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JUNE 1975

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B79	4	IN4007 Sil. Rec. diodes. 1,000PIV 1 amp. plastic
B81	10	Reed Switches, 1" long ⅛" dia. High-speed P.O. type
H35	100	Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked
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H39	6	Integrated circuits 4 gates BMC 962, 2 flip flops BMC 945
H41	2	BD131/BD132 Complementary Plastic Transistors
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H66	4	40362. Type PNP Sil. Transistors TO-5 can comp. to H65

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B1	50	Germanium Transistors PNP, AF and RF
B66	150	Germanium Diodes Min. glass type
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202
B86	100	Dil. Diodes sub. min. IN914 and IN916 types
H20	20	BY126/7 Type Silicon Rectifiers 1 amp. plastic. Mixed volts
H34	15	Power Transistors, PNP. Germ. NPN Silicon TO-3 Can
H67	10	3819N Channel FET's plastic case type

SILICON POWER TRANSISTORS—PLASTIC

40 WATT

Type	*Gain*	*VCE*		*Price*
40N1	15	15	NPN	20p
40N2	40	40	NPN	30p
40P1	15	15	PNP	20p
40P2	40	40	PNP	30p
90 WATT				
90N1	15	15	NPN	25p
90N2	40	40	NPN	35p
90P1	15	15	PNP	25p
90P2	40	40	PNP	35p

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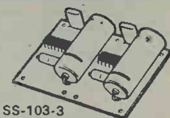

SS-103-3

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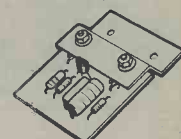
Pre-amplifiers: tone control

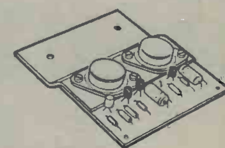
SS.100	Active tone control unit to provide bass, treble, balance and volume controls	£1.60
SS.101	Pre-amp for ceramic cartridge, tape and radio	£1.60
SS.102	Pre-amp for low output magnetic cartridge, tape and radio. With R.I.A.A. correction ...1dB at 1K	£2.25



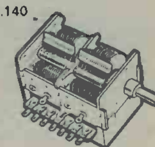
SS.105

POWER AMPLIFIERS

SS.103	Compact I.C. amp. with 3 watts R.M.S. output. Operating voltage 6 to 22. Size 3½" x 2"	£1.75
SS.103-3	Stereo version of above using one I.C. on each channel	£3.25
SS.105	A compact and useful all-purpose amplifier which will run excellently on a 12V supply. With 5 watt output, two make a good stereo amp. Size 2½" x 1¾"	£1.95
SS.110	Similar in size to SS.105 but with a 10 watt output. Ideal for many domestic and small-size P.A. applications. Operates from 26 to 32V.	£2.40
SS.140	Excellently designed 40 watt R.M.S. (into 4 ohms) hi-fi amplifier. S/N ratio better than 75dB. THD better than 0·2%. Power requirements—45V. d.c. With 0·15" centre edge connections. Two can be bridged to give 80 watts R.M.S. into 4 ohms	£3.60



SS.140



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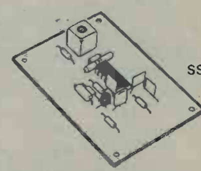
SS.202	I.F. stage (with I.C.) Pre-tuned. A.F.C. connection. Operates from 4·5 to 14V.	£5.25
SS.203	Stereo Decoder. Designed essentially for use with SS.201 and 2, this module can also be used in most mono FM tuners. A LED may be attached. Operating voltage 9-16V. d.c.	£5.62



SS.201

POWER SUPPLY STABILIZER

SS.300	Add this to an unstabilised supply (say typically 45V. output) to obtain a steady powerful working output adjustable from 12 to 60V. Essential for your audio and special systems. Money saving and very reliable. Ideal for workbench use.	£3.25

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Add 35p P. & P. per transformer

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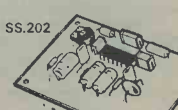
Type B 25v/2A (Suit SS. 110)	£2.00
Type C 30v/2A (Suit SS. 140)	£3.25

Bridge Rectifier Type A 27p Type B/C 38p

SS.202



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Fully transportable. Console fitted twin turntables with cross fade, monitoring, L-R cueing, mic. with over ride. Ampower 40 loudspeaker has built-in mains powered 40 watt RMS power amp. Up to 10 Ampower may be added. With one Ampower and console **£100**

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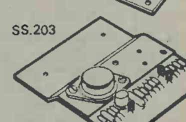
SS.203



SS.300

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AC128/176	11p	BC186/7	20p	BF184/5	15p
ACY28	18p	BC213L	10p	BF194/5/6/7	8p
AD149	40p	BC327/8	19p	BF194A	12p
AD161/2 matched pr.	69p	BC337/8	14p	BF200	20p
AF116/7	12p	BC547/8	11p	BF262/3	23p
AF124/6/7	20p	BC558A	11p	BF336	25p
AF139/178	30p	BCX20	13p	BFS28 Dual Mosfet	92p
AF180/1	30p	BCX32/36	12p	BFW10/11 F.E.T.	45p
AF239	20p	BCY40	60p	BFX29/30	16p
ASY27/73	25p	BCY70/1/2	9p	BFX84/88	16p
BC107A or B	9p	BD112/3/5/6	50p	BFY50/1/2	11p
BC107/8/9	7p	BD131	30p	BFY90	50p
BC108A/B/109B/C	10p	BD132	30p	BR101 (Programmable Unj Junction)	30p
BC147/8/9	7p	BD135	30p	BRY39 (Programmable Unj Junction)	34p
BC147A/B	8p	BD201/2/3/4	£1.00	BRY56 (Programmable Unj Junction)	34p
BC148A/B, 9B/C/S	8p	BD232/4/5	49p	BSV64	40p
BC157/8/9	9p	BDX77	£1.40	BSV79 F.E.T.	£1
BC158A/B	11p	BF115	15p	BSV80 F.E.T.	90p
BC159B/C, 157A	11p	BF167/173	20p	BSV81 Mosfet	90p

Type	Price
BSX20	13p
BSX21	16p
BU105/01	93p
CV7042 (OC41 OC44, ASY63)	7p
GET111	40p
OC35	$32\frac{1}{2}$p
ON222	30p
TIS88A FET	33p
ZTX300	11p
2N393/MA393	30p
2N706	8p
2N987	35p
2N2219	18p
2N2401 (ASY26-27)	20p
2N2904/5/6/7	13p
2N2907A	15p
2N3053	13p
2N3054	35p
2N3055 (or equiv.)	33p
2N3819 FET	16p
2N5036	60p
40250	60p

OTHER DIODES

Type	Price
IN916	6p
IN4148	3p
BA145	14p
Centercel	10p
BZY61	10p
BB110 B Varicap	20p
BA182	24p
OA5/7/10	10p
BZY88 Up to 33 volt	7p
BZX61 11 volt	16p
BR100 Diac.	19p

INTEGRATED CIRCUITS

Type	Price
741 8 pin d.i.l. op. Amp	23p
TAD100 AMRF	£1.00
TAA570	£1.20
CA3001 R. F. Amp	£1.00
TAA300 1wt Amp	£1.25
NE555v Timer	45p
TAA550 Y or G	40p
TAA263 Amp	65p
SN7483 TTL	80p
7400/10TTL	13p
7401/2/4/20/30	14p
ZN414 RX	£1.09

BRIDGE RECTIFIERS

Amp	Volt	Type	Price
½	1,600	BYX10	30p
1	140	OSH01-200	30p
1.4	42	BY164	35p
2	30	LT120 type	30p
0.6	110	EC433	15p
5	400	Texas	75p

TRIACS

Amp	Volt	Type	Price
6	400	Plastic	74p
25	900	BTX94-900	£5.00
25	1200	BTX94-1200	£7.00

THYRISTORS

Amp	Volt	Type	Price
1	240	BTX18-200	50p
1	400	BTX18-300	65p
1	240	BTX30-200	40p
6.5	500	BT102-500R	75p
10	700	BT106	85p
15	500	BT107	£1.00
6.5	500	BT101-500R	90p
6.5	500	BT109-500R	75p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£10.00
30	1000	28T10 (Less Nut)	£4.00

RECTIFIERS

	Amp	Volt	
IN4004	1	400	5p
IN4005	1	600	6p
IN4006	1	800	7p
IN4007	1	1,000	7p
SR100	1.5	100	7p
SR400	1.5	400	8p
REC53A	1.5	1,250	14p
LT102	2	30	10p
BYX38-600	2.5	600	40p
BYX38-300R	2.5	300	36p
BYX38-900	2.5	900	45p
BYX38-1200	2.5	1,200	50p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX49-1200	2.5	1,200	52p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
BYX48-1200	6	1,200	80p
BYX72-150R	10	150	35p
BYX72-300R	10	300	45p
BYX72-500R	10	500	55p
BYX42-300	10	300	30p
BYX42-600	10	600	65p
BYX42-900	10	900	80p
BYX42-1200	10	1,200	95p
BYX46-300*	15	300	£2.00
BYX46-400*	15	400	£2.50
BYX46-500*	15	500	£2.75
BYX46-600*	15	600	£3.00
BYX20-200	25	200	60p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.50

*Avalanche type

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1" Terryclips chrome finish 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia 15p
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DLI Pal Delayline 80p

Relay socket 10p
Take miniature 2PCO relay

B7G or B9A valve can 2p

0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive, 4¼" dia. 10p

OPTO ELECTRONICS

Type	Price
ORP12	44p
BPX40	65p
BPX42	£1.50
BPY10 (VOLTIAC)	£1.00
BPY68, BPY69, BPY77 Diodes	£1.00

Photo transistor

Type	Price
BPX29	£1.00
OCP71	35p

BIG L.E.D. 0.2" 2v 50m/A max.

RED	15p
ORANGE, GREEN, YELLOW	16p

PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp £1.00

.3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v, 10m/a segment 73p

CQY11B L.E.D.
Infra red transmitter £1
One fifth of trade

Wire ended glass neons 5p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p
Holdersorpads 50pper100

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	250 volt	15p
2MFD	250 volt	20p
10MFD	500 volt	80p
4MFD	250 volt	20p
15MFD	150 volt	50p

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5 or 6 pin 240° din
Speaker din switched
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Philips Iron Thermostat 15p
Bulgin 2-pin flat plug and socket 10p
McMurdo PP108 8 way edge plug 10p

TO3 HEATSINK

Europlec HP1 TO3B individual 'curly' power transistor type. Ready drilled 20p

Tested unmarked, or marked ample lead ex new equipment

ACY17-20	8p	OC71/2	5p
ASZ20	8p	OC200-5	10p
ASZ21	15p	TIC44	24p
BC186	11p	2G240	2-50
BCY30-34	10p	2G302	6p
BCY70/1/2	8p	2G401	10p
BF115	10p	2N711	25p
BY127	8p	2N2926	7p
BZY88 series	5p	2N598/9	6p
HG1005	2p	2N1091	8p
HG5009	2p	2N1302	8p
HG5079	2p	2N1907	2-50
L78/9	2p	Germ. diode	1p
M3	10p	GET120 (AC128 in 1" sq. heat sink)	20p
OA81	3p		
OA47	2p		
OA200-2	3p	GET872	12p
OC23	20p		

8 way Cinch standard 0.15 pitch edge socket 20p

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20p each

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McMurdo DA15P 15 way chassis plug 15p

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THE Firm for speakers!

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Baker Group 35, 3, 8 or 15 ohm	£9.50
Baker Group 50/12, 8 or 15 ohm	£13.00
Baker Deluxe 12", 8 or 15 ohm	£11.00
Baker Major 3, 8 or 15 ohm	£9.50
Baker Superb 8 or 15 ohm	£14.50
Baker Regent 8 or 15 ohm	£8.00
Baker Auditorium 12"	£13.00
Celestion PST8 (for Unilex)	£3.00
Celestion G12H 8 or 15 ohm	£13.90
Celestion G12M 8 or 15 ohm	£11.15
Celestion G15C 8 or 15 ohm	£22.25
Celestion G18C 8 or 15 ohm	£30.55
Celestion MF1000 8 or 15 ohm	£10.95
EMI 13 x 8, 3, 8 or 15 ohm	£2.10
EMI 13 x 8, d/cone 3, 8 or 15 ohm	£2.35
EMI 13 x 8 type 350, 8 or 15 ohm	£7.65
EMI 13 x 8 20 watt bass	£6.15
EMI 5" 14A/730 mid-range 8 ohm	£2.80
EMI 6½" 93850 4 or 8 ohm	£2.32
EMI 8 x 5, cer. mag. 8 ohm	£1.65
EMI 8 x 5, 10 watt, d/c roll/s 8 ohm	£2.75
EMI 10 x 6 93870 8 ohm	£2.15
EMI 2½" tweeter 8 ohm	.62
Elac 9 x 5, 59RM109 15 ohm, 59RM114 8 ohm	£2.75
Elac 6½" d/cone, roll surr. 8 ohm	£3.25
Elac 6½" d/cone 8 ohm	£2.50
Elac TW4 4" tweeter	£1.40
Elac 10" 10RM239 d/c 8 ohm	£2.50
Elac 8" 3 ohm	£2.30
Eagle Crossover 3, 8 or 16 ohm	£1.40
Eagle CT5 cone tweeter 8 ohm	£1.65
Eagle CT10 tweeter 8 or 16 ohm	£2.40
Eagle DT33 dome tweeter 8 ohm	£5.05
Eagle FF5 3 way crossover	£2.90
Eagle SN75 crossover with tw. control	£3.75
Eagle FF28 multicell, horn	£7.28
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Eagle HT21 horn tw. 8 ohm	£5.45
Eagle MHT10 horn tw. 8 ohm	£3.55
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Eagle FR65 6½" full range	£7.70
Eagle FR8 8" full range	£9.85
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Fane Pop 25T 30 watt 12"	£6.95
Fane Pop watt 12"	£11.15
Fane Pop 55 12" 60 watt	£12.00
Fane Pop 60 watt 15"	£12.75
Fane Pop 100 watt 18"	£24.00

SPEAKERS

Fane Crescendo 12A 8 or 15 ohm	£31.95
Fane Crescendo 12B 8 or 15 ohm	£33.80
Fane Crescendo 15, 8 or 15 ohm	£43.98
Fane Crescendo 18, 8 or 15 ohm	£38.33
Fane 701 twin ribbon horn	£32.40
Fane 910 horn	£13.85
Fane 920 horn	£31.45
Fane 152/12a 15" 15 ohm	£14.75
Fane 801T 8" d/cone roll surr.	£6.50
Fane 808T 8" d/cone	£2.75
Fane 807T 8" d/cone roll surr.	£3.70
Goodmans 8P 8 or 15 ohm	£5.10
Goodsmans 10P 8 or 15 ohm	£5.40
Goodmans 12P 8 or 15 ohm	£12.95
Goodmans 12P-D 8 or 15 ohm	£15.75
Goodmans 12P-G 8 or 15 ohm	£14.75
Goodman 12AX 100 watt 8 or 15 ohm	£33.75
Goodsmans 15AX 100 watt 8 or 15 ohm	£37.25
Goodmans 15P 8 or 15 ohm	£19.50
Goodmans 18P 8 or 15 ohm	£33.50
Goodmans Hifax 750	£14.95
Goodmans Axent 100 tweeter & crossover	£6.75
Goodmans Audiom 100, 8 or 15 ohm	£11.12
Goodmans Axiom 401, 8 or 15 ohm	£16.00
Goodsmans Twinaxiom 8" 8 or 15 ohm	£8.11
Goodsmans Twinaxiom 10" 8 or 15 ohm	£8.60
Gauss 12" full range 8 ohm	£65.00
Gauss 12" Bass 8 ohm	£65.00
Gauss 15" full range 8 ohm	£70.00
Gauss 15" Bass 8 ohm	£70.00
Gauss 18" full range 8 ohm	£75.00
Gauss 18" Bass 8 ohm	£75.00

All the above Gauss (American) speakers are fitted with 4¼" voice coils and can handle 200 watts RMS.

Kef T27	£4.85
Kef T15	£5.55
Kef B110	£6.70
Kef B200	£7.60
Kef B139	£13.00
Kef DN8	£1.85
Kef DN12	£4.60
Kef DN13	£3.10
Richard Allan CG8T 8" d/c roll rurr. 8 ohms	£5.90
STC 4001G super tweeter	£5.25
2½" 64 ohm, 70mm 8 ohm, 70mm 80 ohm	.62
2½" 75 ohm	.47
7" x 4" 3, 8 or 15 ohm	£1.30
8" x 5" 3, 8 or 15 ohm	£1.40
10" x 6" 6, 8 or 15 ohm	£2.15

SPEAKER KITS (Carr. 75p each. £1.50 pair)

Baker Major Module 3, 8 or 15 ohm	each	£10.75
Goodmans Mezzo Twinkit	pair	£37.75
Goodsmans DIN 20 4 ohm	each	£10.75
Helme XLK25	pair	£20.35
Helme XLK30	pair	£13.75
Helme XLK50	pair	£37.00
Kefkit 1	pair	£38.75
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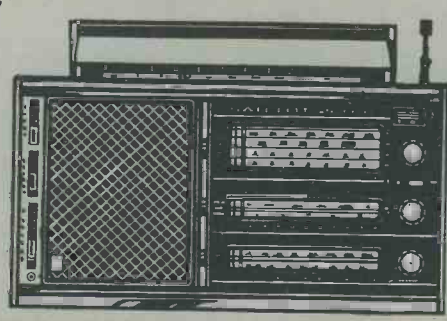

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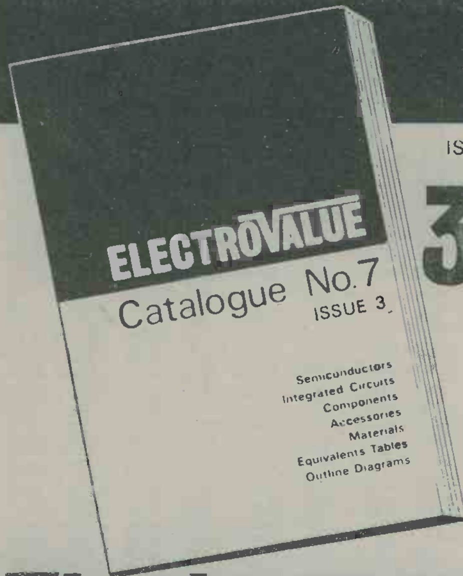

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AC113	0.20	ADT140	0.55	BC153	0.31	BD136	0.44	BF188	0.44	OC19	0.39	2G309	0.39	2N2194	0.39	2N3392	0.16	2N4061	0.13
AC115	0.22	AF114	0.27	BC154	0.33	BD137	0.50	BF194	0.13	OC20	0.70	2G339	0.22	2N2217	0.24	2N3393	0.16	2N4062	0.13
AC117K	0.32	AF115	0.27	BC157	0.20	BD138	0.55	BF195	0.13	OC22	0.52	2G339A	0.18	2N2218	0.22	2N3394	0.16	2N4284	0.19
AC122	0.13	AF116	0.27	BC158	0.13	BD139	0.61	BF196	0.16	OC23	0.54	2G344	0.20	2N2219	0.22	2N3395	0.19	2N4285	0.19
AC125	0.19	AF117	0.27	BC159	0.13	BD140	0.66	BF197	0.16	OC24	0.62	2G345	0.18	2N2220	0.24	2N3402	0.23	2N4286	0.19
AC126	0.19	AF118	0.39	BC160	0.50	BD155	0.88	BF200	0.50	OC25	0.42	2G371	0.18	2N2221	0.22	2N3403	0.23	2N4287	0.19
AC127	0.20	AF124	0.33	BC161	0.55	BD175	0.66	BF222	£1.05	OC26	0.32	2G371B	0.13	2N2222	0.22	2N3404	0.31	2N4288	0.19
AC128	0.20	AF125	0.33	BC167	0.13	BD176	0.66	BF257	0.50	OC28	0.55	2G373	0.19	2N2368	0.19	2N3405	0.46	2N4289	0.19
AC132	0.16	AF126	0.31	BC168	0.13	BD177	0.72	BF258	0.66	OC29	0.55	2G374	0.19	2N2369	0.16	2N3414	0.17	2N4290	0.19
AC134	0.16	AF127	0.31	BC169	0.13	BD178	0.72	BF259	0.94	OC35	0.46	2G377	0.33	2N2369A	0.16	2N3415	0.17	2N4291	0.19
AC137	0.16	AF139	0.33	BC170	0.13	BD179	0.77	BF262	0.61	OC36	0.55	2G378	0.18	2N2411	0.27	2N3416	0.31	2N4292	0.19
AC141	0.20	AF178	0.55	BC171	0.16	BD180	0.77	BF263	0.61	OC41	0.22	2G381	0.18	2N2412	0.27	2N3417	0.31	2N4293	0.19
AC141K	0.32	AF179	0.55	BC172	0.16	BD185	0.72	BF270	0.39	OC42	0.27	2G382	0.18	2N2646	0.52	2N3525	0.83	2N5172	0.13
AC142	0.20	AF180	0.55	BC173	0.16	BD186	0.72	BF271	0.33	OC44	0.17	2G401	0.33	2N2711	0.23	2N3614	0.74	2N5294	0.60
AC142K	0.29	AF181	0.55	BC174	0.16	BD187	0.77	BF272	0.88	OC45	0.14	2G414	0.33	2N2712	0.23	2N3615	0.82	2N5457	0.35
AC151	0.17	AF186	0.55	BC175	0.24	BD188	0.77	BF273	0.39	OC70	0.11	2G417	0.28	2N2714	0.23	2N3616	0.82	2N5458	0.35
AC154	0.22	AF239	0.41	BC177	0.21	BD189	0.83	BF274	0.39	OC71	0.11	2N388	0.39	2N2904	0.19	2N3644	0.10	2N5459	0.44
AC155	0.22	AL102	0.72	BC178	0.21	BD190	0.83	BFW10	0.66	OC72	0.16	2N388A	0.61	2N2904A	0.23	2N3702	0.13	2N6221	0.75
AC156	0.22	AL103	0.72	BC179	0.21	BD195	0.94	BFX29	0.30	OC74	0.16	2N404	0.22	2N2905	0.23	2N3703	0.13	2S301	0.55
AC157	0.27	ASY26	0.28	BC180	0.27	BD196	0.94	BFX84	0.24	OC75	0.17	2N404A	0.31	2N2905A	0.23	2N3704	0.14	2S302A	0.46
AC165	0.22	ASY27	0.33	BC181	0.27	BD197	0.99	BFX85	0.33	OC76	0.17	2N524	0.46	2N2906	0.17	2N3705	0.13	2S302	0.46
AC166	0.22	ASY28	0.28	BC182	0.16	BD198	0.99	BFX86	0.24	OC77	0.28	2N527	0.54	2N2906A	0.20	2N3706	0.13	2S303	0.62
AC167	0.22	ASY29	0.28	BC182L	0.16	BD199	£1.05	BFX87	0.27	OC81	0.17	2N598	0.46	2N2907	0.22	2N3707	0.14	2S304	0.77
AC168	0.27	ASY50	0.28	BC183	0.16	BD200	£1.05	BFX88	0.24	OC81D	0.17	2N599	0.50	2N2907A	0.24	2N3708	0.09	2S305	0.86
AC169	0.16	ASY51	0.28	BC183L	0.16	BD205	0.88	BFY50	0.22	OC82	0.17	2N696	0.14	2N2923	0.16	2N3709	0.10	2S306	0.86
AC176	0.22	ASY52	0.28	BC184	0.22	BD206	0.88	BFY51	0.22	OC82D	0.17	2N697	0.15	2N2924	0.16	2N3710	0.10	2S307	0.86
AC177	0.27	ASY54	0.28	BC184L	0.22	BD207	£1.05	BFY52	0.22	OC83	0.22	2N698	0.27	2N2925	0.16	2N3711	0.10	2S321	0.62
AC178	0.31	ASY55	0.28	BC186	0.31	BD208	£1.05	BFY53	0.19	OC139	0.22	2N699	0.39	2N2926(G)	0.14	2N3819	0.31	2S322	0.46
AC179	0.31	ASY56	0.28	BC187	0.31	BDY20	£1.10	BSX19	0.17	OC140	0.22	2N706	0.09	2N2926(Y)	0.12	2N3820	0.55	2S322A	0.46
AC180	0.22	ASY57	0.28	BC207	0.12	BF115	0.27	BSX20	0.17	OC169	0.28	2N706A	0.10	2N2926(O)	0.11	2N3821	0.39	2S323	0.62
AC180K	0.32	ASY58	0.28	BC208	0.12	BF117	0.50	BSY25	0.17	OC170	0.28	2N708	0.13	2N2926(R)	0.11	2N3823	0.31	2S324	0.77
AC181	0.22	ASY73	0.28	BC209	0.13	BF118	0.77	BSY26	0.17	OC171	0.28	2N711	0.33	2N2926(B)	0.11	2N3903	0.31	2S325	0.77
AC181K	0.32	ASZ21	0.44	BC212L	0.14	BF119	0.77	BSY27	0.17	OC200	0.28	2N717	0.39	2N3010	0.77	2N3904	0.33	2S326	0.77
AC187	0.24	BC107	0.09	BC213L	0.14	BF121	0.50	BSY28	0.17	OC201	0.31	2N718	0.27	2N3011	0.16	2N3905	0.31	2S327	0.77
AC187K	0.25	BC108	0.09	BC214L	0.18	BF123	0.55	BSY29	0.17	OC202	0.31	2N718A	0.55	2N3053	0.19	2N3906	0.30	2S701	0.46
AC188	0.24	BC109	0.09	BC225	0.28	BF125	0.50	BSY38	0.20	OC203	0.28	2N726	0.31	2N3054	0.51	2N4058	0.13	40361	0.44
AC188K	0.25	BC113	0.11	BC226	0.39	BF127	0.55	BSY39	0.20	OC204	0.28	2N727	0.31	2N3055	0.45	2N4059	0.11	40362	0.50
ACY17	0.28	BC114	0.17	BC301	0.30	BF152	0.61	BSY40	0.31	OC205	0.39	2N743	0.22	2N3391	0.16				
ACY18	0.22	BC115	0.17	BC302	0.27	BF153	0.50	BSY41	0.31	OC309	0.44	2N744	0.22						
ACY19	0.22	BC116	0.17	BC303	0.35	BF154	0.50	BSY95	0.14	OCP71	0.48	2N914	0.16						
ACY20	0.22	BC117	0.20	BC304	0.40	BF155	0.77	BSY95A	0.14	ORP12	0.48	2N918	0.33						
ACY21	0.22	BC118	0.11	BC440	0.34	BF156	0.53	BU105	£2.20	ORP60	0.44	2N929	0.23						
ACY22	0.18	BC119	0.33	BC460	0.40	BF157	0.61	C111E	0.55	ORP61	0.44	2N930	0.23						
ACY27	0.20	BC120	0.88	BCY30	0.27	BF158	0.61	C400	0.33	P20	0.55	2N1131	0.22						
ACY28	0.21	BC125	0.13	BCY31	0.29	BF159	0.66	C407	0.28	P346A	0.22	2N1132	0.24						
ACY29	0.39	BC126	0.20	BCY32	0.33	BF160	0.44	C424	0.28	P397	0.46	2N1302	0.16						
ACY30	0.31	BC132	0.13	BCY33	0.24	BF162	0.44	C425	0.55	ST140	0.14	2N1303	0.16						
ACY31	0.31	BC134	0.20	BCY34	0.28	BF163	0.44	C426	0.39	ST141	0.19	2N1304	0.19						
ACY34	0.23	BC135	0.13	BCY70	0.16	BF164	0.44	C428	0.22	TIP29	0.48	2N1305	0.19						
ACY35	0.23	BC136	0.17	BCY71	0.22	BF165	0.44	C441	0.33	TIP30	0.56	2N1306	0.23						
ACY36	0.31	BC137	0.17	BCY72	0.16	BF167	0.24	C442	0.33	TIP31A	0.60	2N1307	0.23						
ACY40	0.19	BC139	0.44	BCZ10	0.22	BF173	0.24	C444	0.39	TIP32A	0.73	2N1308	0.26						
ACY41	0.20	BC140	0.33	BCZ11	0.28	BF176	0.39	C450	0.24	TIP41A	0.73	2N1309	0.26						
ACY44	0.39	BC141	0.33	BCZ12	0.28	BF177	0.39	MAT100	0.21	TIP42A	0.88	2N1613	0.22						
AD130	0.42	BC142	0.33	BD115	0.68	BF178	0.33	MAT101	0.22	TIS43	0.34	2N1711	0.22						
AD140	0.53	BC143	0.33	BD116	0.88	BF179	0.33	MAT120	0.21	UT46	0.30	2N1889	0.35						
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AD149	0.55	BC148	0.11	BD124	0.76	BF182	0.44	MJE3055	0.62	2G302	0.21	2N2147	0.79						
AD161	0.39	BC149	0.13	BD131	0.55	BF183	0.44	MJE3440	0.55	2G303	0.21	2N2148	0.63						
AD161 &		BC150	0.20	BD132	0.66	BF184	0.28	MPF102	0.46	2G304	0.27	2N2160	0.66						
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BA100	0.11	BYZ10	0.39	OA85	0.10
BA116	0.23	BYZ11	0.33	OA90	0.07
BA126	0.24	BYZ12	0.33	OA91	0.07
BA148	0.16	BYZ13	0.28	OA95	0.08
BA154	0.13	BYZ16	0.44	OA200	0.07
BA155	0.16	BYZ17	0.39	OA202	0.08
BA156	0.15	BYZ18	0.39	SD10	0.06
BA173	0.16	BYZ19	0.31	SD19	0.06
BY100	0.17	CG62		1N34	0.08
BY101	0.13	(OA91Eq)	0.06	1N34A	0.08
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BY114	0.13	79)	0.07	1N916	0.06
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BY126	0.16	OA5 short		1S021	0.11
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72741C	0.28	0.27	0.25
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72748P	0.38	0.36	0.34
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BP944	0.16	0.15	0.14
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BP948	0.30	0.28	0.25
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7401	0.15	0.14	0.13	7450	0.15	0.14	0.13	74123	0.75	0.73	0.70
7402	0.15	0.14	0.13	7451	0.15	0.14	0.13	74141	0.85	0.82	0.79
7403	0.15	0.14	0.13	7453	0.15	0.14	0.13	74145	£1.30	£1.25	£1.20
7404	0.15	0.14	0.13	7454	0.15	0.14	0.13	74150	£1.50	£1.40	£1.30
7405	0.15	0.14	0.13	7460	0.15	0.14	0.13	74151	£1.10	£1.05	£1.00
7406	0.39	0.34	0.31	7470	0.32	0.29	0.27	74153	£1.00	0.95	0.90
7407	0.39	0.34	0.31	7472	0.32	0.29	0.27	74154	£1.70	£1.65	£1.60
7408	0.25	0.24	0.23	7473	0.41	0.39	0.35	74155	£1.20	£1.15	£1.10
7409	0.25	0.24	0.23	7474	0.41	0.39	0.35	74156	£1.20	£1.15	£1.10
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7423	0.40	0.39	0.38	7486	0.35	0.34	0.33	74174	£1.60	£1.55	£1.50
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7428	0.45	0.42	0.40	7492	0.74	0.71	0.64	74180	£1.25	£1.20	£1.15
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7432	0.40	0.38	0.36	7494	0.85	0.82	0.75	74182	£1.25	£1.20	£1.15
7433	0.42	0.40	0.38	7495	0.85	0.82	0.75	74184	£1.80	£1.75	£1.70
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7438	0.35	0.32	0.30	74100	£1.50	£1.45	£1.40	74191	£1.95	£1.90	£1.85
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7441	0.74	0.71	0.64	74105	0.60	0.58	0.55	74193	£1.95	£1.90	£1.85
7442	0.74	0.71	0.64	74107	0.44	0.42	0.40	74194	£1.30	£1.25	£1.20
7443	£1.20	£1.15	£1.10	74110	0.60	0.55	0.50	74195	£1.10	£1.05	£1.00
7444	£1.20	£1.15	£1.10	74111	0.90	0.88	0.85	74196	£1.20	£1.15	£1.10
7445	£1.60	£1.55	£1.50	74118	£1.00	0.95	0.90	74197	£1.20	£1.15	£1.10
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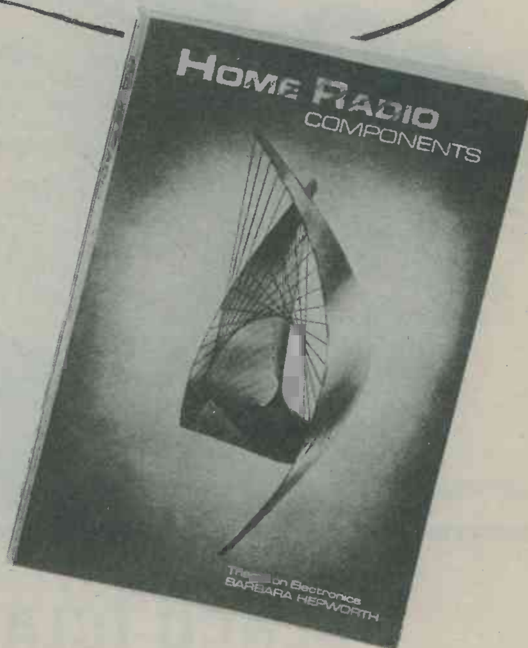

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SUPER-REGENERATIVE 28 MHz RECEIVER

This article gives details of the construction of a super-regenerative receiver designed for the 28-29.7MHz amateur band. The receiver may be employed in conjunction with the transmitter-receiver described in theMarch-April issues, or with the larger transmitter which will be described later in the series.

