THE

RADIO CONSTRUCTOR

Vol. 24 No. 9 APRIL 1971 17½p (3/6)

TRANSMITTER

★ 40, 80 and 160 Metres
★ 10 watts CW
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Special
IN THIS ISSUE

D. C. and AUDIO LCR BRIDGE

'Trio' 9R-59DE MODIFICATIONS - 2

	£/Np
AC107	37
AC126	25
AC127	25
AC128	20
AC176	25
AC187	30
AC188	30
ACY17	29
ACY18	20
ACY19	20
ACY20	19
ACY21	19
ACY22	19
ACY40	15
ACY41	15
AD140	55
AD149	57
AD161	37
AD162	37
AF114	25
AF115	25
AF116	25
AF117	25
AF118	44
AF124	25
AF126	17
AF139	37
AF186	40
AF239	37
ASY26	25
ASY27	30
ASY28	22
ASY29	30
ASZ21	37
AUY10	1.50
BA115	8
BC107	12
BC108	12
BC109	12
BC147	15
BC148	15
BC149	15
BC158	17
BC169C	19
BC182	12
BC182L	10
BC183	9
BC183L	9
BC184	15
BC184L	15
BC186	40
BC212	17
BC212L	12
BCY30	25
BCY31	48
BCY32	50
BCY33	20
BCY34	25
BCY38	30
BCY70	19
BCY71	37
BCY72	16
BD121	1.10
BD123	1.10
BD124	1.03
BDY20	1.05
BF115	25
BF163	40
BF167	25
BF173	30
BF178	52
BF180	37
BF181	37
BF184	25
BF185	25
BF194	17
BF195	15
BF196	15
BF200	35
BFX13	25
BFX29	31
BFX84	26
BFX85	34
BFX86	25
BFX87	30
BFX88	25
BFY50	23
BFX51	19
BFY52	20
BFY53	16
BFY90	67
BSX19	16
BSX20	16
BSX21	37
BSY27	20

	£/Np
BSY29	25
BSY95A	15
BY100	20
BYX10	15
BYZ10	40
BYZ12	30
BYZ13	20
BZY88 Series 3.3V to 30V	15
D13T1	45
MJE520	75
MJ480	97
MJ481	1.25
MJ490	1.00
MJ491	1.35
MPF102	43
MPF103	37
MPF104	37
MPF105	40
NKT124	30
NKT125	40
NKT126	37
NKT128	25
NKT135	26
NKT137	32
NKT210	25
NKT211	25
NKT212	25
NKT213	25
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NKT216	46
NKT217	50
NKT218	25
NKT219	25
NKT223	27
NKT224	25
NKT225	21
NKT229	29
NKT237	31
NKT238	19
NKT239	23
NKT240	20
NKT241	21
NKT242	15
NKT243	56
NKT244	17
NKT245	17
NKT261	21
NKT262	19
NKT264	21
NKT271	18
NKT272	17
NKT274	18
NKT275	23
NKT279A	12
NKT281	29
NKT302	87
NKT304	79
NKT351	75
NKT401	71
NKT402	77
NKT403	65
NKT404	60
NKT405	79
NKT406	62
NKT420	1.83
NKT451	58
NKT452	54
NKT453	50
NKT603F	30
NKT613F	30
NKT674F	30
NKT676F	30
NKT677F	28
NKT713	29
NKT717	44
NKT734	26
NKT736	32
NKT773	25
NKT781	29
NKT10339	25
NKT10419	19
NKT10439	27
NKT10519	22
NKT20329/0013	31
NKT80111	67
NKT80112	83
NKT80113	1.00
NKT80211	75
NKT80212	75
NKT80213	75

	£/Np
NKT80214	75
NKT80215	75
NKT80216	75
OA5	20
OA10	25
OA47	8
OA70	8
OA73	8
OA79	8
OA81	8
OA85	8
OA90	8
OA91	8
OA95	8
OA200	10
OA202	10
OC19	37
OC20	97
OC22	47
OC23	60
OC24	60
OC25	37
OC26	33
OC28	60
OC29	75
OC35	50
OC36	63
OC41	25
OC42	30
OC44	15
OC45	15
OC71	15
OC72	23
OC75	23
OC76	25
OC77	40
OC81	23
OC81D	20
OC81Z	55
OC82	25
OC82D	15
OC83	23
OC84	25
OC139	25
OC140	35
OC170	25
OC171	30
OC200	37
OC201	47
OC202	63
OC203	37
OC204	40
OC205	65
OC206	75
OC207	75
OCP71/M	47
ORP12	50
ORP60	60
ORP61	40
P346A	19
ST140	15
ST141	20
TD716	60
TIP31A	62
TIP32A	74
V405A	46
ZTX108	11
ZTX300	13
ZTX302	18
ZTX303	18
ZTX304	27
ZTX314	11
ZTX320	30
ZTX330	18
ZTX500	16
ZTX501	16
ZTX502	20
ZTX503	17
ZTX504	40
1N34A	20
1N60	20
1N64	20
1N82A	47
1N87A	23
1N914	7
1N4001	7
1N4002	7
1N4003	10
1N4004	10
1N4005	12
1N4006	15
1N4007	20
1N4148	7

	£/Np
2G302	19
2G371	15
2G374	25
2N174	80
2N385A/2N388A	75
2N404	23
2N696	15
2N697	17
2N698	30
2N706	10
2N706A	12
2N708	16
2N711	37
2N711A	37
2N911	50
2N914	20
2N918	42
2N1090	30
2N1091	33
2N1131	30
2N1132	30
2N1302	20
2N1303	20
2N1304	25
2N1305	25
2N1306	30
2N1307	30
2N1308	34
2N1309	31
2N1507	23
2N1613	22
2N1711	25
2N2147	82
2N2148	63
2N2160	62
2N2368	17
2N2369	17
2N2369A	20
2N2646	50
2N2904	44
2N2904A	49
2N2905	65
2N2905A	75
2N2906	44
2N2906A	54
2N2926, all colours	10
2N3053	25
2N3054	63
2N3055	75
2N3702	11
2N3703	10
2N3704	11
2N3705	10
2N3706	9
2N3707	11
2N3708	7
2N3709	9
2N3710	9
2N3711	9
2N3819	35
2N3820	60
2N3826	30
2N4058	17
2N4060	20
2N4061	20
2N4062	20
2N4284	15
2N4287	15
2N4289	15
2N4871	40
3N84	1.30
3N128	69
3N140	76
3N141	73
3N152	86
40250	55
40309	33
40310	45
40312	48
40320	36
40360	43
40361	48
40362	58
40406	56
40407	39
40408	51
40409	54
40468A	35
40600	58
40601	55
40602	40
40603	49

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

CAPACITORS

Mullard Miniature Electrolytic – C426 Series

Mfd	Volt.Wkg.	
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 –	**38 Np**
Veropins pack of 50 for	**21 Np**

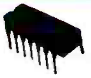
Bargain Pack. 36 square inches of various sizes. .15" &/or .1" **50Np**

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**
110 Semiconductor Projects (Marston)	**£1.25**
Zener Diode Handbook	**84 Np**
Photocell & Solarcell Handbook	**84 Np**
Thyristor (S.C.R.) Handbook	**£1.00**



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SN7401N	Quad 2-input NAND gate open collector	32	27	22
SN7402N	Quad 2-input NOR gate			
SN7403N	Quad 2-input NOR gate open collector	35	30	25
SN7404N	Hex Inverter	32	27	22
SN7410N	Triple 3-input NAND gate			
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

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CA3018	–	85
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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

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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**

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	1–11	12–24	25+
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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
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IOR

DD119	Heat sink compound – Silicone grease	30 Np
DD170	Bargain pack of five 1 Watt Zener diodes	97 Np
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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
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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
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CS120	Cadmium Sulphide photoconductive cell	98 Np

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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*	£1.50
40512	2.2 Amp (RMS @ 25 Amb.) 400 PIV*	£1.45
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

*These types have integral triggering

ZENER DIODES

400mW 10% GLASS CASE TEXAS Mfr

1S2036	3.6 volt	1S2082	8.2 volt
1S2039	3.9 volt	1S2100	10 volt
1S2043	4.3 volt	1S2110	11 volt
1S2047	4.7 volt	1S2120	12 volt
1S2056	5.6 volt	1S2160	16 volt
1S2062	6.2 volt	1S2180	18 volt
1S2068	6.8 volt	1S2270	27 volt
1S2075	7.5 volt	1S2300	30 volt

Prices: 1-24 **15Np** 25-99 **11Np** 100+ **9Np**

THYRISTORS

CR1/051C	1 Amp 50 PIV TO-5	40 Np
CR1/401C	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

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Type No.	Current	Rms Volts	
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C. N. G. Matthews

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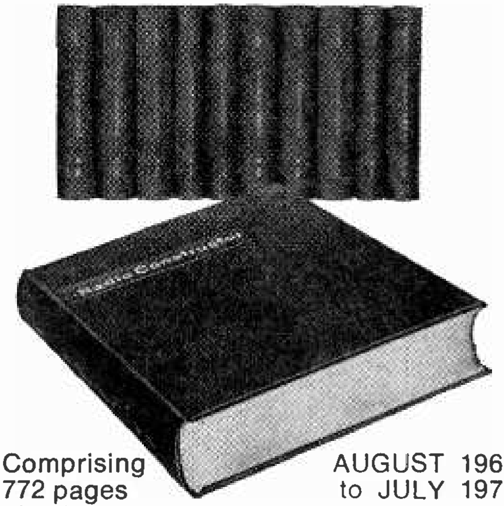

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BP10	7410N	Triple 3-Input NAND GATE ..	23p	20p	15p
BP20	7420N	Dual 4-Input NAND GATE	23p	20p	15p
BP30	7430N	Single 8-Input NAND GATE ..	23p	20p	15p
BP40	7440N	Dual 4-Input BUFFER GATE ..	23p	20p	15p
BP41	7441N	BCD to decimal decoder and N.I.T. Driver	87p	77p	67p
BP42	7442N	BCD to decimal decode (TTL O/P)	87p	77p	67p
BP50	7450N	Dual 2-Input AND/OR/NOT GATE —expandable..	23p	20p	15p
BP53	7453N	Single 8-Input AND/OR/NOT GATE —expandable..	23p	20p	15p
BP60	7460N	Dual 4-Input—expandable	23p	20p	15p
BP70	7470N	Single JK Flip-Flop—edge triggered	35p	32p	29p
BP72	7472N	Single Master Slave JK Flip-Flop ..	35p	32p	29p
BP73	7473N	Dual Master Slave JK Flip-Flop ..	43p	40p	37p
BP74	7474N	Dual D Flip-Flop	43p	40p	37p
BP75	7475N	Quad Bistable Latch	47p	45p	43p
BP76	7476N	Dual Master Slave Flip-Flop with preset and clear	47p	45p	43p
BP83	7483N	Four Bit Binary Adder	87p	77p	67p
BP90	7490N	BCD Decade Counter	87p	77p	67p
BP92	7492N	Divide by 12 4 Bit binary counter ..	87p	77p	67p
BP93	7493N	Divide by 16 4 Bit binary counter ..	87p	77p	67p
BP94	7494N	Dual Entry 4 Bit Shift Register ..	87p	77p	67p
BP95	7495N	4 Bit Up-Down Shift Register ..	87p	77p	67p
BP96	7496N	5 Bit Shift Register	£1·10	£1·00	90p

Data is available for the above Series of I.C's in booklet form, price 13p each.

LINEAR I.C's

Type No.	Case	Leads	Description	Price 1–24	25–99	100
BP 201C – SL201C	TO-5	8	G.P. Amp	63p	53p	45p
BP 701C – SL701C	TO-5	8	OP. Amp	63p	53p	45p
BP 702C – SL702C	TO-5	8	OP. Amp Direct O/P	63p	53p	45p
BP 702 – 72702	D.I.L.	14	G.P. OP. Amp (Wide Board)	53p	45p	40p
BP 709 – 72709	D.I.L.	14	High OP. Amp ..	53p	45p	40p
BP 709P – uA709C	TO-5	8	High Gain OP. Amp..	53p	45p	40p
BP 741 – 72741	D.I.L.	14	High Gain OP. Amp (Protected)	75p	60p	50p
uA 703C – uA703C	TO-5	6	R.F. IF Amp	43p	35p	27p
TAA 263	TO-72	4	A.F. Amp	70p	60p	55p
TAA 293	TO-74	10	G.P. Amp	90p	75p	70p

TTL INTEGRATED CIRCUITS

Manufacturers' "Full outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

PAK No.
UIC00 = 12 × 7400N 50p
UIC01 = 12 × 7401N 50p
UIC02 = 12 × 7402N 50p
UIC03 = 12 × 7403N 50p
UIC04 = 12 × 7404N 50p
UIC05 = 12 × 7495N 50p
UIC10 = 12 × 7410N 50p
UIC20 = 12 × 7420N 50p
UIC40 = 12 × 7440N 50p
UIC41 = 5 × 7441AN 50p

PAK No.
UIC42 = 5 × 7450N 50p
UIC50 = 12 × 7450N 50p
UIC51 = 12 × 7451N 50p
UIC60 = 12 × 7460N 50p
UIC70 = 8 × 7470N 50p
UIC72 = 8 × 7472N 50p
UIC73 = 8 × 7473N 50p
UIC74 = 8 × 7474N 50p
UIC75 = 8 × 7475N 50p
UIC76 = 8 × 7476N 50p

PAK No.
UIC80 = 5 × 7480N 50p
UIC82 = 5 × 7482N 50p
UIC83 = 5 × 7483N 50p
UIC86 = 5 × 7486N 50p
UIC90 = 5 × 7490N 50p
UIC92 = 5 × 7492N 50p
UIC93 = 5 × 7493N 50p
UIC94 = 5 × 7494N 50p
UIC95 = 5 × 7495N 50p
UIC96 = 5 × 7496N 50p

UICX1 = 25 × Asst'd 74's £1·50

Packs cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1 Every PAK carries our BI-PAK Satisfaction or money back GUARANTEE.

DTL (Diode Transistor Logic) INTEGRATED CIRCUITS manufacturers "Fall outs"—out of spec. devices including functional units and part functional but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

Pak No.
UIC930 = 12 × μA 930 .... 50p
UIC932 = 12 × μA 932 .... 50p
UIC933 = 12 × μA 933 .... 50p
UIC935 = 12 × μA 935 .... 50p
UIC936 = 12 × μA 936 .... 50p
UIC944 = 12 × μA 944 .... 50p
UIC945 = 8 × μA 945 .... 50p
UIC946 = 12 × μA 946 .... 50p

Pak No.
UIC948 = 8 × μA 948 ..... 50p
UIC951 = 5 × μA 951 ..... 50p
UIC961 = 12 × μA 961 ..... 50p
UIC9093 = 5 × μA 9093 ..... 50p
UIC9094 = 5 × μA 9094 ..... 50p
UIC9097 = 5 × μA 9097 .....-50p
UIC9099 = 5 × μA 9099 ..... 50p
UIC × 9 25 Assorted 930 Series £1·50

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Epoxy TO-5 case	Price each 1-24	25-99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Data and Circuits Booklet for I.C's. Price 7p.

Dual-in-Line Low Profile Sockets

14 and 16 Lead Sockets for use with Dual-in-Line Integrated Circuits.

Order No.	Price each 1-24	25-99	100 up
TSO 14 pin type...	30p	27p	25p
TSO 16 pin type...	35p	32p	30p

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

PIV	1A TO5	3A TO66	7A TO66	10A	16A TO48	30A TO48
50	23p	25p	47p	50p	53p	£1·15
100	25p	33p	53p	58p	63p	£1·40
200	35p	37p	57p	61p	75p	£1·60
400	43p	47p	67p	75p	93p	£1·75
600	53p	57p	77p	97p	£1·25	—
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PIV	300mA	750mA	1A	1·5A	3A	10A	30A
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100 ..	4p	6p	5p	13p	16p	23p	75p
200 ..	5p	9p	6p	14p	20p	24p	£1
400 ..	6p	13p	7p	20p	27p	37p	£1·25
600 ..	7p	16p	10p	23p	34p	45p	£1·86
800 ..	10p	17p	13p	25p	37p	55p	£2
1000 ..	11p	25p	15p	30p	46p	63p	£2·50
1200 ..	—	33p	—	33p	57p	75p	—

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

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For Use with Triacs
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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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One 50p Pack of your own choice free with orders valued £4 or over.

AF239 PNP GERM, SIEMENS VHF TRANSISTORS. RF MIXER & OSC. UP TO 900 MHZ. USE AS REPLACEMENT FOR AF139-AF186 & 100's OF OTHER USES IN VHF. OUR SPECIAL LOW PRICE:– 1-24 **37p** each, 25-99 **34p** each, 100 + **30p** each.

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OCP71 Type **43p**

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AF117 transistors. Large can 4 lead type. Leads cut short but still usable. Real value at 15 for **50p.**

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300mW	30	50p
40PIV(Min.)	100	£1·50
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Full Tested	1,000	£9

Ideal for Organ Builders.

D13D1 Silicon Unilateral switch **50p** each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

TRIACS

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100	50p	63p	£1
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VBOM + Blocking voltage in either direction.

AD161 AD162
NPN *PNP*
MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS.
For mains driven output stages of Amplifiers and Radio Receivers.
OUR LOWEST PRICE OF **63p** *PER PAIR.*

HIGH POWER SILICON PLANAR TRANSISTORS. TO-3.
Ferranti ZT1487 NPN VCB60 1c 6A fT. 1M/cs VCE 40 Ptot. 75W VEB8 hFE 15-45
Price **30p** each.

2N3055 115W. SIL. POWER NPN
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FULL RANGE OF ZENER DIODES VOLT. RANGE 2-33V
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1-5W (Top-Hat) .. **17p**
10W (SO-10 Stud) .. **25p**
All fully tested 5% tol. and marked. State voltage required.

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Coded and Guaranteed

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T2	8 2G374	OC75
T3	8 2G3744A	OC81D
T4	8 2G381A	OC81
T5	8 2G382T	OC82
T6	8 2G344A	OC44
T7	8 2G345A	OC45
T8	8 2G378	OC78
T9	8 2G399A	2N1302
T10	8 2G417	AF117

All **50p** each pack

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U2	60 Mixed Germanium Transistors AF/RF	50p
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47.. ..	50p
U4	40 Germanium Transistors like OC81, AC128	50p
U5	60 200mA Sub-min. Sil. Diodes	50p
U6	30 Silicon Planar Transistors NPN sim. BSY95A, 2N706 ..	50p
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	50p
U8	50 Sil. Planar Diodes 250mA OA/200/202	50p
U9	20 Mixed Volts 1 watt Zener Diodes	50p
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	50p
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	50p
U14	150 Mixed Silicon and Germanium Diodes..	50p
U15	25 NPN Silicon Planar Transistors TO-5 sim. 2N697	50p
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV ..	50p
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22 ..	50p
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV ..	50p
U19	25 Silicon NPN Transistors like BC108	50p
U20	12 1·5-amp Silicon Rectifiers Top-Hat up to 1,000 PIV	50p
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71 ..	50p
U23	30 Madt's like MAT Series PNP Transistors	50p
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	50p
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27	50p
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min ..	50p
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U29	10 1-amp SCR's TO-5 can up to 600 PIV CRS1/25-600	£1
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	50p
U32	25 Zener diodes 400mW D07 case mixed Volts, 3-18	50p
U33	15 Plastic case 1 amp Silicon Rectifiers IN4000 series.. ..	50p
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	50p
U35	25 Sil. Planar trans. PNP TO-18 2N2906	50p
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	50p
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	50p
U38	20 Fast Switching Sil. trans. NPN 400Mc/s 2N3011	50p
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	50p
U40	10 Dual trans. 6 lead TO-5 2N2060	50p
U41	25 RF Germ. trans. TO-1 OC45 NKT72	50p
U42	10 VHF Germ. PNP trans. TO-1 NKT667 AF117	50p

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

GENERAL PURPOSE GERM., PNP POWER TRANSISTORS

Coded GP100. BRAND NEW To-3 CASE. POSS. REPLACEMENTS FOR:— OC25-28-29-30-35-36. NKT401-403-404-405-406-450-451-452-453. TI3027-3028. 2N250A, 2N456A-457A-458A, 2N511-511 A & B. 2G220-222. ETC.
SPECIFICATION.
VCBC 80V VCEO 50V IC 10A PT 30 WATTS HFE 30-170

PRICE	1–24	25–99	100 up
	43p each	40p each	36p each

GENERAL PURPOSE SILICON NPN POWER TRANSISTORS

Coded GP300. BRAND NEW To-3 CASE. POSSIBLE REPLACEMENT FOR:— 2N3055. BDY20. BDY11.
SPECIFICATION.
VCBO 100V. VCEO 60V. IC 15AMPS. PT. 115 WATTS. Hfe 20-100. PTI MHZ.

PRICE	1–24	25–99	100 +
	55p each	50p each	47p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS.

TO-18 Sim. to 2N706/8, BSY27/28/95A. All usable devices, no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

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FOR POWER APPLICATIONS.

Type			
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Q2	16 White Spot R.F. Trans. P.N.P.	0p
Q3	4 OC 77 Type Trans.	0p
Q4	6 Matched trans. OC44/45/81/810	0p
Q5	4 OC 75 Transistors	0p
Q6	4 OC 72 Transistors	0p
Q7	4 AC 128 Trans. P.N.P. High Gain	0p
Q8	4 AC 126 Trans. P.N.P.	0p
Q9	7 OC 81 Type trans.	0p
Q10	7 OC 71 Type trans.	0p
Q11	2 AC 127/128 Comp. pairs PNP/NPN	50p
Q12	3 AF 116 Type Trans.	50p
Q13	3 AF 117 Type Trans.	50p
Q14	3 OC 171 H.F. Type trans. ..	50p
Q15	5 2N2926 Sil. Epoxy Trans. ..	50p
Q16	2 GET880 low noise Germ. trans.	50p
Q17	3 NPN 1 ST141 & 2 ST140 ..	50p
Q18	4 Madt's 2 MAT 100 & 2MAT 120	50p
Q19	3 Madt's 2 MAT 101 & 1MAT 121	50p
Q20	4 OC 44 Germ. trans. A.F. ..	50p
Q21	3 AC 127 NPN Germ. trans. ..	50p
Q22	20 NKT trans. A.F. R.F. coded ..	50p
Q23	10 OA202 Sil. diodes sub-min ..	50p
Q24	8 OA 81 diodes	50p
Q25	6 IN914 Sil. diodes 75PIV 75ma ..	50p
Q26	8 OA95 Germ. diodes sub-min IN69	50p
Q27	2 10A 600PIV Sil. Rects. IS45R ..	50p
Q28	2 Sil. power Rects. BYZ 13 ..	50p
Q29	4 Sil. trans.2 x 2N696, 1 x 2N697, 1 x 2N698	50p
Q30	7 Sil. switch trans. 2N706 NPN ..	50p
Q31	6 Sil. switch trans. 2N708 NPN ..	50p
Q32	3 PNP Sil. trans. 2 x 2N1131, 1 x 2N1132	50p
Q33	3 Sil. NPN trans. 2N1711	50p
Q34	7 Sil. NPN trans. 2N2369, 500MH2	50p
Q35	3 Sil. PNP TO-5 2 x 2N2904 & 1 x 2905..	50p
Q36	7 2N3646 TO-18 plastic 300MH2 N.P.N.	50p
Q37	3 2N3053 NPN Sil. trans... ..	50p
Q38	7 PNP trans. 4 x 2N3703, 3 x 2N3702	50p
Q39	7 NPN trans. 4 x 2N3704, 3 x 2N3705	50p
Q40	7 NPN amp 4 x 2N3707, 3 x 2N3708	50p
Q41	3 plastic NPN TO-18 2N3904 ..	50p
Q42	6 NPN trans. 2N5172	50p
Q43	7 BC 107 NPN trans.	50p
Q44	7 NPN trans. 4 x BC108, 3 x BC109	50p
Q45	3 BC 113 NPN TO-18 trans. ..	50p
Q46	3 BC 115 NPN TO-5 trans. ..	50p
Q47	6 NPN high gain 3 x BC167, 3 x BC168	50p
Q48	4 BCY 70 PNP trans. TO-18 ..	50p
Q49	4 NPN trans. 2 x BFY51, 2 x BFY52	50p
Q50	7 BSY 28 NPN switch TO-18 ..	50p
Q51	7 BSY 95A NPN trans. 300MH2 ..	50p
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OC25	25p
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OC28	40p
OC29	40p
OC35	33p
OC36	40p
AD140	40p
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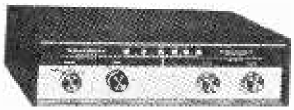

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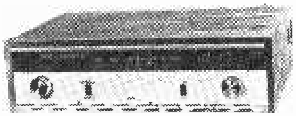

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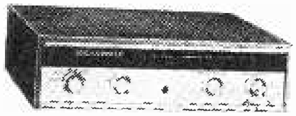

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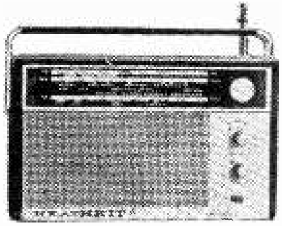

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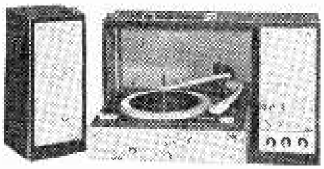

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Exciting sound – budget price. Kit K/SRP-1 **£32.50** Carr. 80p (Teak or Black/Rexine)

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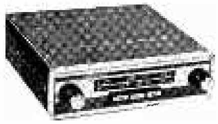
Compact size – lowest cost. Kit K/Trent **£15.20** Carr. 60p (Teak or Walnut)



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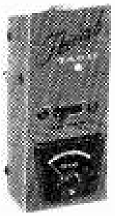
Heathkit value – powerful output. Two tone grey plus chrome trim. Kit K/CR-1 (less speaker) **£13.80** Carr. 30p



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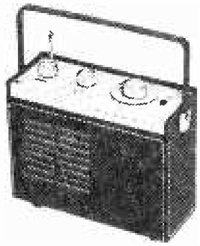

108-136MHz coverage.
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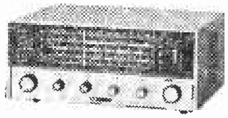

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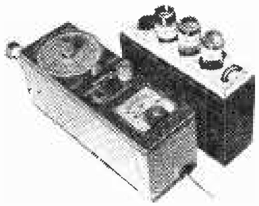

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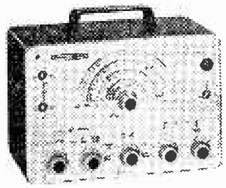

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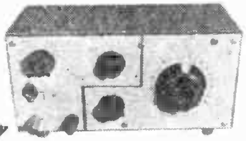

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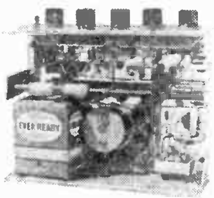

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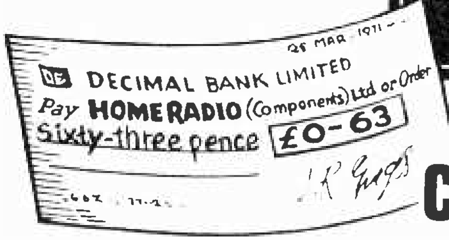
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COVER PRICE

We much regret that, owing to considerable increases in costs of production and overhead expenses, we have to increase our cover price to 20p commencing with the next issue, May, to be published 1st May. Subscriptions commencing with that issue will be £2.70 per annum, existing subscriptions will not, of course, be affected until expiry.

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MAY ISSUE WILL BE PUBLISHED ON MAY 1st

D.C. and Audio LCR Bridge

by

C. CROSBIE

A comprehensive design which provides a wide range of measurements of inductance, capacitance and resistance

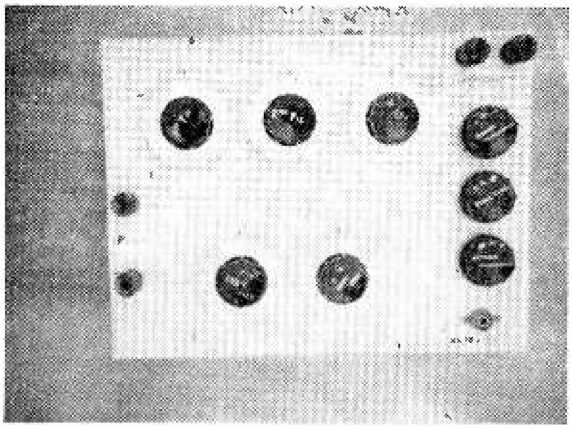
THE LCR BRIDGE DESCRIBED IN THIS ARTICLE OFFERS the following ranges.
Resistance: 0.1Ω to 10MΩ, a.c. or d.c.,
Inductance: 10μH to 1,000H, a.c. only,
Capacitance: 10pF to 100μF, a.c. only.

Accuracy lies between ±1% and ±5%, the higher figure resulting from limitations, which will be discussed shortly.

The prototype operated on d.c. and on a.c. frequencies from 30Hz to 30kHz.

LIMITATIONS

Limitations that are virtually unavoidable in a design of this nature tend to reduce accuracy under some conditions. For instance, few amateurs possess d.c. amplifiers, and the MΩ and 100kΩ ranges will require high d.c. voltages for conventional microammeters, when used as null detectors, to give a readily perceptible zero. Also, on the MΩ and 100kΩ ranges, stray capacitances introduce errors, or no balance at all, when the bridge is powered by a.c. above a few hundred Hz. A final limitation is that the 0.1Ω range is subject to errors due to switch contact resistance.



Front view of the instrument, showing the layout of the controls and terminals

Apart from these limitations the bridge offers considerable advantages, the most important of these being the fact that it is designed around normally available components, this being especially true of the standard capacitor. One of the resistors, a 1Ω component, may be difficult to obtain in close tolerance high stability, whereupon a wirewound component of wider tolerance could be employed with some risk of loss of accuracy on the particular multiplier position in which it is used. Those with access to

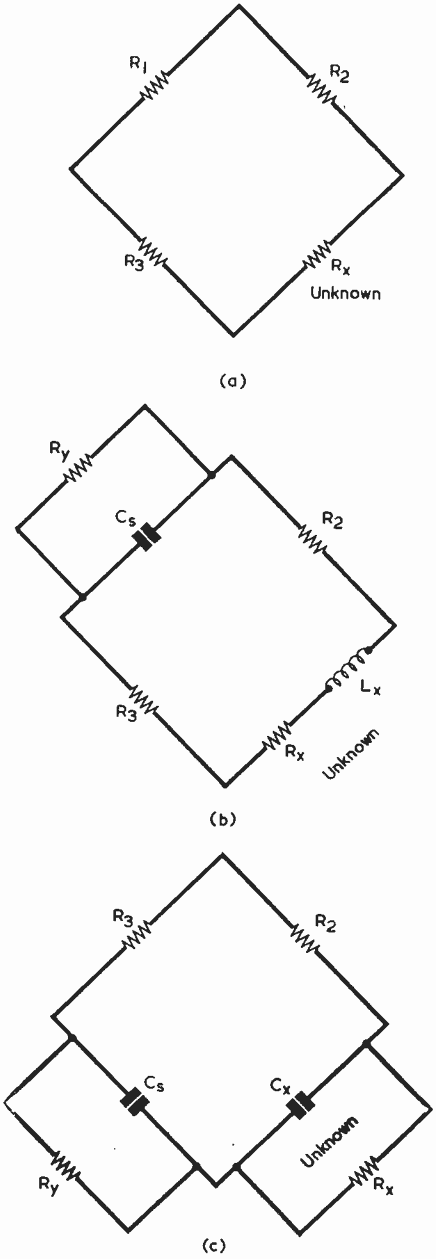


Fig. 1. The basic bridges that are employed in the instrument. That at (a) is used for measuring resistance, that at (b) for inductance and that at (c) for measuring capacitance

Eureka resistance wire will find that a 4.75in. length of 32 s.w.g. Eureka wire offers a resistance of 1Ω.

