THE
RADIO CONSTRUCTOR

Vol. 25 No. 5 DECEMBER 1971 20p

"VIBRATRON" VIBRATO UNIT

Constructional details of a self-contained vibrato unit suitable for electric guitars, portable organs and all other electronic music sources offering a low level signal

Special IN THIS ISSUE

TRANSISTOR STABILIZED POWER UNIT PART 1

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

SILICON RECTIFIERS—TESTED

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

TRIACS

VBOM	2A TO-1 £p	6A TO-66 £p	10A TO-88 £p
100	0.30	0.50	0.75
200	0.50	0.60	0.90
400	0.70	0.75	1.10

LUCAS SILICON RECTIFIERS

35-Amp, 400 P.I.V., Stud Type £1.10 each.

DIACS

FOR USE WITH TRIACS BR100 (D32) 37p each

2A POTTED BRIDGE RECTIFIERS 200V 50p

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

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VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10 W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

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FREE

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Coded and Guaranteed

Pak No.		EQVT
T1	8 2G371B	OC71
T2	8 D1374	OC75
T3	8 D1216	OC81D
T4	8 2G381T	OC81
T5	8 2G382T	OC82
T6	8 2G344B	OC44
T7	8 2G345B	OC45
T8	8 2G378	OC78
T9	8 2G399A	2N1302
T10	8 2G417	AF117

All 50p each pack

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.

2N2060 NPN SIL. DUAL TRANS.

CODE D1599 TEXAS. Our price 25p each.

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ORP60, ORP61 40p each

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

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OCP71 Type. 43p

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		£p
300mW	30 ..	0.50
40PIV (Min.)	100 ..	1.50
Sub-Min.	500 ..	5.00
Full Tested	1,000 ..	9.00

Ideal for Organ Builders.

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TO-18 Lens end. NPN Sim. to BPX25 & P 21. BRAND NEW. Full data available. Fully Guaranteed.

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2N3819	35p
2N3820	50p
2N3821	35p
2N3823	30p
2N5458	50p
2N5459	40p
BFW10	40p
MPF105	40p

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U1	120 Glass sub-min. general purpose germanium diodes	0.50
U2	60 Mixed germanium transistors AF/RF	0.50
U3	75 Germanium gold bonded diodes sim. OA5, OA47	0.50
U4	40 Germanium transistors like OC81, AC128	0.50
U5	60 200mA sub-min. Sil. diodes	0.50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0.50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0.50
U8	50 Sil. planar diodes 250mA, OA/200/202	0.50
U9	20 Mixed volts 1 watt Zener diodes	0.50
U11	25 PNP silicon planar transistors TO-5 sim. 2N1132	0.50
U13	30 PNP-NPN sil. transistors OC200 & 2S104	0.50
U14	150 Mixed silicon and germanium diodes	0.50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0.50
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0.50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0.50
U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0.50
U19	25 Silicon NPN transistors like BC108	0.50
U20	12 1.5-Amp silicon rectifiers Top-Hat up to 1,000 PIV	0.50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0.50
U23	30 Madt's like MAT series PNP transistors	0.50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0.50
U25	25 300Mc/s NPN silicon transistors 2N708, BSY27	0.50
U26	30 Fast switching silicon diodes like IN914 micro-min	0.50
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	1.00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0.50
U32	25 Zener diodes 400mW D07 case mixed volts, 3-18	0.50
U33	15 Plastic case 1 amp silicon rectifiers IN4000 series	0.50
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	0.50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0.50
U36	25 Sil. planar NPN trans. TO-5 BFY50/51/52	0.50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	0.50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0.50
U39	30 RF germ. PNP trans. 2N1303/5 TO-5	0.50
U40	10 Dual trans. 6 lead TO-5 2N2060	0.50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0.50
U42	10 VHF germ. PNP trans. TO-1 NKT667 AF 117	0.50
U43	25 Sil. trans. plastic TO18 A.F. BC113/114	0.50
U44	20 Sil. trans. plastic TO-5 BC115/116	0.50
U45	7 3-Amp SCR's TO-66 case up to 600V	1.00

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

NEW QUALITY TESTED PACKS

Pack	Description	Price £p
Q1	20 Red spot trans. PNP	0.50
Q2	16 White spot R.F. trans. PNP	0.50
Q3	4 OC77 type trans.	0.50
Q4	6 Matched trans. OC44/45/81/81D	0.50
Q5	4 OC75 transistors	0.50
Q6	4 OC72 transistors	0.50
Q7	4 AC128 trans. PNP high gain	0.50
Q8	4 AC126 trans. PNP	0.50
Q9	7 OC81 type trans.	0.50
Q10	7 OC71 type trans.	0.50
Q11	2 AC127/128 comp. pairs PNP/NPN	0.50
Q12	3 AF116 type trans.	0.50
Q13	3 AF117 type trans.	0.50
Q14	3 OC171 H.F. type trans.	0.50
Q15	5 2N2926 sil. epoxy trans.	0.50
Q16	2 GET880 low noise germ. trans.	0.50
Q17	3 NPN 1 ST141 & 2 ST140	0.50
Q18	4 Madt's 2 MAT 100 & 2 MAT 120	0.50
Q19	3 Madt's 2 MAT 101 & 1 MAT 121	0.50
Q20	4 OC44 germ. trans. A.F.	0.50
Q21	3 AC127 NPN germ. trans.	0.50
Q22	20 NKT trans. A.F. R.F. coded	0.50
Q23	10 OA202 sil. diodes sub-min.	0.50
Q24	8 OA81 diodes	0.50
Q25	6 IN914 sil. diodes 75PIV 75mA	0.50
Q26	8 OA95 germ. diodes sub-min. IN69	0.50
Q27	2 10A 600PIV sil. rects. 1S45R	0.50
Q28	2 Sil. power rects. BYZ13	0.50
Q29	4 Sil. trans. 2 × 2N696, 1 × 2N697, 1 × 2N698	0.50
Q30	7 Sil. switch trans. 2N706 NPN	0.50
Q31	6 Sil. switch trans. 2N708 NPN	0.50
Q32	3 PNP sil. trans. 2 × 2N1131, 1 × 2N1132	0.50
Q33	3 Sil. NPN trans. 2N1711	0.50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0.50
Q35	3 Sil. PNP TO-5 2 × 2N2904 & 1 × 2905	0.50
Q36	7 2N3646 TO-18 plastic 300MHZ NPN	0.50
Q37	3 2N3053 NPN sil. trans.	0.50
Q38	7 PNP trans. 4×2N3703, 3×2N3702	0.50
Q39	7 NPN trans. 4×2N3704, 3×2N3705	0.50
Q40	7 NPN amp. 4×2N3707, 2×3N3708.	0.50
Q41	3 Plastic NPN TO-18 2N3904	0.50
Q42	6 NPN trans. 2N5172	0.50
Q43	7 BC107 NPN trans.	0.50
Q44	7 NPN trans. 4× BC108, 3× BC109	0.50
Q45	3 BC113 NPN TO-18 trans.	0.50
Q46	3 BC115 NPN TO-5 trans.	0.50
Q47	6 NPN high gain 3× BC167, 3× BC168	0.50
Q48	4 BCY70 NPN trans. TO-18	0.50
Q49	4 NPN trans. 2× BFY51, 2× BFY52	0.50
Q50	7 BSY28 NPN switch TO-18	0.50
Q51	7 BSY95A NPN trans. 300MHZ	0.50
Q52	8 BY100 type sil. rect.	1.00
Q53	25 Sil. & germ. trans. mixed all marked new	1.50

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VCBO 80V VCEO 50V IC 10A PT 30 WATTS HFE 30-170.

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

EX-STOCK TYPE EACH AS PRICED

Type	Price each £p	Type	Price each £p	Type	Price each £p	Type	Price each £p
OC20	0.50	OC29	0.40	AL103	0.85	BD136	0.80
OC22	0.30	OC35	0.33	BD121	0.60	BD137	0.70
OC23	0.33	OC36	0.40	BD123	0.75	BD138	0.80
OC24	0.45	AD140	0.40	BD124	0.70	BD139	0.75
OC25	0.25	AD142	0.40	BD131	0.70	BD140	0.85
OC26	0.25	AD149	0.43	BD132	0.80	BD155	0.75
OC28	0.40	AL102	0.85	BD135	0.70	Bu105	3.00
						2N3054	0.45

SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20 fT 5MHZ.

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PRICE EACH.	50p	45p	40p

SILICON 50 WATTS MATCHED NPN/PNP

BIP19 NPN BIP20 PNP TO-3 Plastic Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100 ft 3 mHZ.

	1-24 prs.	25-99 prs.	100 prs.
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AD161 *NPN* AD162 *PNP* M/P COMP. GERM. TRANS. OUR LOWEST PRICE OF 63p *PER PAIR*

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20	For	0.50	100	For	1.75	1000	For	13.00
50	For	1.00	500	For	7.50			

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A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each.

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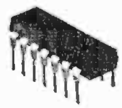

Check our 74 Series List before you by any I.C's. Our prices are the lowest possible. All devices ex-stock. Full spec. guaranteed

BI-PAK Order No.	Price and qty. prices 1–24 £p	25–99 £p	100 up £p
BP00=SN7400	0.15	0.14	0.12
BP01=SN7401	0.15	0.14	0.12
BP02=SN7402	0.15	0.14	0.12
BP03=SN7403	0.15	0.14	0.12
BP04=SN7404	0.15	0.14	0.12
BP05=SN7405	0.15	0.14	0.12
BP07=SN7407	0.18	0.17	0.16
BP08=SN7408	0.18	0.17	0.16
BP09=SN7409	0.18	0.17	0.16
BP10=SN7410	0.15	0.14	0.12
BP13=SN7413	0.29	0.26	0.24
BP16=SN7416	0.43	0.40	0.38
BP17=SN7417	0.43	0.40	0.38
BP20=SN7420	0.15	0.14	0.12
BP30=SN7430	0.15	0.14	0.12
BP40=SN7440	0.15	0.14	0.12
BP41=SN7441	0.67	0.64	0.58
BP42=SN7442	0.67	0.64	0.58
BP43=SN7443	1.95	1.85	1.75
BP44=SN7444	1.95	1.85	1.75
BP45=SN7445	1.95	1.85	1.75
BP46=SN7446	0.97	0.94	0.88
BP47=SN7447	0.97	0.94	0.88
BP48=SN7448	0.97	0.94	0.88
BP50=SN7450	0.15	0.14	0.12
BP51=SN7451	0.15	0.14	0.12
BP53=SN7453	0.15	0.14	0.12
BP54=SN7454	0.15	0.14	0.12
BP60=SN7460	0.15	0.14	0.12
BP70=SN7470	0.29	0.26	0.24
BP72=SN7472	0.29	0.26	0.24
BP73=SN7473	0.37	0.35	0.32
BP74=SN7474	0.37	0.35	0.32
BP75=SN7475	0.47	0.45	0.42
BP76=SN7476	0.43	0.40	0.38
BP80=SN7480	0.67	0.64	0.58
BP81=SN7481	0.97	0.94	0.88
BP82=SN7482	0.97	0.94	0.88
BP83=SN7483	1.10	1.05	0.95