THIS RECEIVER HAS THE ADVANTAGES THAT IT REQUIRES few components and that no adjustments are needed apart from setting up a single coil core for reception on the 28MHz amateur band. Four transistors are employed and they operate a small loudspeaker at reasonable volume.

CIRCUIT OPERATION

The circuit of the receiver is given in Fig. 1. TR1 appears in an untuned r.f. stage, the main purpose of which is to isolate the aerial and the detector. This reduces aerial radiation and also prevents troublesome hand capacitance effects which could upset tuning.

The coil primary, L1, couples to the tuned winding, L2, and this in turn couples to the drain of the detector, TR2. Feedback from the source to the drain is provided by C5. The regeneration level is controlled by VR1, which is ganged with the on-off switch, S1. The audio section is a 2-stage amplifier comprising TR3 and TR4, and these give a high degree of gain. The collector of TR4 feeds into an 80Ω speaker. Total battery current is about 20mA and a PP4 battery can be used. If a sufficiently small speaker can be obtained there should be room, alternatively, for the larger PP6 battery.

This receiver is very easy to tune and operate. When used with the transmitter to be described in the next two articles in this series, it was found to have sufficient

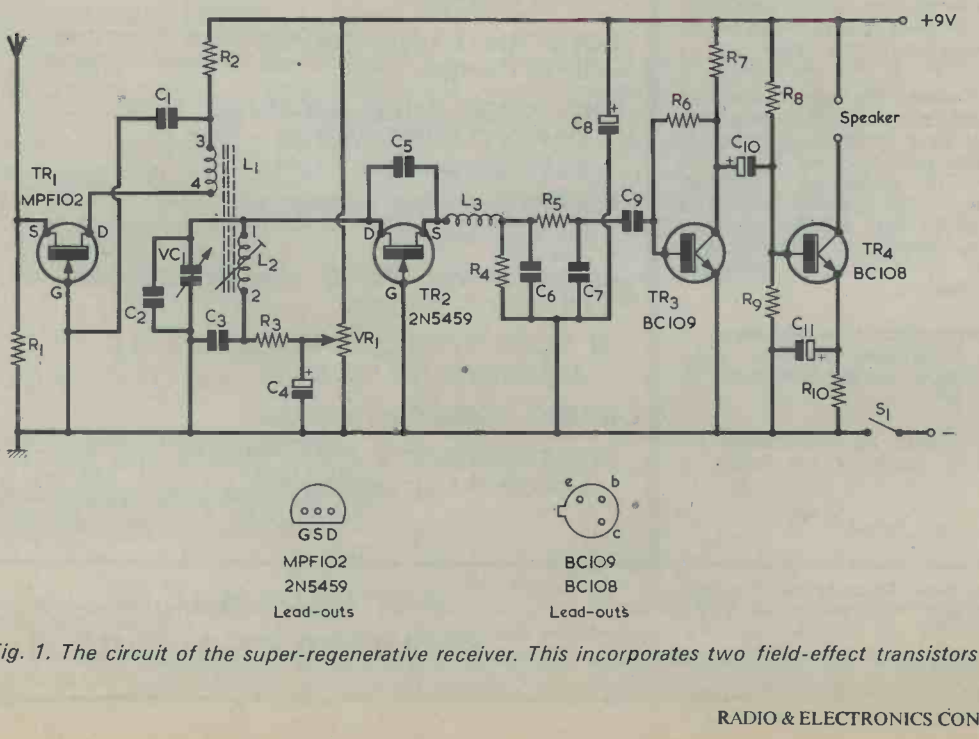


Fig. 1. The circuit of the super-regenerative receiver. This incorporates two field-effect transistors

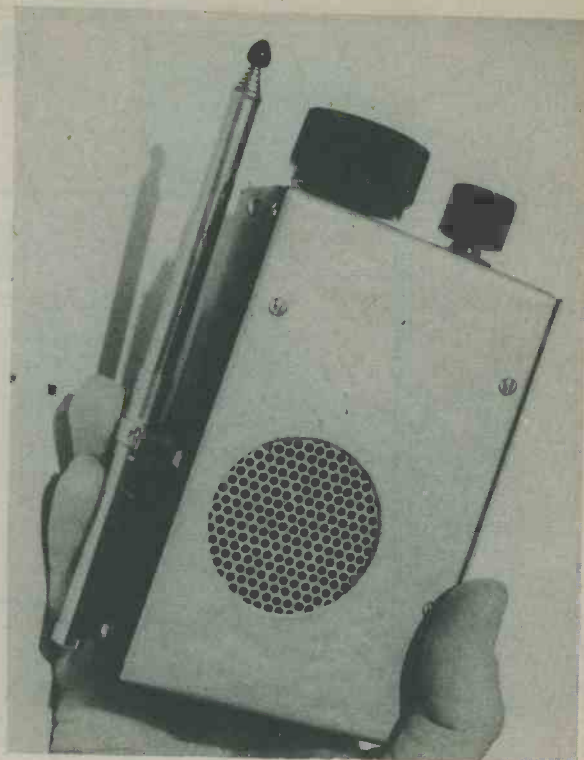
By F. G. Rayer

sensitivity for ample speaker volume without the aerial extended at short range, and to provide easy reception with the aerial extended at a range of 5 miles or more across open country. It can be employed for monitoring signals near the transmitter by turning VR1 just beyond the point at which S1 closes, so that no regeneration is given.

So far as components are concerned, it will be noted that VR1 is specified as a 22kΩ potentiometer. It may alternatively be 20kΩ or 25kΩ if either of these values is easier to obtain. The telescopic aerial employed by the author was about 36in. when extended. If an aerial of this length cannot be obtained, nearly similar lengths are given by a type TA3(A) aerial (32in.) or a type TA10 aerial (46in.). Both of these are available from Henry's Radio Ltd.

METALWORK

The front panel, top and bottom of the case are made up from a single 8 by 3in. Universal Chassis side, available from Home Radio. V-shaped sections are cut



The super-regenerative receiver can be held comfortably in the hand

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	330Ω
R2	1kΩ
R3	1kΩ
R4	10kΩ
R5	15kΩ
R6	2.2MΩ
R7	10kΩ
R8	56kΩ
R9	12kΩ
R10	39Ω
VR1	22kΩ potentiometer, linear, with switch S1 (see text)

Capacitors

C1	1,000pF disc or tubular ceramic
C2	22pF tubular ceramic
C3	1,000pF disc or tubular ceramic
C4	20μF electrolytic, 10 V. Wkg.
C5	4.7pF tubular ceramic
C6	5,000pF disc or tubular ceramic
C7	0.01μF plastic foil
C8	100μF electrolytic, 10 V. Wkg.
C9	0.1μF plastic foil
C10	2.2μF electrolytic, 10 V. Wkg.
C11	50μF electrolytic, 4 V. Wkg.
VC1	10pF variable, type C804 (Jackson Bros.)

Inductors

L1, L2	detector coil (see text)
L3	r.f. choke (see text)

Semiconductors

TR1	MPF102
TR2	2N5459
TR3	BC109
TR4	BC108

Switch

S1	s.p.s.t., part of VR1

Speaker
80Ω Speaker, 2¼ in. (see text)

Miscellaneous
Telescopic aerial, 36 in. extended (see text)
8 x 3 in. Universal Chassis side, (Home Radio)
2 knobs
Plain Veroboard, 0.15 in. matrix, 3 x 2¾ in.
S.R.B.P. and aluminium sheet, as required
Nuts, bolts, solder tags, etc.

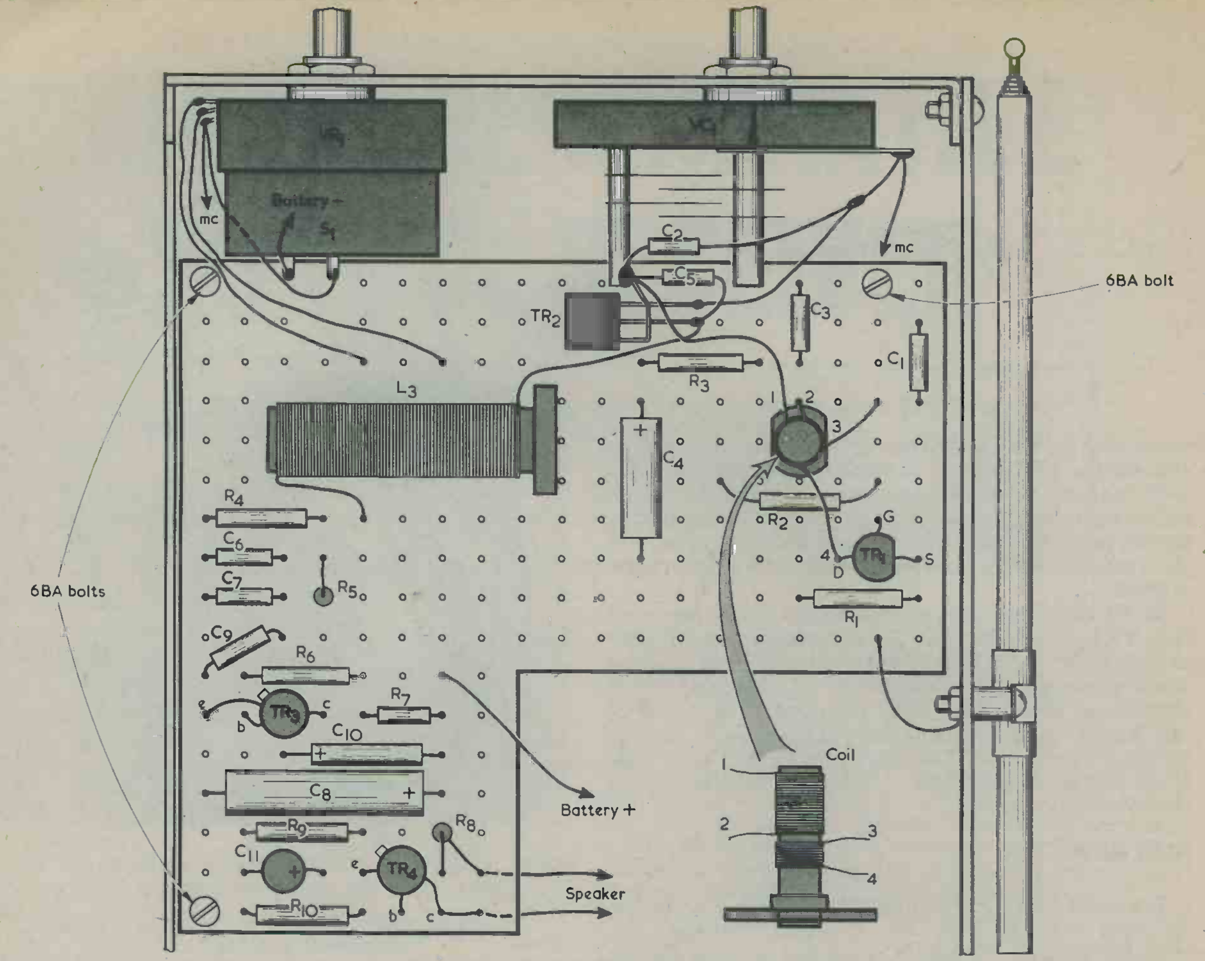


Fig. 2. The component side of the Veroboard panel. Lead 4 of the detector coil shares the same hole as the drain of TR1. TR2, C2 and C5 are mounted on the solder lugs of VC1

from each long flange $1\frac{1}{4}$ inch from each end. The ends of the chassis side are then bent through 90° at the V-cut apexes, resulting in an open case having a top, front and bottom with dimensions of 5 by 3 by $1\frac{1}{2}$in. Naturally, all flanges are on the inside. The sharp bends required are best obtained by gripping the metal between pieces of wood in a vice.

What is now the top of the case is drilled to take VR1 and VC1, which are mounted in the positions shown in Fig. 2. The precise positioning of these two components is not important, provided VC1 lugs and spindle will be clear of the Veroboard panel on which the components are mounted.

The components are assembled on a piece of 0.15in. matrix plain Veroboard having 19 by 17 holes, and with a section cut out for the speaker magnet, as shown in Fig. 2. It is best to cut out the Veroboard panel at this stage since it enables the speaker positioning to be established. VR1 and VC1 may be temporarily fitted and the required speaker position found with the aid of the Veroboard panel. The author used a small $2\frac{1}{4}$in. speaker and it was found possible to position this and the Veroboard such that ample space was left for a PP6 battery. The Veroboard panel passes over part of the speaker, as may be seen from the photographs of the interior. It is probable that constructors will have to employ a slightly larger $2\frac{1}{2}$in. speaker, but this should still allow room for a PP4 if not a PP6 battery. (Nominal dimensions for a PP4 battery are 1in. diameter by $1\frac{15}{16}$ in., whilst those for a PP6 battery are $1\frac{7}{16}$ by $1\frac{3}{8}$ by $2\frac{3}{4}$in.). When the required speaker position has been determined, this is marked out on the chassis, and the Veroboard panel and the two controls are removed. Speaker mounting holes and a $1\frac{3}{4}$in. aperture are then cut out in the front panel at the appropriate points. The back of the aperture is covered with speaker gauze, or similar. Also, the flange on the bottom of the case is cut off to permit easy fitting and removal of the battery.

The right side of the receiver (when viewed from the rear) carries the telescopic aerial, and this consists of a piece of s.r.b.p. ('Paxolin') measuring 5 by $1\frac{1}{2}$in. It is bolted to the side flanges of the case top, front and bottom, and has the aerial secured to it by means of simple home-constructed clamps. The right side can alternatively be cut from aluminium sheet, whereupon an insulated mounting must be made up for the aerial. The right side is secured permanently to the case.

A removable cover can be made up from a piece of aluminium sheet measuring 5 by $4\frac{1}{2}$in. before bending. It is bent through 90° along a line 3in. from one 5in. edge, whereupon it covers the back and left side of the case. It is secured to the case flanges with self-tapping screws.

COIL WINDING

The coil, L1, L2, was wound on a $\frac{3}{16}$in. diameter former with adjustable core. A suitable alternative former is the Home Radio Cat. No. CR26, with core Cat. No. 7/Z87, this former being 5mm. in diameter and 14mm. long. The winding ends are numbered 1 to 4 in the diagrams to assist in showing how the coil is wound and connected into circuit. The winding wire is 32 s.w.g. enamelled wire, and one end of this is secured as near the top of the former as possible, using adhesive, cotton or tape. This is point 1, and 14 turns are then wound side by side, terminating at point 2. A space of approximately $\frac{1}{16}$in. is left, then 8 turns of the wire are wound on, side by side, in the same direction, starting at point 3 and ending at point 4. Although the winding ends may be fixed with adhesive, the windings themselves must not be covered with adhesive, varnish or any other substances which may cause losses.

The r.f. choke, L3, consists of 150 turns of 40 s.w.g. enamelled wire wound side by side on a $\frac{1}{4}$in. diameter former without a core. The former could be a length of $\frac{1}{4}$in. insulated rod, cut from a potentiometer shaft. The winding occupies about $\frac{7}{8}$in., so the former needs to have 1in. clear winding space. The ends of the coil are held with touches of adhesive.

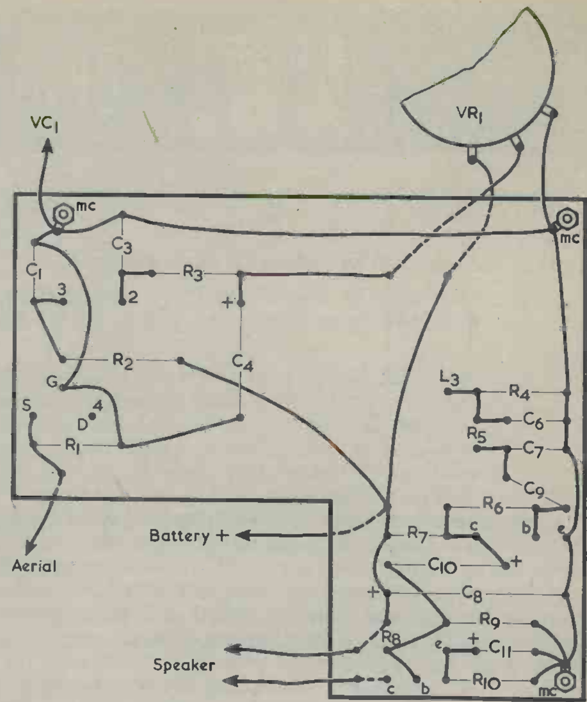
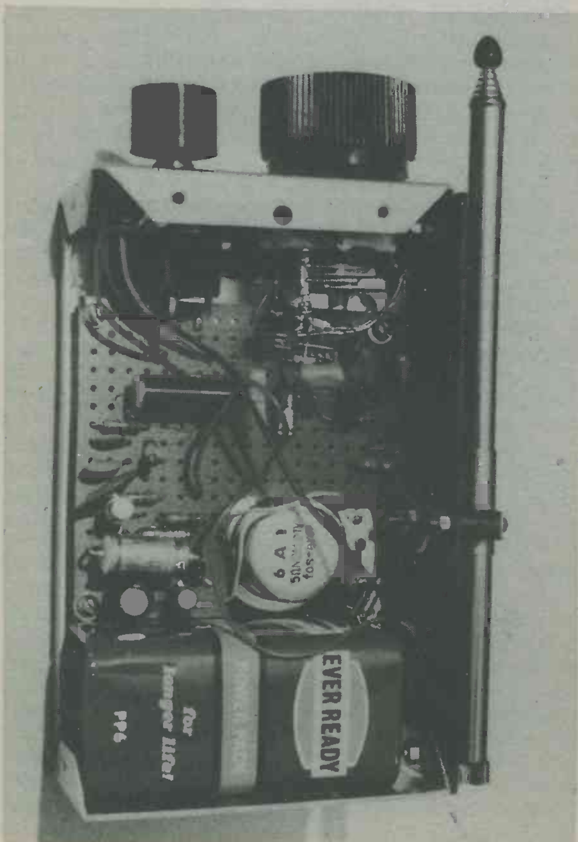


Fig. 3. The wiring on the underside of the board



The components inside the receiver are laid out in compact manner without crowding

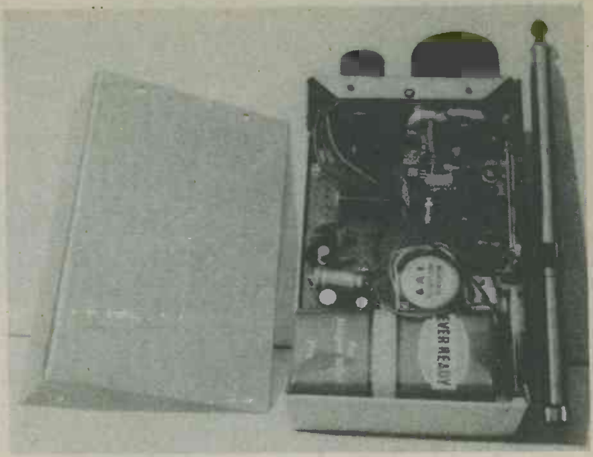
BOARD WIRING

The component and wiring sides of the Veroboard panel are illustrated in Figs. 2 and 3 respectively. Three 6BA clear holes are required for 6BA mounting bolts. These also hold solder tags which provide the chassis connection to the board. The board is spaced about $\frac{3}{8}$in. away from the back of the front panel, and the three screws may pass through three holes in the panel, being secured on either side by nuts. However, a neater appearance is given by fitting 6BA threaded spacers, or terminal heads, on the board securing bolts. Three short bolts may then pass into these from the front of the case, so that bolt heads instead of nuts appear at the front panel. Correct matching of the two sets of 6BA clear holes can be assured by placing the board and case front together before wiring, and drilling both at the same time.

Coil L1, L2 is a push fit in a further hole in the Veroboard panel, and is fixed with adhesive. The r.f. choke, L3, can be secured with adhesive at one or both ends.

There is no particular cramping of wiring, but care should be taken to ensure that joints and leads around the positive end of C8 will not touch the speaker frame. Tinned copper wire of around 20 s.w.g. runs between the 6BA 'MC' tags, and wires are left projecting to be soldered to VC1 and VR1. Also, thin flexible wires are fitted for connection to the speaker, the aerial and the battery positive terminal.

When all the wiring on the board has been completed, it is secured in the case in the manner just described.



The receiver with its removable cover alongside

Connections can then be made to VR1 and VC1. Note that TR2, C2 and C5 are not on the board, but are mounted by their connections to VC1. The speaker and aerial are next connected, and battery clips added to the positive battery lead fom the board and the negative battery lead from S1. If bare battery clips are employed these must be taped over to prevent contact with the chassis. If the negative clip touches the metal case the receiver is switched on, whilst if the positive clip touches the metal the battery can be short-circuited.

Another view of the completed super-regenerative receiver

ADJUSTMENT

A signal, either from a signal generator or from a transmitter, is needed for setting up the receiver. VC1 is set to half maximum capacitance, and the core of L1, L2 turned until the signal is tuned in. After adjustment, the core can be held in place with wax, or thin elastic run between the core and the former when the core is initially screwed in.

The aerial should not be extended when checking near the transmitter, and VR1 should be advanced only a little according to signal strength. For use at a distance, VR1 must be advanced until a hiss is heard, this indicating super-regenerative operation. This hiss ceases when the signal is tuned in, up to the limit of range where signal strength is too low for acceptable reception. The setting of VR1, or the tuning, will not be critical when signal strength is good.

When approaching the limit of useful range, or when circumstances are unfavourable, the angle at which the receiver and aerial are held, together with the aerial height, become more important. If desired, a wire or other longer aerial can be attached. When the receiver is in the super-regenerative mode, interference from it can be picked up by another receiver at a small distance. This should not generally be very important on the frequencies concerned, and especially as the receiver is likely to be used away from the house.

A super-regenerative detector of this type is usually considered to have a sensitivity of around 1µV, which is greater than that expected from a superhet of average non-specialised type. No particular difficulty is likely to be experienced with the circuit, which is capable of quite long distance reception.

If various transistors are tried in the TR2 position it may be found that, with some, the onset of regeneration is more easily controlled than with others. The adjustment of a super-regeneration control is much less critical than the adjustment of a regeneration or reaction control, as used in ordinary t.r.f. receivers, and in fact some commercial equipment employs fixed super-regeneration. However, if any difficulty does arise in this direction, it can be worth-while changing C5 to a low capacitance trimmer of the order of 10pF, this being adjusted for the onset of super-regeneration with VR1 about one quarter from its maximum position.

The description of the super-regenerative receiver is now concluded. In the next article in this series, the 30 watt base transmitter will be introduced. ■

RECENT PUBLICATIONS

TOWERS' INTERNATIONAL TRANSISTOR SELECTOR. By T. D. Towers, M.B.E., M.A., B.Sc., C.Eng., M.I.E.R.E. 142 pages, 295 x 210 mm. ($11\frac{3}{4}$ x $8\frac{1}{4}$ in.). Published by W. Foulsham & Co. Ltd. Price £2.95.

This mammoth work gives electrical and mechanical specifications for over 10,000 American, British, European and Japanese transistors. The transistors appear in numero-alphabetic order and each is accorded a single line in the tables which constitute the bulk of the book. Entries are given in the following columns: polarity and material (i.e. germanium or silicon), case outline, lead identification, VCBO max., VCEO max., VEBO max., IC max., Tj max., Ptot. max., FT min., COB max., HFE, HFE bias (i.e. current at which HFE is quoted), use, manufacturer, suggested U.K. substitute and suggested U.S.A. substitute. There are 80 transistor types per page, and to give an idea of range the 2N series starts at 2N22 and ends at 2N6368 some 41 pages later. Again, the Japanese 2SA to 2SD range occupies more than 23 pages.

This is a most valuable reference source for anyone who has to find his way through the fantastically large number of transistors which are available these days, and it provides a welcome short-cut to the essential data on any of the very large number of devices that it lists.

ELSEVIER'S DICTIONARY OF TELEVISION AND VIDEO RECORDING. Compiled by W. E. Clason. 616 pages, 220 x 150 mm. ($8\frac{3}{4}$ x 6 in.). Published by Elsevier Scientific Publishing Company. Price: see below.

This book gives English/American, French, Spanish, Italian, Dutch and German translations of technical terms employed in modern television and video recording work. The basic language is English, and 420-odd pages of the dictionary give translations in the other five languages of 5,310 English terms listed in alphabetical order. In many instances an English definition of the term is given before the translations. Each term is numbered. If the reader wishes to find the English translation for a French term he consults the French section of the dictionary, which lists all the French terms with their translation numbers in the main English section. This procedure also leads to the corresponding translations in the other languages. Following the French section are Spanish, Italian, Dutch and German sections which similarly allow the reader to find the English translation number.

The work is based on *Elsevier's Dictionary of Television, Radar and Antennas,* which has been completely revised and brought up to date. The dictionary is extremely comprehensive and detailed, and will be of great help to the engineer who consults technical texts in the languages covered.

The book is published in the Netherlands by Elsevier Scientific Publishing Company, P.O. Box 211, Amsterdam, and the review literature quoted the price as Dfl 135.00 or about 51.95 U.S. dollars.

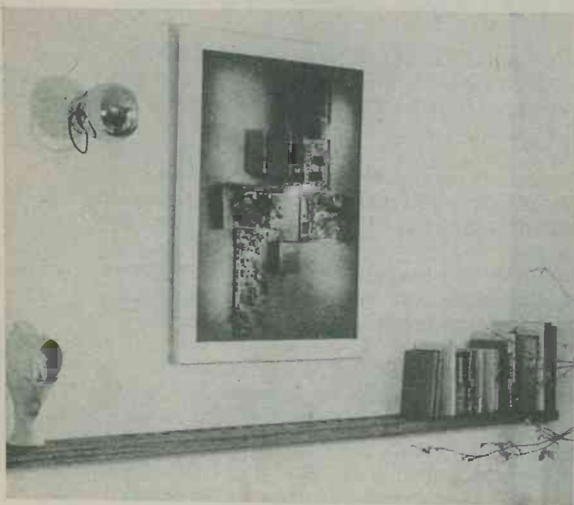
BEGINNER'S GUIDE TO TRANSISTORS, Second Edition. By J. A. Reddihough and I. R. Sinclair, B.Sc., C.Eng., M.I.E.E., M.Inst.P. 162 pages, 185 x 125 mm. ($7\frac{1}{4}$ x 5 in.). Published by Newnes-Butterworths. Price £1.80.

The first edition of this book was written by J. A. Reddihough and appeared in 1968. It has now been completely revised for the second edition by I. R. Sinclair. The book commences with a simple description of how a transistor works, then carries on to related semiconductor devices such as f.e.t.'s, unijunction transistors, junction, point-contact and zener diodes, tunnel diodes and thyristors. Next discussed are amplifier configurations, parameters and basic amplifier circuits. Succeeding chapters deal with a.f. circuits and techniques, including tape recorder circuits and differential amplifiers; r.f. circuits and techniques, at frequencies up to u.h.f.; the transistor employed as a switch; power supplies and integrated circuits. A final chapter gives hints on fault finding and servicing.

The book gives clear explanations which are backed up by well presented diagrams, and will be found particularly useful to the beginner who is embarking on work with semiconductors either as a hobby or as a career.

NEWS . . . AND .