The only other component which could cause difficulties is the input power transformer, which may require to be home-wound.

BASIC BRIDGES

The instrument uses a switchboard combination of the bridges set out in basic form in Fig. 1.

The bridge in Fig. 1(a) is used for measuring resistance, the unknown resistor being shown as Rx. At balance,

$$Rx = \frac{R2.R3.}{R1}$$

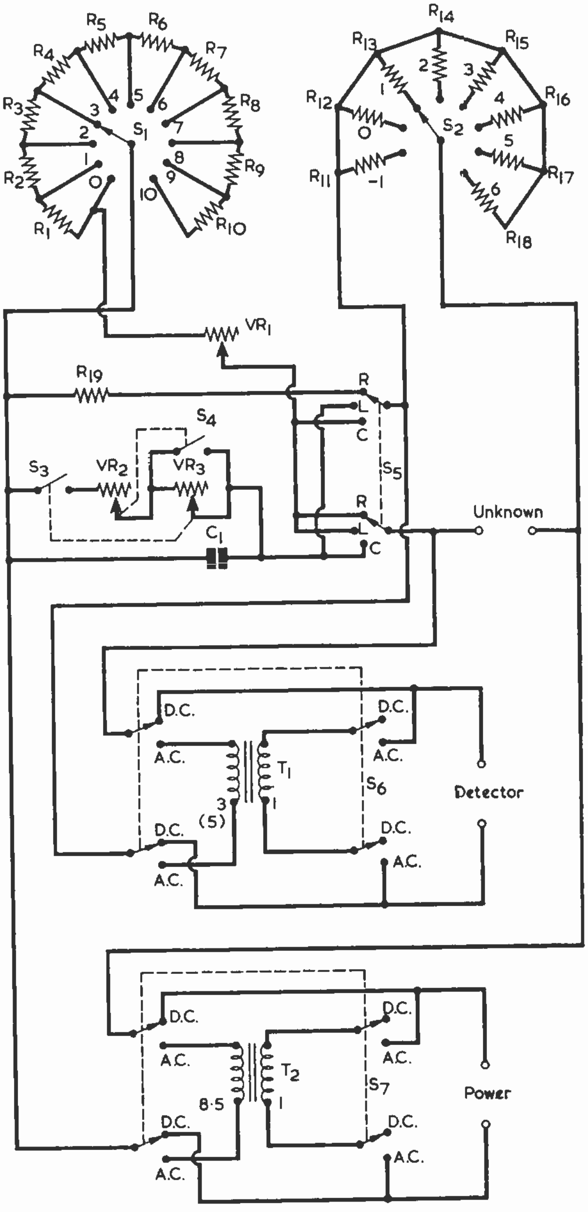
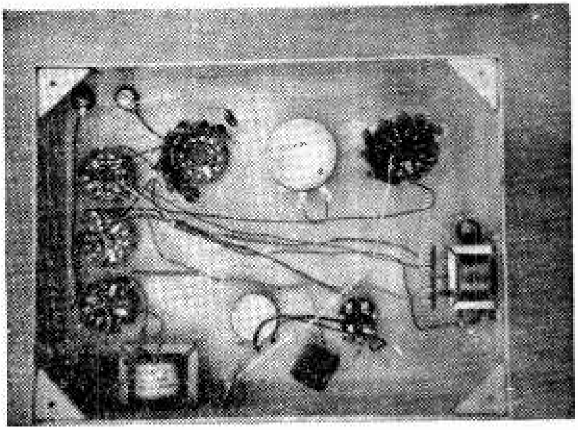


Fig. 2. Complete circuit of the bridge



A view inside the bridge with the back cover removed

The bridge in Fig. 1(b) is switched into circuit for measuring inductance. This is shown as Lx, its losses appearing as the series resistor Rx. Ry is adjusted to balance the losses, whilst Cs is the standard capacitor. At balance,

$$Lx = R2.R3.Cs, \text{ and}$$

$$Rx = \frac{R2.R3.}{Ry}$$

The third bridge, that in Fig. 1(c), is employed for measuring capacitance. The unknown capacitor is Cx and its losses are shown as Rx. Ry again balances out the losses. At balance,

$$Cx = \frac{R3.Cs,}{R2} \text{ and}$$

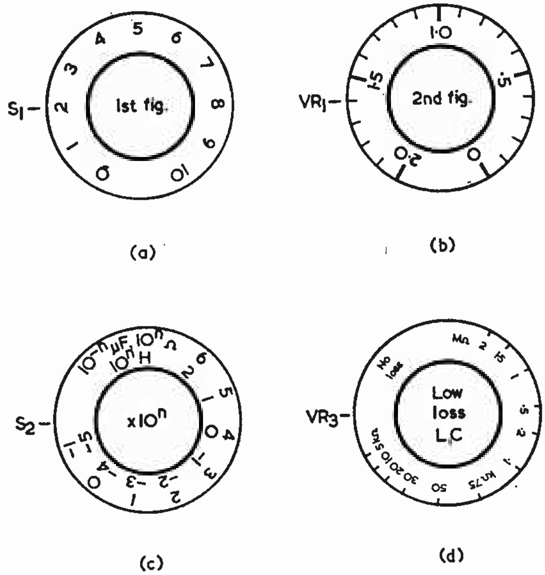
$$Rx = \frac{R2.Ry.}{R3}$$

In the complete bridge circuit, R1 is a 10kΩ standard resistor, and Cs is a 10,000pF standard capacitor. Ry is provided by a series combination of a 2MΩ potentiometer and a 25kΩ potentiometer which are referred to as 'Low Loss' and 'High Loss' controls respectively. R2 is given by eight switched resistors which multiply in succeeding powers of 10. R3 is variable from zero to 12kΩ, consisting of ten 1kΩ switched resistors and a 2kΩ potentiometer in series.

COMPLETE CIRCUIT

The complete circuit is shown in Fig. 2. When S5 is set to position 'R', the bridge set up is shown in Fig. 1(a) and the instrument is capable of measuring resistance.

Setting S5 to position 'L' causes the circuit to take up the form of Fig. 1(b) and introduces the standard capacitor, C1, across which are connected VR2 and VR3. These are standard potentiometers fitted with switches and are wired such that they insert minimum resistance into circuit at the end of their rotation which causes the switch to open. S3 is ganged with VR3, and S4 with VR2. As may be seen, S4 short-circuits VR3 when it is operated, whilst S3 is capable of completely isolating the two potentiometers.



(a) (b)

(c) (d)

Fig. 3. The appearance of the scales for (a) switch S1, (b) potentiometer VR1, (c) switch S2 and (d) potentiometer VR3

This last condition is indicated by the legend 'No Loss' on the scale for VR3.

The instrument becomes suitable for measuring capacitance when S5 is in position 'C', the circuit then being similar to the bridge in Fig. 1(c). C1 and the combination of VR2, VR3, S3 and S4 are retained in circuit.

Power to the bridge may be either d.c. or a.c., switch S7 being suitably adjusted to accomodate the type of input provided. The null detector may be either a d.c. or an a.c. type, switch S6 being set accordingly. The two transformers, T1 and T2, allow both the a.c. input and a.c. output to have one side earthed.

Switch S1 allows the resistance in its bridge arm to increase in 1kΩ steps. VR1 is a 2kΩ potentiometer and offers a 'fine' adjustment in series with S1. Theoretically, VR1 need only be 1kΩ if it is to take up the difference in resistance offered by each step in S1. In practice, however, a 2kΩ potentiometer is preferable, since a normal 1kΩ component with usual tolerances could have a value less than 1kΩ, whereupon there would be a gap for each step offered by S1. A wide tolerance potentiometer with a nominal value of 2kΩ will have a track resistance well in excess of 1kΩ and will also offer a degree of overlap which can be useful when initially searching for a null or when selecting two matched components from a batch.

$10^n\Omega$ $10^{-n}\mu F$	$10^n H$
−1	−5
0	−4
1	−3
2	−2
3	−1
4	0
5	1
6	2

Fig. 4. The scale of S2 shown in tabular form

S2 position	Multiplier Ω	Multiplier µF	Multiplier H
−1	0·1	10	0·00001
0	1	1	0·0001
1	10	0·1	0·001
2	100	0·01	0·01
3	1,000	0·001	0·1
4	10,000	0·0001	1
5	100,000	0·00001	10
6	1,000,000	0·000001	100

Fig. 5. The multiplying functions offered by S2

S1 sets up the first figure of the value of the unknown component, and it has a scale like that shown in Fig. 3(a). Note that this scale, together with the others illustrated in Fig. 3, is fitted to the knob of the appropriate control, and that it rotates with the knob. It is not secured to the panel of the instrument. The legend shown in the centre of the scale ('1st. Fig.' in Fig. 3(a)) is printed on the surface of the knob. The scales may be made of aluminium or plastic approximately 1/16in. thick, and can be secured to the bottoms of the knobs with screws or adhesive. In the prototype the scales were cut out from Perspex with a fretsaw and were enamelled matt white. They were marked up with drawing ink. The knobs were knurled types having a diameter of approximately 1in.

The scale for VR1 is shown in Fig. 3(b) and it is calibrated in terms of the resistance VR1 inserts into circuit. VR1 provides the second figure of the value of the unknown component.

MULTIPLIER

Switch S2 provides multiplication of the figures indicated by S1 and VR1 and it has the scale shown in Fig. 3(c). The markings on this scale will be discussed in detail shortly. VR3 has the scale shown in Fig. 3(d) and is calibrated in terms of the resistance it inserts into circuit. So also is the scale for VR2, the legend in the centre of its control knob being 'High Loss – L.C'.

To explain the operation of S2 it will be helpful to depict its scale in a linear manner, as is done in Fig. 4. It will be seen that the range positions indicated in Fig. 2 apply only to the resistance application. The figures correspond to powers of 10. Thus, when S2 is set to position 2, the figures provided by S1 and VR1 are multiplied by 10^2, or by 100. When S2 is in position 0, readings are multiplied by 1, and when it is set to position −1, readings are multiplied by 0.1.

To take an example, let us assume that balance with an unknown resistor is obtained with S1 at 8,

Unknown Component	1st Fig.	2nd Fig.	S2 setting	Function	Power	Detector	Low Loss	High Loss	Frequency
Transistor O/P Transformer Pri.	3	.16	−2 (ind.)	L	a.c.	a.c.	68kΩ	—	1kHz
2μF±20%	1	.85	0	C	a.c.	a.c.	No Loss	—	200Hz
330pF±1%	3	.1	−4 (cap.)	C	a.c.	a.c.	No Loss	—	20kHz
10,000pF±1%	9	.93	−3 (cap.)	C	a.c.	a.c.	No Loss	—	3kHz
Med. Wave Osc. coil type HO3 (Weyrad)	1	.15	−4 (ind.)	L	a.c.	a.c.	No Loss	—	20kHz
1kΩ±1%	1	.09	3	R	a.c.	a.c.	—	—	2kHz
2.2MΩ±1%	2	.3	6	R	a.c.	a.c.	—	—	75Hz
4Ω±5%	4	.25	0	R	d.c.	d.c.	—	—	—

VR1 at 0.4 and S2 at 3. The value of the resistor is then 8.4 multiplied by 1,000, which is 8.4kΩ.

When measuring capacitance, the resistor multiplying figures correspond to negative powers of 10. That is to say, position 4 corresponds to 10 to the power of −4. Position −1 now becomes 10 to the power of +1. Values are in microfarads. Thus, with S1 at, say, 5, VR1 at 0.7 and S2 at position 2, the value indicated is 5.7 x 0.01, or 0.057μF.

With inductance measurements, a different scale is used, this corresponding to powers of 10 ranging from +2 to −5. Indications are in henrys.

Constructors who find it difficult to calculate quickly in powers of 10 may find it helpful to calibrate S2 for −1 to +6 only and to make up a table giving the actual multiplying factors. Such a table is given in Fig. 5. This may be cut out or copied, for affixing to the front panel of the instrument.

Actual readings obtained with the prototype are listed in the printed table which accompanies this article. These show readings obtained with a variety of different components.

POWER TRANSFORMER

Power transformer T2 in the prototype was a rewound transistor output transformer. The new primary winding has 100 turns of 30 s.w.g. enamelled wire and the new secondary winding has 850 turns of 36 s.w.g. enamelled wire.

A 5:1 transistor interstage transformer *could* be used, but its power handling capacity would only be about 2mW. Alternatively, a 5:1 valve interstage transformer should serve quite well.

The loading imposed by the primary of the power transformer upon the source will vary according to the range to which the bridge is switched. With the 8.5:1 transformer, the primary loading varies from about 14Ω upwards.

AUDIO POWER SOURCE

When an audio power source is required, the audio frequency signal may be provided by an oscillator. A standard variable frequency a.f. oscillator was employed with the prototype. However, in company with other instruments of similar type, its maximum output, being only of the order of several milliwatts, was insufficient for the bridge, which is designed to work with about half a watt input.

It was evident that an a.f. amplifier between the oscillator and the bridge was required, and the amplifier shown in Fig. 6 was constructed. Due to the lack of coupling transformers this has a frequency

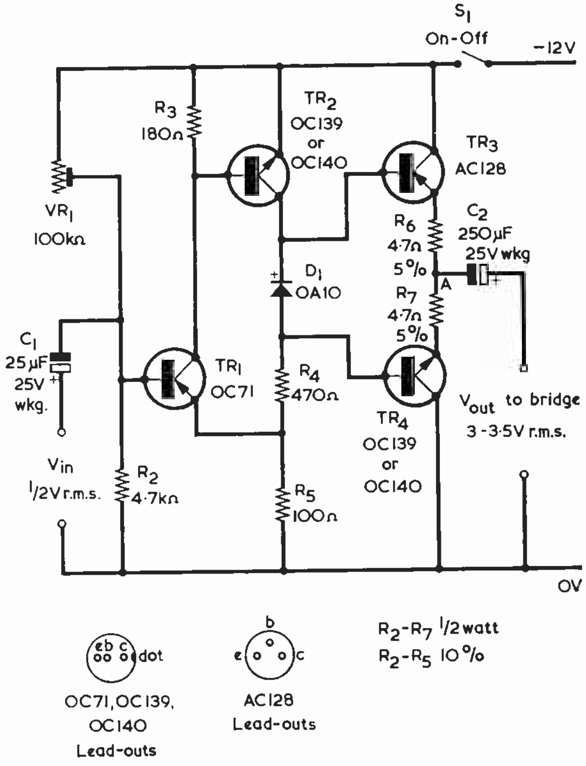


Fig. 6. Circuit of a suitable amplifier for providing a.c. power input to the bridge

COMPONENTS

Resistors
(All fixed values 1% high-stability, ½ watt.)

R1 — R10	1kΩ
R11	1Ω
R12	10Ω
R13	100Ω
R14	1kΩ
R15	10kΩ
R16	100kΩ
R17	1MΩ
R18	10MΩ
R19	10kΩ
VR1	2kΩ potentiometer, linear, wirewound
VR2	25kΩ log, with switch S4
VR3	2MΩ log, with switch S3

Capacitor

C1	10,000pF 1%, silver-mica

Transformers

T1	Intervalve transformer, 3:1 (or 5:1)
T2	See text

Switches

*S1	1-pole 11-way, rotary
*S2	1-pole 8-way, rotary
S3	ganged with VR3
S4	ganged with VR2
S5	2-pole 3-way, rotary
S6	4-pole 2-way, rotary
S7	4-pole 2-way, rotary

*S1 and S2 may be obtained as 12-way, no connections being made to the extra ways.

Miscellaneous

- 4 insulated terminals
- 1 insulated coaxial socket
- 8 knobs (see text)
- Material for scales
- Case (see text)

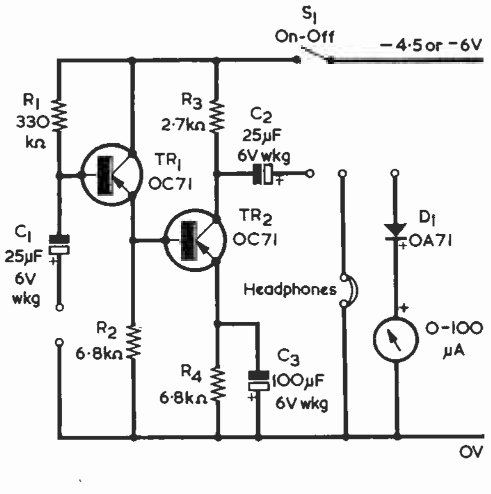


Fig. 7. A null detector unit

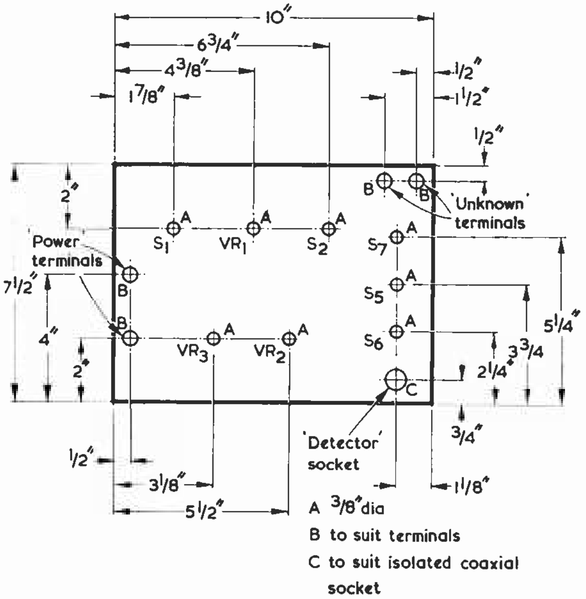


Fig. 8. Plan view, looking at the front of the case for the instrument

response ranging from several Hz to about 50kHz, and it will give about 400mW output with a 12 volt supply.

It should be noted that simple a.f. amplifiers incorporating transformers are not suitable for the present requirements, as few of them are effective below 100Hz or above 10Hz because of the transformers.

In the amplifier of Fig. 6, D1, TR3 and TR4 are all clipped to a 16 s.w.g. aluminium heat sink measuring 1½in. by 3in. Preset potentiometer VR1 is adjusted for −6 volts with respect to the lower supply rail at point 'A', after which it is left alone.

DETECTOR

As the balance equations have no 'ω' term in them, the balances are quite independent of supply frequency. For this reason a tuned detector is not required. Fair results are obtained from high impedance earphones (2,000Ω or 4,000Ω) on their own, but a small amplifier is preferable.

A suitable amplifier unit for increasing the sensitivity of earphones, or for use with a meter, is shown in Fig. 7. The terminals allow the meter or headphones to be connected to the output of the bridge or to the output of the amplifier of Fig. 7.

CONSTRUCTION

The prototype was built on a chassis measuring 10in. by 7½in. by 2¼in. There is plenty of space for components and readers wishing to employ a ready-made chassis of slightly different dimensions may do so, although it may then be necessary to slightly modify some or all of the drilling dimensions accordingly. The outside of the chassis is painted grey before any components are fitted to it.

Fig. 8 gives a plan view of the chassis deck. All the controls and terminals are mounted to the deck, the remaining components, apart from T1 and T2, being soldered to their tags. T1 and T2 are bolted to the chassis sides, close to the 'Detector' and Output' terminals respectively. These terminals are standard large insulated types.

The legends on the knobs for S1, S2, VR1, VR2 and VR3 have already been dealt with. The knob of S5 carries the word 'Function' and letters 'L', 'C' and 'R' at appropriate points to indicate the function selected. The knob of S6 has the legend 'Detector Transformer', and that of S7 has the legend 'Power Transformer'. On the panel, the words 'Power', 'Unknown' and 'Detector' appear alongside the corresponding terminals or socket.

USING THE BRIDGE

It is of great assistance if the approximate value of the unknown component is known or can be guessed, since the multiplier control, S2, can be set to the correct position straight away. Otherwise, S2 may be set to '3' as a suitable starting point.

Intitially, VR3 should be set to 'No Loss'. Then, S1 and VR1 are adjusted for minimum output from the detector, changing the setting of S2 if necessary. After a balance has been obtained, VR2 or VR3 may need to be adjusted for complete balance with inductive or capacitive components, and especially with iron cored inductors. The adjustment is for minimum null output. If VR2 or VR3 cause the balance to be sharpened, consequent adjustments in VR1 and, perhaps, S1 will be needed to ensure that optimum balance is maintained.

It should be noted that a false balance may be observed with a low impedance component, since the power source becomes loaded as S2 is switched to low resistance values. The situation is easily recognisable as the resulting false balance produces an answer of zero impedance. ■

EASE TV DEPOSITS

A strong case for altering the present stringent controls on TV rental has been made by Sir Brian Horrocks, President of the National Television Rental Association.

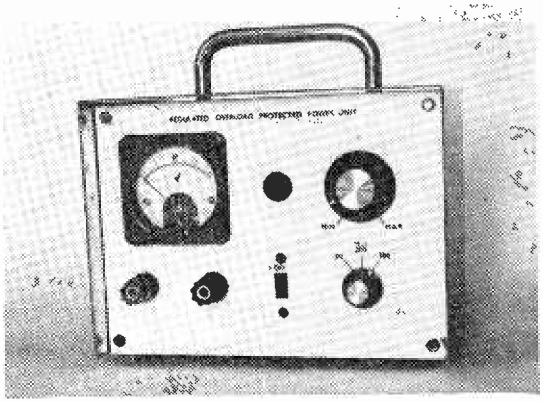
In a letter to the President of the Board of Trade Sir Brian points out that while the controls – ten months advance rental – have been vigorously exercised, check trading and personal loan schemes have been allowed to grow virtually unhindered.

In his letter Sir Brian refers to a report that a 400-strong electrical retail chain is proposing to launch a check-trading scheme to market colour television sets on an initial payment of £10 followed by weekly instalments of 35s. for five years. He says: "The scheme will make nonsense of the credit control policy so far as television is concerned." He also adds that the Crowther Committee on consumer credit was set-up in July, 1968, and it will be some time before any action will be taken on it "thus for up to three years we will have had to suffer unfair competition as a direct result of the inequality of the credit controls."

Finally, Sir Brian urged the President to make an immediate reduction in the advance rental from 42 weeks to 30 weeks.

RADIO CONSTRUCTOR

MAY ISSUE



NON-OVERLOAD POWER SUPPLY

This power supply offers output voltages from 0.5 to 15 volts and cannot be overloaded. The maximum current for which the unit is set up is not exceeded even when a short-circuit is placed across the output terminals.

TRANSISTOR R.F. PRESELECTOR

Covering the Amateur bands from 160 to 20 metres, this preselector may be inserted between any aerial and short wave receiver, thereby enhancing both sensitivity and selectivity. Printed board construction, three transistors (ASZ20) in a cascode r.f. amplifier/emitter follower output configuration. The input circuit features a simple but effective attenuator.

LCR TONE CONTROL CIRCUIT

For economic reasons, professional designers avoid using a.f. inductors in such circuits. With a selection of old transformers and chokes available, the amateur constructor is under no such restriction. This article shows how to use these components to provide true bass lift and cut. The circuitry is simple and adaptable and will work from any supply voltage above about 3V. An equally simple treble control completes the circuit.

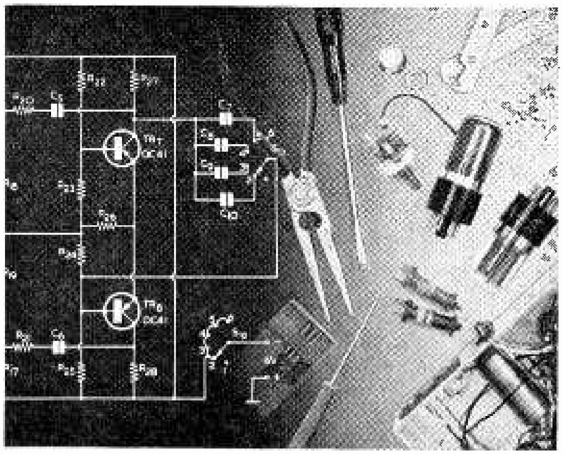
PLUS

- ★ **MORE CONSTRUCTION PROJECTS**
- ★ **NEWS COVERAGE**
- ★ **SHORT WAVE SCENE**
- ★ **SUPPORTING FEATURES**
- ★ **DATA SHEET 50**

ON SALE MAY 1st

Oscilloscope Voltage Reference Unit

by G. A. FRENCH

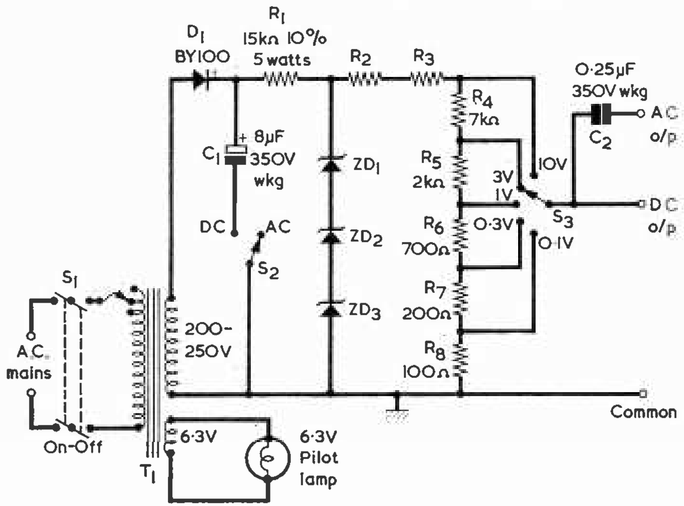


THE UNIT TO BE DESCRIBED IN this month's article in the Suggested Circuit series is capable of providing a series of square waves whose peak-to-peak amplitude is known, being maintained at a constant level by means of a series chain of zener diodes. The unit also provides reference direct voltages for the calibration of direct coupled oscilloscopes, or valve or f.e.t. voltmeters. In some instances it will be possible to incorporate the unit in an existing oscilloscope, with a consequent economy in components.

CIRCUIT DESIGN

The circuit of the voltage reference unit appears in Fig. 1. Here, the secondary of any mains transformer offering a voltage between 200 and 250 volts is applied to rectifier D1. When switch S2 is in the 'D.C.' position, the reservoir capacitor C1 is connected across the rectified voltage from D1, whereupon a direct voltage approaching the peak value of that provided by the transformer secondary appears across its plates. This voltage is applied via R1 to the three zener diodes, ZD1, ZD2 and ZD3. These are each rated at 5.1 volts, whereupon a nominal 15.3 volts appears across the three diodes in series. The regulated voltage across the diodes is then applied to the resistor chain given by R2 to R8. R2 and R3 have values which cause outputs between 10 volts and 0.1 volt to be selected by switch S3. Resistors R4 to R8 are high stability 1% components, with values calculated at 1kΩ per volt. Thus, the total resistance between the 1 volt switch fixed contact point and the common negative terminal is 1kΩ, that between the 3 volt point and the common negative terminal is 3kΩ, and so on. It will be apparent that the correct voltages appear in the series chain given by R4 to R8 when 1mA is caused to flow through them, and the unit is set up by adjusting the value of R3 such that this current flows in the chain.

When S2 is set to 'A.C.', reservoir capacitor C1 is taken out of circuit, whereupon D1 allows positive half-cycles to be applied to R1. When the positive voltage is in excess of the combined zener voltage given by ZD1 to ZD3, these diodes pass zener current and the voltage across them is limited to the total zener voltage, the remainder of the voltage being dropped across R1. Rectifier D1 does not conduct when negative half-cycles are applied to it, with the result that the voltage across the zener diodes then falls to zero. In consequence, the voltage across the zener diodes is very nearly a square wave with a frequency of 50Hz, and having a peak-to-peak voltage amplitude which is almost identical to the direct volt-



ZD1 - ZD3 5·1V 5% 250mW
R2, R3. see text.
R4 - R8. Hi-stab 1% 1/4 or 1/2w
S3 Output voltage selector switch

Fig. 1. The circuit of the voltage reference unit. With S2 at 'A.C.' the output on both output terminals is a square wave whose peak-to-peak voltage is equal to that indicated at the appropriate contact of S3

age given when S2 is in the 'D.C.' position. Corresponding peak-to-peak voltages are then tapped off by S3.

The square wave output can be employed to calibrate an oscilloscope, which may be connected between the 'A.C. Output' terminal and the common terminal. Connection can alternatively be made to the 'D.C. Output' terminal if the oscilloscope to be calibrated has its own input series capacitor. Indeed, if the unit is only to be employed with oscilloscopes having such an input series capacitor, C2 and the 'A.C. Output' terminal can be omitted from the circuit. It is assumed that the oscilloscope has an input impedance of 1MΩ or more, as will normally be the case.

ZENER DIODES

Three 5.1 volt zener diodes are employed instead of one in order to reduce variations in regulated voltage due to temperature change. The temperature coefficient of small zener diodes tends to change from a low negative to a low positive value at zener potentials around 5 volts, whereupon the overall coefficient of the three diodes in series should be close to zero. If a single 15 volt zener diode were employed instead of the three separate diodes, this would exhibit a temperature coefficient of. typically. +11mV per degree Centigrade. In consequence, a temperature change of 25°C (which could quite feasibly occur if the unit were installed inside a compact valve oscilloscope) would result in a change in regulated voltage of 0.275 volt or, approximately, 1.8%. Although the unit is not intended to offer an exceptionally high degree of accuracy it would nevertheless seem reasonable, bearing in mind the current low price of small zener diodes, to employ the three diodes instead of a single diode if reasonable freedom from voltage variation with temperature change results.

