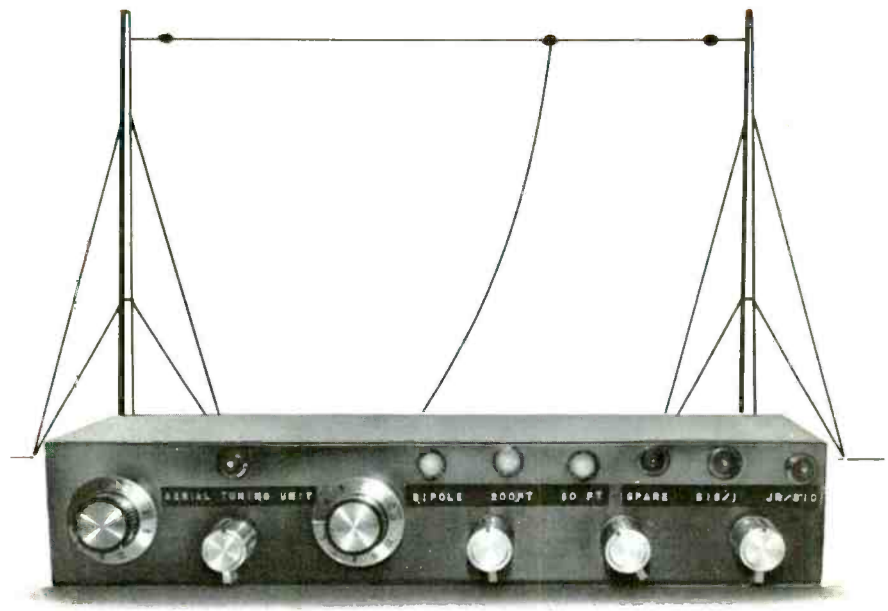
THE

RADIO CONSTRUCTOR

Vol. 24 No. 11 JUNE 1971 20p



AERIAL SWITCHING AND TUNING UNIT

Essential for efficient short wave reception

Special IN THIS ISSUE

LOGARITHMIC SPEECH COMPRESSOR

SEQUENTIAL ON-OFF SWITCH

	£/Np		£/Np		£/Np		£/Np
AC107	37	BSY29	25	NKT80214	75	2G302	19
AC126	25	BSY95A	15	NKT80215	75	2G371	15
AC127	25	BY100	20	NKT80216	75	2G374	25
AC128	20	BYX10	15			2N174	80
AC176	25	BYZ10	40	OA5	20	2N385A/	
AC187	30	BYZ12	30	OA10	25	2N388A	75
AC188	30	BYZ13	20	OA47	8	2N404	23
ACY17	29	BZY88 Series		OA70	8	2N696	15
ACY18	20	3.3V to 30V	15	OA73	8	2N697	17
ACY19	20			OA79	8	2N698	30
ACY20	19	D13T1	45	OA81	8	2N706	10
ACY21	19	MJE520	75	OA85	8	2N706A	12
ACY22	19	MJ480	97	OA90	8	2N708	16
ACY40	15	MJ481	1.25	OA91	8		
ACY41	15	MJ490	1.00	OA95	8	2N711	37
AD140	55	MJ491	1.35	OA200	10	2N711A	37
AD149	57	MPF102	43	OA202	10	2N911	50
AD161	37	MPF103	37	OC19	37	2N914	20
AD162	37	MPF104	37	OC20	97	2N918	42
AF114	25	MPF105	40	OC22	47	2N1090	30
AF115	25			OC23	60	2N1091	33
AF116	25	NKT124	30	OC24	60	2N1131	30
AF117	25	NKT125	40	OC25	37	2N1132	30
AF118	44	NKT126	37	OC26	33	2N1302	20
AF124	25	NKT128	25	OC28	60	2N1303	20
AF126	17	NKT135	26	OC29	75	2N1304	25
AF139	37	NKT137	32	OC35	50	2N1305	25
		NKT210	25	OC36	63	2N1306	30
AF186	40	NKT211	25	OC41	25	2N1307	30
AF239	37	NKT212	25	OC42	30	2N1308	34
ASY26	25	NKT213	25			2N1309	31
ASY27	30	NKT214	23	OC44	15	2N1507	23
ASY28	22	NKT215	21	OC45	15	2N1613	22
ASY29	30	NKT216	46	OC71	15	2N1711	25
ASZ21	37	NKT217	50	OC72	23	2N2147	82
AUY10	1.50	NKT218	25	OC75	23	2N2148	63
BA115	8	NKT219	25	OC76	25	2N2160	62
BC107	12	NKT223	27	OC77	40	2N2368	17
BC108	12	NKT224	25	OC81	23	2N2369	17
BC109	12	NKT225	21	OC81D	20		
BC147	15	NKT229	29	OC81Z	55	2N2369A	20
BC148	15	NKT237	31	OC82	25	2N2646	50
BC149	15	NKT238	19	OC82D	15	2N2904	44
BC158	17	NKT239	25	OC83	23	2N2904A	49
BC169C	19	NKT240	20	OC84	25	2N2905	65
BC182	12	NKT241	21	OC139	25	2N2905A	75
BC182L	10	NKT242	15	OC140	35	2N2906	44
BC183	9	NKT243	56	OC170	25	2N2906A	54
BC183L	9			OC171	30	2N2926, all	
BC184	15	NKT244	17	OC200	37	colours	10
BC184L	15	NKT245	17	OC201	47	2N3053	25
BC186	40	NKT261	21	OC202	63	2N3054	63
BC212	17	NKT262	19	OC203	37	2N3055	75
BC212L	12	NKT264	21	OC204	40	2N3702	11
BCY30	25	NKT271	18	OC205	65	2N3703	10
BCY31	48	NKT272	17	OC206	75	2N3704	11
BCY32	50	NKT274	18	OC207	75	2N3705	10
BCY33	20	NKT275	23	OCP71/M	47	2N3706	9
BCY34	25	NKT279A	12			2N3707	11
BCY38	30	NKT281	29	ORP12	50	2N3708	7
BCY70	19	NKT302	87	ORP60	60	2N3709	9
BCY71	37	NKT304	79	ORP61	40	2N3710	9
BCY72	16	NKT351	75	P346A	19	2N3711	9
BD121	1.10	NKT401	71	ST140	15	2N3819	35
BD123	1.10	NKT402	77	ST141	20	2N3820	60
BD124	1.03	NKT403	65	TD716	60	2N3826	30
BDY20	1.05	NKT404	67	TIP31A	62	2N4058	17
BF115	25	NKT405	79	TIP32A	74	2N4060	20
BF163	40	NKT406	62	V405A	46	2N4061	20
BF167	25	NKT420	1.83			2N4062	20
BF173	30	NKT451	58	ZTX108	11	2N4284	15
BF178	52	NKT452	54	ZTX300	13	2N4287	15
BF180	37	NKT453	50	ZTX302	18	2N4289	15
BF181	37	NKT603F	30	ZTX303	18	2N4871	40
BF184	25	NKT613F	30	ZTX304	27	2N5245	45
BF185	25	NKT674F	30	ZTX314	11	3N84	1.30
BF194	17	NKT676F	30	ZTX320	30	3N128	69
BF195	15			ZTX330	18	3N140	76
BF196	15	NKT677F	28	ZTX500	16	3N141	73
BF200	35	NKT713	29	ZTX501	16	3N152	86
BFX13	25	NKT717	44	ZTX502	20	40250	55
BFX29	31	NKT734	26	ZTX503	17	40309	33
		NKT736	32	ZTX504	40	40310	45
BFX84	26	NKT773	25	IN34A	20	40312	48
BFX85	34	NKT781	29	IN60	20	40320	36
BFX86	25	NKT10339	25	IN64	20	40360	43
BFX87	30	NKT10419	19	IN82A	47	40361	48
BFX88	25	NKT10439	27	IN87A	23	40362	58
BFY50	23	NKT10519	22	IN914	7	40406	56
BFX51	19	NKT20329/		IN4001	7	40407	39
BFY52	20	0013	31	IN4002	7	40408	51
BFY53	16	NKT80111	67	IN4003	10	40409	54
BFY90	67	NKT80112	83	IN4004	10	40468A	35
BSX19	16	NKT80113	1.00	IN4005	12	40600	58
BSX20	16	NKT80211	75	IN4006	15	40601	55
BSX21	37	NKT80212	75	IN4007	20	40602	40
BSY27	20	NKT80213	75	IN4148	7	40603	49

TERMS: Cash with order please. Postage & packing – 10Np Inland, 25Np Europe, 60Np elsewhere. All goods guaranteed. ALL ORDERS DESPATCHED WITHIN ONE WORKING DAY OF RECEIPT. 1971 Retail Catalogue now available. 5Np stamp for postage appreciated.

LST ELECTRONIC COMPONENTS LTD

MAIL ORDER DEPT. (RC)
7 COPTFOLD ROAD
BRENTWOOD, ESSEX Telex 99443

Callers welcome retail counter – same address

Components

RESISTORS
Carbon Film ¼ & ½ Watt 5%
2 Np each
Packs of 10 (of one value/wattage)
15 Np per pack.

PRESETS
P.C. Type 0.3 Watt
Standard size **7 Np**
Sub-miniature **5 Np**
(Available vertical or horizontal mounting).
Usual values 100 ohms to 5 Meg.

POTENTIOMETERS
Log or Lin Less switch – **17 Np**
Log or Lin DP switch – **27 Np**
Log or Lin Stereo L/S – **50 Np**
Values: 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1 Meg, 2 Meg.

CAPACITORS
Mullard Miniature Electrolytic

Mfd	Volt.Wkg – C426 Series	
2.5	16	**8 Np**
10	16	**6 Np**
20	16	**6 Np**
40	16	**6 Np**
80	16	**6 Np**
1.6	25	**8 Np**
6.4	25	**6 Np**
12.5	25	**6 Np**
25	25	**6 Np**
50	25	**6 Np**
80	25	**6 Np**
1	40	**8 Np**
4	40	**6 Np**
8	40	**6 Np**
16	40	**6 Np**
32	40	**6 Np**
50	40	**6 Np**

Mullard Metallised Polyester 250v

Mfd.		Mfd.	
.01	**3 Np**	.22	**5 Np**
.015	**3 Np**	.33	**7 Np**
.022	**3 Np**	.47	**8 Np**
.033	**3 Np**	.68	**11 Np**
.047	**4 Np**	1.0	**14 Np**
.068	**4 Np**	1.5	**20 Np**
.1	**4 Np**	2.2	**24 Np**
.15	**5 Np**		

Mullard Electrolytic – C437 Series

Mfd.	Volt.Wkg.	
250	16	**9 Np**
400	16	**12 Np**
640	16	**15 Np**
1000	16	**18 Np**
160	25	**9 Np**
250	25	**12 Np**
400	25	**15 Np**
640	25	**18 Np**
100	40	**9 Np**
160	40	**12 Np**
250	40	**15 Np**
400	40	**18 Np**

Mullard Sub-Miniature Ceramic Plate – C333 Series
63 volt working. Range 1.8pf to 220pf (usual pref. values)
Packs of 6 (any values) – **30 Np**

NEONS
Miniature neon bulbs: 0.6mA 65vac 90vdc Pack of 5 for **30 Np**
Panel neon indicators, mains voltage. Red lenses – round, square or arrow-shaped faces Each **20 Np**

VEROBOARD

2.5" × 17" × .15"	**57 Np**
2.5" × 5" × .15"	**23 Np**
2.5" × 3.75" × .15"	**19 Np**
3.75" × 17" × .15"	**79 Np**
3.75" × 5" × .15"	**30 Np**
3.75" × 3.75" × .15"	**22 Np**
2.5" × 5" × .1"	**25 Np**
2.5" × 3.75" × .1"	**23 Np**
Spot face cutters –	**45 Np**
Veropins: pack of 50 for	**21 Np**

Bargain Pack. 36 square inches of various sizes. .15" &/or .1" **50Np**

HEATSINKS
T0-5 (Clip-on) pack of 4 for **15 Np**
FINNED type for 2 × TO-3 ready drilled at **43 Np**
FINNED type undrilled for plastic power at **34 Np**

BOOKS
G.E. Transistor Manual **£1.47**
R.C.A. Transistor Manual **£1.40**
Designers' Guide to British Transistors (data book) **£1.25**
R.C.A. Hobby Circuits Manual **£1.40**
New edition now available. Many new circuits. Substitution chart supplied.
110 Semiconductor Projects **£1.25**
Zener Diode Handbook **84 Np**
Photo & Solarcell Handbook **84 Np**
Thyristor (S.C.R.) Handbook **£1.00**

NEW! SN74N SERIES TTL LOGIC

NOW FROM L.S.T. – FULL SPECIFICATION TEXAS INDUSTRIAL INTEGRATED CIRCUITS AT ECONOMY PRICES

		1–49	50–99	100+
SN7400N	Quad 2-input NAND gate			
SN7401N	Quad 2-input NAND gate open collector	32	27	22
SN7402N	Quad 2-input NOR gate			
SN7403N	Quad 2-input NAND gate open collector	35	30	25
SN7404N	Hex Inverter			
SN7410N	Triple 3-input NAND gate	32	27	22
SN7413N	Schmidt Trigger	45	40	35
SN7420N	Dual 4-input NAND gate			
SN7430N	8-input NAND gate	32	27	22
SN7440N	Dual 4-input NAND Buffer			
SN7442N	BCD to decimal decoder TTL output	£1.12	£1.00	88
SN7450N	Expandable Dual 2-wide 2-input AND–OR–INVERT gate			
SN7453N	Expandable 4-wide 2-input AND–OR–INVERT gate	32	27	22
SN7460N	Dual 4-input expander			
SN7470N	J–K Flip-flop	45	40	35
SN7472N	J–K Master-Slave Flip-flop			
SN7473N	Dual J–K Master-Slave Flip-flop	50	45	43
SN7474N	Dual D-type Edge-Triggered Flip-flop			
SN7475N	Quadruple Bistable Latch	65	60	55
SN7476N	Dual J–K Master Slave Flip-flop with Preset & Clear	55	50	47
SN7483N	Four-bit Binary Full-Adder	£1.30	£1.20	£1.10
SN7490N	Decade Counter			
SN7492N	Divide-by-12 Counter	£1.12	£1.00	87
SN7493N	Four-bit Binary Counter			
SN74141N	BCD to decimal Decoder/Driver (Replaces the obsolete SN7441AN)	£1.45	£1.30	£1.15

MIX PRICES. Devices may be mixed to qualify for quantity price
Larger quantities – prices on application

LINEAR AND DIGITAL I/C's

R.C.A.

CA3004	–	£1.80
CA3005	–	£1.20
CA3011	–	75
CA3013	–	£1.05
CA3014	–	£1.25
CA3018	–	85
CA3020	–	£1.30
CA3028A	–	75
CA3035	–	£1.25
CA3043	–	£1.40
CA3044	–	£1.20
CA3046	–	75
CA3047	–	£1.40
CA3048	–	£2.05
CA3049	–	£1.60
CA3052	–	£1.65

BARGAIN OP-AMPS!!

LM709C – **60 Np** (DIL high gain op-amp)
LM741CN **95 Np** (equiv SN72741P)

PC1006/1 Multimeter Sensitiser packaged circuit KIT includes all accessories **£7.55**

FAIRCHILD

	1–11	12–24	25+
μL900	**40 Np**	**35 Np**	**32 Np**
μL914	**40 Np**	**35 Np**	**32 Np**
μL923	**53 Np**	**50 Np**	**47 Np**

Devices may be mixed to qualify for quantity price

G.E. (USA)

PA230	Pre-amp	**£1.10**
PA234	1 Watt Amp	**£1.00**
PA237	2 Watt Amp	**£1.87**
PA246	5 Watt Amp	**£2.63**
PA424	Zero Volt Switch	**£2.45**

MISCELLANEOUS

TH9013P	Toshiba 20 Watt Hybrid IC Amp	**£4.47**
IC10	Sinclair	**£2.75**
SL403A	Plessey New Design	**£2.12**

MULLARD

TAA263	Linear Amp	**75 Np**
TAA293	General Purpose Amp	**£1.00**
TAA310	Record/Playback Amp	**£1.50**
TAA320	MOS LF Amp	**65 Np**
TAD100	IC Receiver	**£1.97**
TAD110	AM/FM Receiver	**£1.97**

ULTRASONIC TRANSDUCERS

Operate at 40kc/s. Can be used for remote control systems without cables or electronic links. Type 1404 transducers can transmit and receive. **FREE:** With each pair our complete transmitter and receiver circuit. **PRICE £5.90** Pair (Sold only in pairs)

NEW!! 'SONALERT'
SOLID STATE ALARM DEVICE
AS USED IN MANY AMERICAN ALARM CIRCUITS
70–80 dB of noise – Operates on 6–28v 3–14mA
£5.50 each

IOR

DD119	Heat sink compound – Silicone grease	**30 Np**
DD170	Bargain pack of five 1 Watt Zener diodes	**97 Np**
DD175	4 pieces 100 PRV Rectifiers 500mA	**50 Np**
DD176	2 pieces 200 PRV Rectifiers 500mA	**30 Np**
DD177	2 pieces 400 PRV Rectifiers 500mA	**50 Np**
DD180	Bargain Transistor pack 2 AF + RF	**57 Np**
DD184	Assortment of RF, audio & power transistor solar cell & diode	**£1.67**
DD190	Pack of 4 assorted solar cells	**50 Np**
EP50A	Solar motor (operates from S4M)	**£1.97**
S1M	Silicon Solar cell 10–16mA	**95 Np**
S4M	Silicon Solar cell 25–40mA	**£1.67**
B2M	Low cost Selenium solar cell	**63 Np**
B3M	Selenium cell in protective case	**75 Np**
CS120	Cadmium Sulphide photoconductive cell	**98 Np**

Only part of the International Rectifier 'Diamond Line' range are listed
Send for free catalogue or ask your local component stockist

TRIACS

2N5756	2.5A (RMS) 400 PIV TO-5 Mod	**95 Np**
40486	6 Amp (RMS) 400 PIV TO-5 Mod	**£1.20**
40430	6 Amp (RMS) 400 PIV TO-66	**£1.01**
40432	6 Amp (RMS @ 75 Amb) 400 PIV* TO-5 Mod.	**£1.50**
40512	2.2 Amp (RMS @ 25 Amb) 400 PIV*	**£1.45**
	*These types have integral triggering	
40576	15A (RMS) 400 PIV TO-66	**£1.70**
SC146B	10 Amp 200 PIV Plastic Flat-pack	**£1.25**
SC146D	10 Amp 400 PIV Plastic Flat-pack	**£1.75**
ST2	Bi-lateral avalanche trigger diode	**47 Np**

THYRISTORS

CR1/05IC	1 Amp 50 PIV TO-5	**40 Np**
CR1/40IC	1 Amp 400 PIV TO-5	**50 Np**
2N3525	5 Amp 400 PIV TO-66	**£1.09**
40739	10 Amp 400 PIV Stud Mtg	**£1.65**

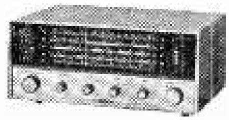
ENCAPSULATED BRIDGES

Type No	Current	Rms Volts	
W005	1 Amp	50	**50Np**
W06	1 Amp	600	**65Np**

Kit building is so easy

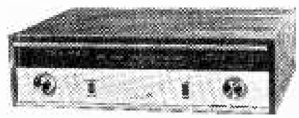
The unique HEATHKIT step-by-step method of construction defies error for the beginner as well as the experienced kit builder

Economy SW Receiver



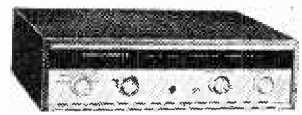
World wide reception.
1-30MHz plus 550-1620KHz
Kit K/GR-64 **£25.00** Carr. 50p

FM Stereo Tuner



Concert hall realism – Amazing low price. Kit K/AJ-14 **£27.00** (Cab. extra) Carr. 40p

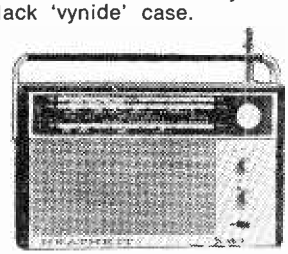
Stereo Amplifier



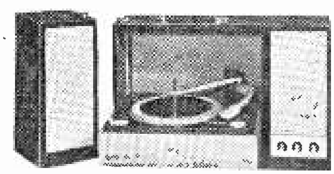
Heathkit unbeatable value – 20W total power output.
Kit K/AA-14 **£32.00** Carr. 30p (Cab. extra)

'Severn' AM/FM Radio

Beautiful looks – luxury sound
Black 'vynide' case.



Kit K/Severn **£19.90** Carr. 50p



Stereo Record Player

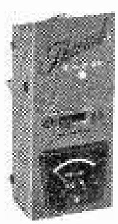
Exciting sound – budget price.
Kit K/SRP-1 **£32.50** Carr. 80p (Teak or Black/Rexine)

'Trent' Speaker

Compact size – lowest cost.
Kit K/Trent **£15.20** Carr. 60p (Teak or Walnut)

Deluxe Car Radio

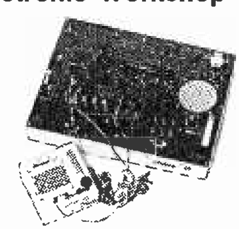
Heathkit value – powerful output. Two tone grey plus chrome trim. Kit K/CR-1 (less speaker) **£13.80** Carr. 30p



Thumb 'Tacho'

Measures RPM on any model engine at low cost.
Kit K/GD-69 **£9.50** Carr. 20p

Electronic Workshop



35 exciting experiments.
Kit K/JK-18 **£16.40** Carr 40p

Hundreds of HI-FI, Radio, Test & other models to choose from.

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The largest selection

NEW LOW PRICE TESTED S.C.R.'S.

PIV	1A TO-5	3A TO-66	7A TO-66	10A	16A TO-48	30A TO-48
	£p	£p	£p	£p	£p	£p
50	0.23	0.25	0.47	0.50	0.53	1.15
100	0.25	0.33	0.53	0.58	0.63	1.40
200	0.35	0.37	0.57	0.61	0.75	1.60
400	0.43	0.47	0.67	0.75	0.93	1.75
600	0.53	0.57	0.77	0.97	1.25	—
800	0.63	0.70	0.90	1.20	1.50	4.00

SILICON RECTIFIERS—TESTED

PIV	300mA	750mA	1A	1.5A	3A	10A	30A
	£p	£p	£p	£p	£p	£p	£p
50	0.04	0.05	0.05	0.07	0.14	0.21	0.47
100	0.04	0.06	0.05	0.13	0.16	0.23	0.75
200	0.05	0.09	0.06	0.14	0.20	0.24	1.00
400	0.06	0.13	0.07	0.20	0.27	0.37	1.25
600	0.07	0.16	0.10	0.23	0.34	0.45	1.85
800	0.10	0.17	0.13	0.25	0.37	0.55	2.00
1000	0.11	0.25	0.15	0.30	0.46	0.63	2.50
1200	—	0.33	—	0.33	0.57	0.75	—

TRIACS

VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
100	0.50	0.63	1.00
200	0.70	0.90	1.25
400	0.90	1.00	1.60

SILICON HIGH VOLTAGE RECTIFIERS

10-Amp 3-K.V. (3000 P.I.V.) Stud Type with Flying Leads, 80p each.

DIACS

FOR USE WITH TRIACS
BR100 .. .. 37p each

2A POTTED BRIDGE RECTIFIERS 200V 50p

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TIS43. BEN3000 27p each. 25-99 25p 100 UP 20p.

NPN SILICON PLANAR

BC107/8/9, 10p each; 50-99, 9p; 100 up, 8p each; 1,000 off, 7p each. Fully tested and coded TO-18 case.

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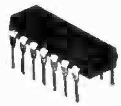

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UIC02 = 12 × 7402N	50p	UIC51 = 12 × 7451N	50p	UIC83 = 5 × 7483N	50p
UIC03 = 12 × 7403N	50p	UIC60 = 12 × 7460N	50p	UIC86 = 5 × 7486N	50p
UIC04 = 12 × 7404N	50p	UIC70 = 8 × 7470N	50p	UIC90 = 5 × 7490N	50p
UIC05 = 12 × 7495N	50p	UIC72 = 8 × 7472N	50p	UIC92 = 5 × 7492N	50p
UIC10 = 12 × 7410N	50p	UIC73 = 8 × 7473N	50p	UIC93 = 5 × 7493N	50p
UIC20 = 12 × 7420N	50p	UIC74 = 8 × 7474N	50p	UIC94 = 5 × 7494N	50p
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BP 702C—SL702C	TO-5	8	OP Amp Direct OP	63p	50p	45p
BP 702—72702	D.I.L.	14	G.P. OP Amp (Wide Band)	53p	45p	40p
BP 709—72709	D.I.L.	14	High OP Amp	5 p	45p	40p
BP 709P—µA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP 711—µA711	TO-5	10	Dual comparator	58p	50p	45p
BP 741—72741	D.I.L.	14	High Gain OP Amp (Protected)	75p	60p	50p
µA 703C—µA703C	TO-5	6	R.F.–I.F. Amp	43p	35p	27p
TAA 263—	TO-72	4	A.F. Amp	70p	60p	55p
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BP933	Dual 4-input expander	25p	23p	20p
BP935	Expandable Hex Inverter	25p	23p	20p
BP936	Hex Inverter	25p	23p	20p
BP944	Dual 4-input NAND expandable buffer without pull-up	25p	23p	20p
BP945	Master-slave JK or RS	35p	32p	29p
BP946	Quad, 2-input NAND	23p	20p	15p
BP948	Master-slave JK or RS	35p	32p	29p
BP951	Monostable	90p	85p	80p
BP962	Triple 3-input NAND	23p	20p	15p
BP9093	Dual Master-slave JK with separate clock	80p	75p	70p
BP9094	Dual Master-slave JK with separate clock	80p	75p	70p
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UIC935 = 12 × µA 935	50p	UIC9093 = 5 × µA 9093	50p
UIC936 = 12 × µA 936	50p	UIC9094 = 5 × µA 9094	50p
UIC944 = 12 × µA 944	50p	UIC9097 = 5 × µA 9097	50p
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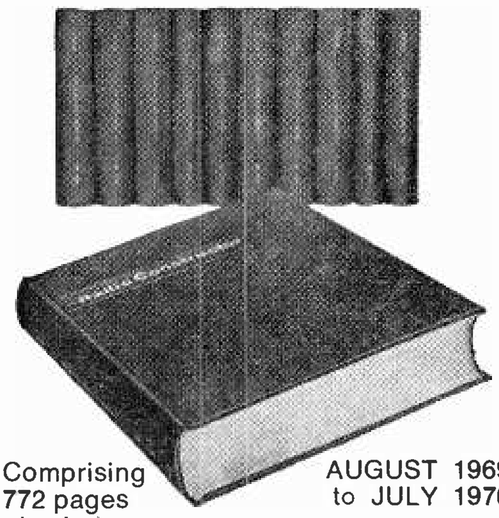

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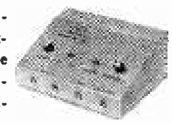

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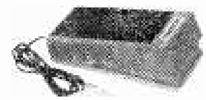

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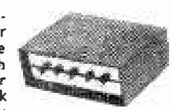

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THE Radio Constructor

Incorporating THE RADIO AMATEUR

JUNE 1971

Vol. 24 No. 11

Published Monthly (1st of Month)
First Published 1947

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141
Telegrams Databux, London

Annual Subscription: £2.70 (U.S.A. and Canada $6) including postage. Remittances should be made payable to "Data Publications Ltd." Overseas readers please pay by cheque or International Money Order.

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

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Production.—Letterpress.

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Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale London, W9 1SN.
The *Radio Constructor* is printed by Kent Paper Company Ltd, London and Ashford, Kent.

JULY ISSUE WILL BE PUBLISHED ON JULY 1st

THE 'SPONTAFLEX' S.A.5 M. & L.W. PORTABLE

by

SIR DOUGLAS HALL, K.C.M.G., M.A.(Oxon)

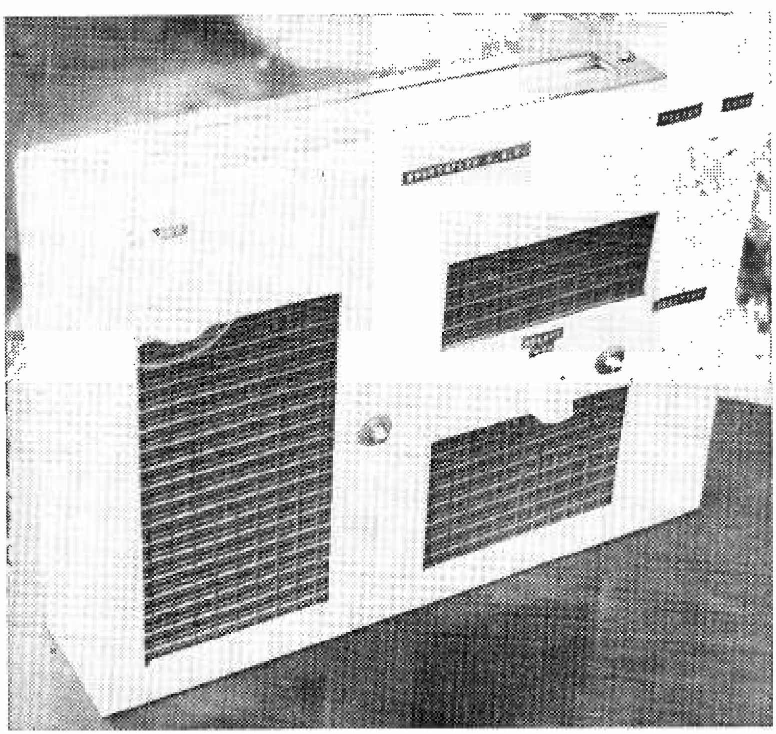
The author reintroduces his 'Spontaflex' Super Alpha tuner circuit in this medium and long wave receiver. The result is a set which, despite its single tuned circuit, offers an exceptionally high level of selectivity and sensitivity

THIS DESIGN INCORPORATES A modified 'Spontaflex' Super Alpha tuning head with a slightly altered 'Sliding Challenger' amplifier,* and the result is, in the author's opinion, the best medium-long wave portable receiver that he has yet published in this journal. Its ratio of selectivity to sensitivity is quite outstanding for a single tuned circuit receiver. A large number of stations can be received on the medium wave band with the panel mounted reaction control preset and left alone throughout the band, and output is ample for portable use. Sensitivity is equally high on the long wave band, but tuning range is restricted here, and this band should be looked upon as being for reception of Radio 2 only.

* The 'Spontaflex' Super Alpha principle was introduced in 'The "Spontaflex" S.A.4 Transistor Portable', published in the May 1968 issue. 'The "Sliding Challenger", published in the August 1970 issue, dealt with the a.f. amplifier circuit of that name.

CIRCUIT OPERATION

The circuit is shown in Fig. 1. The working of the 'Spontaflex' Super Alpha circuit was fully described in the issue for May 1968, and the 'Sliding Challenger' amplifier was similarly explained in the August 1970 issue.



The completely assembled receiver in its case

Pick-up on the medium wave band is given by L1. This is a variable inductance ferrite rod assembly in which tuning is effected by causing a 6in. ferrite rod to move into or out of the coil. A high inductance to capacitance ratio is necessary for the efficient working of this circuit, and capacitance is restricted to about 40pF from VC1 and strays. On the long wave band an extra inductance, L3, on a 4in. ferrite rod, is introduced, together with an extra shunt capacitor, C5. This capacitor should cause Radio 2 to be tuned in with the 6in. rod almost fully in L1 for best results; 82pF will probably prove right, but if Radio 2 cannot be found a slightly larger capacitance, say 100pF, may be used. Alternatively a 140pF trimmer may be used for C5. Do not be worried about the long leads that connect to L3 in the practical version of the circuit. What is important here is that L3 must be kept well away from other components, and that the metal frame of the adjacent speaker should be connected to the negative supply line.

