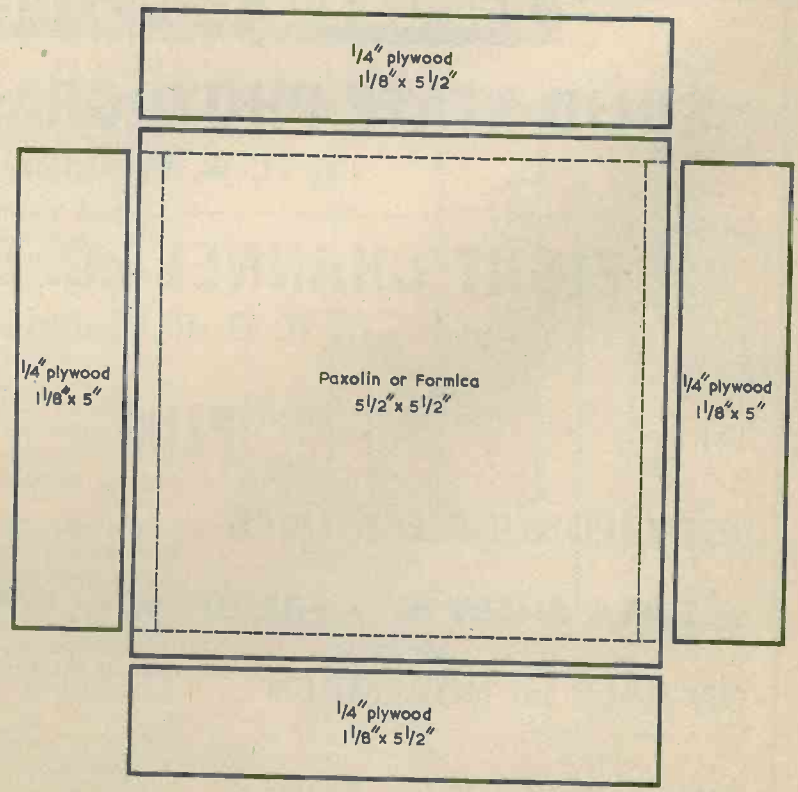
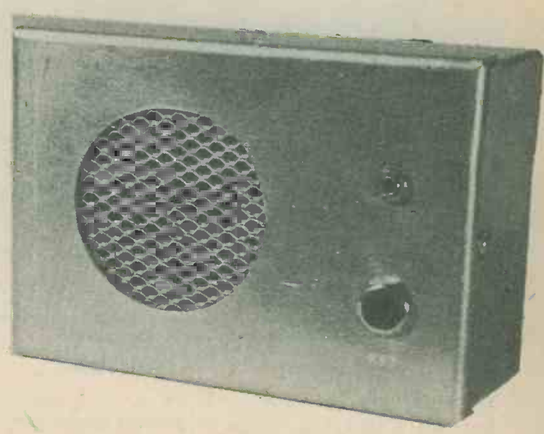


Fig. 5. The parts required for the receiver case, to be used when the set is operated outside the amplifier

When the telescopic aerial is closed it folds neatly over the receiver panel

in the top of the amplifier case. The battery switch, S1, should be in the Off position when the receiver is employed with the amplifier, as the battery of the latter will be automatically brought into use when the receiver is placed in position. The amplifier switch then controls both the amplifier and the receiver. In an emergency, with a run-down battery in the amplifier, it is possible to use the receiver battery for both pieces of equipment by turning the receiver switch on and the amplifier switch off. But the small No. 8 battery in the receiver will not give long service when called upon to provide the fairly heavy current required by the amplifier. Never operate the combined apparatus with both switches on, as a heavy current can then flow from whichever battery has the higher voltage into the other. Remember that the 'Hiflex' has an automatic switch which cuts out its own battery when it is used with the amplifier, this being necessary as a combined wavechange and battery switch is used. However, there is no such automatic arrangement with the present receiver.

MORSE CODE PRACTICE OSCILLATOR



by R. A. Penfold

THIS DEVICE IS A SIMPLE THREE-TRANSISTOR OSCILLATOR unit which can be employed to drive either an integral loudspeaker or high impedance headphones and which is intended for use in learning Morse code. It is self-contained in an aluminium box measuring 4 by 2¾ by 1½in., and the three transistors used are inexpensive silicon types. An output of approximately 150 to 200mW is supplied to the internal loudspeaker, which is a miniature 2½in. type. A current-reading meter is needed to check operation after construction has been completed.

This neat little oscillator unit is completely self-contained, with its own battery and speaker. No on-off switch is required as the battery is disconnected when the Morse key is up.

THE CIRCUIT

A complete circuit diagram of the oscillator unit appears in Fig. 1. Basically, this consists of a single transistor phase shift oscillator driving a complementary pair, TR2 and TR3, in the output stage. The circuit is thus transformerless.

The phase shift oscillator, TR1, is a high gain common emitter amplifier with a phase shift network connected between its collector and base circuits. This network will produce a phase shift of 180° at one frequency and, since there is a further phase shift of 180° between the base and the collector, the circuit will (given sufficient amplification in the transistor) oscillate at that frequency. The operating frequency of the present circuit is in the region of 1.5 to 1.6kHz, the exact frequency depending upon the precise values of the components in the phase shift network. The 2N2924 required for TR1 is available from Bi-Pak or Electrovalue.