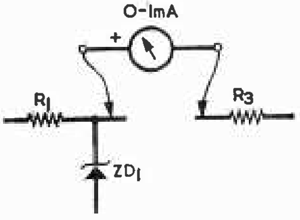


Fig. 2. The unit is set up by temporarily connecting a 0–1mA meter in place of R2 and adjusting R3 for a current of exactly 1mA when S2 is set to the 'D.C.' position

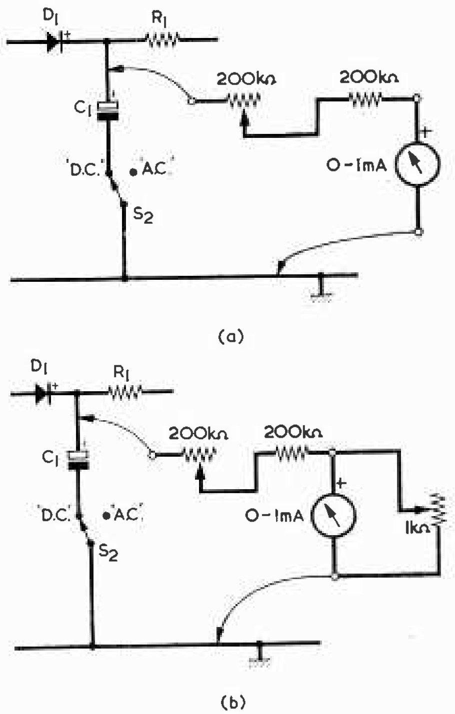


Fig. 3. The unit provides a convenient h.t. voltage across C8 if it is necessary to find the internal resistance of the 0–1mA meter. In (a) the 200kΩ variable resistor, which should be initially set to insert maximum resistance, is adjusted for a reading of 1mA in the meter. The 1kΩ variable resistor of (b) is then added and adjusted for a reading of 0.5mA. The meter internal resistance is then equal to the resistance presented to the circuit by the 1kΩ variable resistor

The three diodes should be 5.1 volt 5% 250mW types. Resistor R1 passes some 15mA when S2 is set to the 'D.C.' position, with the result that each diode then dissipates roughly 75mW. Diodes with ratings greater than 250mW should not be used as they may not exhibit as low a slope resistance at the currents which appear in the circuit.

Transformer T1 can be any small mains transformer having a secondary offering 200 to 250 volts at 15mA or more. The secondary voltage should not be greater than 250 volts, since higher voltages may cause the p.i.v. rating of D1 to be approached or exceeded. If the unit is to be incorporated inside an oscilloscope it may be possible to obtain the requisite voltage from a secondary on the existing mains transformer, provided this is capable of supplying the 15mA required by the circuit. It is assumed that the resistance of the secondary winding plus transformer losses will be more than adequate to limit the charging surge current which flows when S2 is set to the 'D.C.' position. When the unit is made up with its own mains transformer, as in Fig. 1, it will be found that suitable transformers normally incorporate a 6.3 volt heater winding in addition to the 200 to 250 volt secondary. This heater winding may either be ignored, or it can be employed to light a pilot lamp, as shown.

Turning to the other components in the circuit, R4 to R8 should be 1% high stability ¼ or ½ watt types. Should difficulty be experienced in obtaining the 7kΩ and 700Ω values specified for the R4 and R6 positions, these may be made up with series combinations of 2kΩ and 5kΩ, and of 200Ω and 500Ω respectively. If output voltages other than those shown are required, the values in the series chain of resistors can be altered accordingly, working to the figure of 1kΩ per volt.

R3 is ¼ or ½ watt and is adjusted experimentally such that 1mA flows in R4 to R8. It will require a value of approximately 5kΩ. It should ideally be a high stability type but this could involve the constructor in the purchase of a number of expensive resistors when only one will be finally used. An alternative approach would consist of using a variable resistor in the R3 position during setting-up and of then measuring the resistance it inserts in circuit. It could then be replaced by a high stability resistor of slightly lower value in series with an inexpensive carbon composition type to make up the final value required. Resistor R2 is discussed shortly, when the setting-up procedure is described. Resistor R1 is a standard wirewound or carbon composition resistor having the value, tolerance and wattage specified.

The electrolytic capacitor, C1, requires a value of 8μF only. Higher values here will only offer a marginal increase in rectified direct voltage, as was demonstrated in the 'Radio Constructor Data Sheet' No. 33, published in the December 1969 issue of this journal.

SETTING-UP

The unit should be built up without R2 in circuit and with a means for adjusting the value of R3, as has already been discussed. A 0–1mA meter is then temporarily inserted in the R2 position, as illustrated in Fig. 2. The unit is switched on and S2 set to the 'D.C.' position, after which R3 is adjusted until the meter indicates exactly 1mA. The meter is then removed from the R2 position, being replaced by a resistor which should have the same value as the internal resistance of the meter, and which can be a carbon composition type if this resistance is of the order of 100Ω or less. For higher meter resistances it would be marginally preferable to use a high stability component. R2 may have a rating of ¼ or ½ watt.

If the 0–1mA meter is a panel-mounting type it will normally have its internal resistance indicated on the scale, or the internal resistance will be quoted in the appropriate sales literature. If the meter internal resistance is not known (this being especially likely to occur if a multitestmeter is employed to take the current reading), it may be found experimentally, employing the approach shown in Figs. 3(a) and (b). First, connect the meter across C1 of the unit by way of a 200kΩ ¼ or ½ watt fixed resistor and a 200kΩ variable resistor in series, as in Fig. 3(a). The 200kΩ variable resistor is initially set to insert maximum resistance into circuit. The unit is switched on and S2 set to the 'D.C.' position. The 208kΩ variable resistor is then adjusted until the meter indicates exactly 1mA. Next, connect a 1kΩ variable resistor across the meter, as in Fig. 3(b), and adjust this until the meter reads exactly 0.5mA. The internal resistance of the meter is then equal, with negligible error, to the resistance offered by the 1kΩ resistor, which can be disconnected from the circuit and measured in normal fashion.

After R2 and R3 have been finally connected into the circuit the unit is ready for use, and will offer regulated direct and square-wave reference voltages of the values indicated. ■

THOSE DAMNED DOTS – AND DASHES!

With the recent conversion to decimal currency, many of us have probably run into trouble with the decimal point – "those damned dots" – as Lord Randolph Churchill once aptly remarked. However that may be, there must be many readers who have run into the dot problem at some time or another – not to mention the dashes that go with them – and we refer here to the Morse code.

Having struggled through the Morse business to reach a reasonable speed in w.p.m., most of us assume that we know all about Morse – but do we?

Did you know that with the American Morse code, eleven letters and all numerals, except 4, differ from the International Morse code? The letters that differ are C, F, J, L, O, P, Q, R, X, Y and Z.

Did you know that Samual Finley Breese Morse (1791-1872), devisor of the Morse code, was not only an inventor but an artist of repute? He gained a very considerable reputation in the art of portrait painting and was a founder of the National Academy of Design (1825). He not only devised the Morse code but also experimented with submarine cable telegraphy and invented the electric telegraph.

His father, Jedidiah Morse (1761-1826) was an American Congregational clergyman who opposed Unitarianism and also wrote a whole series of geography textbooks which were widely used in their day.

Morse's brother, Sydney Edwards Morse (1794-1871) was not only an inventor but also a geographer and a journalist. Together with another brother he founded the *New York Observer* in 1823 and was a co-inventor of cerography, a method of making stereotype plates. He perfected the bathometer and also edited and wrote books on geography.

TWENTY & ALL THAT

Without a shadow of a doubt the band most favoured by the majority of amateurs for working Dx, and has been for many years, is 14MHz.

From end to end, when things are favourable, good old 'twenty' always carries the most traffic from one Dx location to another – it has been the scene of many exciting contacts and 'pile-ups' by the score. Tuned and hunted over from end to end it has become the Mecca of the Dx enthusiast, both s.w.l. and call holder alike, provided they can tolerate the QRM!

Until fairly recent times, 14MHz was nearly always good for a Dx C.W. contact at the right time and with reasonably good propagation conditions. Despite the QRM, which has been a problem besetting the amateur transmitter and listener for many years, a C.W. QSO was a reasonable proposition. Over the years, many of us have chalked up an impressive list of exotic 'scalps' gathered on the twenty metre war path. The tribal custom of collecting certificate trophies has mostly been achieved by using this frequency range.

Within the last few years however the pattern has changed. For Dx contacts, the s.s.b. mode of transmission now rules the ether waves and the C.W. end of the band lacks something of the lustre it once displayed. Some would, no doubt, claim that this change is all part of the progress pattern of amateur radio, and they are probably right. With the denuding of the l.f. end of the band due to the Dx migrating to the higher s.s.b. frequencies, one of the main incentives to 14MHz key-bashing has vanished. Although many c.w. Dx contacts still do take place, there is considerably less of them than there were in the past.

Anyone tuning over the C.W. end of the band will soon find that it is alive with dots and dashes, but only relatively few of these are of Dx origin. In the main these signals come from Eastern Europe, mostly from the U.S.S.R. What with the s.s.b. migration to higher climes and the growing list of Russian operators, either conditions have to be exactly right for Dx working or, more likely as a general rule, one must dig hard and deep under the semi-local stuff to uncover the buried treasure that occasionally lies beneath.

On 14MHz, one always had the problem of winkling out the Dx from under local signals but never quite to the same extent apparent these days. All things must progress but sometimes one wonders whether it is a plus or minus progression!

It is probable that 'twenty' will never lose its pristine glory of being the main Dx provider. For *regular* Dx working the higher frequency bands are noted for being liably unreliable! The lower frequency bands, apart from odd seasonal flashes, are not generally noted for Dx reliability.

With the steady growth rate of amateur s.s.b. transmissions it maybe that, in due course, this portion of the band will literally burst at the seams, where upon enroachment will further affect the c.w. end. Add to that the certain event of a future flood of new operators from the so-called emerging nations, 'twenty' is in for trouble! ■

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● NIGERIA

Lagos can be heard, by those who rise early, on **4990** (10kW) at 0600 with African drums identification signal followed by the news in English.

● MONACO

Trans-World Radio, Monte Carlo, may be logged with station identification and the English programme at 0725 on **7290** (100kW). Musical chimes identification signal.

● CHINA

Peking can be heard on **4865** and **4905** (20/240kW) at 1600 with programme in Chinese dialect.

● NIGER REPUBLIC

Niamey can often be heard around 1900, in French, on **3260** (4kW) with Network I, the Home Service Address for reports is – Office de Radiodiffusion Television du Niger, B.P.361, Niamey.

● PORTUGUESE GUINEA

Emisora da Guinea, Bissau, often heard around 1930 on **5041** (10kW) with announcements in Portuguese and light music. Schedule is from 0600 to 1400 and 1700 to 2400 weekdays, on Sundays from 0600 to 2400, but unlikely to be heard in the U.K. during daylight hours.

● GHANA

The transmitter at Ejura on **4915** (10kW) can be heard at 0600 with African drums interval signal, identification and local news in English, drums at 0615 then into dialect. Ejura radiates the Home Service programme to the following schedule – Weekdays from 0530 to 0800 and from 1200 to 2300, Sundays 0530 to 2300. Address for reports is – Ghana Broadcasting Corporation, Propagation Engineer, Broadcasting House, P.O. Box 1633, Accra.

● AFGHANISTAN

Kabul can be heard on **3390** (10kW) around 1630 with the Home Service. Arabic-type music and chants are largely featured, the languages being Pushtu or Dari. Schedule on this channel is from 1300 to 1745. Announcement is "Da Radio Afghanistan Kabul Dai", interval signal – a flute. Address for reports – P.O. Box 544, Kabul.

● CUBA

Radio Havana is to be logged on **17705** (50kW) at 2015 with the news in English. The English schedule on this frequency is from 2010 to 2140 beamed to N. Europe. Address is – Radio Habana, Apartado 7026, La Habana.

● U.S.A.

Greenville (Voice of America) is to be heard on **17710** (250kW) at 1945 with an English programme directed to Africa. Schedule for this programme on this channel is from 1600 to 2400.

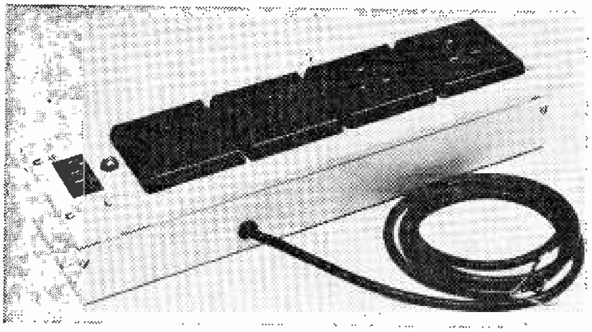
● IRAN

Teheran can be regularly heard on the Home Service (First Programme) channel of **15084** (250kW). The programme language is Farsi (Persian), the schedule on this channel being from 0600 to 2030. Address – Ministry of Information, Meidan Ark, Teheran. ■

Acknowledgements – Our Listening Post.

NEWS . . . AND .

EXTENSION TO LEKTROKIT RANGE



The LKU-413 multi-socket distribution panel with four, 3-pin, 13A shuttered outlet sockets, a combined On/Off switch and magnetic circuit breaker and red neon indicator manufactured by A.P.T. Electronic Industries Ltd.

A.P.T. Electronic Industries Ltd., Chertsey Road, Byfleet, Surrey, have extended their well-known Lektrokit range by the introduction of a new, multi-socket mains distribution panel.

The new unit, designated the LKU-413, consists of four, 3-pin, 13A shuttered outlet sockets, mounted side by side on the top of the unit, a combined On/Off switch and magnetic circuit breaker, a red neon indicator and 6 ft. extension cable as standard.

Light in weight and of compact design, the new unit is robustly constructed from aluminium and measures 17 x 5¼ x 2½ins. high. The housing is attractively finished in a light-grey, bonded plastic coating, with an effective 'leatherette' type texture, whilst the switch and sockets are of bakelite in brown or ivory tone. Rubber feet are fitted on the underside of the unit as an aid to stability when free-standing on bench or floor. If required, Lektrokit brackets type LK-601 may be fitted to each end, thereby enabling the unit to be mounted on a wall or bench face.

The new panel provides outlets for a number of electrical devices to be operated from a single, permanent mains source and simple, quick conversion from existing power distribution systems to 13A outlet sockets.

The versatility of the LKU-413, makes it highly suitable for use in a wide variety of applications, including hospitals, laboratories and surgeries, garages, workshops, photographic studios, etc. Diverse applications are open to D.I.Y. enthusiasts for its use in and around the home.

Available direct from the manufacturers, the new unit is priced at £6.30p including purchase tax. If required, the panel can be supplied with 30ft. of cable (LKU-413L) at an inclusive price of £6.97½p.

SOLDERING – THE INDUSTRIAL WAY

One method of soldering, used industrially in appropriate circumstances, is by means of the 'Instanta' air operated Solder Cream Dispenser.

The technique used ensures that each successive deposit of solder is of equal volume and approximately the same shape.

The complete unit consists of the 'Instanta' dispenser with a connecting air hose and a Control Console which gives the facility of a variable time cycle and varying pressures.

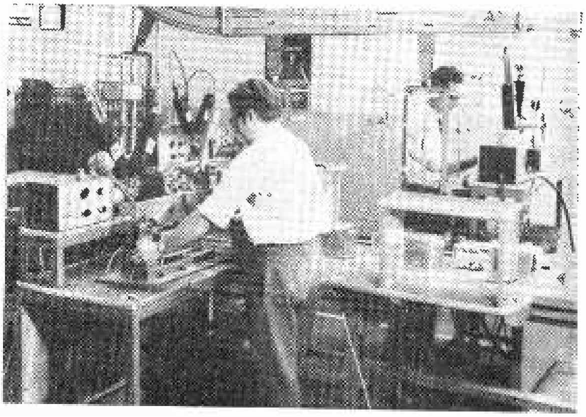
Nozzles of various diameters, which are interchangeable, are available to meet the particular application in hand and in single cycle operation, after the time cycle and nozzle diameter have been specified, each time the start button is pushed, the exact dosage of solder cream is dispensed.

For continuous production line work the time cycle can be linked to a micro-switch for automatic operation and dispensing repeatability is in the order of ± 3% whilst operating pressure is between 10 and 80 p.s.i.

There are ten available nozzles in diameters from 0.027" up to 0.122", solder cream is pre-packed and supplied in plastic cartridges of approximately 18 oz. capacity.

A connection for remote control is fitted to the rear of the console.

U.G.I. (Meters) Ltd. of Streatham Vale, London, when installing their continuous flow line production system chose the Instanta Solder Cream dispenser for the assembly of the two bosses to their top meter cases.



As can be seen in the illustration, the top of the meter case travels to the solder cream dispensing station and the two bosses which have had a bead of solder applied around them, are rivetted to the case and in so doing the solder cream is trapped inside the rivetted joint.

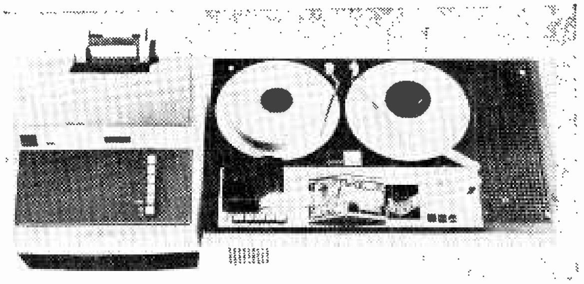
The whole assembly then passes through an oven where the solder is caused to flow and so form a perfect joint.

. . . COMMENT

NEW KIENZLE TAPE AND CARD PUNCHES

New paper tape punching and card punching systems are announced by Kienzle to supplement their well known range of digital printers. As with the digital printers, the new tape and card punch systems accept parallel data directly by means of a built-in serialiser and control unit.

Both the tape punch and card punch may be driven directly from any Kienzle printer by means of an output buffer store. It is therefore simple to print out and punch tape or cards at the same time without extensive interfacing. Alternatively, the tape and card punches may be driven directly by suitable parallel data.



The tape punch includes spools with 'Tape Low' and 'Spool Full' alarms. It also contains 'Tape Jammed or Broken' sensors which stop the punch and bring up an alarm. Parity check is available at a small extra cost. Speed of punching is 50 columns per second, and any 5, 6, 7 or 8 hole code may be specified.

The card punch includes a card hopper and card stacker with appropriate alarms for 'Hopper Low' and 'Stacker Full'. Speed of punching is 25 card columns per second.

ULTRASONIC LEAK DETECTOR

The Type 8900A illustrated above is an instrument designed to locate quickly and easily gas or air leaks. It is particularly useful in the vehicle maintenance field for the detection and speedy, accurate location of air leaks in the pneumatic braking systems of heavy duty vehicles.

The instrument complies with the British Ministry of Defence – Navy requirements.

RSGB PRESIDENT INSTALLED

Mr. F. C. Ward, G2CVV, was installed as the thirty-seventh President of The Radio Society of Great Britain at the Bonnington Hotel, London, WC1, on 15th January.

RADIO DEALERS FORM JOINT PURCHASING ORGANISATION

Early in 1970 a number of radio dealers in the London area decided to form a joint purchasing organisation, provisionally called 'Group One.'

The primary object of the organisation was to buy components at more favourable prices than was possible for dealers acting on their own. This, in turn, would enable the dealers involved to offer a wider range at lower prices to radio constructors.

Secondary objects gradually developed, such as exchanging surplus stocks and conveying information of mutual interest.

Some components are only available direct from the manufacturers and in quantities beyond the resources of the average dealer. In these cases purchases made by the group on behalf of members was of great service to them.

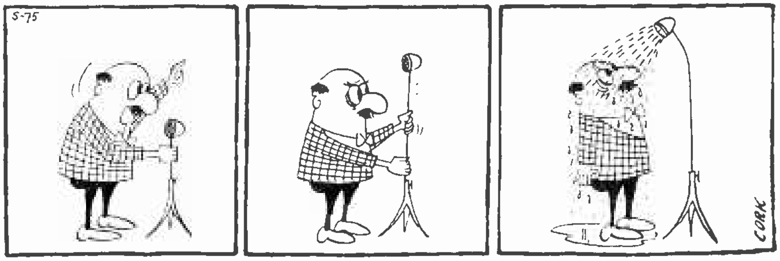
The organisers stress that they are not trying to cut out the services of wholesalers and distributors, indeed they would welcome any small wholesaler or manufacturer who cared to enter the scheme.

'Group One' now feels that it should expand. Originally limited to 20 dealers, because of anticipated administrative problems which did not in fact arise, it now feels that membership can be offered to any bona fide dealer in the U.K.

Anyone interested in the scheme (at present there is no entrance fee or subscription), should write to Mr. A. Sproxton of Home Radio Components Ltd. at 234-240 London Road, Mitcham, Surrey, CR4 3HD.

"The main topic of public interest during the year seemed increasingly to be the effects, if any, of television violence on the public. There was a continued high level of interest also in the problems of advertising control, the impact of television on children and the controversial question of the kind of language suitable for television programmes of different types."

From the 1969/70 Annual Report of the Independent Television Authority.



Constructing a Vertical 3-band Trapped Dipole

by

A. S. CARPENTER, G3TYJ

Aerial trap principles enable reliable multi-band aerials to be assembled without difficulty

ANYONE WHO HAS OBTAINED EITHER A MOSLEY wire trap dipole type TD-3 Jr. or, alternatively, a pair of Mosley traps of similar type can with very little expense convert to a free-standing 3-band vertical to cover the 10, 15 and 20 metre amateur bands; such a dipole will confer the desirable low angle radiation properties essential for Dx working.

A lengthy period of tests carried out by the writer on the three bands mentioned, using alternatively a long wire and the vertical trapped dipole to be described, indicate that for Dx working the vertical yields the best signal reports whilst at shorter distances – say around the Mediterranean area – the vertical is less effective than the long wire.

A free-standing vertical aerial is both elegant and unobtrusive – an advantage perhaps in some modern housing areas – and even if three thin nylon guy ropes are considered essential in windy locations the whole assembly is still barely noticeable.

One distinct advantage a vertical dipole has over its close neighbour, the ground plane aerial, is that it can be fed with standard 75Ω nominal impedance coaxial cable. The ground plane, of course, prefers 52Ω line, which is not always readily available.

Mosley traps of the type mentioned are approximately 1⅛in. diameter with some 14in. length of barrel; fixing lugs are fitted at both ends.

Editor's Note.—The dipole described in this article employs commercially manufactured amateur band trap assemblies which are intended for installation in wire aerials, but which now have aluminium tubes fitted to them. Since this application is different from that for which the trap assemblies were designed, the constructor must ensure that the method of fixing the aluminium tubes does not cause mechanical damage or subsequent strain to the assemblies. A description of aerial trap operation was given by the author of this article in 'Creating A Three-Band Trapped Dipole', published in the May 1969 issue. Basically, a trap (in an aerial with two traps) is a parallel tuned circuit resonant at the highest frequency to be handled by the aerial. It then acts as a virtual insulator at this frequency and as a loading coil at lower frequencies.

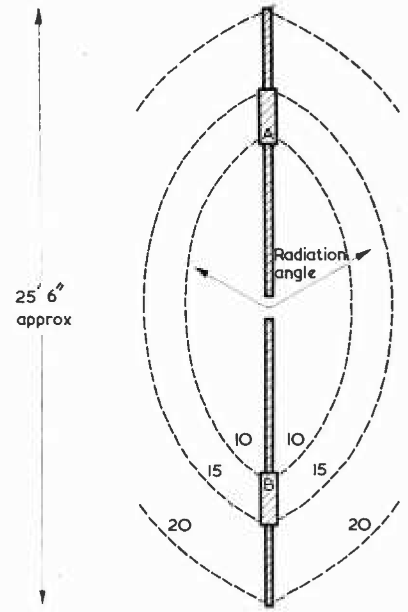


Fig. 1. Current distribution in trapped dipole at 10, 15 and 20 metres. The angle of radiation depends upon the height above ground

A vertical trap dipole radiates and receives from all directions and the traps act automatically as switches since they are frequency-conscious items. On 10 metres for example, and referring to Fig. 1, points A and B offer a high impedance at the frequency involved and the remainder of the aerial is effectively cut off. 20 metre signals on the other hand find little opposition offered by the traps and the whole dipole radiates. The traps do, however, act as loading coils on '20' and so the overall length of the dipole is less physically than that of a trap-free dipole designed for that particular band.

CONSTRUCTION

The method of construction employed is shown in Fig. 2. It is initially necessary to obtain three 8ft. lengths of ½in. i.d. hard drawn aluminium alloy tube. A suitable supplier is quoted in the Components List. On receipt of the material, one piece is cut to provide two lengths of 3ft. 6in. each. The remaining 8ft. lengths form the central 10 metre dipole, the traps being fitted to these with their 'red' ends towards the centre. The writer found it possible to force-fit the traps into the end of the tubes. The 3ft. 6in. lengths of tube are then mounted to the free ends of the traps, nuts and bolts being passed through as required after appropriate holes have been drilled.

The centre section of the aerial is mounted on a length of 3 by 1in. timber which has previously been painted and prepared for outside use. It is necessary to obtain about 12in. of rubber or plastic tubing that will just slide over the metal tube. This tubing is cut into six 2in. lengths which are then slid over the 10 metre section and spaced equidistantly. The thicker the rubber or plastic tubing that can be

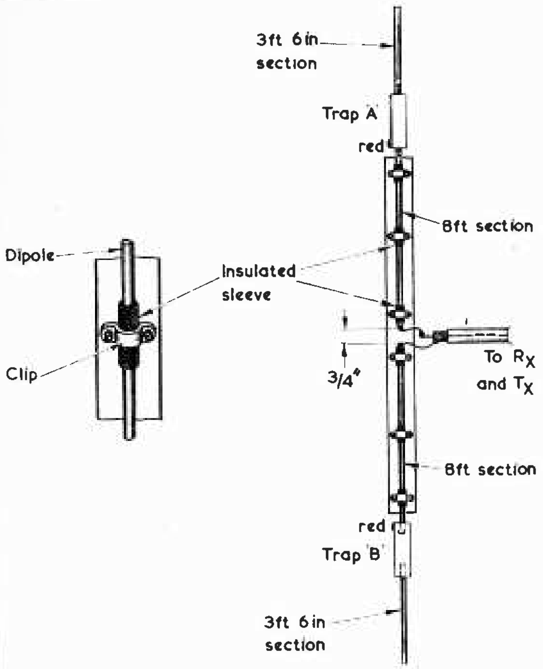


Fig. 2. How the vertical three-band dipole is assembled. For purposes of illustration, the aluminium tubes are shown with greater width than the scale demands

MATERIALS

2 Trap assemblies, part of Wire Trap Dipole Kit type TD-3Jr. (Mosley Electronics, 40 Valley Road, New Costessey, Norwich, Norfolk).
3 8ft. lengths ⅝in. o/d x 16 s.w.g. Aluminium Alloy Tube BS.1471 HT19 WP. (H. Rollet & Co. Ltd., Hainge Road, Tividale, Tipton, Staffs.)
1 10ft. length timber, 3 by 1in.
6 galvanised or copper pipe clips, approx. 1in.
1 12in. length plastic or rubber tubing (see text).
Low-loss coaxial cable, 75Ω.
Bostik No. 2.
Woodscrews, nuts, bolts, etc.

obtained the better. Six galvanised or copper pipe clips, approximately 1in., then secure the aerial to the timber, the clips being placed over the sections of rubber or plastic tubing. The clips may be obtained from builders' supplier or a similar source.

The basic assembly can be clamped to a wooden or other type of mast which will raise it well above the ground. In the writer's installation the assembly was bolted to a garage wall at the foot of the garden.

Coaxial cable of good quality is connected to the dipole elements, as shown in Fig. 2. The cable should be clamped to the support, the connections being well insulated and made weatherproof with Bostik No. 2. Ideally, the cable should leave the dipole at right angles to it for at least 16ft. This, in the case of the prototype, was easy to arrange.

RESONANCE

The assembly can be checked for resonance on the three bands prior to erection, using the simple bridge test method shown in Fig. 5 of the author's article in the May 1969 issue. The aerial should be found satisfactory on both the 10 and 15 metre bands without any adjustment, but the overall resonance may prove to be low of the 20 metre band and an indication around 13MHz is not unlikely. This is an excellent state of affairs, however, for it is then a simple matter to prune away the outermost ends, each 1in. at a time, and continue re-checking until resonance is secured at 14MHz, viz. the low frequency end of '20'. Thereafter, no alterations will be required and all that remains is to seal the uppermost end against the entry of rain and to raise the assembly, which does not weigh overmuch, to its operating location.

IN USE

If required, the dipole can be fed direct to the transmitter or receiver with which it is to operate, whereupon a good standing wave ratio should appear on all three bands. At the author's station, however, coupling to the transmitter is made via a home-brew Z-match unit, standing wave ratio bridge and low-pass filter.

Successful and confirmed contacts have been made on both '15' and '20' with VK, PY, YV, W and others. This has been with only 50 watts c.w. input and with the tip of the dipole no more than 30ft. above ground! ■

NEW COLD-CATHODE NUMERICAL DISPLAY TUBE

The latest addition to the Mullard range of cold-cathode, numerical indicator tubes can display fourteen numerals 10mm high in one envelope 166mm long; a decimal point and 'marking-off' points to indicate hundreds, thousands, etc. can also be displayed between the characters. Type ZM1200, it is known as the Pandicon*, and has been developed for use in electronic desk calculators where large numbers have to be displayed either as the final product or as a check for an operator.

Although it is equivalent to fourteen separate display tubes, the Pandicon requires only 34 leads as against 154 for the separate tubes.

The Pandicon contains a mixture of gases that give an orange-red glow of more than 600cd/m^2 after striking. A particular digit is illuminated by suitable coincident pulses of not less than 150μs duration to the appropriate cathode rail; the decimal and 'marking-off' points have their own cathodes. The tube requires a voltage supply of approximately 170V; if an alternating voltage is applied to the tube, a frequency of 70Hz will ensure a flicker-free display. The Pandicon will operate in the temperature range of +10 to +70°C.

***Pandicon is a registered trade mark for a multiple-digit indicator tube.**

MODIFYING THE 'TRIO' 9R-59DE COMMUNICATIONS RECEIVER

(PART 2)

Modifications to the 'Trio' 9R-59DE communications receiver described here include a high gain r.f. stage, the curing of frequency drift above 15MHz and an added i.f. stage. Complete lining-up details are also given

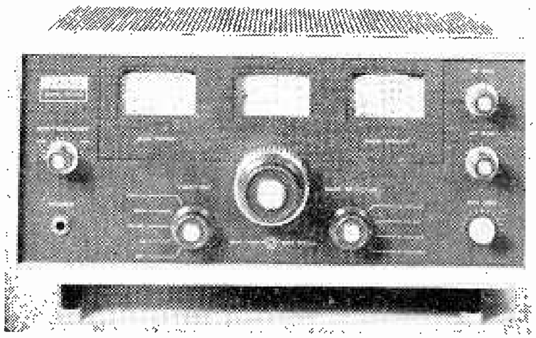
IN THIS CONCLUDING ARTICLE, IT IS ASSUMED THAT the modifications described in Part 1, published last month, and those which appeared in the October 1970 issue, have been carried out.*

Some of the modifications about to be described are fairly complex, beginners are therefore advised not to undertake them unless they are in a position to enlist aid from a more knowledgeable source. A working knowledge of communication receiver techniques is necessary – the modifications are not described in a step-by-step manner.

MODIFICATION 5

The receiver is subject to some frequency drift above about 15MHz, this being especially noticeable when operating in the c.w. and s.s.b. modes. With the receiver warmed up, it will be found that the station tuned in 'wanders' haphazardly from time to time.