An additional feature on the long wave band is that C6 roughly tunes the intermediate r.f. load to 1,500 metres. Tuning of this particular circuit is very broad, as it is at fairly low impedance, but some benefit does, nevertheless, result.

At radio frequencies TR1 and TR2 act as a super alpha, or Darlington pair, which means that the input to TR1 is at very high impedance. After considerable current amplification (several thousand times) by TR1 and TR2 the signal is rectified by D1 and then amplified again by TR2 as a common base amplifier, and by TR1 as a common collector amplifier. The signal then passes to the audio frequency volume control, VR2. Base bias for TR1 is taken from TR1 via R5 and R1, and TR2 obtains its bias from the emitter of TR1 through R4. Regeneration is applied by L2 and controlled by VR1. This reaction circuit has been modified from earlier designs in that when VR1 is turned back, some damping of the intermediate load takes place and radio frequency amplification is reduced. The damping effect is limited by R2 to prevent instability which takes place, otherwise, with VR1 at or very near zero, when TR2 approaches operation as a common emitter amplifier. VR3 is also necessary to prevent instability. If this is set too close to zero resistance there may well be spurious oscillation. When correctly set, as described later, it results in the oscillation position for VR1 remaining remarkably

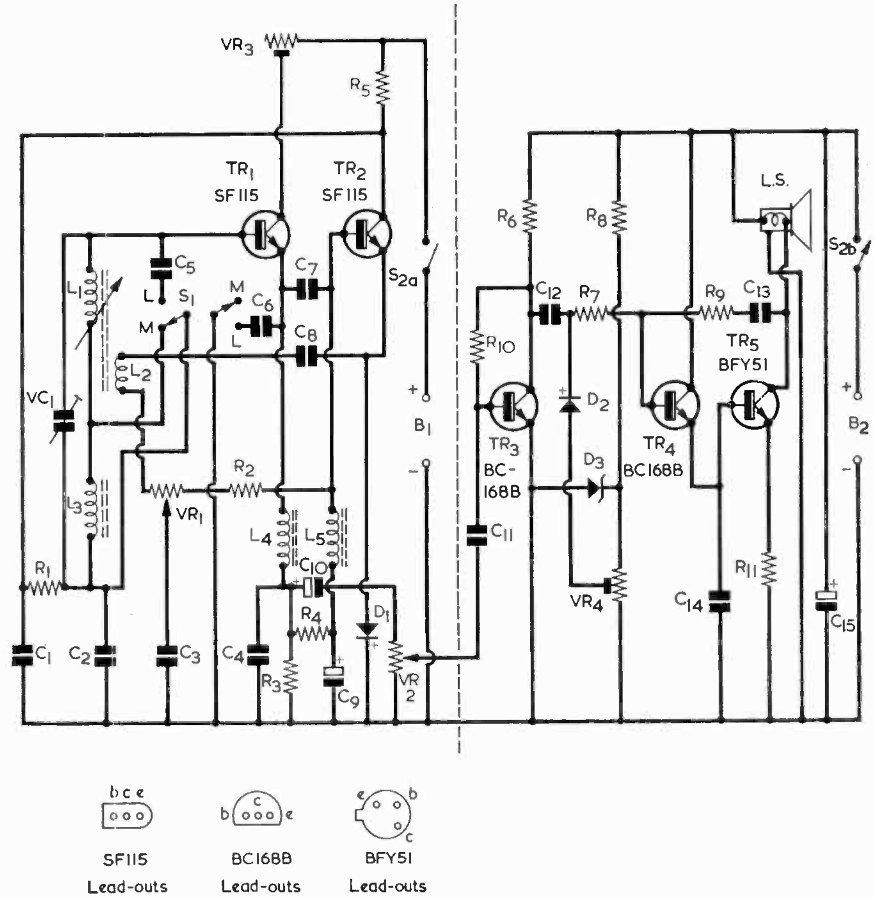


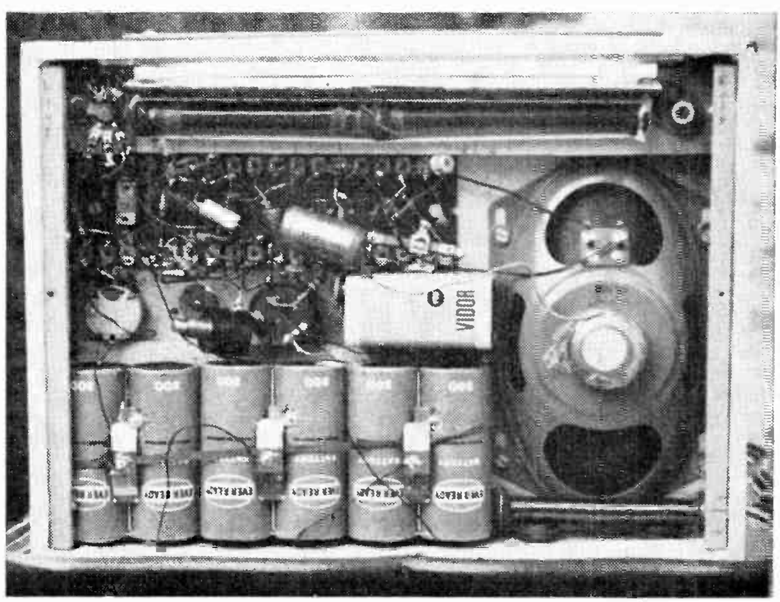
Fig. 1. Circuit diagram of the medium and long wave portable. The a.f. amplifier section is to the right of the broken line

constant throughout the whole of the medium wave band.

There is a small but useful degree of a.g.c. within the circuit. A strong signal reduces the impedance of D1 and consequently the input impedance of TR1. Because of this effect, it will be found that reaction can be advanced much further than normal with a strong signal. For maximum a.g.c. (only applicable with fairly strong signals). VR2 should be backed down to allow critical reaction to be applied, without overloading, while the signal is at a low level due to fading. Then, as signal strength increases, reaction will become less effective due to damping by the lowered input impedance of TR1, and there will be a tendency for the signal to remain steady.

The current drawn from its battery by the tuner section is about 750μA.

The signal next enters the amplifier section to the right of the dashed line. TR3 is a straightforward common emitter amplifier feeding its output to TR4, a common collector device directly coupled



A look inside the receiver with the back cover removed to the common emitter output transistor, TR5. VR4 is adjusted so that, with no signal present, TR4 is nearly cut off, whereupon TR5 only passes a small current since it is dependent for its base current on the collector current of TR4. The zener diode, D3, helps to hold the voltage at the base of TR4 constant as the battery voltage drops. With the arrival of a signal, D2 conducts and applies a positive voltage to the base of TR4 which then draws more current. TR5 also draws more current due to the increased bias current, and the amplifier is able to accomodate the signal. The direct voltages at the bases of TR4 and TR5 are always slightly greater than the signal voltage, and overloading is avoided. A small amount of negative feedback of the signal takes place due to R9 and C13, the presence of C13 ensuring that d.c. conditions are not affected. R11 limits the current that can be passed by TR5, and maximum output is obtained when half the battery voltage is dropped across the speaker and R11. Under this condition TR5 will be drawing about 120mA, but only momentarily, at peaks. The average current at maximum output (about 250mW) is much lower. C14 bypasses any r.f. signals which might otherwise appear in the output stage, where they could give rise to erratic reaction control or oscillation.

COMPONENTS

Some of the components are in the 'mechanical' category, these appearing in the assembly which causes the ferrite rod to be moved into and out of coil L1. The control spindle used here is a Radiospares spindle extender (Home Radio Cat. No. DL52B). As this spindle extender is rotated, a length of nylon cord is wound around its large diameter section, thereby

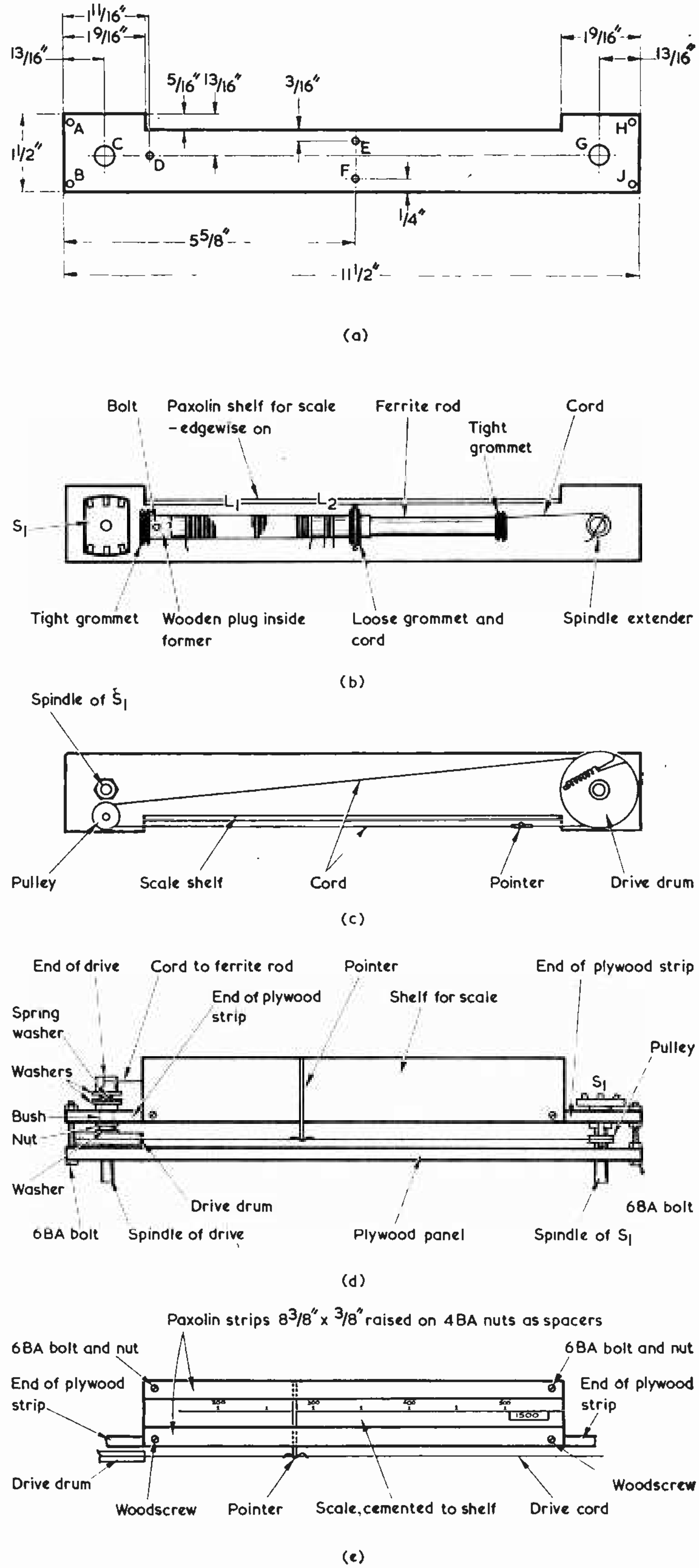


Fig. 2(a). The plywood strip on which the aerial tuner components are assembled

(b). The ferrite rod and aerial coil. For clarity, the rubber band which maintains tension on the ferrite rod is omitted here. The Paxolin shelf projects towards the reader

(c). Showing how the tuning scale pointer is laced up

(d). Details of the friction washers on the tuning drive spindle

(e). Final appearance of the tuning scale

drawing the ferrite rod along the inside of the coil against the tension offered by a rubber band or elastic cord. Friction is applied to the spindle extender by an arrangement of plain washers and a compression spring washer, these maintaining it sufficiently tight to ensure that it cannot be rotated out of position by the pull of the rubber band. Also mounted on the spindle extender is a 1½in. drive drum with spring, this actuating a tuning scale pointer.

The loudspeaker is a Radiospares component which has to be obtained via a retailer. It may be purchased by mail order from 'Radioparts', Market Way, Plymouth. All the transistors, and diode D2, were obtained from Amatronix, Ltd. If difficulty is experienced in obtaining the zener diode specified for D3 a suitable alternative is the type ZF3 from Henry's Radio, Ltd. The ZF3 is a 3V 5% 400mW diode.

CONSTRUCTING THE AERIAL TUNER

The first section of the receiver to make up is the ferrite rod aerial tuning assembly and it is necessary to obtain all the parts required here before starting. Diagrams to which reference is made are Figs. 2, 3 and 6.

When materials have been collected, cut and drill a piece of ¼in. plywood as shown in Fig. 2(a). Holes A, B, H and J should be as near the corners as practicable, and of a size to take 6BA bolts. Holes D, E and F should be of similar size. C and G should be ⅜in. in diameter. Next cut out a piece of ¼in. plywood as in Fig. 3. Lay the plywood strip (Fig. 2(a)) on the top of the plywood panel and mark out holes A, B, H, J, C and G on the panel, through the holes in the strip. Drill these holes through the panel. Also drill holes K, M, L, N, P, Q, R and S, as shown, K and L being ⅜in. in diameter, M and N ¼in. in diameter and P, Q, R and S 7/16in. in diameter. Turn the panel (Fig. 3) over, and lay it on the hardboard panel (Fig. 6(a)) leaving a ⅛in. border round the edge of the hardboard panel. Mark holes G, C, N, M, L, and K on the hardboard panel through the holes in the plywood panel. Drill the holes in the hardboard panel, L and K being ½in., G and C ⅜in., and M and N ¼in. Cut out the three rectangular apertures in the harboard panel, as shown in Fig. 6(a)) and put it on one side.

Take the plywood panel again and pass four 1¼in. long 6BA bolts, with countersunk heads, through holes A, B, H and J so that the heads are underneath when the panel is lying as shown in Fig. 3,

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	100kΩ
R2	470Ω
R3	1kΩ
R4	10kΩ
R5	100kΩ
R6	10kΩ
R7	100kΩ
R8	2.7kΩ
R9	1MΩ
R10	3.3MΩ
R11	4.7Ω
VR1	5kΩ potentiometer, linear
VR2	5kΩ potentiometer, log, with switch S2
VR3	1kΩ or 1.5kΩ potentiometer, preset
VR4	5kΩ potentiometer, preset slider

Capacitors

C1	560pF, silver-mica
C2	560pF, silver-mica
C3	4,700pF, paper or plastic foil
C4	0.1μF, paper or plastic foil
C5	82pF, silver-mica (see text)
C6	330pF, silver-mica
C7	2,200pF, paper or plastic foil
C8	0.01μF, paper or plastic foil
C9	25μF electrolytic, 2.5V wkg.
C10	4μF electrolytic, 2.5V wkg.
C11	0.1μF, paper or plastic foil
C12	0.1μF, paper or plastic foil
C13	0.01μF, paper or plastic foil
C14	0.1μF, paper or plastic foil
C15	640μF electrolytic, 10V wkg.
VC1	100pF or 140pF trimmer.

Inductors
L1, L2, L3 (see text)

L4	2.5mH choke type CH1 (Repanco)
L5	2.5mH choke type CH1 (Repanco)

Semiconductors

TR1	SF115
TR2	SF115
TR3	BC168B
TR4	BC168B
TR5	BFY51
D1	OA5
D2	Silicon 'bias diode'
D3	2.7, 3.0 or 3.3V zener diode, 250mW. (see text)

Switches

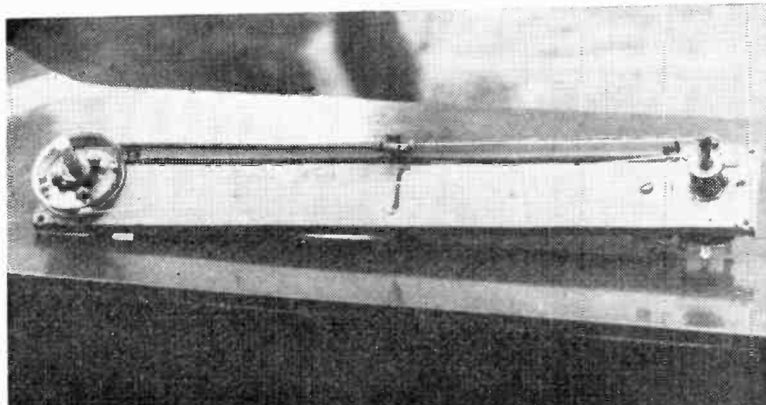
S1	2-pole 2-way rotary, Cat. No. WS14 (Home Radio)
S2	d.p.s.t., part of VR2

Batteries

B1	PP3, PP4 or PP6 (Ever Ready)
B2	3-off No. 800 (Ever Ready) in series

Speaker
Moving-coil, 35Ω, 7in. by 4in. (Radiospares – see text)

Miscellaneous
Ferrite rod, 6in. by ⅜in.
Ferrite rod, 4in. by ⅜in.
18-way group board, Cat. No. BTS10 (Home Radio)
1½in. drive drum
2⅜in. spindle extender
Pulley
Nylon drive cord
4 knobs
¼in. bush
Speaker fabric
Perspex, hardboard, plywood, etc.



The tuning scale pointer drive assembly the stems pointing upwards. Lock these bolts with nuts and washers and put the plywood panel on one side.

The next operation is to make the coil unit. Take a piece of Fablon or Contact, 4½in. by 3in. Remove a ½in. wide strip of the paper backing from one of the 4½in. edges. Leave the rest of the paper in position. Starting with the other 4½in. edge wind the Fablon in the form of a tube round the 6in. ferrite rod so that the rod is a snug fit but is still able to slide freely. Fasten the tube off by means of the edge which has had the paper removed from it. Starting ¾in. from one end of the tube, and with the rod in position, close-wind on 200 turns of 32 s.w.g. enamelled wire, with each turn touching the next. This is L1. Leave a few inches of wire free at each end for future connections. Leave a gap of ¼in. and then close-wind on ten turns of the same wire, in the same direction, and again leaving a few inches af wire free at each end. This is L2. Keep the windings in place with Sellotape. Make sure that the rod can still move freely within the coil. If not, start again! Cut a ½in. length of ⅜in. diameter wood or other insulating material, put a few turns of Sellotape round it to make it a tight fit in the coil tube, and plug it in at the end of the tube near the start of L1. Drill through the tube and the plug, at the mid-point of the plug, to take a 6BA bolt.

Pass a 1in. long 6BA bolt through hole D in the plywood strip (Fig. 2(a)) with the countersunk head underneath. Secure with a nut and washer. Pass on a second nut well down the bolt, and then fit the coil unit to this bolt by means of the hole drilled through the coil unit. See Fig 2(b). Fit a tight-fitting rubber grommet to the end of the coil unit near the 1in. bolt, and a loose-fitting grommet near the other end. Tie this second grommet to the strip through holes E and F having first inserted the ferrite rod into the coil. Use cord and not wire and do not tie the cord so tight as to bind the rod in the coil unit. Adjust the second nut on the 1in. coil holding bolt so that the coil unit lies parallel to the strip, and then tighten a third nut onto this bolt to hold the end of the coil unit firm.

Fit a ¼in. bush through hole G. With a small hacksaw cut a slot through the wide diameter end of the spindle extender. This slot will be used to lock the end of a length of nylon cord. Pass over the spindle extender a plain washer, a compression spring washer and a plain washer, in that order. Then pass the spindle extender through the bush so that its large diameter end is on the same side as the coil former. Pass a plain washer over the open end of the spindle extender, and then the 1½in. drive drum with its flat side against the plain washer just fitted. With one finger on the end of the spindle extender, press hard on the drum to compress the spring washer, and tighten the grub screws in the drum. The final appearance is shown in Fig. 2(d) (in which diagram the plywood strip has been turned round compared with its position in Figs. 2(a), (b) and (c)).

Tie a length of nylon cord through the tight fitting grommet at the end of the rod away from the coil unit and then tie a separate piece of cord round the grommet to hold it tight to the end of the rod. Insert the rod right into the coil and pass the first piece of cord through the slit in the end of the spindle extension, adding a knot to prevent it from slipping through the slit. Fit a large rubber band over the grommet near the bolt through the coil tube and the grommet at the other end of the rod. This band passes round each grommet so that the rod is held fully into the coil when the cord is slack. The author found that a suitable length of ¼in.

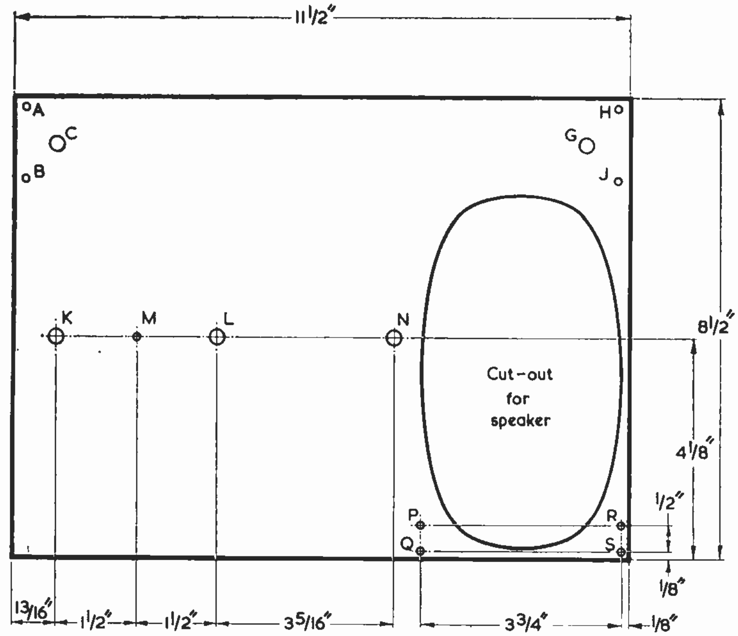


Fig. 3. Dimensions of the plywood panel on which the components are mounted

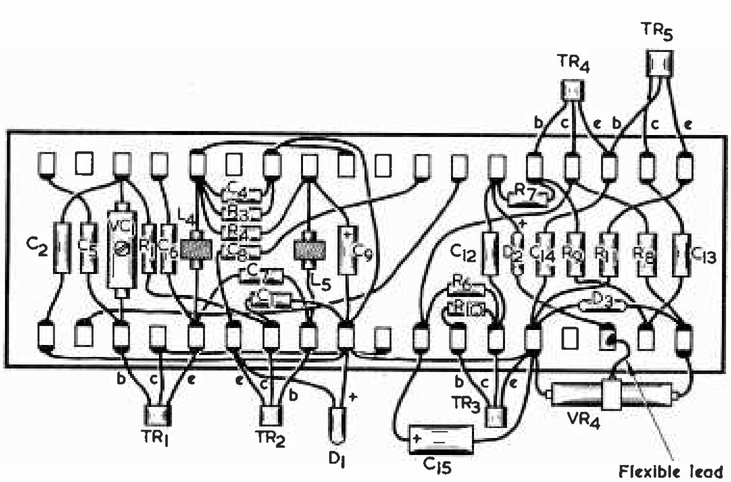


Fig. 4. Wiring up the 18-way group board

'pantie elastic' sewn into a loop gave best results. (The band is not shown in Fig. 2(b).) It should now be found that when the spindle is turned in a clockwise direction (looking at Fig. 2(b) from underneath) the band will draw the rod into the coil, while the cord will pull against the band and draw the rod out when the spindle is turned anti-clockwise.

Turn the assembly over as in Fig. 2(c) and fit the small pulley. This may be secured in the desired position by a wood screw, but it would be preferable to use a short countersunk head bolt of suitable size and appropriate nuts and washers. Fit S1, as shown in Figs. 2(b) and (c). (It should be noted that an alternative to the small pulley is a second 1½in. drum passed over the spindle of S1 without tightening the grub screws.)

Turn the spindle extender so that the rod is fully into the coil. Take a length of cord and pass it through the hole in the drum on the spindle extender, looping it temporarily over the raised hook inside the drum to hold it in place. Take the cord in a left hand direction round the pulley and back to the drum. Take 2½ turns round the drum in an anti-clockwise direction, as shown in Fig. 2(c) and pass the end of the cord through the hole in the drum. Pass this end of the cord through one end of the spring. Remove the other end of the cord from its temporary anchorage and tie the two ends together tightly. Extend the spring and pass the other end of it over the hook in the drum.

Cut a piece of thin Paxolin 8⅜in. by 1¼in. and fasten it with small countersunk screws to the slot cut out of the plywood strip. This forms a shelf for the tuning scale. See Fig. 2(d). Fix the pointer, which can if necessary be made from a length of suitable wire, to the cord so that the full movement of the ferrite rod in and out of the coil coincides with a full movement of the pointer across most of the Paxolin shelf. Cut off the end of the pointer where it extends beyond the edge of the shelf. A final embellishment is to cut two further pieces of Paxolin, each 8⅜in. by ⅜in., cover them with Fablon or Contact, and fit them along the long edges of the shelf. Wood screws are used for the one fitted near the base of the pointer, and short 6BA bolts and nuts are used for the other strip. Thick 4BA nuts, with additional washers if necessary, are employed as spacers to leave room for the pointer which is now seen travelling along the middle of the shelf, this being the ½in. wide section not covered by either of the narrow Paxolin strips. See Fig. 2(e).

If operating the tuning knob results in any mechanical backlash, this can be cured by inserting a second ½in. bush in hole G of the plywood panel of Fig. 3. If this is done hole G in the hardboard panel must be made large enough to take the nut of the bush, and if the action is now unduly stiff a drop of oil may be put in each of the bushes—but not on the washers.

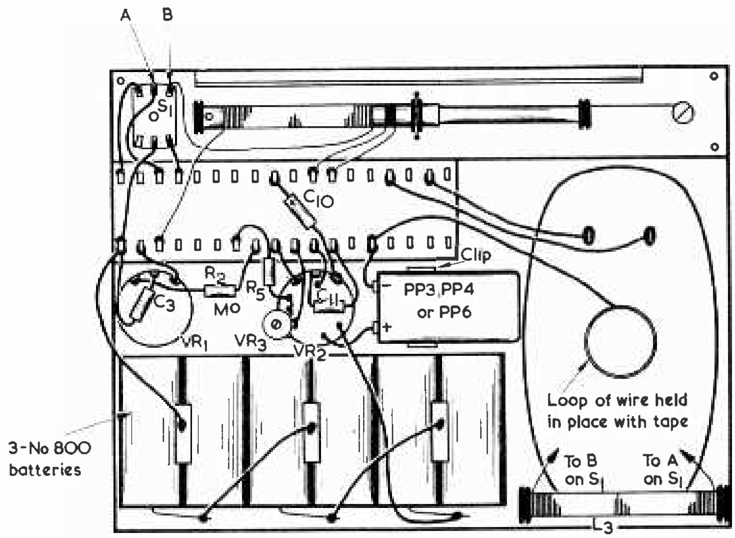


Fig. 5. Final wiring steps

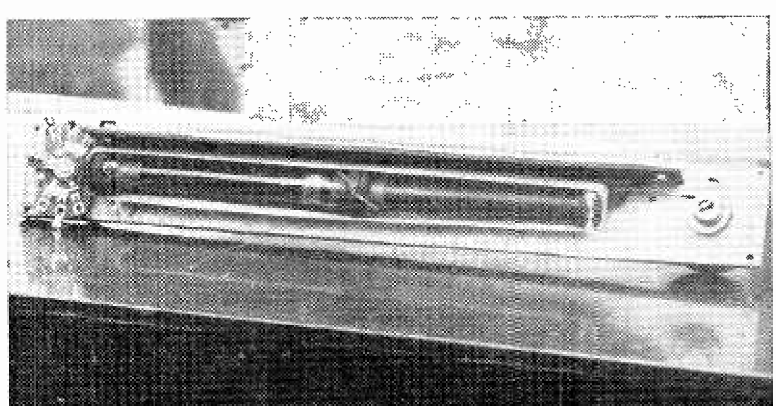
COMPLETING CONSTRUCTION

The first part of the construction has now been completed. A highly efficient tuner, with integral slow motion and a scale about 7½in. long has been built at very low cost. Before the next part of the work is undertaken, all the components shown in Figs. 4 and 5 should be obtained.

Cut out the speaker hole in the plywood panel and fit the aerial tuner assembly over the four bolts already in position on the panel, so that the plywood strip takes up the position shown in Fig. 5. There should be nuts above and below the strip, these being adjusted so that the drum has sufficient room between the strip and the panel.

The 18-way group board should be wired up as shown in Fig. 4. The cathode of zener diode D3 (i.e. the electrode which connects to positive when it is used as a zener diode) connects to the junction of R8 and VR4. The five transistors, VR4 and C15 should stand upwards and not extend beyond the edges of the group board as shown, for clarity, in Fig. 4. Other components mounted on the group board need not take up the exact angles shown, again for clarity, in Fig. 4. They may lie at suitable angles in the interests of short and neat wiring.

The board may next be mounted, as shown in Fig. 5. Note that it lies with TR1, TR2 and TR3 to the



The aerial tuner mechanism

left, and away from the aerial tuner assembly. In Fig. 5 the switch tag layout of S2 (ganged with VR2) is that encountered with the particular component employed in the prototype. Other switches may have different tag layouts, so check first with a continuity tester before wiring to this component. The speaker should be screwed into position with wood screws and a small clip made to hold B1. It is convenient to cut a plywood base measuring 7½in. by 3¼in. for the three No. 800 batteries, passing a large rubber band round its 7½in. length and screwing this base to the plywood panel. The band will hold the batteries in position.

Coil L3 has 300 turns of 32 s.w.g. enamelled wire closewound on a paper sleeve fitted over the 4in. ferrite rod. Grommets are fitted at each end and the coil is secured to the panel by cord passing through holes P, Q, R and S. Extra grommets, lying flat under those at the rod ends, may be used to keep the assembly clear of the speaker.

The metal frame of the speaker is connected to the negative supply rail of the receiver. This is achieved by fitting and tightening up a loop of bare wire around its magnet, the loop then being covered with a layer of insulating tape.

All the assembly and wiring shown in Fig. 5 should now be completed.

SETTING UP

Three setting up adjustments are necessary, to VR4, VC1 and VR3, in that order. First set VR1 and VR2 fully anti-clockwise to zero, and VR3 to a mid-way position. VC1 should be screwed up tight and then backed off about half a turn. Connect a meter capable of giving a voltage reading of 200mV across the speaker terminals (positive lead to right-hand terminal in Fig. 5) and adjust VR4 so that a reading of 200mV is given. Although this setting will probably serve for the full useful life of the batteries, there is some advantage in repeating the adjustment after the batteries have been in use for about 20 hours and have settled down to about their average useful voltage. If the reading cannot be reduced to 200mV it is probable that C12 or C13 is leaky and needs to be replaced.

Now adjust VR2 to maximum and VR1 close to the oscillation point, then set the 6in. ferrite rod right into the coil. Turn the spindle of S1 anti-clockwise, to select medium waves. Tune in a signal at about 550 metres by adjusting VC1. The medium wave band will now be correctly covered, and Radio 2 should be received on the long wave band with the 6in. rod almost fully into L1. If Radio 2 cannot be received C5 may be increased to 100pF, as was mentioned earlier.

Finally, with VR1 and VR2 adjusted to give satisfactory results from stations in the medium wave band, adjust VR3 so that oscillation starts throughout the band with as constant a position of VR1 as possible. Note that if VR3 is set to insert too little resistance into circuit there will probably be violent, though possibly supersonic, oscillation, making reception on either waveband impossible or very distorted, and causing a large current to flow from battery B2.