The output stage is quite standard. The output coupling capacitor, C5, has a fairly low value as this has only to couple a relatively high frequency to the speaker. The purpose of C1 is to smooth the supply against the sudden changes in potential which occur as the Morse key is depressed and released. Without this component there are annoying clicks from the speaker due to the speed of these changes. C1 discharges rapidly when the key is raised, so that the circuit 'follows' key operation faithfully. R6 is a limiter resistor which reduces current surges at the key contacts when these close. C6 helps to give a purer tone from the unit, and it attenuates any higher frequency harmonics

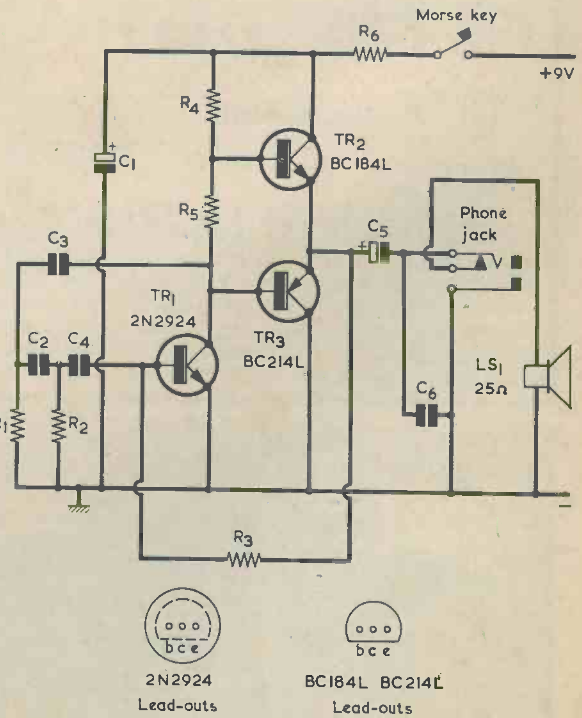
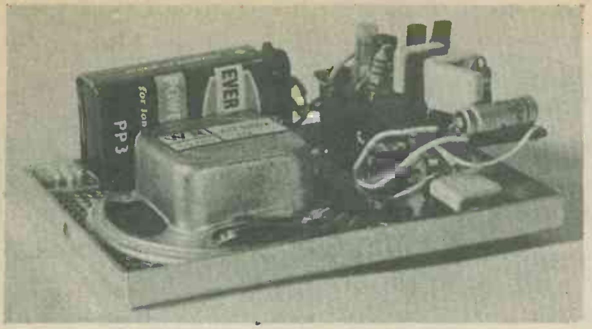


Fig. 1. The circuit of the code practice oscillator.



The components fit neatly around the speaker

COMPONENTS

Resistors
(All ¼ watt 5% unless otherwise stated)

R1	2.2kΩ
R2	2.2kΩ
R3	270kΩ
R4	1.5kΩ
R5	560Ω (see text)
R6	6.8Ω 10%

Capacitors

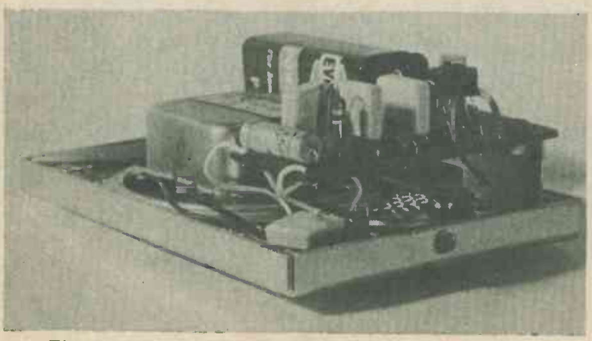
C1	1.5 or 1.6μF, electrolytic, 10 V.Wkg.
C2	0.022μF plastic foil
C3	0.022μF plastic foil
C4	0.022μF plastic foil
C5	25μF electrolytic, 10 V.Wkg.
C6	0.022μF plastic foil

Transistors

TR1	2N2924
TR2	BC184L
TR3	BC214L

Loudspeaker
LS1 25Ω 2½in. (see text)

Miscellaneous
Morse key
Insulated 3.5mm. jack socket (see text)
Switched 2.5mm. jack socket
Veroboard, 0.1in. matrix, 9 strips by 26 holes
Aluminium box, 4 × 2¾ × 1½in., type AB9 (see text)
18 s.w.g. aluminium for bracket
PP3 battery
Battery clips



Three-quarter view, illustrating the components on the Veroboard panel

which may appear in the output. A 2.5mm. switched jack socket appears in the output circuit. When high impedance headphones are plugged into this socket the speaker is silenced. The headphones should have an impedance, or resistance, of at least 500Ω.

The keying circuit employed enables an on–off switch to be dispensed with, as no current is drawn from the battery unless the key is down. The key couples into the circuit by way of a 3.5mm. jack socket (not shown in the circuit diagram). With the key depressed the current drawn from the battery should be of the order of 50mA. When high impedance headphones are plugged in, the current should be a few milliamps only.

CONSTRUCTION

All the components except C6, R6 and the speaker are mounted on a small Veroboard panel of 0.1in. matrix. See Fig.2. This has 9 strips, each with 26 holes. It is mounted, by screws passing through the two 6BA clear holes, to the bracket shown in Fig. 3. There are no breaks in the copper strips but they must, for obvious reasons, be completely cleared away where they would otherwise come into contact with this bracket. A sharp knife is required for this operation.

Fig. 3 gives the dimensions and final shape of the bracket, which is made from 18 s.w.g. aluminium. The three holes should be drilled before it is bent to shape. The two smaller holes are 6BA clear and match up with the two 6BA clear holes in the Veroboard panel. The larger hole is drilled to a size that will take the bush of the 3.5mm. Morse key socket, which is of the insulated type. The exact diameter required can be determined from the socket itself. The bracket is secured to the front panel under the body of the jack socket by passing the socket bush through the large hole. Its final position can be judged from the accompanying photographs.

As was just mentioned, the Morse key jack socket is of the insulated type, i.e. its contacts are insulated from the panel on which it is mounted. A suitable 3.5mm. insulated jack socket is available from Home Radio under Cat. No. JH59.

C6 is connected across the two appropriate tags of the headphone socket. The wiring to the headphone jack socket also causes the aluminium case to be connected to the battery negative line. The tags of this socket should be wired up as indicated in the circuit of Fig. 1. R6, with its leads suitably covered with sleeving, is wired between the Veroboard and one of the Morse key jack socket tags. The other key socket tag connects to the battery positive terminal.