Several distinct steps were taken to curb this annoying fault, these being listed here in order of increasing complexity.



(a) Remove the top and bottom covers of the receiver and the a.c. mains plug, etc. Locate V3 (6AQ8 oscillator) valveholder, remove V3 and solder pins 6, 7 and 8 of the valveholder to chassis. In practice, these three pins can be bent inwards and soldered to the valveholder spigot which is already connected to chassis.

(b) The connections between the bandset and bandspread tuning capacitors of the mixer and oscillator stages and the Band Selector switches S3(d) and S3(f) employ thin p.v.c. covered wire which is subject to movement almost at the slightest touch. Additionally, the stabilised voltage from the OA2 stabiliser tube to the anode (pin 1) of the oscillator V3 (6AQ8) is fed via a very long length of thin p.v.c. covered wire. This length is free to move and causes considerable frequency variations, these being particularly noticeable when the receiver is tuned to the high frequency end of Range D – 10.5 to 30MHz.

The remedy consists of replacing the thin p.v.c. covered wire with wire having a gauge stout enough to resist undue movement, and a reel of 18 s.w.g. tinned copper was brought into service for this purpose. The wire should be covered with suitable lengths of Systoflex prior to soldering into position.

Remove V1 (6BA6), V2 (6BE6) and V3 (6AQ8) from their respective valveholders. First, remove the existing thin p.v.c. covered wiring from S3(d) to the mixer bandset and bandspread variable capacitors (centre section of the variable capacitors assembly). This wiring can easily be traced visually. Replace it with Systoflex covered 18 s.w.g. wire.

Similarly deal with the wiring from the oscillator bandset and bandspread variable capacitors (front section of the variable capacitors assembly) to switch S3(f).

The soldering of the lengths of 18 s.w.g. wire should be carried out with a pencil-bit type of soldering iron. It is necessary to remove and re-solder connections to the variable capacitors at the tags situated underneath them. Ensure that the iron does not 'dwell' unduly when making these soldered joints or the capacitor insulation may suffer damage. The

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* The first modifications to this receiver were described in the October 1970 issue, copies of which may be obtained direct from the publisher at 22p post paid.

lengths of 18 s.w.g. wire should be as short as possible, the ends being tinned prior to soldering them into position.

Replace V1, V2 and V3 in their respective valveholders.

Before replacing the existing wire between the OA2 stabiliser and the anode of the 6AQ8 oscillator (via R41, 150Ω) with 18 s.w.g. wire, the reader may care to consider first carrying out the following alteration.

(c) It will be noted that the OA2 stabiliser tube, which generates a considerable amount of heat, is mounted close alongside the oscillator section (nearest the front panel) of the bandset variable capacitor. This in itself is a source of slow frequency drift as the capacitor fixed vanes warm up.

In the interests of frequency stability, the OA2 should be removed from the holder, the holder removed from the chassis and resited in the hole already in existence for the possible inclusion of a frequency standard circuit.

If the modifications described in the October 1970 issue of this magazine have been carried out, the resiting of the OA2 stabiliser will entail removing the frequency standard circuit and rebuilding it as an outboard unit, either with an integral power supply or taking the necessary power supplies from the receiver. Despite this task, the resiting of the OA2 further away from the oscillator bandset capacitor is a worthwhile modification if long term frequency stability is to be achieved.

With the resiting of the OA2, a length of 18 s.w.g. tinned copper wire suitably covered with Systoflex should be connected from the stabiliser tube to R41. R41 is secured at one end to the tagstrip associated with V3 and to pin 1 of this valve at the other end.

When rewiring the OA2 holder, join pin 1 to pin 5 with a short length of p.v.c. covered wire – this connection not being made during manufacture.

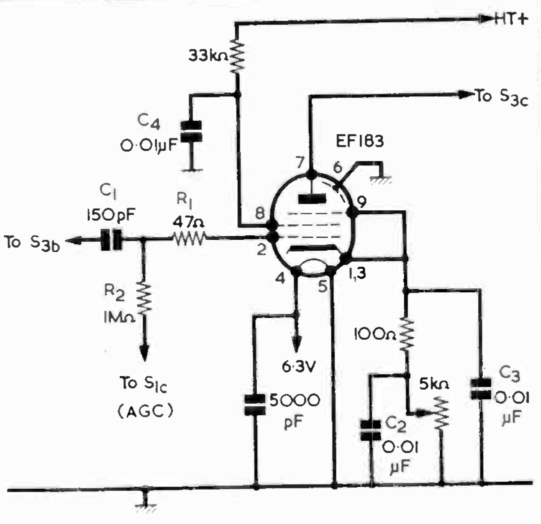


Fig. 3. The circuit of the EF183 r.f. stage

MODIFICATION 6

An increasing number of operators today use a tape recorder with their receivers and the present

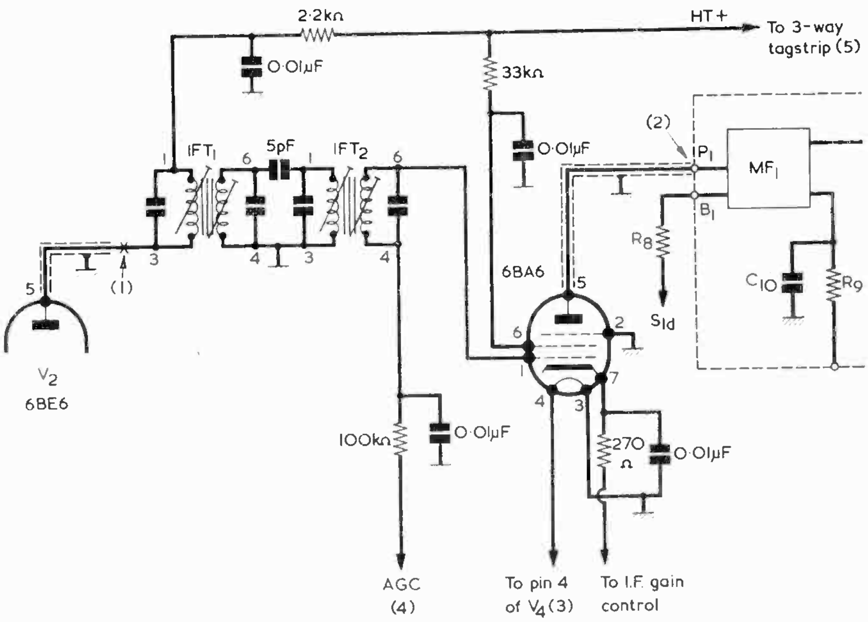


Fig. 4. The added i.f. stage. The receiver circuit is broken between the anode of the mixer (6BE6) and point P1 of MF1, the i.f. stage then being inserted in between. Note that existing components have the R and C designations given in the receiver Manual. Added components have the values shown

modification deals with the very simple task of adding an outlet to the 'Trio' receiver for a recorder.

A hole should be drilled in the chassis rear apron, in a position between the S-Meter potentiometer VR2 and the earth terminal, such that a coaxial socket can be fitted. Under one of the securing nuts of the socket fit an earthed soldering tag.

Obtain a short length of coaxial cable sufficient to reach from the added coaxial socket to capacitor C32 (0.01μF) associated with S1(b) and the a.f. gain control. This capacitor is located behind the front panel and is adjacent to S1(a), (b). One end of C32 being soldered to a tag of a two-way tagstrip, the other tag of which is earthed.

Position the coaxial cable round the rear of the coilpack. Solder one end of the centre wire to that tag of the two-way tagstrip to which C32 is connected. Solder the braiding to the earthed tag of the same tagstrip. At the other end of the coaxial cable, solder the centre wire to the coaxial socket tag and the braiding to the earthed solder tag.

Externally, the tape recorder is connected to the coaxial socket by means of a coaxial plug and a short length of coaxial cable.

The permanent connection of a tape recorder in the above manner has no noticeable effect on the performance of the receiver.

MODIFICATION 7

In this modification a high gain EF183 frame grid pentode is fitted in place of the existing 6BA6 r.f. amplifier valve, V1. It will be recalled that this 6BA6 stage is already modified, as described in Part 1.

The EF183 has a gain factor approximately three times that of the 6BA6. To obtain optimum sensitivity in a valve communications receiver it is normally necessary for the r.f. stage to run at, or near, maximum gain without a.g.c. In the present instance, however, there is one snag, this being that strong signals can then overload the mixer, with consequent distortion and audio 'splashing'. To overcome this drawback, it will be necessary to replace C1 (150pF), R1 (47Ω) and R2 (1MΩ) in the grid circuit of the r.f. stage (these components were removed in the modifications described in Part 1) thus applying a.g.c. to the new EF183 r.f. stage. The circuit incorporating this valve is shown in Fig. 3.

In practical terms, once the existing B7G valveholder has been removed, a B9A chassis cutter will be required to enlarge the hole in the chassis deck. When carrying out this task, remove V6 (6BE6 product detector) from its valveholder or the valve may be damaged when turning the Allen key. The key should be rotated carefully, a little at a time, such that IFT1, positioned at the rear of the chassis deck, is not damaged.

When securing the B9A valveholder to the chassis, ensure that an earth tag is mounted under the nut nearest pin 9.

To ensure r.f. stability, a small metal screen of tinplate cut from a 2-ounce tobacco tin or similar, should be positioned across the valveholder and soldered to pins 5,6, the spigot and to the earth tag under the valveholder securing nut. The tinplate provides a screen between pins 2 and 7.

The circuit shown in Fig. 3 has proved satisfactory with the receiver in question. In individual cases, however, it may be necessary to reduce the stage gain if overloading of the mixer occurs on strong signals at the maximum setting. Raising the cathode bias resistor value to 150Ω, or higher, will prove effective in this respect.

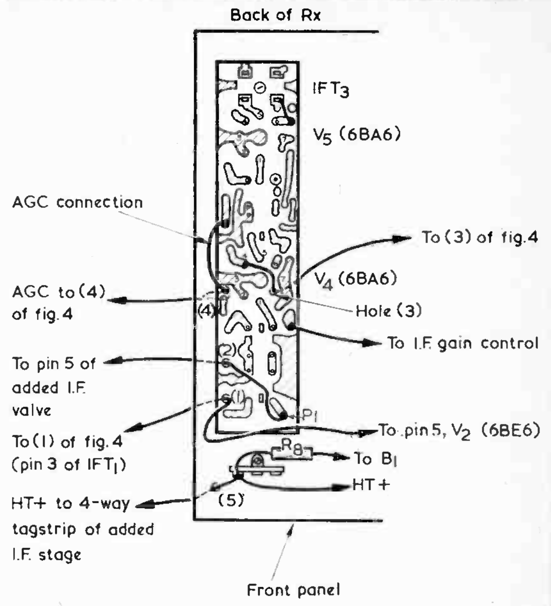


Fig. 5. The printed circuit board of the i.f. strip viewed from the underside. The figures 1 to 4 shown in brackets refer to holes which must be drilled through the Paxolin of the printed circuit, as described in the text. For ease of presentation single lines are shown passing through holes (1) and (2) but, in practice, the connections indicated by these lines are made with coaxial cable

The new r.f. stage not only provides additional gain with stability but also improves the sensitivity of the receiver.

MODIFICATION 8

In this, the last of the present series of modifications, an i.f. stage incorporating two transformers is added to the receiver circuit, it being inserted between the mixer stage and the mechanical filter MF1.

The object of adding the i.f. stage is simply to obtain better selectivity. Some increase of i.f. gain is apparent, and this is not in itself sufficient to cause i.f. instability when correctly aligned.

The circuit of the added stage is shown in Fig. 4, the figures in brackets relating to those similarly shown in Fig. 5. The latter diagram shows the underside of the printed circuit board of the i.f. strip.

In Fig. 4, the added components have values shown alongside, whilst those with R and C designations are already in circuit.

From the circuit of Fig. 4 it will be noted that the added stage is built around a 6BA6. The i.f. transformers are Denco type IFT11/465, and are top-coupled by a 5pF silver-mica capacitor.

A.G.C. is applied to the stage via a 100kΩ resistor, being bypassed to chassis via a 0.01μF capacitor.

The h.t. supply to the anode of the added i.f. stage is via R8 and MF1, the printed circuit board designations B1 and P1 being the respective connection points.

The main problem when adding an i.f. stage to this receiver is lack of chassis space, that available in the required area being almost non-existent. This problem was solved by making up a small sub-chassis as shown in Fig. 6. This sub-chassis is mounted vertically into position above the chassis deck such that the 6BA6 is at the top. The i.f. stage is first wired-up on the bench and then secured to the chassis by means of the existing self-threading screw at the end of the i.f. strip printed circuit board nearest the front panel. When this has been done, the connections to the receiver circuit are made, after which the alignment of the new stage is carried out.

A 4-way tagstrip is mounted to the assembly, alongside the 6BA6 valveholder, as shown in Fig. 6.

The orientation of the two added i.f. transformers is illustrated in Fig. 7, this diagram also showing the wiring in point-to-point form.

Commence by making up the small chassis as shown in Fig. 6 and follow this by securing the components into position and wiring-up the circuit as shown in Fig. 7 – which is drawn in 'exploded' form for purposes of clarity.

Refer to Fig. 8 and disconnect the wire from pin 5 of V2 (6BE6) at point P1 on the printed circuit board.

Two holes of $^7/_{32}$in. diameter should now be carefully drilled through the Paxolin printed circuit board, the positions of these holes being shown as (1) and (2) in Fig. 5. Drill these holes from the underside of the board and ensure that the drill does not 'wander' and cause damage to the actual printed circuit. These two holes are required to take short lengths of coaxial cable from below to above the chassis deck.

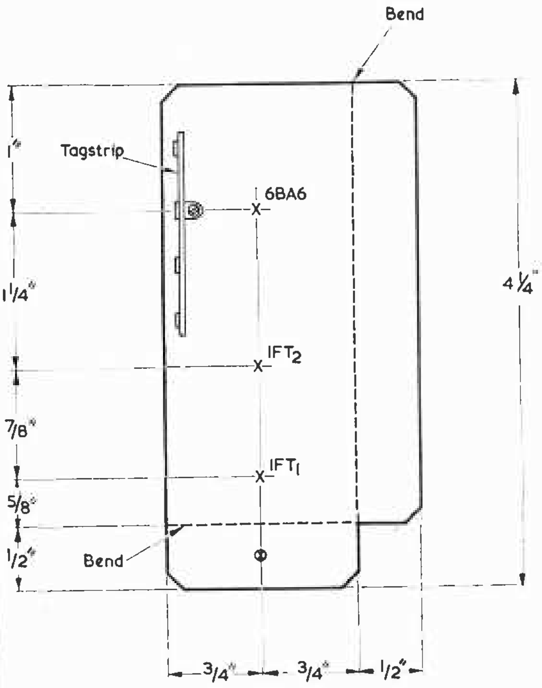


Fig. 6. The small sub-chassis for the added i.f. stage. Both flanges are bent up, towards the reader. The screw securing the sub-chassis to the receiver passes through the hole in the bottom flange

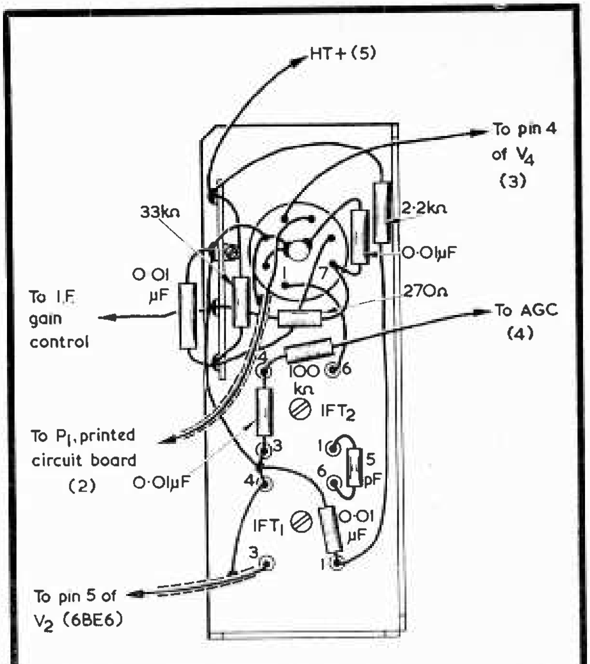


Fig. 7. Point-to-point wiring diagram of the added i.f. stage, shown in 'exploded' form for purposes of clarity

A further two holes, $^7/_{32}$in. diameter – shown as (3) and (4) in Fig. 5 – should next be carefully drilled through the Paxolin board from the underside.

Secure the new i.f. assembly to the chassis deck as previously described but do not tighten the screw as yet, this allowing a small amount of 'play' so that the sub-assembly can be turned slightly to facilitate wiring-up the remaining connections.

Refer to Fig. 5. Connect one end of the centre wire of a short length of coaxial cable to pin 5 of V2 (see Fig. 4) and connect the other end to pin 3 of the added IFT1, feeding the coaxial cable through hole (1) of Fig. 5. Suitably earth the braiding at both ends.

Obtain a short length of coaxial cable and connect point P1 of the printed circuit board to pin 5 of the added i.f. valve. Feed the coaxial cable through the hole (2) of Fig. 5. Suitably earth the braiding at both ends.

Connect one end of a length of p.v.c. covered wire to pin 4 of V4 (6BA6), feed this wire through hole (3) of Fig. 5 and connect the other end of this wire to pin 4 of the added i.f. valveholder. This is the 6.3V heater connection.

Refer to Fig. 5 and locate hole (4) and the printed circuit point marked 'a.g.c. connection' in the diagram. To this point solder one end of a length of p.v.c. covered wire. Feed this wire through hole (4)

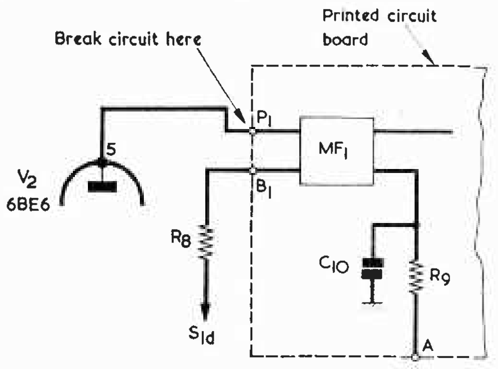


Fig. 8. Showing where the circuit break is made in the original design

and solder the other end to the free end of the 100kΩ resistor (see Figs. 4 and 7).

Next, fit a p.v.c. covered wire to carry h.t. to the 4-way tagstrip on the added sub-assembly. The wire passes through hole (5) in the metal chassis deck, as shown in Fig. 5, this hole being already in existence.

It will be found that the final position of the added assembly, when secured to the chassis deck, is such that the valve top points towards the nearest corner of the front panel.

In practice, the task of lining-up the added i.f. stage may be eased by removing its securing screw and positioning the assembly slightly outboard as far as the wiring will allow. This allows of much easier access to the bottom i.f. dust cores. In this latter position, the earth return is made via the coaxial braiding. Final 'touching-up' of the cores are then made with the assembly secured to the receiver chassis with the previously mentioned self-threading screw.

The 270Ω cathode bias resistor shown in Fig. 4 proved satisfactory with respect to maximum i.f. gain without overloading on a.m. signals. It must of course be realised that, when using the s.s.b. mode, the i.f. gain control will require to be 'backed-off' from the maximum gain position or overloading of the product detector will take place. In some receivers it may be necessary to experiment with cathode bias resistor values higher than that specified here.

When correctly aligned, the increase in selectivity is remarkable and with the slightly enhanced i.f. gain now available, the operator has at his control a very selective and sensitive receiver.

LINING-UP DETAILS

The r.f. alignment details for the 'Trio' 9R-59DE are shown in the Table. Alignment should be carried out in the sequence shown. It must be emphasised that alignment should not be attempted unless a reliable and accurately calibrated signal generator is available and the reader is familiar with the lining-up of superhet receivers. Careless and unskilled attempts at alignment without proper equipment may well do more harm than good. In most instances it is probable that only slight adjustments will be required. Take care, on the higher frequency ranges, to avoid accidentally trimming to the second channel, above oscillator frequency, instead of to the correct signal below oscillator frequency.

Fig. 9 shows the trimmer capacitor and inductor core locations when viewed from the underside, the receiver standing on the bench with the mains transformer at the bottom.

Prior to alignment, a few points should be noted. In Fig. 9, trimmer capacitor CO5 of Range A is shown above CO4; in fact CO5 is positioned slightly to one side and below CO4. The Range A aerial coil has no adjustment facility.

TABLE

'Trio' 9R-59DE R.F. Alignment

Range	Bandset	Signal Generator	Adjust
STEP 1 Remove bottom cover			
A (0.55-1.6MHz)	0.6MHz	0.6MHz	CO5 (Osc)
	1.4MHz	1.4MHz	CO4 (Osc)
Fit bottom cover			
STEP 2			
A	1.4MHz	1.4MHz	CM4 (Mix)
B (1.6-4.8MHz)	2.0MHz	2.0MHz	LO3 (Osc)
	4.0MHz	4.0MHz	CO3 (Osc)
STEP 3			
B	2.0MHz	2.0MHz	LM3 (Mix)
	4.0MHz	4.0MHz	CM3 (Mix)
STEP 4			
B	2.0MHz	2.0MHz	LA3 (Ant)
C	5.0MHz	5.0MHz	LO2 (Osc)
(4.8-14.5MHz)	14.0MHz	14.0MHz	CO2 (Osc)
STEP 5			
C	5.0MHz	5.0MHz	LM2 (Mix)
	14.0MHz	14.0MHz	CM2 (Mix)
STEP 6			
C	5.0MHz	5.0MHz	LA2 (Ant)
D (10.5-30MHz)	13.0MHz	13.0MHz	LO1 (Osc)
	28.0MHz	28.0MHz	CO1 (Osc)
STEP 7			
D	13.0MHz	13.0MHz	LM1 (Mix)
	28.0MHz	28.0MHz	CM1 (Mix)
STEP 8			
D	13.0MHz	13.0MHz	LA1 (Ant)

NOTE: Each step should be repeated until dial reading is correct and no further improvements can be obtained.

The oscillator trimmer capacitor CO1 of Range D and CO2 of Range C, positioned on either side of the Band Selector switch, are capacitors of the threaded screw adjustment type – similar in appearance to the inductor core adjustment screws. This can lead to some confusion when adjustments are

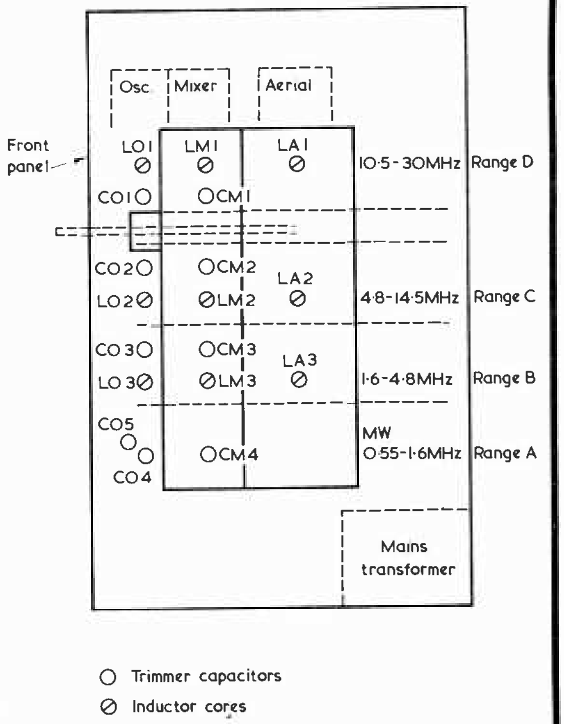


Fig. 9. Locations of the trimmer capacitors and inductor cores when viewed from the underside

made with the bottom cover of the receiver in place. The Table indicates whether the bottom cover should be fitted or removed.

The Aerial Trim capacitor should be set at half-mesh throughout the lining-up process and the Band-spread dial at 100°.

Before attempting to alter any of the capacitor trimmers or inductor cores, it is necessary to carefully 'crack' the white fixative material used by the manufacturer. This particularly applies to the inductor cores, as the slot for screwdriver adjustment can easily be sheared off if care is not taken. With the inductor cores 'cracking' can be carried out by means of a small pair of pliers in the jaws of which is placed some soft cloth material.

The receiver should be allowed to warm up for at least an hour prior to the r.f. alignment being carried out.

When alignment has been completed, the various adjustment devices should be secured in position with a dab of clear nail varnish.

Do not unduly jolt the receiver after alignment and carefully place the set in the required position for operating. ■

POSTAL DISPUTE

We very much regret the inconvenience caused to subscribers by the above dispute.

With bookstall and bookshop supplies, we were able to make arrangements for deliveries to be maintained in the vast majority of cases. In a few instances there was some slight delay, which we much regret.

CURRENT SCHEDULES

Times=GMT Frequencies=kHz

★ KUWAIT

Radio Kuwait has changed the frequency of its English Service to Europe from **11825** to **11735** (250kW). Schedule of this programme is from 1600 to 1800. Address for reports – Kuwait Broadcasting and Television Service, P.O. Box 193, Kuwait.

★ U.S.S.R.

Radio Tbilisi, Georgian Soviet Socialist Republic, is reported to have a Russian language programme on **5980** (240kW) at 2015.

★ MOROCCO

Rabat has an English programme on **11735** (100kW) from 1700 to 1800 directed to W. Africa/Mauritania, Equatorial Africa and S. Morocco.

★ AFGHANISTAN

Radio Afghanistan can be heard with an English programme on **15265** (100kW) from 1800 to 1830 beamed to Europe. Newscast at 1802. For further information see *Now Hear These*.

★ JAPAN

NHK (Nippon Hoso Kyokai) Tokio has added the **15300** (100kW) channel to the **9505, 9570** and **11815** outlets for the English Service from 1800 to 1830 according to reports.

★ MALAYSIA

The Voice of Malaysia, Kuala Lumpur (Kajang), may be heard on **15280** (50kW) in English from 0625 to 0855. Newscast at 0630 and 0830. Address – Department of Broadcasting, P.O. Box 1074, Kuala Lumpur.

★ IRAQ

According to a report, Radio Baghdad has cut the overseas transmissions devoted to the Palestine Liberation organisation. Styled "Voice of Palestine," the programme in English is now from 1715 to 1730 intstead of from 1830 to 1845. Listen on **7240** (100kW) or **11855** (100kW).

★ U.S.A.

WNYW, New York Worldwide, can be heard on **17845** (100kW) with an English programme directed to Europe from 1700 to 1945. After close-down on this frequency, the programme continues on **9690** (100kW) from 2000 to 2300 and on **11890** (100kW) from 2000 to 2030. Address – Radio New York Worldwide, 485 Madison Avenue, New York, N.Y. 10022.

★ BULGARIA

Sofia can be heard with an English programme directed to the U.K. on **6070** (50/100kW) and on **9700** (50/120kW) from 1930 to 2000 and from 2130 to 2200.

★ CENTRAL AFRICAN REPUBLIC

Bangui, the capital of this republic, can be heard on **5030** (30kW) around 1945. Schedule (Home Service) is from 0430 to 0700, 1630 to 2230 Weekdays and from 1630 to 2230 on Sundays. Address for reports – Radiodiffusion Nationale Centrea Africaine, B.P. 940, Bangui.

★ SAO TOME E PRINCIPE

Sao Tome, Portuguese West Africa, can be heard on **4807** (1kW) with the Home Service in Portuguese from 0530 to 2300.

Acknowledgements: – Our Listening Post. ■

NOTES ON SEMICONDUCTORS

2. LIFE IS e^x

by

P. WILLIAMS

Our contributor takes us a little further into semiconductor functioning and operation

IN THE FIRST NOTE IN THIS SERIES, PUBLISHED LAST month, a simple biasing circuit for a single transistor in common-emitter was discussed. It was assumed that the base current could be calculated by dividing the supply voltage by the value of Rb, the base-bias resistor. For this to be true, the voltage drop between base and emitter has to be a small proportion of the supply voltage. We shall return to this later.

The spread in hFE is rarely less than 2:1 and may be greater, to which is added the effect of temperature changes. For silicon planar transistors leakage currents can be ignored except at very high temperatures, but we are still left with a situation where the collector current may easily differ by ±50% from the intended value. A further source of error lies in the combined tolerance effects of Rc, Rb and supply voltages. If all these act in the direction which maximises the drop across the collector resistor, the transistor may well bottom, with consequent loss of output. Since the cost of selection for close tolerance on gain may exceed manufacturing costs, there is a strong incentive to find some other parameter of a transistor, inherently more stable, from which to bias it.

Two methods present themselves:

(1) to monitor the collector current and use negative feedback to control it,

(2) to define the emitter current, knowing that the collector current will be just less than 100% of this value, since the base current is such a small fraction of both collector and emitter currents.

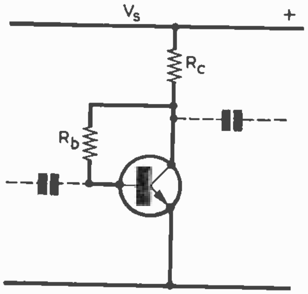


Fig. 1. Obtaining bias by returning the base resistor to the collector

These methods are applicable to single transistors, and lead to the two standard methods shown in Figs. 1 and 2. Both are described in detail in textbooks and have been used with great success in many of the articles that have appeared in this magazine.

If, in Fig. 1, the collector is at half supply voltage then

$$\mathrm{Rb} \approx \frac{\mathrm{Vs}}{2\mathrm{Ib}}$$

$$\approx \frac{h_{\mathrm{FE}}\,\mathrm{Vs}}{2\mathrm{Ic}}$$

$$\approx h_{\mathrm{FE}}\,\mathrm{Rc}$$

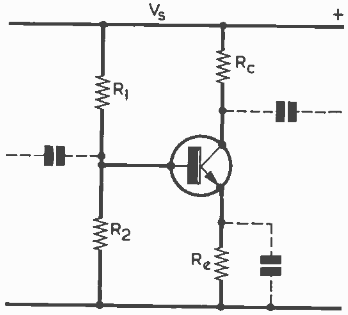


Fig. 2. An alternative method of obtaining bias

Fig. 2 demonstrates an approximate method for calculating convenient values. Choose R1 and R2 to carry about 10 times base current with 1/5 supply voltage across R2. Then, with Rc=2Re half the remaining supply voltage is across the transistor.

$$\mathrm{R2} \approx \frac{h_{\mathrm{FE}}\,\mathrm{Re}}{10} \quad \text{and}$$

$$\mathrm{R1} \approx \frac{h_{\mathrm{FE}}\,\mathrm{Re}}{2.5}$$

EXPONENTIAL SERIES

We shall now turn to a property of transistors that enables simple and elegant biasing circuits to be derived in both conventional and integrated circuits. The mathematical expression e^x may seem to have little bearing on circuit design, but it turns out to be a key to the understanding of much modern design. (At this point comes the rustling of paper as the mathematically inclined turn the page in search of something less boring, while the circuit designer does the same, mystified. You, dear reader, may be the only one left.)