BI-PAK Order No.	Price and qty. prices 1–24 £p	25–99 £p	100 up £p
BP86=SN7486	0.32	0.30	0.28
BP90=SN7490	0.67	0.64	0.58
BP91=SN7491AN	0.87	0.84	0.78
BP92=SN7492	0.67	0.64	0.58
BP93=SN7493	0.67	0.64	0.58
BP94=SN7494	0.77	0.74	0.68
BP95=SN7495	0.77	0.74	0.68
BP96=SN7496	0.77	0.74	0.68
BP100=SN74100	1.75	1.65	1.55
BP104=SN74104	0.97	0.94	0.88
BP105=SN74105	0.97	0.94	0.88
BP107=SN74107	0.40	0.38	0.36
BP110=SN74110	0.55	0.53	0.50
BP111=SN74111	1.25	1.15	1.00
BP118=SN74118	1.00	0.95	0.90
BP119=SN74119	1.35	1.25	1.10
BP121=SN74121	0.67	0.64	0.58
BP145=SN74145	1.50	1.40	1.30
BP150=SN74150	1.80	1.70	1.60
BP151=SN74151	1.00	0.95	0.90
BP153=SN74153	1.20	1.10	0.95
BP154=SN74154	1.80	1.70	1.60
BP155=SN74155	1.40	1.30	1.20
BP156=SN74156	1.40	1.30	1.20
BP160=SN74160	1.80	1.70	1.60
BP161=SN74161	1.80	1.70	1.60
BP164=SN74164	2.00	1.90	1.80
BP165=SN74165	2.00	1.90	1.80
BP181=SN74181	2.75	2.60	2.40
BP182=SN74182	0.97	0.94	0.88
BP190=SN74190	3.50	3.25	3.00
BP191=SN74191	3.50	3.25	3.00
BP192=SN74192	2.10	1.95	1.75
BP193=SN74193	2.10	1.95	1.75
BP195=SN74195	1.10	1.05	0.95
BP196=SN74196	1.80	1.70	1.60
BP197=SN74197	1.80	1.70	1.60
BP198=SN74198	5.50	5.00	4.00
BP199=SN74199	5.50	5.00	4.00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442

DTL & TTL INTEGRATED CIRCUITS

Manufacturers' "Fall 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.			PAK No.	
UIC930 – 12 × μA 930	50p	D	UIC948 – 8 × μA 948	50p
UIC932 – 12 × μA 932	50p		UIC951 – 5 × μA 951	50p
UIC933 – 12 × μA 933	50p		UIC961 – 12 × μA 961	50p
UIC935 – 12 × μA 935	50p	T	UIC9093 – 5 × μA 9093	50p
UIC936 – 12 × μA 936	50p		UIC9094 – 5 × μA 9094	50p
UIC944 – 12 × μA 944	50p		UIC9097 – 5 × μA 9097	50p
UIC945 – 8 × μA 945	50p	L	UIC9099 – 5 × μA 9099	50p
UIC946 – 12 × μA 946	50p		UIC × 925 Assorted 930 Series	£1·50

Packs cannot be split but 25 Assorted Pieces (our mix) is available as Pack UIXC9.
Every Pak carries our BI-PAK Satisfaction or money back guarantee.
Data booklet available the BP930 Series, PRICE 13p

PAK No.		PAK No.		PAK No.	
UIC00=12×7400N	50p	UIC45= 5×7445N	50p	UIC76= 8×7476N	50p
UIC01=12×7401N	50p	UIC46= 5×7446N	50p	UIC80= 5×7480N	50p
UIC02=12×7402N	50p	UIC47= 5×7447N	50p	UIC81= 5×7481N	50p
UIC03=12×7303N	50p	UIC48= 5×7448N	50p	UIC82= 5×7482N	50p
UIC04=12×7404N	50p	UIC50=12×7450N	50p	UIC83= 5×7483N	50p
UIC05=12×7405N	50p	UIC51= 2×7451N	50p	UIC86= 5×7486N	50p
UIC10=12×7410N	50p	UIC53=12×7453N	50p	UIC90= 5×7490N	50p
UIC13= 8×7413N	50p	UIC54=12×7454N	50p	UIC91= 5×7491N	50p
UIC20=12×7420N	50p	UIC60=12×7460N	50p	UIC92= 5×7492N	50p
UIC40=12×7440N	50p	UIC70= 8×7470N	50p	UIC93= 5×7493N	50p
UIC41= 5×7441AN	50p	UIC72= 8×7472N	50p	UIC94= 5×7494N	50p
UIC42= 5×7442N	50p	UIC73= 8×7473N	50p	UIC95= 5×7495N	50p
UIC43= 5×7443N	50p	UIC74= 8×7474N	50p	UIC96= 5×7496N	50p
UIC44= 5×7444N	50p	UIC75= 8×7475N	50p	UIC121=5×74121N	50p

UICX1=25×Asst'd 74's £1.50

Data is available for the above Series of Integrated Circuits in booklet form, price 13p
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.

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18, BALDOCK ST. (A10) WARE, HERTS.

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THE NEW SGS EA 1000 AUDIO AMPLIFIER MODULE

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BP945	Master-slave JK or RS	25p	24p	22p
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μA 703C—μA703C	TO-5	6	R.F.-I.F. Amp	43p	35p	27p
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BSY28	.13	OC35	.25
BSY29	.13	OC36	.37
BSY95A	.13	AD149	.30
OC41	.13	AUY10	1.25
OC44	.13	2N3055	.63
OC45	.13	2S034	.25
OC71	.13	Diodes	
OC72	.13	AAY42	.10
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JANUARY ISSUE WILL BE PUBLISHED ON JANUARY 1st

THE 'DOUBLET' DOMESTIC TEST RECEIVER

by

J. HOSSACK

This general purpose medium-wave receiver incorporates low-cost components and is intended both to provide background radio music for the workshop and to function as an a.f. amplifier or source of a.f. test signal

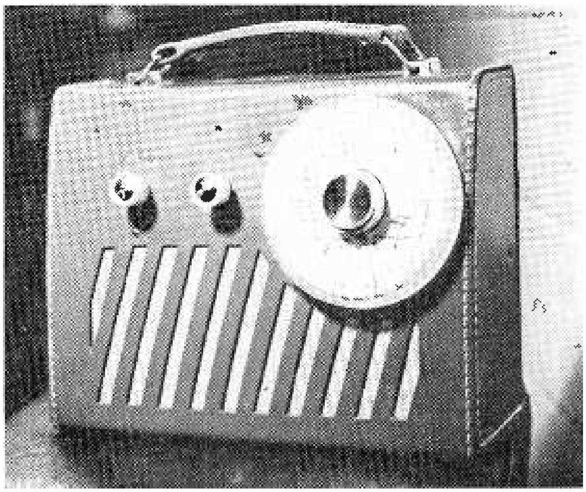
An ordinary transistor receiver is an extremely useful item of equipment for the average shack or workshop. Apart from its more obvious applications (for example, to provide a pleasant background noise to the usual sounds of drilling and hammering), the incorporation of suitable switching enables the a.f. section to be used as a convenient amplifier for checking the operation of tuners or the tuner sections of test receivers. Also, by taking an output from the detector diode, there is available a signal which can be pressed into service as an injection source for testing faulty amplifiers. Certainly, an audio generator will more elegantly fulfil the latter role; but, unless used in conjunction with an oscilloscope, no indication will normally be given of distortion in the amplifier stage under test.

RECEIVER CONSTRUCTION

It is a relatively simple matter to equip the average transistor receiver with the necessary input and output leads together with suitable switching if desired. However, the construction of a receiver specifically designed for the purposes just mentioned can make an interesting and rewarding project. In addition, if housed in a presentable cabinet, there is available a complete unit which can readily 'double' as a portable or domestic radio receiver should the need arise, hence the title of this article.

The present project was, in fact, developed over a period of several months, having been originally envisaged in the form of two separate sections; that is, as separate tuner and audio amplifier designed to fulfill the test functions outlined above. Subsequently, the two sections were combined, forming the complete receiver illustrated in the photographs. The type of construction, which was based on the 'Cir-Kit' board system, permitted a very flexible design pattern to be adopted.

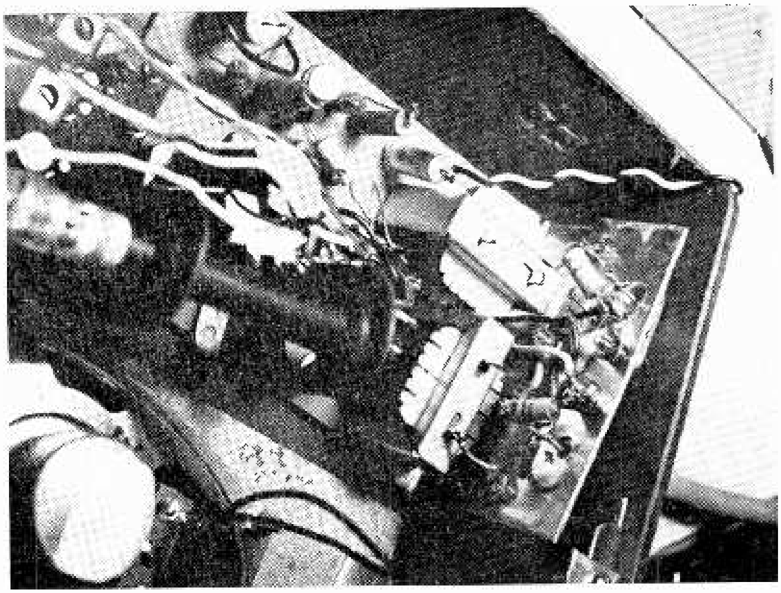
The photograph illustrating the receiver mounted in a cabinet is included purely for interest, and it should be emphasised that the particular cabinet shown is not available to home-constructors. This article deals with the electronics of the receiver, and it is felt that readers capable of assembling the set should not experience difficulty in making up their own



The prototype was fitted in a ready-made case. The central control is the aerial trimmer.

cabinet or in pressing an existing cabinet into service. Since the receiver is partly, at least, intended for workshop use, some readers may not bother about a cabinet at all.

From the constructional aspect, the process of 'making up as one goes along' has several advantages. Firstly, it provides a pleasant change from stereotyped adherence to the precise component specification and constructional detail implicit in many conventional published designs. Secondly, it allows the constructor free rein to press into service alternative components which he may have on hand, and thus to reduce building costs. Finally, and perhaps of greatest value to the less experienced constructor, the improvisation necessitated by his not having to follow a fully detailed plan helps him to become familiar with current circuitry and instils confidence in his ability to design and construct his own equipment and to deal satisfactorily with any future difficulties he may encounter in the process. With this latter consideration in mind, it was decided to include rather more detail than is usual in a constructional article concerning the problems which were met during the design and layout of the present receiver. At the same time, it is believed that sufficient information has been given to enable the reader, if he so desires, to follow the author's original plan to the letter.



A view illustrating the amplifier section

CIRCUIT

Although conventional in the broadest sense, a number of unusual features are evident in the circuit which are associated, in some degree, with the experimental and test functions of the receiver. In the first place, the choice of output stage, as illustrated in Fig. 1(b), calls for some comment. Many small amplifiers for portable receivers will be found to terminate in a pair of OC81 or similar type transistors, which are transformer-fed from a driver transistor and which, in turn, are transformer-coupled to a loudspeaker of suitable impedance. This general arrangement, while providing quite reasonable quality at low or moderate output levels, unfortunately introduces appreciable distortion at higher volume, particularly when the battery voltage has fallen well below its nominal value. Distortion of this type could be a serious disadvantage when testing, for example, v.h.f. tuners, where faulty components in the discriminator stage, or poor i.f. alignment, would be likely to be masked by similar distortion arising within the test amplifier itself.