A commercially made aluminium box type AB9, available from Home Radio (Cat. No. Z239) or Electrovalue, houses the components, and its lid forms the front panel. Drilling details of this panel are shown in Fig. 4. The large circular cut-out for the speaker can be made using an Abrafile, or a suitable fret saw. A large half-round file can then be employed to smooth any rough edges which are produced. A piece of speaker fabric or thin expanded metal is glued behind the speaker aperture and then the speaker is carefully glued to this. A powerful adhesive, such as Araldite, is required in order to produce a sufficiently strong bond.

There should be space for the PP3 battery underneath the speaker and, in the prototype, this was held in place by the steel case of the battery being attracted to the speaker magnet. If the battery is found to be at all

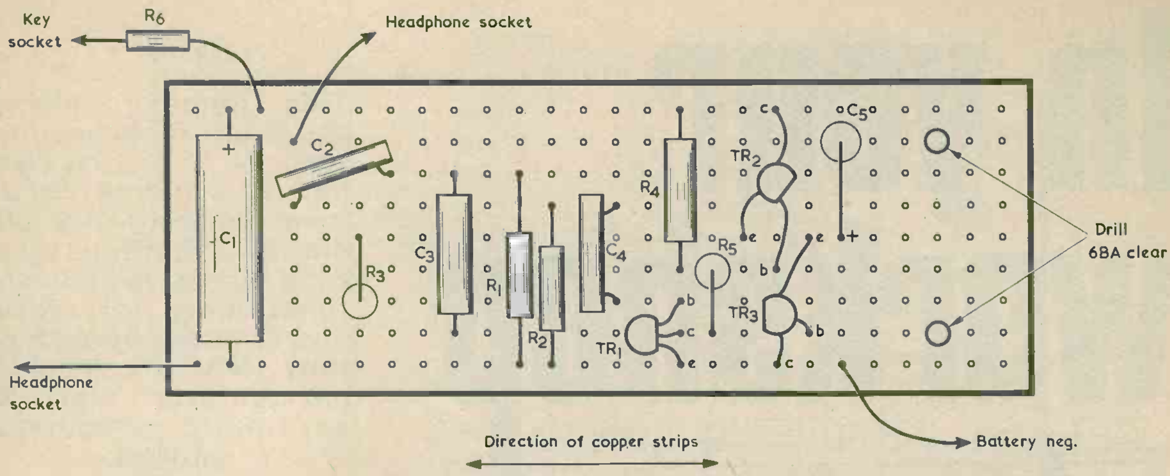


Fig. 2. The Veroboard layout. C6 is not mounted on the board but is wired across the headphone socket

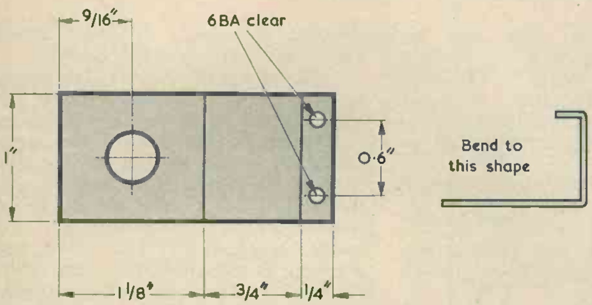


Fig. 3. Details of the mounting bracket for the Veroboard panel

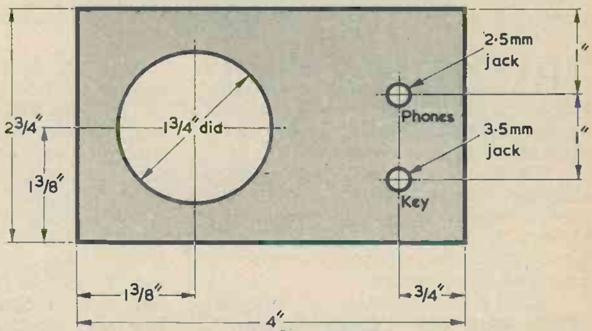


Fig. 4. How the front panel is drilled. The diameters of the jack socket holes depend on the particular sockets used

loose inside the case, some foam plastic padding should be added to cure this. There is a slight risk that some miniature 2½in. speakers may have a construction which does not allow sufficient room inside the case for the battery. The speaker employed in the prototype was obtained from Crescent Radio Ltd., 11 Mayes Road, London, N22 6TL, and is described as a '2½in. 25 ohm S/m loudspeaker'.

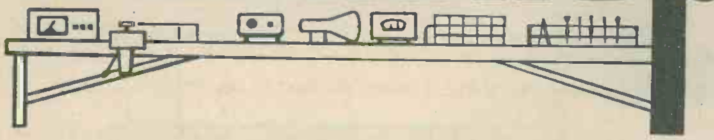
Side view of the Veroboard. Its supporting bracket is secured to the front panel under the body of the key jack socket

TESTING

The experienced constructor will have noted that there are no precautions against thermal runaway in the output circuit in which TR2 and TR3 appear, and the author took care to check that there was no risk of damage to the output transistors because of this. It has been his experience that silicon transistors are much more stable in this respect than the earlier germanium types and he tried to induce thermal runaway deliberately by running the oscillator continuously for a long period with a new battery connected. The result was a slight increase in the current drawn with no load connected to the output.

Nevertheless, it is desirable to confirm that the output transistors are not biased on too hard. The unit should first be checked to ensure that oscillation is taking place, after which current consumption may be measured with a pair of 2,000Ω headphones plugged in. In the absence of such headphones the unit can be loaded by a resistor of around 4 to 5kΩ. Current consumption may then be checked by connecting a current-reading meter across the key terminals. If the current is less than 8mA, all is well. Should the current be higher than this figure, the value of R5 should be reduced accordingly. A value of 510Ω 5% in place of the existing 560Ω resistor will probably be adequately low. ■

In your workshop



This month Smithy's assistant, Dick, encounters an f.m. receiver having a tuning circuit incorporating varicap diodes. Smithy takes time out to explain the functioning of these diodes and to show how they lend themselves particularly well to automatic frequency control.