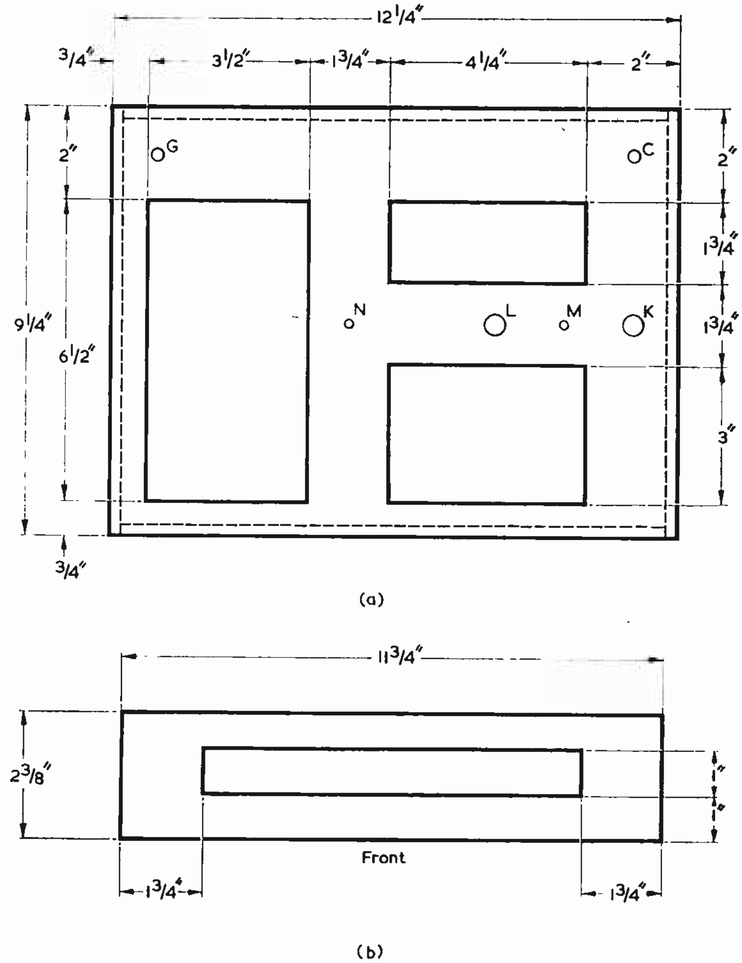


Fig. 6(a). The hardboard front panel of the receiver case (b). The top panel of the case

THE CASE

Before starting on the case it is necessary to make up and calibrate a tuning scale along the lines shown in Fig. 2(e). This scale may be fixed to the Paxolin scale shelf with suitable adhesive.

The case is made as in Fig. 6. The front has already been cut and drilled. The top is cut as in Fig. 6(b) with a window for the scale. Appearance will be improved by a narrow frame, covered in Fablon, glued over the window. The bottom of the case has the same dimensions as the top but, of course, no window. The two sides each measure 9¼in. by 2⅜in.

The top, bottom and sides are made of ¼in. plywood, and these are screwed together, and the hardboard front screwed to them, as shown in Fig. 6(a). The completed case is covered with Fablon or Contact and a piece of thin Perspex is screwed under the window. A piece of speaker fabric (non-metallic) is glued to the inside of the front of the case, and the 'chassis' is passed through the back and held to the front by two 4BA bolts passing through holes M and N in both 'chassis' and case. A neat finish is given by having the heads inside, with chromium plated dome nuts on the front of the case. It should be pointed out that the depth of the case assumes the use of the specified speaker. If a speaker is used which is more than 2in. deep, the dimensions of the case will have to be altered.

With the chassis in position, two lengths of $\frac{3}{8}$in. square section wood are screwed to the inside of the case sides so that their edges are $\frac{1}{8}$in. from the back. These serve to take screws passing through the hardboard back. The latter measures $11\frac{3}{4}$in. by $8\frac{3}{4}$in., is covered with Fablon or Contact, and has a hole in the back, say 4in. by 5in., covered with speaker fabric on the inside. Do not glue the square section runners to the case, as they have to be removed if, at some future date, it is required to remove the 'chassis' from the case. ■

RECENT PUBLICATIONS

TELEVISION ENGINEERING, Volume 2, Video-Frequency Amplification, 2nd Edition. By S. W. Amos, B.Sc., C.Eng., M.I.E.E., D. C. Birkinshaw, M.B.E., M.A., C.Eng., F.I.E.E. and K. H. Green, C.Eng., M.I.E.R.E.

298 pages, $5\frac{1}{2}$x $8\frac{1}{2}$in. Published by The Butterworth Group. Price £3.50.

The first edition of this book appeared in 1956, since which year there have been a number of important developments in television including, in particular, the introduction of the 625 line system and the use of transistors in video amplifiers. In consequence, the calculations in this second edition are now presented in terms of the new line standard, and a chapter on transistor video amplifiers has been added. All three authors are members of B.B.C. staff. Also, the book is published by arrangement with the B.B.C., who retain the copyright.

The book is divided into seven parts, the first six of these dealing successively with the fundamental principles of video amplification, high frequency considerations, low frequency considerations, feedback, noise, and transistor video amplifiers. The seventh part is devoted to appendices.

By the nature of its subject-matter the treatment has to be mathematical although, where possible, mathematical workings have been moved to the appendices. The volume will be of primary use as a text-book to the student who is specifically interested in video frequency amplification as encountered in broadcast and studio usage. Bearing in mind its sponsor and the manner of its publication, it hardly needs to be added that the book can be looked upon as being completely authoritative in its field.

F.M. RADIO SERVICING HANDBOOK, 2nd Edition. By Gordon J. King, Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S., Grad.I.T.A.I.

206 pages, 6 x $9\frac{3}{4}$in. Published by The Butterworth Group. Price £3.00.

The first edition of this book appeared in 1957, and it had four subsequent reprintings. This second edition is a completely revised version of the first and, amongst other changes and additions, incorporates new material on f.e.t. front ends, integrated circuits and stereo decoders, all of these having appeared on the f.m. scene during the last thirteen years.

The first chapters discuss the f.m. signal and its advantages over a.m. transmissions, f.m. detection, r.f. amplifiers, frequency changers and i.f. stages. These are followed by chapters devoted to a.m./f.m. receivers and tuners, f.m. stereo, f.m. aerials, receiver alignment and servicing techniques. The last chapter deals with equipment specifications, including DIN 45-500.

The book is well and clearly illustrated with line drawings and a large number of photographs. The emphasis is on semiconductor devices including i.c.'s, and the treatment is modern and up-to-date. Many of the circuit diagrams apply to current commercially manufactured equipment, and are complete with component values.

The approach to the subject is practical and non-mathematical. Although the title of the work suggests that it is a servicing guide intended for service engineers, the reviewer feels that it will be of equal value to home-constructors, experimenters and anyone else who has a keen technical interest in present-day v.h.f. f.m. reception and stereo reproduction.

TELEVISION SERVICING HANDBOOK, 3rd Edition. By Gordon J. King, Assoc.I.E.R.E., M.I.P.R.E., M.R.T.S., Grad I.T.A.I.

357 pages, 6 x $9\frac{3}{4}$in. Published by The Butterworth Group. Price £3.80.

Yet another title from the pen of one of our most prolific writers, 'Television Servicing Handbook' provides a guide for engineers engaged in TV service and for those who are graduating from sound radio to television work.

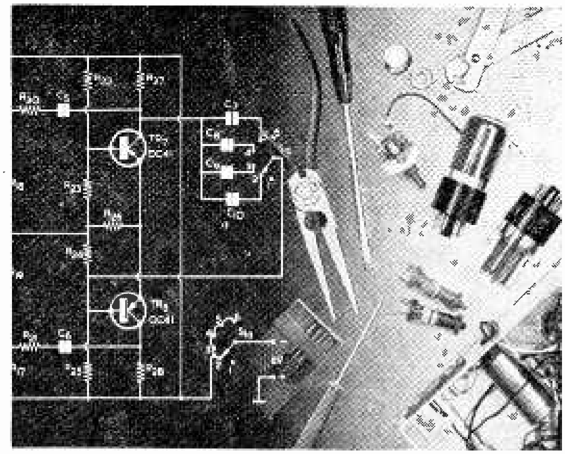
The book may be read in its entirety as a text-book and it may also be employed as a reference for fault-finding during actual servicing work. To this end, nine 'procedure charts' are included, these applying to such faults as lack of raster, impaired synchronising, and timebase defects. The charts have the familiar 'family-tree' style of presentation; the reader commences at the top and follows the line which corresponds to the symptoms observed and the consequent circuit points to check. The book is sturdily bound in hard covers and will be well able to stand up to the rough handling liable to occur in a busy service workshop.

The reference book approach is similarly evident in chapter layout, since most of the chapters deal with an individual fault or an individual section of the receiver. Also included are a long chapter, of 32 pages, on colour television and another long chapter, again of 32 pages, on transistor television receivers.

The third edition introduces the colour television chapter just mentioned. Also, the remainder of the text has been updated where necessary to conform with present-day circumstances. ■

SEQUENTIAL ON-OFF SWITCH

by G. A. FRENCH



THE PUSH-BUTTON SEQUENTIAL switch, by means of which a circuit is alternately switched on or off by successive closures of a push-button, has a number of uses in electronic work. One of these is the control of equipment by means of a remote push-button, and it may be noted here that it is possible to have more than one push-button in the system. Several push-buttons, connected in parallel, enable the controlled equipment to be switched on or off from a number of remote stations. Other applications include transmit/receive switching in amateur transmitting installations and the control of lighting from several different points without complicated inter-switch wiring. It should be mentioned that in both those last two instances it would be necessary for the sequential switch to control a secondary relay having contacts and insulation suitable for the currents and voltages involved.

DESIGN APPROACH

A number of purely electronic circuits capable of offering sequential switching operation are available, but many of these tend to be somewhat complex in design. In consequence, the writer set out to devise a circuit which employed simple principles and incorporated a relatively small number of components. It was decided from the outset to work to the situation in which the circuit actuates, i.e. switches on or switches off, when the push-button is *released,* rather than when the push-button is pressed. This approach eases circuit design problems considerably, since it enables the switch circuit to take advantage of two occurrences for each operation, these occurrences being the closure of the push-button and its subsequent release.

The inherent 'memory' required in the device to be described is provided by a thryistor (or silicon controlled rectifier) which is either conducting or non-conducting. For the benefit of those who have not had experience with these components, the circuit symbol for a thyristor is given in Fig. 1, in which diagram the three electrodes are identified. If the anode of the thryistor is connected, via a suitable load, to a point that is positive of the cathode, only a very small leakage current flows. Should a positive pulse, relative to cathode, be applied to the gate the thyristor triggers and becomes conductive between anode and cathode. The thyristor remains conductive after the gate pulse ceases and can only be made non-conductive again by removing the positive supply to the anode.

WORKING SWITCH

The full circuit diagram of the sequential switch is given in Fig. 2, in which the thyristor appears as TH1.

Also included in the diagram is a relay having two changeover contact sets and one make contact set (i.e. a contact set which closes when the relay energises). The relay coil and contacts are shown with 'detached' presentation. The coil is represented by the rectangle identified as A/3, the two changeover contact sets are identified as A1 and A2 respectively, and the make set is identified as A3. All contact sets are shown in the position they take up when the relay is de-energised.

When the 15 volt supply is applied to the switch, thyristor TH1 remains non-conductive, whereupon the relay is in the de-energised state and the relay contact sets are in the positions shown. To actuate the circuit, push-button S1 is closed. This completes a circuit via relay contacts A1 and A2 between the positive supply line and the junction of R2 and R3. A triggering current flows through R2 to the gate of TH1, which then becomes conductive and draws anode current through the relay coil and R4. However, the lower terminal of the relay coil connects (via the closed push-button) to the positive supply rail by way of D1 and R3, and only a small voltage appears across the coil. Thus, the relay does not energise and most of the voltage appearing in the anode circuit of TH1 is dropped across R4.

The push-button is next released, whereupon the junction of R2 and R3 no longer connects to the positive supply line. The gate current to TH1 ceases but the thyristor still remains in the conductive state. At the same time the voltage across the relay coil is now no longer limited by D1 and R3, and it rises to a sufficiently high level to enable the relay to energise. Contact set A3 closes, switching on the circuit which is controlled by the switch. Also, contact sets A1 and A2 change over, ready for the next closure of the push-button.

When the push-button is next pressed it completes a circuit (via

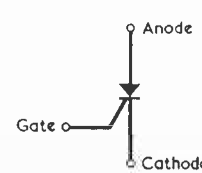


Fig. 1. The circuit symbol for a thyristor, indicating the three electrodes.

contact sets A1 and A2 in the energised position) between the junction of R4 and the relay coil, and the negative supply rail, via the low-value resistor R1. The voltage across the anode and cathode of the thyristor drops to a negligibly low value and the thyristor becomes non-conductive. At the same time, the lower terminal of the relay coil couples to the negative supply rail via R1 and the relay stays energised.

The push-button is next released, with the result that the circuit to the lower terminal of the relay coil via R1 is broken and the relay de-energises. Its contact set A3 opens, switching off the controlled equipment. Contact sets A1 and A2 revert to their de-energised position and the circuit is then prepared for the next cycle of operation.

The functioning of the switch may be summed up in the following manner. When the push-button is initially pressed the thyristor fires and becomes conductive. When the button is released the relay energises. Pressing the push-button a second time causes the thyristor to become non-conductive. When the push button is then released the relay de-energises. If the push-button is pressed again, the thyristor once more fires and another switching cycle commences.

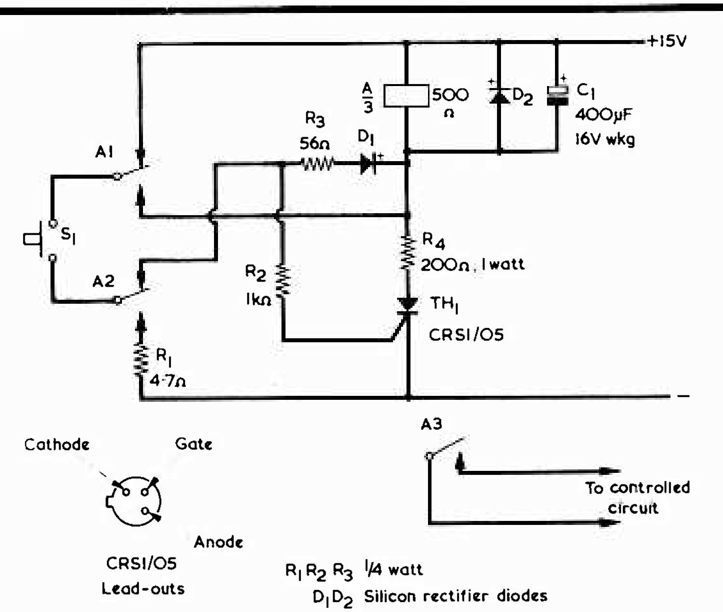


Fig. 2. Circuit of the sequential switch. This causes the controlled circuit to be turned on when push-button S1 is first pressed, and then turned off when S1 is pressed a second time.

CIRCUIT DETAILS

There are a number of detailed points in the circuit which have not been covered in the description of circuit operation just given.

One of these is the reason for incorporating resistor R3. This component is included to provide isolation between the gate and anode circuits of the thyristor. Without R3 the thyristor anode current rises sharply at the same instant as the gate current appears when S1 is closed to initiate the 'on' condition, and the thyristor does not trigger reliably under these conditions. Triggering is quite reliable with R3 in circuit.

Diode D1 is included to ensure that no current flows from the positive supply rail to the gate via the relay coil. This diode is only conductive during the period when S1 is closed for switching the circuit to 'on'.

There is a slight possibility that, with a badly set-up relay, the two outside contacts of the changeover contact sets may both momentarily touch the centre contact at some instant when the relay is energised or de-energising. A relay in this condition should not be used but it is a wise precaution, nevertheless, to ensure that no circuit damage can result if a momentary connection between the two outside contacts should occur accidentally. If the two outside contacts in contact set A1 are momentarily connected together, all that happens is that the positive supply rail connects to the upper end of R4. No excessive current could then flow. Also, a momentary connection between the outside contacts of A2 merely couples R1 to the junction of R2 and R3. No current would flow via R2, and D1 would prevent current flow in R3. It is impossible for any of these momentary connections to take place when the centre contacts of A1 and A2 are both connected together by S1 because the relay only energises or de-energises when S1 is open.

Capacitor C1 and resistor R1 were added after practical experience with the prototype. Originally, the capacitor was not fitted and the lower outside contact of contact set A2 connected direct to the negative supply rail. It was found that the circuit functioned correctly under these conditions except for one small fault which occurred occasionally when the push-button was pressed and released to initiate the 'off' condition. If the push-button was kept closed for one particular short length of time and then opened again, the thyristor re-triggered and maintained the circuit at 'on'. The period of button closure which caused this effect to appear was extremely critical and, even when prolonged attempts were made to purposely produce the malfunction, the latter could only be made to occur about once for every dozen attempts. Nevertheless, it was felt that the circuit should be cleared of this defect. It is presumably caused by the rising back e.m.f. in the relay coil which is given when the coil current is turned off. This rising voltage is applied to the thyristor anode via R4 and is sufficient to trigger the thyristor on again. The effect was completely eradicated by the addition of C1, which slows the rise of voltage across the relay coil.

The inclusion of C1 then necessitated the addition of R1. Without R1 the push-button, when pressed to initiate the 'off' condition, would cause a sudden increase in voltage across C1 and, assuming a low impedance power supply, a consequent surge current. R1 is simply a limiter resistor and obviates the slight sparking which would otherwise occur in S1, thereby extending the life of its contacts.

Experimenters may find it of advantage to initially build the circuit without C1 and R1. If the circuit does not then exhibit the slight shortcoming in operation which has just been described there is no necessity to include these two components. It is probable that variations between different specimens of the thyristor specified may cause the trouble to appear to a greater or lesser degree.

The addition of C1 does not cause any serious slowing-down of relay operation when the 'off' condition is selected. With the circuit as shown, contacts A3 open about a quarter of a second after the push-button, in initiating 'off', has been released.

Diode D2 was initially included to prevent the formation of a reverse back e.m.f. when the relay de-energised. It was retained after the addition of C1, and it now prevents the appearance of an oscillatory voltage in the LC circuit given by the relay coil and C1.

The voltages appearing across the relay coil in the prototype were as follows: button pressed to initiate 'on', 4 volts; button then released, 11 volts; button pressed to initiate 'off', 15 volts; button then released, zero volts. The current drawn from the supply rises to 50mA when the button is pressed to initiate 'on', and it falls to 22mA when the button is next released. It rises to 30mA when the button is pressed to initiate 'off', and then falls to zero when the button is released.

COMPONENTS

The thyristor employed in the switch is an S.T.C. type CRS1/05, available from Henry's Radio Ltd. It is a small component encapsulated in a TO5 can.

Diodes D1 and D2 can be any small silicon rectifier diodes, such as the Lucas DD000. All four resistors should have a tolerance on value of 10%.

The relay employed in the prototype was a P.O. 3000 type, having the contact sets shown and a coil resistance of 500Ω. Since from the writer's experience the relay coil inductance has an affect on circuit operation, there is a possibility that other types of relay or relays with different coil resistance may cause the circuit to give a performance at variance with that obtained with the prototype. In consequence, it is advised that the same relay, or a very similar type, be employed in switches made up to the circuit. P.O. 3000 relays assembled to customer's specification are available from L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, Croydon, Surrey. ■

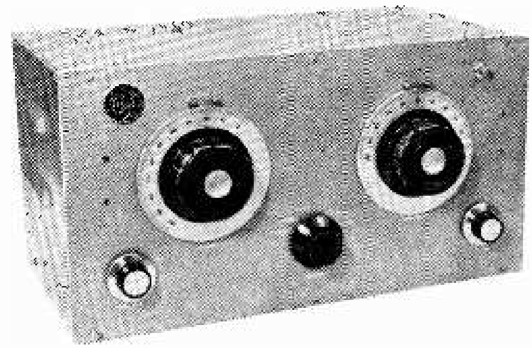
CANADIAN T.V. CONTRACT

A major contract has been received by Marconi's Broadcasting Division, through their Canadian associates, Canadian Marconi Company, for the supply of twenty-one Mark VIII automatic television colour cameras for 'Place de Radio-Canada', Canadian Broadcasting Corporation's building complex currently under construction in Montreal. The camera contract followed an exhaustive evaluation of the Marconi Mark VIII by the CBC. Also included is an order for ancillary equipment for production studios 42 to 48 and presentation studios 63 and 64.

The facilities of the ultra-modern 'Place de Radio-Canada' are scheduled to originate programmes in the autumn of 1972, and will bring together broadcasting services which are now operating from eighteen locations throughout the city of Montreal.

The Mark VIII is the first television camera in the world to have automatic line-up, automatic colour balance, automatic dynamic centring and automatic check-out, all push-button controlled. It is smaller, lighter and more mobile than any other broadcast quality camera.

FURTHER NOTES ON THE 'CRUSADER' SIMPLE SUPERHET



by

F. A. BALDWIN

The 'Crusader' superhet receiver described in our issues dated January, February and March 1971 provides excellent results as it stands. Neverthe-less, two modifications can be carried out, these enhancing its performance at small cost. Added selectivity and the provision of a b.f.o. should prove attractive features to those readers who have constructed the 'Crusader'

THE FIRST MODIFICATION TO BE DESCRIBED IS THE addition of a further i.f. transformer. This offers a significant and worth-while improvement in selectivity.

The circuit incorporating the additional i.f. transformer is shown in Fig. 1, the only extra components required being the i.f. transformer and a 5pF silver mica capacitor. The added transformer is a Denco component type IFT11/465, this being the same as the two transformers already fitted. It is wired 'back-to-back' in conjunction with IFT1, and is inserted between IFT1 and the signal grid of V2.

The additional transformer is mounted immediately behind IFT1, with tags 3 and 1 nearest the chassis rear. Disconnect the lead joining tag 5 of Tagstrip 1 (see Fig. 7) to tag 4 of IFT1, and connect tag 5 of Tagstrip 1 to tag 4 of the added transformer. Disconnect the lead joining tag 6 of IFT1 to pin 1 of V2, and connect tag 6 of the added transformer to pin 1 of V2. Connect tag 4 of IFT1 and tag 3 of the added transformer to the adjacent earth tag (tag 3) of Tagstrip 1. Connect the 5pF silver mica capacitor between tag 6 of IFT1 and tag 1 of the added transformer.

A small amount of i.f. re-alignment will be necessary after the modification has been completed, and this is carried out with a signal generator, or using a received signal. Only a slight readjustment of the transformer cores should be required. It is advisable to finalise by checking the setting of the cores in IFT2 as well, whereupon the last lining-up sequence consists of aligning IFT2, the added transformer, and IFT1.

It will be found that, with the extra i.f. transformer in circuit, receiver selectivity is considerably enhanced.

ADDING A B.F.O. STAGE

The circuit for an additional beat frequency oscillator (b.f.o.) stage is given in Fig. 2. This is an oscillator whose frequency can be varied on either side of 465kHz by adjustment of the 15pF variable capacitor shown in the diagram. The output is coupled via Cx to the i.f. transformer tag connecting to the detector, and the b.f.o. causes an audible beat note to be produced with received carriers. As a

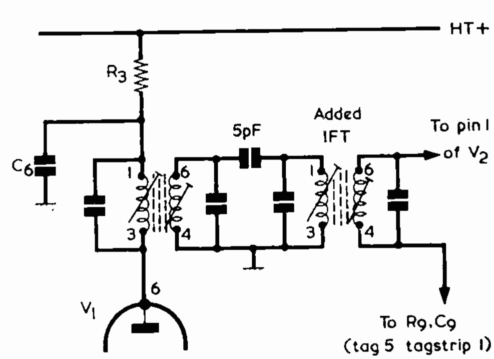


Fig. 1. The insertion of an additional i.f. transformer between IFT1 and V2 results in a significant improvement in selectivity

result, it allows c.w. signals to produce an a.f. tone which can be easily read, and it can also replace the missing carrier of single sideband signals.

It is necessary to short-circuit the a.g.c. line of the receiver to chassis when the b.f.o. is switched on as, otherwise the b.f.o. signal will itself cause the formation of an a.g.c. voltage, with consequent reduction of sensitivity in the earlier stages of the receiver. The b.f.o. switching function is carried out by S3(a) and S3(b), these being the sections of a double-pole single-throw switch. When the b.f.o. is switched on by S3, section S3(a) applies h.t. to the anode circuit of the oscillator. At the same time, section S3(b) short-circuits the a.g.c. line (at the junction of R23 and C28) to chassis.

The coil is a Denco type BFO2/465, this being fitted in a can similar to those in which the i.f. transformers are fitted. Connections are made to its four numbered tags as shown. The two 100pF capacitors and the 140pF capacitor are all silver mica types. The 0.1μF capacitor is a tubular type with a working voltage of 400, and the 15pF variable capacitor is a Jackson Bros. type C804 component. The valve is a 6AT6. This is the same type as is used in the V3 position of the *'Crusader'*, and was chosen because it can function as a temporary spare if V3 should need replacement at any time. The triode section is eminently suitable as an oscillator in the present circuit. The two diodes are unused, and are both connected to chassis. Switch S3 may be either a toggle or rotary component. Also required by the circuit is a small 2-way tagstrip having one tag earthed and one tag insulated.

The b.f.o. circuit may be fitted to the chassis between C2, C11 and V2. The actual layout of components in the circuit is not critical provided that the b.f.o. coil and valveholder are reasonably close together, and that the lead to the fixed vanes tag of the 15pF variable capacitor, which is mounted on the front panel, is kept short. (The chassis connection to the moving vanes will be made automatically by way of the capacitor mounting bush.) The length of the wiring to S3 is not important.

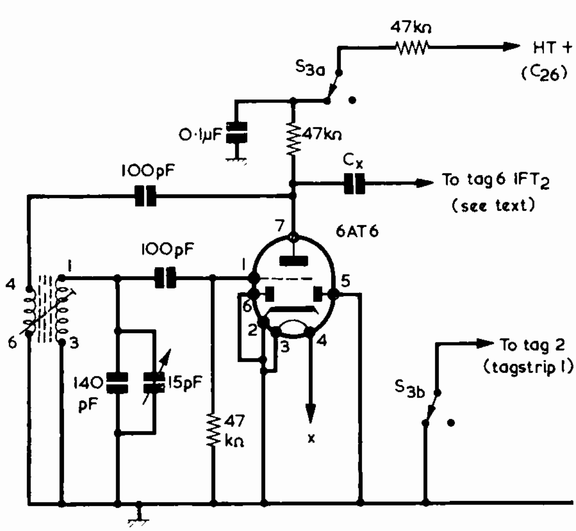


Fig. 2. A b.f.o. stage may be readily incorporated, employing the circuit shown here

whereupon a convenient method of mounting the controls would consist of positioning the capacitor between the coilpack and R13, and the switch between the coilpack and C3.

The valveholder for the b.f.o. valve should have the earthed tag of the 2-way tagstrip secured under the mounting nut nearer pin 7. This earthed tag then connects to the centre spigot and to pins 2, 3, 5 and 6. The earthed tag takes one lead-out of the 0.1μF capacitor, the other lead-out of this component connecting to the insulated tag. The latter also carries the wire to S3(a) and one lead-out of the 47kΩ resistor connecting to the 6AT6 anode.

Pin 4 of the 6AT6 connects to any convenient 6.3 volt point, such as pin 3 of V3. The h.t. positive connection may be taken from tag 7 of Tagstrip 1 or any other point which connects to the positive plate of C26.

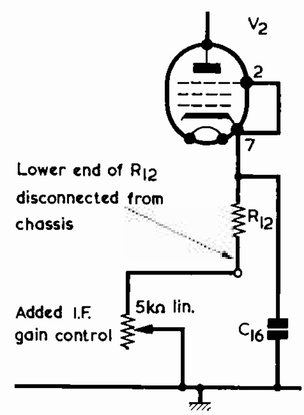


Fig. 3. The simple modification required for the addition of an i.f. gain control

The capacitor shown as Cx is not a physical component. Instead, the symbol represents the capacitance given by wrapping a p.v.c. insulated wire from the 6AT6 anode some four or five times around tag 6 of IFT2 (the tag which connects to pin 6 of V3). Note that there is no *direct* connection to the i.f. transformer tag.

When the b.f.o. circuit has been wired up, the 15pF variable capacitor should be fitted with a pointer knob such that the knob points vertically upwards when the capacitor is at half-capacitance and that clockwise rotation of the knob causes capacitance to increase. Turn on the receiver with the b.f.o. switched off and allow it to warm up. Carefully tune in any steady signal. Then switch on the b.f.o. and, with the variable capacitor knob pointing vertically upwards, adjust the core of the b.f.o. coil for 'zero beat' with the carrier of the signal. This is all that is required for the setting-up of the b.f.o., and any desired beat note for the reception of c.w. signals may be obtained by turning the knob to either side of centre. For s.s.b. reception the knob is turned to the left for lower sideband signals, and to the right for upper sideband signals. The former will be found on the 1.8, 3.5 and 7MHz Amateur bands, and the latter on the higher frequency bands. The centre position, and lower and upper sideband directions, should be marked on the front panel.

It is desirable to fit an i.f. gain control to the receiver when the b.f.o. has been added, and the requisite circuit is shown in Fig. 3. The lower end of R12, the cathode bias resistor for V2, is disconnected from chassis, and a 5kΩ linear potentiometer inserted in series. This potentiometer should always be set for maximum gain (where it inserts minimum resistance into circuit) for normal operation, and only requires to be brought into use when receiving very strong signals with the b.f.o. switched on. The control may be mounted at any convenient point, and the wire coupling it to R12 can be of any reasonable length provided it does not approach the signal grid components and wiring of V1 too closely. If a 5kΩ potentiometer fitted with a double-pole on-off switch is used, the latter could function as the on-off switch for the b.f.o. itself, whereupon the potentiometer may be wired up such that it always inserts minimum resistance into circuit when the b.f.o. is switched off.

With this last modification incorporated in the '*Crusader*', the operator will have at his fingertips all the controls necessary for receiving a.m., c.w. and s.s.b. signals from all parts of the globe. To further improve results obtained from the receiver, recourse could be made to the construction of an aerial tuning unit and a preselector.

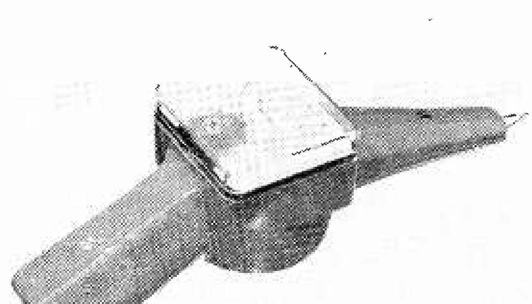
HAND PYROMETER

A neat, new pyrometer for measuring the temperature of liquids has been introduced by Adcola Products Ltd.

Measuring only 7½ in. in length and weighing 6½ oz, the standard model will cover a temperature range from 100°C to 500°C, but a model is also available covering the range 100°C to 800°C. Temperatures are indicated on a large dial – see illustration below.

Originally designed for the comparative temperature checking of soldering instruments the pyrometer is equally suitable for checking the temperature of wax or chemical baths. Applications include use by works engineers in general industry and in the manufacture of confectionery.

The pyrometer is available in a range of colours, is guaranteed accurate to 2½%, and comes complete with full operating and re-calibration instructions. The standard model retails at the recommended price of £6.18 and the larger scale model is priced at £7.18.



METER RESISTANCE

by

W. E. THOMPSON, G3MQT

The measurement of the internal resistance of a moving-coil meter does not always yield reliable results. In this article our contributor discusses the errors to avoid and shows how accurate measurements may be obtained

IT MAY NOT BE OFTEN THAT WE NEED TO KNOW THE internal resistance of a panel-mounting moving-coil meter, but when we do set about measuring it we will want our results to be reliable and fairly accurate. Unfortunately there can be pitfalls, and the purpose of this short article is to show a typical example with a simple mathematical proof, and to suggest a reasonably accurate test procedure for meters of up to 5mA full scale deflection.