AUDIO PICTURES



Talking pictures, audio sculptures, radio paintings – they're all the same to Kit Penny, a former art student who is creating the latest top executive 'toy' in a studio at the back of his father's pub, *The Balls Hut Inn*, Fontwell, near Arundel in Sussex.

In one of his flurries of creative activity, Kit knocked a transistor set over – the cabinet broke into a dozen pieces and the instrument remained mute.

The only flat working surface was the canvas on which Kit was working and this was removed from the easel and placed on the floor. Later, the entrails of the radio were spread over a canvas that measured about 30 x 20 in.

Considering what he now believed to be a pile of worthless junk, Kit was struck by the attractiveness of of the design the radio components made against the background of canvas.

Two weeks later, and having used considerable quantities of impact adhesive (the canvas had been exchanged for fibreboard) and three tins of aerosol paint, Kit was considering his first talking picture . . . or audio sculpture if you like.

A loose wire soldered to its proper connection and the first talking picture, the prototype of many more, talked.

Kit has produced a number now, they sell at about £45.00, and each design is exclusive: the idea has been patented.

Details from Talking Picture Company, Fontwell, Arundel, Sussex.

RADIO CONTROL SYSTEM — SOVEREIGN SERIES

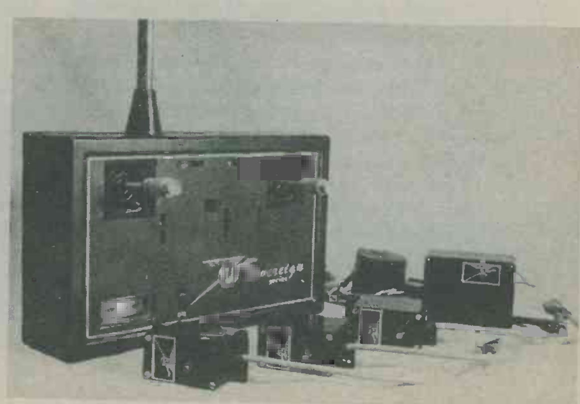
Flight Link Control Ltd., of Bristow Road, Hounslow, Middlesex, who specialise in designing and manufacturing professional-standard radio control equipment for industrial as well as consumer markets, have standardised on Portescap's type 032 DC micromotor for the servo system in their latest radio-control system – the Sovereign Series. This is the motor that they have been using successfully for more than six years in their radio-control products.

The result has been that the company can now offer what they believe to be the highest quality range of 2, 3, 4, 5 or 6-function radio-control units ever made available on the British market.

The servo, which is used to provide the remote mechanical movements that are hand controlled at the transmitter unit, is a tiny (1.6 x 1.35 x 0.95 in.) lightweight (2 oz.) device. It incorporates a motorised potentiometer, which is driven by a type 032 motor having a built-in 15:1 reduction gearhead.

These micromotors are precision engineered units having patented ironless skew-wound rotors that ensure a high power-to-weight ratio and low current consumption. They also incorporate precious metals in the commutator (silver alloy) and brushes (gold alloy) and feature self-lubricating sintered bronze bearings, all of which features contribute to their long life, high reliability and maintenance-free operation.

Such features are essential in any servo system, particularly in the case of Flight Link Control's airborne equipment. Using the type 032 – they purchase large numbers every year – they can offer servomechanisms that produce a pull of 3.25 lb. over ½-inch travel and are claimed to provide the smoothest, quickest and most precise control response available anywhere at a comparable price.



. . . COMMENT

RADIOMOBILE CONSOLES

Radiomobile Limited have made life easier with a selection of new attractively-styled radio Consoles.

The radio and speaker can be mounted into the Console outside the car, prior to installation. The whole assembly is simply fitted into the car and has no visible screws or brackets, resulting in a smart centre console styled in black moulded, padded plastic on strong hardboard which is used in preference to wood which would split in case of an accident.

Radiomobile Consoles are provided with a loud speaker grill, a radio heat shield to prevent over-heating from the car's heating system and all the necessary screw fixings etc., with easy to follow installation instructions. One of the features of the new Console, is that the cut-out has been strengthened to accommodate stereos, and vastly improves the dash-board without impairing safety standards.

The Consoles are available only from Radiomobile dealers price £10.45 excluding VAT.

SINCLAIR RADIONICS WINS QUEEN'S AWARD

It gave us particular pleasure to learn of the above award as Clive Sinclair, prior to founding Sinclair Radionics Ltd., of London Road, St. Ives, Cambs., was an occasional contributor to these pages.

The company has won a Queen's Award to Industry, 1975 in recognition of its outstanding export achievement and for technological innovation in scientific electronic calculators. It is Europe's largest manufacturer of electronic calculators.

Award for technological innovation has been made for the development of the low cost, Sinclair 'Scientific' pocket calculator which replaces slide rules and four figure tables.

Clive Sinclair not only founded the company, but is also its Managing Director.

CASH NEEDED FOR AMSAT-OSCAR 8 PROJECT

AMSAT is trying to raise $15,000 needed for the development of advanced hardware for the AMSAT-OSCAR 8 project. Currently under development are 146-to-435 MHz repeaters, new telecommand and telemetry systems, and on-board microprocessor controlled systems for applications in future AMSAT-OSCAR spacecraft.

Donations can be sent to Radio Amateur Satellite Corporation, P.O. Box 27, Washington, D.C. 20044.

In co-operation with AMSAT, Skip Reymann, W6PAJ has published an AMSAT-OSCAR orbital data calendar containing all orbits for 1975 for both AMSAT-OSCAR 6 and AMSAT-OSCAR 7.

The orbital data calendar is available postpaid for 20 IRC's. Overseas orders will be shipped via airmail. Orders and payment should be made to: Skip Reymann, W6PAJ, P.O. Box 374, San Dimas, California 91773, U.S.A.

All excess receipts over costs will be donated to AMSAT.

A Stand devoted to O.S.C.A.R. was a feature of the Exhibition staged recently by the Norwich Astronomical Society. Much interest was shown in it as it demonstrated the 'overlap' of the sciences these days, in this case that between radio and space activities and the more traditional aspects of astronomy.

"So all these anti-static precautions of yours are strictly down to Advanced Technology eh! Mr. Poskitt?"

SEQUENTIAL TRANSISTOR OSCILLATOR

By G. A. French

Suggested Circuit 295

In the 'suggested circuit' article which appeared in last month's issue the writer described a sequential switching circuit by means of which a 'moving light' impression could be achieved in a rectangle of lamps. Successive lamps were extinguished in turn, the whole system being controlled by an oscillator comprising three transistors.

The oscillator design is, on its own, of sufficient interest to merit further attention in a second article, and aspects concerning its operation which did not need to be referred to in last month's switching lamp application will now be dealt with.

OSCILLATOR CIRCUIT

The oscillator circuit is shown in Fig. 1 and it comprises three transistors, two of which are always on and one of which is always off. Oscillator functioning was fully described in the previous article and so only brief details will be given here. When, during the cycle, TR1 turns off, capacitor C1 is able to charge to nearly the full supply voltage by way of R2 and the base-emitter junction of TR2. Later, TR1 turns on again whereupon the charged C1 takes TR2 base positive of the lower supply rail and turns off this transistor. C2 charges, in turn, via R4 and the base-emitter junction of TR3, whilst C1 discharges at a lower rate into R3. When C1 has discharged sufficiently TR2 turns on, whereupon the charged C2 causes TR3 to turn off. The cycle continues around the ring of transistors in this manner, with the transistors turning off successively in the order: TR1, TR2, TR3, TR1, TR2, TR3. External circuits may be controlled by switching transistors inserted in the collector circuits of the oscillator transistors.

The oscillator is self-starting, and it is necessary for the three transistors to be germanium types as silicon transistors do not have reverse base-emitter voltage ratings which are high enough for the present application. Also, the voltages on the bases and emitters of conducting silicon transistors would cause reverse polarising voltages to be applied to the electrolytic coupling capacitors. An important feature of the oscillator is that at least one transistor in the ring must always be fully turned on to break any linear amplification chain through the three, as feedback would otherwise become degenerative and the oscillator would cease to function. The oscillator will, in consequence, only run at relatively low frequencies. In last month's article the oscillator was made to run at about 12Hz, which is approaching the limiting highest frequency at which it can function. At this frequency, the three coupling capacitors were 4μF electrolytic, and it was necessary for these to have low leakage currents for oscillator operation to take place.

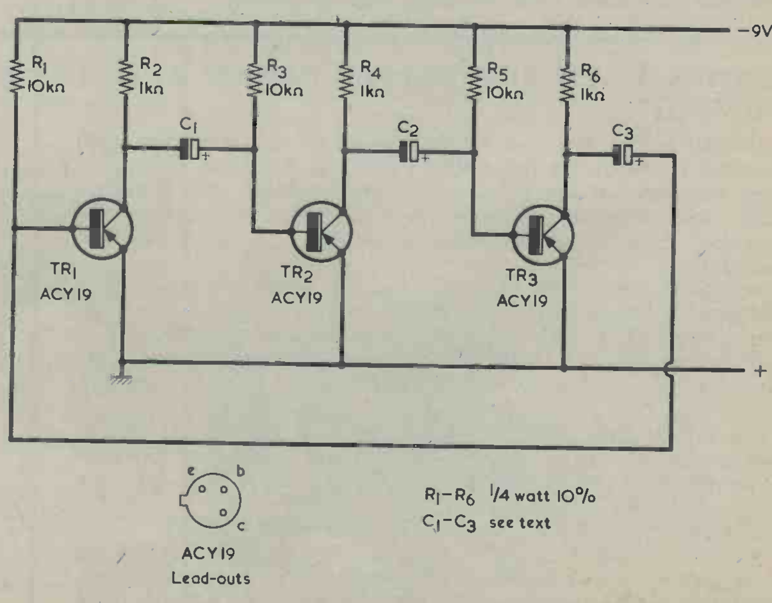


Fig. 1. The basic three transistor sequential oscillator. The transistors turn off in sequence

When the three coupling capacitors have values of 10μF or more the requirements for low leakage current are not so stringent and the oscillator runs with capacitors having leakage currents that fall within manufacturers' specifications. Even so, it is desirable to employ reasonably new capacitors of modern design and not capacitors which have seen extended periods of service in other equipment or which have been knocking around in a junk box for a long time.

With coupling capacitors of 100 to 200μF the oscillator completes a cycle in a period of several seconds and it then becomes attractive for applications in which sequential control of three functions is required. The main advantage of the oscillator is the fact that it is so simple; only three transistors, three capacitors and six resistors are required.

CAPACITOR VALUES

Up to now, references to the oscillator have assumed that all three coupling capacitors have the same nominal capacitance. This is the preferred method of operation because there is a slight lag between the turn-off of an oscillator transistor and the consequent cutting off of a switching transistor in its collector circuit due to the charging of the capacitor coupling to the following base, and an excessively large capacitance in one position would result in a disproportionately high time lag. It should be remembered also that one capacitor in the oscillator has to become charged well before the capacitor preceding it is discharged. Because of these factors it is better to run the oscillator with all three capacitors having the same nominal value.

Oscillator frequency varies inversely with capacitor value. When the three capacitors have a value of 100μF the length of a complete cycle is a little longer than 2 seconds, with 200μF it is about 4.5 seconds, and so on up to about 11 seconds with 500μF.

Oscillator running is a little erratic when the coupling capacitors have values much above 1,000μF, and so it would appear reasonable to state that the maximum capacitance for reliable operation is 500μF. At lower capacitances oscillator frequency is increased, being one cycle in about 0.2 sec., or 5Hz, with 10μF, and at intermediate values for capacitances up to 100μF. Below 10μF, capacitance leakage current becomes more important and a minimum capacitance value for reliable operation would be of the order of 2μF.

All these capacitance values refer to aluminium electrolytic capacitors with their normal wide tolerance on value and having working voltages of 10 volts or more. The author has not tried tantalum capacitors in the oscillator. Some tantalum capacitors can be damaged by reverse polarising voltages and there is a very slight risk of small reverse voltages appearing in the circuit.

The author has checked circuit operation with ACY19 transistors. Other transistors in the same immediate 'family', i.e. ACY17 to ACY21, will probably function equally well, but these have not been tried by the author. The oscillator runs at supply voltages lower than 9 volts, with 4.5 volts representing a minimum satisfactory figure.

FURTHER STAGES

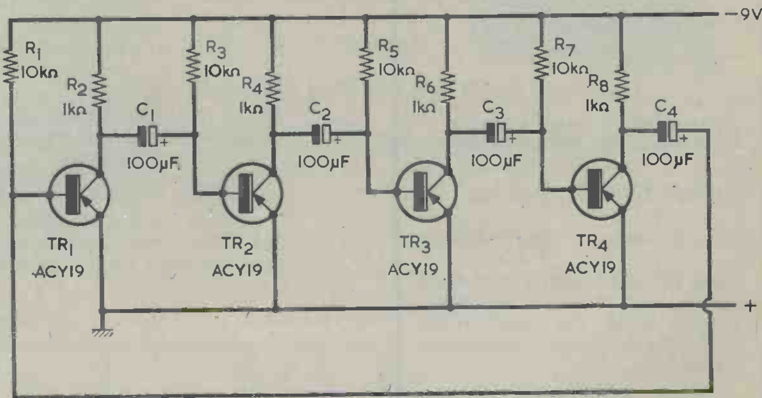
As shown in Fig. 1 the oscillator has, effectively, a turned-off transistor running continually around the ring of three transistors. It was decided to add one or more stages to see if the same effect could be achieved with a larger number of transistors.

The four transistor circuit of Fig. 2 (a) was first checked. This also oscillated reliably and was self-starting. But, instead of one turned-off transistor it was found that there were *two* turned-off transistors running round the ring! TR1 and TR3 both turned off and on at approximately the same times, as did TR2 and TR4.

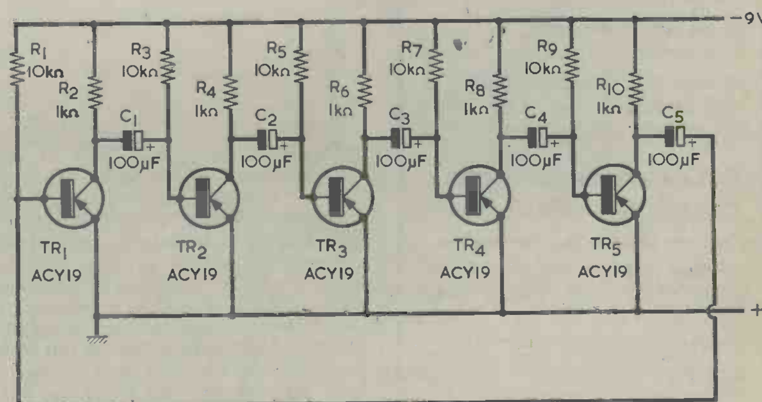
Much the same occurred with the five transistor circuit of Fig. 2(b). Again, there were two turned-off transistors running round the ring although this time the turning on and turning off of any two transistors did not coincide. The circuits of Figs. 2(a) and (b) are amusing and instructive, but, regrettably, do not offer any obvious practical application.

EXTERNAL SWITCHING

It will be desirable for the three transistor oscillator to control external circuits, and this can be achieved by inserting switching transistors in the collector resistor circuits. For external loads up to 100mA a single BC107 may

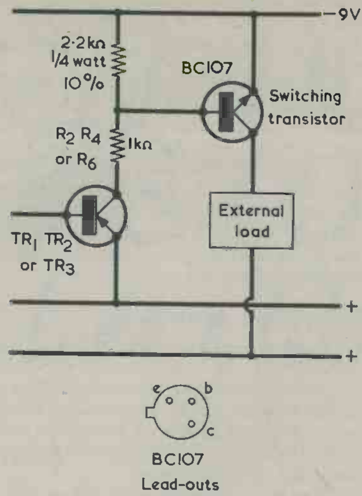


(a)

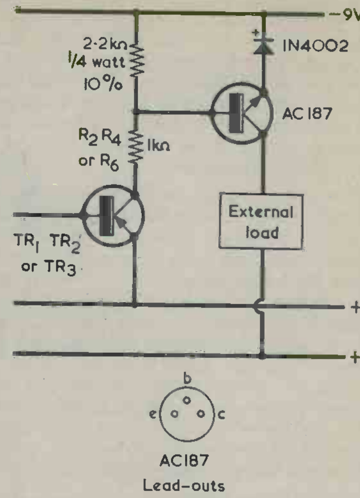


(b)

Fig. 2. (a). An experimental oscillator employing four transistors (b). Here, five transistors are coupled in sequence

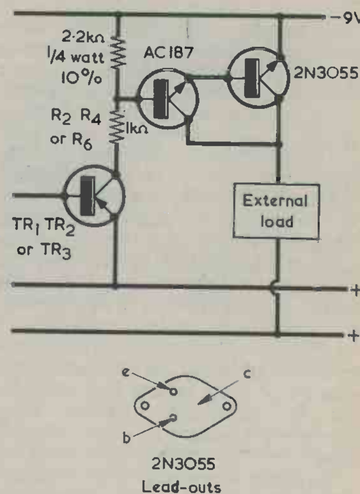


(a)



(b)

Fig. 3 (a). A switching transistor circuit for low external load currents
(b). A small power transistor is employed for larger currents in the external load
(c). This circuit can switch load currents up to several amps



(c)

be inserted, as in Fig. 3(a). If the external load is between 100 and 500mA, the switching transistor may be an AC187, as indicated in Fig. 3(b). For loads up to some 4 amps, the arrangement shown in Fig. 3(c), in which an AC187 is used in conjunction with a 2N3055 should be employed. A check on switching transistor temperature should be initially carried out with the circuits of Figs. 3(b) and (c), and a heat sink should be fitted to any transistor which shows evidence of running warm. If the switching transistors remain cool, as will probably be the case, no heat sink is required. The switched load circuits are shown as being returned to a separate positive rail, this being decoupled from the oscillator positive rail. Such an approach is desirable if load currents are high, since it ensures that switching surges do not affect the oscillator. For load current of around 100mA or less, the load and oscillator circuits could share the same negative and positive rails, provided these are adequately bypassed by a high value capacitor.

It was mentioned earlier that there is a slight time lag between the turning off of an oscillator transistor and the cutting off of the switching transistor in its collector circuit. The time lag will normally be too short to be significant, but it can be reduced if desired by employing a lower value resistor in place of the 2.2kΩ component shown in Figs. 3(a), (b) and (c). With a 9 volt oscillator supply, values down to 130Ω may be substituted. ■

SOFT AUDIO LIMITER

By A. Foord

Our contributor discusses two low level voltage limiting circuits, one of which gives hard limiting whilst the other provides soft limiting.

When an audio amplifier is allowed to clip without control some listener irritation is bound to occur, for two reasons. Firstly, because the limiting action is usually hard and a profusion of harmonics are generated. Secondly, because the negative feedback characteristics of the amplifier alter and spurious high frequency oscillations may occur for the duration of the overload.

If soft limiting is applied to an audio power amplifier there are several benefits. Soft limiting is defined here as a linear amplification up to at least half of full amplitude with progressive compression of larger amplitudes. Recovery from the ever-present peak inputs would be very rapid. The input voltage that would cause complete saturation would be increased, giving the illusion of a greater power reserve. High quality need not be sacrificed since the amplifier output can be linear to within 3dB of its maximum output.

Suitable compression networks using diodes or zener diodes are simple and can be added around an existing power amplifier or between the pre-amplifier and power amplifier.

BRIDGE HARD LIMITING CIRCUIT

Initial experiments were conducted with the circuit of Fig. 1. Here, IC1 represents the last stage in the pre-amplifier. A low output impedance is required because of the low value of RL which has to be driven. If the output of the preceding stage has a zero voltage d.c.

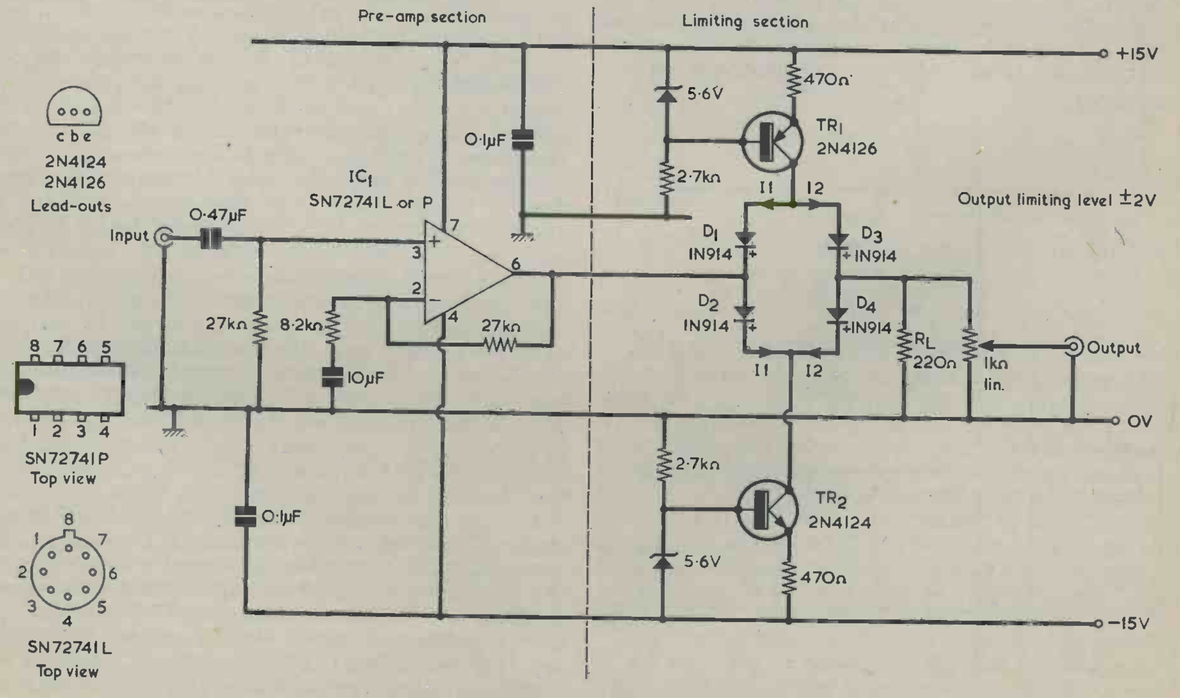


Fig. 1. A circuit which gives hard limiting

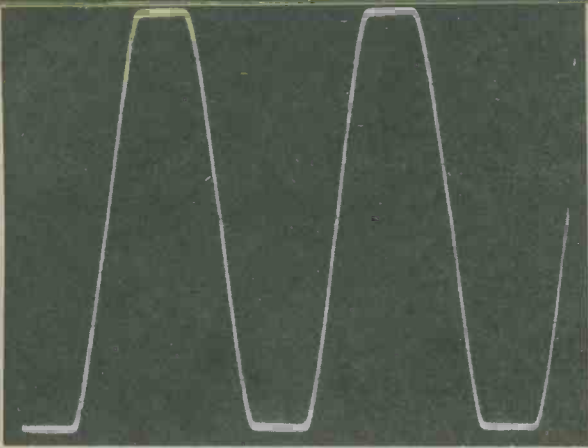


Fig. 2. The limiting effect on a sine wave given by the circuit of Fig. 1

level then direct coupling to pin 3 of the i.c. can be used; otherwise the input coupling can be capacitive, as shown. Transistors TR1 and TR2 generate and sink a constant current of 10mA. This divides equally into I1 and I2 which forward bias the diodes D1, D2, D3 and D4. Since the diode bridge is symmetrical, both the input and output of the diode bridge will be approximately at earth potential under no-signal conditions. For small signals the diodes remain forward biased and the gain of the diode bridge is 0.94 times. However for large signals the maximum possible output level is determined by the constant current and the load resistance RL. Thus the output limiting level is approximately plus or minus 2 volts.

The limiting effect on a sine wave is shown in Fig. 2. This is a hard limiting circuit and non-linearities in the diode bridge produce a distortion level of up to 2% for all output levels up to 1 volt r.m.s.

Such a simple circuit, with the network between the pre-amplifier and power amplifier, can only be justified where the 2% distortion is acceptable. Possible examples include public address and electronic music applications.

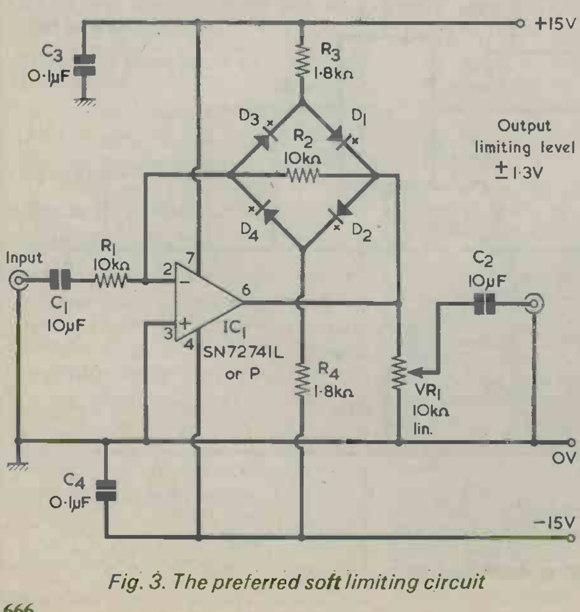


Fig. 3. The preferred soft limiting circuit

SOFT LIMITING CIRCUIT

For high quality applications an alternative arrangement must be used, and a suitable circuit is shown in Fig. 3.

Here a slightly different form of diode bridge is placed in the negative feedback path of an integrated circuit, IC1. Under small signal conditions D1 and D2 are forward biased (by R3 and R4) and D3 and D4 are reverse biased. Then the overall gain is unity, as determined by R1 and R2.

However, for large positive-going signals D2 and D4 become forward biased. Similarly for large negative-going signals D1 and D3 become forward biased. This increases the negative feedback for large signals and reduces the gain.

The limiting effect on a sine wave is shown in Fig. 4.

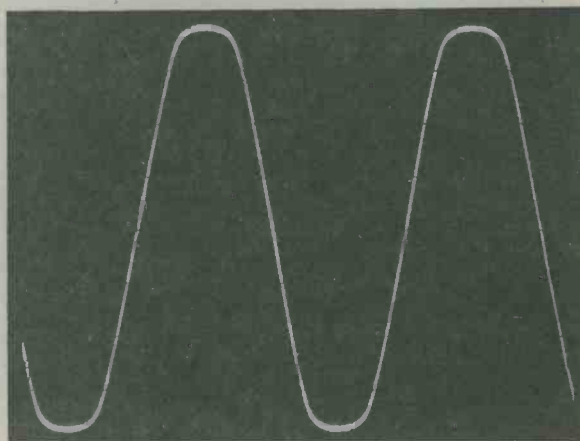


Fig. 4. The soft limiting effect on a sine wave is shown here

PERFORMANCE

Since the diodes are within the feedback loop the distortion is kept low until limiting starts. The total harmonic distortion is less than 0.1% up to an output level of 0.7 volt r.m.s. (1.98 volts peak-to-peak). This rapidly increases to 1.1% at 0.8 volt r.m.s. (2.26 volts peak-to-peak). The nominal limiting level is 0.919 volt r.m.s. (2.6 volts peak-to-peak).

Thus the circuit generates very little distortion up to 75% of the limiting level.

To set up the circuit, the output potentiometer VR1 should be adjusted so that the power amplifier cannot be overdriven no matter what the setting of the pre-amplifier gain control.

COMPONENTS

In both the circuits, the i.c. can be SN72741P (8 pin d.i.l.) or SN72741L (8 pin round can). The pin numbers connecting into circuit are the same for both versions. No connections are made to pins which do not appear in the circuits. The fixed resistors are all $\frac{1}{4}$ watt 5%.

In Fig. 3 capacitors C1 and C2 can be electrolytic, and their polarities will depend on the d.c. levels of the preceding and succeeding stages. If d.c. levels here are at earth potential they may not be required. C3 and C4 are ceramic. ■

The BASE TRACER

By S. F. May

This inexpensive switching circuit determines the base lead-out and the polarity of any unknown bipolar transistor.

HOME CONSTRUCTORS, EXPERIMENTERS AND SERVICE engineers do not need to be reminded of the vast number of bipolar transistors in existence these days which have unfamiliar or defaced type numbers or which are even completely unmarked. Problems arising from these transistors consist primarily of determining whether they are n.p.n. or p.n.p. and of finding the lead-outs which correspond to base, emitter and collector. The fact that an unknown transistor is in a familiar encapsulation is not always of assistance here, since it is quite common for transistors with the same encapsulation to have quite different lead-out layouts.

A very advanced design for the determining of transistor polarity and lead-outs is the 'Transistor Lead Locater' described by J. R. Davies in the October and November, 1974, issues of this journal. By means of two rotary switches and a display of four l.e.d's this instrument is capable of finding both the polarity and the individual lead-outs of any normal bipolar transistor, and it has the advantage of high speed of operation.

BASE TRACER

The switching circuit to be described in the present article does not pretend to have a performance approaching that of the previous design, and it requires two separate operations to ascertain lead-out layout. On the other hand it is extremely inexpensive and easy to assemble. Two 3-way switches and an l.e.d. are employed, and they determine the polarity and the base lead-out of the unknown transistor. The collector and emitter are then found by checking the transistor on a normal transistor gain meter or by using a second test circuit which is described later in this article.

The circuit of the device is shown in Fig. 1, in which the two switches are designated S1 and S2. The switch contacts and the three test terminals are numbered 1, 2 and 3. and it will be obvious that the l.e.d. will light up when both switches are set to the same number. The series resistor, R1, limits the l.e.d. current to some 5 to 7mA, and the supply voltage is 3 volts only. These low values of current and voltage are unlikely to damage any transistor being checked.

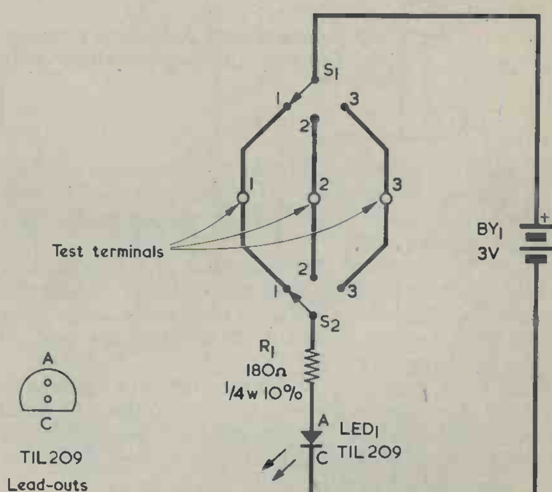


Fig. 1. The circuit of the base tracer unit. The only components required are two switches, an l.e.d., a resistor and a battery

The leads of the unknown transistor are connected in any manner to the three test terminals. S2 is then set to position 1 and S1 is taken through its three positions. The l.e.d. is bound to light at one setting of S1 and may light at a second setting. If it lights at all three settings of S1 then the test is complete and the transistor polarity and base lead-out have been found. Should the l.e.d. light at only one or two settings of S1, S2 is set to position 2 and S1 is taken through its three settings once more. Should this not yield a light at all three settings, S2 is set to position 3 and S1 is once more taken through its three positions.