"BLOW ME," GRUMBLED DICK, AS HE looked inside the f.m. portable radio on his bench, "I don't mind the odd simple snag every now and again but this is getting ridiculous."

"Don't you ever," admonished Smithy, busy with his test prods at his own bench, "stop moaning about things? You've done nothing but drip away continually from the moment you came in this morning."

"And with reason, too," retorted Dick aggrievedly. "Every darned set I've picked up today has a fault which I can see as soon as I take the back off. They've all been things like wires broken off, batteries corroded and nonsense like that. I haven't had to even *look* at my testmeter yet!"

VARICAP TUNING

"What," asked Smithy mildly, "is wrong with the set you've got now?"

"It's another one with a wire broken off," stated Dick bitterly. "Some ham-handed Henry must have done it while he was changing the batteries or something like that."

Carefully, Dick stripped the end of the wire in question and resoldered it to the tag from which it had obviously broken away. This accomplished, he glanced over the remainder of the receiver chassis to ensure that the wire-breaker had not created any damage elsewhere. Suddenly, his jaw dropped.

"Ye gods," he breathed.

Subconsciously aware that something was amiss, Smithy turned round to look at his assistant. That worthy was staring glassy-eyed into the back of the receiver.

"Dash it all," snorted Smithy irately, "What's up now?"

"It's this set," spluttered Dick. "It hasn't got a tuning capacitor!"

"Well, perhaps it's permeability tuned."

"No, it's not. All the tuning knob couples up to is a pot!"

Smithy's eyebrows rose and he walked over to Dick's side to inspect the receiver. His assistant's statements were perfectly true: there was no tuning capacitor, and the tuning knob was quite definitely coupled to a potentiometer.

"Now, that *is* interesting," remarked Smithy. "We've had varicap tuning on a few of the larger mains-driven f.m. receivers for at least four years or so, but this is the first time I've seen it used in a battery portable."

"I should have known," groaned Dick, "that *you'd* be fully clued up in advance on this tuning pot business. All right then, Smithy, how does it work?"

Smithy did not answer immediately, but walked over to the filing cabinet and leafed through the service manuals.

"Ah, good," he remarked. "We happen to have a manual in stock for this set. It will help me to explain the tuning scheme to you."

Smithy returned, opened the service manual at the circuit diagram and pointed a finger at the r.f. amplifier and mixer-oscillator stages. (Fig. 1.)

"Now, if," he continued, "you hadn't been so full of complaints about all the simple faults you'd encountered this morning, you'd have noticed several other unusual features about this set. To begin with, although it only covers the f.m. band it has four push-buttons on the front. These could hardly be for waveband changing, could they?"

"I suppose not," conceded Dick grudgingly. "What are they for, Smithy?"

"Three of them," pronounced Smithy, "select pre-tuned stations, and the fourth selects the variable tuning pot which couples to the tuning knob. There are three pre-set pots at the back of the chassis, and these are adjusted for the three pre-tuned stations."

"This business of tuning with a pot has me completely baffled," stated Dick. "How on earth is it done?"

"By means of variable capacitance diodes," replied Smithy, "which are also referred to as varicap diodes or varactors. To be precise, the word 'varactor' really applies to variable capacitance diodes which are used for frequency multiplication at radar frequencies and things like that and not for the tuning of f.m. radios, but the term is still employed quite often for the sort of diode we've got here. If you look at the circuits you'll find two varicap diodes, one of them appearing in the D1 position and the other in the D2 position."

Dick looked blankly at the diodes in question.

"They've certainly got a funny symbol," he remarked. "An ordinary diode symbol with an arrow going through it."

"That's right," agreed Smithy. "The arrow means 'variable', of course. Now, these varicap diodes are silicon junction types which have been specially developed for the tuning application, and they function by reason of the fact that the self-capacitance of any reverse-biased semiconductor diode reduces as the reverse voltage across it increases. With varicap diodes this effect is controlled to a relatively close tolerance and they are designed to have as high a level of Q as is practicable."

DEPLETION LAYER

"I seem," said Dick thoughtfully, "to have heard about this business of decreasing self-capacitance in a semiconductor diode before. I know that the diode consists of a p.n. junction. Isn't there something called a depletion layer between the p. bit and the n. bit where there are no mobile charges wandering around?"