TEXTBOOK METHOD

Some textbooks give the circuit of Fig. 1 as a means of measuring the resistance Rm of a meter, and usually suggest the following procedure:

(1) Disconnect R2 and adjust R1 so that the meter reads full scale deflection (1.0mA in this case).
(2) leaving R1 at this setting, re-connect R2 and adjust it so that the meter reading falls to half scale (i.e. 0.5mA).

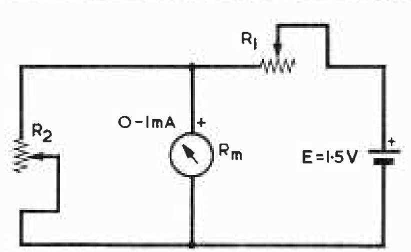


Fig. 1. A circuit sometimes employed for measuring meter resistance

(3) disconnect R2 and measure the value set up on it with a suitable bridge. The figure obtained will be the value of Rm, the meter resistance.

On the face of it, this seems a valid procedure. If we measure a 1mA meter we should most likely find after such a test that Rm comes out, say, at about 93Ω, but unfortunately we have arrived at a wrong answer.

Before using some figures to prove our point, let us look briefly at what we think we have done. We have set up 1mA in the meter, then shunted half this current through R2. Then we have said, in effect, that R2 and Rm carry equal current, and because they are in parallel they must also have equal resistance. And that is where we make our mistake! Now for some figures.

PRACTICAL CASE

Going through our measuring procedure, E is 1.5V so in Step 1 the current of 1mA passes through Rm and R1 in series. Suppose Rm is known to be 100Ω. Then from Ohm's Law.

$$Rm + R1 = \frac{E}{I}$$

$$= \frac{1.5 \times 1{,}000}{1}$$

$$= 1{,}500\Omega,$$

and as Rm is 100Ω R1 must be 1,500Ω minus Rm, or 1,400Ω. The voltage across the meter is

$$Em = Im \times Rm$$

$$= \frac{1 \times 100}{1{,}000}$$

$$= 0.1V,$$

so R1 drops the remaining 1.4V, as in Fig. 2.

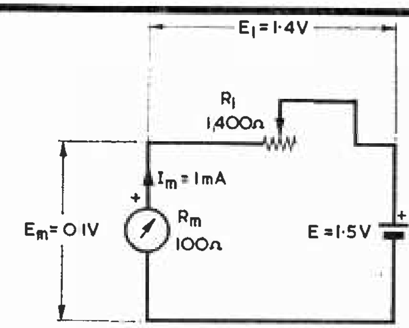


Fig. 2. The first step consists of setting up R1 for full scale deflection in the meter

Next, in Step 2, we shunt Rm with R2 and reduce the meter reading to 0.5mA. The voltage across the meter (and also across R2) is now

$$Im \times Rm = \frac{0.5 \times 100}{1{,}000}$$

$$= 0.05V,$$

which means that R1 now drops 1.45V, not 1.4V as before. The current through R1 is therefore

$$I1 = \frac{E1}{R1}$$

$$I1 = \frac{1.45 \times 1{,}000}{1{,}400}$$

$$= 1.036\text{mA}.$$

Now 0.5mA of this current passes through the meter resistance Rm, so R2 must carry 1.036mA minus 0.5mA, or 0.536mA. As the voltage across R2 at this value of current is 0.05V,

$$R2 = \frac{E2}{I2}$$

$$= \frac{0.05 \times 1{,}000}{0.536}$$

$$= 93.28\Omega$$

This is shown in Fig. 3.

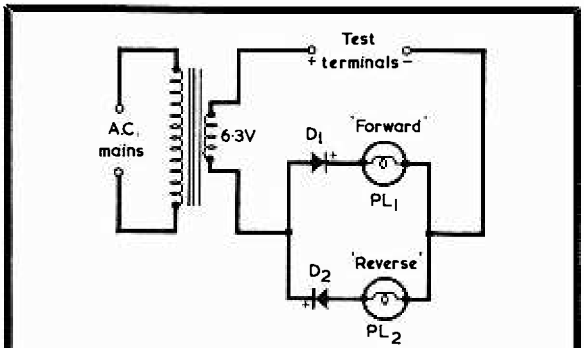


Fig. 3. R2 is then adjusted for half scale deflection

When we measure R2 in Step 3 and find it to be 93.82Ω, it is *not* indicating the true value of Rm. The reason for this is quite simple; the voltages in the circuit have altered to such an extent by shunting Rm that the distribution of current has become unequal in Rm and R2. The question now is, how can we avoid this? Fortunately the answer to this problem is fairly easy. We merely make E and R1 larger so that the current is not altered so much by R2. We are, in effect, simulating a 'constant-current' source.

HIGHER VOLTAGE

Suppose we make E equal to 15V. In Fig. 2 R1 would then be 14,900Ω and the voltage across it would be 14.9V. Then when we connect R2 as in Fig. 3 the voltage across R1 would become 14.95V, so the current through it will then be

$$I2 = \frac{14.95 \times 1000}{14{,}900}$$

$$= 1.003\text{mA}.$$

The current in R2 then becomes 1.003mA minus 0.5mA, or 0.503mA, so

$$R2 = \frac{0.05 \times 1{,}000}{0.503}$$

$$= 99.4\Omega$$

This is so near to 100Ω that we would be safe in assuming Rm to be the 100Ω it actually is. Our error is about 0.5% low, and we could in fact allow this as a general rule.

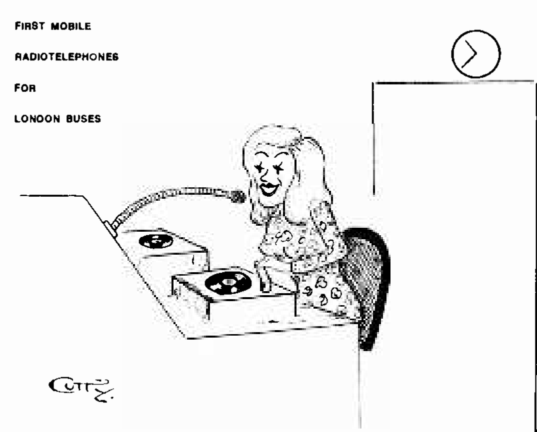
As a matter of interest, making E=150V gives us an error as low as 0.1%, though this may hardly be worth the extra voltage owing to possible difficulty in setting up R1 accurately.

A few simple calculations will readily show that if E is, say, 18V (which can be obtained from a couple of 9V dry batteries), a commendable accuracy of about 0.5% can be consistently achieved.

INITIAL VALUES

For some guidance in allotting initial values for R1 and R2, we can bear in mind that most first-grade moving coil meters require about 75mV (0.075V) for full scale deflection. A 50μA movement would therefore have an internal resistance of about 1.5kΩ so, with E at 18V, R1 would need to be of the order of 360kΩ, for which a 500kΩ potentiometer could be used. From this estimated value for Rm, R2 would need to be about 2kΩ maximum. Other meters, naturally, would require different values for R1 and R2, and these are easily estimated as is shown in the previous example.

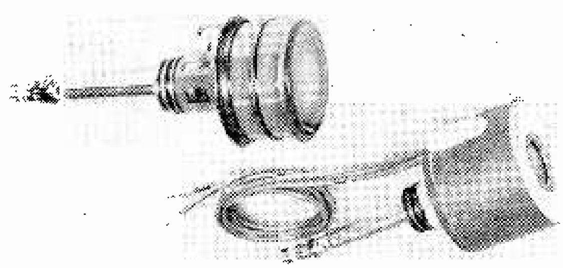
Some care is needed when measuring the resistance of meters having full scale deflections in excess of 5mA because the values of R1 and R2 must necessarily become rather low. For example, using 15V to measure the resistance of a 100mA meter will require R1 to be about 200Ω. A 100mA meter could also result in R2 being less than 1Ω. It follows that some consideration of the test conditions and component values should always be undertaken before a test circuit is set up. ■



" . . . . and now for Sid, who is on the 95b somewhere between the Strand and Marble Arch. Here is the London Philharmonic playing . . . . " (With apologies to the article which appeared in our January issue)

NEWS . . . AND .

THE EBITRON NEW INTENSIFIER VIDICON



A new vidicon camera tube with, it is claimed, more than 250 times the sensitivity of a conventional 26mm vidicon has been introduced by the Electron Tube Division of EMI Electronics Ltd. The intensifier tube, designated the Ebitron type 9777 vidicon, produces television pictures at illumination levels down to half moonlight conditions.

The vidicon employs electron bombardment induced conductivity in the zinc sulphide target together with a high sensitivity S20/S25 photocathode. The image section is all electrostatic and the scanning portion similar to a conventional 13mm magnetic vidicon.

The Ebitron can be specified to replace existing 26mm vidicons in CCTV cameras, the 9777 tube and its coils being no bigger than the conventional vidicon and coils. Its 18.2mm photocathode makes it suitable for use with standard 26mm vidicon lenses.

THE RADIO AMATEUR – NEW IMAGE

In a recent issue of the Radio Amateur Satellite Corporation's Newsletter AMSAT, appeared an article by Bob Clark, WB4SMH entitled *The Image Problem*.

The writer of the article tells how at a scientific conference his interest was suddenly caught by a speaker describing a rather elaborate aerial and receiving station. What particularly claimed his attention was the fact that the speaker pointed out, more than once, that the transmitter was an amateur station. He contrasts that attitude with the quite common view held by some scientists, that the amateur has no real ability to make a worthwhile contribution to science.

In his article he says ". . . the image of the amateur is changing in the scientific community. Credit for the change belongs, in large part, to the amateurs in AMSAT; in project MOONRAY; and to those in the scientific community who are actively using amateur radio in their research work. Many of them, it is interesting to note, use amateur radio gear because the big budget slash has them operating on a shoestring (in the best ham tradition!). The change is a refreshing, needed and long overdue one."

"Helping to push the change are people like D. T. Bellair of the University of Melbourne. He has written a paper titled *Disturbances to Trans-Ionosphere Propagation at 29.45MHz Observed using the Australian Oscar 5 Satellite* . . . Bellair is quite proud of the fact that his results were obtained with the help of amateurs."

Our only objection to the above is the use of the term "ham!" a particular "bête noir" of ours.

VARIABLE SPEED CONTROLLER

Any electric tool such as drills, sanders, polishers, lathes and so on, or equipment such as food mixers, coffee grinders, or sewing machines, can be speed controlled by this neat device. Coupled between a 240 volt a.c. mains and the equipment, it enables the speed of operation to be adjusted as required by turning the control knob. The bypass switch slides over to cut out the controller and give full speed immediately, when required.
The Tragonic Variable Speed Controller is available from hardware and accessory stores at approximately £2.70. Tragonic Solid State Products is the registered name for tools and accessories marketed by Tragonic Sales Limited.

. . . COMMENT

AUDIO EQUIPMENT COMPANY – VITAL ROLE FOR DISPOSABLE PAPER WIPER

Kimwipes, are used for all wiping jobs during the manufacture and assembly of high fidelity loudspeaker equipment at the Kent factory of K.E.F. Electronics. This includes the wiping of precision electronic parts such as magnets, voice coils, inductors and resistors and the removal of surplus adhesives and solvents. The wiper must therefore be soft and not scratch components, and also be absorbent and fluff-free. They are seen being used with an adhesive before coils are fixed to the speaker's diaphragm.

Within the electronics industry, manufacturers have found it vital to examine scientifically the question of component cleaning. This small but nevertheless critical part of the manufacturing process, in which even minute scratches can drastically affect the efficiency of intricate components, has proved a problem area to many companies.

As a high proportion of machinery and finished products in the industry consist of highly-polished surfaces and delicate instruments and parts, the slightest dust particles or scratch marks left by the wrong type of wiper could prove highly expensive.

K.E.F. Electronics Ltd., of Tovil, Maidstone, Kent, one of the country's major manufacturers of high-fidelity, loudspeaker equipment for home and overseas broadcast services and last year's winner of both the Queen's and British National Export Council's awards for Export Achievement, has found the best solution in the disposable paper wiper.

K.E.F. is using Kimwipes Disposable Wipers, manufactured by Kimberly-Clark Ltd., of Larkfield, Kent, extensively through its factory in the cleaning and preparation of equipment such as magnets, voice coils, diaphragms and electronic components for filter networks and the removal of surplus adhesives and solvents from speaker chassis during their assembly.

Kimwipes, are seen being used to de-grease damping rings during the manufacture of high fidelity loud speaker equipment at the Kent factory of K.E.F. Electronics. These plastic rings are fixed to the speaker's diaphragm and it is vital to the adhesion process that not only are they cleaned perfectly of all dust and dirt but are not scratched in any way. It is therefore necessary to use a wiper which is fluff-free, soft and absorbent.

IN BRIEF

● Marconi sound and television transmitters will be supplied to the Western Nigerian Government Broadcasting Corporation under a £300,000 order. Marconi built the original Western Nigerian Television station in 1959 when it was the first television service in Africa, and helped to establish it on the air.

● The Council of the Radio Society of Great Britain have decided not to support an exhibition this year. An alternative function is considered necessary and discussions are taking place to decide its nature.

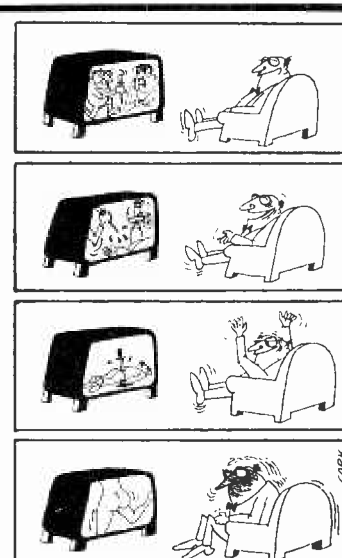
● A laser-beam lighthouse, believed to be the first one, was recently opened at Point Danger on the borders of Queensland and New South Wales.

● Hanworth Mobile Rally will be held on 27th June at Hanworth Airpark. Further details of this rally, organised by the Echelford Amateur Radio Society, may be obtained from A. G. Wheeler, 32 Feltham Hill Road, Ashford, Middlesex.

● With reference to the article, *Constructing a Vertical 3-Band Trapped Dipole* in our April issue, Mosley Electronics Ltd., inform us that they cannot supply the traps as individual items.

● BBC Radio had one of its largest evening audiences of the year for the live commentary on the Henry Cooper v Joe Bugner fight. 13 million people, it is estimated, listened to the commentary on Radios 1 and 2.

● In preparation for the next extension of the BBC's stereophonic radio service, work is in hand to adapt the vhf Radio 3 transmitter at Rowridge, Isle of Wight, it is expected that the stereophonic service from Rowridge will start by the autumn of this year.



LOGARITHMIC SPEECH COMPRESSOR

by

R. A. BUTTERWORTH, G8BI

This unit provides smooth compression of audio peaks instead of abrupt clipping. It was originally designed for amateur transmitter use, but it has many other potential applications where microphones and amplifiers are employed in combination

THE UNIT TO BE DESCRIBED IS CHEAP, EFFECTIVE and easy to build and set up. It can be used for tape recording, p.a. work and transmitting, either a.m. or s.s.b. In fact, it can be brought into service almost anywhere where a microphone and amplifier are used. Before going into detail about it, let us have a look at the reasons why speech compression is an advantage wherever speech amplification is used.

SPEECH COMPRESSION

When looked at and examined on an oscilloscope coupled to a microphone and amplifier, human speech can be shown to have a low average to peak power ratio. Peaks which are greater than average are of short duration, and so form a very small portion of the total waveform power. Now, if we can control the peaks without distortion and increase the average level in proportion we will be boosting the speech. Speech clippers, automatic control of level, etc., are very unsatisfactory for this purpose because they work on the basic principle of clipping the top off speech peaks that go above a predetermined level. This has two serious disadvantages. First the level of clipping is fixed, which means that the clipping varies according to how loudly one speaks into the microphone, and the resultant distortion with louder speech makes the intelligence hard to copy. Second, clipping results in a sudden change of waveform which causes harmonic distortion. The pattern, as seen on an oscilloscope, resembles a square wave. As is well known, a square wave contains an infinite number of odd harmonics of the fundamental frequency and constitutes an excessively broad-band signal.

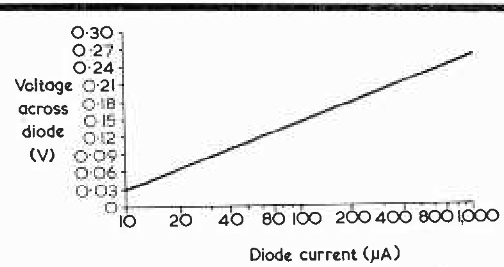


Fig. 1. At low forward voltages a logarithmic relationship exists between current and voltage in a germanium diode

The faults just described can be eliminated to some extent by filters, but these add to size and cost. In an s.s.b. transmitter the filter limits the bandwidth automatically but the level at which to clip still remains a problem.

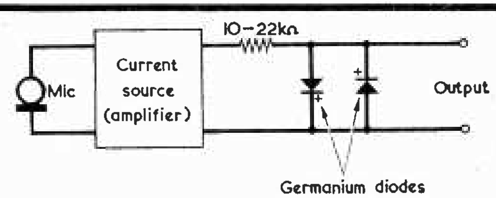


Fig. 2. Illustrating the basic method of operation of the logarithmic compressor

The disadvantages just described can be overcome and eliminated by what is known as a 'logarithmic speech compressor', which is a highly technical name for a very simple and cheap bit of equipment. It puts to good use the forward characteristics of the common germanium diode. Fig. 1 shows that this consists of a logarithmic voltage/current curve. If speech amplitude is controlled by a curve of this nature there is a logarithmic conversion of the speech waveform, resulting in a smooth reduction of speech amplitude. There is no abrupt change of waveform and the conversion is continuous; also there is no specific clipping to cause harmonic distortion. A practical logarithmic speech compressor is simple, consisting only of a current source (such as a 2-transistor amplifier) and two germanium diodes connected back-to-back. See the basic arrangement shown in Fig. 2.

THE CIRCUIT

The complete circuit of the compressor unit is shown in Fig. 3 and consists of two cheap easily available transistors and two germanium diodes, also cheap and easily available, plus some small resistors

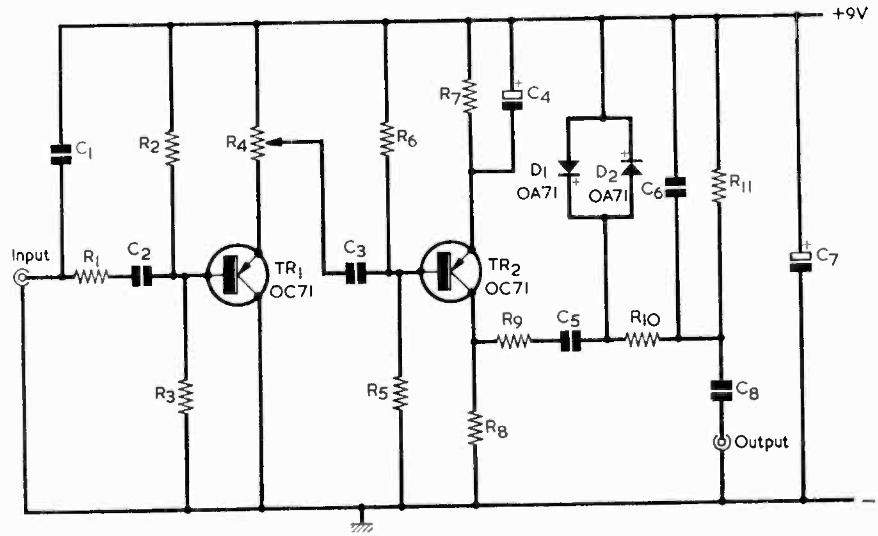


Fig. 3. Circuit diagram for the compressor unit

COMPONENTS

Resistors
(All fixed values $\frac{1}{4}$ or $\frac{1}{8}$ watt 10%)

R1	100kΩ (see text)
R2	1MΩ
R3	4.7MΩ
R4	10kΩ preset potentiometer, skeleton
R5	180kΩ
R6	33kΩ
R7	3.3kΩ
R8	10kΩ
R9	10kΩ
R10	3.3kΩ (see text)
R11	68kΩ (see text)

Capacitors

C1	100pF, ceramic or silver-mica
C2	0.01μF, paper or plastic foil
C3	1μF paper or plastic foil
C4	2μF electrolytic, 10V wkg.
C5	0.1μF, paper or plastic foil
C6	0.001μF, paper or plastic foil
C7	100μF electrolytic, 10V wkg.
C8	0.1μF, paper or plastic foil

Semiconductors

TR1	OC71
RR2	OC71
D1	OA71
D2	OA71

Battery
9-volt battery type PP3 (Ever Ready)

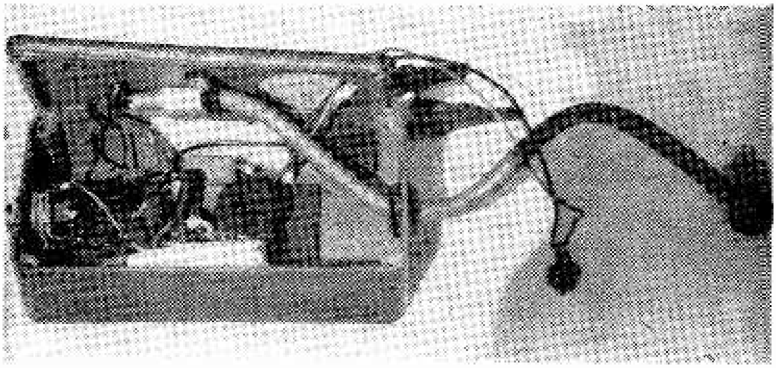
Miscellaneous
Input jack
Jack plug
Battery clips
Screened case (size to accommodate components employed)
Screened wire, circuit board or tagstrips, etc.

and capacitors. It is preferable to match the diodes as near as possible on a testmeter switched to read resistance. The constructor could be lavish and go in for low noise components, of course, and adjust the values as required.

TR1 is a high impedance input emitter follower with a variable compression control potentiometer, R4, in its emitter circuit. The signal from R4 is fed to TR2 via C3. TR2 is operated as a grounded emitter amplifier from whose collector an output is fed via R9 and C5 to the back-to-back diodes D1 and D2. The output from the diodes is then passed to the attenuator and filter system given by C6, R10 and R11. This reduces gain and provides additional wave-shaping, eliminating any spikes that may get through.

C7 bypasses the battery supply. Should the power be obtained from the main equipment with which the compressor is used it may be necessary to provide additional smoothing or decoupling. This however is hardly necessary since the total consumption of the unit is only about 0.5mA. A PP3 battery lasts for months, and the onset of hiss and distortion is a sure indication that the battery has run down.

The output, as shown in Fig. 3, is suitable for high impedance input to the following stages. If low impedance output is required a further stage, say an emitter follower, could be added. Depending on the microphone, some adjustment may be needed to the value of R1. Also, depending on the gain of the apparatus to which the compressor is connected, some adjustment may be needed to R10 and R11.



The completed compressor unit with the lid of the die-cast box removed

In some cases, R10 may be made as high as 100kΩ. The values shown in the Components List have however been quite satisfactory in the writer's unit and in several models made up for friends.

The unit has been in use for some years, which explains why the fairly old-fashioned OC71 appears in the transistor stages. The OC71 is quite satisfactory in operation and has the advantage nowadays of being very inexpensive. The microphone connects to the input of the compressor. A wide variety of microphones have been used with the unit including crystal and dynamic microphones, the latter having inbuilt step-up transformers. The combination used most by the author is the Grampian DP4/L microphone in combination with a Radiospares 'Hygrade' 1:65 microphone transformer (Home Radio Cat. No. M22A). When using different microphones the important thing is to set the gain of the compressor to suit each type.

CONSTRUCTION

There are no difficulties in construction. The components should be laid out in more or less the same manner in which they appear in the circuit diagram, using tagstrips, perforated component board with terminal pins, or any other means of assembly favoured by the constructor. The whole unit must be completely screened, and the writer employed a small die cast box, with lid, for this purpose. Obtain the actual components first and check on the space they will take up before working out the size required for the case. An input phone jack is fitted to the case, whilst the output is taken to the following equipment by way of a length of screened cable terminated in a jack plug. An on-off switch may be mounted at any convenient point.

If miniature components are used the unit could possibly be incorporated in the main equipment because it needs very little space and, once compression control R4 has been set up (for a specific microphone), it need not be touched again.

SETTING UP

The compression unit can be adjusted by ear quite satisfactorily in the following manner. First set up the apparatus with which the unit is to be used to the volume or level required without the compressor. Connect up the unit and adjust the compression control, R4, to about a third of the way up from the earthy end of its track, and switch on. Advance R4 until distortion is apparent. Now retard the input gain control of the following equipment, *not* R4, until it disappears. If this is not effective, back off the compression control until it does. The setting up process may be difficult to carry out if the amplified sound is reproduced by way of a loudspeaker, because of acoustic feedback to the input microphone. In this instance the sound should be monitored by a pair of headphones suitably coupled into the main equipment.

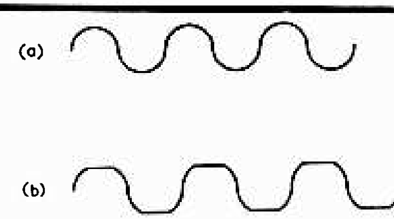


Fig. 4(a). Output waveform with the compression control set correctly
(b). Distortion given when the control is set too high

If an audio signal generator and oscilloscope are available, these can be used to show convincingly that the compressor unit is working. Set the audio generator to about 1kHz at low output (0.02V) and connect up with the oscilloscope coupled to the output of the unit. With R4 at a low setting, adjust the oscilloscope until a trace similar to that in Fig. 4(a) is obtained at a manageable size. Advance R4 slowly until the trace shows distortion, i.e. flattening at the peaks, as in Fig. 4(b), then back it off until it comes back to that in Fig. 4(a).

FINAL NOTES

This unit can be used to advantage with various types of equipment but *do remember that it is not a gain control*. Many people who have tried various types of compressor units and have condemned them make this mistake. There is obviously gain present but this is counteracted by the gain control of the associated equipment. Use this and not R4.

For a number of years the author has continually used the compressor with his s.s.b. transmitter on the h.f. bands, and its performance has been adequately demonstrated 'on the air'. ■

NOTES ON SEMICONDUCTORS

4. THE TRANZENER

by

PETER WILLIAMS

One silicon transistor can offer as many as four different Zener voltages

ZENER DIODES ARE CHEAP, EFFECTIVE AND RELIABLE devices for obtaining a stable voltage from a variable supply. Count up the number of planar transistors in your spares-box. You have four times as many Zener diodes.

This piece of Einsteinian mathematics can only be explained if we look at the nature of Zener diodes. Any p.n. junction subjected to a high enough reverse voltage will break down, i.e. it will begin to conduct heavily with large increases in current for small increases in voltage. If the junction is heavily doped on one side, the depletion layer (the region free of carriers) is narrow and only a low voltage is needed to break it down. Below five volts the breakdown depends on the presence of a high enough field strength to part the current carriers from their parent atoms, and the diodes have a rounded 'knee' and small negative change in voltage with rising temperature (typically 2mV/°C for diodes with 3.3 volts breakdown). Above seven volts the breakdown is occuring in the broader depletion layer of a less highly doped diode, and depends on an ionisation-by-collision process where the current is said to avalanche. Breakdown is sharp and the temperature coefficient is just less than +0.1%/°C.

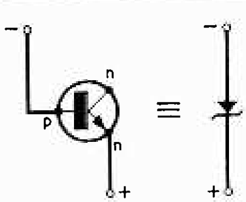


Fig. 1. Avalanche breakdown can occur when the base-emitter junction of a transistor is reverse-biased

BASE-EMITTER BREAKDOWN

For many small-signal planar transistors the doping of the emitter needed to provide good transistor action is such that the base-emitter junction has a reverse breakdown voltage close to 6 volts. For others it may be up to 12 volts, but is rarely higher. This voltage around 6 volts puts breakdown in the intermediate class between true Zener or field-effect breakdown and avalanche breakdown. The properties are similarly a mixture with a fairly sharp breakdown and a temperature drift that may approach zero (At moderately high current this occurs around 5.6 volts breakdown, but at lower currents may be above 6 volts.) One reservation is that the current levels one may use in the base-emitter junctions of small transistors should not exceed a few milliamps for good regulation. As compensation the voltage remains stable to ridiculously low currents – often to less than 1μA. This makes them suitable for reference diodes, biasing circuits, etc., but not for regulating voltages where large currents are involved.

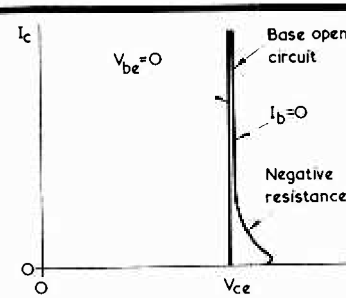
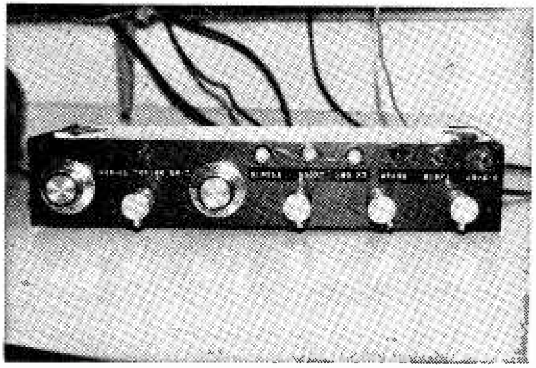


Fig. 2. The collector-emitter breakdown curve of a transistor with base open-circuit exhibits a negative resistance region where voltage decreases as current increases

Where are the other three Zeners? One of them is obtained by using the collector-base junction in reverse. The voltages are much higher but may still lie in a useful range, say from 12 to 40 volts, again at low currents. This leaves two more to find. Consider the properties of collector-emitter breakdown in an n.p.n. transistor with the collector negative with respect to the emitter. The collector-base junction is forward-biased and will have a forward voltage drop of 0.6 volt; the base-emitter junction is reverse-biased and will break down as described above. The total voltage drop ought to be 0.6 volt above that for the reverse-biased junction alone. Similarly the collector-emitter breakdown with collector positive (still n.p.n.) should be 0.6 volt above the collector-base breakdown. For example, with base-emitter and collector-base breakdowns of 6 and 15 volts respectively we have available diodes for 6 volts, 6.6 volts, 15 volts and 15.6 volts – all from one transistor.

'Should . . . . . ought'. These are the big words in the last paragraph that reveal some over-simplifications. A closer look at collector-emitter breakdown shows a more complex pattern (Fig. 2) in which negative resistance regions appear, and this will have to be left till later. The amazing saga of the transistor with the missing terminal will be continued in the next instalment. ■



AERIAL S
AND TUN

MARTIN E

Details of a neat short-wave receiv aerials to be switched to different cated by small pilot lamps. An aeri when

THE WRITER, WHO IS A KEEN SHORT-WAVE LISTENER and has a number of communications receivers, has always found it of considerable interest to make comparisons between different receivers tuned to the same frequencies and using the same or different aerial combinations.

In the past such comparisons necessitated plugging and unplugging the aerials, a process which took time and sometimes made it difficult to obtain a true estimate of relative performance. The switching unit to be described in this article allows immediate and direct switching of aerials and receiver inputs to be achieved, and it also enables an aerial tuning filter to be switched in or out of circuit, as desired. All aerial and receiver switching operations are monitored by coloured pilot lights, and a pilot lamp also indicates when the aerial tuning filter is in circuit.