At the other end of the power output spectrum, a popular arrangement, found in many high-quality record players and tape recorders, consists of a pair of audio transistors, such as OC35's, fed by a transformerless phase inverter, and designed to operate from a power supply of 25 to 35 volts, which is normally provided by a mains power unit. Such amplifiers can deliver a comparatively high power output with low distortion when used under the conditions specified, but are much less satisfactory as portable units for operation from a 9-volt battery. There appeared to be few circuits in the range between these two extremes, i.e. offering medium power output and low distortion coupled with low supply voltage requirements; in the present amplifier an attempt has been made to bridge this gap. Application of the correct amount of negative feedback has enabled an output power of some $1\frac{1}{2}$ watts to be achieved from a pair of OC35 transistors, with an acceptably low level of distortion, and using a standard 9-volt battery or power pack. Admittedly, the no-signal current of about 25 mA is just a little higher than is normally expected with a small receiver but, even so, the drain on a larger battery of the PP9 type is not excessive, and a life of several hundred hours could easily be achieved with normal domestic use.

The circuit of the amplifier is shown in Fig. 1(b). C14 and R18 represent the negative feedback network just mentioned. Because of the resulting reduction in gain, a single stage of a.f. amplification preceding the output was not quite sufficient for test applications (although it was adequate for general listening) and an additional OC71 was therefore inserted prior to the driver transistor. Negative feedback, however, is operative only over the driver and output stages. Provided the supply voltage is limited to 9 volts, it is not necessary to include series limiting resistors in the OC35 emitter circuits. Base bias for the OC35's is provided by R20, in conjunction with R21 and R22. Under no circumstances should the amplifier be switched on with R20 absent or disconnected since, in the absence of an emitter resistance, thermal runaway could damage the output transistors. This precaution is necessary with all output transistors connected in the above configuration, but is doubly important in the present case, due to the low d.c. resistance of the audio transformers. It is recommended, incidentally, that only transformers of the type specified should be used in this circuit, as ordinary types suitable for OC81 output possess resistances which are too high for the present application.

For the tuner, whose circuit is given in Fig. 1(a), a conventional medium wave circuit utilising a mixer and two i.f. amplifier stages was found to be satisfactory. Some difficulty was experienced with tracking. It was intended to use a tuning capacitor with an integral

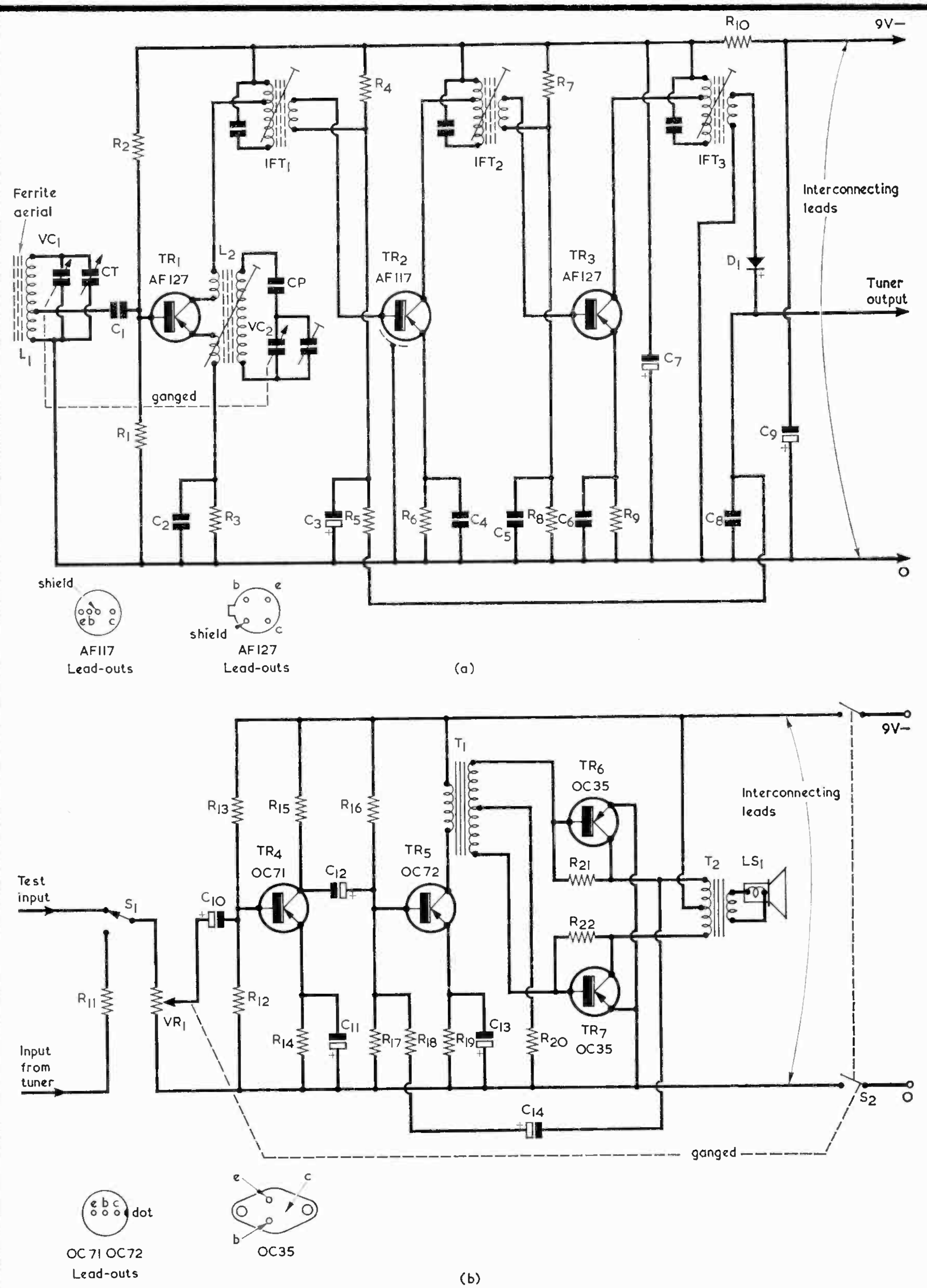


Fig. 1(a) Circuit of the tuner section of the receiver. (b). The a.f. amplifier. Both this and the tuner section may be employed individually for test purposes

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
R1 10kΩ
R2 39kΩ
R3 1.5kΩ
R4 56kΩ
R5 10kΩ
R6 560Ω
R7 22kΩ
R8 8.2kΩ
R9 1.5kΩ
R10 330Ω
R11 820Ω
R12 10kΩ
R13 47kΩ
R14 150Ω
R15 8.2kΩ
R16 47kΩ
R17 10kΩ
R18 27kΩ
R19 100Ω
R20 47Ω
R21 8.2kΩ
R22 8.2kΩ
VR1 10kΩ potentiometer, log, with switch S2

Capacitors
C1 0.01μF paper or plastic foil
C2 0.05μF paper or plastic foil
C3 10μF electrolytic, 6V. wkg.
C4 0.05μF paper or plastic foil
C5 0.02μF paper or plastic foil
C6 0.05μF paper or plastic foil
C7 50μF electrolytic, 10V. wkg.
C8 0.01μF paper or plastic foil
C9 100μF electrolytic, 10V. wkg.
C10 8μF electrolytic, 6V. wkg.
C11 50μF electrolytic, 6V. wkg.
C12 8μF electrolytic, 10V. wkg.
C13 50μF electrolytic, 6V. wkg.
C14 10μF elecrolytic. 10V. wkg.
CP 390pF silvered mica
CT 50pF variable, Type C804 (Jackson Bros.)
VC1/2 208+176pF, 2-gang variable, integral slow-motion drive, type '00' (Henry's Radio)

Inductors
L1 Ferrite aerial coil, home-wound on 6in. x ⅜in. dia. ferrite rod (see text)
L2 Oscillator coil and, IFT1, 2, 3 I.F. transformers (Set of four coils type C10 (Henry's Radio))
T1 Driver transformer, type MDT (Henry's Radio)
T2 Output transformer, type MOP (Henry's Radio)

Semiconductors
TR1 AF127
TR2 AF117
TR3 AF127
TR4 OC71
TR5 OC72
TR6 OC35
TR7 OC35
D1 OA91

Switches
S1 s.p.d.t., toggle or rotary
S2 d.p.d.t., part of VR1

Loudspeaker
LS1 3Ω loudspeaker

Miscellaneous
Mica washer and insulated bushes (for TR6)
'Cir-Kit' kit No. 2 (Home Radio)
Knobs, scale, etc. (as required)
9-volt battery and battery connectors

slow-motion drive and the only component available with reasonably appropriate values was a 208pF + 176pF component obtainable from Henry's Radio. The 208pF section connects across the aerial coil. After much experiment it was found that this capacitor offered best tracking when capacitor CP had a value of 390pF. Even so, the writer was not completely satisfied and so he added trimming capacitor CT in parallel with the aerial tuned circuit. CT is a panel component, and is adjusted to finally peak up any signal that is tuned in, whereupon it ensures that optimum reception conditions are given for all stations.

The writer employed the same oscillator coil that is used here in an earlier design,* the coil being tuned by the 70pF section of a 165pF + 70pF capacitor complete with trimmers, which is also available from Henry's Radio. The 165pF section connected directly across the aerial coil and the 70pF section directly across the tuned winding of the oscillator coil without a series padding capacitor. This combination offered good tracking and constructors who do not require the slow-motion facility offered by the tuning capacitor specified in the Components List could employ the 165pF + 70pF component instead. It will then be possible to dispense with CT.

Since the entertainment value of long waves in the writer's part of the country is practically nil, a design for medium waves only was employed.

Two stages of i.f. amplification are used, the respective transistors being an AF117 and an AF127. The reason for employing different transistors is a very simple one – the AF117 is an older version of the AF127, so, having some of each available, the author decided to experiment a little with a view to comparing the relative gains and associated circuitry of the old and the new versions. It was found that the AF127 gave a slightly higher gain than its older counterpart, but required a larger negative base bias, resulting in the resistor values indicated for R4, R5, R7 and R8. The emitter bypass capacitors C4 and C6 are also a little higher in value than those commonly used, again to ensure that the i.f. amplification is adequate. Lower values for these capacitors, while providing increased stability, tend to introduce some negative feedback and reduce gain – a point to be noted if, for any reason, it is decided to re-design the circuit and/or alter component values. The author found that, with the values shown and using the transistors in the positions specified, excellent i.f. gain, coupled with satisfactory stability was available.

Apart from the tuning capacitor circuitry already mentioned, the mixer stage is quite conventional. Either an AF117 or an AF127 could have been used here.