"There is a depletion layer," agreed Smithy. "Provided, of course, that the

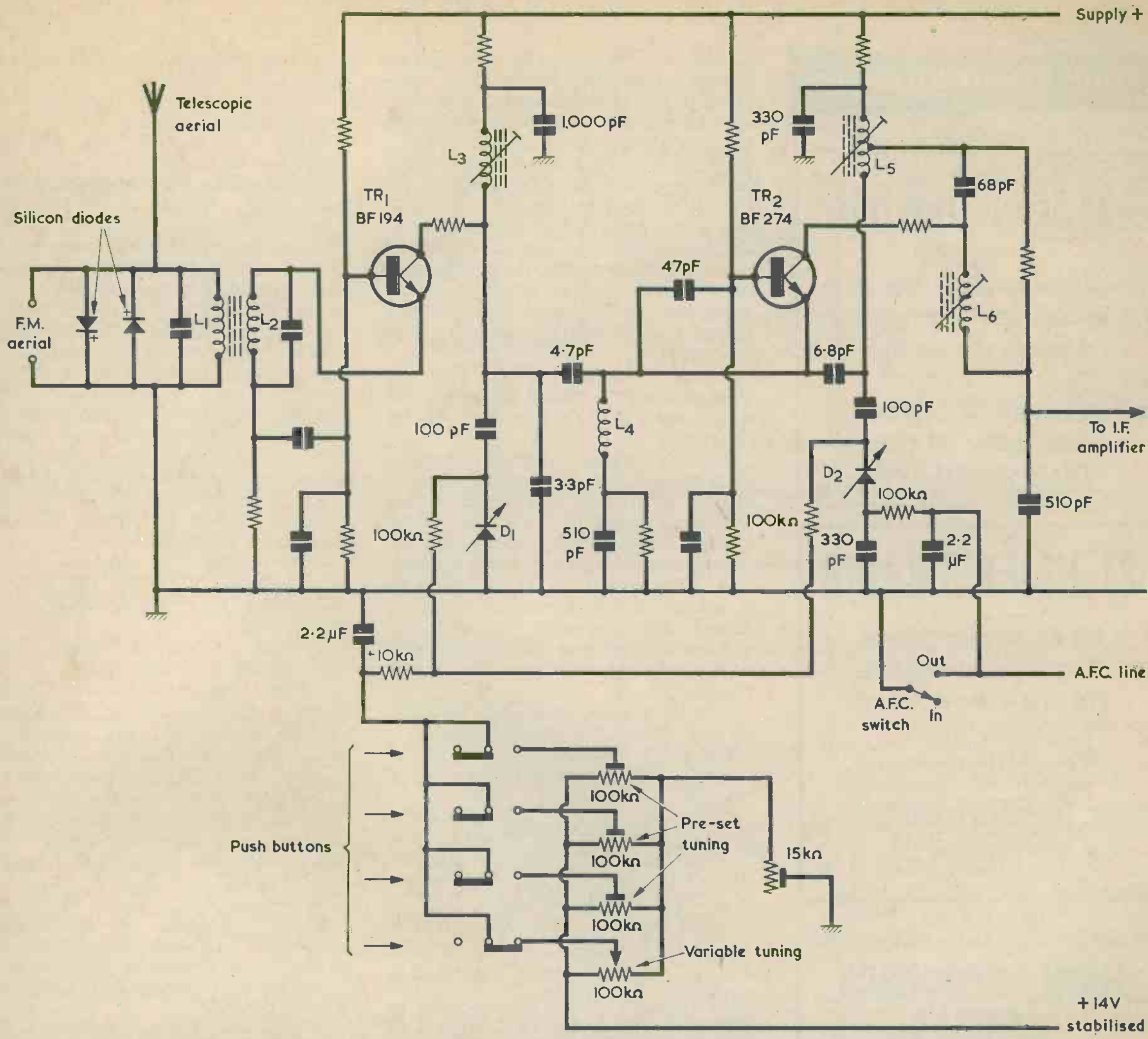


Fig. 1. An f.m. receiver front-end incorporating varicap diode tuning. (As is explained in the Editor's Note, this circuit and those shown in Figs. 3 and 5 are based on a commercially manufactured design.)

diode isn't passing forward current."

"Then," continued Dick, his brow furrowing with concentration, "if I'm still on the right track, the width of that depletion layer increases if there is a reverse voltage across the diode and that reverse voltage increases."

"You are," commented Smithy, "and it does."

"Right," said Dick decisively. "Now, there are no mobile charges in the depletion layer, which means that it's pretty well the same as an insulator. There *are* mobile charges in the p. and n. bits, though, so these are capable of passing current, just like a conductor."

"You're nearly there," stated Smithy encouragingly. "There's just one final little step to cover and you're then at the varicap diode."

"And that step," went on Dick triumphantly, "must be the obvious one of stating that a diode which does not pass forward current is virtually a capacitor with the depletion layer acting as the dielectric. Since the depletion layer widens with increasing reverse voltage, the capacitance offered by the diode will correspondingly reduce as the reverse voltage increases."

"Exactly," confirmed Smithy. "One of the delightful aspects of this situation is that, since the diode is reverse biased, it passes negligible current. A control voltage can, in consequence, be applied to it via a high value of resistance and this won't damp down the Q of the coil or tuned circuit to which the diode is coupled. If you control the reverse voltage by means of a pot, then that pot controls the resonant frequency of the coil or tuned circuit." (Fig. 2.)

"This is all clear to me now," remarked Dick cheerfully, as he examined the service manual circuit with markedly increased confidence. "I see that a stabilized potential of 14 volts is applied to the tuning pots in this receiver circuit."

"That's right," agreed Smithy, "and you will note also that their

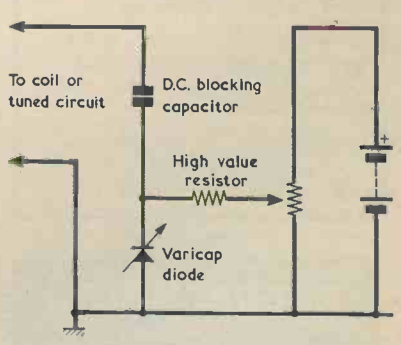


Fig. 2. Basic method of controlling the capacitance of a varicap diode by means of a potentiometer. If there are no other tuning capacitances, the diode then provides the total capacitance tuning the coil. If there are other tuning capacitances the diode modifies the resonant frequency to a lesser extent

sliders are selected by the press-button switch. As I've already said, three of the pots are pre-set and they can be set up to provide pre-tuned frequencies. The fourth pot is variable, and this is the one which is controlled by the receiver tuning knob. There is a further pre-set pot, this being the 15kΩ one which couples the earthy ends of the tuning pots to chassis. This last pot is adjusted so that the tuning pots offer the correct tuning range. It will normally be adjusted for correct tuning at the low frequency end of the f.m. band."

"I see," remarked Dick, "that the voltage from the sliders of any of the tuning pots is always positive of the chassis."

"That's right," agreed Smithy. "There's a 2.2μF electrolytic down to chassis to provide decoupling of this positive voltage and this is followed by a series 10kΩ resistor. After this, the tuning control voltage passes through one 100kΩ resistor to D1, and through a second 100kΩ resistor to D2. The diodes are connected so that the positive voltage goes to their cathodes, causing them to be reverse-biased, as is required."