Mathematically, e^x can be shown to be equal to the infinite series

$$1 + {}_{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots\ldots$$

and this enables the value of 'e' to be calculated by making $x=1$ whereupon

$$e = 1 + 1 + \tfrac{1}{2} + \tfrac{1}{3} + \dots\dots\dots$$
$$= 2.72 \dots\dots$$

to two decimal places Physically, a number of the most important processes taking place inside semiconductors have one variable which depends on another in an exponential manner, i.e. is proportional to 'e' raised to the value of the variable.

This has to be taken on trust by us ordinary mortals, but the results are easy to verify in some cases. The current I in a p.n. junction in terms of the potential difference, V, across it is

$$I = Io\,(e^{\frac{qV}{kT}} - 1)$$

where Io is called the saturation current. The term q/kT covers the electron properties of the material and turns out to have a value of 1/26mV at room temperature. Assume for the moment that the −1 term is negligible at normal currents (Io is what we often think of as leakage current and will be much less than I). Then I varies as eV/26mV. This means that every time V increases by 26mV the current is multiplied by the factor 'e'. Since 'e' has such an odd value it is usually more convenient to find what change in V is needed for I to be multiplied by 2 exactly. This can be shown to be about 18mV, or roughly 20mV if we want to get answers in round numbers.

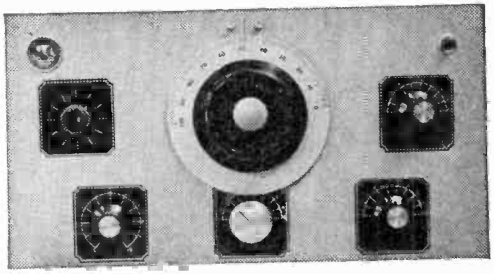
No practical circuits this time, I'm afraid, but the promise of better things to come. The above fact *can* however be of considerable practical application. If we measure the voltage across a diode or between base and emitter of a transistor at a given operating current, then we can calculate the voltage at any other current this by adding 20mV for every factor of 2 by which the current is increased. ■

THE RADIO AMATEUR OPERATOR'S HANDBOOK

The twelfth edition of this well-known reference work is now in preparation, undergoing a most extensive revision. The prefix lists and all associated information have been completely updated, new maps added and old maps redrawn – complete with current prefixes.

When published (an announcement will be made in these pages in due course) it will contain all that information constantly required by the amateur bands operator, all within one cover and to hand at the operating position.

Which country has that prefix? Which prefix is allocated to that country? In which zone is that prefix? Which bearing? Mileage? Local time? All these recurring queries can be simply answered by having a copy of this indispensable publication to hand.



TRI-BAND RANGER

PART 1

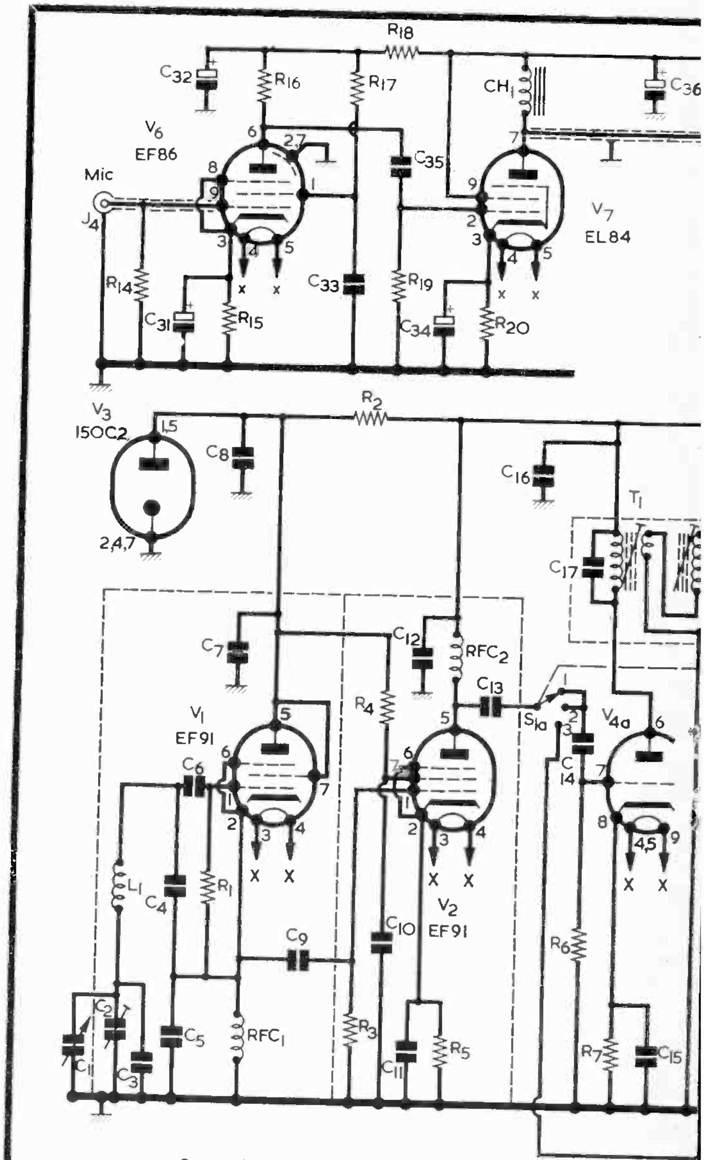
by

DAVID M. PRATT (G3KEP)

Covering the 40, 80 and 160 metre bands, this transmitter offers c.w. and phone at power inputs of 10 and 7 watts respectively. It has its own mains supply, but provision is made for powering from an external supply. Further advantages are simplicity of operation, small size and the ability to match into wide range of aerials. This article describes the circuit and its functioning; constructional details will be given in the concluding article, to be published next month. The transmitter must not, of course, be operated without the appropriate Post Office licence

SOME TIME AGO THE WRITER DESIGNED A MINIATURE receiver for the low frequency bands*, the main purpose of which was that it could be lent to young people with a view to their subsequently obtaining a transmitting licence. So successful was the performance of the receiver, and so handy was its size, that a suggestion was made that a matching transmitter be designed.

In designing the transmitter there were two purposes in mind. Firstly, the transmitter should be suitable for use during the National Field Day of the Radio Society of Great Britain. Hence, it should be capable of a maximum d.c. input of 10 watts c.w. on three amateur bands with provision for using an external power supply. Secondly, the transmitter should be suitable for fixed station use with its own internal power supply and amplitude modu-



S1 positions: 1 7MHz
2 3·5MHz
3 1·8MHz

Fig. 1. Complete circuit diagram of the trans

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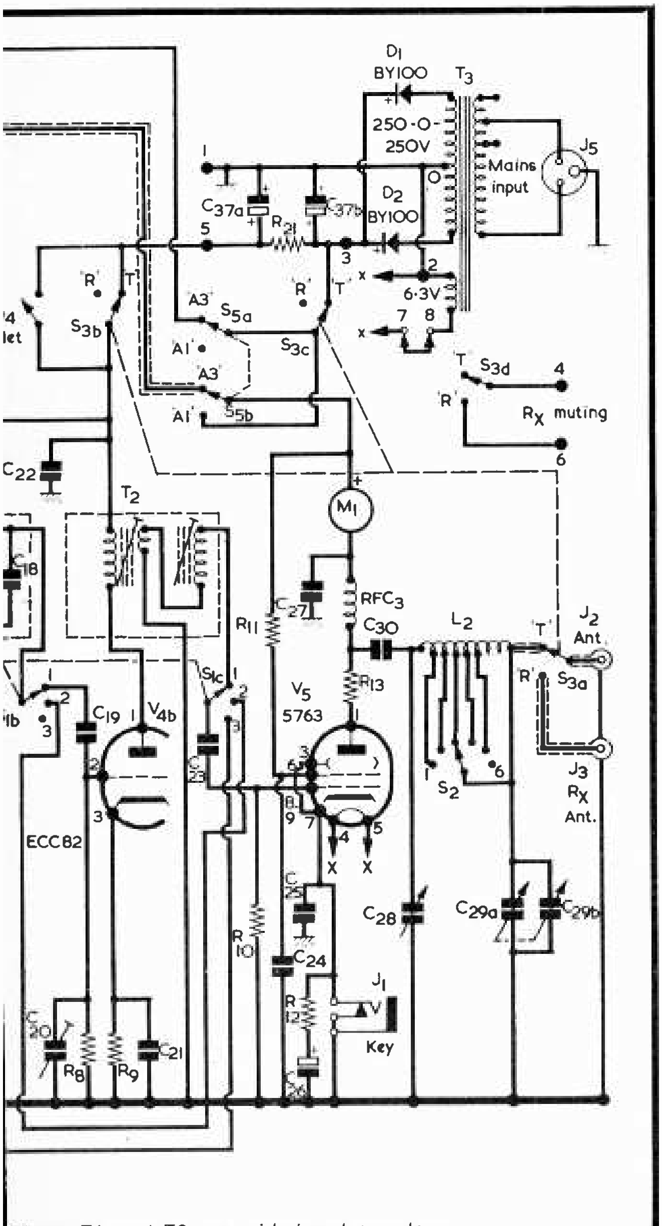
* David Noble and David M. Pratt, 'Miniature "Top-Band" Receiver', *The Radio Constructor*, July 1964.

lator. As the transmitter was to be used with many different aerial systems the method of aerial coupling used must be capable of tuning a wide range of aerial impedances.

The specification of the transmitter is as follows:

Bands:	1.8, 3.5 and 7 MHz,
Emission:	A1 (c.w.) and A3 (a.m. d.s.b. telephony),
Power Input:	10 watts A1; 7 watts A3,
Power Supply:	Internal mains power supply; provision for using external supply.
Dimensions:	11½ x 5 x 7in.



nitter. T1 and T2 are wide-band couplers

Cover Feature

CIRCUIT

As may be seen from the circuit diagram in Fig. 1, the variable frequency oscillator comprises an EF91 (V1) operating in a Clapp oscillator circuit. This has a frequency coverage of 1.75 to 2 MHz. The anode circuit is operated at zero r.f. potential, and the output is taken from the cathode in order to limit 'pulling' due to the effect of loading of the v.f.o. circuit. V2 is an untuned buffer amplifier operating a relatively high anode voltage, thus providing sufficient output to adequately drive the subsequent stages. Voltage stabilisation of the v.f.o. and of the buffer amplifier screen voltage is achieved by a 150 volt miniature stabilizer valve, V3.

On the 1.8 MHz band the output of the buffer amplifier is switched via S1 to the control grid of the p.a. valve, V5. V4 is a double triode, each section of which is used as a frequency doubler. For 3.5 MHz operation V4(a) is used as a doubler from 1.75 MHz and its output is fed via S1(b) to the p.a., while for 7 MHz both halves of V4 are used as doublers, V4(b) providing an output of 7 MHz to the p.a. stage. The trimmer capacitor C20 is included to provide the same additional capacitance across the output from T1 as is given when T1 couples directly to the p.a. grid.

The p.a. valve V5 is a 5763, chosen for its miniature size and ideal characteristics for a transmitter with the present specification. With 250 volts h.t. the valve is capable of a 'comfortable' 10 watts d.c. input on c.w. A key jack is provided in the cathode circuit of the p.a. valve, a key click filter, R12 and C26, being incorporated to limit the click on 'break'.

The p.a. tuned circuit is a pi-tank type with a multi-tapped coil to provide a wide range of impedance matching. The variable capacitor C28 is used to resonate the p.a. circuit, while the two-gang capacitor C29 is used for aerial loading.

TRI-BAND RANGER

TRI-BAND RANGER

COMPONENTS

Resistors

(All resistors ¼ watt 10% unless otherwise stated)

R1	100kΩ
R2	5.1kΩ 8 watt 5%
R3	47kΩ
R4	22kΩ
R5	150Ω
R6	22kΩ
R7	470Ω
R8	22kΩ
R9	470Ω
R10	27kΩ
R11	10kΩ 1 watt
R12	270Ω
R13	47Ω
R14	1MΩ
R15	2.2kΩ
R16	100kΩ
R17	1MΩ
R18	39kΩ
R19	680kΩ
R20	180Ω 1 watt
R21	680Ω 8 watt 5%

Capacitors

C1	75pF variable (ex-RF27 unit or Jackson Bros. Type U101)
C2	30pF miniature trimmer, air-spaced.
C3	120pF 5% silvered-mica
C4	1,000pF 5% silvered-mica
C5	1,000pF 5% silvered-mica
C6	100pF 5% silvered-mica
C7	0.1μF polyester film, 350V wkg
C8	10,000pF ceramic, 350V wkg
C9	100pF silvered-mica
C10	10,000pF ceramic, 350V wkg
C11	10,000pF ceramic, 350V wkg
C12	10,000pF ceramic, 350V wkg
C13	100pF 5% silvered-mica
C14	100pF 5% silvered-mica
C15	10,000pF ceramic, 350V wkg
C16	10,000pF ceramic, 350 wkg
C17	5pF 5% silvered-mica
C18	5pF 5% silvered-mica
C19	100pF 5% silvered-mica
C20	3-27pF Mullard concentric trimmer
C21	10,000pF ceramic, 350V wkg
C22	10,000 pF ceramic, 350V wkg
C23	100pF 5% silvered-mica
C24	1,000pF ceramic, 500V wkg
C25	1,000pF ceramic, 500V wkg
C26	2μF electrolytic, 350V wkg
C27	1,000pF ceramic, 750V wkg
C28	500pF single-gang variable (Jackson Bros. E-Gang, Cat. No. 4507)
C29	500+500pF twin-gang variable
C30	2,000pF 10% mica, 750V wkg
C31	100μF electrolytic, 16V wkg
C32	16μF electrolytic, 350V wkg
C33	0.1μF polyester film, 350V wkg
C34	25μF electrolytic, 25V wkg
C35	10,000pF polyester film, 400V wkg
C36	50μF electrolytic, 350V wkg
C37	16+16μF twin electrolytic, 450V wkg

Inductors

CH1	L.F. choke, 10H 70mA
L1	128 turns, 32 s.w.g. enam. copper wire close-wound on ½in. diameter Perspex rod. Former length 2⅛in. Winding length 1$\frac{9}{16}$in. Upright mounting by 6BA bolt.
L2	90 turns, 24 s.w.g. enam. copper wire close-wound on 1in. diameter Perspex tube. Winding tapped at 60, 40, 30, 20 and 10 turns from anode end. Winding length 2$\frac{3}{16}$in. Former length 3⅛in. Upright mounting by means of small bracket at base and 4BA bolt.
RFC1	2.5mH, miniature r.f. choke
RFC2	2.5mH, miniature r.f. choke
RFC3	1.5mH, 100mA, r.f. choke
T1	3.5MHz wide-band coupler (to be described in Part 2)
T2	7MHz wide-band coupler (to be described in Part 2)
T3	Mains transformer, drop-through, secondaries: 250-0-250V 100mA, 6.3V 3.5A (R.S.C. Hi-Fi Centres Ltd., Audio House, Henconner Lane, Leeds 13).

Valves

V1	EF91
V2	EF92
V3	150C2
V4	ECC82
V5	5763
V6	EF86
V7	EL84

Rectifiers

D1	BY100
D2	BY100

Meter

M1	0-50mA moving-coil meter (S.E.W. Type MR38P)

Switches

S1	3-bank rotary switch, 1-pole 3-way per bank (see text)
S2	1-pole 6-way ceramic rotary switch
S3	4-pole 2-way rotary switch
S4	s.p.s.t. spring biased toggle switch
S5	d.p.d.t. toggle switch

Jack Sockets

J1	Closed-circuit jack
J2	Coaxial socket
J3	Coaxial socket
J4	Coaxial socket
J5	3-way mains input plug and socket assembly, Bulgin type P360, (Home Radio Cat. No. P360)

COMPONENTS

(Continued)

Valveholders

- 3 B9A valveholders
- 1 B9A valveholder, with skirt and screening can (for V4)
- 3 B7G valveholders
- 1 Octal valveholder

Miscellaneous

- 5 pointer knobs, Bulgin Type K424/Chr., or similar
- 5-way tagstrip, centre tag earthed
- 10-way tagboard, Bulgin Type C125 (Home Radio Cat. No. BTS34F)
- Epicyclic 6:1 ball drive, Type 4511/F (Jackson Bros.)
- Nylon lead-through insulators, Lektrokit Type LK2021, as required
- Octal plug (with pins 7, 8 bridged)
- Die-cast box, Eddystone Type 7134P (Home Radio Cat. No. E896)
- Chassis, 16 s.w.g. Type 'K'; L = 10¼in., W = 4¾in., D = 1¾in. (H. L. Smith and Co. Ltd.)
- Panel and Cabinet. 16 s.w.g. Type 'W'; L = 11½in., W = 5in., D = 7in., with three 3in. louvres on both sides (H. L. Smith and Co. Ltd.)

MODULATION

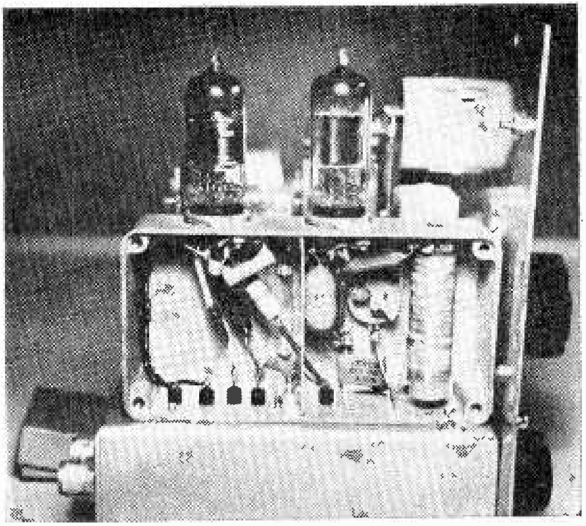
When telephony operation is desired the anode and screen-grid of the p.a. valve are switched by S5(b) to the output of the two-stage modulator, V6 and V7. The circuit operates as a Heising choke anode and screen modulator. Theoretically the circuit is not capable of 100% modulation without distortion, but with the component values specified the modulation level was found to be adequate, and the quality far superior to other types of modulation which have been tried. The circuit is designed for use with a crystal microphone which is applied via J4 to the control grid of V6. The output of this valve is then resistance-capacitance coupled to the grid of V7. The gain of the microphone amplifier stage was carefully adjusted by experiment to provide the correct amplification for the microphone used, thus obviating the need for a variable gain control. The gain of the modulator may be varied to suit different microphones by adjusting the value of R19.

POWER SUPPLY

In order that the transmitter may be self-contained for fixed station use an internal mains power supply is included. It employs a 250-0-250 volt transformer and silicon rectifiers in order to provide maximum rectified h.t. voltage. H.T. to the p.a. and modulator is taken direct from the reservoir capacitor C37(b), while a stage of smoothing, R21, C37(a), is used for the remainder of the r.f. circuit.

It should be emphasised that the BY100 rectifier diodes used have a maximum peak inverse voltage rating of 800 volts. In the full-wave rectifier circuit employed here the actual peak inverse voltage of each diode is given by 2.828 times r.m.s. transformer output voltage. It is important therefore that the output from each half of the transformer secondary does not exceed 270 volts, as this will most certainly result in breakdown of the diodes and consequent damage to the mains transformer.

Various points of the power supply circuit are taken to an octal socket mounted at the rear of the transmitter. The pin connections are shown in the circuit diagram. An external strap between pins 7 and 8 is removed to disconnect the transformer heater winding when working from an external supply. The external heater voltage may then be applied between pins 2 and 7. External h.t. is applied to pins 1 and 3. The octal socket is also used for the muting connections to the receiver and for the measurement of voltages without the necessity of removing the unit from its cabinet.



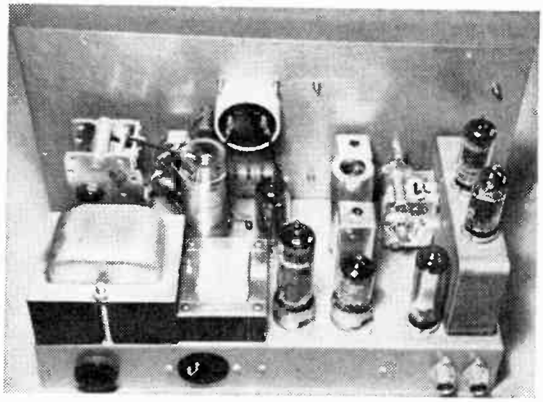
Side view of the transmitter. The v.f.o. box cover has been removed to show the internal components

TRI-BAND RANGER

TRI-BAND RANGER

SWITCHING

The transmitter contains five switches which provide a variety of functions. S1 is the main band switch which selects the appropriate frequency multiplier stages and feeds drive to the p.a. valve. The construction of this switch is shown in Fig. 2. The author used an N.S.F. 'Oak' switch as shown, but if this cannot be obtained a suitable alternative is a Radiospares 'Maka-Switch' assembly. 'Maka-Switch' kits are available both from Henry's Radio and from Home Radio. The 'Maka-Switch' assembly should be made up to the dimensions given in Fig. 2, and the wafers may be 1-pole 12-way or 4-pole 3-way 'break-before-make' types, with no connections made to the unused tags.



A view of the transmitter from the rear. The v.f.o. box is at the right. The p.a. output coil is upright and appears midway between the meter and the mains transformer

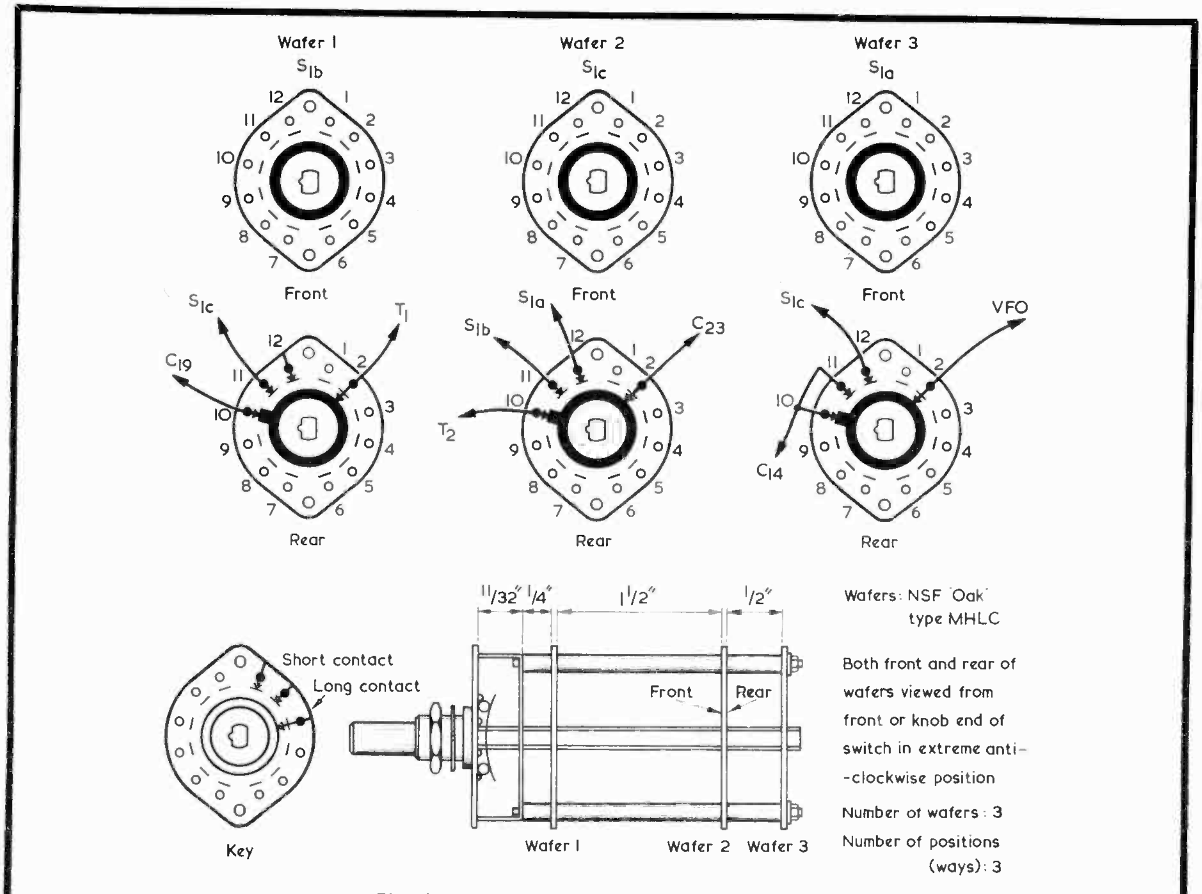
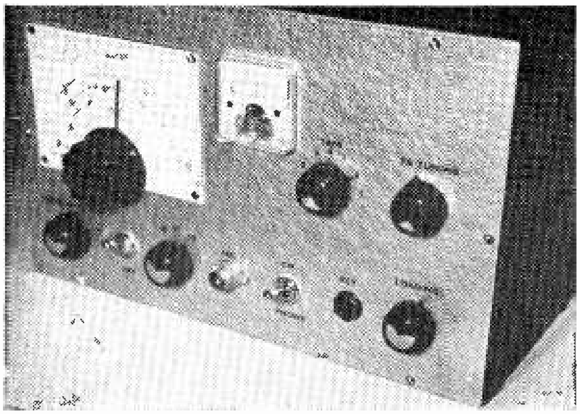


Fig. 2. Details of the 3-wafer band switch, S1

As has been mentioned earlier, the multi-position p.a. switch, S2, provides a range of tapping connections on the p.a. tank coil L2 in order to facilitate loading for a wide range of aerials. The main Transmit/Receive switch S3 switches h.t. to the transmitter. Aerial changeover with an output for the receiver is provided, as also is receiver muting, which is taken to pins 4 and 6 of the rear octal based socket.

A provision for switching on the v.f.o. and driver



Three-quarter front view of the miniature three-band transmitter. Control layout is neat and uncluttered

stages alone for netting purposes is made using the spring biased toggle S4. S5 is the emission switch; on 'A1' the h.t. is fed direct to the p.a. valve, while in the 'A3' position h.t. is applied to the modulator, and the supply to the p.a. is switched to the anode of the modulator output valve V7.

(To be concluded)

NEW INTEGRATED POWER VOLTAGE REGULATORS

SGS announce three new power voltage regulators specially designed for professional and industrial applications where problems of common ground coupling, circuit coupling, sensitivity to spurious signals and voltage drops in cables and connectors are particularly important.

These devices, designated L005, L036 and L037, have fixed output voltages (respectively 5, 12 and 15V), and are able to supply typical regulated currents of 850, 720 and 600 mA. They are sealed in a standard TO-3 package, and an effective protection circuit against overload and permanent short circuit is included. Apart from the output capacitor, external components are not required.

The L005 gives an output voltage of 5V with an input voltage range of 7.5 to 20V; the L036 an output voltage of 12V with an input voltage range of 14.5 to 27V; the L037 an output voltage of 15V with an input voltage range of 18.5 to 27V.

The three devices have an output voltage within ±5% of nominal, and feature very low output resistance, high ripple rejection (typ. 60 dB) and extremely low temperature coefficient (0.003%/°C typ).

Latin American Quest
(1) Making a Start

IF YOU ARE, OR INTEND TO BECOME, A BROADCAST bands listener, you will soon discover that there are four main areas of the globe from which Dx signals emanate – at least in terms of residence within these Sceptred Isles. These target areas are Asia and the Pacific, the Far East, Africa and, last but not least, Latin America.

For successful reception of many of the low powered stations – not to mention identification – radiating from any of these areas one must acquire the specialised know-how and develop a technique which, in association with first class equipment, will alone bring results. Patience, perseverance and first class operating are prerequisites – without these attributes little of value will be achieved.

Many listeners throughout the world specialise in listening to one or more of the above-mentioned target areas. In this country there are several highly specialised enthusiasts who have been logging Latin American stations for many years. The reasons for this interest are not hard to find, most of the stations are comparatively low powered – from as little as 0.25kW (250 watts) to 1kW (1,000 watts) they have a charm and peculiarity of their own, their transmissions are colourful to say the least and, what is of paramount interest to the Dx'er – they are rather elusive to log.

Stations in Latin America are mostly privately owned and operate on a commercial basis primarily to serve a small surrounding local area – hence their low power. Their aerial arrays are, in the main, omni-directional – that is to say they are designed merely to radiate for general local coverage and are not beamed to a specific area. This, of course, makes such stations all the more difficult to receive from this country.

Latin American stations, or LA's as they are known to the experienced Dx'er, also exhibit other fascinating traits, the most trying of these being their innate ability to appear several kilocycles off the listed frequency from time to time. This often results in an LA station being reported as 'Unidentified' when in fact it merely signifies that the transmitter in question has decided to take a walk!

LA MX

This sub-heading is merely the contraction used by Dx'ers for the term *Latin American music* and is one that will be often seen in SWL literature. LA mx – the genuine kind – is probably the greatest charm of these stations, it is folksy, original, tuneful, unmistakable and colourful to a high degree and once heard will be instantly recognisable on later occasions. This particularly applies to the highly individual music of the Peruvian Andes which is both haunting and memorable.

LA SPECIALITIES

In addition to their music, Latin American stations also exhibit other specialities peculiarly their own, the most notable of these being their wealth of identification signals. Some of these take the form of a single gong or chime, or series of such sounds; a cock crowing or even the sound of a diving plane!

Then, of course, one can often hear the well known Coca-Cola commercial or a 'futebol' commentary – the LA's are fanatics about soccer!

In latter years, the practice among LA stations to present station announcements superimposed on an echo effect has grown – much to the chagrin of Dx'ers as this does little to help when trying to identify a particular station. This is especially true when the Dx'er is also coping at one and the same time with QRM and the effects of mediocre conditions.

A further red-herring thrown in the path of the Dx'er trying to establish station identification is that of the commercial networks to which various stations subscribe and from which they 'tap off' some of their programmes. The most notable of these is the Caracol network.

WHEN TO LISTEN

The best period to listen for Latin American stations is during the 'season' which begins around March/April and ends around September/October. LA stations can be heard outside the season of course but, generally speaking, the period mentioned provides the best opportunity for reasonable success – providing that propagation conditions allow.

During the season for optimum LA reception, the best time period in terms of GMT is from 2200 to 0600, although the writer has logged several 5kW LA's as late as 0745 on several occasions. Generally speaking, for the experienced Dx'er busily chasing the rare LA Dx, the most favourable time period is that from 0130 to 0400 GMT. To be a successful Latin American Dx'er, the budding SWL must become a night owl!

HOW TO START

If, as a beginner SWL you would like to make a start with becoming an LA specialist, it would be a wise course to start familiarising yourself with the technique by logging some of the more powerful 10kW stations in the 60 metre band (4750 to 5060kHz). This will involve you in getting out of bed around 0300 GMT or earlier!

For a start, try the following stations:–

4800kHz, YVMO Radio Lara, Barquisimeto,

Venezuala. This station closes at 0400 GMT with station identification and the National Anthem.