CONSTRUCTION

Both tuner and amplifier sections are built up on 'Cir-Kit' circuit boards. For the benefit of newcomers to this technique, it may be mentioned that the 'Cir-Kit' kit includes a sheet of plain laminated board which can be cut to size and drilled to accommodate components. Channel connections are provided by self-adhesive copper strip. No chemicals or etching are required. The design used by the author is shown in Figs. 2(a) and (b) for the amplifier and tuner respectively. In these diagrams the copper side of the board is towards the reader.

It is probably best to commence construction with the amplifier, which has a rather more 'open' design. First of all, cut and drill the 'Cir-Kit' board, using a No. 50 drill for the component lead-out holes, and the appropriate sizes for the remaining holes, as indicated. The combined volume control and

*J. Hossack, "'Cir-Kit" Personal Portable Superhet', *The Radio Constructor*, October 1969.

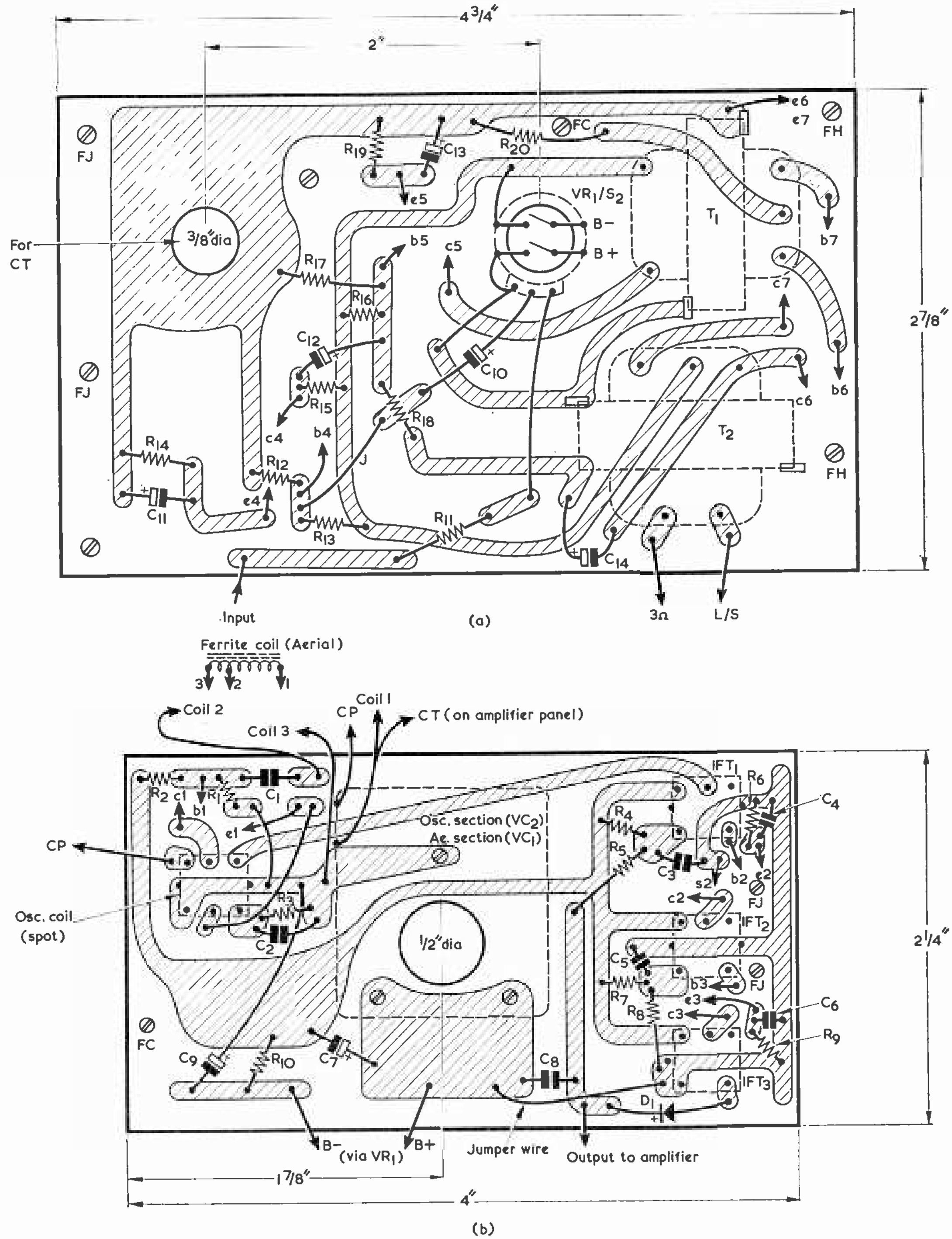


Fig. 2(a). The 'Cir-Kit' layout for the amplifier. (b). The 'Cir-Kit' layout for the tuner section. Both this diagram and (a) are reproduced full size and may be traced on-off switch is mounted in the position shown, with its spindle protruding on the copper side of the board and its body on the component side. The remaining ⅜in. hole is intended for the aerial trimmer, CT, which is fitted later. If CT is not required, the hole may be employed to take a tone control potentiometer, or a 'functions' switch for the test applications of the receiver. Since flexibility is the keynote of the 'Cir-Kit' constructional system, it is very easy to modify the circuit board even after construction has been completed, and final details of the design are therefore left to the discretion and personal taste of the reader. It should be noted that the 'functions' switch of Fig. 1(b) is not included in the layout of Fig. 2(a). It can be added later, if desired, after completion of the receiver.

In Fig. 2(a), connections to transistors are indicated by lines ending in arrow-heads and then a letter and a number. The letter stands for the electrode, with 'e', 'b' and 'c' corresponding to 'emitter', 'base' and 'collector' respectively, whilst the number corresponds to the suffix number of the transistor. Thus, an arrow-head labelled 'b7' refers to a connection to the base of TR7. Note that the mounting lugs of transformer T1 link together two sections of the copper.

After wiring the circuit board, attention should be turned to the output transistors, which are mounted side by side on a separate heat sink. This is one region in which the constructor would be advised to follow the wiring plan reasonably closely, since the arrangement of the heat sink, which is at right angles to the board, introduces rather tight spacing of the components and wiring in this area. The heat sink itself is made up from a piece of aluminium approximately 3in. square, bent as shown in Fig. 3 so as to leave a small flange for screwing to the board. After drilling, in accordance with this diagram, mount the OC35's with their lead-outs pointing inwards (i.e. in the same direction as the flange) taking care that TR6 is insulated from the sink by a mica washer and that its mounting bolts are fitted with insulating bushes. (These are standard items which are sold by retailers of transistors.) A small solder tag is clamped below one of the transistor fixing nuts to carry the collector connection for TR6, while the collector connection for TR7 goes to the heat sink itself. The heat sink is secured to the board at the two holes marked 'FH' in Fig. 2(a), R21 and R22 are wired directly between the appropriate collector and base on the heat sink assembly, and do not appear on the board.

Construction of the tuner follows similar lines to that of the amplifier although, due to the necessarily closer spacing of the components around the i.f. transformers, slightly greater care is required in laying out and soldering the connections to the circuit points. It is best to mount the oscillator coil, tuning capacitor and i.f. transformers first of all. The orientation of these components will be clear from Fig. 2(b) but, since the oscillator coil has six connections and is therefore symmetrical, care must be taken to ensure that it is mounted with the coloured side towards the side shown. Follow this with the smaller components, and finally solder C7, C9 and R10 into position beside the oscillator section. The connections to the ferrite rod coil shown in Fig. 2(b) can be left, at this stage, in the form of lengths of wire protruding from the component side of the board, preferably numbered for easy reference later.

If mistakes are made in the wiring, or if unwanted solder 'bridges' form between adjacent strips, it is not worth the trouble of trying to remove them – it is easier merely to detach the offending strips, by the application of gentle heat if necessary, and then replace them with fresh 'Cir-Kit' sheeting.

The AF127's (TR1 and TR3) are smaller than the AF117 (TR2). The arrow-head terminating in 's2' indicates the shield connection for TR2. No shield connection is made to the two AF127's. The aerial section of the tuning capacitor is the one closer to the board. Padding capacitor CP is wired between the appropriate point of the board and the fixed vanes tag of the oscillator section of the tuning capacitor.

TESTING THE UNITS

If a pair of high resistance phones is to hand, it is advantageous to get the tuner operational first of all, as a signal will then be available when attention is turned to the amplifier. A suitable aerial coil (L1) should first of all be wired up to points indicated in Fig. 2(b). Either a commercial or home-wound coil can be used. The author obtained good results with 70 turns close-wound of 26 s.w.g. enamelled copper wire on a thin cardboard former, and tapped seven turns from the earthy end for the connection to C1. The former was a sliding fit on the ferrite rod, which was 6in. long by ⅜in. in diameter. Leave the leads coupling the board to the ferrite aerial coil fairly long at this juncture, as they can be shortened once the best position for the coil has been determined. Next, insert the ferrite rod about one-third of its length through the coil former. Since the latter is unsupported at this stage, care should be taken to ensure that the weight of the rod does not

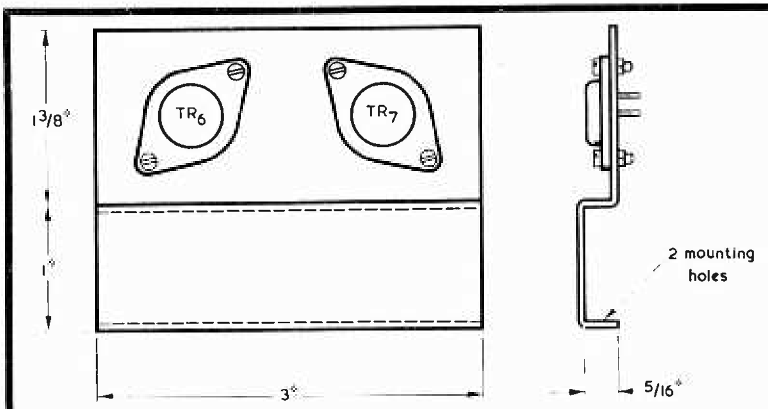
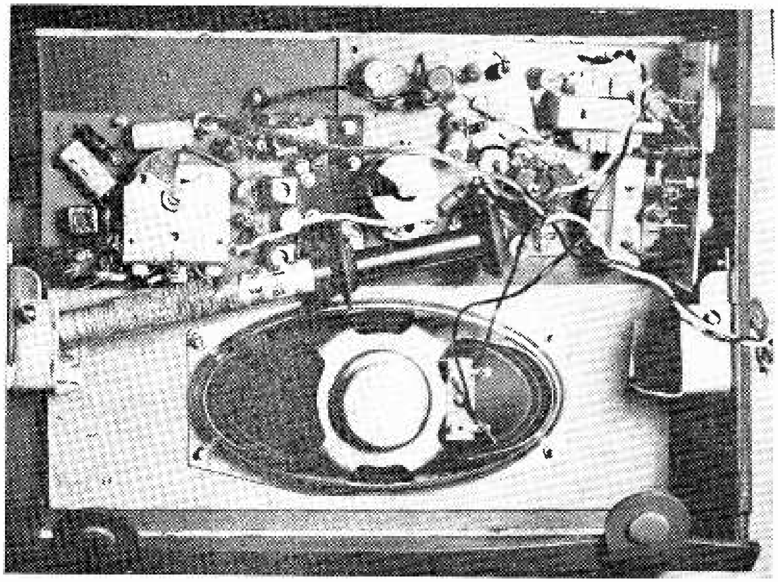


Fig. 3. The heat sink for TR6 and TR7. The two mounting holes correspond with holes 'FH' in Fig. 2(a)

cause undue strain on the coil connections or any other components. Particular attention has to be paid to this point when the board is being moved around in the course of carrying out trimming adjustments. Temporarily wire the headphones between the positive lead-out of diode D1 and the battery positive line, and connect a 9-volt battery to the points marked 'interconnecting leads' in Fig. 1(a) (and 'B+' and 'B–' in Fig. 2(b)).