If it has not been possible yet to obtain illumination of the l.e.d. for all settings of S1, this switch is set to position 1 and S2 is taken through all its settings. Should the l.e.d. light at all three settings then the test is at an end. If not. S1 is set to position 2 and S2 taken

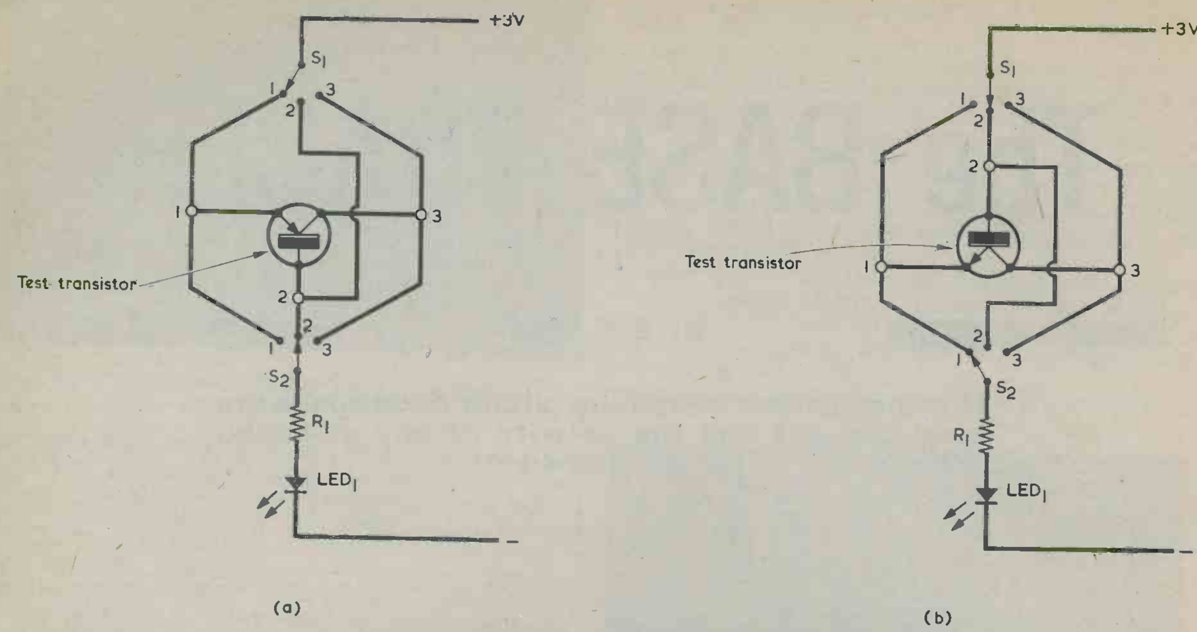


Fig. 2 (a). Typical circuit conditions when an p.n.p. transistor is connected to the test terminals (b). The circuit given when an n.p.n. transistor is connected

through all its positions. If this still yields no success, S1 is moved to position 3 whereupon, unless the transistor is open-circuit, the l.e.d. should finally light up at all settings of S2.

As can be imagined, the procedure of taking S1 and S2 through their settings takes much longer to describe than it does to carry out. What is aimed at is a switching pattern which causes the l.e.d. to be illuminated at all settings of either S1 or S2.

If the l.e.d. lights up at all settings of S1 then the unknown transistor is a p.n.p. device and the arm of S2 is connected to its base. Should the l.e.d. be illuminated at all settings of S2 then the unknown transistor is an n.p.n. type and S1 arm is connected to its base.

TRANSISTOR JUNCTIONS

The reason for this beheaviour of the switching circuit can be readily understood if the circuit is redrawn with a transistor connected to the test terminals. This is done in Fig. 2(a), in which the transistor is a p.n.p. type with its emitter connected to terminal 1, its base to terminal 2 and its collector to terminal 3. S2 is in position 2, thereby connecting to the transistor base. Putting S1 to position 1 allows current to flow from the positive rail through the forward biased emitter-base junction of the transistor to S2 and thence to the l.e.d., which lights up. Setting S1 to position 2 allows current to flow to the l.e.d. via the direct connection between the two switch contacts. When S1 is set to position 3, current flows through the forward biased collector-base junction of the transistor to S2 and the l.e.d., which once more lights up. It is only possible for the l.e.d. to light up at all three settings of S1 when S2 connects to the transistor base. There is no other switching combination which allows either S1 or S2 to illuminate the l.e.d. at all three settings.

If the p.n.p. transistor had had its base connected to terminal 1, S2 would have needed to be switched to position 1 to obtain a light at all settings of S1. Similarly, S2 would have had to be in position 3 if the transistor base had been connected to terminal 3.

Fig. 2(b) shows the situation when an n.p.n. transistor is connected to the test terminals. Again, for ease of presentation, the emitter is connected to terminal 1, the base to terminal 2 and the collector to terminal 3. When S1 connects to the base at position 2, the circuit to the l.e.d. is completed via the base-emitter junction with S2 in position 1, via the direct connection with S2 in position 2 and via the collector-base junction with S2 set to position 3. Again, there is no other switching pattern which allows the l.e.d. to light up at all settings of S1 or S2, and the arm of S1 connects to the transistor base.

There is no need to provide an on–off switch for the unit. When out of use, the two switches are set to different numbers to break the circuit to the l.e.d.

PRACTICAL VERSION

The circuit may be assembled in a small case having the front panel layout shown in Fig. 3. The two switches are fitted with pointer knobs and the front panel is covered with white card or a similar material on which are drawn three lines joining the test terminals to the three corresponding positions taken up by the switch knobs. The test terminals and switch contacts have the same general layout as in Fig. 1. As shown in Fig. 3, the arms of both switches connect, via their contacts, to the left-hand test terminal There is no need to use the numbers 1, 2 and 3 on the front panel card. Since it is difficult to remember the switching relationships, a legend summarising the situation is written alongside each switch.

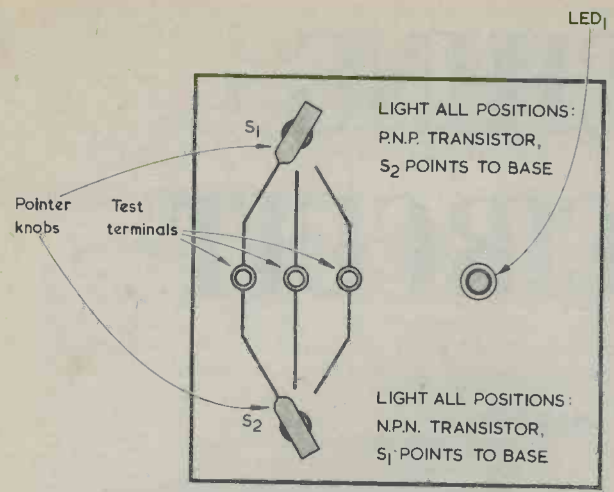


Fig. 3. A suitable front panel layout. All legends and lines inside the rectangle are written or drawn on the panel

The unit functions satisfactorily with all germanium and silicon bipolar transistors, but a little care is needed when checking germanium power transistors. This is because some germanium power transistors exhibit relatively high leakage currents, and these may be sufficient to illuminate the l.e.d. at reduced level when they flow through a reverse biased junction. In consequence the situation may arise in which either S1 or S2 causes the l.e.d. to be fully illuminated at two settings and to be partly illuminated at the third setting. Such indications should be ignored and the final switching pattern should be found which causes full illumination at all three switch settings.

EMITTER AND COLLECTOR

After the base lead-out and the polarity of the unknown transistor have been found it is necessary to determine the emitter and collector leads. As already mentioned, this process may be carried out with the aid of a standard transistor gain meter. Alternatively, the circuit shown in Fig. 4 can be used.

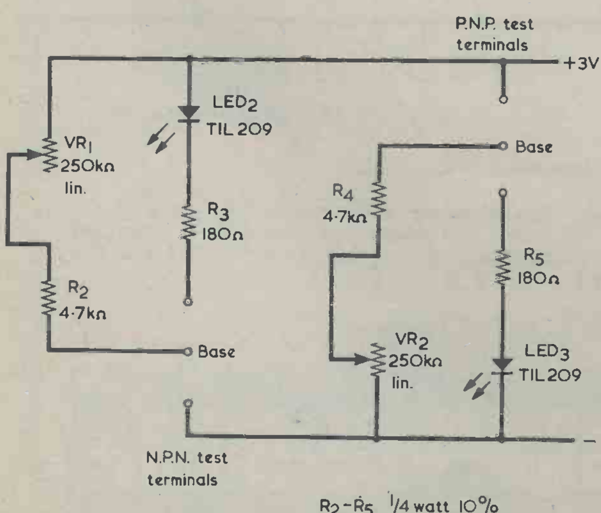


Fig. 4. A circuit which enables the emitter and collector of the test transistor to be determined

In Fig. 4 there are two separate sections for p.n.p. and n.p.n. transistors because it is simpler to provide two separate circuits here than to use a single set of components with polarity switching. If an n.p.n. transistor is to be checked it is connected to the n.p.n. test terminals. It will then function as a common emitter amplifier if the emitter connects to the negative rail, whereupon the base current flowing through VR1 and R2 will produce a collector current sufficiently high to illuminate the l.e.d. in its collector circuit.

Unfortunately, the symmetric construction of a junction transistor allows it to function as an amplifier with the emitter and collector transposed, but the current gain then given is less than that produced when it is connected correctly. It is for this reason that the variable resistor, VR1, is included in the base circuit. The transistor should be connected up with VR1 set to insert minimum resistance. If the l.e.d. lights up, VR1 is adjusted until the l.e.d. is just illuminated, after which the collector and emitter leads are changed over. The connection which allows l.e.d. illumination with the higher value in VR1 is the correct one, and with this the transistor emitter is connected to the negative rail and the collector to the l.e.d. circuit. If a very high gain transistor is connected up in the correct manner the l.e.d. may still be lit when VR1 inserts maximum resistance, but it should still be possible to differentiate between the correct and incorrect forms of connection.

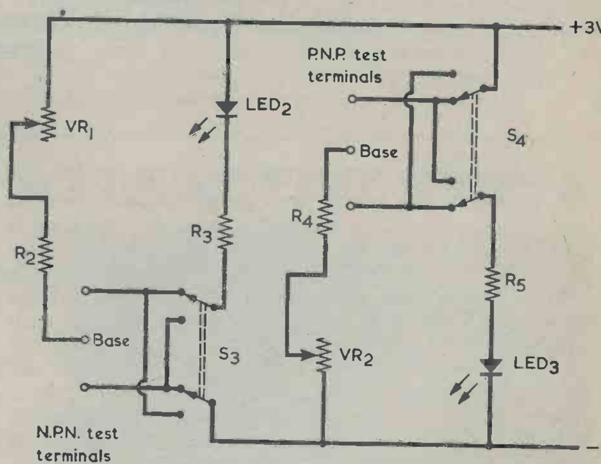


Fig. 5. The addition of a commutating switch at each set of test terminals considerably speeds the process of finding the emitter and collector leads

A p.n.p. transistor is checked in the same way, except that it is connected to the p.n.p. test terminals and it is VR2 which is adjusted.

The process of determining the emitter and collector can be greatly speeded by adding a commutating switch at each of the two sets of test terminals, as in Fig. 5. The switch is simply flicked from one position to the other as VR1, or VR2, is adjusted, and the difference in l.e.d. illumination can then be assessed instantaneously. The switches can be mounted on a front panel which is also covered with a white card. This can carry legends alongside each switch which indicates the circuit they set up. ■

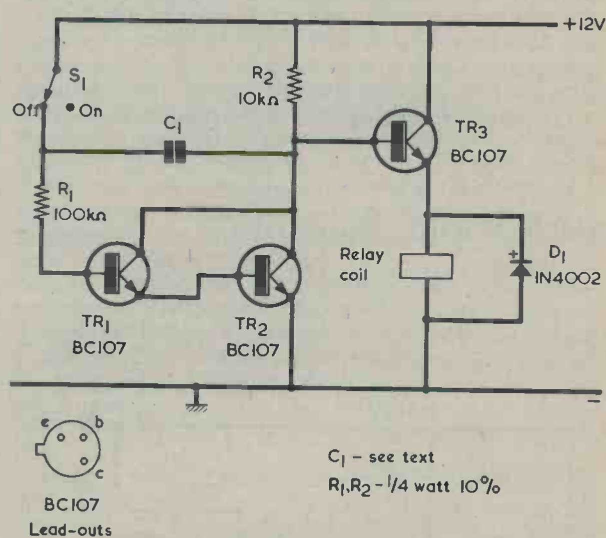
SWITCHING DELAY CIRCUIT

By P. F. Hughes

An inexpensive delay circuit which functions without thermal devices or high value electrolytic capacitors.

Automatic delay circuits which prevent the application of power for a period are encountered occasionally in electronics, and a particular instance is given with higher power amateur transmitters incorporating valves. Here, it is desirable to delay the application of h.t. voltage, after switch-on, until the lower voltage circuits have warmed up. A common approach with transmitters consists of employing devices incorporating bimetal strips to delay the switching on of h.t., but these do not always reset immediately after completing a delay cycle. Circuits using a charging capacitor can also be used, but if a long delay, of the order of 1 minute, is required the capacitor has to be a large value electrolytic component with its attendant leakage current problems.

The delay circuit to be described here can offer delay periods of up to several minutes. It employs a capacitor to provide the delay, but this needs a relatively low value only and can be a plastic foil, rather than an electrolytic, component. The only other parts needed in the delay circuit proper are two resistors, two small silicon transistors and an on-off switch. A third transistor, functioning as an emitter follower, couples the delay circuit to a relay coil.



The switching delay circuit. The value of C1, which is a plastic foil capacitor, is effectively multiplied by the voltage gain of TR1 and TR2

CIRCUIT FUNCTIONING

The circuit appears in the accompanying diagram. When S1 is in the 'Off' position the positive rail couples to the base of TR1 via R1. The consequent base current causes both TR1 and TR2 to turn on, and the voltage at TR2 collector is close to the negative supply line. In consequence, the voltage on TR3 emitter is equal to or only slightly above that on the negative line and the relay does not energise. The current drawn from the 12 volt supply under these circumstances is about 1.2mA via R1 and R2. At the same time, C1 is charged to a voltage which is very nearly equal to the supply voltage.

If S1 is now moved to 'On' the positive supply is disconnected from R1, whereupon no base bias current is available from the supply for TR1. However, a base bias current is still available from the charged C1, whose left-hand terminal is positive of the collector of TR2. The bias current required by TR1 is very low and the overall effect is that C1 discharges gradually. As it discharges, the collector of TR2 goes slowly positive, keeping up a balance in which the sum of the voltage at TR2 collector and that across the capacitor is always just sufficient to provide the bias current needed to maintain the collector current.

The low rate of rise in TR2 collector voltage may perhaps be more readily understood when it is appreciated that C1 is returned to the inverting input at TR1 base; the effective value of the capacitor is then multiplied by the total voltage gain of TR1 and TR2.

RELAY COIL CURRENT

The voltage at TR2 collector is passed by way of the emitter follower, TR3, to the relay coil. When it is sufficiently high the relay energises and its contacts (not shown in the diagram) switch on the delayed circuit. The delay is now over and all that happens subsequently is that the voltage at TR2 collector continues to rise until, eventually, it is close to the voltage on the positive supply line.

If at any time during or after the delay period S1 is set to 'Off', the circuit reverts to its initial state with the relay de-energised and capacitor C1 charged. Another delay period will then be given if S1 is once more set to 'On'.

The relay is not at all critical and the only main requirement is that it should have a coil resistance of 250Ω or more, and that it should be capable of energising reliably at around 9 volts or so. The prototype circuit employed a P.O. 3000 relay with a 500Ω coil.

The value required in C1 depends upon the voltage gain of TR1 and TR2 and the coil voltage at which the relay energises. In consequence, C1 has to be determined experimentally. This is not a difficult task because the length of the delay varies in approximately linear manner with capacitance value; it is only necessary to carry out a trial run with a known capacitance and then calculate the value needed for the actual delay required.

The author initially checked the circuit with a 1μF capacitor in the C1 position and found that the delay was 68 seconds. With a 0.1μF capacitor the delay was approximately 7 seconds, with a 0.5μF capacitor it was approximately 35 seconds, and so on. To see what effect different transistors gave, the BC107's in the TR1 and TR2 positions were removed and two others connected up in their place. This time the 1μF capacitor gave a delay of 85 seconds, with proportionate times given with other capacitance values.

It is recommended that the circuit be initially run with a 1μF capacitor in the C1 position and the length of the delay noted. The required alternative value can then be calculated and wired in.

As a final point, D1 is the usual reverse biased diode connected across the relay coil to prevent the formation of a high back e.m.f. voltage when the relay de-energises. This diode must be wired into circuit correct way round as, otherwise, excessive current will flow in it and in TR3, with the risk of consequent damage. ■

INTEGRATED CI

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By R. A

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INTEGRATED CIRCUITS ARE BEING USED IN NEARLY ALL fields of electronics, and there is now at least one i.c. specifically designed for use in most of the more common applications. Even when there is no i.c. for a particular purpose, it is often possible to adapt one which has been designed for an allied role.

RECEIVER I.C.

The receiver described in this article covers three ranges, these being two short wave bands plus the ordinary medium wave band. The nominal ranges covered are: Range 2, 0.515 to 1.54MHz (580 to 194 metres); Range 3, 1.67 to 5.3 MHz (180 to 57 metres); and Range 4, 5.0 to 15MHz (60 to 20 metres).

The Range numbers, 2, 3 and 4, correspond with the numbers of the Denco coils employed. These are plug-in types and the desired waveband is selected by plugging in the set of three coils for that band.

The receiver is suitable for the reception of a.m., c.w. and s.s.b. signals. The output is intended for high impedance headphones of 2,000 to 4,000Ω. An S-meter is included to provide a useful means of comparing signal strengths.

An R.C.A. integrated circuit type CA3088E forms the basis of the receiver, and although this i.c. is primarily intended for use in an a.m. broadcast receiver, it functions extremely well in the simple short wave receiver to be described. This i.c. contains almost all the active circuit elements for the receiver, the only additional active device being a silicon transistor.

An optional output stage which provides enough signal to drive a speaker may be added. This output stage is described in Part 2, which will be published next month.

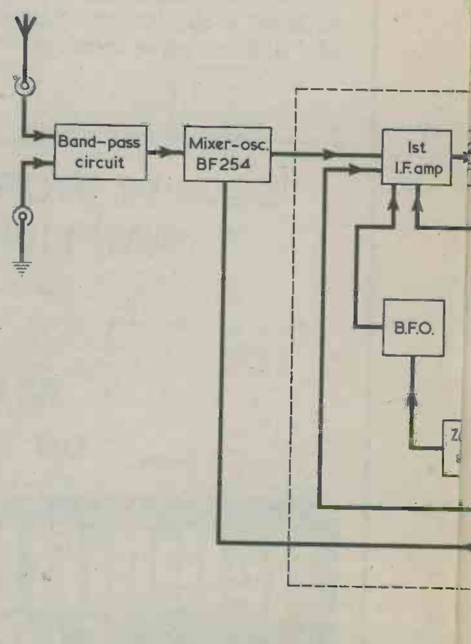

Fig. 1. Block diagram showing the stages of the
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Part 1

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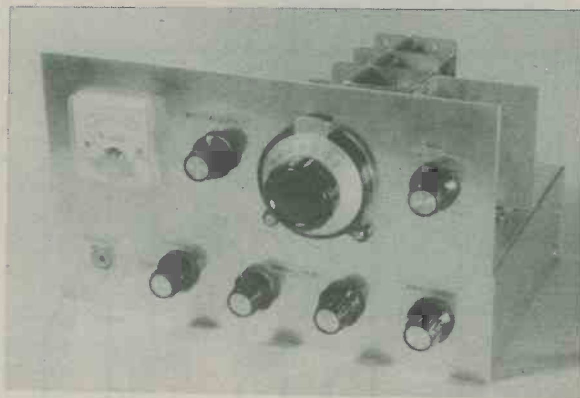
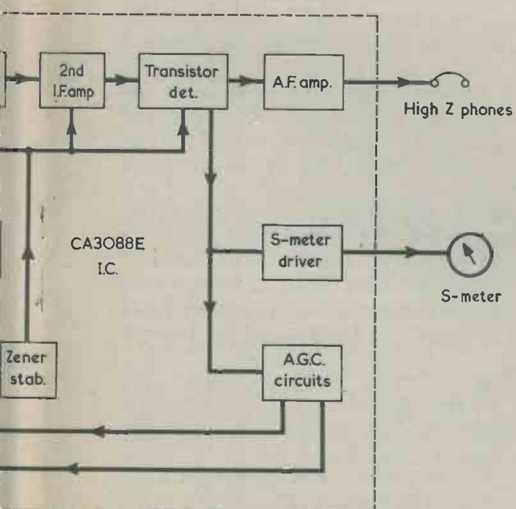




ne receiver. Apart from the mixer-oscillator transistor,
ained inside the integrated circuit

BLOCK DIAGRAM

A block diagram illustrating the functions of the various stages of the receiver is shown in Fig. 1. The aerial signal is passed to a conventional mixer-oscillator stage via a band-pass filter tuned to the frequency of reception. This arrangement gives good image rejection. From the mixer-oscillator the signal is passed to the two i.f. amplifiers, and then to a transistor detector. The detected output is fed to a pair of headphones via a 2-stage audio amplifier.

A b.f.o. is provided for the reception of c.w. and s.s.b. signals, and its output is coupled to the first i.f. amplifier. The power supplies to the b.f.o., i.f. amplifiers and detector are all stabilized by a zener diode.

Apart from providing an audio output, the detector also produces a d.c. bias which is used to drive the a.g.c. and S-meter circuits. A.G.C. is applied to both the first i.f. amplifier and the mixer-oscillator stages. It is not normally advisable to apply a.g.c. to the mixer-oscillator as, amongst other effects, it may cause oscillator detuning, but in this simple design there is no r.f. stage to which a.g.c. could be applied, and so the a.g.c. coupling to the mixer-oscillator was tried. No adverse effects at all have been noticed, and it results in an extremely flat a.g.c. characteristic.

INTERNAL CIRCUIT

The internal circuit of the CA3088E appears in Fig. 2. As may be seen, the i.c. incorporates 14 transistors, 23 resistors and 6 diodes. One of the diodes is a zener type.

R3 to R6, D1 to D4 and TR2 to TR4 provide two stable voltage sources which are used to bias the base of TR1 via R1 and that of TR5 from the emitter of TR4. TR1 would normally function as a converter, or mixer-

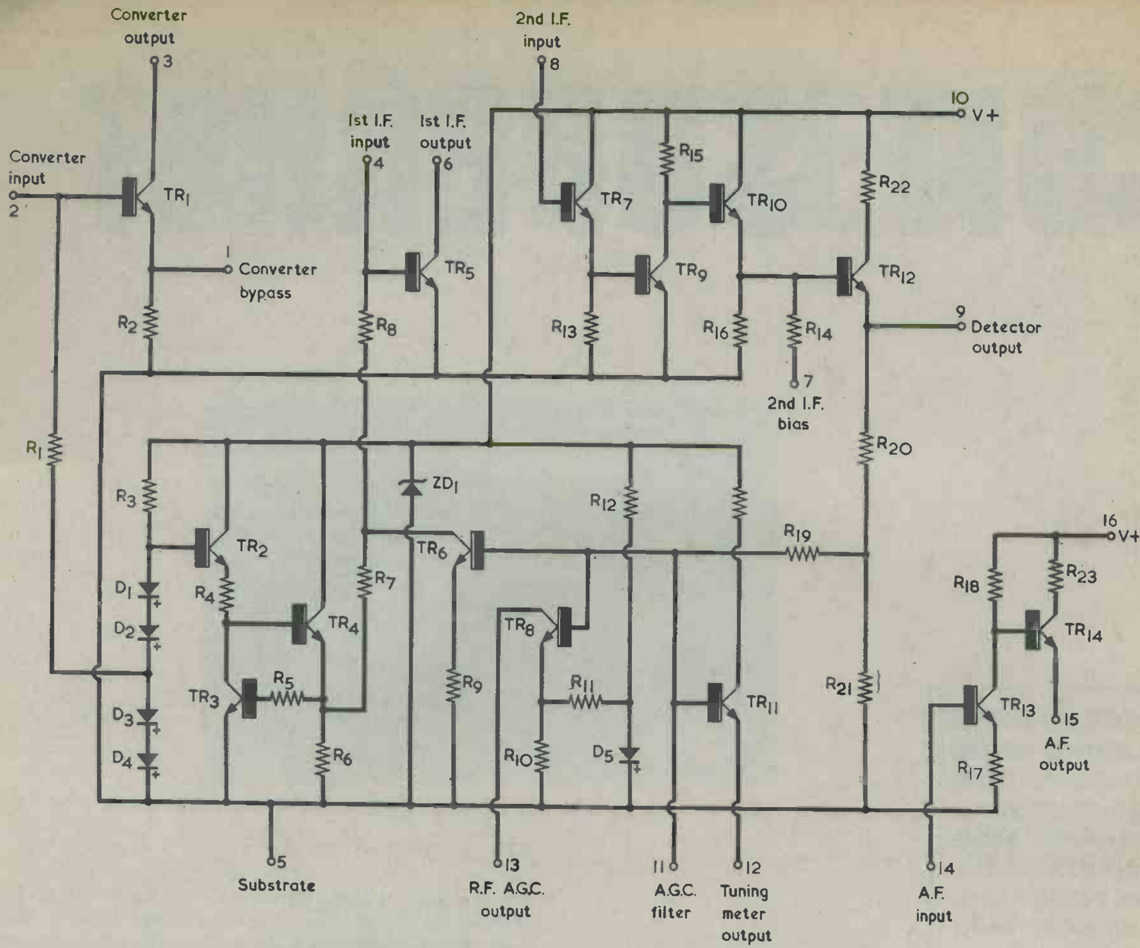
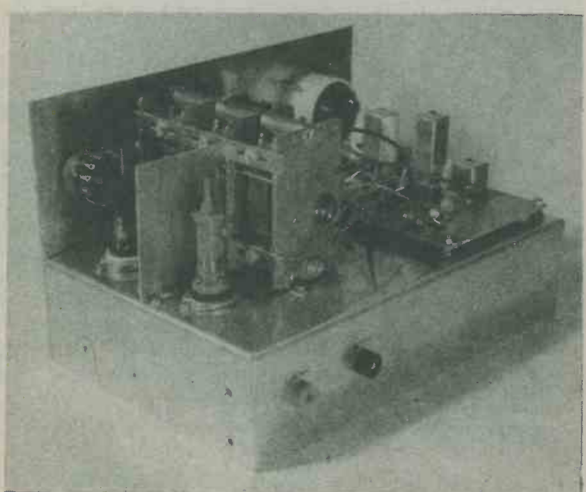


Fig. 2. The internal circuitry of the i.c. type CA3088E



Rearside view of the receiver. The i.c. component panel is to the right, above the chassis

oscillator, but it is a little difficult to couple it to an oscillator coil of the type required for the present receiver. In consequence, an external mixer-oscillator transistor is employed, and TR1 is brought into use as a b.f.o.

TR5 is the first i.f. amplifier, and is used in the common emitter mode of operation. TR7, TR9 and TR10 constitute the second i.f. amplifier, with TR7 and TR10 as emitter followers and TR9 in the common emitter configuration.

Detection of the i.f. signal is provided by TR12, which is biased close to cut-off. Unlike most transistor detectors it offers no voltage gain, as it is connected as an emitter follower. On the other hand, it gives a very low level of distortion. The signal at the emitter of TR12 can be coupled to an external i.f. filter and the receiver volume control.

The voltage at the emitter of TR12 is coupled also, via R20 and R19, to an external a.g.c. filter capacitor, which can be a relatively high value electrolytic component. This bypasses to chassis any a.f. or i.f. signal which might otherwise be present and allows an a.g.c. voltage to be produced. The voltage is fed direct to the base of TR11, an emitter follower, whose emitter may be coupled to a tuning meter. In the present receiver it connects to the S-meter.

The a.g.c. voltage is applied also to the base of TR6, the collector of which connects to the junction of R7

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)

R1	8.2kΩ
R2	680Ω
R3	4.7kΩ
R4	1.5kΩ
R5	1.5kΩ
R6	150Ω
R7	2.7kΩ
R8	4.7kΩ
R9	4.7kΩ
R10	220Ω
R11	470Ω
R12	1.5kΩ
R13	5.6kΩ
R14	1.2MΩ
R15	2.7kΩ
R16	33Ω
R17	560Ω
VR1	10kΩ potentiometer, log track, with S2

Capacitors

C1	10pF silvered mica or ceramic
C2	10pF silvered mica or ceramic
C3	0.01μF plastic foil or disc ceramic
C4	100μF electrolytic, 6 V. Wkg.
C5	0.047μF plastic foil or disc ceramic
C6	350pF silvered mica (see text)
C7	1,100pF silvered mica (see text)
C8	3,000pF silvered mica (see text)
C9	27pF silvered mica
C10	0.01μF plastic foil or disc ceramic
C11	1,000pF polystyrene or silvered mica
C12	0.022μF plastic foil
C13	0.1μF plastic foil
C14	0.01μF plastic foil
C15	0.01μF plastic foil
C16	100μF electrolytic, 6 V. Wkg.
C17	0.01μF plastic foil
C18	10μF electrolytic, 10 V. Wkg.
C19	0.22μF plastic foil
C20	125μF electrolytic, 10 V. Wkg.
C21	0.01μF plastic foil
C22	0.022μF plastic foil
C23	10μF electrolytic, 10 V. Wkg.
C24	1.8pF silvered mica or ceramic
VC1	25pF variable, type C804 (Jackson Bros.)
VC2,3,4	310+310+310pF 3-gang capacitor, type E3 (Jackson Bros.)
VC5	25pF variable, type C804 (Jackson Bros.)
VC6	5pF variable, type C804 (Jackson Bros.)
VC7	15pF variable, type C804 (Jackson Bros.)