"Hang on a bit," said Dick, pointing to a section of the circuit. "There's a bit of extra gubbins between D2 and chassis. There's two capacitors and a resistor."

"They're for the automatic frequency control circuit," stated Smithy. "Forget them for the moment and just assume that the voltage at the anode of D2 is at chassis potential."

"Fair enough," said Dick equably. "Let's have a quick run through the whole works now."

"Righty-ho," said Smithy. "Well now, these r.f. stages are intended to receive signals in the f.m. Band II of 87.5 to 100MHz, and to pass them on to the subsequent 10.7mHz i.f. amplifier. Both transistors are operated in grounded base, which offers a higher frequency response than grounded emitter. The aerial input signal is tuned by L1, L2 and the associated capacitors. The tuned circuits here are broadly resonant over the whole of Band II and no means of variable capacitance tuning is provided. The two silicon diodes guard the input circuit from excessively high voltages on the aerial. The signal is then amplified by TR1 and a tuned inductance in the collector circuit is given by L3. The tuning capacitances coupling to this coil include that given by the varicap diode, D1, and the overall combination is such that the coil resonates at the desired signal frequency, this being that selected by whichever tuning pot is switched in."

"What's L4 for, Smithy?"

"With the capacitor below it, L4 forms a 10.7 MHz acceptor trap," said Smithy. "Without such a trap, it would be possible for 10.7MHz signals to break through the r.f. stages into the i.f. amplifier .The second transistor, TR2, comes next. This is the mixer-oscillator transistor, and the oscillator coil is L5."

Dick looked at the oscillator coil, then scratched his head.

"How," he asked, "do you get oscillation feedback?"

"By coupling the bottom end of L5 back to the emitter of TR2 via the 6.8pF capacitor," replied Smithy. "The collector couples into the tap in L5 and, since the collector and emitter of a grounded base transistor are in phase, the feedback is of the correct type for oscillation to take place. You'll see that one of the capacitances coupling to L5 is that given by the varicap diode, D2, whereupon this becomes capable of varying oscillator frequency according to the reverse voltage applied to it. After the oscillator circuit you have L6, which is the first i.f. coil in the receiver. This appears in a pi tuned circuit and feeds the subsequent i.f. amplifier."

AUTOMATIC FREQUENCY CONTROL

"Well, all that," remarked Dick, "seems to be very reasonable."

"Good," responded Smithy. "Seeing that I've given you all the gen on these varicap diodes and the manner in which they work in this receiver, I think it's time for me to press on back to my bench now."

"Wait a minute," returned Dick quickly. "You haven't told me about this automatic frequency control business yet."

Smithy sighed.

"Dear, oh dear," he complained wearily. "I'll never get any work done at all this morning. What is it you want to know about the automatic frequency control circuit?"

"Pretty well the lot!" grinned Dick.

"Oh, all right then," said Smithy resignedly. "Now, in a radio receiver the function of automatic frequency control, or a.f.c., is to keep the receiver correctly on tune even if the tuning control should happen to be displaced from its proper position. It's an extremely easy function to add to an f.m. receiver which is tuned by varicap diodes, as you'll shortly see."

Smithy pointed at the ratio detector section of the receiver and then indicated the a.f.c. line passing back to diode D2. (Fig. 3.)

"The ratio detector in this set," he continued, "is of the balanced type, which means that the components following the last i.f. transformer winding are symmetrical about chassis. If an unmodulated carrier is tuned in, the voltage at the junction of the two 5.6kΩ resistors swings over to one polarity as the correct tuning point is approached, reduces to chassis potential at the correct tuning point and then swings over to the opposite polarity as the correct tuning point is passed." (Fig. 4.)

"Do you," asked Dick, "get a linear change of voltage with change of frequency?"

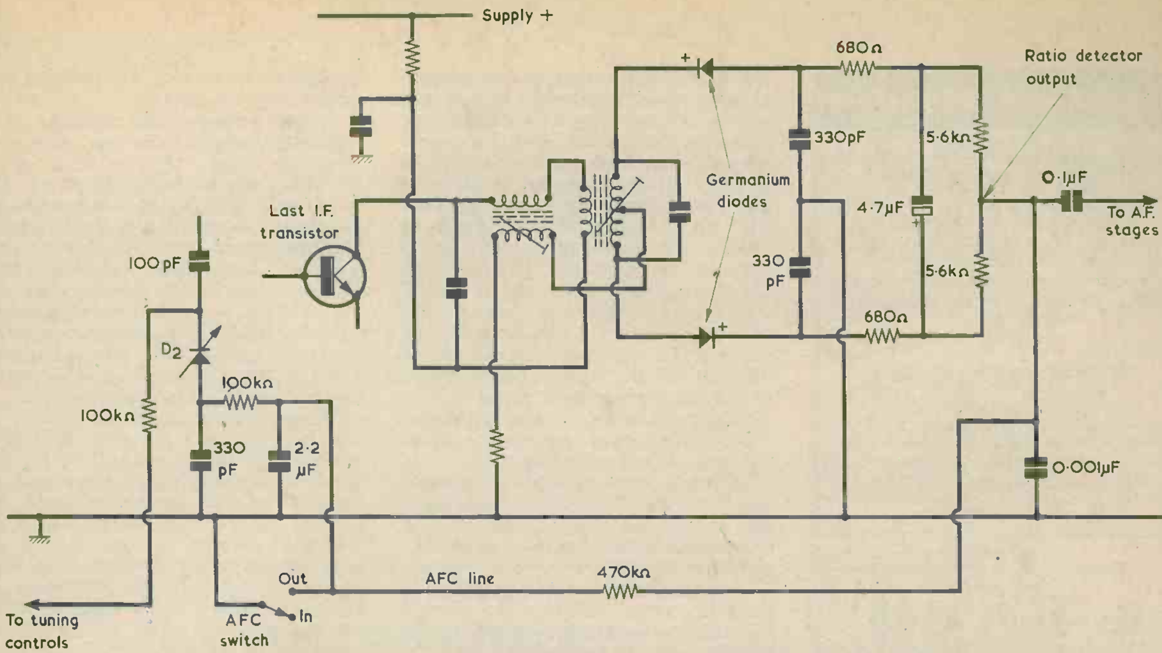


Fig. 3. Illustrating how the output from a balanced ratio detector stage may be employed to provide automatic frequency control. The components around D2 are the same as those in Fig. 1.