Current consumption should be around 3 to 4mA. If a signal generator is available, the i.f. transformers can be adjusted for maximum output at 455kHz; otherwise it will be necesary to turn the ganged capacitor slowly through its range, at the same time moving L1 along the ferrite rod as required, until a station is audible. The i.f. transformers can then be peaked, after which the oscillator trimmer, which is located on the ganged



The amplifier and tuner joined together and mounted in a suitable case

capacitor itself, is adjusted in conjunction with the oscillator coil core until good sensitivity is obtained over the major part of the tuning range. Adjustments to the aerial trimmer integral with the ganged capacitor will also assist here.

For use as a test tuner the unit will be perfectly satisfactory at this stage, even if only a few stations are audible at good headphone volume.

Attention should now be turned to the amplifier. This can be operated from a separate 9-volt battery or, if desired, power can be taken from the tuner by making connections between the points indicated as 'interconnecting leads' in Fig. 1. (Permanent connections between these points will, of course, be made if it is later decided to make up the units into a composite receiver). Current consumption for the amplifier, in the absence of a signal, should be between 25 and 30 mA. Connect a 3Ω loudspeaker to the output terminals and turn the volume control fully clockwise. A faint hiss should be audible if all is well, and this should increase considerably, or alter to a buzz, if the input lead is touched with the finger. If a healthy response is evident, all that will now be necessary, to obtain a fully operational receiver, is to complete the amplifier input circuit by joining it to the tuner output connection (the point previously employed for headphone testing) and checking that the audio response is clean and free from distortion.

Incidentally, if instability was evident on first switching on the amplifier, as evidenced by a loud whistle, or perhaps continuous motor-boating, it is a probable indication that the negative feedback circuit is wrongly phased. In this case, re-route the connection between C14 and T2 to the other side of T2 primary, using a fresh 'Cir-Kit' strip for the purpose.

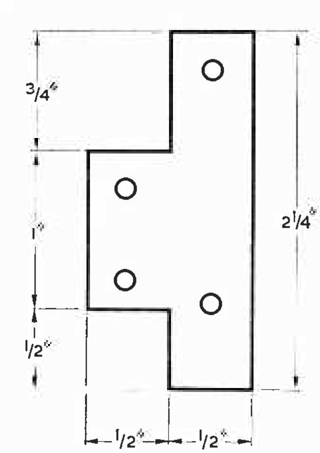


Fig. 4. The two boards may be joined together by a piece of Paxolin having the dimensions given here. The four holes correspond with holes 'FJ' in Figs. 2(a) and (b)

COMPLETE RECEIVER

Once the tuner and amplifier are functioning satisfactorily, the original aim of the exercise will have been achieved, namely, the provision of a suitable pair of units for the test bench. Many constructors will, however, now wish to join the two parts together, thereby making up a complete receiver.

The two boards can be joined together with the aid of a piece of Paxolin cut out in the form illustrated in Fig. 4. Four 6BA nuts and bolts pass through the holes in this item and the holes marked 'FJ' in Figs. 2(a) and (b). Permanent interconnecting leads then connect the two sections together. Trimmer CT may next be mounted at the appropriate hole in the amplifier board. Set the integral aerial trimmer on the ganged capacitor to minimum value and then connect the nearer fixed vane tag of CT to the fixed vane tag of the aerial section of the ganged capacitor. Trimmer CT will now provide a control of aerial tuning at all points of the range covered. In most instances, it will be found that its optimum position is close to the minimum capacitance end of its range of control.

The holes marked 'FC' in Figs. 2(a) and (b) are intended to take screws which can secure the composite board assembly in a suitable cabinet. As was mentioned earlier, however, the provision of a cabinet is left to the constructor, who can work to his own requirements in this respect. ■

INSTITUTION OF ELECTRICAL ENGINEERS

—

CORPORATE MEMBERSHIP

Important steps have been taken by the IEE Council to broaden the scope of "responsible experience" required to qualify a candidate for corporate membership by recognising the wide field of activities in an engineering environment, such as management, marketing, production, etc., which are open to the trained electrical engineer. The grade of work and the manner of its execution will continue to form important elements in the assessment of a candidate's application but weight will also be attached to the quality of his education and training, his progress and potential for further promotion.

These considerations will apply to all current and new applications for corporate membership.

NOTES ON SEMICONDUCTORS

Further Notes – 1

CANCEL IT!

by

P. WILLIAMS

Our contributor continues with his helpful and instructive notes on semiconductor basics, starting this new series with advice on cancelling Vbe in common collector transistor voltmeters

IN THE NOTES IN THE PRECEDING SERIES ('NOTES ON Semiconductors', 1 to 6, published in the March to August 1971 isues) the relative constancy of Vbe in silicon transistors has been stressed. It is equally true that the base-emitter voltages of similar transistors are nearly equal under equal operating conditions – a fact of great importance in the design of integrated circuits.

Wherever this Vbe term interferes with the desired behaviour of a circuit it is worth considering whether a second device may be added to balance out the effect. The word 'device' is used deliberately since we may use either a diode or a diode-connected transistor. The latter is likely to provide a better balance since we are matching like with like, while the former might be cheaper. As usual it all depends on the contents of the spares box or the depth of the pocket.

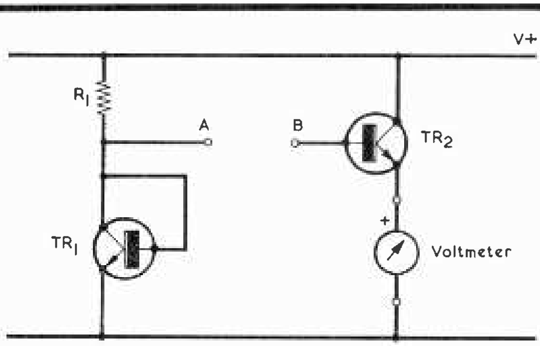


Fig. 1. In this voltmeter circuit, Vbe in TR1 compensates for Vbe in TR2

METER BOOSTER

Applying this idea to the meter booster described in the August 1971 issue is straightforward and leads to the circuit shown in Fig. 1. The unknown voltage is applied between A and B and, for identical transistors, the voltage across the meter should equal the unknown voltage to within a few tens of millivolts. Bias current is needed in TR1 to bring its Vbe as close as possible to that of TR2. This cannot be exact at all meter readings since TR2 current varies, but clearly the least error should occur if we achieve cancellation at mid-scale. Then we have under-compensation at full-scale and over-compensation at low readings, though both effects should be small.

Once the meter to be used is known, find the f.s.d. current drawn when used on voltage ranges, and choose R1, in conjunction with the supply voltage, to provide a bias current in TR1 of about half that value. Alternatively R1 may be made variable to adjust the balance between the transistors at a particular scale reading. Temperature drifts will cancel almost completely if the transistors are well-matched and it should be possible to use meters of 1V sensitivity or even less without significant error. As before, the current drawn from the source is reduced by the factor hFE below that in the meter. With transistors readily available with gains of several hundred, the input resistance of the circuit can be in the multi-megohm range.

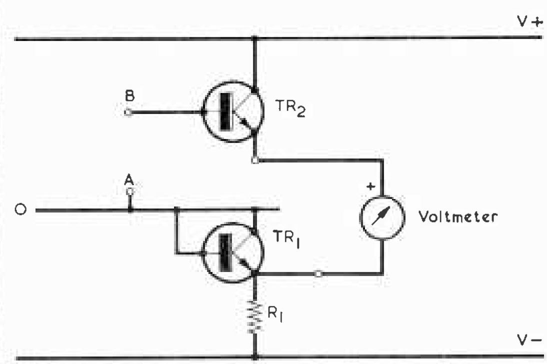
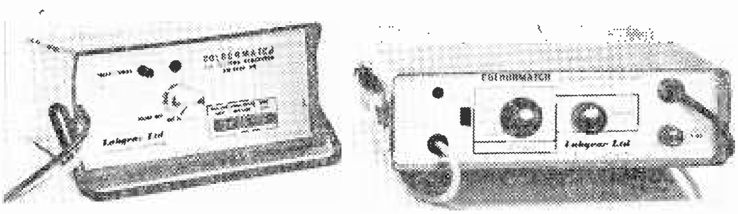


Fig. 2. If a supply of opposite polarity is available, one of the voltmeter terminals can connect direct to the zero volts line

One disadvantage of this circuit is that there is no common point between the input voltage and the supply lines. Thus it is not possible to use this circuit directly from the supply voltage of an existing system while retaining this form of cancellation. Fig. 2. shows the modification that allows this if an opposite polarity supply is already available. All the precautions suggested in the previous note still apply – do not exceed the breakdown ratings of the transistor and remember that the circuit cannot cope with voltages greater than the supply voltage. ■

NEWS . . . AND .

SPECIALIST INSTALLATION INSTRUMENTS FROM CLAYRIDGE ELECTRONICS



COLOURMATCH pattern generators by LABGEAR now available from CLAYRIDGE ELECTRONICS

Clayridge Electronics, the north London specialist radio and T.V. component distributors, have further expanded their coverage by stocking the wide range of specialist installation and service instruments manufactured by Labgear of Cambridge, which have such a high reputation as Field Servicing Equipment for Colour Receivers.

The Labgear range includes impedance compensated uhf aerials, uhf and ultra wideband signal amplifiers and dual voltage power supplies, distribution amplifiers and splitter units. Clayridge Electronics can offer from stock the complete range at really competitive prices.

For further details please write to Clayridge Electronics Ltd., 2 Stoke Newington, High Street, London N16 7PL.

A WORKSHOP ON AMATEUR RADIO SATELLITES

It is interesting to read in the current issue of the AMSAT Newsletter, that the University of Hartford, U.S.A., in conjunction with the Talcott Mountain Science Centre for Student Involvement and the National Aeronautics and Space Administration, is running a three month graduate course for teachers and supervisors in elementary, middle, and secondary education, on the use of amateur radio satellites as a means of teaching space science and physics. The course will be a laboratory-oriented 'workshop' one and will be based on the AMSAT-OSCAR-B satellite, which it is hoped will be launched next June.

Amateur radio has on many occasions in the past been recommended as a very valuable hobby for those wishing to progress to professional knowledge of radio communications and electronics. It is good to see a university course for professionals being based on the latest techniques in the amateur radio field.

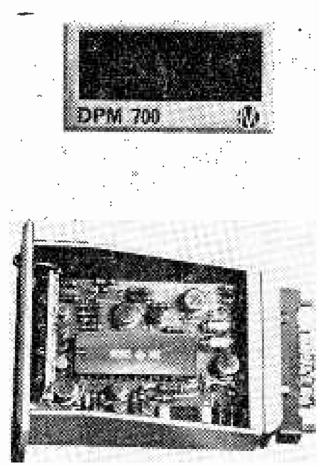
MINIATURE DIGITAL PANEL METER WITH SOLID STATE DISPLAY

Avo Limited (Thorn Group) have introduced its first panel meter.