4900kHz, YVNK Radio Juventud, Barquisimeto, Venezuala, which also closes at 0400 GMT.

The above two stations have been listed first for the benefit of those who do not have frequency checking equipment but who are equipped with a receiver exhibiting accurate dial readings at the 100kHz points. For those who possess frequency measuring equipment, or those who are able to accurately interpolate frequencies from dial readings, the following stations are listed.

4880kHz, YVMS Radio Universo, Barquisimeto, Venezuala, closing at 0400 GMT.

4970kHz, YVLK Radio Rumbos, Caracas, Venezuala, closing at 0500 GMT; 4980kHz, YVOC Ecos del Torbes, San Cristobal, Venezuala, which has a 24 hour schedule and 4990kHz, YVMQ Radio Barquisimeto (24 hour schedule).

From the above it would appear that you will be busily engaged in identifying some of them on successive mornings at 0400 GMT! In fact these stations do identify around every quarter of an hour although it pays to keep an ear open a few minutes before and after each quarter hour as such announcements are not always strictly to time!

As a change from the Venezualans the beginner may like to try reception of the two comparatively powerful Colombians listed below – they are also easy to log.

5075kHz, HJGC Acción Cultural Popular, Bogota (25kW), try around 0300. HJGC closes at 0400 GMT.

5095kHz, HJGC Acción Cultural Popular, Bogata (50kW). This one also closes at 0400, try logging it at 0300 GMT.

All the above listed stations are, of course, the easy-to-receive transmitters operating from Latin America. Provided conditions are at all reasonable at the time of listening then success should be achieved. There are a whole host of other LA stations that can be received but these have much lower power and are therefore more difficult to successfully identify and log.

In the next article we will be dealing with some of the more difficult to receive Latin American stations in the LA Quest.

(To be continued)

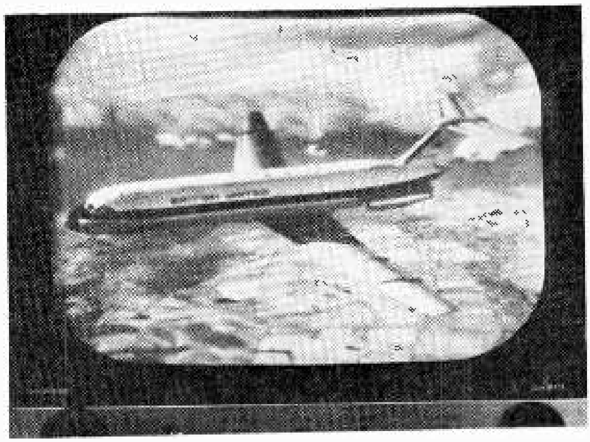
NEW CAMERA TUBE DEVELOPMENT

A new TV camera tube incorporating a silicon target is being developed by English Electric Valve Co. Ltd. The target of this tube – The Sidicon – is in the form of a mosaic of isolated silicon diodes and its production follows a sequence of modified micro-circuit practices resulting from improved microlithographic techniques.

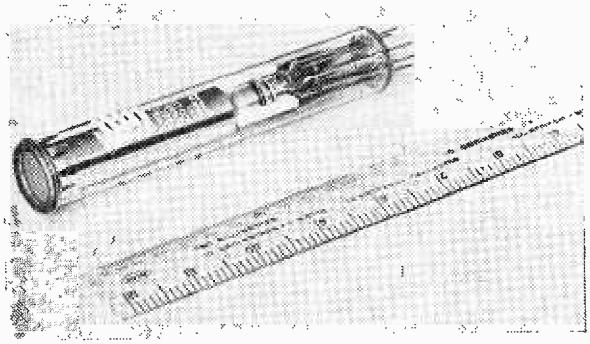
Results of developments so far, have shown these tubes which are interchangeable with one inch vidicons, to be mechanically, thermally and electrically very rugged, with high sensitivity throughout the visible and infra-red range. The Sidicon has considerably less lag than conventional vidicons and much higher sensitivity. The nature of the targets allows full high-vacuum processing, so ensuring a long life expectancy.

Other advantages of this tube so far evident are its capacity to withstand extreme overloads both of light and scanning beam. It can also be stored in high temperatures under any lighting conditions.

Applications envisaged for these tubes are in all branches of industrial c.c.t.v. and video-telephone systems, where long maintenance-free life in uncontrolled environments is of paramount importance.



A monitor picture from a TV camera using a EEV sidicon tube to view a photograph under normal room lighting conditions



The EEV Silicon Vidicon – a standard magnetically focused and scanned one inch vidicon with a silicon diode array target

Direct Conversion Receivers

Part 2

by

PAUL DEWHURST

In this concluding article our contributor continues with the synchrodyne story, and introduces a practical 80 metre 3-valve receiver which offers high selectivity and sensitivity and has only one critically tuned resonant circuit

BEING NOW CONVINCED BY THE PERFORMANCE OF the simple receivers described in Part 1 of this series that the synchrodyne system was an entirely usable one, the author decided to make up a complete receiver for the 80 metre band (3.5 – 3.8MHz) as this is a good band for s.s.b. stations. It also provides a good test for any receiver since pretty good selectivity is required, as anyone who has listened to the 80 metre band after dark will agree. After the usual period of experimentation and research, the circuit shown was arrived at.

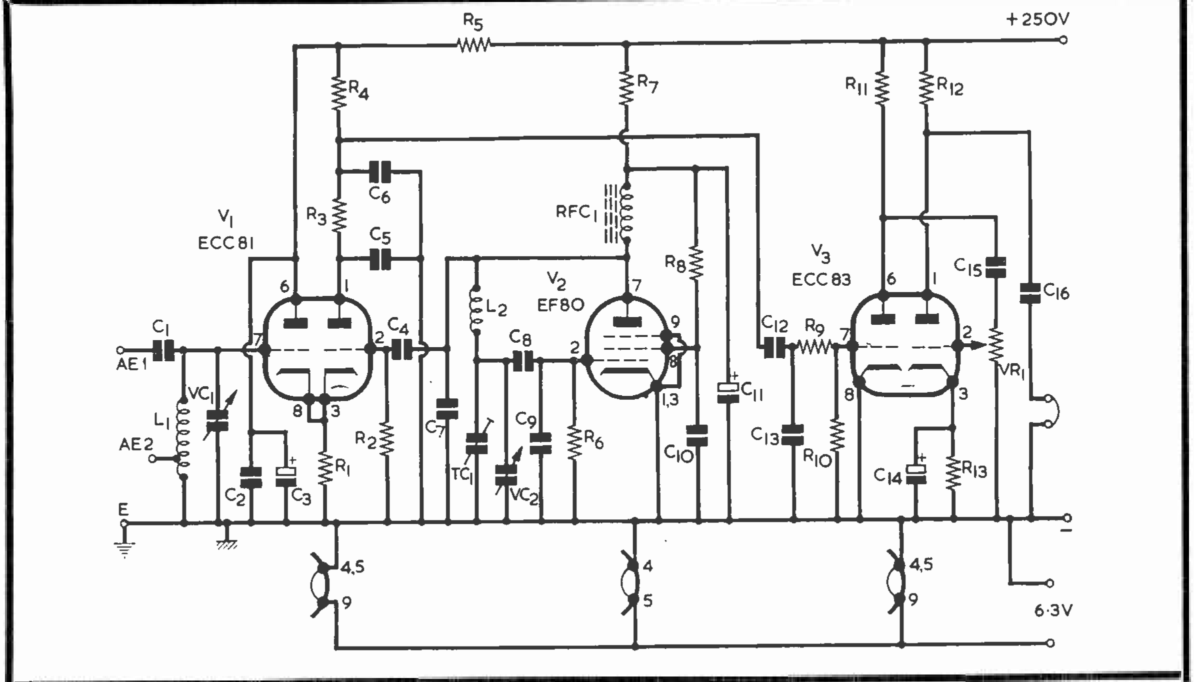
3-VALVE RECEIVER

As can be seen from the circuit diagram only three valves are used, and ample gain is given for headphone reception. The input circuit consists of the previous simple tuned circuit, this resonating at 3.5–3.8MHz. The coil is tapped a few turns from the earthy end for a long aerial, and when a short aerial (up to about twenty feet or so) is used it is taken to the 'hot' end of the tuning coil via the small capacitor, C1. This input circuit is not in any way critical and merely serves to peak the required signal and to get rid of any signals which might beat with harmonics of the oscillator, thus performing a task similar to the input tuned circuit of the usual frequency changer in a superhet. A commercial coil may be used here, of course, such as the Osmor trawler band aerial coil type QA4.

The signal is then taken to the ECC81 which acts as a heterodyne or product detector. The two sections of the valve are cathode-coupled which helps to isolate the r.f. circuit from the oscillator circuit and thus minimises interaction between them, or 'pulling'. At the same time the cathode coupling cuts down radiation of the local oscillator to an acceptable level. This product detector is commonly used in superhets at the end of the i.f. strip when s.s.b. and c.w. reception is required, and in the circuit usually employed an ECC82 is specified. Do not be tempted in this present design to use an ECC82 instead of an ECC81 as results will be disappointing. The author initially used an ECC82 but results were poor. On substituting an ECC81 signals which had just been audible with the ECC82 came right up out of the noise. An ECC83 was tried, and this gave better results than the ECC82 but still nowhere near as good as the ECC81. It became apparent why the ECC81 was so much better after checking some figures on mixers and mixer noise, these showing the ECC81 to be streets ahead of the ECC82 from the point of view of noise figure. Obviously the ECC82 is the valve to use in a superhet, where good dynamic range is more important than noise factor, but for the direct conversion technique the requirement of the heterodyne detector without r.f. amplification is precisely the same as that of the frequency changer in a superhet without r.f. amplification, namely a low noise figure. In this case a good dynamic range is not so important, unless old G9XYZ just across the road starts up on or near the frequency with his high power transmitter, in which case not much could be done whatever receiver one was using. The dynamic range of the ECC81 should be more than sufficient to deal with most signals encountered at the end of a receiving aerial.

The local oscillator uses an EF80 in the Vackar or Tesla configuration. This oscillator was chosen for three reasons: first, it is a favourite of the author's; second, it is very stable, obviously a good thing when receiving s.s.b.; and third, it has a low harmonic output, a good thing in this case, because signals might beat with the haromnics to produce interference. The output from this oscillator is fed to the ECC81 and the amount of injection can be varied by experimenting with the value of the resistor, R7, used to feed the oscillator with high tension. This resistor is not very critical but it should nevertheless be adjusted, as there is an optimum value. Too little injection will result in high noise and weak signals. Too much injection will cause spurious signals to appear, these being produced by signals beating with harmonics of the oscillator, since however low the harmonic output of the oscillator is, the second triode of the ECC81 will produce harmonics if driven too hard. In the author's case a value of 330kΩ for R7 gave good results, but constructors are advised to experiment with different values until best all-round performance is obtained.

The audio signal which appears at the anode of the second triode of the ECC81 is passed through a low pass filter and fed to the ECC83 for amplification. This amplifier has a high gain and should give a gain of about 70dB. It might be thought that the 500kΩ gain control is a bit superfluous; it is, in fact, very necessary. It will be seen that audio coupling capacitors are low in value throughout. This is to make sure that unnecessary low frequencies below



COMPONENTS

Resistors
(All fixed values ½ watt 10%)

R1	1kΩ	
R2	100kΩ	
R3	2.7kΩ	
R4	47kΩ	
R5	12kΩ	
R6	6.8kΩ	
R7	220kΩ	470kΩ (see text)
R8	100kΩ	
R9	12kΩΩ	
R10	2.2MΩ	
R11	470kΩ	
R12	470kΩ	
R13	4.7kΩ	
VR1	500kΩ potentiometer, log track	

Capacitors

C1	25pF
C2	0.05μF
C3	32μF electrolytic, 350V wkg.
C4	50pF silver-mica
C5	500pF
C6	500pF
C7	250pF silver-mica
C8	3,000pF silver-mica
C9	250pF silver-mica
C10	0.01μF
C11	32μF electrolytic, 350V wkg.
C12	1,000pF
C13	500pF
C14	25μF electrolytic, 12V wkg.
C15	1,000pF
C16	1,000pF
VC1	150pF variable (see text)
VC2	150pf variable
TC1	56pF trimmer, concentric

Inductors

L1 35 turns of 26 s.w.g. enamelled copper wire close-wound on 1in. diameter former, tapped 10 turns from earthy end

L2 25 turns of 36 s.w.g. enamelled copper wire close-wound on ½in. diameter former

RFC1 2.5mH r.f. choke type CH1 (Repanco)

Valves

V1	ECC81 (12AT7)
V2	EF80
V3	ECC83 (12AX7)

Phones

High resistance (2,000Ω) headphones

about 300Hz are cut down as far as possible, since they are not necessary for speech reception. The low value capacitors also make it easier to avoid mains hum being amplified to any great extent.

The value of the capacitor connected from the grid of the ECC83 to chassis, C13, may seem rather large. However, this capacitor plays two parts: first, it prevents high frequency oscillation in the high gain audio amplifier; and second, it cuts the higher frequencies of the audio response, and so increases the selectiviy of the receiver. C13, together with the R9 and R10 must be connected as close to the grid pin of V3 as possible, otherwise hum will be picked up, or r.f., the latter giving rise to instability. The lead from the anode of V1 to the grid of V3 may have to be screened to avoid hum pickup; this depends to some extent on the layout. Coaxial cable may be used, with the braiding earthed at both ends.

Since there is a slight possibility of leaky-grid detection taking place at the grid of the left-hand triode of V3 (whereupon the circuit might not be considered as functioning as a true synchrodyne) this stage was temporarily modified by inserting a 4.7kΩ resistor and 25μF capacitor between pin 8 of the valve and chassis. These components provided cathode bias in the usual manner and ensured that leaky-grid detection could not take place, although the valve would still function as an a.f. amplifier. There was no noticeable difference in receiver performance, apart from a slightly increased hum, when these cathode bias components were fitted, which proved the point it was intended to check. The circuit is marginally better with pin 8 of V3 connected direct to chassis, as in Fig. 4, because of the slightly reduced hum level.

The whole of the oscillator should be in a screened compartment if possible to avoid interaction between the oscillator and signal circuits. If this is not possible, then the whole of the wiring associated with the oscillator and V1 except for the input tuned circuit should be underneath the chassis; and the lead from pin 7 of V1, to the input tuned circuit should be screened and immediately pass through the chassis as near as possible to the grid pin. It was found possible with this latter method to keep pulling between the two circuits down to an acceptable level. All the valves must be fitted with screening cans, and the wiring must be kept as short as possible, using one earthing point for each valve.

The input tuning capacitor, VC1, can be 150pF, but a smaller one could be used if desired. A 50pF variable capacitor should have sufficient swing to cover the 3.5 to 3.8MHz band once the tuned circuit has been padded into the band by means of a 50pF trimmer (not shown in Fig. 4) in parallel with it.

All the capacitors associated with the oscillator tuned circuit should be high quality components, and preferably should not be cooked by the soldering iron when connecting up the circuit. The oscillator coil should not be mounted too near any metal. The oscillator trimmer should be of the concentric type.

In the original circuit the heater connections were made with screened wire so as to avoid hum pick-up. This may not be necessary, depending on the layout, but it is a good idea in any case. Coaxial cable can be used.

A slow motion drive must be used for VC2; the common 8:1 cord drive gives a reasonable tuning rate, as the frequency coverage is small. The headphones used must be high resistance ones. Almost any power pack supplying 250 volts and 6.3 volts can be used, as the currents taken are less than with an ordinary domestic radio set, being about 12 mA at 250 volts and 0.9 A at 6.3 volts.

RECEIVER OPERATION

The receiver is very easy to use. First, make sure

STANLEY ROBERT MULLARD

IN SEPTEMBER LAST, 50 YEARS SINCE HE FOUNDED THE first company to bear his name, 81-year-old Mr. Stanley Mullard retired from the Board of Mullard Ltd. after nearly 72 years with the electrical and electronic industries.

Announcing the retirement at a Golden Jubilee reception at Grosvenor House, Dr. F. E. Jones, managing director, said: **"We shall always be grateful for Mr. Mullard's wise counsel over the years and for the contributions he has made to the company's continued progress. We shall all miss him very much."**

Stanley Robert Mullard was born November 1st 1883 and was apprenticed to an electrical engineering firm at the age of 15. He joined Ediswan in 1910, was made head of their Lamp Laboratory three years later and in 1915 invented the Pointolite arc lamp. In World War I he enlisted in the Engineers Battalion of the Royal Naval Division and in 1916 was commissioned in the RNVR and attached to the RNAS. As a member of a team at H.M. Signal School, he was involved with the invention and development of high-power transmitting valves. He was later asked to produce them for the Admiralty and in 1920 he formed the Mullard Radio Valve Co. With the spread of radio he began to manufacture small receiving valves. Under the name ORA these were soon coming off the line in hundreds a week. Demand outstripped capacity and a move was made to a larger factory at Hammersmith. Later he acquired still larger premises at Balham and, in 1927, at Mitcham. In 1930, on health grounds, he decided to relinquish leadership of the company, but he has since been far from inactive. Apart from retaining his seat on the Board and participating in company affairs, he has interested himself in new horticultural and other industrial developments. He lives in Sussex with his wife to whom he has been married for 62 years.

that the oscillator is working on 3.5-3.8 Mhz. The 50 pF trimmer, TC1, is used to set the band covered. This is easy if another receiver which will tune this band is available, as one can easily pick up the signal from the oscillator on this other receiver. Failing that, an ordinary domestic radio which covers short waves may be used to get the oscillator roughly on frequency by listening for the harmonic of the Vackar oscillator with the domestic receiver tuned to 7.0 Mc/s, which is about 43 metres or just above the 41 metre broadcast band.

Failing this, one must rely on the hit or miss method and fiddle until one hears Amateur s.s.b. signals. Turn the gain control to maximum, and connect the best aerial available to the tap on L1. Then tune VC1 till the noise in the headphones peaks. Some signals should now become audible on adjusting VC2. Some pulling of the oscillator circuit may be noticed when peaking the input tuner, but this should not be bad enough to cause much bother. Experiments should be made as mentioned before with the value of R7 until best signals are received. The receiver should sound and tune just like a selective superhet with the b.f.o. on and adjusted to the centre of the i.f. passband, s.s.b. signals should be very easy to resolve. C.W. signals should also be easily received, and a.m. phone stations can be received quite well by tuning to zero-beat. Incidentally, when listening to the average Amateur a.m. QSO it is amazing how few stations net accurately on to one another; this is immediately noticed on the direct conversion receiver, as retuning to zero-beat is necessary nearly every time one a.m. station passes the transmission to another.

Provided due care with the layout and wiring is taken, results with this simple receiver should surprise the constructor, as the sensitivity is quite good and the selectivity very good. Naturally, as no r.f. stage is used, a good aerial helps a lot. But, then, one should not be using a few feet of wire for Amateur Band listening anyway, however good the receiver.

As a matter of interest the author compared the receiver with his trusty S.640 on 80 metres, using the same outdoor 50 foot wire (height 25 feet, sloping to 10 feet at the far end: hardly a DX special!). Although the S.640 with the crystal filter in had a slight edge over the simpler receiver, it was very difficult to find a signal on the S.640 which could not be copied on the direct conversion receiver. The author was frankly amazed, as the difference in cost and complexity between the two receivers is obviously very great; and although the S.640 is an oldish set, it is still very good on the low frequency bands – the author can hear American Amateurs on s.s.b. phone on their 75 metres band from time to time using his S.640.

So, here is a very simple receiver which, if built with care, will rival a much more costly superhet, and without the fiddly reaction controls usually needed with simpler receivers. It is basically a one knob affair, as the input circuit only needs touching up as one goes from one end of the band to the other, and the gain control setting is obviously not critical. It is as simple to operate as a superhet but as easy to build and "align" as a small straight set – and, above all, it is something new to try.

FUTURE POSSIBILITIES

The circuit given here is by no means the ultimate in direct conversion, and the author is of the firm opinion that the days of the superhet are numbered, for Amateur communications receivers at any rate, once the development of direct conversion receivers is taken up seriously. The author hopes in a later article to describe some rather more sophisticated receivers of this type, but for those wishing to experiment with direct conversion further development will probably be along the following lines: 1, the use of a balanced linear heterodyne detector (similar to a balanced mixer, except that the output is audio and not r.f.); 2, the use of a very low noise audio amplifier immediately after the heterodyne detector, perhaps using an EF86 operated under "starvation" conditions; 3, the use of audio filters or selective audio amplifiers, especially for narrow band c.w. reception; 4, the use of the phasing technique, as mentioned earlier, using two balanced liner heterodyne detectors, thus making single signal reception possible without the usual necessity for highly selective tuned circuits; and 5, the use of the local oscillator of the direct conversion receiver as the transmitter v.f.o. in a transceiver: a very simple c.w. transceiver should be possible using this technique.

The author would be very interested to hear from anyone who experiments along these lines, and also from anyone who constructs a direct conversion receiver, especially should the constructor feel that the author could assist him in any way. ■

COASTAL RADIO AT BOAT SHOW

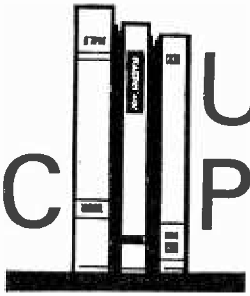
Coastal Radio Ltd., a subsidiary of the Marconi International Marine Co. Ltd., displayed a wide range of communications equipment and navigational aids at the International Boat Show at Earls Court.

The main features of the display included a Thrige-Titan autopilot, a 150-watt 'Falcon I' single-sideband radiotelephone, and a 'Raymarc 8' 8in. display transistorised radar.

Also included in the display were no less than seven echosounders, ranging from the sophisticated 'Seachart,' suitable for the larger type of luxury yacht and cruiser, down to the 'Seascribe,' which may be installed in a small open boat.

Other equipment on the stand included a 'Westminster 15' VHF radiotelephone transceiver, a 'Minicall' 5-way crew/call selector panel and associated loudspeakers, a 'Lifesaver' portable transceiver for distress alarm calls, a 'Viking IV' transistorised loud-hailer, and a radiogoniometer together with a D.F. loop aerial.

Another item of interest on display was a multi-standard television receiver, capable of receiving television programmes from over 100 different countries throughout the world when within range of their transmissions.



UNDERSTANDING BASIC PRINCIPLES —

by W. G. Morley

In the second article in this short series, which has been written specifically for the beginner, we discuss the basic properties of capacitance and inductance

IN LAST MONTH'S ISSUE WE INTRODUCED the fundamentals of electricity, and then carried on to voltage, current, resistance and power. We now turn our attention to capacitance.

CAPACITANCE

Fig. 1(a) illustrates two metal plates which are mounted parallel to each other in air. If, as in Fig. 1(b), we connect a battery to the two plates by way of a resistor, we will find that the electromotive force provided by the battery causes a redistribution of the electrons in the two plates. Electrons in the lower plate are attracted towards the positive terminal of the battery, whilst an equal number of electrons flow from the negative terminal of the battery into the upper plate. In Fig. 1(c) we disconnect the battery, whereupon the lower plate retains its deficit of electrons, and thereby possesses a positive charge of electricity, whilst the upper plate retains its excess of electrons, and thereby possesses a negative charge of electricity. The two charges are distributed along the inside surfaces of the plates, being maintained in position by the attraction which exists between unlike charges of electricity. In Fig. 1(d) we connect a wire between the two plates. Since both plates are now connected together by a conductor, the excess of electrons in the upper plate flows through the wire and makes up the deficit of electrons in the lower plate. Both plates then have zero charge, as occurred before the battery was connected in Fig. 1(b).

The two plates form a *capacitor* or, to use a common earlier term, a *condenser*. In Fig. 1(c) the capacitor is *charged* (because its individual plates hold a charge) and in Figs. 1(a) and (d) it is *discharged* (because neither plate holds a charge).

It should be noted in passing that, although a charging current flows immediately when, in Fig. 1(b), the battery is connected to the plates, the voltage across the plates themselves does not rise at once to that of the battery. This is because, at the instant of connecting the battery, virtually all the battery voltage is dropped across the series resistor. As the capacitor charges the charging current reduces until, after a period, the voltage across the resistor falls to zero and that across the plates becomes equal to battery voltage. Thus, one attribute of a capacitor is that it opposes changes in voltage across its plates.

If the plates of the capacitor of Fig. 1 are brought closer together the mutual attraction between unlike charges on their inside surfaces becomes greater, and each plate will be capable of holding a larger charge after the battery has been applied and removed. If the plates are kept at the same spacing and their surface area is increased they will also be capable of holding a larger charge. This last effect is simply due to the fact that there is then a greater area over which the charge can appear.

The ability of a capacitor to hold a charge is expressed in terms of its *capacitance* or (with earlier terminology) *capacity*. As the capacitance of a capacitor increases, so also does the charge it can hold.

When we require a capacitance larger than can be conveniently provided by two plates, we can effectively increase plate surface area by using a multi-plate construction, as in Fig. 2. All the adjacent surface areas in the multi-plate assembly add together to give (approximately) the same capacitance as would be given in a two-plate capacitor whose plates had the same total surface area. The multi-plate assembly is more robust and compact than a two-plate capacitor when large surface areas are required in the plates.

The insulating material between the plates is known as the *dielectric* of the capacitor and in the examples we have so far considered this has been air. Solid insulating materials may also be employed as dielectrics, typical examples used in practical capacitors being mica, ceramic, wax impregnated paper, and plastic materials such as polystyrene and polyester. All of these materials produce a greater capacitance if they appear between the capacitor plates instead of air, the increase in capacitance being defined in terms of the *dielectric constant* of the particular material. The capacitance increases because the solid dielectrics allow a greater density of 'lines of electric force' (which are imaginary lines depicting the attractive field between unlike charges) to appear in them, thereby enabling larger charges to be held on each plate of the capacitor. 'Dielectric constant' is a figure which represents the ratio between the line density permitted by the insulating material and that by a vacuum. The dielectric constant of air is 1.006 whilst that of all the solid substances is well in excess of this figure.

Under working conditions in a radio circuit, capacitors frequently have a direct voltage appearing across their plates. Whatever dielectric is employed, it will be evident that, if the spacing between the capacitor plates is too small for the voltage, sparking or a similar electrical discharge can occur between them. With solid dielectrics the result can be a chemical breakdown of the dielectric material which results in its becoming, at the point of discharge, a partial conductor. An alternative effect can

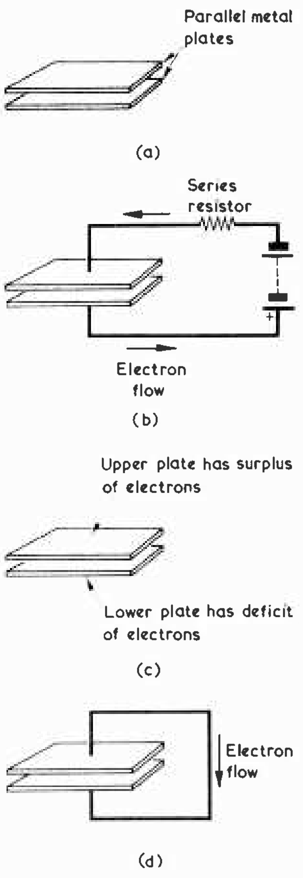


Fig. 1(a). Two metal plates held parallel to each other form a capacitor
(b). Connecting a battery to the plates causes the capacitor to charge
(c). When the battery is removed, the capacitor remains charged
(d). The capacitor becomes discharged if its two plates are connected together

be the mechanical rupturing of the dielectric, whereupon the two plates may come into contact with each other. In either case the capacitor ceases to function efficiently, and is described as having 'broken down'. To guard against breakdown, an individual capacitor is designed to work at a specific maximum voltage, this being referred to as the *maximum working voltage* of the capacitor concerned. If the voltage on the plates of any capacitor exceeds its maximum working voltage rating, that capacitor is likely to break down.

The basic unit of capacitance is the farad, but this is rather too large for the capacitances encountered in radio work. The units employed here are the *microfarad* (μF) which is one-millionth part of a farad, and the *picofarad* (pF) which is one-millionth part of a microfarad. Occasionally encountered are the *nanofarad* (nF) which is one-thousandth part of a microfarad, and the *micromicrofarad* ($\mu\mu$F) which is an earlier term for the picofarad.

CAPACITOR CONSTRUCTIONS

The type of construction employed for capacitors depends to a great extent upon the dielectric used.

A commonly employed dielectric is mica. This is mined in its natural state, and is capable of being split accurately into thin sheets, these having thicknesses which may be as small as 0.0005 in. In modern mica capacitors, the 'plates' consist of thin layers of silver fired, or otherwise deposited, directly on the surface of the mica. For low values of capacitance, the silver may be deposited on both sides of a single piece of mica. Higher values may be given by a multi-plate construction, in which the silver is deposited on one side of each mica sheet, as in Figs. 3(a) and (b).

Another dielectric, ceramic, is a hard brittle substance which, by suitable firing and moulding, may be formed into almost any shape required. (Ordinary china, as used for crockery, is a form of ceramic.) The process of making a ceramic capacitor consists of depositing a thin layer of silver on two opposing sides of a piece of ceramic material, so that the ceramic provides the dielectric between the two 'plates' thereby formed. Some ceramics have exceptionally high dielectric constants, these extending up to 3,000 or more. Such ceramics enable relatively large capacitances to be provided in small-size capacitors, but have the disadvantage that the capacitance varies considerably with change in temperature. Capacitors of this nature are employed in applications where the change in capacitance with temperature is not important.

The most common ceramic capacitor constructions consist of the *disc ceramic capacitor* (Fig. 4(a)) and the *tubular ceramic capacitor* (Fig. 4(b)). Ceramic capacitors are essentially two-plate components; they are not made in multi-plate form.

Paper and plastic foil capacitors are made up in a rolled construction. In the simplest form of the capacitor the roll consists initially of a length of metal foil, a length of paper or plastic foil, a second length of metal foil and a second length of paper or plastic foil. The two metal foil sides protrude on opposite sides of the two dielectric foils as in Fig. 5(a), so that, after the metal and dielectric are rolled up, connection to them can be made from the sides. See Fig. 5(b). The rolled construction enables a relatively high capacitance to be achieved in a small volume.

With some plastic foil capacitors, particularly the polystyrene types, the metal foils are less wide than the dielectric strips and do not protrude on either side. Lead-out wires are then welded individually to the foils when the capacitor is partly rolled.

With modern paper and plastic foil capacitors it is more common to apply metallising to one side of each dielectric foil rather than to use separate metal foils. The metallising replaces the metal foils of Fig. 5, but construction is otherwise basically the same.