Inductors
(L1, L2, L3 all Denco Miniature Dual Purpose coils, transistor usage)

L1	Blue coils, Ranges 2T, 3T and 4T
L2	Yellow coils, Ranges 2T, 3T and 4T
L3	Red coils, Ranges 2T, 3T and 4T
IFT1	i.f. transformer type IFT14 (Denco)
IFT2	i.f. transformer type IFT18/465kHz (Denco)
IFT3	i.f. transformer type IFT18/465kHz (Denco)

Transistor
TR1 BF254

Integrated Circuit
CA3088E (R.C.A.)

Meter
M1 S-meter, Henelec 38 Series (Henry's Radio)

Switches

S1	1-pole 2-way miniature rotary (see text)
S2	s.p.s.t., part of VR1

Sockets

SK1,2	wander plug sockets
JK1	3.5mm jack socket

Battery
9-volt battery type PP7 (Ever Ready)

Miscellaneous
8:1 tuning drive, 2 in. type T502 (Eagle)
6 knobs
Headphones (2,000 to 4,000Ω)
3 B9A valveholders
Chassis and front panel (see text)
3.5 mm. jack plug
Battery connectors
S.R.B.P. panel, 4¼ x 3⅛ in.
Trimming tool type TT5 – see text (Denco)
Bolts, nuts, wire, etc.

and R8 in the bias feed to the first i.f. amplifier, TR5. As signal strength at detector TR12 increases, this transistor passes more current, whereupon its emitter goes positive. In consequence, so does the base of TR6, with the result that its collector goes negative, reducing the bias current available for TR5 and, hence, its gain. An a.g.c. loop back to the first i.f. amplifier is thus set up. TR8 functions in the same way as TR6 but, in this instance, the collector couples to an external bias circuit at the r.f. amplifier or, with the present receiver, the mixer-oscillator. A.G.C. is, therefore, applied to the controlled external stage as well.

TR13 and TR14 form a simple 2-stage a.f. amplifier which is isolated from the other circuits. TR13 is a common emitter amplifier feeding into the emitter follower, TR14. An a.f. output can be taken from the emitter of TR14.

The final component to be considered is the zener diode, ZD1. This provides a stabilized voltage at a nominal level of 5.6 volts. The requisite series resistor is external to the integrated circuit.

The CA3088E may be obtained from Ambit International, 37 High Street, Brentwood, Essex, CM14 4RH.

RECEIVER INPUT

Fig. 3 shows the circuit of the input stages of the receiver. Although no r.f. amplifier is used ahead of the mixer-oscillator, TR1, the circuit still incorporates two tuned circuits resonant at signal frequency. These are loosely coupled by C24. The coils are tuned by VC2 and VC3, these being ganged with the oscillator tuning capacitor, VC4. VC1 and VC5 are separate variable capacitors which provide fine tuning of the input tuned circuits. It will be noted that no connection is made to one of the windings of both L1 and L2.

TR1 is biased by R1 and R3, with a.g.c. from the integrated circuit being applied via R7. C4 ensures that there is a complete absence of a.f. on the control voltage applied to TR1 base. The mixer-oscillator stage is quite conventional and uses a familiar oscillator configuration. R2 and R6 are included in circuit to prevent instability at the high frequency ends of the bands covered. C6, C7 and C8 are the padding capacitors for each band. They connect to different pins of the valveholder into which L3 is inserted, and are automatically selected since each oscillator coil has its tune winding returned to the pin corresponding to its padding capacitor.

The padding capacitors have slightly unusual values and some difficulty may be experienced in obtaining these as single components. It is quite in order to make them up with two capacitors in parallel. For instance C8, specified as 3,000pF, can consist of two 1,500pF capacitors in parallel. The padding capacitors should have a tolerance on value of 5% or better.

VC6 offers fine tuning of the oscillator and operates as a bandspread control on the short wave bands. Power is applied by way of the r.f. decoupling components, R5 and C10. The BF254 specified for TR1 is available from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.

I.F. AND DETECTOR STAGES

The circuit of the remaining stages of the receiver is reproduced in Fig. 4. An i.f. transformer, IFT1, is used as the b.f.o. oscillator coil and this couples to the base of TR1 inside the i.c. (Fig. 2 transistor numbering) via C11 and R8. The transistor is employed in the emitter follower mode, whereupon its emitter is in phase with the base and there is slightly less than unity voltage gain. The emitter couples via C12 to a tap in the i.f. transformer tuned winding, and the consequent step-up in voltage is sufficient to provide oscillation. No connection is made to the untuned winding of the i.f. transformer.

VC7 is the b.f.o. frequency control, and the positive supply is obtained by way of decoupling components R9 and C14. S1 is the b.f.o. on-off switch. There is no direct connection between the b.f.o. and i.f. amplifier stages, and the b.f.o. is coupled into the i.f. amplifier by stray capacitances. This provides an adequate level of b.f.o. injection which is, at the same time, not so excessive as to produce a high a.g.c. voltage.

The S-meter connects directly between pin 12 of the i.c. and chassis with the polarity shown. C16 is the a.g.c. filter capacitor. The rather high value of 100μF specified for this capacitor is quite in order as the a.g.c. circuits

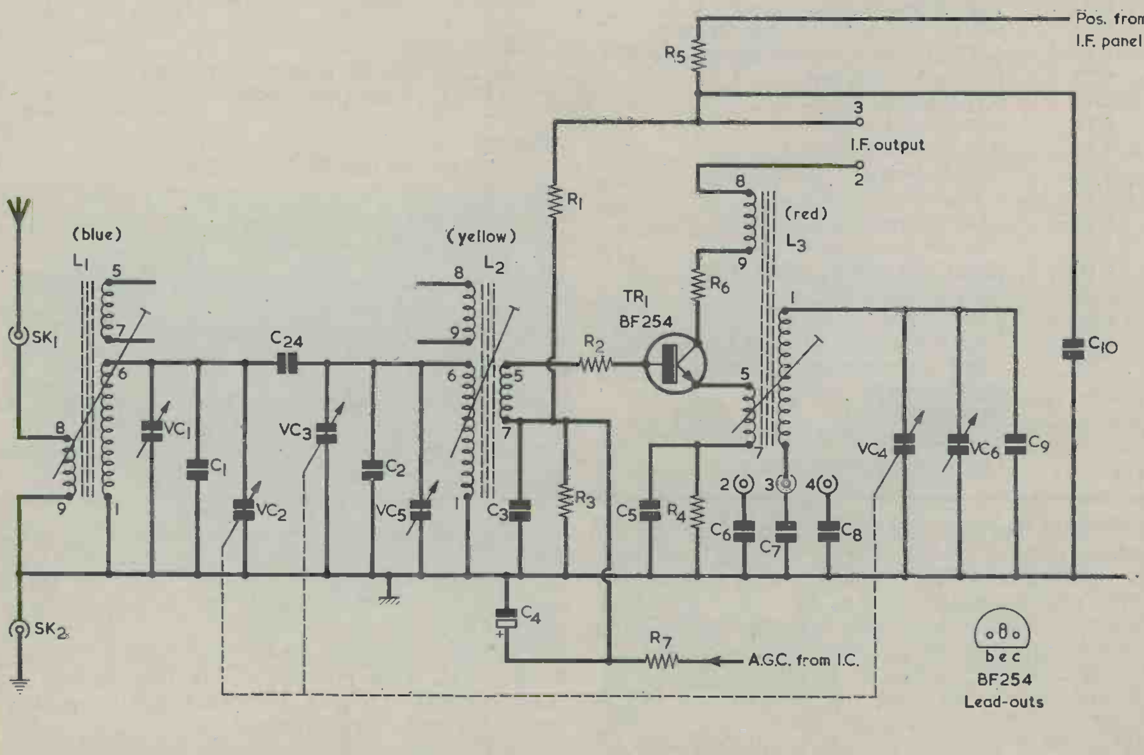


Fig. 3. The aerial input and mixer-oscillator circuits of the receiver

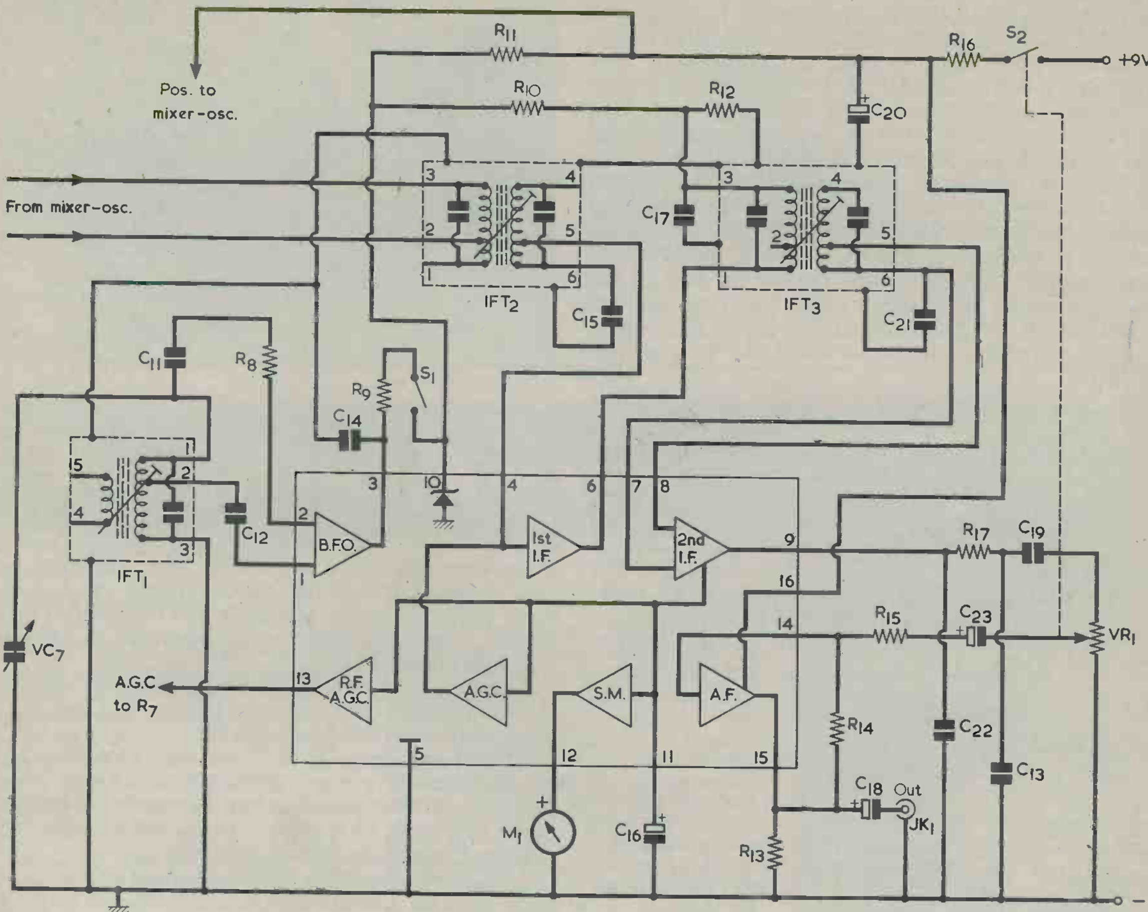


Fig. 4. The i.f., b.f.o., detector and a.g.c. stages of the receiver. As will be seen, a number of chassis connections are carried by the i.f. transformer screening cans

inside the i.c. are at low impedance. A capacitance of 50μF is suggested by R.C.A. for the normal broadcast receiver application, but it was found that a slightly higher value was required to prevent slight instability on strong signals.

The output from the mixer-oscillator stage of Fig. 3 couples to the primary of IFT2, and the secondary of this transformer passes the signal to the input of the first i.f. amplifier in the integrated circuit. C15 bypasses the earthy end of the secondary winding to chassis without upsetting the bias conditions for the i.f. amplifier transistor. IFT3 couples the output of the first i.f. amplifier to the input of the second i.f. amplifier. Bias current for the second i.f. amplifier input is taken from pin 7 of the i.c. to pin 8 via the i.f. transformer secondary. The biasing is stabilized by a high level of d.c. negative feedback, but there is no feedback at the intermediate frequency because of the bypass provided by C21. In consequence, the full gain of the second i.f. amplifier is achieved.

The use of double-tuned i.f. transformers means that there are four tuned circuits in the i.f. amplifier, whereupon quite sharp selectivity is achieved. Resistors R10, R11 and R16, and capacitors C17 and C20 are all supply decoupling components. R12 causes the supply voltage at the first i.f. amplifier output to be slightly reduced.

C22, R17 and C13 filter out the i.f. content of the detected signal, leaving the required audio signal, which is applied to volume control VR1 via C19. The slider of the volume control then couples to the input of the a.f. amplifier in the i.c. via C23 and R15. R14 is a bias resistor, coupling the emitter of TR14 back to the base of TR13 (both transistors inside the i.c.). The a.f. output is fed to a phone jack socket via the d.c. blocking capacitor C18. S2 is the on-off switch and is ganged with VR1.

The maximum audio output signal level approaches 1 volt r.m.s., which is perfectly adequate for a pair of high impedance headphones.

METALWORK

The front panel is cut out from 18 s.w.g. aluminium sheet. Drilling details for the front panel, together with details of the other main metalwork are given in Fig. 5.

Most of the drilling is quite straightforward. The large cut-out for meter M1 can be made with a fretsaw or a coping saw fitted with a blade having fine teeth, and the $\frac{3}{4}$ in. diameter hole for the tuning drive can be made with a $\frac{3}{4}$ in. chassis punch. (If it is desired to have this last hole very accurately positioned, it can be marked up and cut out after the other holes in the panel and chassis have been drilled. The panel and chassis are temporarily assembled, and VC2, 3, 4 is placed on the chassis surface with its spindle against the rear of the panel. The height of the centre of the $\frac{3}{4}$ in. hole can then be marked off from the capacitor spindle, after which the panel and chassis are disassembled and the $\frac{3}{4}$ in. hole cut out).

The four smaller mounting holes for meter M1 are drilled 6BA clear using a No. 31 drill. Their positions may be marked out, after the large hole has been cut out, with the aid of the meter itself. There are two small mounting holes for the tuning drive, and these are located and drilled as described later.

The chassis is best obtained ready made, and is available from H. L. dmith & Co. Ltd., 287-289 Edgware Road, London, W.2. It is in Style 'K', measures $8\frac{1}{2}$ by $5\frac{1}{2}$ by 2 in., and is made of 16 s.w.g. aluminium. For clarity, the chassis is shown in Fig. 5 with its sides opened out.

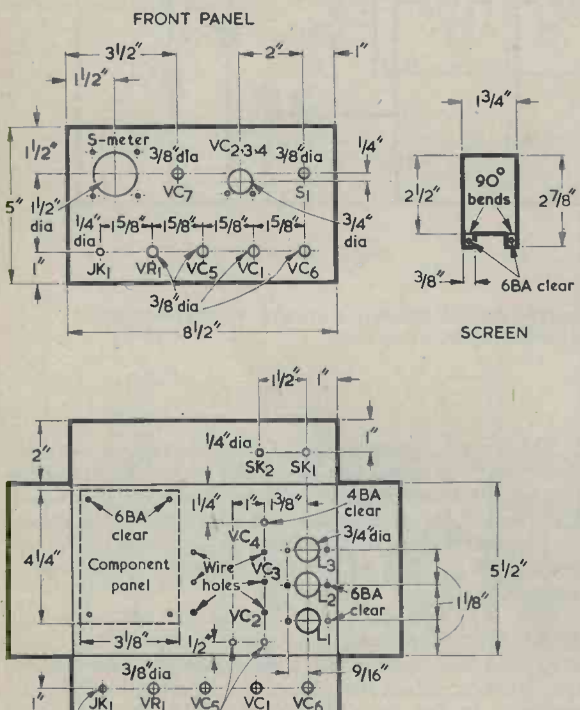
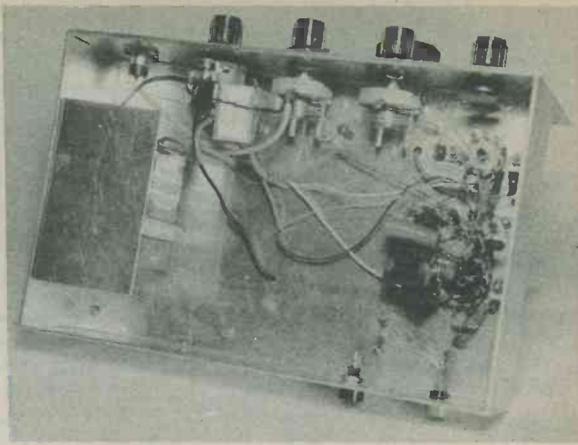


Fig. 5. The dimensions of the front panel, chassis and screen. The positions of undimensioned holes are discussed in the text



The components and wiring under the chassis

Again, most of the drilling is quite straightforward. The three mounting holes for VC2,3,4 are drilled 4BA clear with a No. 24 twist drill. The three holes between these mounting holes allow leads from the fixed vane tags to pass through the chassis. There are a further three holes for wires alongside the component panel outline. The sizes and precise positions of these six holes are not critical.

The component panel, which will be fully described in next month's issue, can be initially cut out at this stage, and it consists of a piece of $\frac{1}{16}$ in. s.r.b.p. ('Paxolin') sheet measuring $4\frac{1}{4}$ by $3\frac{1}{8}$ in. Four 6BA clear holes are drilled at the extreme corners, after which it is used as a template for marking out the four corresponding 6BA clear holes in the chassis. The component panel may then be put on one side for later use.

As can be seen from the photograph of the chassis underside, an L-shaped aluminium bracket holds the battery in place on the side opposite the three valveholders. This bracket, whose actual dimensions are unimportant provided that it holds the battery securely, may next be made up. It is secured to the chassis side by two 4BA bolts and nuts. The holes for these may be drilled in the bracket and chassis side.

SCREEN

To improve stability, a vertical screen is placed between L2 and L3. The dimensions of this are given in Fig. 5, and it is made of 18 s.w.g. aluminium.

Start by cutting out a piece of aluminium measuring $1\frac{3}{4}$ by $2\frac{7}{8}$ in. Then make two hacksaw cuts, each $\frac{3}{8}$ in. deep and each $\frac{3}{8}$ in. from, and parallel with, the $2\frac{7}{8}$ in. edges. Use a sharp modelling knife to make a deep score in the metal between the inside ends of the cuts, and then repeatedly bend the piece of metal between them backwards and forwards until it breaks off.

This leaves the shape shown in Fig. 5, which can next be bent and drilled as indicated. It is used as a template to mark out the corresponding two 6BA clear holes in the chassis, which are then drilled.

When all possible drilling is complete, the chassis and front panel are temporarily assembled by the mounting nuts of JK1 and one or more of the lower row of controls. It will probably be necessary to shorten the spindle of the 3-gang tuning capacitor slightly so that, when it is mounted, none of the spindle extends beyond the front panel. The spindle must, of course, be cut with great care to ensure that there is no damage to the capacitor. The capacitor is then secured to the chassis with three short 4BA bolts. The tuning drive is next placed on the spindle and the positions of the two small holes marked on the front panel with its aid. The front panel and chassis are then disassembled and the two holes in the panel drilled out 6BA clear. The drive is supplied with a short bolt which screws into a threaded hole at the top. This third mounting bolt was not found necessary, and no hole was drilled for the bolt.

NEXT MONTH

In next month's issue, details will be given of assembly and wiring up. Also, the optional a.f. output stage will be described.

For completeness, a full Components List for the receiver (apart from the a.f. output stage) accompanies this article. References to some of the parts must, of necessity, be kept to the next article, which will clear up any outstanding points concerning the components.

Readers who intend building the receiver complete with the a.f. output stage may prefer not to obtain the headphones specified. The receiver headphone output could also be applied to an external amplifier. It is, however, probably more convenient to bring the receiver into working order with headphones first, after which the use of the optional a.f. stage or an external amplifier may be taken into consideration.

(*To be concluded*)

Trade News

TV SOUND CHANNEL

An i.c. which provides all the active devices for a TV sound channel, including the a.f. output stage, is announced by SGS-ATES, whose U.K. distributors include ITT Electronic Services, Harlow. The functions provided by this i.c., the TDA1190, are i.f. amplifier and limiter, active low-pass filter, f.m. detector, d.c. volume control and power output amplifier. The limiting voltage is 30μV and the i.c. can operate at any i.f. between 4.5 and 6MHz. It has a high input impedance and can, in consequence be fed via a ceramic filter or tuned circuit. The a.c. gain of the unit is determined by the value of an external fixed resistor.

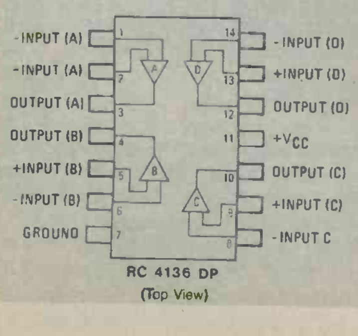
The a.f. output is typically 4.2 watts into a 16Ω speaker at 10% distortion with a 24 volt supply. Distortion falls to 2% at 3.4 watts typical and to 0.55% typical at 50mW under the same conditions. There is no frequency radiation, whereupon there is no necessity for screening.

The TDA1190 is in a 12-pin quad in-line plastic package with two protruding tabs at the centre which are soldered to a heat sink. The latter can be provided by an area of copper on the p.c.b. on which the i.c. is mounted, or by a simple folded metal sink. The photograph shows the i.c. mounted on a printed circuit board complete with all external components, including the volume control which will normally be fitted to the receiver front panel. The square screening can contains a quadrature coil.

A complete television sound channel incorporating the SGS-ATES integrated circuit type TDA1190. This includes the a.f. output stage which drives the speaker

QUAD 741

Four 741 op-amps in a single 16 pin d.i.l. package. This new Raytheon i.c. is stocked by Jermyn Distribution, Sevenoaks, Kent



RC 4136 DP
(Top View)

One of the most popular operational amplifiers available these days is the 741, which has the advantages of requiring no external frequency compensating components together with an output which may be short-circuited to earth or either power supply rail without damage. A development of the 741 has now been introduced by Raytheon. This, the 4136, consists of four 741 amplifiers contained in a 16 pin d.i.l. package. The accompanying illustration shows the appearance of the 4136 and its pin allocations.

The four independent amplifiers in this i.c. meet, or in some cases exceed, standard 741 specifications, and channel separation is no less than 105dB under open-loop conditions. The amplifiers are all on a single silicon chip with the result that there is good parameter tracking over a wide frequency range.

The power supply required is 15 volts positive and negative, and this may be provided by a Raytheon 4194 dual tracking voltage regulator. The latter is capable of supplying up to forty-five 4136 i.c.'s, which corresponds to a total of 180 operational amplifiers. Both the 4136 and the 4194 have the prefix RC or RM according to whether they meet commercial or military temperature specifications. There is also a choice of package styles. U.K. distributors are Jermyn Distribution, Sevenoaks, Kent, who stock all versions of both the 4136 and the 4194.

THE WHEATSTONE TELEGRAPH

By D. P. Newton

A few simple parts and a little ingenuity are all that are needed to recreate a signalling instrument which originally appeared more than a century ago.

A HUNDRED YEARS AGO THIS YEAR CHARLES WHEATSTONE died at the age of seventy-three, yet that for which he is remembered – the Wheatstone bridge – was not even his idea. Samuel Hunter Christie, a mathematician older than Wheatstone, mentioned that it should be possible to 'balance' four resistors by such a circuit and the more practical Wheatstone turned the idea into a useful reality and popularized it.

TELEGRAPH

It is ironic that the very thing for which Wheatstone was famous in his own time, the telegraph, did not bear his name. Again, the basic idea was not his own. It was brought to him from Germany by Cooke, but he greatly improved on it.

It was only a few years earlier, in the 1820's, that the deflection of a compass needle by a wire carrying a current had been found. Wheatstone's telegraph worked on this principle, which is illustrated in basic form in Fig. 1. With five needles he found he could point pairs of them at any of the important letters of the alphabet. Thus, in Fig. 2, 'S' lies at the point of intersection of the two displaced needles. The wires underneath these needles carry an electric current and have magnetic lines of force around them, as in Fig. 1. These lines of force interact with the magnetic needles.

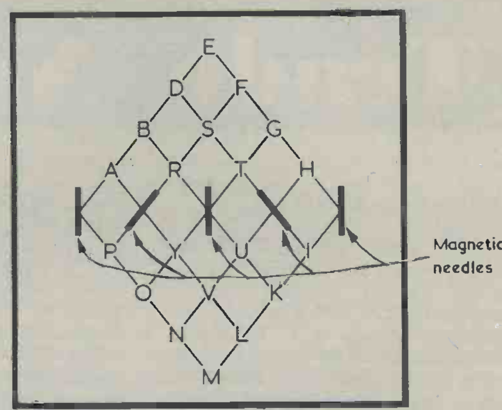


Fig. 2. Here there are five needles which may be deflected in either direction. The second and fourth needles have been deflected to indicate the letter 'S'

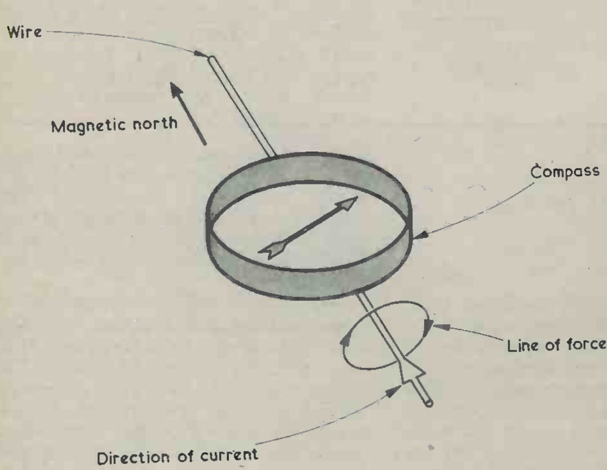


Fig. 1. A compass needle is deflected when a current passes through a wire below it

In fact, it is easy to make a model telegraph similar to that of Wheatstone. The most difficult task is to make and balance the magnetic needles. Of course, five cheap compasses would be the easiest solution, and if it is decided to buy them then this step is omitted.

MAGNETIC NEEDLES

Out of thin tin sheet, such as is used in a biscuit tin, cut and shape five needles as in Fig. 3. With a nail-punch make a depression at the balancing point. Magnetize each needle by rubbing a magnet along it in a loop about fifty times, as in Fig. 4. If a magnet is not available, one may possibly be obtained from an old loudspeaker or TV tube focus assembly.

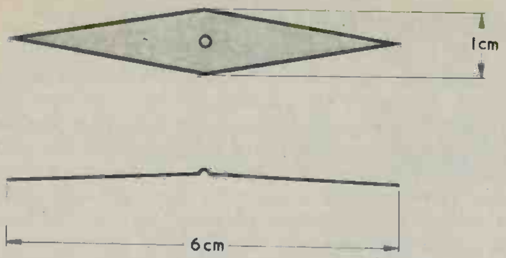


Fig. 3. A home-made magnetic needle can be cut out from thin tin-plate, as here

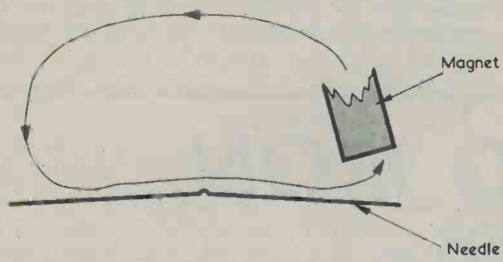


Fig. 4. The needle is magnetised by being continually stroked in one direction with a magnet

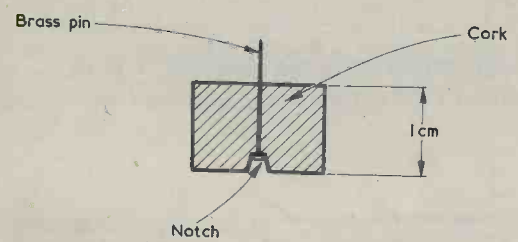


Fig. 5. A mounting pivot for each magnetic needle can be made with a brass pin and a cork

The support for each needle is the point of a brass pin, of the type used in dressmaking, fitted in a cork as in Fig. 5. Cut a notch on the underside of the cork to allow a wire to pass underneath. Try balancing the needle; it is unlikely that this will be successful at first, especially after the needle has been magnetized. Redress any unbalance by sticking adhesive tape on the lighter side.

The wooden board for the receiver should be large enough to allow each needle to settle north-south without too much mutual interference. For needles of the size of Fig. 3, a spacing of 10 to 12cm. between each is adequate. Smaller needles can be placed closer together. Onto the board fasten five parallel wires, each running under a needle and all connected together along the top, as in Fig. 6. Securely glue the corks in place. Mark on the letters as in Fig. 2. Note that only twenty positions are available, so some letters are omitted. Turn the board to face north.

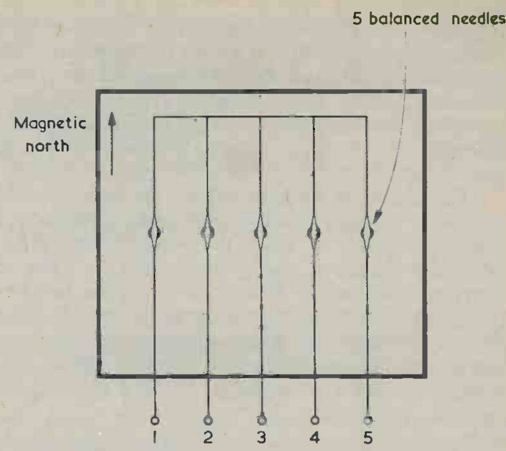


Fig. 6. The telegraph receiver. Five parallel wires pass under the needles and are connected together at the top

THE TRANSMITTER

Five brass screws, with one transmitting wire connected to each, are fixed on a small wooden board as shown in Fig. 7. Corresponding wires 1, 2, 3, 4 and 5 are connected over the required distance of transmission between the transmitter and receiver. Mark on the letters at the transmitter as shown. In this working

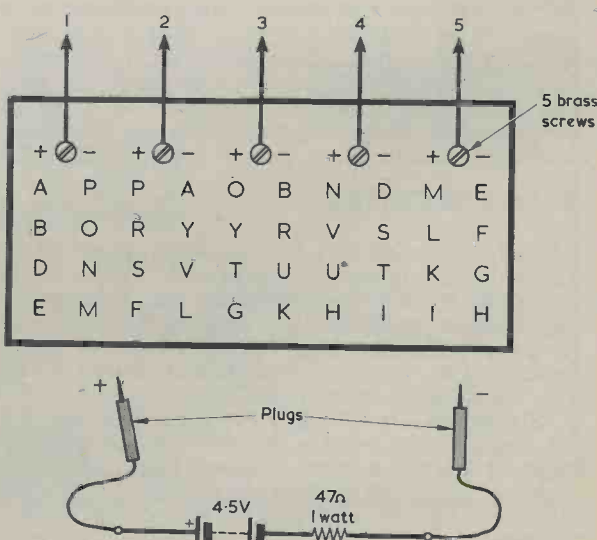


Fig. 7. The transmitter. The two plugs are applied to the appropriate screws for each letter with the polarity indicated

model a 47Ω resistor is inserted in series with one of the battery leads to limit the current drawn from it to around 100mA and thus prolong battery life. If there were very long leads between the transmitter and the receiver, the resistance in these would alternatively keep battery current to an acceptable level. The battery may be an Ever Ready No. 126 'Bell' type, or similar.