CIRCUIT OPERATION

In the writer's installation the unit selects the following aerials: a K.W. trap dipole; the same aerial with the down-lead in use as well, making an effective 'T' aerial for Top Band; and a 60ft. general purpose wire. The switching unit caters for three receivers, two of these being a Collins 51S1-1 and a Trio JR310. The third position is kept spare so that any other set can be tested and compared in performance with the first two.

The circuit diagram appears in Fig. 1, and it will be seen here that three sockets, SKT1, SKT2 and SKT3, accept connections from the aerials. S1(a) and S1(b) then select, for connection to the arm of S2(a), either the 60ft. aerial, the dipole with both sides of the feeder connected together, or the dipole with one side of the feeder connected to chassis. S1(c) causes either PL1, PL2 or PL3 to be illuminated according to the aerial system switched in.

Signals from the selected aerial now pass to the arm of S2(a). S2(a) and S2(b) either cause the signal to pass through the aerial tuning filter given by C1, L1 and C2 and then on to the arm of S4(a), or they allow the signal to be fed direct to the arm of S4(a) with the aerial tuning filter out of circuit. When the aerial tuning filter is in circuit, S2(c) causes pilot lamp PL4 to be illuminated.

The signal at the arm of S4(a) passes to SKT4, SKT5 or SKT6, according to the position of the switch, and thence to the appropriate receiver aerial input. The receiver selected is indicated by PL5, PL6 or PL7, as appropriate. The connections to the receivers are made via short lengths of coaxial cable.

The pilot lamps are all supplied by the small 6.3 volt heater transformer, T1.

The aerial tuning filter employs a design due to L. Saxham* which has been found to be extremely satisfactory in use. Both C1 and C2 are 2-gang 410pF capacitors with their two sections in parallel, causing them to each have maximum values of 820pF. The inductance which can be inserted between these two capacitors is adjustable by means of S3.

*L. Saxham, 'Aerial Tuner Unit For The S.W.L.'. *The Radio Constructor*, August 1968.

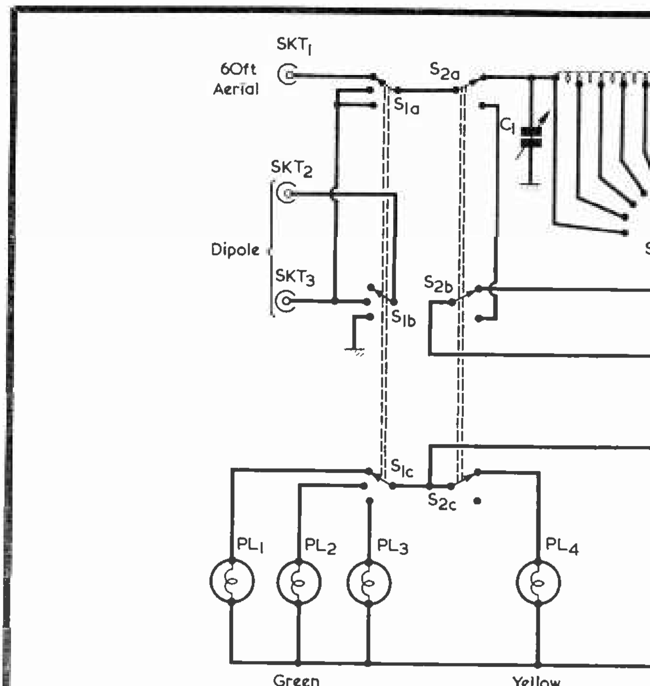


Fig. 1. Circuit diagram of the

'VITCHING
ING UNIT

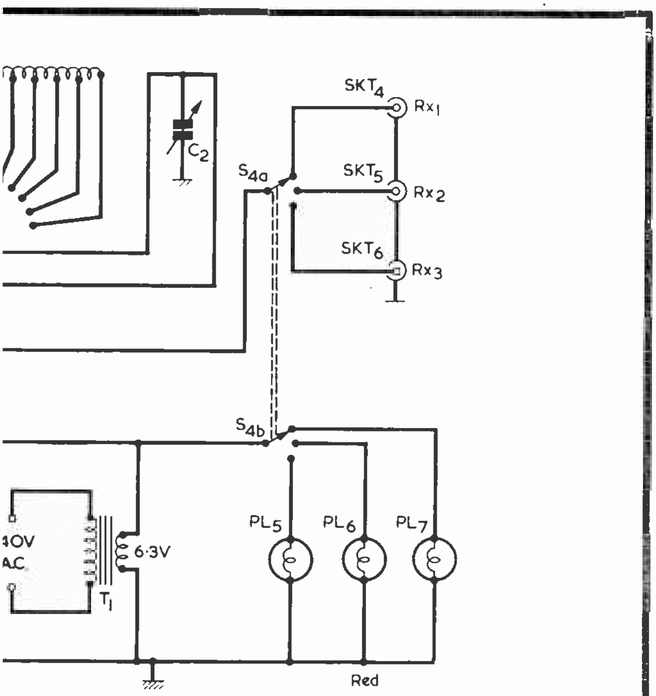
Cover Feature

;T, F.S.V.A.

ıncillary unit which enables different eivers, circuit conditions being indi- :uning filter can also be switched in juired

CONSTRUCTION

There are no problems with layout provided that L1 is not mounted too close to any large metal area. The author's unit is built in a chassis measuring 12 by 4 by 2¼in., obtained from H. L. Smith and Co. This is a chassis type 'K', with corners strengthened. The heater transformer was also obtained from H. L. Smith and Co., although any small mains transformer offering 6 or 6.3 volts at 0.5 amp or more will be satisfactory. Take care to ensure that the transformer employed has a height less than the depth of the chassis. If not, it will project above the chassis edges. Similarly, tuning capacitors different to those used by the author may be difficult or impossible to fit in. It would be best to check these



'al switching and tuning unit

COMPONENTS

Capacitors

C1 2-gang variable 410pF (both sections connected in parallel) Type 02 (Jackson Bros.)
C2 2-gang variable 410pF (both sections connected in parallel) Type 02 (Jackson Bros.)

Inductors

L1 Home-wound on Lantex tubing, 6in. by 1in. dia. (Home Radio Cat. No. ZA24) with 24 s.w.g. enamelled wire
T1 Mains transformer, secondary 6.3 (or 6) volt at 0.5 amp or more (see text)

Switches
(See text for alternatives)

S1 3-pole 3-way, miniature rotary
S2 3-pole 2-way, miniature rotary
S3 1-pole 3-way, miniature rotary
S4 2-pole 3-way miniature rotary

Pilot Lamps

PL1, PL2, PL3 12-volt pilot lamps complete with panel-mounting holder, green (H. L. Smith & Co.)
PL4 12-volt pilot lamp complete with panel-mounting holder, yellow (H. L. Smith & Co.)
PL5, PL6, PL7 12-volt pilot lamps complete with panel-mounting holder, red (H. L. Smith & Co.)

Sockets

SKT1 – SKT6 two 3-way socket assemblies (H. L. Smith & Co.) or six standard co-axial sockets

Miscellaneous

Four pointer knobs
Two pointer or scaled knobs (for C1 and C2)
Two stand-off insulators type SO1.1 (Denco)
One chassis, 12in. by 4in. by 2¼in., type K, with strengthened corners (H. L. Smith & Co.)
Two angle brackets (for mounting unit to operating surface underside)
One aluminium sheet 12in. by 4in.
Systoflex sleeving, connecting wire, etc.

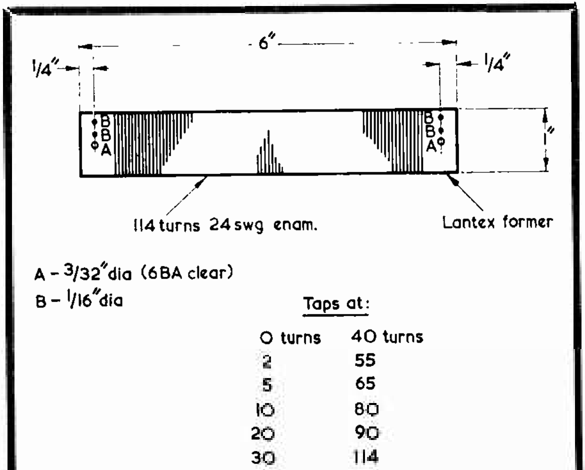
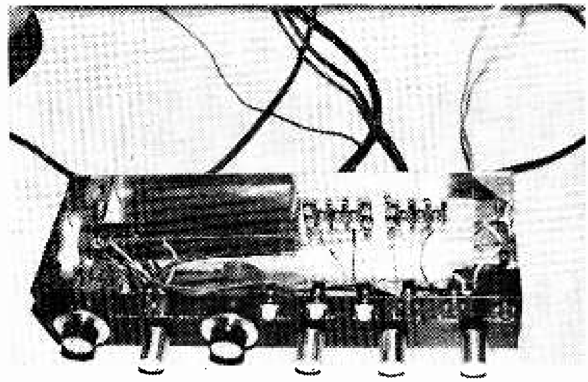


Fig. 2. Details of the tapped coil employed in the tuning filter



A view inside the chassis, whose open side is towards the top. The aerial filter coil may be seen at the left and the pilot lamp transformer at the right. The tags of the transformer are covered with p.v.c. insulating tape

last two points before making or obtaining the chassis.

All four switches are of the miniature rotary type. S3 is readily available as 1-pole 12-way, but it may be necessary to obtain S1 and S4 in 4-pole 3-way and to make no connections to the unused poles. Similarly, S2 could be 4-pole 2-way with no connection made to the unused pole. When wiring up to these switches it is helpful to have on hand a simple continuity tester, such as an ohmmeter or a battery and bulb in series, to determine which contacts are closed at each switch position.

The pilot lamps, holders and lenses were also obtained from H. L. Smith and Co., and are green for PL1 to PL3, yellow for PL4 and red for PL5 to PL7. It was found that 12 volt, rather than 6 volt, bulbs were to be preferred as they gave the required illumination without being too bright.

Coil L1 is wound on a 6in. length of 1in. diameter Lantex tubing, as shown in Fig. 2. Two 6BA clear holes are drilled $\frac{1}{4}$in. from each end to take the stand-off insulators by means of which the former is mounted to the chassis. Two $\frac{1}{16}$in. holes are also drilled at each end to enable the ends of the coil wire to be anchored. The coil has 114 turns of 24 s.w.g. enamelled wire with the turns spaced at one wire thickness. Total winding length is approximately 5.4in. Taps are made at the turns indicated in the diagram. The tap at the 'O' position (which connects to C1) is really the start of the coil. This tap is included to enable comparative checks to be made without inductance in circuit.

The positions on the coils where taps are to be made should be carefully scraped clear of enamel with a small bladed pen-knife, taking care to avoid removing the enamel from adjacent turns. The bared copper points should then be carefully tinned using a small pencil-bit iron. Short lengths of 24 s.w.g. or slightly thinner tinned copper wire may be soldered to the tinned sections. The tap wires should be soldered to the coil before it is mounted in position on the chassis. They may then be connected, shortened as necessary, to the appropriate tags of S3, being covered with Systoflex sleeving to insulate them from each other.

The writer's unit employed two 3-way phono socket assemblies for input and output connections. Standard aerial coaxial sockets could be employed instead, if desired.

FRONT PANEL

Front panel layout is shown in Fig. 3. Here, the four switch spindles should all be on a horizontal line which is just sufficiently high to provide com-

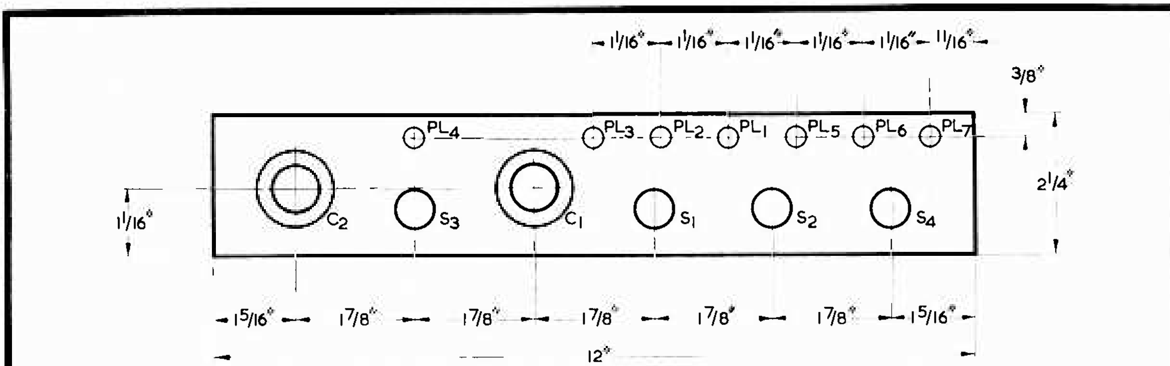


Fig. 3. Front panel layout. The open side of the chassis is at the top

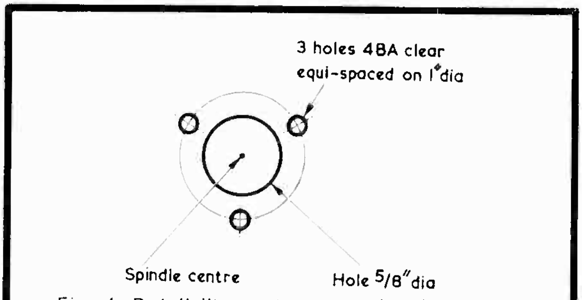
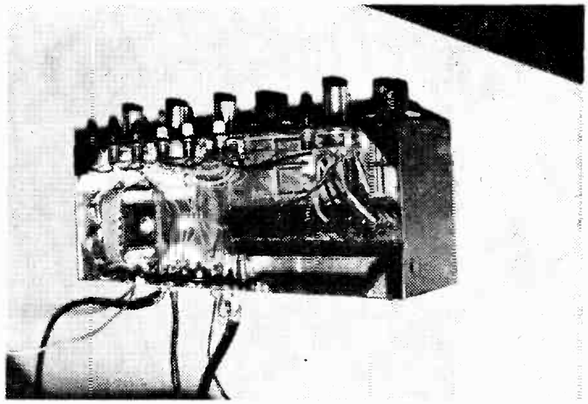


Fig. 4. Detail illustrating mounting hole layout for C1 and C2


Another view of the internal components of the unit. Layout is neat without being cramped

fortable access to their tags for wiring at the rear without the risk of short-circuits to chassis. Because of possible slight variations, it is preferable to use the components themselves as a guide to height. The spindles of C1 and C2 should also be on a horizontal line. These two capacitors are each secured by three 4BA bolts passing through the front panel. Take care to ensure that these bolts do not pass sufficiently far into the capacitor to foul the front fixing vanes. Short bolts, ¼in. or less, are required here, with sufficient washers between the back of the front panel and the front of the capacitor frame to provide spacing. Hole positioning is given in Fig. 4.

Fig. 5 shows the layout of the principal components inside the unit. The wiring is simple and follows the circuit diagram of Fig. 1. It is advisable to keep the pilot lamp wiring reasonably well spaced away from aerial circuit wiring, but there is no neces-

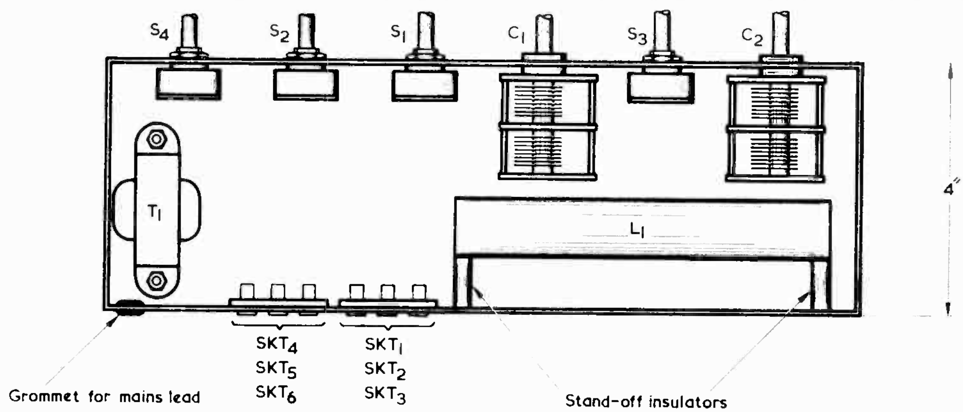


Fig. 5. Layout of the principal components inside the chassis

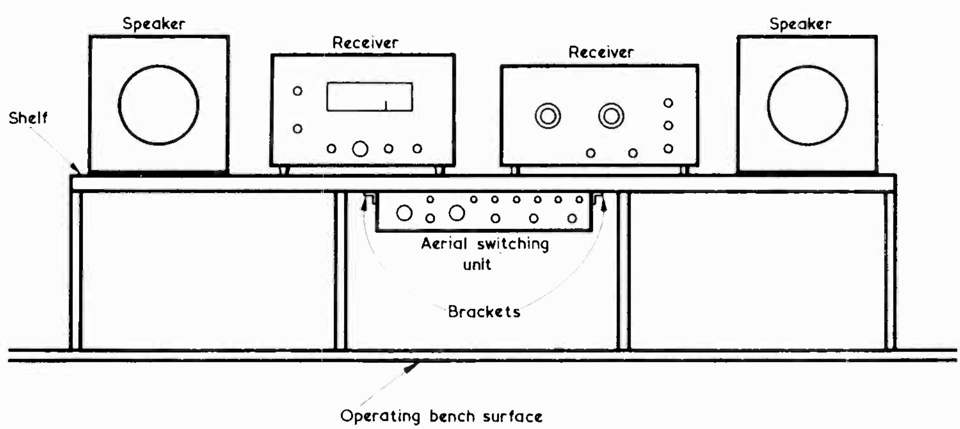


Fig. 6. The unit is intended to be mounted below the operating position, as shown here

sity to go to excessive lengths to achieve such spacing. If the mains transformer has tags at its upper end, these must be well covered with insulating tape to prevent short-circuits to a metal screen which, later, causes the entire unit to be screened. No mains on-off switch for the transformer is provided. In the author's installation a single switch controls mains power to all the outlets on the operating bench. When these are switched on, so also is the supply to the transformer in the aerial switching unit.

So far as finish is concerned, the outside of the chassis may be painted or covered with black 'Fablon'. The second method was used with the prototype.

As will have been observed from the photograph of the front panel, the unit is correct way up when the open side of the chassis is at the top. This method of construction is employed because the unit is secured to the underside of the shelf, on which the receivers stand, in the manner shown in Fig. 6. An aluminium sheet of appropriate size is fitted to the underside of the shelf so that, when the aerial switching unit is fitted, it becomes completely screened. All wires from the aerials to the unit, and from the unit to the receivers, pass through a slot at the rear of the shelf, enabling a neat receiver installation to be given. The unit is earthed via the braiding on the coaxial leads to the receivers.

OPERATION

Operation with the switches is self-explanatory, and the indicator lights are extremely helpful in showing what aerial system has been selected and which receiver output has been switched in. The pilot lamps indicating aerial are green and those for receiver output are red. A yellow pilot lamp gives indication when the aerial tuning filter is switched in.

The best method of using the aerial tuning filter is to initially tune in the desired signal with the filter switched out. The filter is then switched in by means of S2, and C1 and C2 are set to approximately mid-position. The 12-way switch S3 is next rotated for highest signal strength, as shown on the receiver S-meter, after which C2 and C1 are adjusted, in that order, for maximum strength. A final slight adjustment to C2 again, and then to C1, will give optimum results.

It should be noted that a good earth connection is necessary if the aerial tuning filter is to operate to best advantage. A gain of some two S-meter points should be given with most transmissions.

Finally, the author would like to point out that the usefulness of the unit has been almost incredible, and that it has added immensely to the pleasure he obtains from short-wave listening and from the evaluation of receiver and aerial performance. ■

THE SHAPE OF THINGS TO COME?

With all the improvements to television reception and the added attraction of colour, can we next expect to go onto three dimensional pictures? Or even the appropriate aromas to go with each pictorial scene?

No, surely not!

With an educational tour around a sewage establishment, someone would be bound to say:–

"Turn the smell down a bit!"

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

★ GUINEA REPUBLIC

'La Voix de la Revolution', Conakry, now has an English language schedule from 1830 to 1900, from 0000 to 0100 and from 0300 to 0330 on **4910** (4kW) and on **7125** (50kW). The address is:– Radiodiffusion Nationale, B.P. 617, Conakry.

★ COLUMBIA

HJAF 'Radio Sant Fe', Bogota, now has a power of 13kW (2.3kW listed) according to a recent verification. HJAF has a 24 hour schedule on **4965**. The address is:– Aereo 9339, Bogota.

★ CANADA

Radio Canada broadcasts to Europe, in English daily, from 0715 to 0745 on **9625** (50kW) and **11780** (50kW). From 1217 to 1313 on **17820** (50kW) from 1516 to 1522 featuring a newscast on **17820** and **21595** (50kW), from 2115 to 2152 (Saturdays and Sundays from 2100 to 2152) on **11715** (50kW), **15325** (50kW) and **17820.** The latter channel closes down at 2148) The address is:– Radio Canada International, P.O. Box 6000, Montreal 101.

★ SOUTH AFRICA

Radio South Africa, Johannesburg, beams a programme in English to the U.K. from 1800 to 1850 daily on **15250** (250kW) and on **21480** (250kW).

A worldwide programme in English is radiated from 0930 to 0946 on **17825, 21535** and on **25790** (all 250kW).

★ SWEDEN

Radio Sweden now broadcasts to the Far East on **11970;** to the Middle East on **11970, 15240** and **21690;** to Africa on **21690;** to Eastern N. America on **11825, 15315** and to Western N. America on **11705.**

★ TAIWAN

The Voice of Free China, Taipei, uses the following channels in parallel, **9765, 15125, 17890** (all 50kW). In French from 1700 to 1800 and in English from 1800 to 1900.

★ NEPAL

Radio Nepal has dropped the **11970** channel and reactivated the **4600** (5kW) outlet. May be heard from 0120 to 0350 with **7105** (5kW) in parallel and from 1320 to 1650 with the added **7165** channel. On Tuesdays and Saturdays the English programme (External Service) is from 1350 to 1420 with newscast at 1400.

★ INDONESIA

RRI Djakarta may now be heard from 2200 to 0000 on **9795** (20kW) – a move from **9770.** News at 2200, 2300 and 0000.

RRI Djakarta has a new outlet on **11720** (20kW) for the Foreign Service in Chinese, Malay and English from 0800 to 0930. This outlet replaces that of **11770.**

★ PORTUGAL

Ibra Radio has daily broadcasts to Europe over the 250kW transmitter of Radio Trans-Europe on **9575.** The English programme can be heard on Saturdays from 2130 to 2200 and on Thursdays from 2145 to 2200.

Acknowledgements:– Our Listening Post, SCDX. ■

LINE-OF-SIGHT COMMUNICATION
A CLOSER LOOK

by

H. A. COLE, C.Eng., M.I.E.R.E.

Some interesting facts and figures on a mode of propagation which is extensively used in present-day communications

RADIO AND TELEVISION TRANSMISSIONS IN THE V.H.F. and u.h.f. bands tend to follow a line-of-sight path, which means that their effective range is, generally speaking, about as far as the horizon. This being so, it follows that the higher the transmitting aerial, or the ground on which it is located, the further will be the range which can be covered. This is why, for example, the ITA transmitting aerial serving some eight million people in the North-West of England is situated on the summit of Rivington Moor, near Bolton; a site which is more than 1,400 feet above sea level. The aerial itself is supported by a mast of 1,000 feet, which means that the effective height of the aerial is well in excess of 2,000 feet above sea level.

To give you some idea of what is meant by line-of-sight range, imagine you are standing on the seashore at the water's edge, looking out to sea. If you are 5ft. 10in. tall, your eyes will be about 5ft. 6in. above the ground and the horizon will appear to be approximately three miles away. This fact was determined from the following simple equation, and is illustrated in Fig. 1:-

$$\text{Optical horizon (in miles)} = \sqrt{1.5 \times \text{height of observer (in feet)}}$$

Imagine you are now standing on top of a 300ft. cliff again looking out to sea, as in Fig. 2. The effective height of your eyes above sea level is now 300 + 5.5 = 305.5 ft., and the horizon is now about 21 miles away, i.e.:

$$\sqrt{1.5 \times 305.5} = 10\sqrt{4.6} = 21.4 \text{ miles.}$$

It is interesting at this stage to calculate the distance of the optical horizon presented to the pilot of a modern aeroplane flying at 30,000 ft. (about the same height as Mount Everest). Using the simple formula, this distance is found to be:-

$$\sqrt{1.5 \times 30{,}000} = 10^2\sqrt{4.5} = 212 \text{ miles.}$$

This is a formidable distance although, in practice, the visibility is unlikely to be good enough for the pilot to see as far as this.

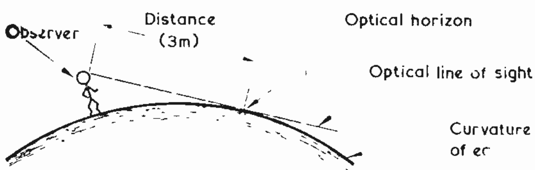


Fig. 1. The optical horizon for a person 5ft. 10in. tall is three miles away

HORIZON HEIGHT

When determining the horizon distance, it is important to know the effective height of the horizon itself. For example, if you can see 21 miles when you are 300 ft. above sea level, then someone at sea level on the horizon must be able to see you (or at least the place where you are standing) even though his optical horizon is, theoretically, only three miles: the same as yours was when *you* were standing on the seashore. What you have done is to increase his line-of sight range by bringing into view objects which were otherwise below his theoretical horizon.

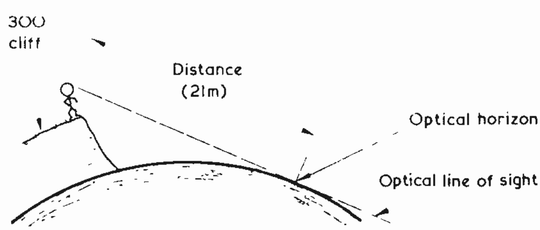


Fig. 2. The distance to the optical horizon increases with the height of the observer

To demonstrate the importance of this, consider the case where two observers are looking towards each other across a 20-mile stretch of water (the English Channel, for example). The observers could be looked upon as representing the transmitting and receiving aerials of a v.h.f./u.h.f. line-of-sight communications link.

Observer 'A' is standing on top of a 350 ft. cliff, and observer 'B' is standing on top of a 150 ft. cliff. See Fig. 3. If we ignore the comparatively small heights of the individual observers, the optical

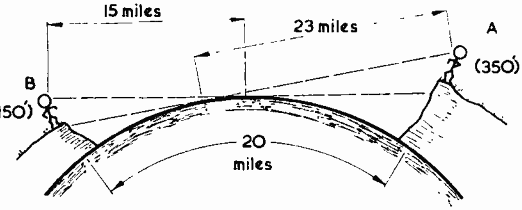


Fig. 3. Demonstrating optical line-of-sight between two distant observers

horizon of observer 'A' is $\sqrt{1.5 \times 350}$, or 23 miles approximately, and that of observer 'B' is $\sqrt{1.5 \times 150}$, or 15 miles approximately. The effective line-of-sight range of each observer is therefore $23 + 15 = 38$ miles, which is about 18 miles greater than the surface distance between them. The two observers are therefore able to communicate with each other, which they may do, for example, by visual means or by use of a 2-way v.h.f./u.h.f. radio.

It is important to realise that had the combined line-of-sight range of the two observers been *less* than their separation distance, then they would *not* have been able to communicate with each other. This is illustrated in Fig. 4, which shows the two observers of Fig. 3 now separated by a surface distance which is greater than the combined line-of-sight range.

It is usual to express the equation giving the combined line-of-sight range (r) of two observers as follows:

$$r = \sqrt{1.5Ah} + \sqrt{1.5}\ Bh \text{ miles.}$$

where Ah is the height (in feet) of observer A, and Bh is the height (in feet) of observer B.

ATMOSPHERIC REFRACTION

The simple formula used to determine the optical horizon is only valid if the light waves can be assumed to travel in straight lines between the two points of interest. In most cases they do, although there are times when they are bent, or refracted, in such a way that they tend to follow the curvature of the earth for some considerable distances. When this happens, objects which are normally far below the optical horizon suddenly come into view, sometimes with startling results. Typical examples of this happening are the desert mirage, or the sight of ships on the horizon when the observer is many miles from the sea. The reason for the phenomenon is

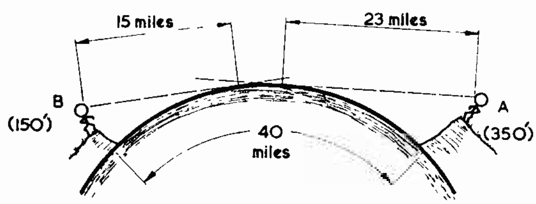


Fig. 4. The effective line-of-sight becomes broken when the distance between the two observers increases, as illustrated here

due to what is called 'temperature inversion', and radio waves are very susceptible to this.

Under normal conditions, the temperature, air pressure and water vapour content of the atmosphere decreases with increasing altitude (as any mountaineer will confirm), and radio waves travelling in the upper atmosphere tend to travel slightly faster than those travelling closer to the ground. This is because the refractive index of the atmosphere also decreases with altitude, and the velocity of a radio wave is inversely proportional to this index.* The effect is to cause the wave to droop somewhat from its expected straightline path, and to follow the curvature of the earth for some distance before continuing on its way. The effect is illustrated in Fig. 5 which shows that an object which is situated below the line of the optical horizon is within the range of what is called the 'radio (or radar) horizon'. Because of this, the simple equation used to determine the optical horizon must be modified to take into account the increased range of the radio horizon.

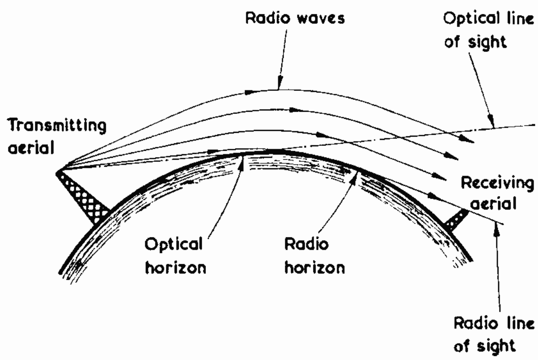


Fig. 5. The effects of atmospheric refraction

The amount by which the equation must be modified depends upon the likelihood and extent of the atmospheric refraction. Unfortunately, this is not easily predictable because it depends upon so many unknown factors. It is, for example, less likely at great heights in cold dry climates whereas it is more likely at lower altitudes in tropical, humid climates. The correction factor can therefore only be a compromise and is generally different for various parts of the world. The equation usually specified for the middle range of latitudes of the Northern hemisphere is:

$$r = \sqrt{2Th} + \sqrt{2Rh}$$

where r is the radio line-of-sight range in miles, Th is the height (in feet) of the trasmitting aerial, and Rh is the height (in feet) of the receiving aerial.

TEMPERATURE INVERSION

Another factor which can have a pronounced effect on the radio line-of-sight range is the phenomenon known as temperature inversion.

As was said earlier, the temperature and moisture content of the atmosphere normally decreases with

* The refractive index of a radio wave may be defined as the ratio of the velocity of the wave in the first medium, to that in the second.

altitude, and continues to do so for many thousands of feet. The rates of these decreases are usually quite small, and linear, as is shown by the thick-line curves in Fig. 6.

Under certain atmospheric conditions, however, which usually occur in the Spring and Autumn, there may exist regions in which a layer of cool moist air is lying below a layer of warm dry air. When this happens, the temperature gradient of the atmosphere within the layers actually increases with altitude instead of decreasing and the gradient is therefore reversed, or inverted; this is shown by the dashed-line curves of Fig. 6.