"You do," replied Smithy, "or at least you do over the range between the two outside peaks of the frequency-voltage response. We have referred to an unmodulated signal. What happens when the signal is modulated?"

"That's an easy question," replied Dick confidently. "If the signal is frequency modulated, the frequency applied to the ratio detector circuit will vary in sympathy with the modulating audio signal. The output of the detector will then swing along the linear centre section of its response, producing a corresponding audio signal voltage which can be fed to the following audio amplifier stages."

"Right," commended Smithy. "The *average* voltage at the output of the ratio detector will, however, be the same whether the signal is modulated or not. This is because the modulation is symmetrical on either side of the centre frequency."

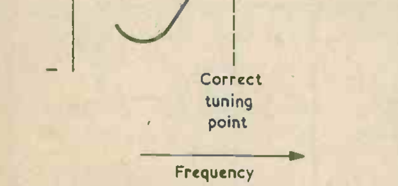


Fig. 4. The voltage output, with reference to chassis, of a balanced ratio detector for frequencies on either side of the centre frequency

"I think," remarked Dick, "that light is beginning to break through here. Do we use this average voltage for the automatic frequency control?"

"We do," replied Smithy. "To get the average voltage, all we have to do is to pass the signal at the detector output through a network which removes the audio frequencies from it. In our present circuit, the output voltage from the ratio detector passes through a 470kΩ resistor to a 2.2µF capacitor, and these components remove the audio frequencies. The voltage then passes through a 100kΩ resistor to the 330pF capacitor which couples the anode of D2 to chassis. The phasing of the circuit is such that, if the receiver is detuned in one direction, the correcting voltage from the ratio detector which is applied to the varicap diode has the requisite polarity to bring the set back on tune again. If the receiver is detuned in the other direction the correcting voltage once more brings it back on tune again. This time the correcting voltage will be of opposite polarity to the previous one."

"Blimey, that's neat," commented Dick. "I can see what you mean now when you say that it's an easy matter to apply a.f.c. in an f.m. radio using varicap tuning. The set will already have a ratio detector capable of providing the necessary control voltage and, if it is fitted with varicap tuning diodes, will already have a tuning device capable of being controlled by a voltage from the detector. Incidentally, why isn't the control voltage also applied to the varicap diode which tunes the r.f. coil?"

"You mean to D1?"

Dick nodded.

"There'd be no point in feeding an a.f.c. voltage to D1," stated Smithy. "The a.f.c. operates over a small band of frequencies only, and this is much smaller than the band of frequencies passed by the r.f. coil. Don't forget that it is the oscillator frequency which effectively selects the input signal frequency that is to be passed to the highly selective i.f. amplifier. Adjusting oscillator frequency is like tuning the whole set."

"Why yes, of course," said Dick thoughtfully. "There's one snag that I can see, though, so far as a.f.c. is concerned."

"What's that?"

"Well," explained Dick, "if the a.f.c. causes the receiver to be correctly tuned, even when the tuning control is displaced, you'll never know when you've found the proper tuning setting!"

"True enough," chuckled Smithy. "And it's for that reason that an a.f.c. switch is added. This short-circuits the a.f.c. line to chassis when you don't want it, whereupon a signal can be tuned in in the normal manner. The usual approach is to tune in the required signal with the a.f.c. switched out. The a.f.c. can then be switched in, whereupon it will keep the set locked on tune despite any subsequent drift in oscillator frequency."

STABILIZED SUPPLY

"I wonder," mused Dick, "what the advantages of having varicap diodes instead of an ordinary tuning capacitor are."

"One big advantage," replied

Smithy, "is that they allow a considerable amount of freedom in component layout. If you have a tuning capacitor, then the r.f. and oscillator components must be mounted close to this, and the tuning capacitor in its turn must be mounted in a position that allows it to be adjusted from the front panel of the set. If, on the other hand, you use varicap diodes, these and the r.f. and oscillator components can be positioned at any place inside the receiver. The tuning pot, or pots, can similarly be positioned anywhere, as the connections required are of a d.c. nature only, with no r.f. involved."

"It seems to me," remarked Dick, "that the varicap approach offers nothing else but advantages."

"There's one possible disadvantage," remarked Smithy. "Or at least it's a possible disadvantage if the receiver is a battery operated model."

"What's that?"

"It's necessary," said Smithy, "to provide some means of voltage stabilization for the d.c. supply to the tuning pots. If you didn't, all the stations would go up to one end of the tuning scale as the battery ran down!"

"Blow me, that's a point. Hey, there's something else I've noticed!"

"What's that?"

"The stabilized supply for the tuning pots in this set is 14 volts. And yet the battery only gives 9 volts."

"I was wondering," groaned Smithy, "when you'd get round to seeing that. As a matter of fact, this set uses an oscillator circuit to provide the relatively high voltage needed for varicap control and to keep that voltage stable as well. It's in this part of the overall circuit."

Smithy indicated the oscillator and stabilizer section of the receiver. (Fig. 5.)

"This bit is fairly simple," he remarked. "The BC184 is an oscillator running at a low r.f., and a sufficiently high voltage in excess of that on the 9 volt rail is available at the tap in the oscillator coil in its collector circuit. This voltage is rectified by the diode, with the 0.22μF capacitor acting as a reservoir component. After passing through the 330Ω resistor a 14 volt stabilized output becomes available."