The signal is transmitted by holding the plugs from the battery onto the appropriate screw heads. Thus, to transmit letter 'N' place the positive plug onto screw 4 and the negative plug onto screw 1. This sends the current in opposite directions under the two needles for 'N' and deflects them the opposite way to point at the letter. Polarity must be observed at the transmitter screws since this determines whether letters are selected above or below the needles. For the missing letters it is easy to improvise.

ASTATIC NEEDLES

Of course, Wheatstone's telegraph was more sophisticated. For example, he did not have to worry about lining it up along the north-south line. This problem he overcame by using *astatic* needles, that is, pairs of needles which are unaffected by the earth's magnetic field. Wheatstone's inventive genius did not end here. As well as his telegraph, patented in 1837, he invented the concertina and stereoscope, and we owe the word 'microphone' to him although this was coined for a non-electrical device which arose from some experiments with sound.

With the advent of the railways, he could anticipate the success of his telegraph. Its simplicity of operation, as demonstrated by the model, was so attractive that it remained in use until the early years of this century. ■

SOLDERING IRON SAVER

By P. Thomas

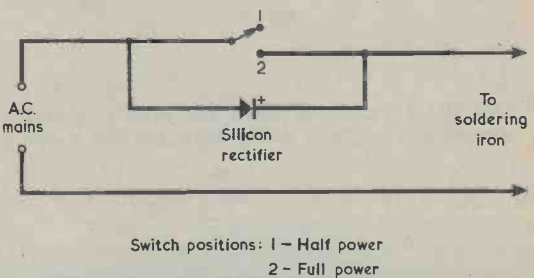
The life of a soldering iron can be considerably extended if it is run at half power when not in use.

One of the first things most of us do when settling down to a spell of work at the bench is to switch on the soldering iron. If the iron is used fairly continually it is then able to maintain a reasonably constant temperature. If on the other hand it is used only infrequently it can take up a higher than average temperature, whereupon both element and bit life are needlessly reduced.

SERIES RECTIFIER

What is required here is a switching circuit which allows the iron to run at reduced power whilst not in use, so that it can be brought up very quickly to operating temperature whenever it is required. The result will be an extended soldering iron life with the added facility that the iron can be brought into use very shortly after it has been switched to full power.

All that is needed is a silicon rectifier in series with the a.c. supply to the iron, as indicated in the accompanying diagram. When the switch is closed both mains half-cycles are applied to the iron and it operates in normal manner. When the switch is set to the 'half power' position the rectifier is in series with the iron and only alternate half-cycles of mains current are applied to it. In consequence, it runs at a reduced temperature. The author will be the first to agree that the use of a series rectifier in this manner is not a new idea. Nevertheless, it is one which quite a few constructors do not appear to have heard about.



The switch is set to the 'half power' position when the soldering iron is not required. Setting the switch to 'full power' causes the iron temperature to rise very quickly to normal working level

Since the soldering iron represents a resistive rectifier load without a parallel reservoir capacitance, the minimum p.i.v. rating of the rectifier needs to be only 1.414 times the r.m.s. mains voltage. With 240 volt mains, this works out as 340 volts. The current drawn by the soldering iron will be quite low. For instance, a 25 watt 240 volt iron will draw a little more than 0.1 amp only. A 1 amp silicon rectifier with a p.i.v. rating of 400 volts, such as the 1N4004, would be quite adequate in the circuit. Since the 1N4004 is a very small component it could be wired directly across the switch. Any other silicon rectifier with similar or higher ratings could also be employed. ■

THE 'SLIDE RULE' RECEIVER CUM CAPITANCE METER

Part 2 **By Sir Douglas Hall, K.C.M.G.**

This concluding article describes the wiring and calibration of the earphone version of this unusual design, and then gives details of the added a.f. stage required for loudspeaker reception.

IN LAST MONTH'S ARTICLE DETAILS WERE GIVEN OF circuit operation, and the initial steps in the construction of this receiver were covered. We pass on next to the process of wiring up.

WIRING

An 18-way tagboard was specified in the Components List which appeared last month, and this is the R.S. Components 'Standard' tagboard. An 11-way tagstrip is cut out from this tagboard, and is secured to the inner top surface of the receiver (i.e. to the underside of the Fig. 2(b) item) in the manner shown in Fig. 7. A piece of Fablon having approximately the same outside dimensions should be stuck to the plywood before the tagstrip is screwed down, to keep the tag undersides insulated from the wood. Small woodscrews pass through the holes in the third tag from the left and the second from the right, both of which are earthy so far as r.f. is concerned. Next to be fitted are VR1/S2, S1 and the earphone jack socket. It may be necessary to temporarily remove the Perspex panel at the top to enable these parts to be fitted. Fig. 7 shows a slide switch, but the same connections will be required if a toggle switch is employed instead.

Next wire up the small components, as illustrated. For clarity these are shown spread out in the diagram but in practice they should be connected up with reasonably short leads and no part should be outside the 'chassis' depth, as defined by the two 1 in. side pieces. Take care to connect to the correct tags of the earphone socket. If any doubt exists here, refer to the circuit diagram of Fig. 1 and identify the appropriate tags with a continuity tester or ohmmeter. VC1 is held in place by two stiff wires which also connect it to the test terminals. In the prototype it was positioned over the slide switch.

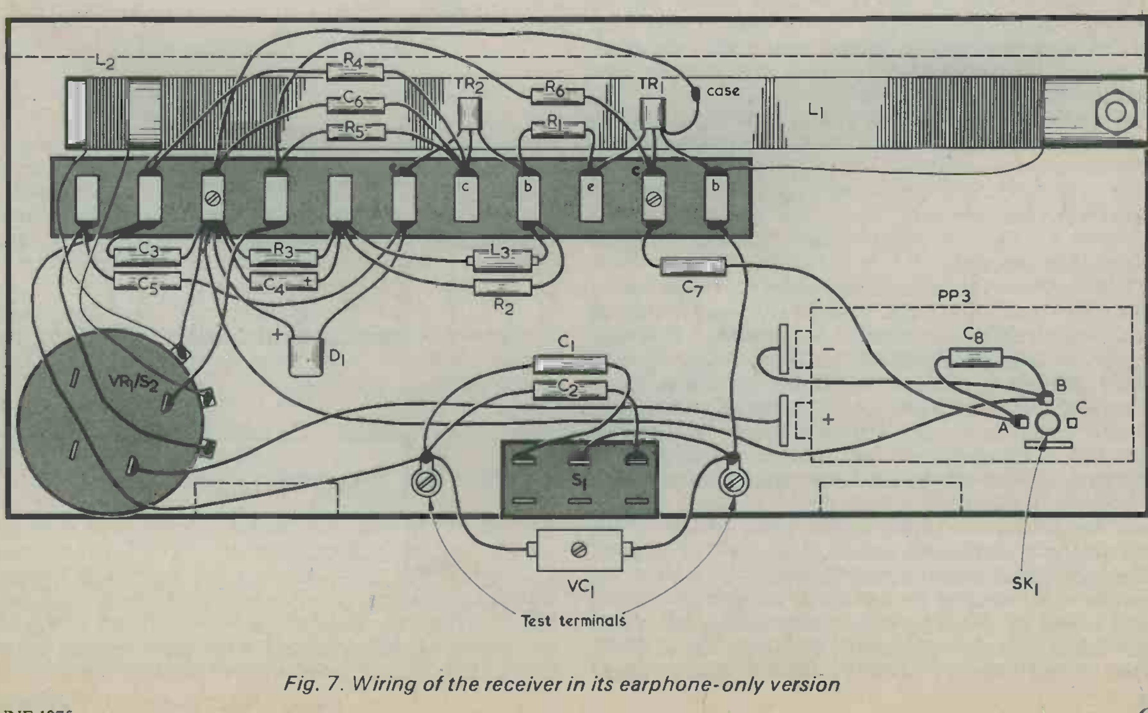
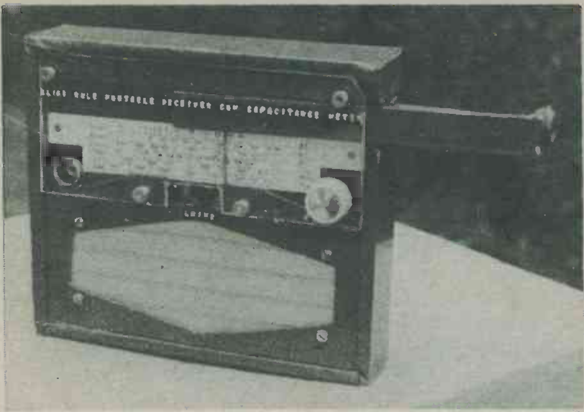


Fig. 7. Wiring of the receiver in its earphone-only version



The receiver when the a.f. output stage and loudspeaker have been added

SETTING UP

Setting up the receiver is a simple process. Fit the PP3 battery, plug in the earphone, set S1 to the central position and switch on. Do not connect any capacitor to the test terminals. Set the ferrite rod so that it is about $\frac{3}{8}$ in. from full insertion into the coil. Adjust VC1 with an insulated trimming tool until Radio 1 is tuned in, using VR1 to give critical reaction. The hands should be kept away from the left-hand side of the receiver when setting up VC1, to avoid hand capacitance effects. The final setting in VC1 will be near its minimum capacitance. If necessary, slide the rod a little further out of the coil to find the Radio 1 Signal. The position taken up by the pointer for Radio 1 will represent zero pF on the first capacitance scale.

Three capacitance scales and three tuning scales need to be marked out on the white card which will be positioned under the pointer. As the card is only 1 in. wide the scale lines will be quite close together and small figures will be required. A mapping pen may be used for the final scales. With S1 in the centre position, coverage will be from about 120 to 250 metres. When S1 is set to bring C1 into circuit there will be medium wave coverage from about 190 to 550 metres, and with S1 set to bring C2 into circuit the band from 550 to 1900 metres can be received. Plenty of stations will be received after dark to assist in calibration if no signal generator is available.

Calibration of the capacitance scales is carried out by noting the position of the pointer with capacitors of known value connected to the test terminals. It is suggested that a tolerance of 5% in these would be adequate, although obviously the calibration will be more accurate if closer tolerance components are employed. Silvered mica capacitors are particularly suitable as these are normally close tolerance types. Hi-K ceramic capacitors should not be used for calibration purposes as these normally have a very wide tolerance, but the lower value ceramic types, below some 150pF or so, normally have reasonably close tolerances. The range of calibration capacitances can be increased by connecting capacitors in parallel or series. A particularly useful range would be given by capacitors having the individual values of 1pF, 2.2pF, 4.7pF, 10pF, 22pF, 47pF, 100pF, 220pF, 470pF, 1,000pF, 2,200pF and 4,700pF. However, the question of obtaining suitable calibration capacitors is left to the reader, who may already have a good range of values in his spares box.

Setting up the receiver for capacitance calibration is as described in the previous issue. The first scale may be from zero to 56pF using Radio 1, the second from 56pF to 560pF using Radio 3, and the third from 560pF to 5,000pF using Radio 2. Remember that the zero pF point is that at which Radio 1 is received with no capacitor across the test terminals. If any difficulty is experienced in identifying Radios 1, 2 or 3 when measuring unknown capacitors it is helpful to temporarily remove the capacitor under test and tune in the station required in the normal manner to find what programme is being put out.

As indicated earlier, it may be necessary to adjust VC1 from time to time. This can be done through a hole in the bottom of the case, and the need for the adjustment will be apparent whenever the pointer fails to be at the zero pF position when Radio 1 is tuned in with S1 central and no capacitor across the test terminals.

SIMPLE CASE

If the receiver is to be used as an earphone-only set it can be housed in a simple case, and a suggestion for this is given in Fig. 8. The four sides are made of $\frac{1}{4}$ in. plywood and the base of s.r.b.p. or Formica. Small woodscrews are used to fix the pieces together and the whole is covered with Fablon or Contact. Check the exact measurements of the receiver 'chassis' before making the case, and make any necessary amendments to the dimensions given in Fig. 8 that are required in practice. Discrepancies from nominal dimensions can result from slight inaccuracies in the cutting of plywood, or in the use of plywood which is not exactly $\frac{1}{4}$ in. thick.

The current drawn from the PP3 battery by the 2-transistor receiver is only 350μA, and so battery life will be very long. Something of the order of 1,000 hours can be expected from a new battery.

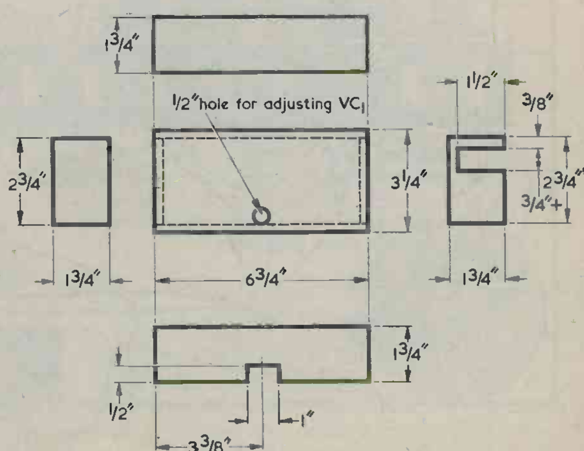


Fig. 8. A simple case for the receiver may be constructed along the lines illustrated here

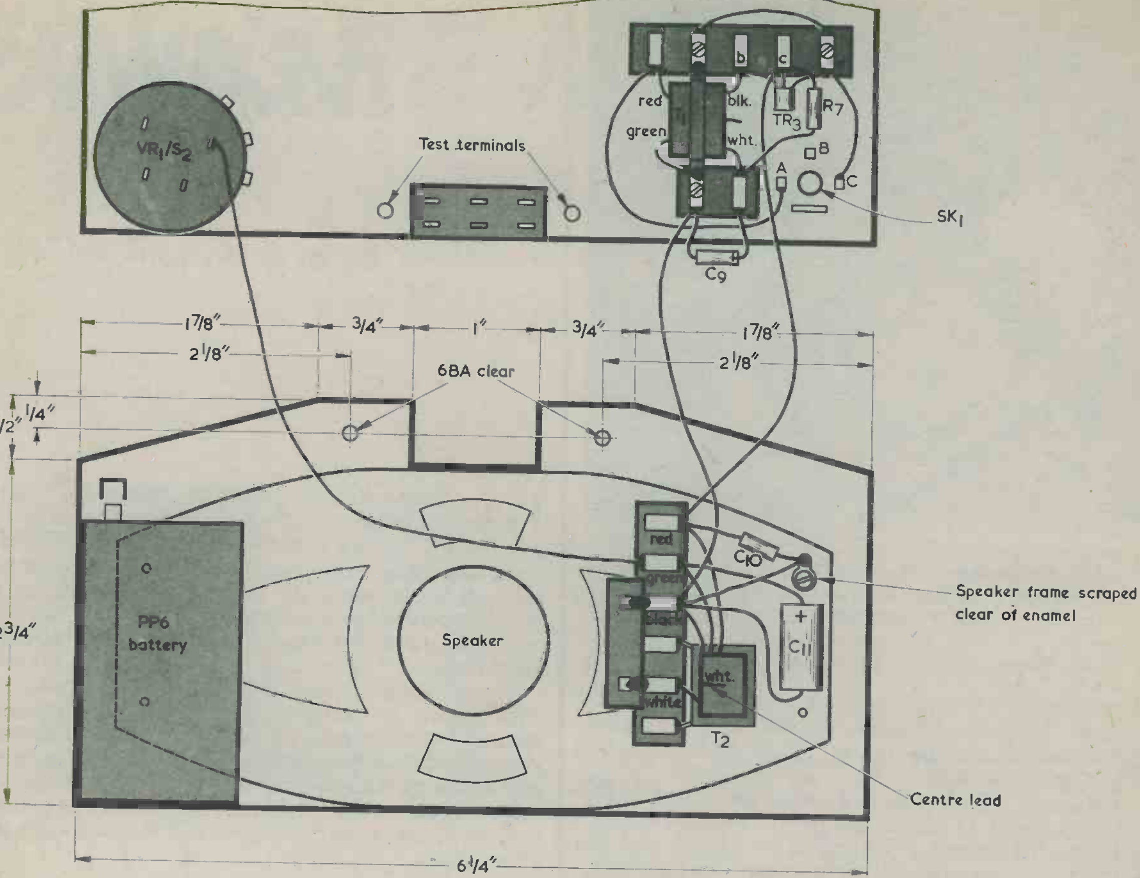


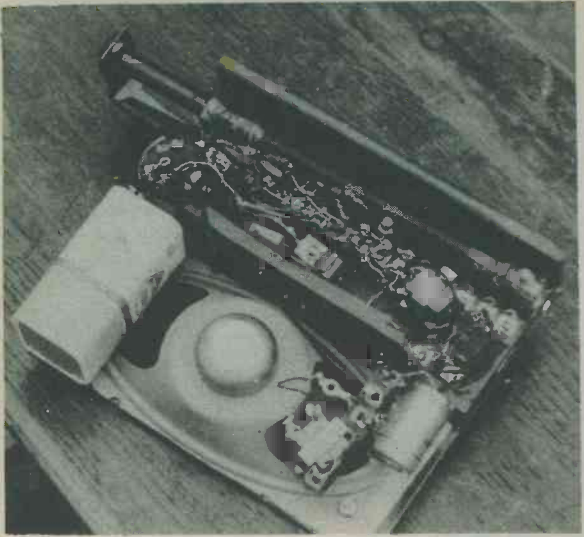
Fig. 9. How the a.f. output stage is assembled and wired

A.F. SECTION

As so far assembled the receiver has been built up to the phone socket in the circuit of Fig. 1, which was published last month. If it is desired to include the a.f. output stage shown to the right of the broken line in that diagram, construction may proceed in the manner next to be described. No modification is made to the wiring that has already been carried out and the receiver may still be used with the earphone when desired. The only change is that the aluminium or tinplate clip which held the PP3 battery is not required in the loudspeaker version. The current consumption of a transistor in the TR3 stage is typically 10mA and so a larger PP6 battery is employed instead of the PP3. The PP6 uses the same type of connector as the PP3 battery.

A 5-way tagstrip and a 2-way tagstrip, both cut from the 18-way groupboard, are now secured to the underside of the plywood piece of Fig. 2(b) in the manner shown in Fig. 9. Note that the lugs of T1 are soldered to a tag on each strip and that the strips should be positioned to allow this. The 5-way tagstrip is secured with small woodscrews passing through the holes in the second and fifth tags from the left, and the 2-way tagstrip by a small woodscrew passing through the hole in the left-hand tag. Pieces of Fablon should be stuck to the plywood before securing the tagstrips, to insulate the tag undersides from the wood.

A piece of s.r.b.p. is cut out to form the speaker baffle and this has the shape and dimensions, apart possibly from the $2\frac{3}{4}$ in. height dimension, which are shown in Fig. 9. It has been the author's experience that most speakers described as 5 by 3 in. have actual outside dimensions of about $5\frac{3}{8}$ by $2\frac{3}{4}$ in., and the $2\frac{3}{4}$ in. height dimension given in the diagram assumes that a speaker of this type is employed. If the speaker to be used happens to be larger along the nominal 3 in. dimension, then the height of the s.r.b.p. panel should be increased accordingly. The panel is secured to the receiver, as so far assembled, by passing the test terminal screws through the two 6BA clear holes at the top. The s.r.b.p. panel is secured immediately under the Perspex panel, and thereby provides some of the spacing previously given by the spacing washers here. Smaller spacing washers below the s.r.b.p. may still be required to space off the Perspex panel correctly. The s.r.b.p. panel requires an aperture for the speaker and four holes for the speaker mounting bolts. A solder tag is fitted under one of the mounting nuts, and the speaker frame is scraped clear of enamel at this point to enable



The additional parts for the a.f. stage and speaker are affixed quite simply to the earphone version of the receiver

a good connection to be made. A 6-way tagstrip, again cut from the 18-way tagboard, is soldered to the speaker tags as shown, and the lugs of T2 are soldered to two other tags on the strip.

Additional wiring is carried out as illustrated in Fig. 9. The frame of T1 carries the negative supply connection from the emitter of TR3 to its own green lead and to the 6-way tagstrip on the speaker. When the a.f. section has been completed, the black and white leads from T1 should be tried first one way round and then the other. If these leads are connected in the wrong phase there may be instability.

When the earphone plug is inserted, the output stage is completely cut off since its negative supply is then disconnected. If, however, the plug is inserted when the receiver is switched on, signals will still be heard from the speaker for a few seconds until capacitor C11 discharges. The earphone socket circuit now causes a standing direct voltage to appear across the earphone, but this caused no difficulty with the prototype. The direct voltage may be removed, if desired, by inserting a 0.22μF capacitor between the phone socket and the red lead of T1. This is only a suggestion, however, and has not been checked out on the prototype, which performed quite satisfactorily with the circuit as shown.

A case for the loudspeaker version of the receiver may be made up on the same lines as that shown in Fig. 8, having an s.r.b.p. or Formica base, and plywood sides. The $2\frac{3}{4}$ in. sides will now extend up to $5\frac{1}{2}$ in., and the base has its $3\frac{1}{4}$ in. dimension increased to 6 in. These new dimensions will need to be longer if a larger speaker is used, and the final dimensions should in any case be taken from the actual receiver, as built. The case will not need the 1 by $\frac{1}{2}$ in. cut-out shown in Fig. 8.

The four side pieces may need to be wider than $1\frac{3}{4}$ in. to accommodate the speaker and the battery, and this point has to be checked in practice with the actual speaker and battery before commencing work on the case. ■

(*Concluded*)

MAINS

By N. R. Wilson

It is occasionally desirable to provide a positive means of warning that an a.c. mains supply has cut off. Such a facility can be useful when the supplied equipment does not give audible or visual indications to show that it is turned on. A mains failure monitor can also be useful when soak testing intermittent television receivers and the like when these occasionally blow their main fuses.

A very simple mains failure monitor consists of a relay which is energised by the mains supply. On cessation of the supply the relay then de-energises and a pair of its contacts complete a circuit between a battery and a bell or buzzer. The only real disadvantage with this approach is that the battery is needed, and batteries tend to be neglected or forgotten if they are used only infrequently.

CHARGED CAPACITOR

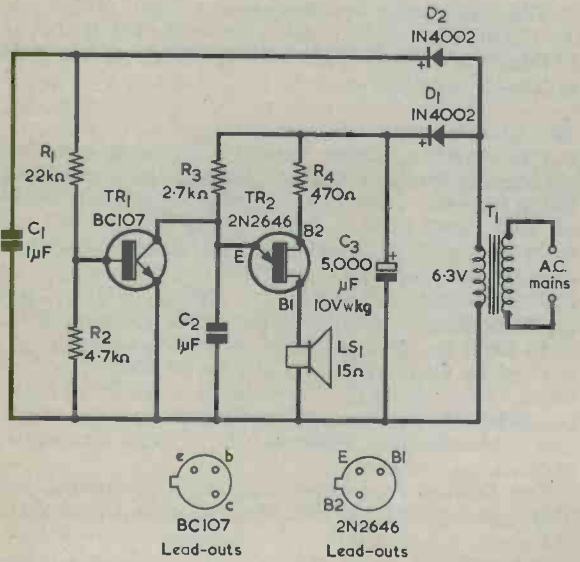
The unit to be described here does not require a battery. Instead, a large value electrolytic capacitor is charged when the mains supply is available. As soon as the mains supply cuts off, the charged capacitor feeds into an audio oscillator coupled to a loudspeaker. The oscillator then starts to run and continues until the capacitor has discharged. The resultant sound, although present for a short time only, should be sufficient to attract attention to the cessation of the mains supply.

The circuit of the monitor appears in the accompanying diagram. In this, the audio oscillator incorporates the unijunction transistor, TR2. A unijunction transistor is employed because, apart from the small standing current which flows between the base 2 and base 1 of the device, nearly all the current drawn is converted into the pulses which appear in the emitter and base 1 circuit. A unijunction oscillator is, in consequence, reasonably efficient and can give a relatively high output without, in the present case, too rapidly discharging the electrolytic capacitor which supplies it.

If TR1 is ignored for the moment, the circuitry around TR2 functions as a standard unijunction transistor oscillator in the following manner. When a supply voltage is present, C2 charges via R3 until the voltage on its upper plate reaches the emitter triggering level, whereupon it discharges rapidly via the emitter and base 1 into the speaker. The voltage across the capacitor is then below triggering level, and it commences to charge via R3 once more. There is, in consequence, a

FAILURE MONITOR

This little unit gives audible warning of mains supply cessation.



The circuit of the mains failure monitor unit. The unijunction transistor oscillates at an audio frequency when the mains supply ceases

train of current pulses in the speaker. With the component values shown the pulses have a repetition frequency of around 350Hz, and they result in a tone at this frequency being reproduced by the speaker.

UNIJUNCTION SUPPLY

The unijunction transistor supply is obtained from the 6.3 volt secondary of transformer T1, the primary of which connects to the a.c. supply to be monitored. The secondary voltage is rectified by D1 and applied to the reservoir capacitor C3. C3 is also the high value capacitor which supplies the unijunction oscillator when the mains supply ceases.

If TR1 is now taken into consideration, it will be found that the unijunction oscillator does not in practice operate when the mains supply is present. A second rectifier, D2, causes a rectified positive voltage to appear on the upper plate of C1. This voltage is coupled via R1 to the base of TR1, which is thus turned hard on. Its collector holds the upper plate of C2 at a voltage slightly higher than that on the lower negative supply rail, whereupon C2 cannot charge via R3. In consequence, TR1 prevents the oscillator from operating when the mains supply is on.

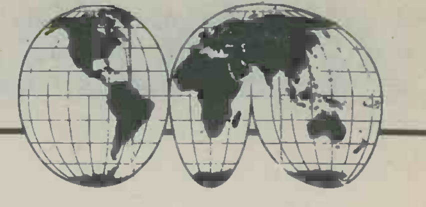
If the mains supply ceases, the voltage across T1 secondary drops to zero. C1 discharges very quickly into R1 and R2, with the result that TR1 turns off. C2 is now able to charge via R3, and the unijunction oscillator commences to operate, producing an audible tone from the speaker. The oscillator obtains its power from the charged capacitor C3, and the tone continues until C3 is discharged.

Thus, the unit gives audible warning of the cessation of the mains supply. If the supply is re-applied, capacitors C1 and C3 will become fully charged again and the unit will be ready for use once more.

In the author's circuit, C1 and C2 were plastic foil capacitors. Electrolytic capacitors of the same value and with a working voltage of 10 volts or more could alternatively be employed. The speaker gives a reasonably loud tone which should be adequate for normally quiet premises. The volume of the tone will be increased if the speaker is mounted on a small baffle or is housed in a cabinet. The speaker should have an impedance of 15Ω. Transformer T1 can be any heater transformer having a 6.3 volt secondary.

The length of time during which the tone sounds depends on the value of C3. When this is 5,000µF, as shown, the tone is reproduced at a high level for 15 seconds and then gradually fades out over the following 30 seconds. If desired, C3 can be given a higher value than 5,000µF. If it is made 10,000µF the tone will sound for approximately twice as long, and the time will be lengthened again if the value of C3 is increased further. Readers who have access to stocks of high value electrolytic capacitors may connect these in parallel to produce a very high capacitance for C3, whereupon the tone may be made to sound, on cessation of the mains supply, for a considerable period. If the capacitance is made very large, however, it would be advisable to insert a 10Ω resistor rated at 3 watts or more between D1 and the secondary of the transformer. This resistor will reduce switch-on current surges. ■

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

Clandestine transmissions still claim a certain amount of attention from many short wave listeners. As a change from logging some of the fairly regular "bread and butter" transmissions, chasing the clandestines can be interesting and the successful reception of some of them represents a Dx feat in itself. The aerial system must be good, the receiver in tip-top condition and the operator fully aware of the difficulties to be encountered – chasing clandestines is not noted as being an easy occupation. As an illustration of this, try the relatively easy Azad Kashmir currently (at the time of writing) operating on **3383**; listen from around 1815 till sign-off (usually from 1820 to 1830 after an interminably long choral anthem). The battle here will not only be the standard one of prevailing conditions but also the sea of surrounding commercial QRM.

Higher up the spectrum we have the Voice of the Thai People, last logged by us in late March at 1542 on the regular **9422.5** channel, this one tending to close down around 1615 after some military music and slogans in Thai.

The "Voice of the Malayan Revolution" broadcasts in English to Singapore and Malaysia from 0930 to 1000 and from 1500 to 1530 on **11830** and **15790**; despite several attempts, we have singularly failed to log this one.

Radio Pathet Lao is well worth logging, listen around **6212** (frequency is apt to vary) from 1530 onwards until they sign-off at 1600 or, if you want to make life even more difficult for yourself, listen for the much weaker parallel channel on **6199**, this will certainly test the sensitivity and selectivity of your receiver – not to mention the operator.

CURRENT SCHEDULES

● THAILAND

Radio Thailand, Bangkok, has an Overseas Service in English for Europe and Asia from 1040 to 1140 on **9655** and on **11905** (also on **7115** from 11.30). In the North American Service, Radio Thailand broadcasts in English from 0415 to 0530 on **9655** and on **11905**.

● SRI LANKA

The Sri Lanka Broadcasting Corporation, Colombo, directs a service in English to Europe from 1900 to 2000 on **9720**, **11800** and on **15120**, the newscast is from 1915 to 1920.