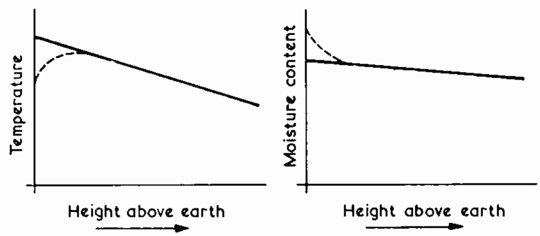


Fig. 6. Variations in temperature and moisture content of the atmosphere plotted against height above earth

The circumstances necessary to bring about a condition of temperature inversion are usually caused by the passage of warm dry air over a body of cool water (the sea or a large lake, for example). The presence of the warm air causes evaporation to occur from the surface of the water, and this is rapidly absorbed by the lower layers of the dry air. The result is a concentration of cool moist air close to the surface of the water, and below the layer of warm air above.

The region of temperature inversion may exist for only a few feet, or maybe to a height of several thousands of feet. When the effect is very pronounced, the usual curvature of the radio wave due to normal atmospheric refraction is increased to such an extent that it may exceed even that of the earth itself. When this happens, the wave is trapped between the surface of the earth and the lower of the two inversion layers and it is forced to travel round the earth for an abnormally great distance; this is illustrated in Fig. 7.

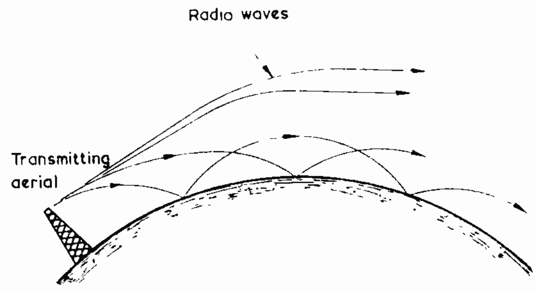


Fig. 7. 'Surface trapping' due to temperature inversion

Bending of the radio wave in this way does, of course, greatly increase the line-of-sight range of the transmitter, which may or may not be a good thing. In most instances it will upset the calibration of a radar set and cause confusion in estimating ranges. In other instances it may cause interference between radio or television programmes; as sometimes happens in this country when our reception is affected by abnormal radiation from Continental stations. Of course, if the temperature inversion could be relied upon, or readily predicted, it could be useful in extending the range of a transmitting station.

The parts of a radio wave which are most affected by the phenomenon, are those which are radiated from the aerial at fairly shallow angles. Those which are radiated at steeper angles are much less affected and are not bent sufficiently to become trapped; this is also shown in Fig. 7. ■

BOOK REVIEW

RM Singlet Set. By Paul Newell.
16 pages, 6 x 8¼in. Published by Radio Modeller Book Division. Price 30p.

This booklet, produced by the publishers of the *Radio Modeller* magazine, describes in detail a radio control transmitter and two R/C receivers suitable for use with it; one a super-regen receiver, the other a superhet receiver.

Paul Newell, its author, has described in considerable detail, the construction of R/C equipment which could be easily constructed by even an inexperienced enthusiast keen to try his hand at radio control work.

The transmitter uses the latest h.f. transistors, is crystal controlled and is simple to construct. An assembly sequence is used which enables each section to be tested as completed. A multi-test meter is all that is required for checking out and final alignment can be done with a simple field strength meter. The unit is built on a printed board, full drilling details for which are given. The constructional details given are very complete and include particulars for making up a suitable case.

Similarly, the instructions for building the super-regen receiver are complete and easy to follow. This receiver is designed specifically to work with the transmitter, giving single channel radio control. Both relay or relayless versions of the receiver are described. A super-regen r.f. detector is capacitively coupled into a two stage audio amplifier, the second stage of which is transformer coupled into either a 10 ohm actuator direct, or into a 50 ohm relay, which in turn switches an actuator. Transistors are of course used throughout. Again full drilling instructions are given for the printed circuit board.

The superhet receiver described, whilst not recommended as a "first try" at a project of this type, should not prove too difficult for the experienced constructor and no special equipment is required for setting up, other than a multimeter. Some space is given to outlining the theory of superhet receivers, which is a useful feature of the booklet, and also an explanation is given of the use of matched pairs of crystals in the transmitter and in the superhet receiver. The advantages of using a superhet receiver are also outlined. This receiver will drive an actuator or relay direct. Very full constructional details are given and checking, testing and alignment are fully covered.

This little booklet can be thoroughly recommended to both newcomers to the art of radio control and to the more experienced who we are sure will find much of interest within its covers.

Latin American Quest

(3) 60 & 90 METRE TROPICAL BANDS

SO FAR IN THIS SERIES WE HAVE DEALT WITH RELAtively 'easy-to-get' stations broadcasting from Latin America on the LF bands. Beginners who have now logged some of the transmitters listed may now care to listen for some of the low-powered South American stations operating in the 60 metre (4750 – 5060kHz) and 90 metre (3200 – 3400kHz) bands.

The stations listed represent a general 'round-up' of just what may be heard given reasonably favourable conditions and in fact are those that were logged during the 1970 'season'. Next month we shall be dealing with individual countries on the South American continent, beginning with Colombia, Ecuador, Guyana and Venezuala.

TO HEAR OR NOT TO HEAR?

That is the question. Whether one is successful in having a good listening session or not mainly depends on propagation conditions at the time. Should the right conditions for LA reception coincide with the chosen listening date and time then a certain amount of success will be possible providing the equipment, and the operator, are efficient.

Assuming the equipment is up to standard, the operator must be able to interpolate frequencies with some accuracy and should have the requisite patience to listen for, and correctly indentify, the station being received – often through man-made interference. Furthermore, he must have a genuine interest in LA reception – sufficient in providing an incentive to get out of bed at 01.00 or so clock time!

60 METRE BAND

Within the frequency limits of this band lie most most of the transmissions emanating from Latin America and it is this band which is the happy hunting ground of the LA Dx'er. A few LA transmissions are also made in the 75 metre band (3900 to 4000kHz) and in the 120 metre band (2300 to 2498kHz) but they are seldom heard on this latter band in this country.

Here then are a few stations that are relatively low-powered which should interest the budding LA specialist.

4755kHz HJKC Bogota, Colombia (1kW), "Emisora Nueva Mundo", 24 hour schedule, language – Spanish, logged at 0415 with identification.

4770kHz HCJF2 Guayaquil, Ecuador (1kW), "Radio Guayaquil", 24 hour schedule, languages – Spanish and Quechua, logged at 0330 with Coca Cola advertisement and identification.

4865kHz HCXX4 Bahia de Caraquez, Ecuador (1kW), "Radio Difusora Cenit", 1100–0335 schedule, languages – Spanish and Quechua, logged at 0305. This one may be heard after PRC5 Belem, Brazil closes at 0302.

4865kHz PRC5 Belem, Brazil (2kW), "Radio Clube do Para", 0900–0300 schedule, language – Portuguese, logged at 0300 with musical box interval signal, identification with single chime and closing. No National Anthem.

4915kHz HJSG Valledupar, Colombia (1kW), "Radio Guatapuri", logged at 0415 with station identification.

4920kHz YVKR Caracas, Venezuala (1kW), "Radio Caracas", 24 hour schedule, language – Spanish, logged at 0625 with identification.

4960kHz YVQA Cumana, Venezuala (1kW), "Radio Sucre", 1000–0430 schedule, logged at 0345 with four chimes and station identification.

5025kHz HCOB5 Cuenca, Ecuador (3kW), "Radio Splendit", 1130–0400 schedule, heard at 0330 with identification.

5035kHz ZYW22 Goiania, Brazil (1kW), "Radio Anhanguera", 0900–0400 schedule, logged at 0335 with station identification.

Having successfully logged and identified some of the listed stations (tick them in the margin) in the 60 metre band, the next progression in the LA Quest is to arrange a further listening session on the more difficult 90 metre band.

90 METRE BAND

In practical terms, propagation conditions *must* be good for the LA to UK path if success is to be achieved with low-powered stations operating within the confines 3200 – 3400kHz. Often it will be found by experience that whilst the 60 metre band LA's are coming in at good signal strengths, those in the 90 metre band are almost conspicuous by their absence! If short-skip conditions are prevailing, all the local and semi-local utility services – with which this band abounds – will 'blanket' any much weaker signals lying underneath.

A further hazard to LA Dx'ers on this band, especially during the 'seasonal' summer months, is the greater prevalence of static. Unfortunately for the LA specialist, the 'season' for LA's is also that for summer static! It will soon be found by the beginner that lightning storms, although many miles away from the home location, are easily capable of producing those annoying 'bangs and crashes' – and usually just when the station identification is being made!

However, despite the hazards, some LA specialists prefer this band for the simple reason that the successful reception, and taping, of a station identification represents a greater feat of Dx'ing than one obtained on the 60 metre band.

Here are a few stations that may be logged.

3245kHz YVKT Caracas, Venezuala (1kW), "Radio Libertador", heard at 0315 with identification.

3250kHz OCX7D Juliaca, Peru (1kW), "Radio Collasuyo", logged at 0257 with identification, repeated again at 0305.

3330kHz OAX1M Piura, Peru (1kW), "Radio Progresso", heard at 0350 with Andean flute music. Identification at 0357 and sign-off.

3350kHz OAX5J Ica, Peru (1kW), "Radio Independencia" identification at 0250. Sign-off with choral song at 0254.

3355kHz YVLC Valencia, Venezuala (1kW), "Radio Valencia", at 0300.

3378kHz HCDY4 Esmeraldas, Ecuador (0.25kW), "Radio Iris", identification at 0400. Signs off at either 0400, 0447 or at 0500!

The above represent some of the stations that may, given the right conditions, be heard on the 90 metre band. In the Latin American Quest, the band is not an easy one to explore.

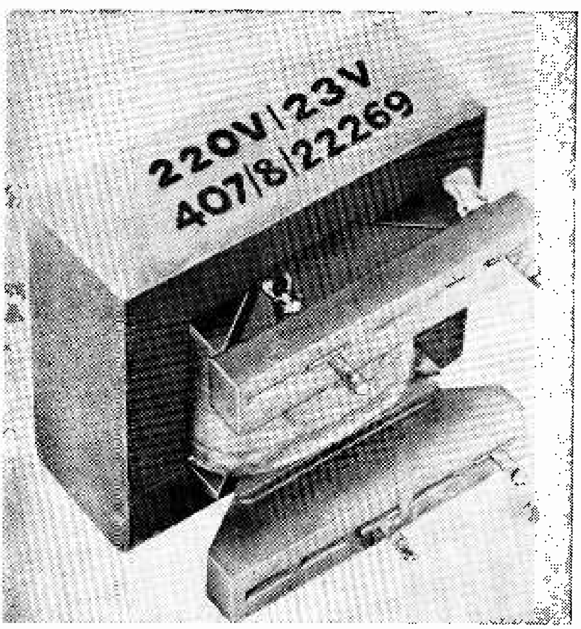
(To be continued)

NEW MINIATURE TRANSFORMERS

A new miniature laminated transformer, designed to DIN specifications, is announced by the Industrial & Electronic Components Division of Plessey Components Group.

Simplicity of construction in this high performance unit ensures low cost. Designed for use with printed circuits, the present model has a power output approaching 1.5W at an input voltage of 220V, 50Hz, and measures 30 by 25 by 25mm. It has facilities for up to ten pins for input and output connections, and the terminal strips are 20mm apart. A flying lead version is also available.

This component is primarily designed for instrumentation applications, but is also suitable for audio and other requirements.



NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **ANGOLA**

CR6RY Radio Clube do Cuanza Sul, Novo Redondo, may be heard around 2100 on **4840** (2kW). Schedule (evenings) is from 1600 to 2200. The identification in Portuguese is "Aqui Portugal, transmite de Novo Redondo, Angola, Radio Clube do Cuanza Sul". Address:- CP 10, Novo Redondo.

CR6RG Radio Commercial de Angola, Sa da Bandeira, heard often with identification in Portuguese at 2015 on **4793** (listed **4795**). Power is 10kW and the evening schedule is from 1700 to 0100.

● **EQUATORIAL GUINEA**

EAJ206 Radio Bata, Rio Muni, can often be heard around 2015 with the Home Service in Spanish on **4926** (5kW). Sign-off is at 2200, identification is "Transmite Radio Bata, La Voz de Rio Muni". The address is:- Apt. 57, Bata, Rio Muni.

● **SAO TOME E PRINCIPE**

From Portuguese West Africa, signals can often be logged from Sao Tome during the early mornings or late evenings. Schedule is from 0530 to 2300 on **4807** (1kW). The address is:- Emissora Nacional de Radioifusao, CP 44, Sao Tome. (CP = Caixa Postal).

● **KUWAIT**

Radio Kuwait can be heard, in English, from 1600 to 2100 on **4967** (10kW) with the local service. Logged at 1809 with a talk and identification. The address is:- Kuwait Broadcasting and TV Service, P.O. Box 193, Kuwait.

● **TANZANIA**

Radio Tanzania can be heard with the Home Service in Swahili on **5050** (20kW). Schedule is from 0300 to 0500 weekdays and from 0300 to 0700 on Sundays. Address is:- P.O. Box 9191, Dar es Salaam.

● **CAMEROON**

A station not often reported is that at Garoua, mainly for the reason that the channel of **5010** (4/30kW) is usually occupied by a powerful utility station. However, Garoua can sometimes be logged if conditions are right. Listen around 2130. Schedule is from 0500 to 2200 using French and local dialects. The address is:- BP 103, Garoua and the announcement "Ici Garoua Radiodiffusion de la Republique Federale de Cameroon".

● **BOLIVIA**

CP110 Radio Norte, Montero, has been reported on the new channel of **4995** (1kW), this being a move from **4870.**

● **EQUADOR**

HCEH3 Radio Progresso, Loja, listed on **4775** has now been heard on **4715** (0.2kW) with sign-off at 0410.

● **N. KOREA**

Pyongyang can be heard at 1945 with a programme in French on **6540** (120/240kW).

● **CHINA**

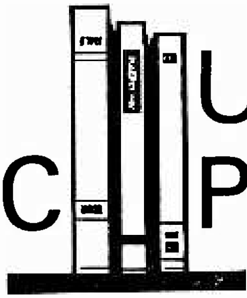
Whilst tuning around the above channel, try the **6520, 6560** and **6620** outlets of Radio Peking.

● **BRAZIL**

ZYZ34 Radio Nacional, Rio, can often be heard as early as 2230 on **6145** (50kW) with programmes of typical LA music.

Acknowledgements:- Our Listening Post, SCDX. ■

UNDERSTANDING BASIC PRINCIPLES —



by W. G. Morley

In the fourth article in this short series, which has been written specifically for the newcomer to radio, we discuss the transformer and the resonant circuit as encountered in radio receivers

IN LAST MONTH'S ISSUE WE introduced both the series resonant, or tuned, circuit and the parallel resonant, or tuned, circuit, and we saw that both of these became resonant at the frequency where the reactance of the capacitor becomes equal to the reactance of the inductor. We now turn our attention to the manner in which the 'goodness' or 'quality factor' of these resonant circuits may be determined.

MAGNIFICATION FACTOR

In Fig. 1(a) we see, once again, the series resonant circuit connected to an alternating voltage generator. (Fig. 1(a) omits the series resistor which was included in the diagram given last month, and which was intended to represent the resistance and other 'losses' present in the tuned circuit.) As we know, the series tuned circuit allows maximum current to flow from the generator at the resonant frequency, the only opposition to current flow being offered by the resistance (including 'losses') in the resonant circuit. Since the reactances of the capacitor and inductor are much higher in value than the resistance, and since the same current flows through all three, it follows that the alternating voltages which appear across the capacitor and inductor must be greater than the voltage provided by the generator. This effect actually takes place in practice, and alternating voltages which are considerably higher than the generator voltage appear across both the capacitor and inductor. These voltages have no effect on the external circuit because they are equal in value and 180° out of phase and therefore cancel out.

A similar effect appears in the parallel resonant circuit of Fig. 1(b) which, at resonance, draws minimum current from the generator. In this case, however, it is the current circulating between the capacitor and inductor within the resonant circuit which is greater than the current supplied by the generator.

The increase in voltage across either the capacitor or inductor in the series resonant circuit relative to that supplied by the generator is defined as the *magnification factor* of the series resonant circuit. In similar manner, the increase in circulating current in the parallel resonant circuit relative to that supplied by the generator is known as the *magnification factor* of the parallel resonant circuit. The magnification factor in both cases can be shown to be equal (after a mathematical step which equates voltage and current in terms of reactance) to $\frac{XC}{R}$ or $\frac{XL}{R}$, where XC is the reactance of the capacitor, XL is the reactance of the inductor and R is the resistance (including 'losses') offered by the tuned circuit. With the parallel resonant circuit these expressions hold true if it is assumed that all the resistance and 'losses' are in the inductor and may be represented by a resistor equal to R in series with that inductor. This assumption is based on the premise that there are no losses in the capacitor, and is quite valid provided that a capacitor suitable for the resonant frequency is employed.

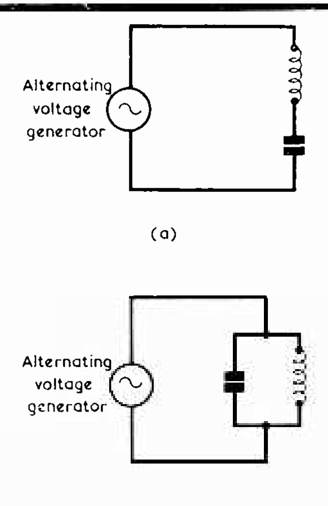


Fig. 1. An alternating voltage generator applied to (a) a series resonant circuit and (b) a parallel resonant circuit

The expressions $\frac{XC}{R}$ or $\frac{XL}{R}$ are also equal to the *quality factor*, or *Q*, of the resonant circuit. Fig. 2 gives a number of graphs showing the performance of resonant circuits with different Q values at frequencies around the resonant frequency. The resonant circuits may be either series or parallel and could be coupled to the alternating voltage generator of Fig. 1. For series resonant circuits the uppermost part of each curve corresponds to maximum current from the generator; and for parallel resonant circuits the uppermost part of each curve corresponds to minimum current from the generator. It will be seen that the curve peaks become sharper as the Q value increases. In radio work, we normally use resonant circuits to select one frequency, or a small band of frequencies, in favour of the neighbouring frequencies, and it is evident from Fig. 2 that the higher the Q of the resonant circuit, the more capable it becomes of carrying out this task efficiently. We say that the higher Q circuits are more *selective* or exhibit greater *selectivity* than the lower Q resonant circuits.

Before concluding on series and parallel resonant circuits it should be pointed out, for completeness, that the equation given last month for resonant frequency in a parallel resonant circuit is approximate, since it ignores the presence of resistance in the circuit. In practice, however, the error introduced by this approximation is negligibly low, provided that the parallel resonant circuit has a Q value of 10 or more. The equation can, in consequence, be considered as being accurate for all practical radio work, in which the Q value of resonant circuits is likely to lie between about 25 and 200. As we saw, the same equation is employed for series resonant circuits as well. With these, the equation is true regardless of the Q factor.

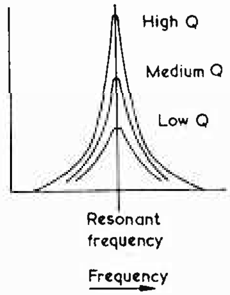


Fig. 2. High Q resonant circuits exhibit sharper selectivity than do low Q resonant circuits. These curve shapes apply to parallel resonant circuits. (They also apply to series resonant circuits but, in this case, the peaks should all be at approximately the same height along the current axis, with the remainder of the curves shifted upwards accordingly

TRANSFORMERS

We initially considered the inductor in Part 2 of this series, and we noted at that time that when a direct voltage is applied across the inductor an expanding magnetic field is produced in its turns. Let us now see what occurs if we position a second inductor close to the first inductor. This we do in Fig. 3(a), in which we also connect a centre-zero current-reading meter across the second inductor.

Fig 3(b) shows the situation immediately after the direct voltage, supplied by a battery, has been applied to the first inductor. The expanding magnetic field is produced, and some of the lines of force in this cut the turns of the second inductor and induce a voltage in it. As a result, a current flows from the second inductor into the meter, causing its needle to be deflected away from the central zero position. After a period, the expanding field reaches its full magnitude and expands no more. Since the lines of force are then at rest there are no moving lines of force cutting the second inductor and no further voltage is induced in it. The needle of the current-reading meter falls back to zero.

In Fig. 3(b) we disconnect the battery from the first inductor, whereupon the magnetic field collapses. There are now moving lines of force cutting the turns of the second inductor in the reverse direction to that which occurred previously, whereupon a voltage is once more induced but with opposite polarity. The current in the current-reading meter flows, in consequence, in the reverse direction, with the result that the meter needle is deflected to the opposite side of the zero mark. After a period the collapsing field disappears, whereupon the meter needle once more returns to zero.

It will be apparent that, if we wish the arrangement of Figs. 3(a) and (b) to be of any practical use in the production of voltage and current in the second inductor, we must find a means of continually changing the magnitude of the magnetic field produced by the first inductor. One way of doing this would consist of continually connecting and disconnecting the battery so that the field was always either expanding or contracting. But a much better scheme would consist of connecting an alternating voltage generator to the first inductor. The field around the first inductor would then expand, contract, pass through zero, expand in the opposite direction, contract and pass through zero again in a time equal to that occupied by one cycle of the alternating voltage. An alternating voltage of the same frequency would be induced in the second inductor, and an alternating current would flow in any external circuit connected to its terminals.

An arrangement employing two inductors, or coils, coupled together magnetically is described as a *transformer*, the first inductor being referred to as the *primary* coil, or *primary*, and the second inductor as the *secondary* coil, or *secondary*.

Transformers are very commonly encountered in radio work, in which they are used to transfer alternating power from one circuit to another. Amongst the many useful effects provided by a transformer is the fact that no direct connection exists between the primary and the secondary. Thus, a transformer can be used for passing power from one circuit to another without any direct electrical connection existing between the two.

In general terms, the transformers encountered in radio work tend to fall into two categories. In one of these categories the transformer is required to pass power from one circuit to another with maximum efficiency. In the other category the transformer is still required to pass power from one circuit to another, but the question of efficiency is less important than are such factors as that it provides isolation between the primary and secondary circuits. Indeed, efficiency may be purposely made quite low with transformers in the second category. Transformers in the first category consist of components intended for operation at

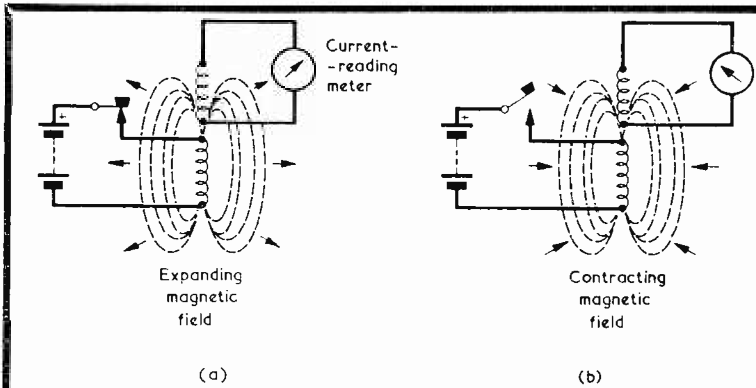


Fig. 3(a). Immediately after the battery shown here has been connected to the lower inductor an expanding magnetic fie'd appears about it, inducing a voltage in the upper inductor (b). When the battery is disconnected, the field collapses, inducing a voltage of opposite polarity in the upper inductor

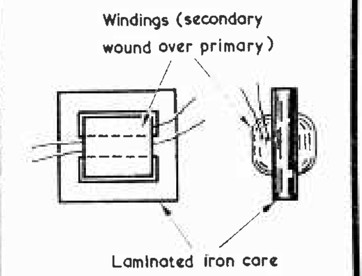


Fig. 4. Side and end views of an iron-cored power transformer having a single secondary

mains or audio frequencies, whilst those in the second category are intended for operation at radio frequencies. We shall next examine transformers which fall in the first category.

LOW FREQUENCY TRANSFORMERS

Transformers intended for operation at mains and audio frequencies are required to transfer power from primary to secondary with a high level of efficiency. Since mains and audio frequencies are relatively low, it is possible to employ a transformer having a common iron core for both primary and secondary, and thereby obtain an efficient magnetic coupling without introducing excessive losses. The core is made up of thin iron laminations insulated from each other, the insulation preventing an excessive flow of induced currents in the core itself. Such currents would produce unwanted heat, which would constitute an undesirable loss of power. The most common construction for mains and a.f. transformers consists of having the core pass through the primary and secondary and then complete the magnetic circuit around them on both sides, as shown in Fig. 4. The primary and secondary are wound on a common bobbin, the primary usually being wound on first. There is, therefore, a very high degree of magnetic coupling between the two coils. The circuit symbol illustrating this type of transformer is given in Fig. 5, the solid vertical lines between the coils indicating that they share a common iron core.

If the secondary has the same number of turns as the primary, the alternating voltage appearing across the secondary is equal to the alternating voltage applied across the primary. If the secondary has twice the number of turns that appear in the primary, the secondary voltage will be twice the voltage applied to the primary. If the secondary has half the number of turns that appear in the primary, the secondary voltage will be half the primary voltage. This relationship holds true (assuming efficient transformer design) for all ratios between secondary and primary turns and may be expressed thus:

$$\frac{\text{Secondary voltage}}{\text{Primary voltage}} = \frac{\text{Secondary turns}}{\text{Primary turns}}$$

An inverse relationship holds true for primary and secondary currents. To visualise this relationship it is helpful to think in terms of a 'perfect' transformer, this being a component which has infinite inductance and zero resistance in both its primary and secondary, and which has no 'losses' in the magnetic coupling between the primary and secondary. Let us assume that the secondary of such a transformer has twice as many turns as the primary and that 100 volts r.m.s. alternating is applied to the primary. The r.m.s. secondary voltage is therefore 200 volts. If the secondary has no load connected to it no current flows in it, and no current flows in the primary. If a resistor is connected across the secondary, the resistor having a value which causes 1 amp r.m.s. at the 200 volts available to flow in it, the current flowing in the 100 volt primary will rise to 2 amps. This is because, since the transformer is a 'perfect' component, the power (volts times amps) fed to the primary must equal the power taken from the secondary. In both cases the power is 200 watts. Had the secondary been wound with half as many turns as the primary, so that it offered 50 volts r.m.s., and had a resistor been connected across it which caused 4 amps r.m.s. to flow, the current in the primary would once more have been 2 amps. Again the power is 200 watts in both secondary and primary circuits.

We may see, therefore, that:

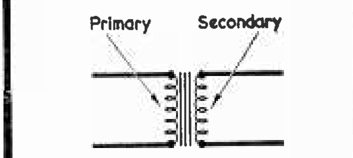


Fig. 5. Circuit symbol for an iron-cored transformer. Here, the primary is the winding on the left of the core, but it can be shown in a circuit diagram on any side of the core

$$\frac{\text{Secondary current}}{\text{Primary current}} = \frac{\text{Primary turns}}{\text{Secondary turns}}$$

We had to introduce a 'perfect' transformer when discussing the current relationship because common-sense observation informs those of us who have had experience with iron-cored transformers that a small current flows in the primary even when no current flows in the secondary. This current is loosely referred to as 'magnetising current', and is that required to overcome 'losses' including 'losses' in the core. The primary current which flows due to secondary current is then, approximately, the 'magnetising current' plus the current indicated by the equation just given.

It is common to specify a transformer in terms of its *turns ratio*, the figure for the primary appearing first. Thus, if the secondary has three times as many turns as the primary the component is a 1 : 3 transformer. Again, if the secondary has one-fifth of the primary turns, the component is a 5 : 1 transformer. The transformer is described as a *step-up* transformer when the secondary has more turns than the primary and as a *step-down* transformer when the secondary has

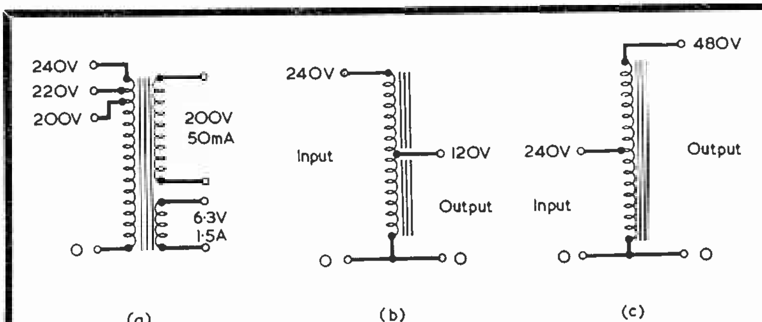


Fig. 6(a). Power transformers are normally specified in terms of secondary voltage and current. In this typical example of a mains transformer, the primary has taps for 200, 220 and 240 volt mains supplies, and the secondaries provide 200 volts at currents up to 50mA and 6.3 volts at currents up to 1.5 amps
(b). A 2:1 step-down autotransformer
(c). A 1:2 step-up autotransformer

fewer turns than the primary. Alternatively, and particularly if the component is intended as a power transformer for driving equipment from the mains, it may be specified in terms of the secondary voltage and maximum secondary current which may be drawn. Mains transformers frequently have more than one secondary, a typical example being shown in Fig. 6(a). It is possible also to have one section of either the primary or secondary common to the other, thereby forming an *autotransformer*. Two typical examples of the autotransformer, both intended for 240 volt a.c. mains input, are illustrated in Figs. 6(b) and (c). The autotransformer provides a saving in wire and winding space, but does not have isolated primary and secondary circuits.

Audio frequency transformers are normally referred to in terms of turns ratio, and their physical size depends mainly upon the power they are called upon to carry and the efficiency with which they are required to handle the wide range of frequencies in the a.f. spectrum. Transformers intended for coupling high power a.f. amplifiers to loudspeakers can be quite large in physical size, of the same order as mains power transformers. Transformers coupling a.f. amplifiers to loudspeakers are often specified in terms of the impedances of the circuits they couple together. A brief example will illustrate the manner in which this specification operates.

Let us say that we have an a.f. amplifier which functions at its best if it feeds the output a.f. signal into a 16Ω load. This would normally be a 16Ω loudspeaker functioning, so far as the amplifier is concerned, as though it were a 16Ω resistor. Only a 4Ω loudspeaker is available. A little thought will show that, for the same power, a 4Ω loudspeaker will require less a.f. voltage across it and greater a.f. current through it than does a 16Ω loudspeaker, and so the transformer we require will be a step-down component, connected as in Fig. 7. The ratio required in the transformer is the square root of the ratio of the impedances, which works out, in our example, as the square root of 16 : 4 or, simplifying, the square root of 4 : 1. The transformer required will need a turns ratio of 2 : 1.

We can take this example a little further by assuming, next, that at a certain output level the amplifier of Fig. 7 applies an r.m.s. voltage of 16 volts across the primary of the 2 : 1 transformer. The voltage appearing across the secondary will be 8 volts, which will cause 2 amps to flow in the 4Ω loudspeaker. From the current transformation examples we have just seen, this means that a current of 1 amp will flow in the primary. So for an output voltage of 16 volts from the amplifier an output current of 1 amp flows in the transformer primary, which is equivalent to the amplifier feeding into a 16Ω load.

The process of converting one impedance to another in this manner is referred to as 'matching', and the turns ratio required may be summed up by stating that, for a matching transformer,

$$\frac{\text{Primary turns}}{\text{Secondary turns}} = \sqrt{\frac{\text{Input impedance}}{\text{Output impedance.}}}$$

The same equation applies for a step-up transformer which matches a low input impedance to a high output impedance.