The meter – known as DPM700 – occupies only a very small panel area (72 x 36mm) with a depth of only 100mm behind the panel. These dimensions are achieved by a design centred around a single MOS LSI logic chip and a solid state 4.8mm high display using light emitting diodes. The MOS chip incorporates all the logic required for a three-digit display plus an overrange digit, whilst the light emitting diodes offer not only small size, but also long term stability and considerable resistance to shock and vibration.

A nominal input of one volt full range with 100% overranging is available, with a typical accuracy of $\pm 0.1\% \pm 1$ digit, and automatic indication of overranging and polarity reversal. Input impedance is $1M\Omega$ and the temperature coefficient $\pm$ 0.1mV/°C. Power supplies of $\pm$ 12V d.c. and +5V d.c. are required and power dissipation is less than 2W.

The DPM700 will find wide application in avionics, process control, data logging instruments and optical and medical instrumentation.



Avo's first panel meter has dimensions of 72 by 36mm with a depth of only 100mm behind the panel

STONEHENGE PROTECTED BY UNDERGROUND "EARS"

Peter Hopkirk recently described in *The Times* a secret device which detects and identifies intruders from a mile away, which has been installed at Stonehenge.

The system consists of a large number of small "geophones" which are laid like a minefield around the area to be protected.

The "geophones" are buried about a foot deep, and an operator can "listen in" to the vibrations picked up and it is possible to distinguish from them whether the intruder is only one person or more.

Early teething troubles were caused by the vibrations made by moles, but that problem has been overcome.

The system is a French one known as 'Vigilante', made in Britain the patent having been acquired by Messrs Chubb.

Prior to the installation of the system, vandals caused damage at Stonehenge costing several thousand pounds each year.

. . . COMMENT

IN BRIEF

● Thorn Electrical Industries Ltd. have purchased the Electronic Instrument Division of British Physical Laboratories of Radlett, Hertfordshire. The Thorn measurement interests now include Avo, Taylor Electrical Instruments, Evershed & Vignoles, H. W. Sullivan and The Record Electrical Company.

● In a year's time the Wireless Telegraphy (Control of Interference from Radio-Frequency Heating Apparatus) Regulations, 1971, will give the Minister of Posts and Telecommunications power to control interference to radio and television from certain types of radio-frequency heating apparatus. This apparatus is mostly used in manufacturing processes like welding plastics.

● Czechoslovak Television have placed a £¾ million order with Marconi Communication Systems for outside broadcast units fitted with Marconi's new Mark VIII automatic colour camera: this order was won against strong international competition.

● The Junk sale arranged by the Star Short Wave Club of Leeds, which was announced in our September issue, was a great success. As a result £116 has been handed to The Radio Amateur Invalid Bedfast Club. Below is a photo taken at the sale showing officials of the club relaxing after the event. In the white shirt is G3DLD who as auctioneer was under fire for four hours.

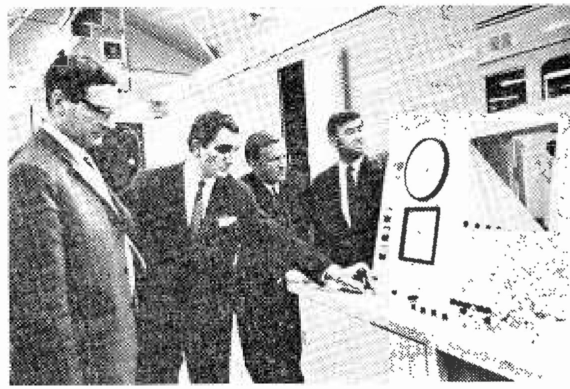
● Also news from Yorkshire is the proposal to form an amateur radio club serving the Harrogate and Knaresborough districts. It is intended that other electronic hobbies as well as amateur radio will be catered for. Enquiries to R. Troughton, 2 King James Road, Knaresborough. Telephone: Knaresborough 3494.

● EMI Electronics is to supply three of its new type '2004' TV cameras and ancillary equipment to the Inner London Education Authority (ILEA). They are monochrome 625/525 line cameras and have been ordered for a mobile video recording vehicle being assembled by the education authority's TV service.

WHO WAS HE?

A radio amateur and the first man authorised by the Postmaster General to conduct short wave tests for six months in establishing a service to the then British Empire. Answer: see page 294.

PYE WIN ITA CONTRACT



The Director General of I.T.A. and other officials recently visited Pye TVT in Cambridge

Pye TVT last week announced that it had received a contract from the I.T.A. worth £330,000 for UHF television transposers.

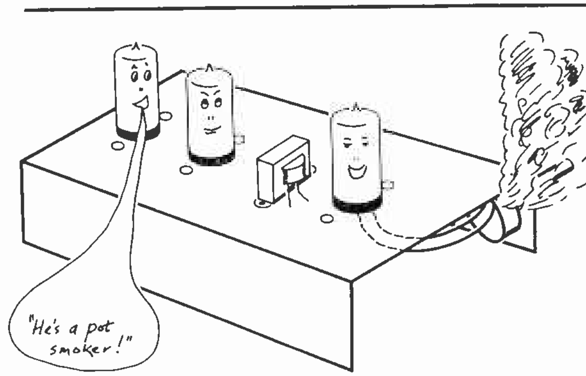
The picture shows from left to right Mr. Brian Young, Director General of the Independent Television Authority, Mr. David Gray, Managing Director of Pye TVT Limited, Mr. Howard Steele, Director of Engineering at I.T.A., and Mr. John Willis, Manufacturing Manager, Pye TVT Limited.

MILESTONE FOR ITV COLOUR

By the end of September, every Independent Television region with the exception of the Channel Islands had at least one UHF transmitter putting out programmes in colour.

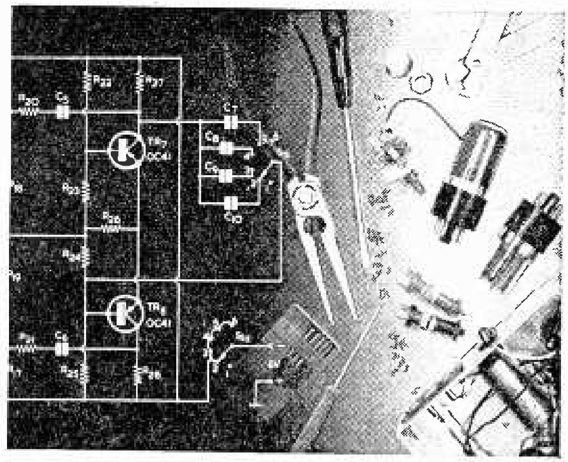
The Independent Television Authority has so far brought 27 of these 625-line colour/black-and-white transmitters into service, covering over 80% of the population.

It is two years since regular ITV colour programmes first appeared with the opening of UHF stations at Crystal Palace, Sutton Coldfield, Emley Moor and Winter Hill on 15th November 1969.



PARALLEL-T-RADIO 2 TUNER

by G. A. FRENCH



ELECTRONIC CIRCUITS CAN BE made to provide quite unusual performances, these being far removed from the functions for which they were initially conceived. The tuner unit which is described in this month's 'Suggested Circuit' provides a good example of an unusual application since it incorporates a filter circuit, normally associated with audio frequency work, which allows station selection to be achieved without any tuned circuit whatsoever!

The tuner is intended for single-station reception of the Radio 2 programme on 200kHz (1,500 metres) and is presented primarily as an interesting exercise for constructors who like to experiment with unfamiliar circuits. The tuner is, nevertheless, capable of offering quite a useful performance in practice, and in areas where the long wave Radio 2 transmission is received at reasonable strength and where other signals are not excessively strong it can offer good service as a high quality a.m. tuner. The prototype gave a satisfactory performance in this respect when checked at a location on the West coast, where the local medium wave signal is significantly stronger than the long wave Radio 2 transmission. The a.f. output level from the tuner is of the same order as that given by a crystal pick-up and the subsequent a.f. amplifier should have an input resistance of 250kΩ or more.

PARALLEL-T FILTER

The filter employed in the receiver is a parallel-T type, and its circuit is given in Fig. 1. When the conditions shown by the equations in this diagram are satisfied, and provided that the output of the filter is not loaded, the circuit offers *infinite* attenuation at the appropriate frequency. This ability to provide infinite attenuation makes the filter extremely useful in a.f. distortion measuring equipment, in which it can cause a fundamental frequency to be suppressed so that its harmonics become available for measurement.

The circuit of the tuner is given in Fig. 2, in which diagram the parallel-T filter appears as the network R1 to R3 and C2 to C4. The values specified for these components cause the theoretical attenuation frequency to be 200kHz.

In Fig. 2, signals picked up by the aerial are applied via C1 to the base of TR1, a silicon planar n.p.n. transistor type BC107. Capacitors C1 and C2 in the filter circuit apply heavy negative feedback from the collector back to the base of TR1 at all frequencies except those at and very close to the attenuation frequency of 200kHz. At this frequency there is virtually no feedback at all since the attenuation provided by the filter approaches infinity, and the transistor provides the maximum amplification of which it is capable. (The filter does not offer its full infinite attenuation because its output is loaded by the input impedance at TR1 base.) Thus, the circuit around TR1 is frequency-selective, and favours the required 200kHz signal only. The discrimination against unwanted signals is roughly equal to the gain of the transistor, since unwanted signals receive negligible amplification whilst the desired signal receives almost the full amplification which TR1 can offer. This discrimination is not as high as that offered by a tuned circuit with regeneration, but it is still high enough to enable interference-free reception of the Radio 2 transmission to be obtained in localities where other transmissions are not excessively strong.