Other broadcasts in English are from 1030 to 1130 to S.E. Asia, Japan and Australia on **11835**, **15120** and on **17830**; from 0030 to 0430 on **6075**, **11725** and on **15425**, from 1230 to 1730 on **7190**, **11725** and on **15425** in the All Asia Service.

● ANGOLA

The Angolan Home Services (First Programme) radiated by Emissor Official, Luanda, in Portuguese, are as follows – from 1700 to 2400 (Saturdays to 0200) on **3375**; from 0500 to 0815 (Sundays from 0600) and from 1600 to 2310 on **4820**; from 1700 to 2400 (Saturdays to 0200) on **5960**; from 0500 to 2400 Mondays to Fridays (0500 to 0200 Saturdays, 0600 to 2400 Sundays) on **7245**; 0500 to 1600 (Sundays from 0600) on **9535**; from 0800 to 1600 on **11875**. The programme is networked by Cabinda City, Cabinda on **4925**; Sao Salvador, Zaire, on **4825**; Henrique de Carvalho, Lunda, on **4860**; Serpa Pinto, Cuando-Cubango, on **4780**; Luso, Moxico, on **4970** and by Tezeira de Sousa, Moxico, on **4885**.

The Second Programme operates continuously on **6175** and on **7265**, also on **9660** but operational times unknown.

The political programme "Fighting Angola" presented by the MPLA from Nova Lisboa is radiated in the First Programme of Radio Clube de Huambo from 1720 to 1750 on **7160** and on the Second Programme from the same station from 1950 to 2020 on **5060**.

Programmes in English may be heard from 1130 to 1145 on **9535** and **11875** and from 1500 to 1530 Mondays to Saturday inclusive.

● KUWAIT

Broadcasts in English from Radio Kuwait are being heard from 1700 to 2000 beamed to Europe on **11940** and to East and S.E. Asia on **9555**.

● SPANISH SAHARA

Radio Sahara, Al-Uyun, operates in Arabic from 0900 to 1330 and from 1500 to 2300; in Spanish from 0800 to 0900, from 1330 to 1500 and from 2300 to 2400 on **11805** from 0800 to 1800 and on **6095** from 1800 to 2400.

● ITALY

"RAI — Italian Radio and Television", Rome, operate an External Service in English to the U.K. from 1935 to 1955 on **6050**, **7275** and on **9710**. Further transmissions in English are – to the Near East from 2025 to 2045 on **6050**, 7235 and on 9575 and to the Far East from 2200 to 2225 on **5990**, **9710** and on **11905**. A relay of the Home Service to the Mediterranean Basin with newscasts in German and French on the half-hours and in Italian and English on the hours is made from 2230 to 0500 on **6060**.

● **CHINA**
Radio Peking has the following schedules for the main domestic First and Second Programmes in Standard Chinese – First Programme from 1303 to 1730 and from 2000 to 2200 on **3220**; from 0903 to 1735 and from 2000 to 2400 on **4460**; from 1353 to 1735 and from 2000 to 2300 on **4905**; from 0948 to 1735 and from 2000 to 0100 on **5320**; from 1233 to 1735 and from 2000 to 2320 on **7935**; from 2000 to 1735 on **9080**; from 2203 to 1300 on **11330**; from 2300 to 0800 on **12120**; from 2303 to 1230 on **15030**; from 0003 to 0900 on **15230**; from 2304 to 1350 on **15550** and from 0103 to 09045 on **17605**.

The Second Programme from 1303 to 1645 and from 2100 to 2245 on **3290**; from 1118 to 1645 and from 2100 to 2330 on **4250**; from 1003 (0950 Weds and Fri) to 1645 and from 2100 to 0245 on **5075**; from 1023 (0950 Weds and Fri) to 1645 and from 2100 to 2400 on **6345**; from 2333 to 1115 on **7190**; from 2248 to 1300 on **10260**; from 0003 to 1020 on **11040**; from 0248 to 1000 on **15450** and from 0500 to 0800 and from 2300 to 0355 on **15590**.

AROUND THE DIAL

● **IRAQ**
Baghdad at 1945 on **9745** with identification and programme in English, news, music and talks.

● **AUSTRIA**
Vienna at 1230 on **11970** with identification at commencement of the English programme.

● **JAPAN**
Tokyo at 0800 on **15430** with English announcements and identification in the European Service.

● **ROUMANIA**
Bucharest at 2115 on **5990** with programme in English directed to the U.K.

● **JORDAN**
Radio Amman may be heard at 1700 on **9560** at which time we logged a newscast in English after station identification.

● **CHINA**
Radio Peking on **11600** at 0945 with a newscast in English read by a female announcer.

● **MEXICO**
Radio Mexico announcing as "Radio Fiesta" (formerly announcing as "Radio Tricolour") at 2107 on **15110**, typical Mexican music, Spanish announcements with frequent soundings of a siren – all heady stuff!

● **COSTA RICA**
Radio Capital as late as 0810 on the regular **4832** channel with identification at 0811 after programme of local music and songs.

● **VENEZUELA**
Radio Popular at 2305 on **4810** with programme of local music, many commercials and identification at 2312. This station has a schedule from 1000 to 0400 and is one of the myriad Venezuelans that can be heard on the 60 metre band.

Radio Monogas at 0221 on **3325**, Latin American music, commercials in Spanish, songs etc in usual LA format.

● **PAKISTAN**
Islamabad at 1533 on **4835**, local music and songs, OM announcer, signal just audible through noise level.

● **NEPAL**
Radio Nepal at 1605 on **5007** and also in parallel on **3425**, songs, local music with YL announcer in Nepali.

● **INDIA**
AIR Gahauti at 1658 on **3375**, OM with announcements in vernaculars then station suddenly off the air, without National Anthem.

● **AUSTRALIA**
ABC Brisbane at 0804 on **4920**, OM with news and announcements in English then into dance music records programme.

● **CAPE VERDE IS.**
Radio Clube de Cabo Verde at 2016 on **3886** measured (listed **3883**), OM announcer in Portuguese, songs and music of Portugal.

● **GHANA**
Ejura at 1840 on **3350**, OM announcer in vernacular, African orchestra and music, YL with song.

● **MALAWI**
Blantyre at 2025 on **3380**, local music, songs and chants in typical African style.

● **AFGHANISTAN**
Kabul at 1710 on **4775** with a talk by male announcer until 1713 then into programme of local music.

● **MOZAMBIQUE**
Radio Clube de Mozambique at 2020 on **4855**, OM in Portuguese with announcements then into programme of 'pops'.

● **BRAZIL**
Radio Relogio at 2310 on **4905**, second pulses in time-checks, OM in Portuguese, Latin American music.

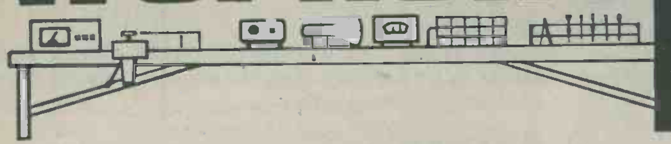
Radio Brazil Central at 2330 on **4995**, OM with identification then Portuguese 'pop' music programme.

● **NIGERIA**
Lagos at 2200 on **4990**, OM with newscast in English after station identification.

● **TOGO**
Lome at 1930 on **5047** with newscast in English by male announcer, into French at 1938.

● **SINGAPORE**
Radio Singapore at 1554 on **5010**, light music, announcements and songs in English.

In your workshop



This month Smithy the Serviceman, accompanied as always by his able assistant Dick, embarks on a consideration of operational amplifiers in general and the 709 in particular. He will be concluding on the subject of op-amps next month.

"WE CERTAINLY," REMARKED DICK chattily, "see plenty of variety in this servicing racket."

He popped the last of his lunch-time sandwich into his mouth and fastidiously brushed the crumbs off the front of his overall jacket.

"And what," asked Smithy, as he carefully removed the wrapping from a pork pie, "prompted that remark?"

"I've just had two jobs in a row," explained Dick, "which pretty well represent the ultimate extremes in domestic electronics these days."

"In what way?"

By now, Smithy had exposed the crust of the pork pie. He took a large bite from it.

"Well," said Dick, "both jobs were record players. One was a cheap old mono player with a single UL84 pentode amplifier and a UY85 half-wave mains rectifier, and the other was a modern stereo player which had hardly anything in it except an integrated circuit for each channel. There must be nearly twenty years of design development between those two players."

OPERATIONAL AMPLIFIERS

"I see what you mean about variety," stated Smithy in muffled tones. "Working on valves one minute and i.c's the next certainly represents a big change."

He swallowed the piece of pork pie he had been chewing, then took another gigantic bite.

"Dash it all, Smithy," complained Dick testily. "Can't you bring in sandwiches for lunch like any normal person? When *you* have lunch the place gets to feel like a buffet on B. Railways."

"But I don't like sandwiches," replied Smithy with difficulty as he struggled with the pie. "I prefer to have a bit of diversity in what I eat."

As he spoke, a large piece of crust escaped. Deftly, he caught it as it fell and replaced it in his mouth.

"Ye gods," snorted Dick in a tone of utter revulsion. "Watching you eat is enough to put anyone off food for the rest of his life. I've forgotten what I was talking about now."

"You were talking about valves," said Smithy helpfully, "and integrated circuits."

"Oh yes, that's right. Well, I'm getting quite used to integrated circuits now but there's one thing about them I don't understand."

"What's that?"

"You often read about integrated circuits being used as operational amplifiers. But the integrated circuits I bump into in the sets I service are a.f. or i.f. amplifiers and things like that. I don't recall even *seeing* any i.c. that could be called an operational amplifier. Come to think of it, I'm not all that certain what an operational amplifier is!"

Smithy, his mouth temporarily clear of pork pie, was able to give an audible chuckle.

"Many of the amplifying integrated circuits you see in sets," he remarked, "are in fact loosely based on operational amplifier principles, with the design directed towards a particular end such as driving a loudspeaker. But so far as straightforward operational amplifiers are concerned, you won't find any of these in a conventional domestic set."

"All right then," said Dick. "If that's the case, what *are* operational amplifiers intended for?"

"Initially," said Smithy, "operational amplifiers were meant to be used in analogue computers. An operational amplifier is a device having an extremely high level of voltage gain. By coupling a suitable negative feedback circuit to it the amplifier gain is reduced, and it then carries out a function which is controlled by the feedback circuit. For instance, a simple resistive feedback circuit can cause an operational amplifier to have a voltage gain which is entirely controlled by the values of the resistors. If the feedback circuit is capacitive the amplifier becomes capable of changing a square wave to a triangular wave of the same frequency. There are all manner of feedback circuits which can cause an operational amplifier to carry out different functions. You can even have a negative feedback circuit where the output connects directly back to the input. The amplifier then has a gain of unity and can be employed as a voltage follower."

"Blimey," said Dick, impressed. "These operational amplifiers seem to be pretty versatile."

"In combination with the feedback circuits they are," stated Smithy. "Apart from computer work op-amps, to give them their shortened name, lend themselves to no end of applications in test equipment and things like that, and they are very interesting gadgets for the home constructor to play around with. They are, of course, readily available from many component suppliers, and what are probably the most popular types are the 709 and the 741. The 709 is rather a venerable device these days, since it first came on the scene about ten years ago. The 741 is a more recent version and is in many ways an improvement on the 709. You'll usually find these two op-amps referred to with a letter after the three figures, such as 709C or 741C. There may also be some letters and numbers before the three figures. For instance, the full Texas instruments names for the two devices are SN72709 and SN72741 with a letter following to indicate the type of package."

"Type of package?"

"The size and shape of the device and the number of pins it has."

DIFFERENTIAL AMPLIFIERS

"Oh," remarked Dick.

He absorbed this information whilst Smithy continued to eat his pork pie.

"If," remarked Dick thoughtfully, "an op-amp can have negative feedback from its output back to its input, then the input must be out of phase with the output."

Smithy put his pie on one side for a moment.

"True enough," he agreed. "But that doesn't give the full picture. An op-amp has one output and *two* inputs. One input is known as the inverting input and it is out of phase with the output. That's the input to which negative feedback is applied. The other input is referred to as the non-inverting input and it is in phase with the output. In circuit diagrams the inverting input is marked with a minus sign and the none-inverting input is marked with a plus sign. The two op-amp inputs go to the bases of two transistors in a differential amplifier."

"Blow me," said Dick bleakly. "This op-amp business is getting complicated already, and we're only at the input stage! What in heck is a differential amplifier?"

"It's simply another name for what you may know as a long-tailed pair. Here, I'll show you."

Smithy beckoned Dick towards him, then pulled his note pad over and sketched out a circuit. (Fig. 1.)

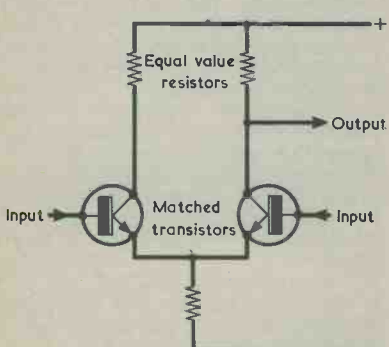


Fig. 1. A differential amplifier. In this instance an output is taken from the collector of one of the transistors

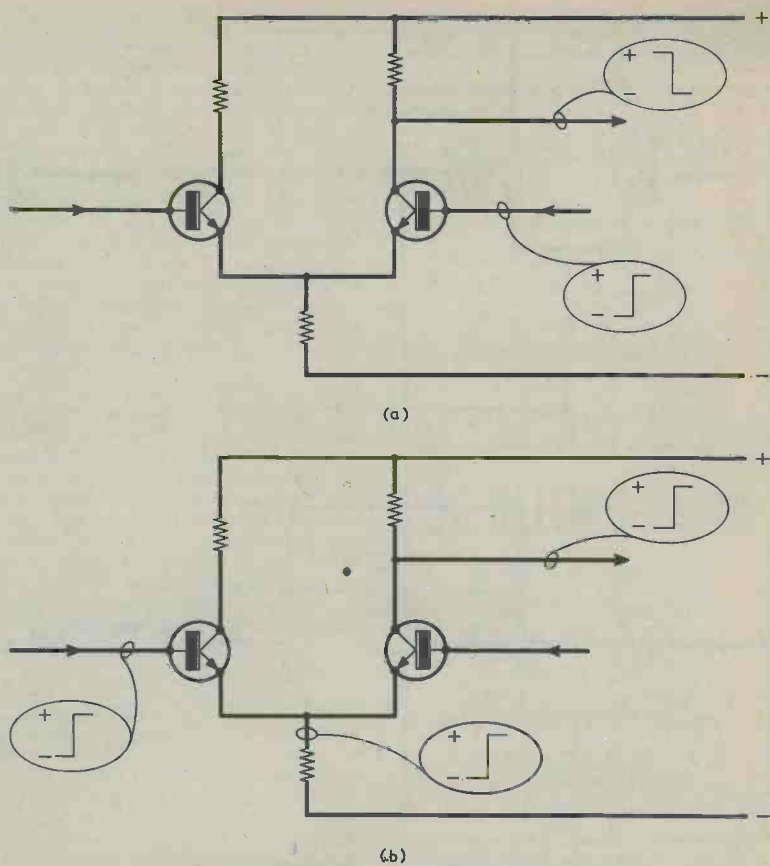


Fig. 2 (a). If a positive-going signal is applied to the base of the second transistor in the differential amplifier, the collector of the second transistor goes negative
(b). When a positive-going signal is fed to the base of the first transistor, the collector of the second transistor goes positive also

"Now here," he continued, "is a differential amplifier. The two transistors are a matched pair and the two collector load resistors are equal in value. Let's say that we take an output from the collector of the second transistor. Now, what happens if we apply a positive-going input to the base of this second transistor?" (Fig. 2(a).)

"Why," said Dick, "its collector will go negative. The collector will go in the opposite direction to the base."

"Fair enough," commended Smithy. "Now what happens at the output if we apply a positive-going input to the base of the *first* transistor?" (Fig. 2(b).)

"Ah," said Dick thoughtfully, "there are a few more steps involved here. Now if the base of the first transistor goes positive the emitter, due to the emitter follower action, will also go positive. This means that the emitter of the second transistor goes positive, too. The emitter of the second transistor going positive has the same effect as the base of the second transistor going negative, and so the collector of the second transistor goes positive."

"Very good," stated Smithy approvingly. "To sum up, the output from our differential amplifier goes negative if the base of the second transistor goes positive and the output goes positive if the base of the first transistor goes positive."

"That seems to be about it."

"Right," said Smithy briskly. "Now, I'm going to redraw that differential amplifier and introduce an earth or ground point into the circuit. This earth is a central point and will be common with the chassis of the equipment on which the differential amplifier would be fitted. We will now have an upper supply rail which is positive of earth and to which the two collector resistors connect. And we will also have a lower supply rail of the same voltage, but which is negative of

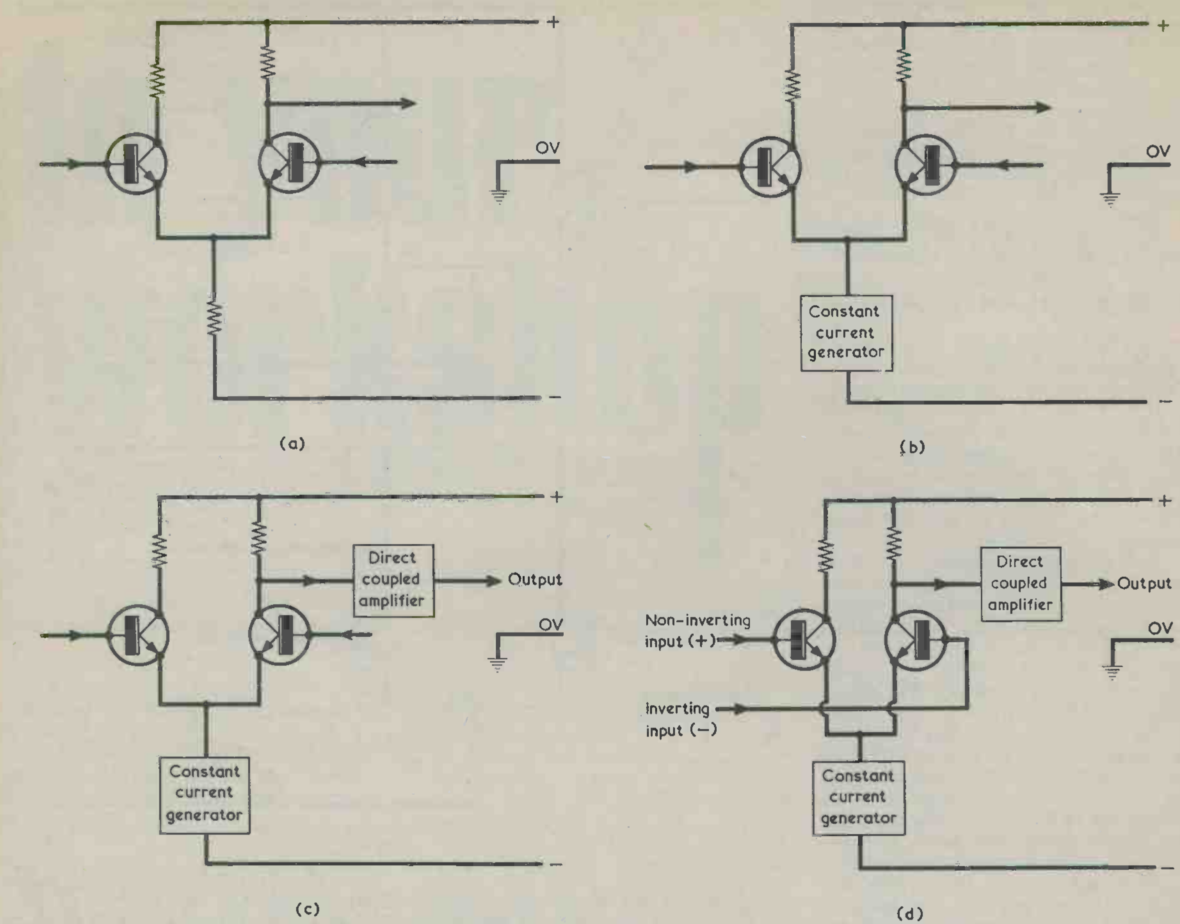


Fig. 3(a). Here, the differential amplifier is powered by supply rails that are positive and negative of earth
(b). Differential amplifier performance is improved if the common emitter resistor is replaced by a constant current generator
(c). A direct coupled amplifier is added after the differential amplifier
(d). The whole system is now an operational amplifier with inverting and non-inverting inputs

earth. The common emitter load will be connected to this lower negative rail. Okay up to now?" (Fig. 3(a).)

"Yes," said Dick, looking at the new circuit Smithy had sketched out. "In other words, the earth point is mid-way between the positive and negative supply rails."

"That's right," said Smithy. "I'm next going to take the simple step of replacing the common emitter resistor with a constant current generator. This can consist of a single transitor with its base held at a fixed potential and with a suitable value of resistance in its emitter circuit. A constant current generator has the same effect as a very high value common emitter resistor and it ensures that the two differential amplifier transistors share a fixed current." (Fig. 3(b).)

"All right," said Dick, frowning. "I'm still with you."

"Good," stated Smithy, busy yet again with his pen. "I'm next going to connect the output of the differential amplifier to a rather complicated direct coupled transistor amplifier which I'll represent as a block. This direct coupled transistor amplifier does three things. First, it provides more voltage amplification. Second, it has a totem pole output stage roughly similar to the Class B audio output stage you get in transistor radios, and this gives a low impedance output voltage with plenty of current drive behind it. And third, the direct coupled transistor amplifier shifts the standing voltage level of the signal at the collector of the second transistor in the differential amplifier such that, when both the differential amplifier bases are at earth potential, so also is the output from the direct coupled transistor amplifier." (Fig. 3(c).)

"Phew," gasped Dick, "that's a fair old work load for one amplifier, isn't it?"

"It is rather," conceded Smithy. "Still, it's marvellous what you can do with transistors if you connect enough of them up in the right way. Now, there's a further point about the direct coupled amplifier which I next need to introduce, and this is that its oufput is in phase with the input it takes from the differential amplifier. If the collector of the second transistor in the differential amplifier goes positive so also, by an amplified amount, does the output of the direct coupled amplifier. The same thing happens in the negative direction. Can you see what we now have?"

"No, what do we have?"

"We have a card-holding fully paid up duly certified operational amplifier!"

OP-AMP INPUTS

Whilst Dick gaped at Smithy's circuit in the light of this intelligence, the Serviceman picked up his pork pie and took another enormous bite.

"These darned pies," he grumbled, "never seem to have any taste in them these days."

"Perhaps," said Dick absently, "it needs a bit of mustard."

"That," remarked Smithy, "is what I call good thinking."

Leaning forward, he picked up a small Philips screwdriver and, with its aid, bored four deep holes into the meat of the pie. Opening a drawer in his bench he produced a tube of Colman's mustard, the cap of which he removed. He next applied the end of the tube to each of the four holes, filling each with mustard, after which he replaced the cap on the tube. He took a further bite of the mustard-laced pie.

"Ah," he muttered contentedly, "that's a bit more like it."

But Dick had eyes only for the sketch on Smithy's note pad.

"Tell me more about this amplifier circuit, Smithy."

"Okey-doke," replied Smithy obligingly. "Now, the overall amplifier has two inputs. Following from what we've seen up to now, if the input at the base of the second transistor in the differential amplifier goes positive the final amplified output goes negative. So the input to the base of the second transistor in the differential amplifier is the inverting input of the op-amp and we can identify it with a minus sign. At the same time, if the input to the base of the first transistor in the differential amplifier goes positive so also, in an amplified manner, does the final output of the op-amp. So this is the non-inverting input of the op-amp and we can mark it with a plus sign." (Fig. 3(d).)

"Why," asked Dick, "do you have to have a differential amplifier? Couldn't the op-amp just consist of a simple straight-through amplifier with single stages following each other in sequence?"

"The first reason for using a differential amplifier," replied Smithy, "is that it enables you to have balanced inverting and non-inverting inputs. When there is a constant current generator in the common emitter circuit the inputs both have the same sensitivity, so that an input of a small fraction of a volt at the non-inverting input causes the same voltage change at the op-amp output as does an input of the same fraction of a volt at the inverting input. Another good reason for having a differential amplifier is that the two halves stabilize each other. In consequence, any changes in performance due to temperature or supply voltage variations in one transistor are balanced out by similar changes in the other. This balancing out process will be particularly effective when the two transistors are on a single chip in an integrated circuit. Now, there is a third advantage given by the differential amplifier which introduces another new point about the op-amp."

"Fire away!"

"I said just now," remarked Smithy, "that the output of the op-amp is at earth potential when the two inputs are both at earth potential. Now, the output of the op-amp will also be at earth potential when both the inputs have the same potential even when this potential is quite some way positive or negative of the earth point. This facility can be quite useful for a lot of op-amp applications."

"Gosh, that's another thing I've learned," exclaimed Dick. "Wait a minute, though! There's something that's worrying me here."

"What's that?"

"You say that the direct coupled transistor amplifier following the differential amplifier causes the voltage level to be shifted so that the op-amp output is at earth potential when the two inputs are at the same potential. Now, I'm prepared to believe that an op-amp has many magical qualities but I cannot for the life of me accept that you can have a transistor circuit which works as precisely as that."

"Your scepticism," pronounced Smithy, "does you credit."

"Does it?" said Dick happily. "I knew I couldn't be wholly bad."

"And I say that," continued Smithy, "because in practice the direct coupled transistor amplifier cannot take the output exactly to earth potential when both inputs are at the same potential. Instead, it *tends* to take the output towards earth potential. To get the output exactly at earth potential one or other of the two inputs has to be made very slightly positive of the other. The voltage involved is quite small and it varies with different op-amps. It is referred to as the 'input offset voltage'. There is another allied term here, this being 'input offset current'. This is the difference between the currents flowing into the inputs when the op-amp output is at earth potential. Again, it is quite a tiny figure."

709 OP-AMP

Smithy rose, walked over to the filing cabinet, and returned with a bulky manufacturer's data book on linear integrated circuits. He leafed through the contents, then opened out the book at a page on which appeared a circuit diagram. He laid the book down on his bench and indicated the circuit to his assistant. (Fig. 4.)

"Now here," he remarked, "is the internal circuitry of an actual op-amp. It is, in fact, what you get inside a 709 operational amplifier."

"Hell's teeth," stuttered Dick. "There are enough transistors here to start a mail-order business."

"Actually," said Smithy soothingly, "there are only fifteen transistors on the chip. Don't forget that we are now entering the Realm of the Integrated Circuit, where it's usually easier to add a transistor than a resistor, and where inductance is absent and capacitance is

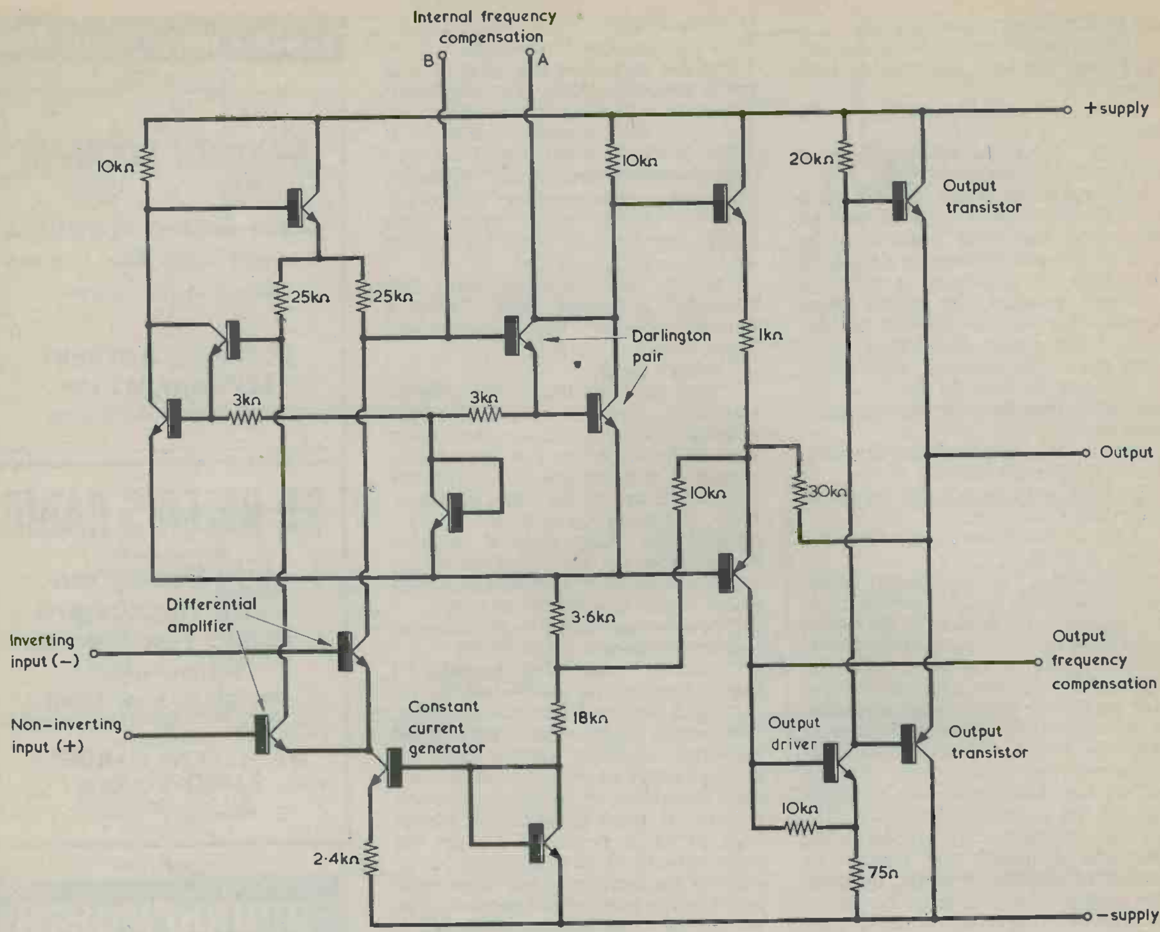


Fig. 4. The internal circuitry of the 709 op-amp, with some of the transistor functions identified

very hard to come by. Despite the fact that there are more transistors here that you'd employ in a similar sort of circuit using discrete devices, it's still fairly easy to find a few familiar configurations."

"If," remarked Dick despairingly, "you can see anything familiar in *that* jungle then you must have e.s.p. or something."