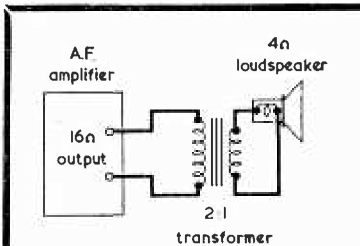


Fig. 7. Employing a transformer for matching a loudspeaker to an a.f. amplifier. This diagram also, incidentally, introduces the circuit symbol for a loudspeaker

R. F. TRANSFORMERS

Transformers intended for radio frequency work fall into the second category referred to earlier. They rarely have magnetic coupling between primary and secondary which is as *tight* (i.e. close, or efficient) as is given in mains and a.f. transformers. Frequently the coupling is intentionally quite *loose*.

A typical example of an r.f. transformer with a loose coupling is given in the aerial input stage of a radio receiver employing an external aerial and earth connection, the circuit employed being illustrated in Fig. 8(a). The aerial and earth connect to the primary winding of an air-cored r.f. transformer, this winding coupling loosely to a secondary which forms part of a parallel resonant circuit. See Fig. 8(b). The resonant frequency is varied by a variable capacitor, or tuning capacitor, which may be one section of a ganged capacitor or, in a very simple receiver, the only tuning capacitor provided. We know that a parallel resonant circuit connected to an alternating voltage generator draws minimum current at the resonant frequency, which is another way of stating that it offers maximum impedance at that frequency. All the signals picked up by the aerial and earth system will be applied to the primary of the r.f. transformer of Fig. 8(a) and these will induce corresponding currents into the secondary, which is part of the resonant circuit. The greatest voltage across the resonant circuit will correspond to the signal at its resonant frequency, because that is the frequency at which the impedance of the circuit is highest. (This corresponds to the situation we considered last month, when an alternating voltage generator of varying frequency was applied to a parallel resonant circuit.) We then say that the resonant circuit has 'tuned in' the particular frequency at which it is resonant. It will be obvious from Fig. 2 that the fre-

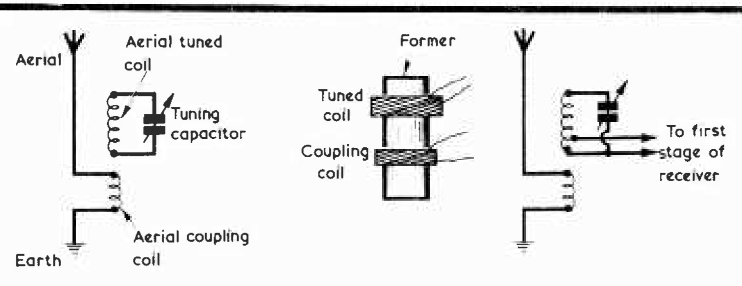


Fig. 8(a). A typical r.f. transformer, as encountered in a radio receiver. Two new symbols, those for aerial and earth, are introduced here
(b). The coupling between the two coils in (a) is normally relatively loose, the coil having the typical construction illustrated. The 'former' is a tube of insulating material on which the coils are wound
(c). If the first stage of the receiver operates at low impedance it may be fed from a tap in the aerial tuned coil

quency will be tuned in with less interference from signals on neighbouring frequencies if the tuned circuit has a high Q.

In practice we do not often use the term 'transformer' to describe the arrangement shown in Fig. 8(a). More general usage consists of referring to the secondary as the 'aerial tuned coil' and the primary as the 'aerial coupling coil'. Nevertheless, the arrangement is still a transformer.

The signal r.f. voltage appearing across the tuned coil in Fig.8(a) may be applied to the input circuit of the associated receiver. If this operates at high impedance (as occurs when a valve or field-effect transistor appears in the first stage, or section, of the receiver) the connections may be taken from the outside ends of the coil. If the input circuit has a low impedance (as occurs with most transistors) the connections cannot be taken from the outside ends of the coil. This is because the low impedance across the coil would tend to nullify the comparatively high impedance given by the tuned circuit at resonance, whereupon the tuned circuit will operate as though it had a low Q. The input circuit can, however, connect to a tap part way up the tuned coil, as in Fig. 8(c). Here we have the high impedance offered by the tuned circuit coupling to the low input impedance by way of a step-down transformer, the transformer in this case being the autotransformer given by the tuned coil and its tap.

A popular type of aerial for medium and long wave reception is the *ferrite rod* aerial. This aerial comprises a tuned coil wound on a rod or slab of ferrite material with a tuning capacitor in parallel, as illustrated in Fig. 9(a). The result is a parallel resonant circuit of very high Q in which the inductor acts as a sensitive aerial on its own without any external aerial wire being required. The tuned coil can connect directly to a high impedance receiver input circuit but a step-down autotransformer connection, as in Fig. 9(b), is required if it couples into a low impedance input. An alternative method is illustrated in Fig. 9(c), where a coupling coil having considerably fewer turns couples the high impedance tuned coil to the low impedance input circuit. Here again, we have a step-down transformer, this time with separate windings, to provide impedance matching. In this instance the coupling winding is tightly coupled to the tuned coil, in most cases being wound directly over it at one end.

The r.f. transformers illustrated in Figs. 8 and 9 have one of the coils tuned. This is a common feature in radio work and it is seldom that an r.f. transformer without at least one of the coils tuned is encountered. Also, the resonant circuits employed are nearly always of the parallel, rather than the series, type.

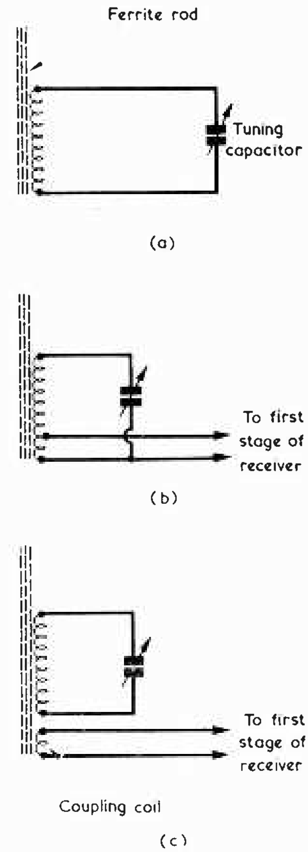


Fig. 9(a). The ferrite rod aerial is very commonly employed for medium and long wave reception. A coil is wound on the ferrite rod, the tuning capacitor connecting directly across it

(b). A tap may be provided in the ferrite rod tuned coil if the receiver first stage input is at low impedance

(c). Alternatively, a coupling coil having fewer turns than the tuned winding may be employed to feed a low input impedance first stage

NEXT MONTH

In next month's article we shall investigate the processes involved in amplitude modulated transmission and reception. ■

In your workshop

Radio and television fault-finding can be carried out by means of exceptionally cheap and simple service aids. In this month's episode Smithy the Serviceman introduces Dick to two of these: one being employed for signal tracing and the other for signal injection

"Well, stap me!"

Dick turned round, his curiosity aroused by this sudden utterance from the Serviceman. It appeared that Smithy had been clearing out a drawer in his bench, since the bench surface was covered with odd bits and pieces of varying antiquity, together with the drawer itself. The latest item retrieved by Smithy was obviously that which had prompted him to announce his willingness to submit to stapdom, and the Serviceman gazed fondly at the object which he now held in his hand. Intrigued, Dick walked over and examined it.

"Corblimey," he snorted in disgust. "From the way you called out I thought you'd struck oil in there or something. Why are you making all this fuss over *that* thing?"

A.F. TRACER

"This device," retorted Smithy indignantly, "which you refer to so contemptuously as a 'thing', is a servicing aid which has rendered me considerable assistance in the past."

"Considerable assistance?" repeated Dick incredulously, "why, it's nothing else but an ordinary large-size headphone!"

"An excellent description," commended Smithy. "As a matter of fact it's one of the earpieces from a standard pair of high resistance headphones, and it has the usual coil resistance of 2,000Ω. It also has a length of 2-core flex connected to it."

"How on earth," asked Dick, returning to the attack, "could a gubbins like that give you all this considerable assistance you're talking about?"

"I used to employ it in fault-finding," explained Smithy. "In the old days I didn't have service gear which is as efficient as that we use at present and I often relied on simple auxiliary items to help me out. A single headphone was one of these items, and it was excellent for signal tracing in faulty receivers. Indeed, a single headphone, properly used, can be an ideal fault-finding aid for anyone who only does occasional servicing and who doesn't want to spend a lot of money on proper test gear. A mate of mine does the odd service job on the side every now and again, and he often uses a headphone to trace signals through a faulty set."

"Well," conceded Dick reluctantly, "I suppose it *could* be of use in simple radio servicing."

"He uses it for fixing TV's, too."

"Pull the other one, Smithy," advised Dick. "This one is completely encrusted with bells."

"I'm perfectly serious," stated Smithy. "It would be silly to say that you can do *all* fault-finding with a single headphone. At the same time, though, it's surprising how much you can do once you get the knack of using it."

"Well then, how *do* you use it?"

"As I've already remarked," replied Smithy, "you use it for signal tracing. Let's start off with its use as an a.f. tracer for checking the passage of a signal through a faulty a.f. amplifier. In this instance you terminate one lead from the headphone in a crocodile clip, which connects to the chassis of the set or amplifier you're working on, and you terminate the other lead, via a series 0.02μF high voltage capacitor, in a test prod. If you're dealing with high level signals you can also add a series 1MΩ resistor. What you then do is to feed a signal into the amplifier and, starting at the input end, prod along its stages until you find the point at which the signal disappears."

"Carrying out that process with a headphone," remarked Dick critically, "doesn't sound to me like the culminating point in efficient modern servicing."

"It isn't intended to be," returned Smithy, a little irritably. "As I keep telling you, all it's meant to be is a useful dodge for people who don't have a lot of expensive service gear around the place. Besides, it's not all that inefficient in any case."

"What makes you say that?"

"Because there is a fantastically wide dynamic range of amplitude levels at which the headphone can operate. This is why a single headphone is employed instead of a full pair of phones with a headband. The single headphone is held up against the ear with one hand whilst the other hand holds the test prod. If you anticipate a signal at high level you hold the earphone some distance away from the ear, whilst if you're looking for a weak signal you hold it up tight. If you used a *pair* of headphones they'd be continually pressed against your ears and you'd be working at maximum sensitivity all the time. An unexpectedly high level signal would then, to say the least, be uncomfortably if not painfully loud. The same applies if you employed an earpiece of the personal type which is intended to lodge in the ear."

"How," asked Dick, "did you connect up the series 0.02μF capacitor and 1MΩ resistor?"

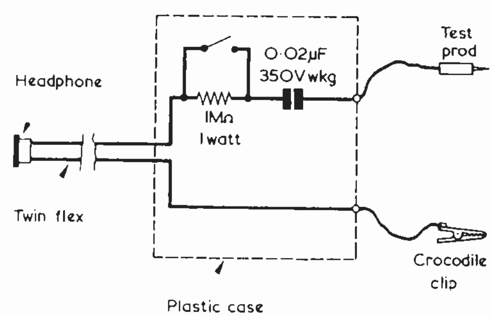


Fig. 1. This simple a.f. signal tracer has a large number of applications in radio and TV fault-finding

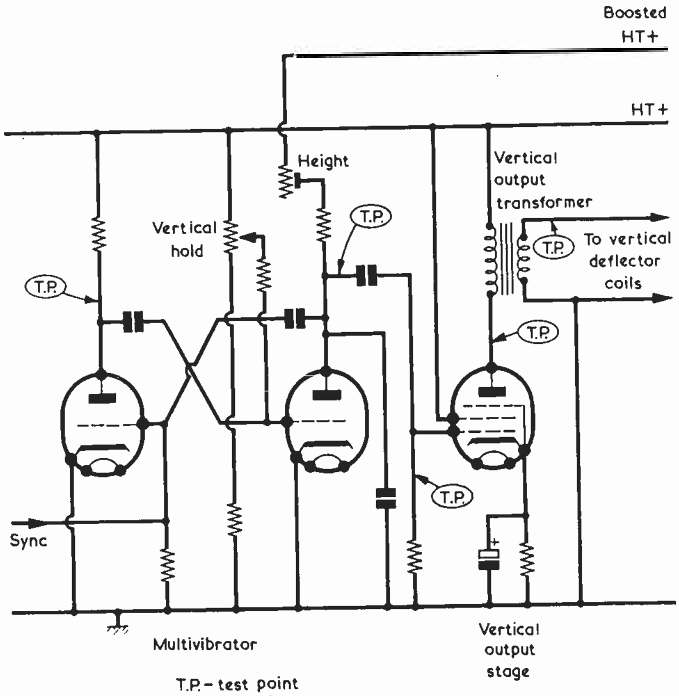


Fig. 2. A basic vertical timebase oscillator and output stage, illustrating suitable test points for audio signal tracing

"I used to use temporary connections," replied Smithy. "But if you wanted to, you could put the components in a little insulated box, complete with a switch to short out the 1MΩ resistor when it wasn't wanted." (Fig. 1).

"Hmm," grunted Dick, impressed despite himself. "I should imagine that that covers all the a.f. signal tracer applications that headphone can offer. What uses does it have in TV sets ?"

"Plenty," replied Smithy. "The first and most obvious one is, of course, that of signal tracing through the sound a.f. stages. Secondly, you can use the headphone to check the vertical timebase circuits. Suppose for instance you've got a set with no vertical scan. If the vertical timebase consists of a separate valve multivibrator feeding a vertical output valve (Fig. 2) the headphone will tell you at once whether or not the multivib is running. Since there will be some pretty high oscillatory voltages knocking around, it would be necessary to have the 1MΩ resistor in series for these tests. If you apply the test prod to either of the multivib anodes you'll hear a good old raucous 50Hz buzz if the multivib is running. You can then trace that buzz through to the vertical output grid, to the vertical output anode and, finally, to the secondary of the vertical output transformer and the vertical deflection coils themselves. Don't forget, incidentally, that there'll be some fairly high voltages on the vertical output anode, so the test prod should have good insulation."

"What happens," asked Dick, "if the vertical output valve is also part of the multivib ?" (Fig. 3).

"In that case," replied Smithy, "you can still check that this multivib is running and whether the timebase signal is getting through to the vertical output transformer secondary."

VIDEO CHECKS

"This headphone idea," remarked Dick, "seems to be rather better than I thought at first. It's almost as though a headphone is the poor man's oscilloscope !"

"It's certainly useful," stated Smithy, "for signal tracing when the signals have an audible content. Another TV application is given when you've got no video getting through to the tube, since you can trace the video signal all the way from the vision detector to the tube cathode. The video signal has a strong 50Hz component, which is readily audible. If you're lucky so far as choice of headphone and your own hearing ability is concerned, you can even trace the line timebase signal, although you wouldn't, of course, check at any e.h.t. points

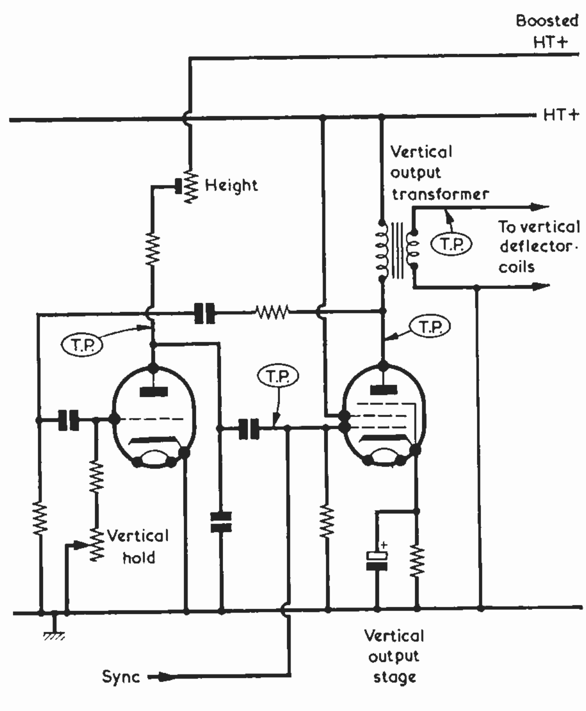


Fig. 3. In some television receivers, the vertical output valve also forms half of the timebase multivibrator, as illustrated in this simplified circuit

such as a line output valve anode."

"I've just had an idea," broke in Dick. "Why not add a diode to the phone and use it as an r.f. signal tracer as well ?"

"Why not ?" repeated Smithy. "A 100pF series capacitor and a shunt germanium diode such as the OA71 would do the trick very nicely." (Fig. 4(a)). "In fact you could add these two components to the little insulated box with the switch on it I was talking about just now." (Fig. 4(b)). "When the 100pF capacitor and diode are in circuit the headphone unit will detect and reproduce any reasonably high level amplitude-modulated signal, but I must warn you not to expect any significant output from the early stages of a receiver. And, of course, the diode won't detect frequency-modulated signals."

"If you're using this detector with a receiver," said Dick, "the latter should be tuned in to a pretty powerful signal, shouldn't it?"

"That would help," agreed Smithy. "And to finalise on this headphone business I should point out that you want to try it out in practice on a number of serviceable sets and amplifiers first, so as to get the 'feel' of how it operates. Don't start off straightaway on a faulty receiver or your unfamiliarity with the results that are given may mislead rather than help you. Also, you'll get signal levels with transistor circuits that are different from those you get with valve circuits."

Smithy stopped for a moment, and collected his thoughts.

"Oh yes," he went on, "there's one more point I should mention. Don't use a headphone which has exposed terminals or a metal body. The headphone should be completely insulated. There are enough shock hazards in our job without adding to them !"

A.F. INJECTION

"Well," said Dick musingly, "that seems to clear the field so far as inexpensive service aids for signal tracing are concerned. Is it possible to have low-cost gadgets which provide signal *injection* ?"

"A simple signal injector for audio work can be made up quite easily and at little expense," replied Smithy, "and it would just consist of an a.f. oscillator running at about 1kHz. I'm not so keen on simple signal injectors for radio frequencies. I personally prefer to use a conventional modulated signal generator for r.f. work."

"How would you make up the audio frequency injector ?"

"A single transistor a.f. oscillator would do the trick quite nicely," said Smithy. "It wouldn't be a lab instrument, but it would still be very useful in practice. Also, it could easily be carried around for doing service jobs at home or in other people's houses."

As he spoke the Serviceman

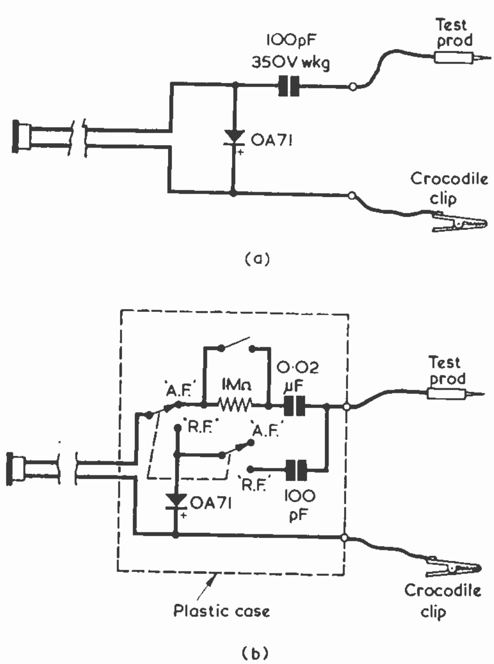


Fig. 4(a). An r.f. signal tracer
(b). By the addition of a d.p.d.t. switch the r.f. tracer can be combined with the a.f. tracer of Fig. 1

chanced to glance at the Workshop clock.

"Dear, oh dear," he sighed, "I see you've done it again."

"Done what ?"

"Conned me into wasting valuable time in talking when we should be working. How on earth do you manage to do it ?"

Dick's expression was Innocence Incarnate.

"I don't start this talking business on *purpose*, Smithy," he said reproachfully. "Indeed, it's rather the other way round. I just don't like to stop you when you're holding forth about something you're interested in."

Smithy directed a gaze of intense suspicion at his assistant's guileless face.

"And I certainly," continued Dick, applying a further layer of cajolement with the effortless skill of long practice, "wouldn't have *dreamed* of engaging in a discussion if it wasn't for the fact that work was rather quiet at the time being."

Smithy looked around him. It was true that the Workshop was temporarily going through a slack period. This had, in fact, been the reason why he had cleared out his bench drawer in the first place.

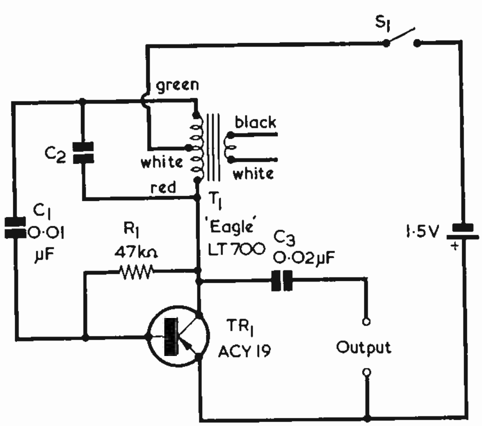


Fig. 5. The a.f. oscillator circuit checked out by Dick. The value required in C2 has to be found experimentally

"Oh, I give up," he snorted in disgust. "If ever there was a pastmaster in flannel you would be it, mate. You're lucky, too. What you don't know is that I've been thinking for some time that we could do with a home-built a.f. injector in this place. We've only got one a.f. signal generator and there have been a lot of occasions recently when we've both wanted to use it at the same time. So we're due to have a natter about a.f. signal injectors in any case."

"Perhaps we could actually knock one up now," put in Dick, suppressing the glint of triumph in his eyes. "I've got a real itch to do some constructional work at the moment."

"We'll have to make an experimental lash-up first," said Smithy. "This is because I don't know for certain the values I'll be requiring in some of the components until I've tried out the oscillator circuit in practice."

Smithy drew his note-pad towards him.

"I think," he said reflectively, "that we'll use one of those little Eagle LT700 transistor output transformers in this oscillator. I've got a few knocking around and one of them would be just the job for an oscillator like this."

Smithy opened one of the remaining drawers in his bench and extracted a small cardboard box.

"Ah, that's good," he remarked, "the lead-out colour coding is given on the box."

He took out his pen and quickly drew out a circuit. (Fig. 5).

"This circuit will do for starters," he remarked. "The LT700 has a centre-tapped primary and this fits nicely into a Hartley oscillator circuit. The inductance of the winding is tuned by C2, and we'll have to find a suitable value for this capacitor after we've got the oscillator going. A transistor of the ACY19 class will do and, since this will have a fairly high gain, we won't need too much feedback to the base. So we'll make C1 0.01μF, which has a reactance of slightly more than 15kΩ at 1kHz."

"What about R1 ?"

"We'll make that pretty high to keep current consumption down," stated Smithy. "The value of 47kΩ I've shown in my sketch should be all right. At a supply potential of 1.5 volts this will mean a base bias of about 30μA, which should raise the base current reasonably well above leakage value."

"A supply potential of 1.5 volts ?" repeated Dick. "Are you sure ?"

"Of course I'm sure," retorted Smithy, indignantly. "Blimey, I've marked it '1.5 volts' in my circuit diagram, haven't I ?"

"But isn't 1.5 volts rather low ?"

"Not at all," returned Smithy. "If we get an output from this effort in excess of 1 volt peak-to-peak that should be more than adequate. So why waste batteries ? A single 1.5 volt cell will be perfectly satisfactory."

Dick shrugged his shoulders.

"If you say so," he remarked. "Anyway, what's the next thing to do ?"

"It's for you," said Smithy, "to make up that little circuit in temporary form on an odd bit of tagboard or something like that. Wire it up initially without any capacitor in the C2 position."

Dick found a tagboard and the few components required, and quickly wired up the temporary circuit on Smithy's bench. The Serviceman leaned over, checked Dick's wiring for errors and gave a grunt of satisfaction.

"Very good," he commended. "Right now, connect up to the 1.5 volt supply and see if this circuit oscillates. You can check for oscillation with that single headphone I was talking about just now. Simply put one of its leads to the collector of the transistor." (Fig. 6).

"Blow me," grumbled Dick. "This is going to be a right mess-up, I can see. First of all you want this thing to oscillate with only 1.5 volts supply and now you want me to monitor it by connecting just *one* lead of this headphone to it. I daren't even ask you where I should put the other lead."

Smithy refused to pass any comment, and Dick mutinously set about connecting the oscillator to the 1.5 volt cell. He then took up the earphone, held it against his ear and suspiciously touched one of its leads to the collector lead-out of the ACY19. He gave a gasp of surprise.

"It's working," he called out. "It's actually working."

"Of course it's working, you twit," snorted Smithy. "With an oscillator circuit as simple as that, there'd be something pretty badly wrong if it didn't."

"But I *heard* it. The oscillator tone was weak, mind you, but it was definitely there. And I've only got one headphone lead connected !"

"You heard that tone," said Smithy, "because standard 2,000Ω headphones are very sensitive, surprisingly so in fact. The tiny bit of stray capacitance between the headphone lead you didn't connect and the wiring in that oscillator was sufficient for the tone to be reproduced in the phone. Incidentally, this method of connecting a headphone represents a very useful tip for those occasions when you want to check the operation of an a.f. oscillator without loading it too much. You simply connect *one* lead of a high resistance headphone or pair of headphones to any point in the oscillator circuit which should be carrying the oscillatory voltage at fairly high voltage level. You can nearly always hear the tone if the oscillator is working."

OSCILLATOR TUNING

"That's something I'll definitely bear in mind for the future," said Dick. "The frequency was pretty high, by the way."

"Then we'll bring it down," replied Smithy, "by fitting a capacitor in the C2 position. Let's start off with 0.02μF."

"Righty-ho," returned Dick. "I'll have one soldered into circuit in a flash."

Dick quickly disconnected the 1.5 volt cell and connected an 0.02μF capacitor across the primary of the LT700 transformer. He reconnected the cell and listened to the earphone.

"Still too high, I think."

Smithy took the headphone from him and listened.

"Yes," he agreed, "it could come down a little lower than this. Slap another 0.02μF capacitor across the one you've just put in."

Dick carried out Smithy's instructions, and the pair listened to the result.

"That's better," said Smithy. "This particular LT700 transformer oscillates at around 1kHz with 0.04μF across its primary. Now connect that headphone across the proper output points, so that it follows C3."

Dick reconnected the headphone. The sound it produced now was clearly audible to both of them.

"The frequency," remarked Dick critically, "seems to be a bit lower than it was when I had only one headphone lead connected."

"It probably is," said Smithy. "When you're directly coupling into an oscillator of this nature its frequency will change a little with different loads, particularly if they're inductive. Now let's see what happens if we connect the output to a 3Ω speaker."

Smithy walked to the spares cupboard and returned with a small speaker. He connected this to the output of the oscillator. The tone was just barely audible.

"Not too bad," he remarked. "The oscillator gives a perceptible effect even with a load of this nature. I shall now demonstrate a little trick which I've kept up my sleeve. I didn't choose an output transformer for this a.f. oscillator merely because it has a convenient primary. I chose it because it also has a convenient secondary."

Smithy connected the black and white secondary leads of the LT700 transformer to the 3Ω speaker. This now produced a strong and clearly audible tone.

"That's it then," said Smithy cheerfully. "We now have an a.f. signal injector with a high voltage high impedance output and a low voltage low impedance output. So let me next draw up its circuit in final form."

Smithy returned to his note-pad and proceeded to draw up the final circuit for the a.f. signal injector. (Fig. 7).

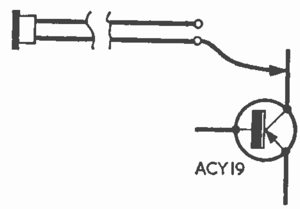


Fig. 6. In many cases it is possible to check the operation of an a.f. oscillator by applying one lead only of a high resistance headphone to a high amplitude circuit point. Here, the connection is made to the ACY19 of Fig. 5

"There you are," he said. "As you'll see, you've got two quite separate outputs. For valve amplifiers you'll normally use the high voltage output, relying only on the low voltage output for checking the speaker itself. And for transistor amplifiers you'll normally use the low voltage output all the time. For connection into the equipment being tested, you'll require two lengths of flex with plugs suitable for the output sockets. The free end of one length of flex will terminate in a crocodile clip for clipping to the chassis of the amplifier under test and the free end of the other length of flex will terminate in a test prod."

"You've marked the low voltage output terminals plus and minus," commented Dick.

"That's right," agreed Smithy. "It's necessary to insert a series capacitance in the low voltage output circuit and, because of its low impedance, this has to be a relatively high value electrolytic component. Test connections must be made such that the polarity marked on the output sockets agrees with the polarity of any voltage across the circuit points being checked. Also, this last voltage must not exceed the working voltage of the electrolytic in the injector. I've specified a 64 volt capacitor and indicated a maximum voltage of 60 at the terminals. This should be adequate in practice."

"If," objected Dick, "you connect the output terminals to a speaker there won't be any polarising voltage for the electrolytic."

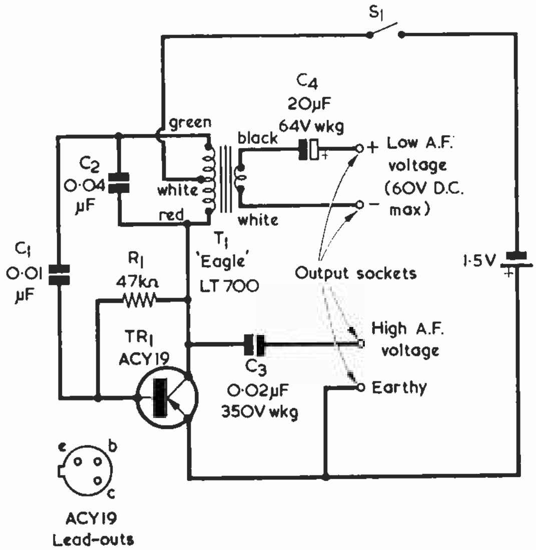


Fig. 7. The final circuit of Smithy's a.f. injector has a low voltage output in addition to the high voltage output. The amplitude of the latter is in excess of 1 volt peak-to-peak

"True," agreed Smithy. "But you'll find that an electrolytic capacitor exhibits a low impedance even without a polarising voltage at all. No harm will result if it is operated in such a manner for short periods, as would occur here."

"I wonder," mused Dick, "how much current this oscillator draws from the 1.5 volt cell."

"I can think," remarked Smithy gently, "of a very easy way of finding out."

Taking the hint, Dick pulled Smithy's testmeter over and, switching it to a suitable current range, inserted it in series with the negative supply to the oscillator.

"Blimey," he said, "this circuit isn't bad at all. The oscillator's only drawing 0.4mA."

"Good," replied Smithy decisively. "Well, that just about buttons up its design. When you've cleared the odd few sets that are still waiting to be fixed, you could perhaps make up that oscillator in more permanent form, fitting the works in a neat little plastic box or something like that. The components won't take up much space."

COMPONENT CHANGES

"Okey-doke," said Dick obligingly. "I suppose this circuit could be built up by anybody else who also wanted a simple a.f. signal injector."

"Oh definitely," confirmed Smithy. "There are several points to note, though. It may be necessary to use a value other than 0.04μF for C2 to get the tone desired, as there's bound to be some tolerance on the primary inductance of the transformer. Nevertheless, 0.04μF or thereabouts represents a good starting-off value. With a high-gain transistor like the ACY19, C1 should be quite large enough at 0.01μF and R1 small enough at 47KΩ. Low gain specimens *could* require C1 to be increased or R1 to be decreased a little, but I doubt whether such changes in value would be required in practice."

With a gesture of finality, Smithy took up Dick's temporarily wired-up tagboard and placed it on the shelf at the rear of his bench.

"And that," he remarked, "is that. There's a nice little job waiting for you in the future."

"Good show," replied Dick keenly. "For the time being, though, it looks as if I'll have to get back to the normal business of servicing."