The r.f. signal at the collector of TR1 is fed via C6 to TR2, another

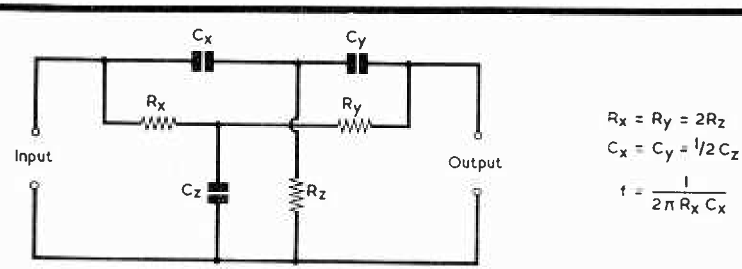


Fig. 1. The parallel-T filter, together with the appropriate equations

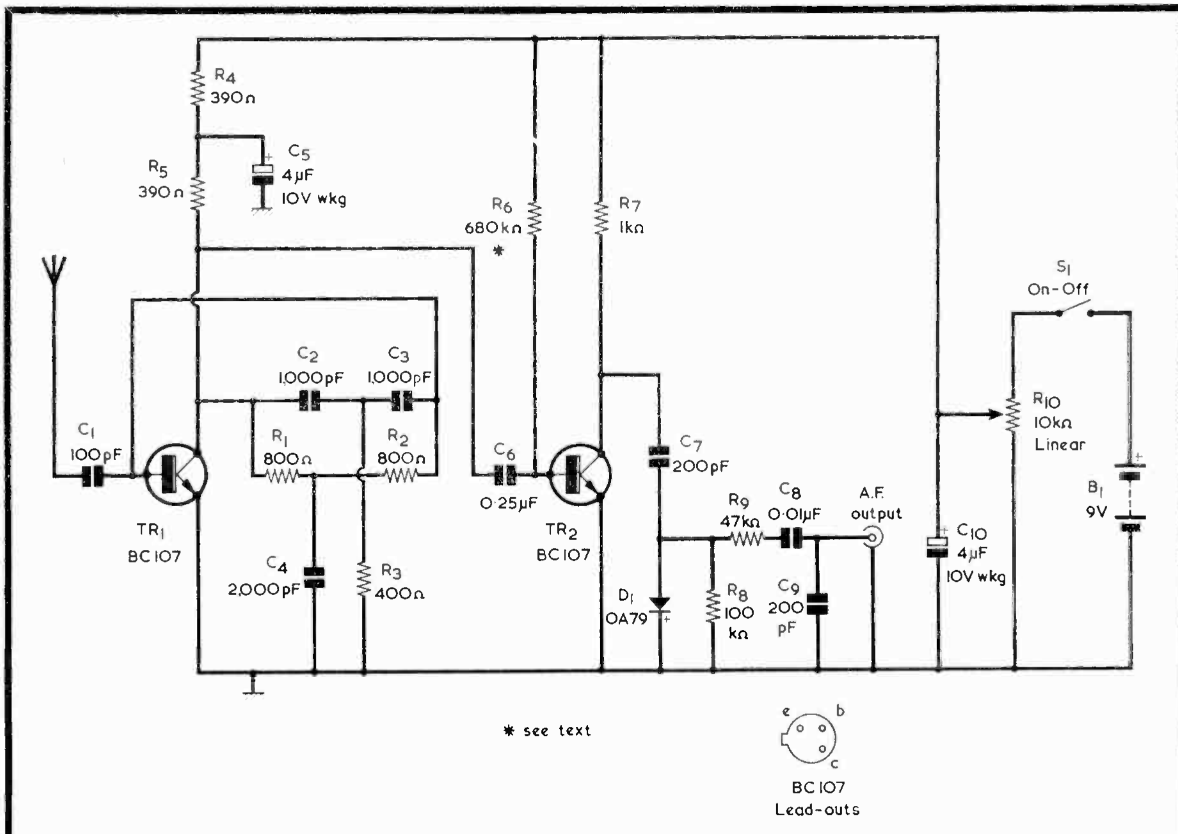


Fig. 2. Circuit of the Radio 2 tuner. Station selection is achieved by means of an RC circuit

BC107. This functions as an r.f. amplifier and the amplified signal at its collector is passed to the shunt detector diode, D1, by way of C7. D1 detects in normal manner and the resulting a.f. signal is fed via C8 to the output coaxial socket. R9 and C9 act as a low-pass filter to remove r.f. from the detected signal.

Because the parallel-T filter coupled to TR1 is operating at a much higher frequency than that for which it is normally intended, stray capacitances in the circuit cause altered phase relationships which would not be present at audio frequencies. In consequence TR1 goes into oscillation when its collector supply current rises above a certain level. This collector current is controlled by the potentiometer R10, which functions as a sensitivity control. As the slider of R10 approaches the upper end of its track the gain offered to the Radio 2 signal increases progressively, reaching a maximum just before the circuit goes into oscillation. Operation of R10 is reminiscent of the operation of a conventional reaction control in a receiver incorporating a tuned circuit; indeed, one would imagine that one was actually operating such a reaction control if one did not already know that there were no tuned circuits in the tuner. Since there is positive feedback just below the oscillation point, it is feasible also that some signal magnification also takes place in the present design. There is a small amount of backlash in the adjustment of R10, but this does not introduce any difficulty in its setting up. It is intentional that R10 also controls the supply voltage for TR2.

The tuner requires a very short aerial, about 3ft. of wire being sufficient. Alternatively, a small telescopic aerial could be employed. Large aerials are not recommended as they merely increase the strength of unwanted signals, and thereby increase the risk of their breaking through.

The current drawn from the 9 volt battery by the prototype was 4mA under non-oscillating conditions. This current rose to 10mA when the circuit went into oscillation with R10 slider at the top of its track.

COMPONENTS

The two transistors in the circuit are standard types, and no difficulty should be experienced in obtaining them.

All the fixed resistors are quarter watt and, with the exception of R1, R2 and R3, 10% in tolerance. R1, R2 and R3 are discussed in detail later when constructional information is given. The value of R6 may need to be adjusted to suit particular transistors in the TR2 position. The potentiometer, R10, should be a standard component and not a miniature type.

C2, C3 and C4 are silvered mica capacitors with a tolerance of 2% or better. C1, C7 and C9 are also silvered mica but they do not, of course, need to have a close tolerance on value. C5 and C10 could be high-value non-electrolytic types, but the electrolytic capacitors specified for these two components are smaller in size and function just as well at the frequencies involved. C6 and C8 are standard paper or plastic foil components.

On-off switch S1 should not be ganged with R10 but should be a separate component. This is because, when local reception conditions enable the tuner to be used as a permanent item of equipment, it will be found convenient to leave R10 set to the position of optimum sensitivity, and to adjust it occasionally only as battery voltage falls. Output level may be controlled by the volume control in the following amplifier.

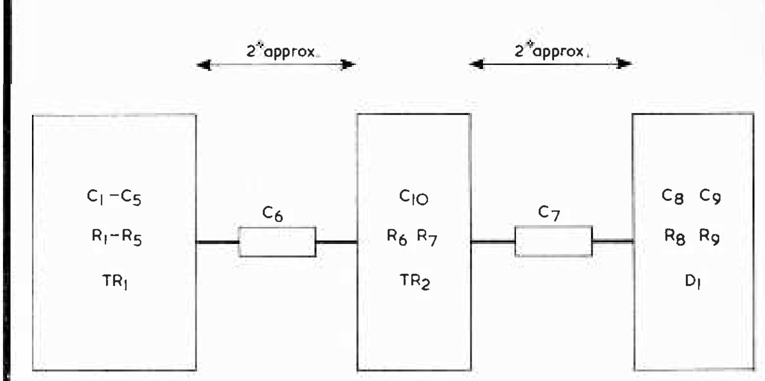


Fig. 3. The tuner components should be laid out along the chassis in three separate groups in the manner shown here

CONSTRUCTION

The layout of the tuner is not very critical provided that the components around TR1 are kept reasonably well spaced from those around TR2. In particular, R7 and the subsequent detector components should be kept well clear of the circuitry around TR1. The best plan is to lay out the components in three separate groups. The first group consists of all the components to the left of C6, including C5. The second group, positioned about 2in. away. consists of TR2. R6, R7, and C10. Capacitor C6 bridges the gap between these two groups. The third group, again several inches further along the chassis, consists of D1 and the other detector components, with C7 positioned in between. The general idea is shown in Fig. 3. There is no necessity to screen the TR2 circuit from the TR1 circuit. R10 can be positioned at any convenient point, since the connection to its slider is bypassed for r.f. by C10.

As several unusual processes are involved in setting up the receiver it is best to proceed in stages, checking each stage after its wiring has been completed. An a.f. amplifier is required to enable the tuner output to be tested.

First, wire up TR2, C6 to C10, R6 to R10, S1 and the battery. Switch on and set R10 slider to the top of its track. Measure the voltage between the negative supply rail and the collector of TR2. If this is approximately half the supply voltage within a volt or so, all is well. If the collector voltage differs considerably from half supply voltage adjust the value of R6 to correct it. Increasing R6 causes collector voltage to rise and decreasing R6 causes collector voltage to fall. It is very probable that there will be no necessity to alter R6 but, at the same time, it is still desirable to check that the output transistor is working under the conditions required by the circuit.

Switch off the tuner and next wire in TR1, C1, C5, R4 and R5. Temporarily wire a 680kΩ resistor between the base of TR1 and the positive plate of C5. Switch on and ensure that TR1 collector has a voltage, with respect to the negative supply line, that is roughly half of that on the positive plate of C5. If it is not, alter the value of the temporary resistor accordingly.

Next, connect the a.f. amplifier to the output of the tuner, and connect a 3ft. length of wire, to act as an aerial, to C1. If both transistors are operating correctly, the amplifier will reproduce the modulation of at least one local station. Probably, several transmissions will be reproduced at the same time, the strongest signal predominating.

The tuner is now ready, after removal of the temporary resistor between the base of TR1 and C5, for the addition of the parallel-T filter components. Capacitors C2, C3 and C4 are, as already specified, close-tolerance components. It might be thought advisable to use close-tolerance resistors for R1, R2 and R3, but the expense of such components is not really justified because some slight adjustments to their value may still be necessary to make the filter attenuation frequency exactly 200kHz. As has already been mentioned, the filter output is not unloaded, as is required by the filter equations; this point could make the actual resistance values required in practice slightly different from those calculated theoretically. For the prototype the author simply selected resistors taken from stock by measuring their values with an ohmmeter, and was fortunate enough to find that the filter responded at the first attempt to a frequency very slightly lower than 200kHz. A slight readjustment to one of the resistors then caused the Radio 2 signal to be correctly received.

An alternative approach, not checked by the writer, could consist of using three 1kΩ skeleton preset potentiometers in place of R1, R2 and R3, these being initially set to give resistances of 800Ω, 800Ω and 400Ω respectively. They can then be finally adjusted for optimum reception of the Radio 2 signal, maintaining the correct ratios between their values. A decrease in resistance corresponds to an increase in frequency. Final setting is best carried out using a very short aerial consisting of about 6in. of wire, as this enables reception conditions to be more readily assessed.

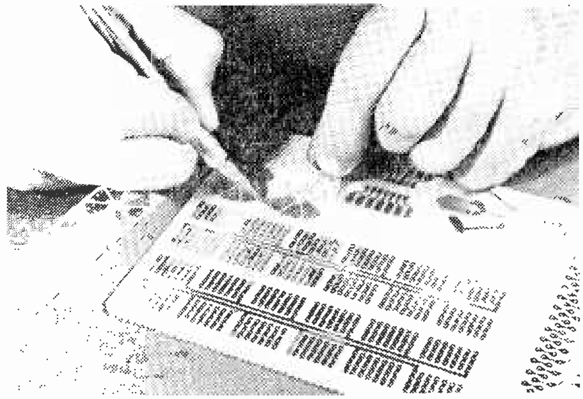
If available, a modulated signal generator will be found very helpful. This should be very loosely coupled to C1 and its output frequency adjusted around 200kHz. It will then indicate the frequency at which the circuit offers greatest amplification.