"How does the circuit stabilize?"

"The emitter of the BC159," explained Smithy, "is held fixed by the 6 volt zener diode. At the same time, a fraction of the output voltage is applied to its base. Note that the collector current of this transistor provides the base bias current for the BC184. If, now, the stabilized output voltage attempts to go negative, this causes the base of the BC159 transistor to similarly go negative, whereupon the BC159 passes more collector current. This causes increased base bias in the BC184, whereupon it oscillates harder and produces a higher output voltage, thereby cancelling out the initial negative excursion of the output voltage. And if the output voltage tries to go positive, the base bias current of the BC159 reduces, as also does the base current of the BC184, thereby counteracting the positive excursion. The output is fixed at the 14 volt level by setting up the 20kΩ pre-set pot."

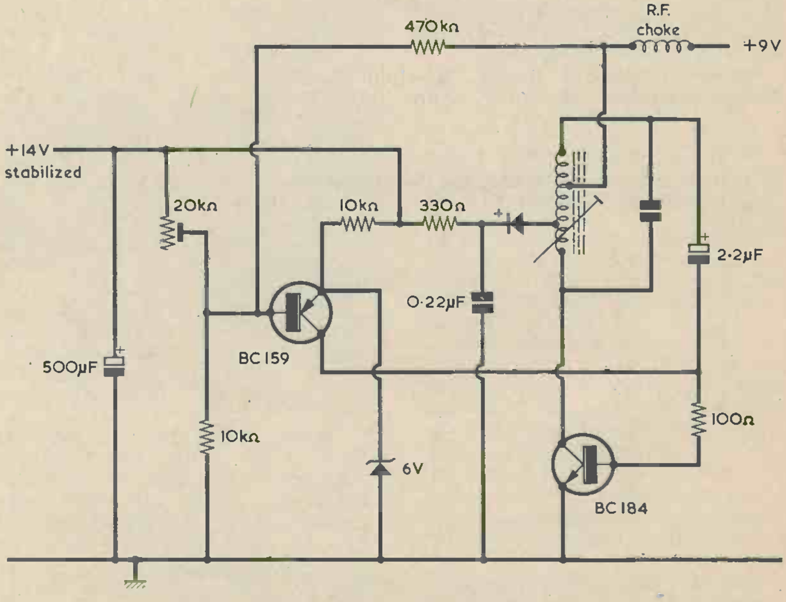


Fig. 5. A stabilizing circuit which provides the 14 volts required by the tuning potentiometers

FINAL TEST

Smithy looked at his watch.

"And now," he said firmly, "I really must get back to my own work. Come to think of it, all this business started just because you found a broken wire in this set."

"I suppose it did, really."

"And we don't," continued Smithy, "even know whether your resoldering of that wire has made the set serviceabel again!"

"Well, we'll soon check that," retorted Dick.

He switched on the receiver. This at once gave an excellent performance, producing a high quality output at good volume level. Each of the three pre-set station buttons caused the desired local transmission to be received, whilst the fourth button allowed the full f.m. band to be covered by the tuning control.

Satisfied, Dick switched off the receiver.

"Do you know what this proves, Smithy?"

"What?"

"You may be able to dish out the theoretical stuff," grinned Dick. "But I'm the bloke who gets the sets to work!"

And even Smithy could find no answer to this monumental impudence.

EDITOR'S NOTE

The circuits reproduced in Figs. 1, 3 and 5 are based on the corresponding circuits in the H.M.V. Model 2176 f.m. mains/battery radio receiver. For the purpose of explaining the general principles involved, some small simplifications have been introduced. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

'Convair' 6 transistor medium and long wave portable.—C. E. Fuller, 136 Croydon Road, Penge, London, SE20 – name and address of maker or servicing information.

* * * *

Book: 'Mathematics for Radio and Electronic Technicians' by Dr.-Ing. Fritz Bergtold, published Newnes 1947.—H. Berry, 37 York Road, Bowdon, Altrincham, Ches. WA14 3EF – To purchase.

* * * *

3 Transistor donkey siren circuit.—John Hunt, 251 W. Bruceton Road, Pittsburgh, Pa, 15236, USA – any information enabling circuit to be obtained.

* * * *

Radio Constructor, November and December 1968.—Z. Lazari, 65 Compton Street, London, EC1V 0BN – wishes to purchase or borrow.

* * * *

CR100 Service Manual.—J. Morgan, 43 September Road, Liverpool, 6 – to purchase or borrow.

* * * *

Philips 2 Track Tape Recorder AG8109.—D. Watson, 19 Byrd Walk, Baldock, Herts., SG7 6ZN – information as to suppliers of spare parts.

* * * *

Radio Constructor, May 1965.—A. Agnew, 60 Station Road, Portstewart, Co. Londonderry, BT55 7HQ – wishes to purchase or borrow.

* * * *

Beulah D.909.—Mark Alder, 54 Kimberley Road, Edmonton, London, N18 2DP – circuit diagram and/or other details required.

* * * *

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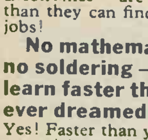

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(Continued on page 195)

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(Continued from page 193)

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Key	Frequency (Hz)	Key	Frequency (Hz)	Key	Frequency (Hz)	Key	Frequency (Hz)
Middle C	261.63	C	65.41	Middle C	261.63	C	1,046.50
B	246.94	B	61.74	D	293.66	D	1,174.66
A	220.00	A	55.00	E	329.63	E	1,318.50
G	196.00	G	49.00	F	349.23	F	1,396.92
F	174.61	F	43.65	G	392.00	G	1,568.00
E	164.81	E	41.20	A	440.00	A	1,760.00
D	146.83	D	36.71	B	493.88	B	1,975.50
C	130.81	C	32.70	C	523.25	C	2,093.00
B	123.47	B	30.87	D	587.33	D	2,349.30
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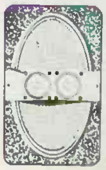

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