ELECTROLYTIC CAPACITORS

If, as in Fig. 6, a piece of aluminium foil is immersed in a metal bath containing a suitable solution, or *electrolyte*, and a battery is connected with its positive terminal to the aluminium foil and its negative terminal to the metal bath, a very thin film of aluminium oxide forms on the surface of the aluminium. This aluminium oxide is an insulator. The electrolyte is capable of passing electric current, whereupon an *electrolytic capacitor* is produced, the dielectric being the aluminium oxide and the 'plates' being the aluminium foil on one side of the oxide and the conducting elec-

Fig. 2. The surface area of the plates is effectively increased by using a multi-plate construction, in which alternate plates are connected together

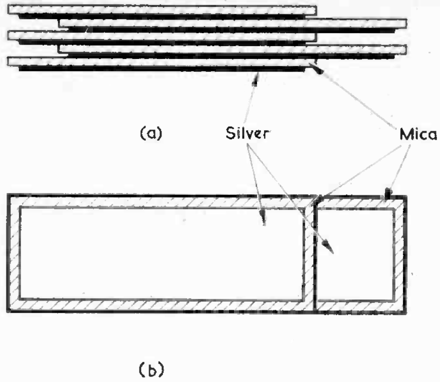


Fig. 3(a). Side view illustrating the method of assembling a multi-plate silvered-mica capacitor. Lead-out wires are connected to the silver deposit which projects on either side
(b). Top view of the multi-plate silvered-mica capacitor

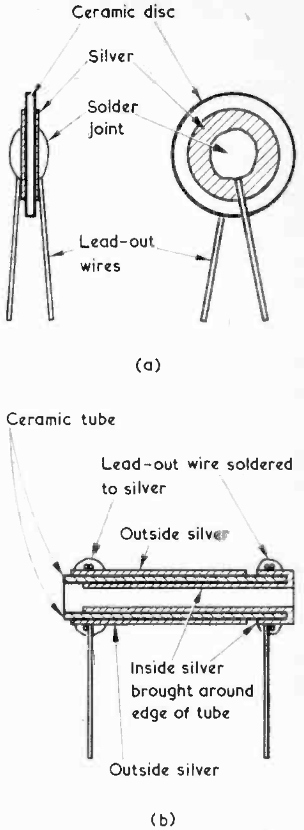


Fig. 4. Ceramic capacitors are manufactured most frequently in (a) disc and (b) tubular form. The capacitor is finally covered with a protected coating of hard resin or enamel

trolyte on the other. Since the film of aluminium oxide is very thin, a capacitor formed in this manner is capable of offering a very high value of capacitance.

Early 'wet' electrolytic capacitors used a construction based on that shown in Fig. 6, but they have for many years been superseded by the 'dry' electrolytic capacitor. In the dry electrolytic capacitor two aluminium foils, one of which has already had an oxide film built up on it, are rolled up, with two lengths of highly absorbent paper between them, in much the same manner as the paper or plastic foil capacitor of Fig. 5. The roll is then immersed in a bath of electrolyte, which is absorbed by the paper, after which it is removed and fitted into its final protective housing. Since the previously formed oxide film may have become damaged during handling, a voltage of suitable polarity is applied to the capacitor to rebuild the oxide film at any point where it may be absent. The electrolytic capacitor is then ready for use.

In order to obtain increased capacitance in a small volume, many modern electrolytic capacitors have the surface of the oxide-bearing foil 'etched' before the oxide is built upon it. The etching process creates a large number of 'hills' and 'valleys' in the foil surface, with the result that its overall surface area is considerably increased. The electrolyte is in intimate contact with the foil oxide and is capable of conforming to the etched contour.

It is necessary for an electrolytic capacitor to have a direct voltage across it when in use, in order to maintain the oxide film. This is easy to arrange in most radio circuits, where a direct voltage can be continually applied across the component whilst it carries out its function as a capacitor. A small 'leakage current' continually flows in the capacitor, to maintain the oxide film, this current being allowed for in the circuit in which it is employed. It is important that the voltage applied to the capacitor should always have correct polarity. If it is applied with reverse polarity, the oxide film will disappear and the capacitor will break down.

A fairly recent type of electrolytic capacitor employs the metal tantalum instead of aluminium. The basic mode of operation with the tantalum electrolytic capacitor is the same as with the aluminium electrolytic capacitor. However, tantalum oxide is tougher than aluminium oxide and has a higher dielectric constant, thereby allowing larger capacitance values to be provided for the same volume. Tantalum capacitors also exhibit a lower leakage current and can operate at higher temperatures.

VARIABLE CAPACITORS

All the capacitors we have considered up to now are described as *fixed capacitors* when it is desired to distinguish them from *variable capacitors*. Variable capacitors are components designed to offer a varying capacitance by way of a mechanical means of control. The most commonly encountered version of the component is illustrated in Fig. 7(a). The construction and operation of a variable capacitor of this type will be apparent to anyone who has, for instance, examined the inside of a medium and long wave radio receiver and has observed such a component coupled to the tuning drive. Variable capacitors have a fixed set of plates, known in this case as 'vanes', and a moving set of plates, or 'vanes'. The capacitance offered by the capacitor varies as the moving vanes are taken into mesh with or out of mesh with the fixed vanes. The two sets of vanes are spaced from each other, the dielectric between them being air. Capacitors in this category are sometimes described as 'air-spaced variable capacitors'. The fixed and moving vanes must be rigid and very accurately positioned to ensure that they maintain constant spacing as the moving vanes rotate. A lower-cost version uses thin sheets of insulating material between the vanes, whereupon the latter do not need to be rigid or accurately positioned. Such capacitors are known as 'solid-dielectric variable capacitors', and an example is shown in Fig. 7(b).

When closely examined, it will be found that the variable capacitor employed in most medium and long wave radio receivers does not employ just a single set of moving and fixed vanes. Instead, it has two sets of moving vanes on a common spindle, these meshing with two separate sets of fixed vanes. A capacitor of this type is referred

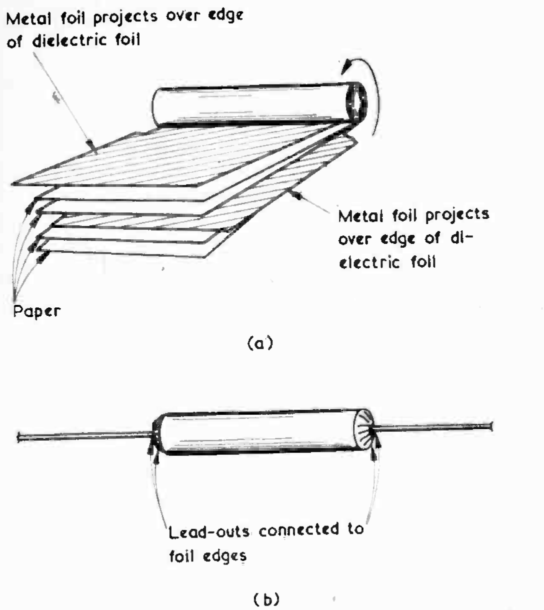


Fig. 5(a). Rolling up a paper or plastic foil capacitor (b). Lead-out wires are connected to the projecting metal foil edges after the roll is complete

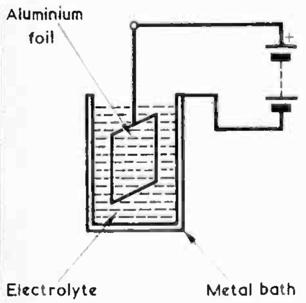


Fig. 6. If a piece of aluminium foil is suspended in a suitable electrolyte and a battery is connected as shown here, a very thin film of aluminium oxide is formed over the surface of the foil

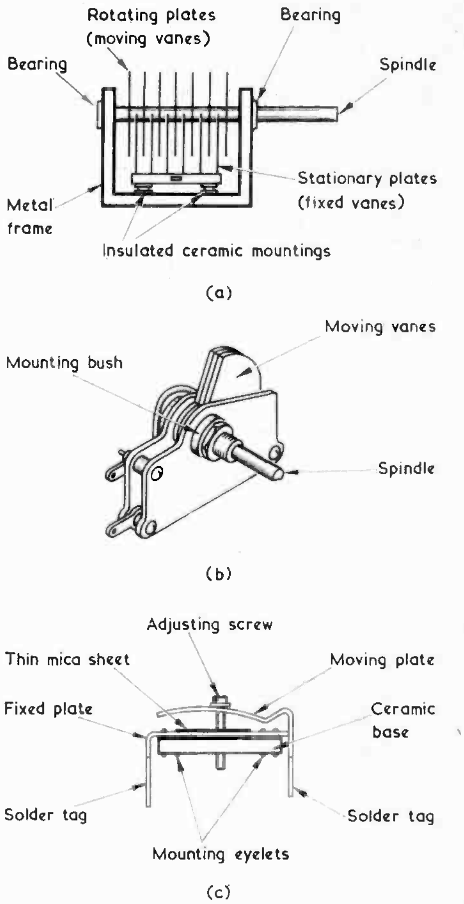


Fig. 7(a). The basic variable capacitor (b). A solid dielectric variable capacitor (c). The construction of the mica trimmer

to as a '2-gang variable capacitor'. If there are three sets of moving and fixed vanes, the component is a '3-gang variable capacitor', and so on. The basic variable capacitor, with the single set of moving and fixed vanes, may occasionally be referred to as a 'single-gang variable capacitor' when it is necessary to differentiate it from the multi-gang types.

Radio circuits frequently incorporate preset variable capacitors, or *trimmers*, which can be adjusted to a particular value of capacitance and then left alone. Usually, the maximum values required here are relatively low and, once again, the construction and method of operation are obvious upon visual inspection. A typical example is given by the 'mica trimmer', in which the moving plate consists of a sheet of springy metal, as in Fig. 7(c). The distance between this and a second fixed plate is controlled by an adjusting screw. A sheet of mica is interposed between the two plates.

SYMBOLS

The circuit symbols for the various capacitors we have discussed are illustrated in Fig. 8. Fig. 8(a) shows a fixed capacitor, which can be of any type other than electrolytic. An electrolytic capacitor appears in Fig. 8(b), the plus sign indicating polarity. Figs. 8(c), (d) and (e) illustrate a single variable capacitor, a 2-gang variable capacitor and a 3-gang variable capacitor respectively. Note the broken lines joining the arrows in Figs. 8(d) and (e) which indicate that the individual capacitors are ganged together. Fig. 8(f) gives the symbol for a preset variable capacitor, or trimmer. The T-shaped sign appears here, to indicate 'preset', in the same manner as occurred with the preset variable resistor symbol we discussed last month.

INDUCTANCE

A component which can be considered as being the 'opposite' to the capacitor is the *inductor*, which is more usually referred to as a *coil*. An inductor is formed when any length of insulated wire is wound up into a coil and it presents the property that it opposes changes in any current which flows through it. When, in Fig. 1(b) we connected a battery to a capacitor, current immediately flowed from the battery to produce a charge on the capacitor plates. If we connect a battery to a coil, a finite time elapses before the current in the coil reaches its maximum value, the latter being limited by the resistance of the wire in the coil together with any other resistance which may be present in the circuit.

When a direct current flows in a coil it sets up a magnetic field in and around that coil. It is the form-

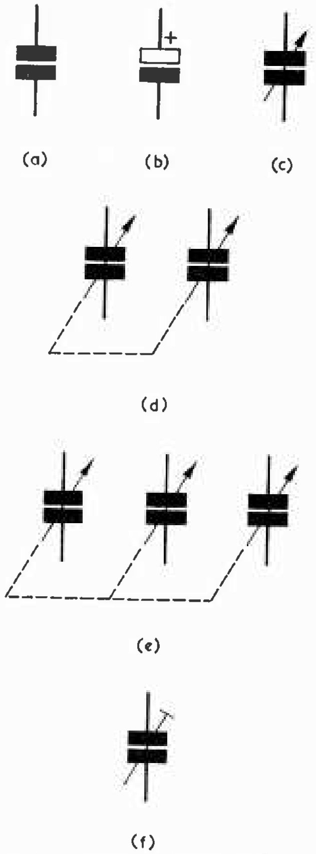


Fig. 8. Circuit symbols for:
(a) Any fixed capacitor other than electrolytic
(b) An electrolytic capacitor
(c) A variable capacitor
(d) A 2-gang variable capacitor
(e) A 3-gang variable capacitor
(f) A preset trimmer capacitor

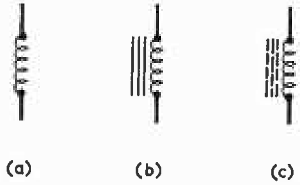


Fig. 9. Circuit symbols for (a) an inductor, or coil, without a core, (b) an inductor with an iron core, and (c) an inductor with an iron dust or ferrite core

ation of this magnetic field which causes the slow rise of current. The initial current sets up an expanding magnetic field, the lines of force of which cut the turns of the coil and, in so doing, produce a voltage that *opposes* the applied voltage. The same effect in the coil causes it to oppose a *change* in the current flowing through its turns. This is because the changing current results in the production of an increasing or decreasing field and a similarly opposing voltage.

If an iron *core* is inserted inside the coil, the inductance of the latter increases by a considerable amount, because many more lines of magnetic force can appear in iron than in air. Since the iron is a conductor, a secondary and undesirable effect is that currents can be induced in the core itself when the coil field is expanding or contracting. Fortunately, these currents can be considerably reduced by making up the core in the form of thin iron sheets (known as 'laminations') each of which is insulated from its neighbours. Another approach towards preventing current flow in the core is used with small radio coils, and consists of employing a core made up of many tiny particles of iron, these being suspended in a hard plastic material which causes them to be insulated from each other. This type of core is referred to as an *iron dust core*. An alternative to the iron dust core is the *ferrite core*. Ferrite materials are hard brittle substances with magnetic properties roughly similar to those of iron. They are fired in much the same way as are ceramics, and do not readily conduct electricity.

The ability of a coil to oppose changes in the current which flows through it is defined in terms of its *inductance* (or, to be precise, *self-inductance*). A coil with high inductance offers greater opposition to change of current than does one with low inductance. The basic unit of inductance is the henry (H). Subdivisions of the henry are the millihenry (mH) which is one-thousandth of a henry, and the microhenry (μH) which is one-millionth of a henry.

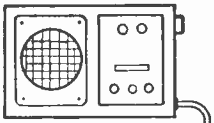
Although the basic property of inductance is that it opposes change of current, inductors are not always used *ostensibly* for this particular function of radio work. In many applications, an inductor is combined with a capacitor to form a *resonant* or *tuned circuit*. In a resonant circuit, current flows from a charged capacitor into an inductor and produces a magnetic field until the capacitor is discharged; the field then collapses and returns energy to the capacitor. The latter thus charges again until there is zero field in the inductor, after which the capacitor discharges into the inductor once more to produce a second field. This process can continue indefinitely, the time occupied by the cycle of capacitor charge, discharge, charge and discharge being dependent upon the capacitance of the capacitor and the inductance of the inductor. The value of the capacitor affects the time of cycle length because, as we saw at the start of this article, a capacitor opposes change in voltage across its plates; and the value of the inductance affects the time of cycle length because an inductor opposes changes in the current which flows through its turns.

The circuit symbol for an inductor without any core (a condition sometimes referred to as 'air-cored') is given in Fig. 9(a). The symbol for an iron-cored inductor is shown in Fig. 9(b), while Fig. 9(c) gives the symbol for an inductor having either an iron-dust core or a ferrite core.

NEXT MONTH

In next month's issue we shall introduce the subject of alternating voltage and frequency, and will discuss the important part carried out by resonant circuits made up of inductance and capacitance. ■

In your workshop



Even the apparently elementary things in radio can exhibit a surprising degree of complexity when considered in depth. Smithy proves this point to his assistant Dick when the latter asks him to discuss what is usually considered to be the humblest section of a radio receiver – the cord tuning drive

"LEAVE IT ALONE!"

Dick jumped as Smithy's voice unexpectedly roared out behind him. His hand, outstretched to remove the broken tuning drive cord in the small transistor radio on his bench, faltered in mid-air.

"Cor blimey," he protested, turning round to face the Serviceman, who had risen from his stool and was now standing behind him, "you nearly gave me heart failure then! What's the idea – shouting out at me like that?"

Smithy pointed an accusing finger at the radio on Dick's bench. The broken drive cord sagged listlessly across its chassis, whilst the tuning cursor lay at a drunken angle against the back plate of its scale.

"Were you," asked Smithy, "going to replace that drive cord without even attempting to check how the broken one was strung up?"

TUNING DRIVES

"Of course I was," replied Dick indignantly. "Blow me, Smithy, this tuning drive is only a bit of string coupling the drive spindle, the tuning capacitor and the dial pointer together. You don't need a diagram to sort out something as simple as that."

"Don't you?" returned Smithy. "Why is it, then, that the service manuals of virtually all radio sets incorporating a cord drive include a diagram showing how that drive is laced up?"

"Well," said Dick, slightly taken aback at this undeniably true item of information, "I suppose it's because the set-makers have just got to put the drive cord diagram in. In the same way that they've got to put the chassis layout diagram in."

"They put in the cord drive diagram," pronounced Smithy, "to ensure that the likes of you and I don't have to rely on guesswork if we ever have to re-string it. What you don't appear to realise, Dick, is that you can often spend ages trying to get a tuning drive to work properly when you don't know precisely how it's supposed to be laced up. If a service manual for the set isn't available, the next best thing is to try and work out how the broken cord was strung up before you remove it."

"I still can't understand," replied Dick, "how on earth you can go wrong with a cord drive anyway. What, for instance, are the particular points you have to pay attention to?"

"I'll show you one of them right now," said Smithy, taking out his pen and pulling Dick's note-pad towards him. "To start off with, one of the most important things to establish is the way the cord passes round the drive spindle to which the tuning knob is fixed. Before removing the old cord, and assuming you haven't got the service manual, you want to try and find out the number of times the cord went round the spindle and in which direction. There are four ways in which the cord can pass round the drive spindle and if you choose the wrong one, *or* put the wrong number of turns on, you may find that the cord slips, or that it jams up at one end of the tuning range, or that the tuning knob has to be turned in the wrong direction. Here are the four ways in which the drive cord may be fitted."

Smithy quickly sketched out the different methods of winding the cord on the drive spindle. (Fig. 1).

"It's obvious," he went on, "that if you wind the cord on the spindle the wrong way round you'll have to turn the tuning knob in the opposite direction to that which occurred,

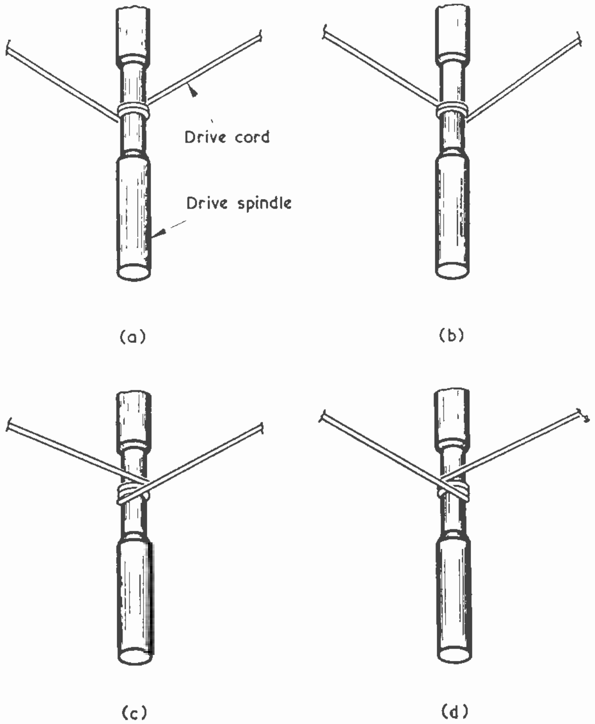


Fig. 1. A replacement tuning drive cord should always be wound round the drive spindle in the same way and with the same number of turns as the original. Demonstrated here are the four different ways in which the cord may be fitted

previously in order to obtain the same rotation of the tuning capacitor. So, two of my four examples will result in incorrect tuning knob rotation, if nothing else. What is not so obvious is that the new cord should go onto the drive spindle with the same side nearer the front as occurred with the previous cord."

Smithy stabbed his finger at two of the drawings on the pad. (Figs. 1(a) and (b)).

"These two sketches," he said, give an example of the different ways of winding the cord round the spindle with first one side and then the other nearer the front. Surprising as it may seem, you will quite often find that the system won't work properly if you put the cord on the drive spindle with the wrong side nearer the front."

Dick looked impressed.

"There seems," he remarked, "to be rather more to this tuning drive business than I'd realised. If the cord is broken, though, how can you tell how many times it went round the tuning drive spindle and which side should be nearer the front ?"

"You'll usually find," replied Smithy, "that the broken cord still lies loosely around the drive spindle whereupon you can quite easily determine how many turns it had on that spindle and, if you're lucky, which side should be to the front. Another thing you want to determine is the route the new cord should follow. This may also necessitate a little bit of detective work before you take the old one out."

"Are there any other points concerning tuning drives I should know about ?"

Smithy regarded his assistant suspiciously.

"This business began," he remarked querulously, "when I happened, just by chance, to glance over towards your bench at the moment you were beginning to remove the broken drive cord. It now looks as though I'm embarking on a full-time session on cord tuning drives."

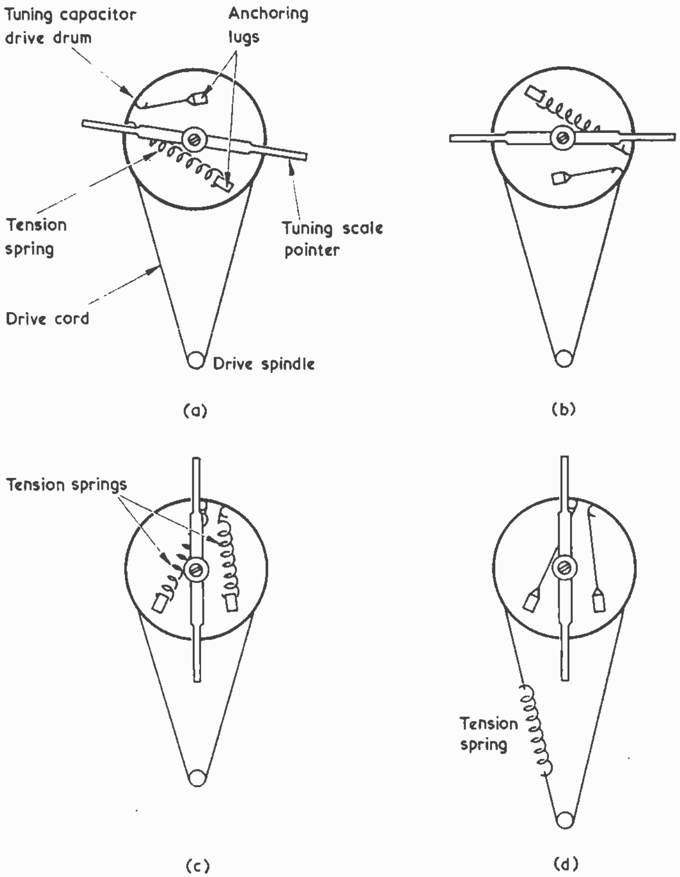


Fig. 2(a). A very simple cord tuning drive
(b). The situation in which the maximum amount of cord at the tension spring end lays on the drum surface
(c). A system with two tension springs
(d). A drive with the tension spring external to the tuning capacitor drive drum

"What's wrong with that?" retorted Dick promptly. "Anyone connected with servicing has to repair tuning drives from time to time, so why don't we have a sesh on them here and now?"

SIMPLE SYSTEMS

Smithy frowned and consulted his watch.

"Well, the subject of tuning drives is certainly an interesting one," he admitted. "So I suppose it will do no harm if we did stop work for a short while to discuss them. I'll go and bring my stool over."

Smithy walked over to his own bench on the other side of the workshop, picked up his stool, then returned to Dick's side. He settled himself comfortably alongside his assistant.

"For starters," he remarked, "I should mention that modern tuning cord drives are by no means as troublesome as they used to be in the old days before nylon cord was introduced. In those days the cords tended to break far more readily. In fact, tuning drives were an absolute menace at times and the situation was not eased by the fact that some manufacturers used to go in for really weird and wonderful systems. They used to make radios that had more tuning drive cords in them than connecting wire! A further complication was that it was standard practice in those days to have radio receivers which covered a short wave band as well as the medium and long wave bands."

"How did that affect the tuning drive?"

"It meant that, with some sets, you had to be careful not to make the cord which went to the tuning capacitor drive drum too tight," explained Smithy. "The tuning capacitor was usually mounted on rubber washers to prevent acoustic feedback from the speaker through the chassis to its vanes. Otherwise, there would have been a microphonic howl when short wave signals were tuned in."

"Oh, I see what you're getting at, now," put in Dick. "If you strung up the capacitor drive drum too tight, this could stress it against the rubber mounting washers, which wouldn't then provide the mechanical isolation required."

"That's right," confirmed Smithy. "The consequence was that an over-tight drive cord resulted in a receiver which howled on short wave signals! This is an effect you have to watch out for even with modern sets, if they happen to have a short wave band and the tuning capacitor is mounted on resilient washers. The microphonic effect is absent on medium and long waves, of course."

"What about microphony with v.h.f. f.m. sets?"

"Funnily enough," said Smithy, "there doesn't seem to be too much trouble in practice with tuning capacitor microphony on the v.h.f. band. Perhaps it's because v.h.f. tuning capacitors have got much wider spacing between their vanes

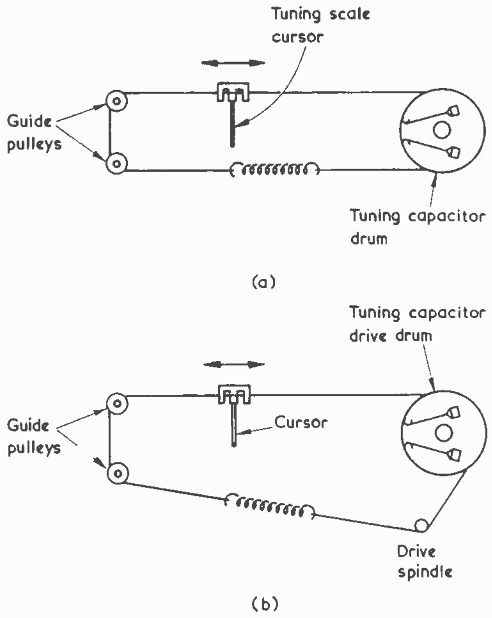


Fig. 3(a). In this system the tuning capacitor has its own integral slow-motion drive. The drum then couples to the tuning scale cursor (b). A very commonly encountered system in which the drive spindle, cursor and tuning capacitor drive drum are all coupled together by a single cord

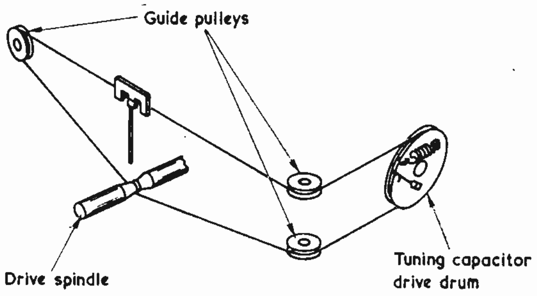


Fig. 4. An advantage provided by a cord tuning drive is that it offers considerable flexibility in the positioning of the tuning scale cursor, the drive spindle and the tuning capacitor. In this typical example the drive is taken through 90°

than occurs in the tuning capacitors in sets which cover long, medium and short wave bands. Anyway, there's nothing more to say on that particular aspect, so let's have a look at cord tuning drives in general."

Smithy picked up his pen and sketched out a new diagram. (Fig. 2a)).

"Now here," he remarked, "is one of the simplest cord drives going, and it has the tuning scale pointer fixed to the end of the tuning capacitor spindle. There is, also, the usual tension spring which, in this instance, is mounted inside the tuning capacitor drum."

"That drive," said Dick, "shouldn't give rise to any trouble."

"It can do," replied Smithy. "When the tuning capacitor is at the end of its rotation which causes the sprung end of the cord to be most fully wound on the drum (Fig. 2(b)) the tension spring has to overcome the friction between the cord and the drum surface on which the cord lays. Should this friction be too great the spring cannot apply the requisite amount of tension. The result is that, if the drive drum surface is not exactly concentric with the tuning capacitor spindle. you may end up with the system being either too tight or too loose at that end of the tuning range. If this snag is considered to be potentially serious by the manufacturer he may fit two springs in the drum for each end of the cord (Fig. 2(c)), or he may insert the spring in the cord away from the drum altogether." (Fig. 2(d)).

"Blimey," said Dick, "I hadn't realised that you could get difficulties with as simple a tuning drive as that."

"In servicing," chuckled Smithy, busy once more with his pen, "you get difficulties with *anything*, mate! Well, now, let's get on to two more simple tuning drives. Here's another easy one. (Fig. 3(a)). In this case the tuning capacitor is operated by an epicyclic ball drive, which may be integral with the capacitor itself. A drum is fitted to the section of the shaft which rotates in unison with the moving vanes, and this drum is coupled by a cord drive to the tuning scale cursor. And here is the very familiar drive system in which a single cord couples together the tuning drive spindle, the tuning capacitor drive drum and the cursor." (Fig. 3(b)).

"I sometimes wonder," remarked Dick, "why set designers go to all this trouble with cord drives when they could use simple mechanical reduction drives instead."

"One reason for the popularity of cord drives," replied Smithy, "is that they allow attractive cabinet presentations to be given. They enable the tuning knob, tuning scale and tuning capacitor to be positioned almost anywhere within reason, and this gives the design boys a considerable amount of freedom. The cord drive can even go round corners if necessary, which is a great advantage for the chassis layout engineers, too."

Smithy drew out a typical example of a cord drive passing through 90°. (Fig. 4).

"Right," he said briskly. "Let's next deal with a few variations. To start off with, there are a few sets knocking around which, for presentation reasons, have two circular tuning scales alongside each other. One may be marked up for medium waves and the other for long waves, and their two pointers rotate in unison. There are usually strung up something like this."

Smithy commenced to sketch out the two-scale dial drive. (Figs. 5(a) and (b).

"You'll meet this two-scale approach in some a.m./f.m. sets, too," he continued. "These sets have separate tuning capacitors for a.m. and f.m., and the scale drums and pointers are fixed direct to the capacitor spindles."

Smithy completed his diagrams and looked up.

"And that," he remarked, "clears up the simpler types of drive which operate tuning capacitors. Let's carry on next to the drives used in sets which have permeability tuning."