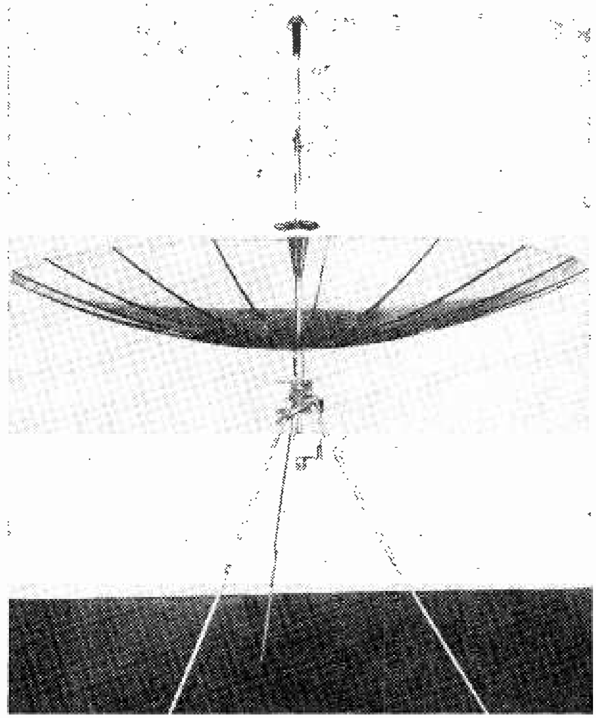
"Something along those lines," commented Smithy, "would seem to be indicated."

"I think," said Dick, "I'll borrow that headphone of yours. I might use it on a few future fault-finding jobs to get the hang of its use."

"Help yourself," replied Smithy. "Even if you only use the headphone occasionally, it may still represent another weapon in your armoury. And since the real task of the service engineer is to locate a fault in the quickest possible time, any tool which helps you here, however humble it may be, represents a true asset."

A statement, it may be noted in conclusion, whose accuracy is exceeded only by the rich variety of metaphor it contains. ■

APOLLO COMMUNICATIONS



The recent mission to the Moon by the spacecraft Apollo 14 brings to the fore, as far as radio hobbyists are concerned, an interest in the methods by which communications were maintained with Mother Earth. In this short article, we present some information on the communications systems adopted by the Apollo space programme

WHEN YOU WEIGH 30 POUNDS and you are standing on the surface of the moon, aiming a 2.5 pound S-band antenna for transmission of real live television, voice and telemetry data at the earth is not the easiest task.

That is why engineers at RCA's Defence Electronic Products in Moorestown, New Jersey, U.S.A., under contract to Grumman Aircraft Engineering Corp., decided on a length of flexible shaft coupled to the cranking mechanism which adjusts the antenna in azimuth and elevation.

The reason for choosing a flexible shaft instead of direct gearing was simple: it completely isolates any motion of the astronaut from the antenna, and reduces the time required to bring it into precise alignment with the direct communications path.

Time is important. In fact, the antenna was designed to be a very small package, carried outboard of the Lunar Module, but capable of automatically opening to a paraboloid, 10 feet in diameter, within about 20 seconds. Allowing for erection of the tripod, and fine-pointing the big dish via a built-in telescope, the total elapsed time should be no more than 20 minutes.

A type 150L65 flexible shaft, made of stainless steel, was engineered specifically by S.S. White Division of Pennwalt Corporation, New York City, for this application.

Capable of a minimum torsional breaking load of 22 in.-lb. in either direction, this control shaft is 0.15in. in diameter and close to 15in. long. After special stainless steel fittings have been secured to both ends, the assembly was shipped to RCA where it was covered with a special housing. One fitting was inserted into the "gear-shift" inside the antenna, the other end connected to a lightweight crank.

By pushing the control shaft fully into position, the elevation gear is engaged. If the astronaut wishes to turn the antenna about a vertical axis, a pull on the shaft engages the azimuth gear. Cranking the remote control flexible shaft will adjust the antenna through 360 degrees in azimuth, or down as far as 90 degrees from the vertical. The importance of precision alignment, and the need to prevent jogging the antenna unnecessarily, is underscored by the fact that, seen from the moon, mother earth subtends an arc of only some two degrees.

Most readers will know that some radio frequencies, those commonly termed the 'popular bands', are unable to leave the Earth and the immediate environment, being refracted by the ionospheric layers and turned back towards us – hence the world-wide contacts that are made on frequencies up to 30MHz.

Radio waves are grouped according to their oscillation count, those up to 30 million cycles per second being bounced back from the ionised layers surrounding the planet Earth.

VHF (very high frequencies) and UHF (ultra-high frequencies) however are endowed with the property of breaking through these layers and thereby reaching far into outer space. VHF and UHF waves travel in a straight line and will only bounce back when a solid obstacle is encountered. It is these frequencies which have made space communications possible.

SPUTNIK I

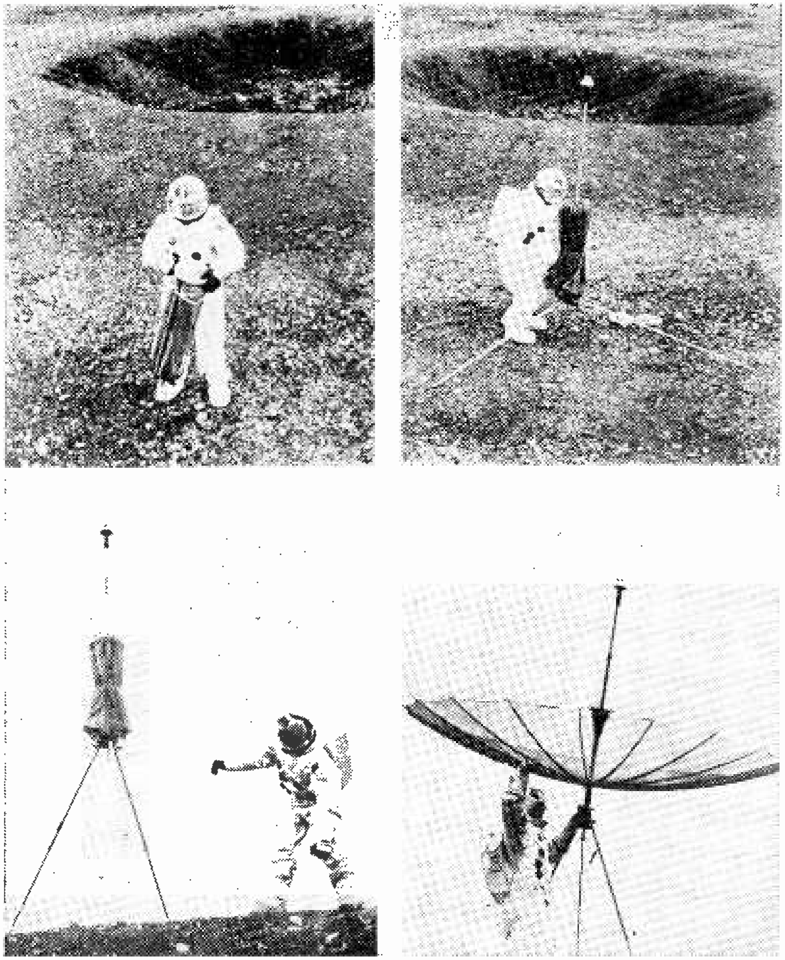
In the early days of artificial satellites orbiting the Earth (1950's) signals from Sputnik I could be received on 20MHz. The writer recalls hearing the faint 'bleep-bleep' signals soon after launch as the satellite came over the rim of the Earth, rose to maximum signal strength and then gradually faded out into the noise level as the vehicle curved round behind the globe.

The telecommunications system of the Sputnik did make some use of the VHF bands.

Since that early period of space communications, UHF (microwaves) have proved to be indispensable and from that time until rockets were launched to the Moon, Mars and Venus, and to date, communications are based entirely on UHF. Microwaves are also used for guiding and tracking space vehicles for millions of miles into outer space.

APOLLO MOONSHOTS

TV transmissions from outer space are almost taken for granted these days and millions of viewers all over the world watch pictures from the Moon almost as a matter of course. The Apollo moonshots, from which the most memorable TV pictures have been received, are manned missions and it is this type of dramatic space flight which captures the public interest.



Under the simulated conditions shown here, the Apollo antenna is erected and aimed, with the aid of an alignment telescope, at the Earth all within the allotted 20 minutes period

The communication systems of the Apollo spaceships establishing two-way contacts between the spacecraft and the Earth control centre for transmitting speech and a large amount of data, requires three radio wavebands – shortwave, VHF and UHF.

The spacecraft itself consists of three units, the command, lunar and service modules. The first two modules contain the actual radio communications equipment providing VHF contact on 259.7 and on 296.8MHz with amplitude modulation. The UHF (microwave) equipment is used for contacts both within the space craft itself and to Earth, both transmission and reception taking place in what is termed the S Band where space noise is at a minimum. The particular frequency used is 2.2GHz (gigahertz). After blast-off, contact between Apollo and the Earth is maintained on VHF during the period in which the craft is orbiting the Earth. When the space craft leaves this orbit, contact is switched from VHF to the 2.2GHz frequency in the microwave bands. This is the band used when Apollo is heading towards the Moon target.

The equipment operating in the S Band includes one on 2287.5MHz used by the command module for speech and information on the course of the craft, another operating on 2273.5MHz transmitting TV pictures or data whilst a third uses the 2106.4MHz channel for speech and exchange of data between the space craft and Earth.

Further microwave equipment is fitted in the lunar module. Consisting of two transceivers, one is used for transmitting speech, TV pictures or data on 2282.5MHz and the other used to transmit speech or data on 2101.8MHz. This latter module also includes a VHF station operating on 243MHz as a signal transmitter used during the return flight to Earth. Another transceiver used on the return path operates on 10,006MHz.

All this equipment and the frequencies used make it possible for the Earth control centre to follow the space craft with a relatively simple narrow-space aerial system.

The power outputs of all the transmitters fitted to the Apollo vehicles are quite small, that of the microwave transmitters being 2.8 and 11.2 watts.

A sound frequency system is used within the craft enabling the crew to communicate with each other, the conversations being transmitted to Earth by the microwave transmitter. When the craft is behind the Moon, contact with the Earth is cut off, the speech then being recorded on tape. ■

Radio Topics

By Recorder

MOST READERS WHO INTENDED to see the film 'Battle of Britain' will have done so by now. Despite its realism, it didn't quite evoke in me the nostalgia I had anticipated. Nevertheless, it was a good film and it was a pleasure to find that it didn't contain any of the sequences which nowadays keep families away from the cinema.

EARLIER DAYS

Looking back, it seems almost incredible to remember the antediluvian nature of the radio equipment which was fitted in those early wartime aircraft. Obviously, valves were the order of the day, but it is a bit shattering to realise that these were mainly 2-volt filament types powered by a lead-acid accumulator and a 120-volt h.t. battery.

The R/T set in actual Battle of Britain Spitfires would very probably have been the TR9 h.f. transmitter-receiver. The transmitter section of the TR9 had a small Pierce crystal oscillator feeding an a.f. output pentode which functioned as power amplifier. The receiver had two screen-grid r.f. amplifiers feeding into a leaky-grid triode detector, this being followed by the a.f. stages. It was an out-and-out straight set, with no pretensions at superhet operation or the incorporation of a.g.c. whatsoever. Sensitivity and selectivity were souped up a bit by a regeneration control which consisted of a very low value variable capacitor whose plates could be brought closer together or moved further away by a threaded spindle mechanically coupled to one of them. This capacitor simply connected between the anode of one r.f. screen-grid valve and the anode of the other whereupon, if advanced too far, it enabled oscillation to occur in the tuned-anode tuned-grid mode. After tuning up the receiver, the drill was to bring the two plates of the capacitor together until the set howled, then turn the knob on the threaded spindle back by three revolutions. Remote fine control of receiver tuning was achieved by a fearsome Bowden cable installation. The pilot moved a lever backwards or forwards, and this, by way of the Bowden cable, rotated a ganged tuning capacitor in the receiver which had a much lower capacitance than the individual tuning capacitors in each stage.

Bombers had an additional W/T set, this consisting of the R1082 receiver and the T1083 transmitter. The R1082 receiver was another straight set with 2-volt filament valves, and it had one r.f. stage which again used a screen-grid valve. It had plug-in coils, which were stowed in a coil-box situated nearby, and tuning was carried out by two separate variable capacitors, each fitted with a Muirhead slow-motion drive. Regeneration control with this receiver was very smooth indeed. In fact, an 'oscillation test point' appeared on the front of the panel to enable the operator to find whether or not he had passed into oscillation. The oscillation test point consisted of a little metal stud coupled by a low-value capacitor to the anode of the triode leaky-grid detector. If the operator moistened his finger and touched the test point he would hear a click if reaction had gone into oscillation and no click if it hadn't.

The accompanying transmitter, the T1083, had two large 6-volt triodes (with filaments run from *three* 2-volt lead-acid accumulators), one acting as master oscillator and the other as power amplifier. This had four pairs of plug-in coil units, each unit having a few additional components to suit the particular range covered.

Later on, the R1082 and T1083 were superseded by the R1155 and T1154 which are nowadays, of course, familiar items of surplus equipment. And the TR9 gave way to the TR1133, which was followed by the TR1143 and the American TR5043 (the last-named nowadays being famous amongst hams as a source of modulation transformers), all of which operated on v.h.f.

Well, that's enough looking back for the moment, although brief mention should be made of the T1087 ground station h.f. transmitter. This, an outsize construction with a power supply section reminiscent of Battersea, had so many relays clattering away inside it when it was on the air that it was affectionately known as the 'animated meat safe'.

REVERSE ROLES

Some time ago I mentioned in these notes that, if you require a high wattage resistor in a hurry, you can sometimes make do temporarily with a mains soldering iron. Naturally this requires to have the value of resistance needed, but in practice soldering irons tend to have

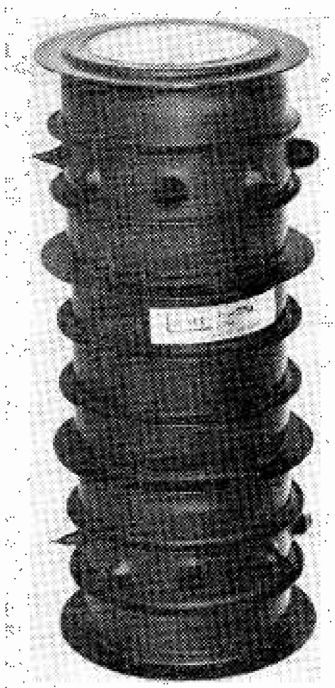
The Birch-Stolec suppressor illustrated herewith is one of a range specially designed to meet the requirements of the latest technological developments covering thyristor and triac suppression and equipment used in computers, data logging instruments and communications. The suppressors combine three facilities, the elimination of discrete inductors and capacitors, the absorption of unwanted interference power and the use of suppressor rather than filter techniques. Available from Birch-Stolec Ltd., Ponswood Industrial Estate, Hastings, Sussex resistance values which are of the same order as are needed for high wattage resistors anyway. Thus, a 240 volt 50 watt iron has a resistance of 1,150Ω, a 240 volt 30 watt iron has a resistance of 1,920Ω and a 240 volt 15 watt iron has a resistance of 3,840Ω. An advantage of using a mains soldering iron as a temporary resistor is that its resistance remains virtually constant even when it warms up. And, of course, no guess-work is required so far as its wattage rating is concerned!'

It has since occurred to me that quite a few other bits and pieces can be used for applications differing from those for which they were originally designed. I recently, for instance, employed a crystal microphone as a crystal earphone, which I didn't happen to have on hand at the time. I wanted a reproducer with a very high impedance as a monitor in an experimental home-built capacitance measuring instrument I was just checking out, and in which the unknown capacitor was connected across a tuned circuit in an oscillator. A second tuned circuit in another oscillator was then tuned to zero-beat with the first (by way of a detector common to both) and the value of the unknown capacitor was read from the scale of the variable capacitor in this second tuned circuit. The crystal microphone reproduced the heterodyne and indicated the zero-beat very nicely. I must hasten to add that signal amplitude was very low and that it would be extremely naughty, to say the least, to feed a high amplitude signal to a crystal microphone. My own microphone did not appear to have suffered as a result of its reversed role, but I can't guarantee that others might not be damaged. So, if you use a crystal microphone for low-level reproduction, you do so at your own risk!

There is no risk involved in another fairly unusual application, that of employing a single 2,000Ω headphone as a microphone. These headphones work surprisingly well as microphones, and the quality they offer is certainly more than good enough for intelligible speech. The output voltage level is of the same order as that from a moving-coil microphone with a step-up transformer. The headphone connects straight into any high impedance a.f. amplifier input.

Incidentally, headphone coil and magnet assemblies, removed from the headphone, make excellent pick-ups for electric guitars. The type to use here are those in which a very short magnet appears between the two coil cores so that the iron path in the assembly takes up the form of the letter U. The spacing between the two open ends of the coil cores is usually just right to enable them to be positioned under an adjacent pair of the steel strings of the guitar. A number of coil and magnet assemblies are required to accommodate all the strings of the guitar, and they are all connected in series. The coils can then be connected to a high impedance a.f. amplifier input.

Finally, if you want a 'relay' without moving parts, why not pop an m.e.s. pilot lamp and an ORP12 photoconductive cell inside a matchbox? When the pilot lamp is illuminated the resistance of the ORP12 will drop from about 1MΩ or so to 300Ω or less. The matchbox is adequate to keep extraneous light away from the cell, provided that it is not positioned in strong sunlight or bright artificial lighting. The maximum voltage which should be allowed to appear across the cell is 110 volts, and its maximum dissipation at or below 40°C is 200mW.



A three-stage cascade image intensifier tube, type 9794, has been added to the extensive range of tubes produced by the Electron Tube Division of EMI Electronics Ltd., Hayes, Middlesex.
The 9794 magnetically-focused tube has a typical gain of 2.10^5 and is designed to suit many applications, particularly those in astronomy, analytical spectrophotometry, medicine and nuclear physics. The main features of the 9794 include a low level of image distortion and a limiting resolution greater than 50 line pairs per mm which is substantially maintained over the tube's 48 mm diameter

LOG RESPONSE

'Why,' asked an enquiring nephew, who is just advancing to the stage where he'll be making his first radio, '*do* a.f. volume controls need to have log tracks?'

This is an oldie, of course, but I set about giving an answer along the usual lines. I explained that the human response to loudness follows a logarithmic pattern. If an increase in signal voltage in an a.f. amplifier causes the impression of a certain increase in loudness, to get successive impressions of the same increase in loudness the increases in signal voltage have to follow a geometric series, such as 1, 2, 4, 8, 16 and so on. This is catered for by a log volume control, in which the changes in resistance as the slider is rotated at the low volume end of the track are small and the changes in resistance as the slider is rotated at the high volume end of the track are large.

I can't say that my nephew was particularly impressed by all this, and I must confess that I was getting into rather deep water myself. As we were in my work-room at the time I decided to give him a demonstration of what happens when a *linear* potentiometer is used as a volume control. I quickly hitched up a circuit in which a 500kΩ linear potentiometer was connected, in volume control fashion, between a mono record-player pick-up and the input of an a.f. amplifier.

That circuit did the job perfectly. As my nephew adjusted the linear potentiometer he found that control was 'fierce' at the low volume end, with only a small degree of rotation being required to effect a large change in sound output level from the amplifier. At the same time, quite large amounts of rotation at the high volume end had very little effect on the perceptible level of output.

My nephew was satisfied with this demonstration, and is now convinced of the desirability of using log tracks in a.f. volume controls. He also knows from first-hand experience that the human response to sound intensity really is logarithmic in character. I must admit that my own reaction was one of relief. I hadn't expected that the demonstration would be half as effective as it turned out to be! ■

HOBBY CIRCUITS MANUAL

LST are pleased to announce that they now have stocks of the new HM.91 Hobby Circuits Manual, and have a full substitution list available to supply with the handbook giving equivalents to every semiconductor device used.

This substitution chart can be supplied on its own, but a stamped addressed envelope would be appreciated.

LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● **PARAGUAY**
Zone 11 can be logged in the form of ZP5CS. currently quite active on the 14MHz band using CW. Last heard on **14030** at 2012.

● **GRENADA**
VP2GLE has been heard several times of late using the CW mode on, or around, **14020** at 2100.

● **MOZAMBIQUE**
CR7AM is currently very active on 14MHz CW and usually is to be found around the **14045** mark at 2030 or so.

● **ST. HELENA**
Prize catch of late is that of ZD7SD using SSB on **14195** at 1713 working G's and bravely continuing throughout the evening despite the 'pile-ups' around the channel. QTH P.O. Box 16, St. Helena.

● **FALKLAND ISLANDS**
Another station working G's despite the QRM was VP8HZ on **14200** at 2045, using SSB.

● **INDIA**
Currently active from this country is VU2BEZ. heard using the SSB mode at 1830 on **14180.**

● **HONDURAS**
HR2WTA is often to be heard on the 14MHz band using SSB. A favourite 'spot' is **14210**, listen around 2215.

● **CHILE**
For those who need Zone 12, listen on **14180** around 2215 for the SSB signals of CE5DF.

★ BROADCAST BANDS

● **ABU DHABI**
A station logged several times during the past few weeks, with programmes in Arabic, on a measured frequency of **4988** around 1900 or so, has now been identified as the Abu Dhabi Broadcasting Service. Further details of this newcomer to the Short Wave scene are awaited.

● **REPUBLIC OF CONGO**
A new outlet of 'La Voix de la Revolution Congolaise' is that of **3264** where it has been heard several times from 1830 to 2130. The transmitter would appear to have a power of around 100kW. The 4kW **3232** channel is still operating.

● **CLANDESTINE**
'The Voice of the Free South', thought to be operating from Saudi Arabia, has been reported by the British Association of Dx'ers on **5345** from around 1740 to close down at 1931. In their journal 'Bandspread' (No 10) the BADX provide the information that this station also uses **8405** in parallel, this latter channel providing better reception. Identification in Arabic is 'Sawt al Janub al-Hurr'.

● **GAMBIA**
The British Association of Dxer's also report reception of Radio Gambia on **4820** (3kW). Heard intermittently from about 2000 to 2300 sign-off under Angola on the same channel.

● **GREENLAND**
According to the BADX, Greenland Radio may be heard around 2150 till 2230 on **9575.** Celeste interval signal at 2158, identification and news in Danish at 2200.

Acknowledgements:– BADX, Our Listening Post. ■

MORE AMATEUR BAND NEWS

For 14MHz SSB addicts, the following will be of interest. Heard at 2205 on **14140** 8R1U in QSO with ET3DS. CR6GA is active around **14170** at 1930.

9G1DY heard at 1930 on **14184** giving his QTH as POB 2949 Accra.

ZP5EC logged at 2145 on **14174;** 5Z4KL at 2140 on **14186;** CR4BC at 1940 on **14195** and TA3GB at 2130 on **14180.**

CR3KD heard on **14270** SSB at 1620, on **14300** at 1900, on **21194** at 1541 and on **21361** at 1940.

CW enthusiasts may care to take a note of these stations. HK7XI at 2120 on **14040;** CE8CF at 2127 on **14084;** CX9BT at 2120 on **14016;** EL2BZ at 2150 on **14052;** KV4CK at 2155 on **14025;** PJ2HT at 2200 on **14010;** HP9KRT at 2000 on **14080** and TU2CX at 1916 on **14050.**

LAST LOOK ROUND

The 1971 edition of *How to Listen to the World* is available from the Modern Book Company, 19 Praed Street, London, W.2, at £1.30 post paid.

This latest edition is of 168 pages and contains a wealth of information for all those who are interested in operating over the short wave broadcast bands. In all, a total of thirty-six chapters are contained within the covers, the whole presenting a worth-while addition to the bookshelves.

The majority of the chapters deal with the broadcast scene, the remainder providing information on TV and FM reception.

Apart from hints on short wave broadcast reception, there are technical articles of specific interest to short wave listeners. Every chapter is written by an acknowledged expert and the book is recommended to all short wave enthusiasts.

'TRIO' MODIFICATIONS

With reference to our note in the May issue, we have now located a limited supply of the October 1970 issue containing the original modifications. Copies available at 22p each, post paid.

FOR THE S.W.L. . . .

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by F. A. Baldwin

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BARGAINS. P.S. Units, radio test gear, etc. S.A.E. lists. Don Smith, 12 Channel Heights, Bleadon, Weston-Super-Mare, Somerset. Telephone: Bleadon 672.

(Continued on page 705)

SMALL ADVERTISEMENTS

(Continued from page 703)

RECORD TV SOUND using our loudspeaker isolating transformer. Provides safe connection to recorder. Instructions included. 70p plus 10p P. & P. Crowborough Electronics (R.C.), Eridge Road, Crowborough, Sussex.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept. – both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor,* containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazines, etc., £1.75 per annum. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

FOR SALE: Specialist stamp collection. Space, Railway Centenary, ITU, IGY, etc. issues. Catalogue value approx. £150. Offers? S.A.E. for details. Another collection of early Space issues £25 o.n.o. Small general collection at £5. Box No. G151.

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500mW AMPLIFIER KITS. 3-transistor, complementary output to 3-15 ohm speaker, 7½-15V supply. All parts with instructions. 75p post paid. A. Manley, 13 Randisbourne Gardens, Bromley Road, London S.E.6.

CRYSTALS. Marine frequencies. 2381, 2089, 2306, in holders with ¾in. pin spacing £2 each. Box No. G154.

WORLD DX CLUB covers all aspects of SWLing on Amateur and Broadcast Bands through its monthly bulletin *"Contact"*. Membership costs £1.38 a year. Enquiries to Secretary, WDXC, 11 Wesley Grove, Portsmouth, Hants., PO3 5ER.

RELAYS. Sigma type 72AOZ, octal base, £1.50; Carpenter polarised, £1; D164816, £1.50. Box No. G155.

FOR SALE: Ex-American army oscilloscope A/APN4. Needs minor repairs, otherwise good condition. £9. Apply: Heydecker, Friends' School, Saffron Walden, Essex.

HOLIDAY ACCOMMODATION. Burwood Lodge Hotel, Dawlish Road, Teignmouth, S. Devon. Especially for parents with young children. Facing south, on the cliffs, direct access by private path to sea. Mothers' kitchen, automatic washing machines, baby listening service. Licensed lounge. Ample free parking.

HEADPHONES, NEW, BOXES, HALF PRICE. One "Trio" HS–4 8Ω, £3. One "Echo" HS–606D, 8Ω/4000Ω, switchable impedance, quality make, £2. One mint R1155 SM Drive, replaces early type, £1. Box No. G.160.

INTERESTED IN RTTY? Then buy a copy of our booklet, *"RTTY – The Easy Way."* 15p post paid from: Miss G. Southby, 51 Norman Road, Swindon, Wilts.

FOR SALE. Heathkit AG9U audio generator, perfect condition. Little used. £14 complete with manual and leads. Also a variety of radio books in perfect condition. Box No. G161.

(Continued on page 707)

SMALL ADVERTISEMENTS

(Continued from page 705)

WANTED: Marine type sextant. Details & price to Box No. G152.

IF YOU HAVE ENJOYED A HOLIDAY on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from:– The Hon. Membership Secretary, The Broads Society, "Icknield", Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S.

MAGAZINES FOR SALE: *"The Radio Constructor"* – 1967 except June & October, 90p; all 1968 issues £1; all 1969 issues £1; or the lot £2.75 to clear. *"Practical Wireless"* – 1967 except July, 95p; 1968 except November, 95p; all 1969 issues £1; or the lot £2.75 to clear. *"Practical Electronics"* – 1967 except November & December, 90p; 1968 except January & March, 90p; or the lot £1.65 to clear. Prices include postage. All in good condition. Box No. G162.

"MEDIUM WAVE NEWS" Monthly during Dx season – Details from: K. Brownless, 7 The Avenue, Clifton, York.

WANTED: *The Radio Constructor* Volume 18. Copies Nos. 1 (August), 2 (Sept.), 4 (Nov.), 5 (Dec.), all 1964. Your price by London cheque plus air mail costs all four copies. Also index to Vol. 18 (August 1964 to July 1965). Millar, 5H3AP, Post Box 381, Morogoro, Tanzania.

VALVES TO CLEAR: 801-A, VT136, VT62, DK91, T20, UX865S, HP4106, 41MP, 6B4G, 10LD, N142, U142, 10F9, TH141, 3ML, UY41, 171DDP, 3S4, VR91. All at 13p each postage paid. Box No. G165.

FREE GIFT when you request our quality stamps, supplied on approval. Generous discounts. Details from: Watson's Philatelic Service, 6 Beech Avenue, Brentwood, Essex.

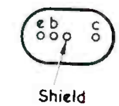
SELLING UP. Oscilloscope £30, solid-state voltmeter £15, CR Bridge £10. All nearly new. Large quantity components, many unused, £15 to clear. Box No. G166.

FREQUENCY LIST TRANSFERS. We have a limited supply of sheets of Dial Frequency Transfers in black. Short Wave frequencies 1.8Mc/s to 32Mc/s and 144Mc/s and 146Mc/s. Includes amateur band marker frequencies at 100kc/s points and other short wave frequencies from 2 to 32Mc/s at every 500kc/s points. Each frequency is repeated. Two sheets for 5p, five sheets for 10p, postage 2½p. Data Publications Ltd., 57 Maida Vale, London W9 1SN.

ESSEX GARDENERS. Buy your bedding and rock plants, shrubs, etc., also cacti from May's Nurseries, 608 Rayleigh Road, Hutton, Brentwood, Essex. Callers only. Monday to Saturday.

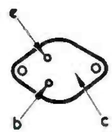
P.N.P./N.P.N. Transistor Lead-outs

The Table lists commonly encountered transistors having lead-out layouts as shown in Diagrams 'A', 'B' and 'C'. Transistors conforming to Diagram 'A' are in TO–18 or TO–72 encapsulations, those conforming to Diagram 'B' are in M1, M3 or SO2/2 encapsulations, and those conforming to Diagram 'C' are in TO–7 or M5 encapsulations. The letter in brackets after each type-number indicates whether the device is germanium or silicon.



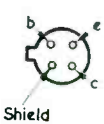
'C'

DATA SHEET 50 – it is regretted that the inset transistor lead-out diagram for Data Sheet 50, published in the May issue, was omitted. The diagram is shown alongside.

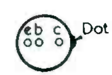


DS50

P.N.P. Diagram 'A'	N.P.N. Diagram 'A'	P.N.P. Diagram 'B'		N.P.N. Diagram 'B'	P.N.P. Diagram 'C'
AF124 (G)	BF115 (S)	AC107 (G)	OC77 (G)	OC139 (G)	AF102 (G)
AF125 (G)	BF167 (S)	BCZ11 (S)	OC78 (G)	OC140 (G)	AF114 (G)
AF126 (G)	BF173 (S)	OC41 (G)	OC78D (G)	OC141 (G)	AF115 (G)
AF127 (G)	BF184 (S)	OC42 (G)	OC81 (G)		AF116 (G)
AFZ11 (G)	BF185 (S)	OC43 (G)	OC81D (G)		AF117 (G)
AFZ12 (G)	BF270 (S)	OC44 (G)	OC82 (G)		AF118 (G)
	BF271 (S)	OC45 (G)	OC82D (G)		ASZ20 (G)
	BF308 (S)	OC65 (G)	OC200 (S)		ASZ23 (G)
	BF309 (S)	OC66 (G)	OC201 (S)		OC122 (G)
	BFW63 (S)	OC70 (G)	OC202 (S)		OC123 (G)
	BFW64 (S)	OC71 (G)	OC203 (S)		OC170 (G)
		OC72 (G)	OC204 (S)		OC171 (G)
		OC73 (G)	OC205 (S)		
		OC75 (G)	OC206 (S)		
		OC76 (G)	OC207 (S)		



'A'



'B'