"For a start," said Smithy, ignoring his assistant's comments, "take a look at the inverting and non-inverting inputs. These go straight to the bases of two transistors which form a differential amplifier just like the one we've been discussing up to now. Also, there is a single transistor in the common emitter circuit which acts as a constant current generator exactly in the manner I described just now."

"Why," stated Dick excitedly, "I can see that now! Also, there are two 25kΩ resistors in the collector circuits of those differential amplifier transistors. Together," he ended disconsolately as his elation faded, "with a whole conglomeration of other transistors."

"Well," said Smithy, "if you look closely you'll see that two of those transistors form a Darlington pair which couples the collector of the second differential amplifier transistor to the voltage shifter and output driver circuit. You can see the same pattern of transistors and resistors in the collector circuit of the *first* differential amplifier transistor. These two sets of transistors keep the differential amplifier collector circuits balanced out and symmetrical, and they stabilize the differential amplifier against changes in temperature and supply voltage. The three transistors which follow the Darlington pair couple through to the two output transistors. These have their bases connected together and act as output emitter followers in much the same way as two emitter follower output transistors in an a.f. amplifier. The transistors which precede them ensure that the output voltage is at earth potential when the inverting and non-inverting inputs are at the same potential. Or, rather, when the inverting and non-inverting inputs are at potentials which are within the offset voltage range."

"Those two output transistor bases," said Dick critically, "are connected together directly. In an audio output stage, though, you'd have a diode or a resistor or something like that between the two bases to keep the transistors turned partly on in the absence of signal. Won't you get crossover distortion with the output circuit you've got here?"

"You will," agreed Smithy. "However, the op-amp will normally be used with a high level of negative feedback and this will effectively reduce the distortion to a very low level."

"There's another thing I've just spotted," said Dick thoughtfully. "The base and collector of the first transistor in the Darlington pair are taken out to two pins marked 'Internal Frequency Compensation'. Also, there's another pin marked 'Output Frequency Compensation'. What's all this compensation business, Smithy?"

"The word 'compensation'," grinned Smithy, "is a euphemistic term for a process which ensures that the i.c. doesn't take off at a high frequency!

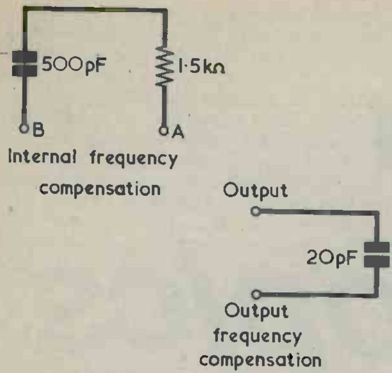


Fig. 5. External frequency compensating circuits are connected to the appropriate op-amp pins as illustrated here. The capacitor values shown are representative

There's stacks of gain on the i.c. chip and if you just connected a supply up to it and did nothing else it would simply burst into high frequency oscillation. To prevent this, external capacitance is coupled to the frequency compensation points to hold down the high frequency response. Like this."

Smithy added external frequency compensating components to the circuit of the operational amplifier. (Fig. 5.)

"As you can see," he went on, "one of the frequency compensating external circuits consist of a series resistor and capacitor coupling the collector of the first Darlington pair transistor back to its base. Such a circuit obviously introduces high frequency attenuation at this point in the amplifier chain. The output compensation is provided by a single capacitor which couples from the output transistor emitters to the base of the transistor which drives them. Again, you have quite obvious high frequency attenuation."

"I wonder why they call them 'compensation' circuits."

"Well," said Smithy, "the word 'compensation' is frequently used when you have a component which alters frequency response in a circuit. For instance, TV video peaking chokes are also referred to as 'compensating chokes'."

Pleased with his excursion into the field of etymology, Smithy picked up the remainder of his pork pie and took a further massive bite. A thin stream of mustard shot out and splattered over the circuit of the 709. Dick turned round and, unbelievingly, looked at the Serviceman. A competent cosmetician would have unhesitatingly declared that, whilst the layer of yellow on Smithy's lips might well be quite striking, it was otherwise *most* unbecoming.

"Look," said Dick flatly. "I'll go out now and I'll come back in again in two minutes' time. By then you should have consumed the very last piece of that revolting pork pie of yours."

"You needn't bother," replied Smithy airily, albeit indistinctly. "The final bit is going in right now."

Shuddering, Dick waited whilst Smithy masticated his way through the ultimate remnants of pie. The Serviceman then drew out a large handkerchief and, with a flourish, wiped his lips.

"Thank goodness for that," said Dick in a relieved tone, "now let's get on with a bit more gen about this 709. What about the pin connections, for instance?"

"You can see them in this data book," said Smithy. "Here you are."

He pointed to three pin layout diagrams on the page in front of them. (Fig. 6.)

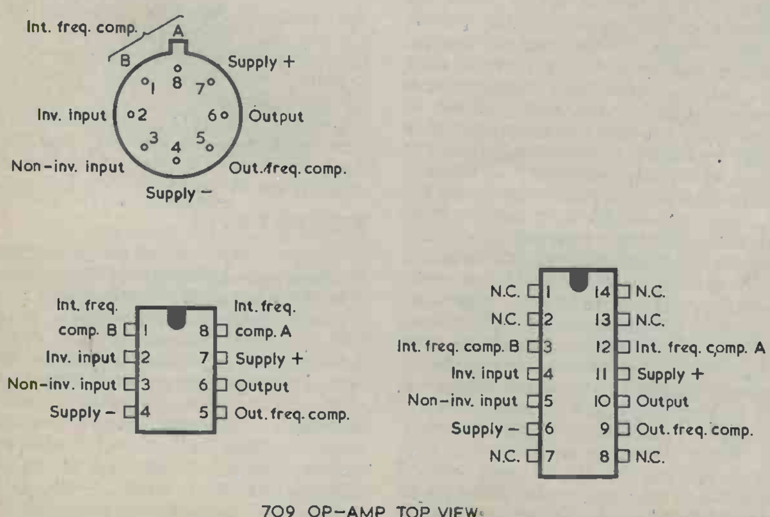


Fig. 6. Pin connections for the 709 in its three most common packages

"There are three generally available versions of the 709," he went on. "One is in the round TO99 can, which is about the same size as a TO5 can, and the other two are in 8 pin dual-in-line and 14 pin dual-in-line. You'll note that the round can and 8 pin dual-in-line packages both have the same lead-out numbering. The 14 pin d.i.l. package is really the same as the 8 pin d.i.l. package with four 'no connection' pins added at one end and two 'no connection' pins added at the other. The letters d.i.l. are, of course, short for 'dual-in-line'. Sometimes, you'll see the abbreviation d.i.p. instead."

"What does that mean?"

"It means dual-in-line together with with fact that the chip is in a plastic encapsulation."

AFTERS

"Fair enough," remarked Dick. "What about performance figures?"

"You can," said Smithy, "get the more important ones from this data book."

Smithy pointed out the principal parameters for the 709 i.c. to his assistant. Dick studied these carefully.

709 – Principal Parameters

Supply voltage (VS+ and VS—)	18V max.
Supply current (VS=15V)	2.6mA typical
Input voltage range, either input	±10V
Minimum output load	200Ω
Input offset voltage	2mV typical
Maximum p-p output swing	28V typical
Large signal voltage gain	45,000 typical
Input resistance	250kΩ typical
Total dissipation (below 70°C ambient)	300mW max.

"Blimey," he remarked, "the typical voltage gain is no less than 45,000 times."

"True," agreed Smithy. "That's before you add the negative feedback, of course."

"You were saying," went on Dick, "that the 741 op-amp is an improvement on the 709. How about giving me the low-down on the 741?"

"I'm afraid," said Smithy regretfully, "that we've come to an end so far as this particular gen-session is concerned. I'll deal with the 741 when we have our next technical natter, and I'll also show you how you can use op-amps in simple circuits which do not require separate positive and negative supply rails."

Whereupon Smithy, having brought the discussion to an end, reached to the back of his bench and produced a McVitie's Bramley Apple Pie for further sustenance. And what, dear reader, can be more fitting than applie pie to terminate an interlude which takes in pork pie for bodily nourishment and the 709 op-amp for mental stimulation? ■

Radio Topics

By Recorder

'We wouldn't half be in trouble if all the electrons went on strike.'

So spoke a junior member of the Recorder family this last winter as we sat in front of a nice warm electric fire watching a TV programme relayed by satellite from America. He was right, too.

NO ELECTRONS

Just imagine what would happen if, for some reason, electrons decided that they would no longer travel through conductors in the obliging manner that they do at the present time. We would at once be returned to the days before electricity when the only source of mobile power was steam and human effort. There would be no radio, no television, no telephone, no electric light or heat, no cars and no services where electricity plays any part in their functioning. Admittedly, our forebears coped quite happily with a world of this type, but that was mainly because they had nothing better to compare it with. Also, there were a lot less of them then than there are of us now, and the human way of life had not in those days assumed the crowded, complicated and interdependent state at which it has currently arrived. If we were unexpectedly robbed of electricity virtually all our mass-production food plants would come shuddering to a halt, and it would not be long before our civilization, precarious enough as it is, just finally gave up all pretence of adequacy and slowly crumbled away.

None of us have ever seen any electrons but we all take it for granted that they exist and that, when set in motion, they do all sorts of useful things such as producing heat and creating magnetic fields. Could it be that electrons actually do not exist? Could it be that it is only our *faith* in electrons that enables us to do tricks with conductors and insulators which are only an order or so of complexity ahead of the remote bending of forks? Suppose a TV cameraman suddenly asked himself why on earth he was pointing a metal box with a pattern of knobs on the outside towards an artiste; suppose he decided to himself that the processes carried out by the camera were so improbable that they just could not happen; suppose he considered that it was entirely unfeasible that a jumble of invisible electrons could flow in planned directions and, as a result, send as evanescent a thing as a picture down a length of wire. Would his lack of credence cause the signal from his camera to gradually fade away to nothing? And if this refusal to accept the presence of the unperceivable electron were to spread to other members of the studio crew could not. . .

Hallo, my desk lamp has just started flickering.

Okay, Electron, I take it all back. I believe! You exist, you are, and you flow for ever on your preordained quest towards the everlasting Positive.

FIGURE FACTS

Quite a few fortuitous things happen in electronics and general physics, and a striking example of this is the fact that the velocity of light happens to be 299,776,000 metres per second. If we take this to 3 significant figures we can, then work, for general applications, to the very convenient figure of 300 million metres per second as the velocity of light and, of course, of radio waves. Some reference books quote slightly different figures for light velocity incidentally, so please don't write in and say I've got it wrong. For instance, Langford-Smith's 'Radio Designer's Hanbook' Fourth Edition (Iliffe) gives the velocity as 299,790,000 metres per second. I took the figure I mentioned from 'A Dictionary of Electronics' by S. Handel, published as a Penguin paperback.

Since radio wavelength in metres multiplied by frequency in Hz can be considered to come to 300 million, we can say that 3MHz corresponds to a wavelength of 100 metres, 30MHz to 10 metres, 300MHz to 1 metre, and so on. When, in the earlier days of radio, the frequency ranges were being sorted out, it was decided to work in terms of wavelengths to powers of 10. In consequence, the range below 30kHz (or 10,000 metres) was designated very low frequency (v.l.f.), 30 to 300kHz as low frequency (l.f.), 300 to 3,000kHz as medium frequency (m.f.), 3MHz to 30MHz as high frequency (h.f.) and 30MHz to 300MHz as very high frequency (v.h.f.). They had to dig in the dictionary as higher frequencies became usable, whereupon 300 to 3,000MHz appears as ultra high frequency (u.h.f.) and, wait for it, 3,000 to 30,000MHz comes up as super high frequency (s.h.f.). Then, when a 30,000 to 300,000MHz range had to be considered viable this was called, rather lamely, *extremely* high frequency (e.h.f.).

In the U.K. some far-sighted genius of the past chose 200kHz, or 1,500 metres, for the B.B.C. long wave station which is now Radio 2. The 200kHz signal is picked up by a number of companies making electronic equipment, and its carrier is employed as a frequency standard having a very convenient round number value.

The line output stages of many television receivers radiate a fairly strong signal at line frequency and its harmonics, with the result that if you hold a portable radio tuned to Radio 2 on 200kHz close to a working TV set you can get a background beat whistle whose volume depends on the level of the line frequency harmonic radiated by the televsion set and the strength of the Radio 2 signal in the locality. This pick-up, by the way, is normally much higher with very old radios having a wire aerial than it is with sets having a ferrite rod aerial, possibly because the wire aerial offers a higher capacitive coupling to the radiating TV set.

BEAT FREQUENCIES

Nominal line frequency on a 405 line set which is locked to a signal is 10,125Hz, and its 20th harmonic pops up at 202.5kHz. This gives a 2.5kHz beat note with the 200kHz Radio 2 signal. Locked line frequency on 625 lines is 15,625Hz (easy to remember because the last three digits are, fortuitously again, 625), and its 13th harmonic is 203,125Hz. The beat note given with the Radio 2 signal is therefore 3.125kHz. So you have spot frequencies of 2.5 and 3.125kHz available, albeit in a roundabout manner, if you're experimenting with an audio oscillator and want some comparison tones to determine what its output frequency is.

In practice, the beat note frequency with 405 lines is of an approximate nature only, since the 405 line signal is normally locked to the U.K. electricty Grid, and could fall a little if the Grid frequency drops during heavy consumption periods. The 625 line signal is much better, and line frequency is held, at the transmitter, to ±0.15Hz. Multiplied by 13, this gives ±1.95Hz only as the tolerance on the 3.125kHz beat note.

Piano notes offer useful comparisons when one is trying to determine audio frequencies. If you've had the piano tuner in recently, the C two octaves above Middle C should give 1,046Hz, and the B immediately below it 988Hz. A popular audio frequency for signal generator modulation is 400Hz and, here, the G above Middle C gives 392Hz. As with the velocity of light, some text books may give slightly different frequency figures for these notes. Whilst talking about finding audio frequency standards, I am indebted to G. W. Short for the information that if a pre-decimal penny is balanced on the little finger it will ring at about 1kHz when tapped with a screwdriver. (This fact appeared in G. W. Short's article 'LCR Tone Control Circuit' which was published in our May 1971 issue.) Many houses have pre-decimal pennies lurking away somewhere, probably in the box where the buttons are kept.

Turning to dimensional figures, it is possible to use enamelled copper wire if you want to feel out spacings in tens of thousandths of an inch. 34 s.w.g. enamelled wire is approximately 10 'thou' thick, 26 s.w.g. enamelled wire is approximately 20 'thou' thick and 22 s.w.g. enamelled wire is approximately 30 'thou' thick. The actual thicknesses within tolerances of these wires are, respectively, 0.0099 to 0.0104in., 0.0193 to 0.0199in. and 0.0296 to 0.0303in. The enamel on the wire should be normal oil-based, and this is the type usually sold by home-constructor retailers.

Before concluding on the subject of figures, here is a final little item of interest. If a capacitor charges up to a voltage via a resistor, it reaches 63% of the voltage after the time constant period has elapsed. Similarly, if a charged capacitor discharges into a resistor the voltage across its plates falls to 37% of its initial voltage after the time constant period has transpired. The time constant in seconds is the product of the resistance and capacitance in ohms and farads or, more conveniently, in megohms and microfarads. What is perhaps of greater interest is that a capacitor charges to half the applied voltage after 0.7 times the time constant, and that it similarly *discharges* to half the initial voltage after 0.7 times the time constant. This can be a useful thing to remember if you are designing any unusual timing devices. ■

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2N909	NS	TO18	LO1	60V	30V	5V	200MA	175C	500MWF	50M	25P	110MN	50MA	AMG	SGI	BSX 33	2N731	0

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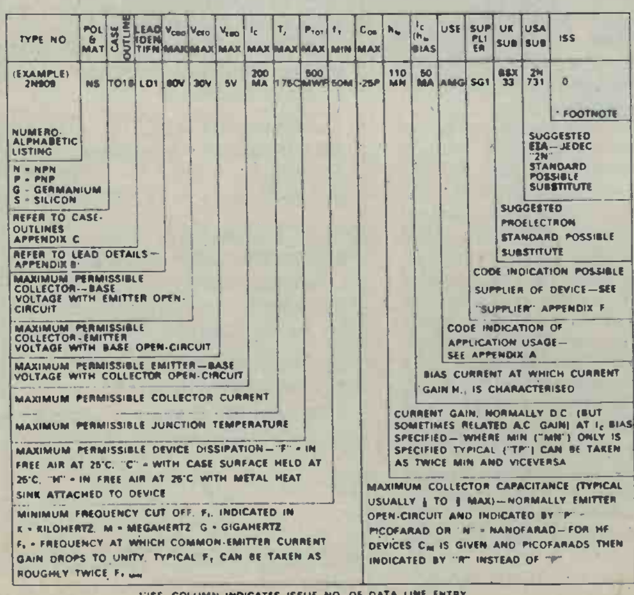

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6BW6	.94	30FL2	.78	ECC85	.47	GZ34	.70	PY83	.45	BC113	.33
6BW7	.82	30FL14	.82	ECC88	.52	HVR2A		PY88	.47	BC118	.29
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6C9	1.17	30P19	.88	ECF82	.53	KTW62		QQV03/10		BF163	.26
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6H6GT	.29	50L6GT	.76	ECL80	.47	PC97	.41	UAF42	.70	OC25	.49
6J5GT	.53	85A2	.70	ECL82	.40	PC900	.47	UBC41	.70	OC44	.13
6J6	.35	807	1.17	ECL83	.82	PCC84	.35	UBC81	.53	OC45	.14
6K7G	.35	5763	1.76	ECL86	.47	PCC85	.52	UBF80	.47	OC46	.20
6K8G	.53	ATP4	.59	EF22	1.76	PCC88	.70	UBF89	.47	OC70	.16
6L6GT	.68	AZ31	.70	EF40	.88	PCC89	.53	UC92	.53	OC71	.14
6Q7G	.59	DAF91	.35	EF41	.82	PCC189	.56	UCC84	.88	OC72	.14
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(Continued from page 699)

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(Continued on page 701)

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(Continued from page 700)

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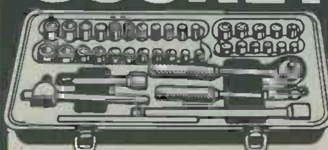

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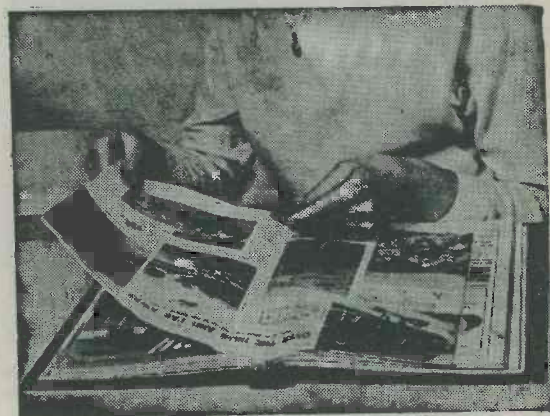

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0.75	7.5	5.0	3.4	2.8	1.9	1.5	1.1	0.91	0.75
1	10	6.7	4.5	3.7	2.6	2.1	1.5	1.2	1
1.5	15	10	6.8	5.6	3.8	3.2	2.2	1.8	1.5
2	20	13	9.1	7.4	5.1	4.3	2.9	2.5	2
3	30	20	14	11	7.7	6.4	4.4	3.7	3
4	40	27	18	15	10	8.5	5.9	4.9	4
5	50	33	23	19	13	11	7.4	6.1	5
6	60	40	27	22	15	13	8.8	7.3	6
7	70	47	32	26	18	15	10	8.5	7
8	80	53	36	30	21	17	12	9.8	8
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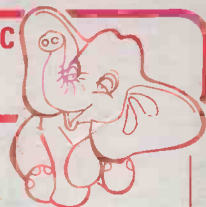

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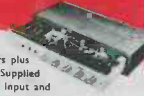
TEXAN 20 — 20 WATT IC STEREO AMPLIFIER



Features glass fibre PC Board. Gardners low field transformer, 6-IC's, 10-transistors plus diodes, etc. Designed by Texas Instruments engineers for Henry's and P.W. 1972. Supplied with full chassis work, detailed construction handbook and all necessary parts. Full input and control facilities. Stabilised supply. Overall size 15½" × 2¾" × 6¾" mains operated. Free teak sleeve with every kit. **£31.00 (carriage 50p)** (also built and tested £37·50)

HENELEC STEREO FM TUNER

Features capacity diode tuning, lead and tuning meter indicators, stabilised power supply—mains operated High performance and sensitivity with unique station indication IC stereo decoder Overall size in teak sleeve 8" × 2½" × 6¾". Complete kit with teak sleeve. **£21.00 (Carriage 50p)** (also built and tested £24·95)

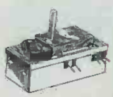
JOIN THE LARGE BAND OF HAPPY CONSTRUCTORS!

NEW SPECIAL PURCHASE AM/FM TUNER MODULES

Mullard type LP 1179 and LP 1171

These two modules together form a high quality AM/FM tuner covering the long, medium and VHF broadcast bands. Requires only 16 resistors and capacitors and a switch to complete.
Supplied with circuits and spec. data.

LP1179
FM Coverage 87·108MHz
Bandwidth 300 kHz
Selectivity 35 dB
Signal to noise at limiting threshold 40 dB
Audio ouput 75mV



LP1171
AM Bandwidth 6·5kHz
Sensitivity 1mV
Built-in AGC

Supply 6V negative earth
LP 1179 and LP 1171 £4 each or £7.50 pair.
suitable Ferrite aerial 75p

AMPLIFIERS WITH CONTROLS

E1210	12 volt 2½+2½ watts 8 ohms	8.25
SAC14	Mains 7+7 watts 8 ohms	11.75
SAC30	Mains 15+15 watts 8 ohms	14.95
CAO38	9 volt 1½+1½ watts 8 ohms	6.95
CAO68	12 volt 3+3 watts 8 ohms	10.50

MULLARD MODULES

LP 1157	AM/Type	£2.50
LP 1185	10.7 I.F. Unit	£5.50
LP 1186	10.7 F/M Tuner	£5.85
Gorler Perm. F/M Tuner		£4.20

FM AND AM TUNERS AND DECODERS

FM5231 (tu 2) 6 volt FM tuner	7.95
FM5231 (tu 3) 12 volt version	7.95
SD4912 Decoder for tu 3	7.95
SP621 6v stereo FM tuner	14.80
Sinclair FM tuner	11.95
Sinclair decoder for above	7.95
A1007 9v MW–AM tuner	4.80
A1018 cased FM tuner	13.95
A1005M (S) decoder for above	7.50
5475 12v. Stereo decoder general purpose kit	6.99

PREAMPLIFIERS

Sinclair Stereo 60 Preamplifier		6.75
E1300	Cart/Tape/Mic Inputs 9 volt	2.85
E1310	Stereo 3–30mV mag. cart. 9 volt	4.75
FF3	Stereo 3mV tape head 9 volt	4.95
3402	Stereo 5–20mV Mag. cart. mains	5.95
EQ25	Mono 3–250 mV Tape Cart Flay 9 volt	1.95

POWER SUPPLIES MAINS INPUT

(*chassis-rest cased)

470C 6/7½/9V 300 MA with ad'rs	2.25
P500 9 volt 500 MA	3.20
HC244R 3/6/7½/9v. 400 MA stabilised	5.50
*P11 24v, ½ amp 3.30	3.30
*P15 28V. ½ amp.	3.30
*P1080 12 V 1A 4.70	4.70
*P1081 45V 0.9A	7.80
P12 4½–12V 0.4–1 amp	7.15
SE101A 3/6/9/12V, 1 amp stabilised	12.75
P1076 3/4½/6/7½/9/12V ½ amp	4.20
SE800A 1–15 VOLT 0–½A stabilised	17.50

SINCLAIR MODULES AND KITS

ST80 stereo preamplifier	£11.95
Audio filter unit	£6.95
Z40 15 watt amplifier	£5.45
Z60 25 watt amplifier	£6.95
PZ5 power supplies for 1 or 2 Z40	£4.98
PZ6 power supplies (STA3) for 1 or 2 Z40	£7.98
PZ8 power supplies (STA3) for 1 or 2 Z60	£7.98
Transformer for PZ8	£4.00

EMI SPEAKERS

SPECIAL PURCHASE

13 in × 8 in chassis speakers
(Carr./packing 30p each or 50p pr.)
*150 TC 10 watts 8 ohms twin cone £2.20
450A Built-in tweeter 8 ohms £3.85
EW 15 watt 8 ohm with tweeter £6.25
350 20 watt 8, 15 ohm with tweeter £8.95 each
* Polished wood cabinet £4.80 carr., etc. 35p each or 50p pair.

UHF TV TUNERS

625 line receiver UHF transistorised tuners UK operation. Brand new. (Post/packing 25p each).
TYPE A variable tuning. Slow motion drive £3.00
TYPE B 4-button push-button (adjustable) £4.00
TYPE C variable tuning £2.50
TYPE D 6-button UHF/VHF £4.50

PA-DISCOTHEQUE LIGHTING EQUIPMENT

Without doubt U.K's best range of modular and complete equipment. Lighting, mixing, microphones, accessories, speakers, amplifiers, lenses, etc., etc.
FREE stock lists (Ref. No. 18) on request. CALL IN AND SEE FOR YOURSELF at HENRY'S DISCO CENTRE, 309 EDGWARE ROAD. TEL. 6963.

EP27 Low Cost Seven Segment Led. Digit Height ⅓ inch £1.35 pp 15p

L450 Rechargeable Battery 2v 400mA/HR 50p p.p. 15p.

Philips 12V Fluorescent Invertor for 8w fluorescent tube. Supplied with instr. and tube £3.50 p.p. 30p.

STC & ITT Miniature Relays

150R	6v	2 p.c.o.	BRAND NEW 65p p.p. 15p
180R	6/12v	2 p.c.o.	
185R	12v	2 p.c.o.	
1250R	12/55v	2 p.c.o.	
1700R	18/24v	2 p.c.o.	
1800R	24v	4 p.c.o.	
2500R	18/24v	2 p.c.o.	
4000R	24v	2 p.c.o.	

10.7 MHZ Miniature Ceramic IF FILTER 40p per pair p.p. 15p

SL414 Plessey 5w Power Amp IC £1.65 p.p. 15p

40KHZ Ultra Sonic Transducers £5.90 p.p. 25p
TAA 960 40KHZ AMP IC £1.75 p.p. 15p

TEST EQUIPMENT MULTIMETERS

Carr/packing 35p £ p

U4311 Laboratory meter	£52.00
U4312 20kΩ/V with case	£10.75
U4315 20kΩ/V with case	£10.00
U4317 20kΩ/V with case	£17.00
U4324 20kΩ/V with case	£9.85
U4313 20kΩ/V with steel case	£13.80
U4317 20Ω/V with case	£17.00
U4341 33kΩ/V plus transistor steel case	£11.00
U4323 20kΩ/V plus 1kHz OSC with case	8.00
ITI–2 20kΩ/V slim type	5.95
THL33D (L33DX) 2kΩ/V Robust	7.50
TP55N 20kΩ/V (Case £2)	10.75
TP10S 2kΩ/V	8.50
TW20S 20kΩ/V	13.00
TW50K 50kΩ/V	14.50
S100TR 100kΩ/V plus transistor tester	22.50

NEW REVOLUTIONARY SUPER TESTER 680R

680R Multi-tester	18.50
†TE40 AC Multivoltmeter	19.75
†TE15 Grid dip meter 440kHz–28mHz	19.50
†TE65 28 Range valve voltmeter	22.50
†TE20D RF Generator 120kHz–500mHz	18.95
†TE22D AF Generator 20Hz–200kHz	19.95
*HM350 in circuit transistor tester	19.50
*TT145 Compact transistor tester	14.75
* G3/36 R/C osc 20Hz–200kHz	£19.75
* CD342 SWR Meter	£5.75
* SE350A De luxe signal tracer	£12.95
* SE400 Mini-lab all in one tester	£15.50
C-15 Scope 500.000kHz (carr. £1)	£43.00
Radio activity counter 0–10r (carr £1)	£9.97
Mains unit for above (carr 50p)	£3.75

TAPE HEADS

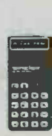
Marriot XRSP/17½ Track High	£2.50
Marriot XRSP/18½ Track Med.	£3.50
Marriot XRSP/36½ Track Med.	£5.00
Marriot XRSP/63½ Track High	£1.75
Marriot Erase Heads for XRSP 17/18/36 (XES11)	75p
Marriot BXIZE 343 ½ track erase	75p
R/RPI Record/Play ½ Track	45p
H/RP Single Track Rec/Play	35p
Bogen Type UL290 Erase	£1.50
Miniature Stereo Cassette Rec/Play	£2.25 p.p. 15p

EXCLUSIVE 5 WATT IC AMPLIFIERS

Special purchase 5 watt output 8–16 ohm load, 30 volt max. DC operation, complete with data. Price £1.50 each or 2 for £2.85. Printed Circuit Panels 50p.

CALCULATORS

8 DIGIT POCKET ELECTRONICS CALCULATORS SINCLAIR:



Cambridge Built	£11.00
Cambridge Kit	£9.00
Cambridge Memory Built	£17.50
Scientific Built	£16.00
Scientific Kit	£13.50

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NOMBREX TEST EQUIPMENT

MODEL 35 STABILISED POWER SUPPLY
A Short-circuit proof power supply delivery up to 30v at 1A. Built-in colts and ammeters. **£34.00**

MODEL 40 WIDE RANGE AUDIO SIGNAL GENERATOR
A high stability signal generator using the low distortion Wien bridge principle. **£34.00**

MODEL 41 RF SIGNAL GENERATOR
Covering 150kHz to 220MHz in eight ranges. Built-in AF mod. Output up to 50mV. **£38.00**

MODEL 42 WIDE RANGE RF SIGNAL GENERATOR
Covering 150kHz to 300MHz in eight ranges. Highest range in harmonic. **£24.50**

MODEL 43 RC BRIDGE
Null indicating bridge for resistors and capacitors. Resistance range 10R to 10M ±2% at Centre Scale. **£23.50**

MODEL 44 INDUCTANCE BRIDGE
Measures 1μH to 100H in four ranges 5% accuracy. Q measurement from 0.1–1,000 ±10%. **£34.00**

MODEL 45 DIRECT READING FREQUENCY METER
10Hz to 100kHz in four ranges. Input from 10mV to 5v £36.00

All models except Model 35 are internally powered from 9v battery (extra). Carriage and packing all models 37p.

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