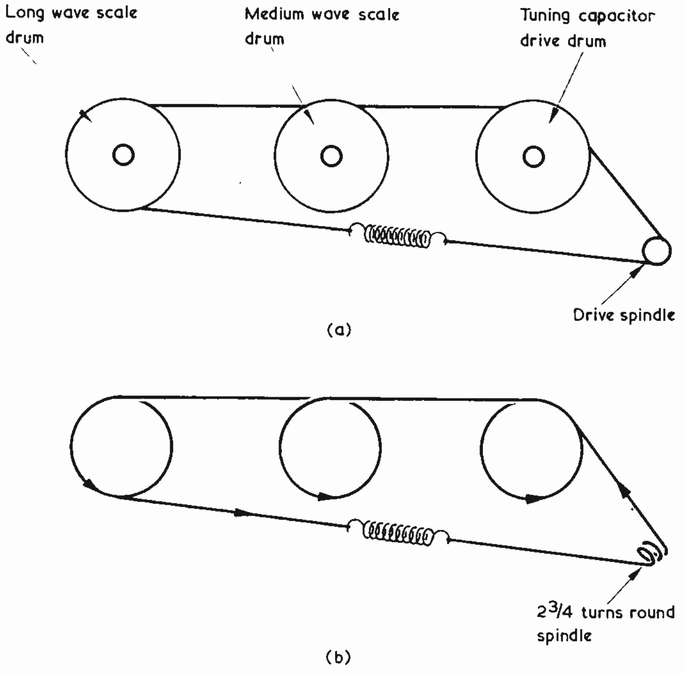


Fig. 5(a). A cord drive which caters for separate medium and long wave tuning scales. A rotary pointer is fixed to the axle of each of the tuning scale drums
(b). How the drive in (a) is laced up

"Permeability tuning?" queried Dick. "What sets use permeability tuning?"

"Quite a few a.m./f.m. models do," replied Smithy. "They use a standard tuning capacitor on a.m. and permeability tuned v.h.f. coils on f.m. The permeability tuner has a mechanical assembly which causes two cores to move, in unison, in and out of the r.f. amplifier and oscillator tuning coils. Sets of this type normally employ a standard cord drive coupling to the a.m. tuning capacitor drive drum. A second cord is then wound around a narrow diameter spindle concentric with the drive drum, and this actuates the permeability tuning core assembly. There are two basic ways of doing this."

Smithy tore off the top sheet of Dick's pad and, on the fresh page underneath, drew out two further sketches. (Figs. 6(a) and (b)).

"In the first of these sketches," he said, "a spring is attached to the end of the core assembly remote from the drive cord and it keeps the whole system under tension. As the tuning capacitor rotates, the drive cord causes the assembly to move in or out of the coils, as appropriate, the drive cord always pulling against the tension imposed by the spring."

"How," queried Dick, "does the second system work ?"

"In much the same way," replied Smithy. "Once again there is a narrow diameter spindle on which a second drive cord is wound. This time the cord pulls the permeability tuning core assembly in both directions, and not in just one direction against the action of a spring. The usual tension spring is incorporated and I've shown it here inserted in one of the cord lengths. In some versions, however, you may find that a tension spring is mounted on the drive drum itself."

DRIVE RATIOS

With a gesture of finality, Smithy put down his pen and gazed cheerfully at his assistant.

"Is that all?" asked Dick, disappointed at what was apparently

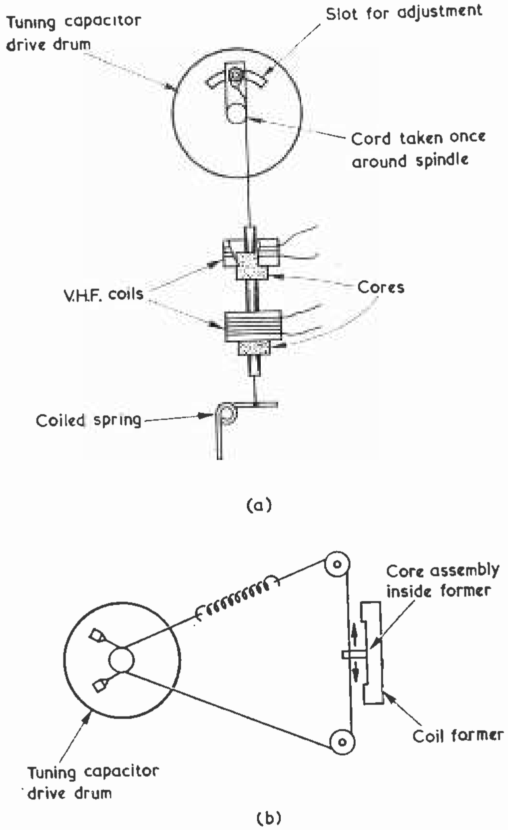


Fig. 6. Combined a.m./f.m. receivers may use a tuning capacitor for a.m. and permeability tuning for f.m. Shown here are two examples of cord drive coupling between the tuning capacitor and the permeability tuning core assembly. The tuning capacitor drive drum in each case has a separate cord drive (omitted for clarity) coupling to the drive spindle and tuning scale cursor in normal fashion

the end of Smithy's dissertation on the subject of cord tuning drives.

"Oh no," grinned Smithy. "It's just that I've finished so far as the more elementary drives are concerned. In a moment I'm going to carry on to drive systems that are more complex. I've left them to the end because they're rather knobby ones."

"Are they?" remarked Dick, intrigued. "In what way are they knobby?"

"They use pulleys to offer what is effectively a step-up or a step-down in speed ratio."

"What's the purpose of that?"

"The idea behind having a speed ratio," said Smithy, "is that it then becomes possible to give the tuning cursor a wide travel without the necessity of having a correspondingly large drive drum on the tuning capacitor. In all the systems with sideways-moving cursors we've discussed up to now the cursor is coupled directly to the tuning capacitor drive drum, with the result that the lateral movement of the cursor is equivalent to half the circumference of that drum. This means that if a wide cursor travel is required the tuning capacitor drive drum becomes correspondingly large and difficult to fit into the layout. With the systems I'm next going to talk about, the cursor travel is automatically doubled, and thus becomes equal to the full circumference of the drive drum. In consequence, the drum can be quite a lot smaller in size than it would need to be with the previous systems. Here's one of the ways in which a step-up in speed ratio is obtained."

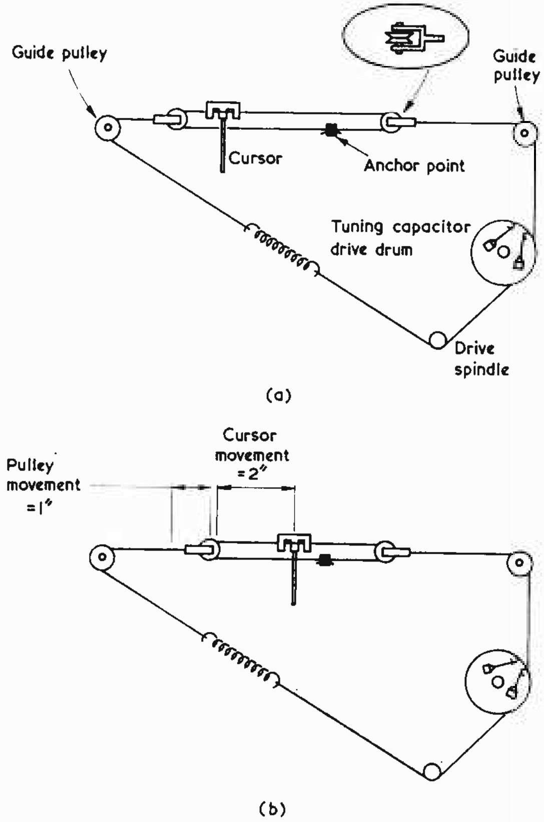


Fig. 7(a). A tuning capacitor drive which doubles the travel of the cursor. A side view of one of the two free pulleys is shown inset (b). When the pulleys move to the right by 1in., the cursor moves by 2in.

Smithy drew out a further cord drive system, then showed it to his assistant. (Fig. 7(a)). Dick gazed at it blankly, then scratched his head.

"I don't get it," he said, frowning. "How does this give you the step-up effect?"

"You'll soon find out," promised Smithy, "if you concentrate on it for a moment or two. As you can see, this system has got the usual drive spindle and tuning capacitor drive drum, these being coupled directly together. The cord then terminates in two pulley assemblies which are not secured to the receiver metalwork in any way and are free to move. Passing through these pulleys is a second piece of cord, this forming a loop which is anchored at the point I've indicated. The cursor is fitted on to the upper section of this loop."

"I can see all that," interrupted Dick impatiently, "but how does the system *work*?"

"Imagine," said Smithy in reply, "that you're rotating the tuning knob such that the two pulleys move to the right by one inch. (Fig. 7(b)). This means that one inch of the cord in the loop will also have passed through the pulleys. Since the pulleys have themselves moved by an inch, the upper section of the loop on which the cursor is fitted will have moved to the right by two inches. Do you see what I mean?"

The corrugations on Dick's forehead grew even deeper as he absorbed Smithy's explanation. Suddenly, his expression cleared.

"I'm with it now," he exclaimed. "Blimey, it's obvious when you think about it, isn't it?"

"It is, rather," said Smithy.

"Another thing," went on Dick excitedly, "is that, since the two pulleys are coupled together by the loop of cord, the distance between them is always the same. Which means that there's a constant length in the first piece of cord, the one which passes round the drive spindle and the tuning capacitor drum."

"That's right."

"Stap me, you were right when you talked about knobby schemes. This one's a real winner."

"I'm glad you approve of it," remarked Smithy, taking up his pen. "Here's another variation on the same theme. In this instance the tuning capacitor is driven by a separate mechanical drive, but it would be quite in order to have a drive spindle coupling into the cord which passes round the tuning capacitor drive drum."

Smithy drew yet another sketch (Fig. 8(a)) and passed it over to Dick for his inspection.

"Gosh," pronounced Dick, "this one looks as though it's going to be a bit of a toughie. Let's think, now. There's one cord which passes round the tuning capacitor drive drum and there's a second cord which is anchored at the right and left hand sides."

"Go on."

"Now, that second cord has a fixed length, which means that the spacing between the two pulleys must, once again, always be the same."

"So?"

"So, if we move the pulleys to the right by one inch, the cord between the pulleys on which the cursor is fitted will move by one inch plus an inch of the cord itself. Why, it's almost the same as the previous one!"

"They're very similar," agreed Smithy. "Hang on a jiffy and I'll

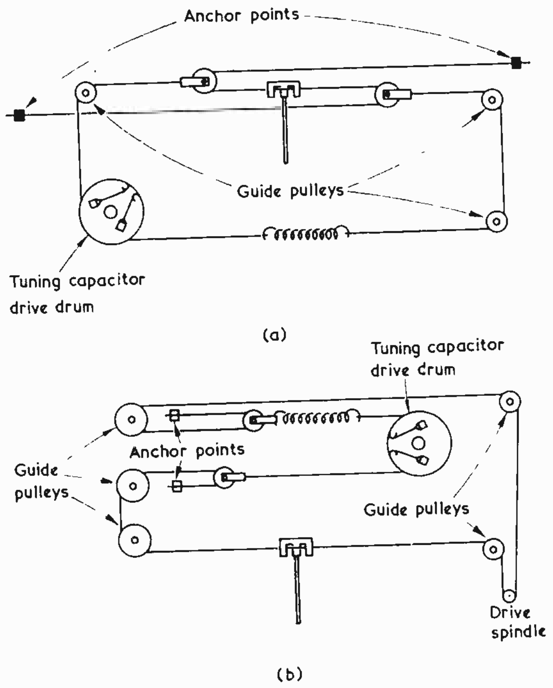


Fig. 8(a). Another drive which doubles cursor travel. In practical versions, smoothed-surfaced metal 'links' may be employed instead of the two free pulleys

(b). Another approach towards obtaining wide cursor travel

show you another version, which tackles the situation in a rather different manner."

STEP-DOWN SYSTEM

Smithy tore off the second sheet of Dick's note-pad and drew out the next diagram. (Fig. 8(b)).

"Here we are," he announced. "How about this ?"

"That's a crafty one, too," commented Dick. "But I think that it's a lot easier to follow from first sight than the other two were."

"How does it work, then ?"

"Well," said Dick. "In this case the drive spindle is on the same piece of cord as the cursor. As you rotate the spindle you move the cursor along and vary the positions of the two free pulleys, to which the second length of cord is coupled. You get a straightforward 2 : 1 step-down effect at each pulley, so that the second length of cord moves half as fast as the first piece of cord."

"That's the idea." confirmed Smithy. "If you trace the cords through, you'll see that the first piece of cord always requires the same length because, as one pulley goes to the right the other goes to the left by the same amount. It's neat though, isn't it ?"

"Definitely," agreed Dick. "Do you know, Smithy, I hadn't realised until now that there were so many different types of tuning drive in use."

"There *are* quite a few," returned Smithy. "Anyway, let's press on to the next one. This one is a real dilly, and it's capable of offering much more than the 2 : 1 step-up you get with the last three systems. The secret of its operation lies in the use of two special identically-sized pulleys whose basic shape is like this."

Smithy sketched out the pulley. (Fig. 9(a)).

"The pulley is made in one piece," he went on, "and it has a small diameter section and a large diameter section with a thin slot joining the two."

"How is it used ?"

"Like this," said Smithy, busy with his pen. (Fig. 9(b)). "One length of cord is used for the whole system. The cord starts at the tuning capacitor drive drum, passes over the drive spindle, and then is wound a number of times over the small diameter section of the right-hand pulley. It next passes through the slot and is wound a few more times on the large diameter section of the right-hand pulley, after which it carries over to the large diameter section of the left-hand pulley. It is wound round a few more times here, passes through the slot and is wound on again on the small diameter section of the left-hand pulley. After that it passes over a guide pulley and returns to the tuning capacitor drive drum, where it terminates in the tension spring. The cursor is mounted on the cord between the large diameter sections of the two pulleys."

"All this sounds rather complicated."

"Actually," said Smithy, "it's surprisingly simple. As the drive spindle is rotated, so also are the small diameter sections of the pulleys. These take the large diameter sections round with them, with the result that the cord between the large diameter sections moves a greater distance than the remainder of the cord, the step-up ratio being the ratio between the large and small diameters of the pulleys."

"Oh, I see," said Dick. "Now, let's go a bit further into it. So far as I can see, there must always be the same length of cord in the system because, as the cord comes off one large diameter pulley section it's wound on to the other large diameter pulley section. Also the pulleys, being the same in size, rotate at the same rate, so that the cord coming off one small diameter section is balanced by that going on to the other small diameter section. Is there anything special about the slots in the pulleys ?"

"They're merely a means of enabling the cord to be taken from one diameter to the other," explained Smithy. "One thing I didn't elaborate on just now concerns the number of turns of cord there are on the two sections of each pulley. When the cursor is at the right-hand end of its travel, the large diameter section of the left-hand pulley is almost completely unwound, as also is the small diameter section of the right-hand pulley. Similarly, when the cursor is at the extreme left-hand end of its travel, the large diameter section of the right-hand pulley is almost completely unwound, as is the small diameter section of the left-hand pulley. So, there is always *some* cord on each of the four pulley sections, and the cord which passes through the slot in each pulley is never disturbed. It just stays in place all the time."

"Well," remarked Dick, "that system *is* one for the book. Are there any other cord drive ideas you can show me ?"

"That's the last one," replied Smithy. "And I've now shown you pretty well all the basic approaches you're liable to encounter in the sets you service. There are one or two minor details to pass on, though."

"What are those ?"

"Sometimes," said Smithy, "you will encounter guide pulleys which don't rotate. Instead, they just present a polished grooved surface for the cord to slide along. Also, some of the 2 : 1 pulley systems may not have actual pulleys. Instead, they may use shaped metal pieces, called 'links', through which the cord slides. And that, I think, is about all there is to say on the subject."

FINISHING OFF

"You've certainly," said Dick, "opened my eyes to some useful techniques today. Incidentally, those 2 : 1 pulley systems could be particularly useful for home-constructor projects, couldn't they?"

"Indeed they could," agreed Smithy. "Especially since all they need are just the pulleys and odd bits of hardware in addition to the cord."

"Well," said Dick. "I've always looked upon cord tuning drives as being so simple that they aren't worth more than a moment's consideration. Yet, when I start looking at them seriously, I discover they're stock full of really interesting designs and ingenious ideas."

"You'll find," said Smithy sagely, "that that happens whenever you look deeply into *anything* which has to do with radio. It's the fact that one detail always leads to another, which makes working with radio such a completely fascinating pursuit."

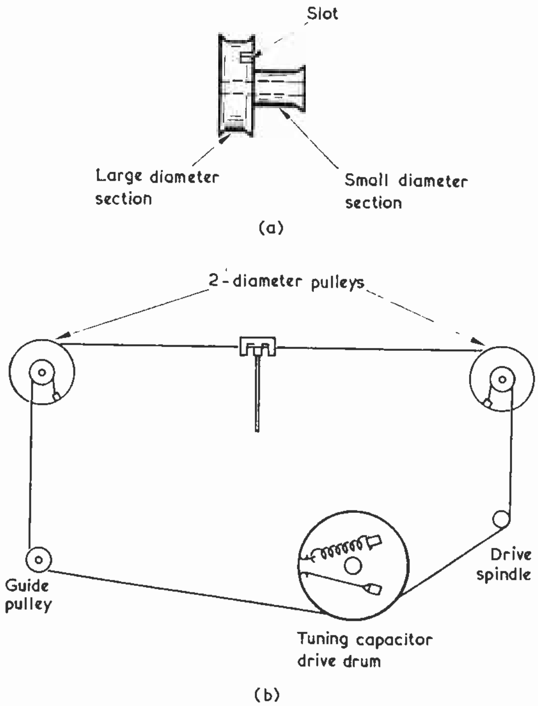


Fig. 9(a). A drive system, employed in some Thorn receivers, incorporates two pulleys having the shape shown here (b). How the system is laced up. For reasons of clarity, the large diameter sections of the pulleys are shown at the rear; in practice they are at the front

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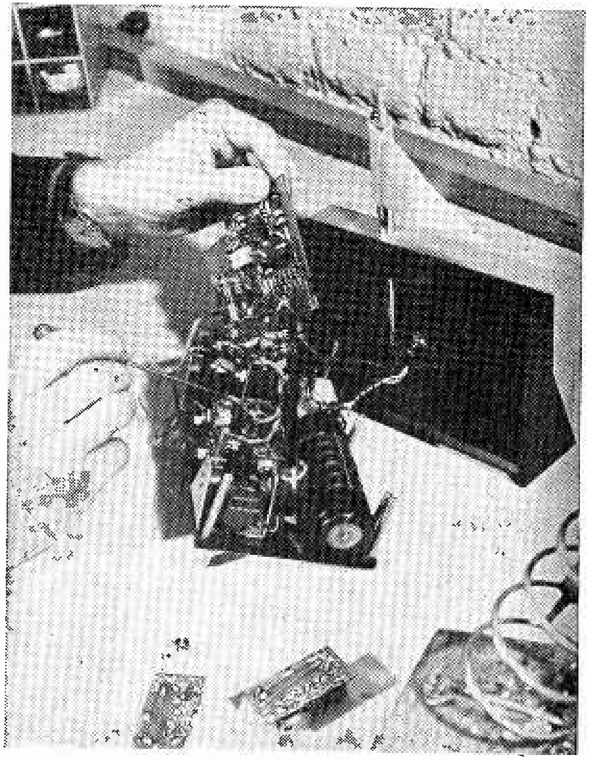
RADIO CONTROL TX CASE

Our illustration (Mobile 1999A) shows the electronic assemblies of a new transmitter made by Flight Link Control Ltd., Bristow Road, Hounslow, Middlesex, for radio-controlled model aircraft and boats. The transmitter's chassis and case are moulded from 'Beetle' glass-reinforced polyester dough moulding compound (DMC) made by BIP Chemicals (Turner & Newall Ltd.), Oldbury, Warley, Worcs.

The transmitter originally had an aluminium case which cost £8.00 to manufacture. Its DMC successor is moulded for only 75p. This is typical of the savings which can be realised when small quantities of cases, covers, and similar items are made from DMC instead of metal. The aluminium case was expensive because the metal had to be cut, folded, drilled, welded, and so forth, whereas the new case is formed in one single compression moulding operation.

The case is moulded by International Tooling and Marketing Ltd., Bagshot, Surrey.



LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● MALDIVE ISLANDS
VS9MB has been heard on **21220** SSB at 1145 and at 1615 giving his QTH as Gan and working into the U.K.

● GABON REPUBLIC
TR8VW heard on **14130** SSB at 0652, on **14200** SSB at 1700, on **21205** SSB at 1605 and on **28585** SSB at 1430.

● MALAGASY REPUBLIC
5R8AB heard on **28020** CW at 1453, and on **28530** SSB at 1430. 5R8AP heard on **7004** CW at 2237 and on **28576** SSB at 1108. 5R8AS on **28585** SSB at 1630.

● SWAZILAND
ZD5X has been heard on **14040** CW at 1855.

● SPITZBERGEN
JW7UH heard on 14MHz band often using CW. One the last occasion he was using **14030** at 1850.

● THAILAND
HS1AEG has been heard on **14120** SSB at 1915 giving his QTH as Bangkok.

● NETHERLANDS ANTILLES
PJ2CC has been logged on **14055** CW at 1855. PJ2PS is also active on this band using CW.

● UPPER VOLTA REPUBLIC
XT2AA reported on **14187** SSB at 2210 and on **14278** SSB at 1620.

★ BROADCAST BANDS

● U.S.A.
The current English schedule of WNYW New York is as follows – to Europe from 1700 to 1945 on **17845**; from 1700 to 1845 on **21525**; from 1900 to 1945 on **15440**; from 2000 to 2030 on **11890**; from 2030 to 2215 on **11885**; from 2000 to 2300 on **9690** and from 2230 to 2345 on **6075.**

To the Caribbean and the Americas, in English, from 1700 to 0000 on **17760**; from 2315 to 0100 on **15215**; from 0015 to 0230 on **5985**; from 0130 to 0230 on **9615**; from 2145 to 0115 on **15130**; from 0000 to 0230 on **11885** and from 0115 to 0230 on **9715.**

WINB Red Lion, Pennsylvania, broadcasts to Europe, in English, from 1700 to 2000 on **17720** and from 0000 to 2200 on **11795.**

● ITALY
Radio Rome broadcasts to the U.K. from 1935 to 1955 on **6050, 7275** and **9710.** To the Near East, in English, from 2025 to 2045 on **6050, 9575** and **9710.**

● U.A.R.
Cairo can be heard with an English/Arabic language lesson at 1400 on **17920.**

● ECUADOR
HCJB 'Voice of the Andes' can be heard with a daily English programme to Europe from 0530 to 0600 on **11735.** In English, also daily, from 1930 to 2000 on **17755.**

Acknowledgements: – Our Listening Post, ISWL. ■

MORE NEWS

ON THE AIR?
From Finland it has been reported that OH2BH is in Iraq and, subject to a licence being granted, hopes to be on the air from the Finnish Embassy.

FROM IRAN
9C9WB has been heard using **14200** SSB, both in English and German, on Sundays. Cards to EP Bureau.

MONGOLIA
JT1KAA from Ulan Bator on **14029** CW from 0945 till 1030.

LIBERIA
EL2CT is DL2YM, on **21300** SSB at 1845.

PANAMA CANAL ZONE
For those who can brave the noises on the 7MHz band, listen for KZ5ZZ on **7010** CW around 2300.

LAST LOOK ROUND

TOP BAND DX – EUROPEAN

In addition to the Trans-Atlantic Dx recently reported on this page there are also a number of European stations that have been active on this band. Apart from the Czechoslovakians, apt to be numerous on CW, there have been the Dutch PA0LOU, PA0PN, the Swiss HB9CM, HB9NL and the German DJ9TK, DK0KC, DL8AM and DL9KRA stations all putting fair CW signals into the U.K.

Nearer home, signals have been heard from GC2LU in Jersey, from GW3GWX, GW3HGL, GW3ZPA and GW3ZQG in Wales and from GM3KMR/A, GM3LWS/A, GM3OXX, GM3YCB and GM3ZSP in Scotland, all on CW.

Trans-Atlantic CW signals heard on the last Test of the present series, when conditions were very poor, were – KV4FZ, W1BB, W1BHQ, W1HGT, W1PL and W9UCW. ■

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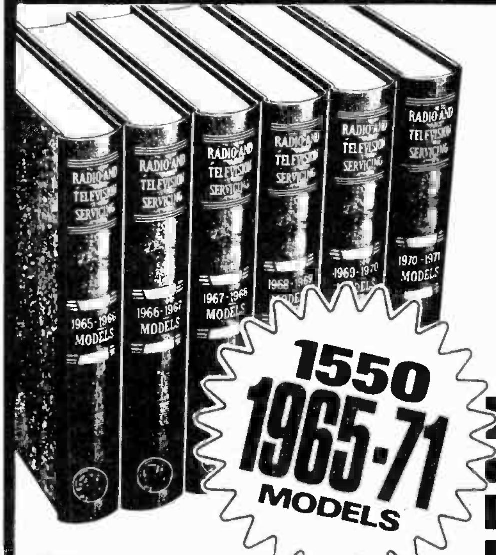

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(Continued on page 577)

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10F18	.35	ECH84	.38	PCF82	.33	U191	.63	AF180	.48	OA200	.09
12A6	.63	ECL80	.35	PCF84	.40	U301	.53	AF186	.55	OA202	.10
30C15	.65	ECL82	.33	PCF86	.50	U801	.95	AF239	.38	OC23	.38
30C17	.80	ECL83	.52	PCF200	.67	UABC80	.33	BA102	.45	OC24	.38
30C18	.64	ECL86	.40	PCF801	.35	UBC81	.40	BA115	.14	OC25	.38
30F5	.80	EF22	.63	PCF802	.45	UBF80	.29	BA116	.20	OC26	.25
30FL1	.64	EF41	.50	PCF806	.64	UBF89	.34	BA129	.13	OC28	.60
30FL2	.75	EF80	.23	PCH200	.62	UC92	.35	BA130	.10	OC35	.32
30FL14	.73	EF85	.29	PCL82	.37	UCC84	.40	BC107	.13	OC36	.43
30L15	.64	EF86	.32	PCL83	.50	UCC85	.37	BC108	.13	OC38	.43
30L17	.78	EF89	.25	PCL84	.38	UCF80	.42	BC113	.25	OC44	.10
30P4/19	.60	EF91	.17	PCL805/		UCH21	.60	BC118	.23	OC45	.13
30P4MR	.98	EF183	.30	85	.45	UCH42	.63	BCY10	.45	OC46	.15
30P12	.69	EF184	.30	PCL86	.43	UCH81	.33	BCY12	.50	OC70	.13
30PL1	.69	EH90	.38	PEN45DD		UCL82	.35	BCY33	.20	OC71	.13
30PL13	.78	EL34	.53		.75	UCL83	.50	BCY34	.23	OC72	.13
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DY802	.48	EL84	.24	PL36	.48	UF80	.35	BCY39	.25	OC75	.13
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ECC81	.19	KTW62	.63	PY81	.27	AC128	.20	BY105	.18	OC200	.22
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(Continued from page 575)

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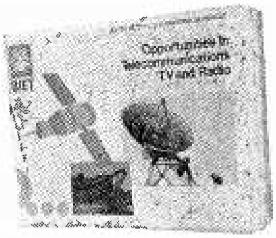

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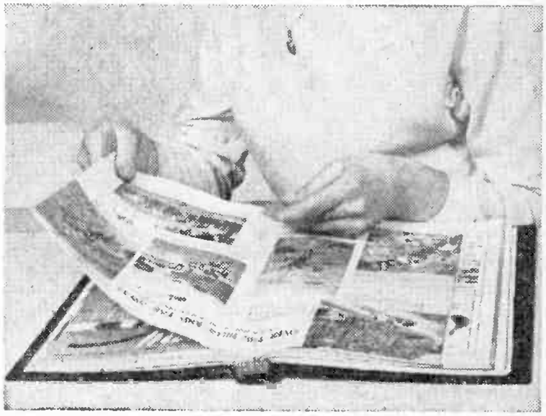

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(Continued from page 577)

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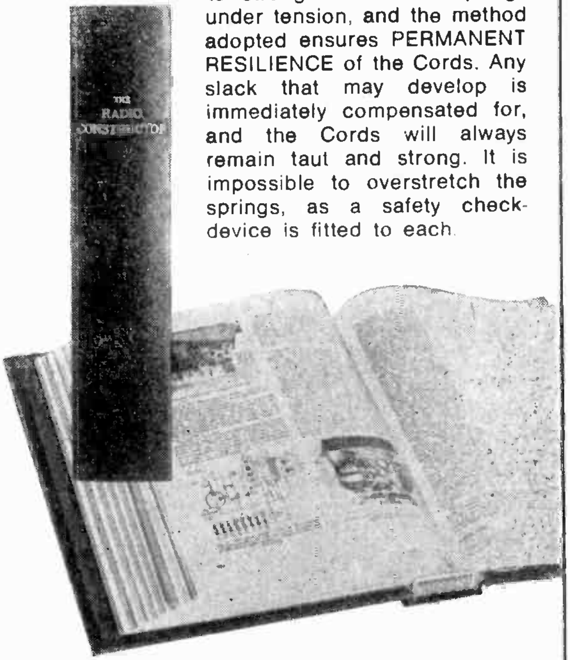

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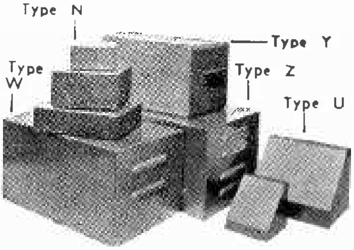

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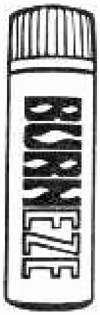

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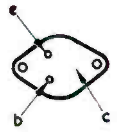
P.N.P. Transistor Lead-outs



The Table lists commonly encountered p.n.p. transistors in TO-3, TO-41 or SO-55 encapsulations whose lead-outs conform to the layout in the accompanying diagram. (The list will be concluded in Data Sheet No. 50.) The letter in brackets after each type-number indicates whether the device is germanium or silicon.

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AD149 (G)
AD162 (G)
AU103 (G)
AUY10 (G)
MJ450 (S)
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MP1612 (G)
MP1613 (G)
MP2060 (G)
MP2061 (G)
MP2062 (G)
MP2063 (G)
MP2200A (G)
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MP3730 (G)
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NKT401 (G)
NKT402 (G)
NKT403 (G)
NKT404 (G)
NKT405 (G)
NKT451 (G)
NKT452 (G)
NKT453 (G)
OC19 (G)
OC20 (G)
OC22 (G)
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OC30 (G)
OC35 (G)
OC36 (G)
TI3027 (G)
TI3028 (G)
TI3029 (G)
TI3030 (G)
TI3031 (G)
2G220 (G)
2G221 (G)
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2N457 (G)
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2N1559 (G)
2N1559A (G)

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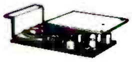

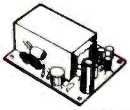

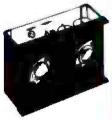

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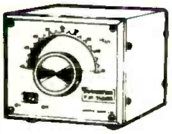

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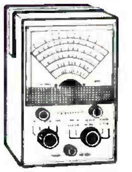

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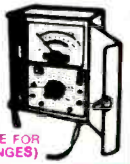

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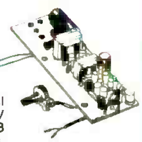

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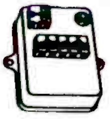

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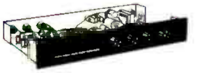

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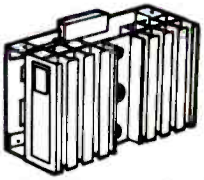

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