As stated earlier, the author's circuit was at its most sensitive just before the onset of oscillation. The process of oscillation is dependent upon a number of random factors, including the gain and r.f. performance of the transistor in the TR1 position. It is possible that some tuners made up to the circuit will not oscillate even with R10 slider at the top of its track, but this fact need not impair the usefulness of the tuner if Radio 2 reception is otherwise satisfactory. Again, it is possible that oscillation may commence at a low position of R10 slider. This should not detract from the performance of the tuner, but it might be advisable to slightly increase the value of R4, so that oscillation commences with R10 slider at a higher position. TR2 will then have an adequate supply voltage at the point just below oscillation. In the prototype, oscillation commenced when R10 spindle was about 20° removed from the maximum voltage end of the potentiometer travel. ■

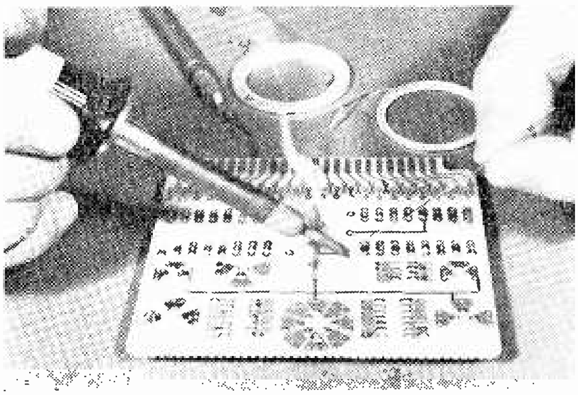
Trade News . . .

INSTANT CIRCUIT BOARDS

The photographs illustrate two stages in the preparation of a board assembly incorporating Circuit-Stik circuit sub-elements. These sub-elements consist of thin specially shaped foil conductors having a pressure sensitive adhesive backing, and they may be applied to any pierced insulating board having hole spacing on a 0.1in. matrix. A very wide range of shapes is available, these including circuit sub-element patterns for TO3, TO5 and TO18 transistors, and for flat pack 10-and 14-lead and dual-in-line integrated circuit packages. Also available are epoxy-glass pre-punched boards with 0.1in. hole grid, together with insulated jumpers, pressure sensitive copper sheets which can be cut to shape, and a number of other items which may be employed in circuit board assembly.



Applying one of the Circuit-Stik conductor patterns to a pre-punched circuit board



Circuit-Stik sub-elements are pre-fluxed and retain their adhesive properties at soldering temperatures

One of the advantages given by Circuit-Stik sub-elements is that they enable prototype circuit boards to be made up without the necessity of pre-design and draughting, thereby saving considerable time and energy in research and development work. Design changes can be carried out by merely removing or adding sub-elements as required. The sub-elements are supplied pre-plated, flux coated and ready for soldering. They are designed to withstand soldering temperatures whilst still retaining their adhesive properties.

The Circuit-Stik range is handled in the U.K. by Bourns (Trimpot) Ltd., Hodford House, 17/27 High Street, Hounslow, Middlesex.

TWO NEW TV INTEGRATED CIRCUITS

SGS have added two new linear integrated circuits to the list of its devices suitable for application in TV receivers.

These devices, designated TBA 581 and TBA 591, are for use in the sound section as IF/FM amplifier, detector and AF preamp/driver.

The TBA 581 is suitable for driving class AB complementary power output stages. If used with BC 286 and BC 287 as output stage transistors a power output of 1.5W can be achieved.

The TBA 591 is intended for driving class A high voltage transistors.

Data sheets are available from SGS (United Kingdom) Limited, Planar House, Walton Street, Aylesbury, Bucks.

SWITCHING TUBE FOR 2-COLOUR DISPLAY

The M-O Valve Co. Ltd., has introduced a high impedance triode type A3369, for high speed accelerator electrode potential switching for two-colour display cathode ray tubes or for use as a shunt or series stabiliser in low current, high voltage power supplies.

Change of colour in a two colour cathode ray tube (e.g. Red/Green) is affected by the change in energy of the beam typically using 10kV for Red 15kV for Green.

The maximum voltage rating of the A3369 is 20kV.

ITT APPOINT LINGRAEL STOCKISTS FOR MULTIMETERS

Bournemouth based Lingrael Limited has been appointed a stockist for the ITT Metrix MX202B multimeter.

This low-cost (£24.15) universal multimeter has a taut band meter movement which provides a very high sensitivity (up to 40,000 ohm/volt) and a robust meter suspension.

With the appropriate accessories, the instrument will measure frequency response, decibel level resistance and light intensity as well as a.c./d.c. currents and voltages. Range selection is by thumbwheel and the instrument is equipped with a range indicator.

For further information write Lingrael Limited, 10 Cardigan House, Waterloo Road, Winton, Bournemouth BH9 1AH.

AUDIBLE CONTINUITY TESTER

by

C. DICKSON

This simple transistor circuit allows continuity checks to be carried out without the necessity of looking at a meter scale

IN HOME CONSTRUCTION AND SERVICING WORK IT IS often necessary to carry out simple continuity tests. Typical examples are given by the tracing out of the tags on a complicated wave-change switch or the tags or lead-outs on a multi-winding coil or transformer. A continuity test is also required when locating the burnt-out valve in an open-circuit heater chain.

The normal approach to carrying out continuity checks of this nature consists of employing a multi-testmeter switched to one of its ohms ranges. Unfortunately, the use of a testmeter in this manner introduces the difficulty that the meter needle has to be watched whilst connections are being made to the tags or lead-outs being checked, whereupon if the connections are of a 'fiddling' nature, time and patience can be wasted. Also, maintaining a watch on a meter scale can be inconvenient if one is trying, at the same time, to keep an eye on the test connections which, with such things as a printed circuit board may be difficult to hold in position.

AUDIBLE INDICATION

A good solution to these problems consists of employing a continuity tester in which evidence of continuity is indicated audibly rather than visually. The simplest type of continuity tester offering audible indication is, of course, an electric bell or buzzer in series with a battery, as in Fig. 1. Here, the bell or buzzer sounds when the test terminals are connected together. However, a testing device of this nature is of little use for radio work since the current drawn by the bell or buzzer is far too high to be passed through electronic circuits. In addition, such a testing device could not be used for checking heater chains or other circuits where a fairly high resistance is liable to be present.

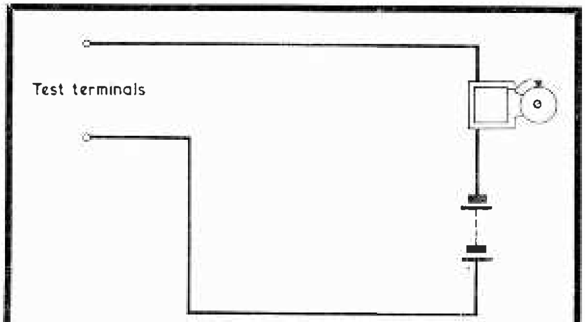


Fig. 1. A very simple continuity tester consists of a bell, or buzzer, in series with a battery

The writer has devised a continuity tester which, with the aid of a few transistors and other components, is suitable for continuity testing of radio circuits and components. The circuit of this tester is given in Fig. 2. The tester has two ranges, and is capable of checking continuity in circuits having resistances from zero to approximately 30kΩ on one range and from zero to approximately 1kΩ on the other range. Continuity is indicated by an audible tone from a loudspeaker. The frequency of the tone increases with the resistance of the circuit being checked for continuity and this factor can be of assistance since it is capable of indicating when the resistance of a circuit is grossly incorrect.

In Fig. 2, TR1 and TR2 form a multivibrator running at approximately 500Hz. The emitter of TR2 couples to the multivibrator positive supply line (i.e. the supply line connecting to on-off switch section S2(b)) by way of the base-emitter junction of TR3. Thus when TR2 is conducting, during the multivibrator cycle, so also is TR3. Similarly, when TR2 is cut off, TR3 is cut off as well. The collector circuit of TR3 is completed by R5, across which is coupled, by way of electrolytic capacitor C3, the primary of output transformer T1. The secondary of T1 couples to a 3Ω speaker. The overall operation of the circuit is that, when the multivibrator is running, TR3 drives the speaker at multivibrator frequency.

The multivibrator operates when the test terminals are short-circuited, since the upper negative supply is then completed to collector loads R1 and R4, and to base resistors R2 and R3. It is this factor which allows the circuit to function as a continuity tester, since the test terminals may then be applied to a circuit being checked. If the circuit is continuous, the multivibrator operates and its tone is heard from the loudspeaker.

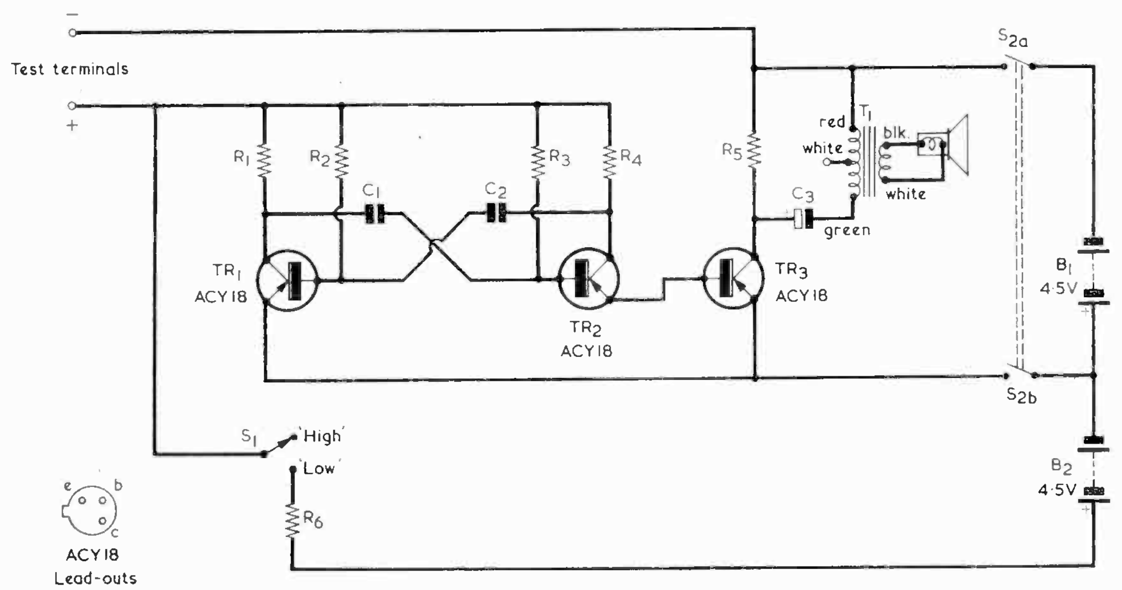


Fig. 2. Circuit of the continuity tester described in this article. No connection is made to the white lead of the output transformer primary

RANGE SWITCHING

The multivibrator will also work if the circuit to which the test terminals are connected has a significant value of resistance. When, with the author's model, switch S1 is set to 'High', the multivibrator still operates when a resistance of approximately 30kΩ is connected to the test terminals, but ceases to operate for higher resistance values. The frequency of the tone when the 30kΩ resistance is applied is considerably higher than is given when the test terminals are short-circuited.

For many applications an indication of continuity at a test circuit resistance as high as 30kΩ represents too great a sensitivity. The sensitivity may be decreased by putting S1 to the 'Low' position, whereupon the lower test terminal couples to the positive side of battery B2 by way of R6. It will be obvious that the upper supply line to the multivibrator will now be positive of its lower supply line unless a resistance of suitably low value is connected to the test terminals. With the prototype a resistance of approximately 1kΩ brings the multivibrator upper supply line just sufficiently negative for the multivibrator to sound. Thus, when S1 is set to the 'Low' position the unit can check for continuity of all circuits presenting a resistance of less than 1kΩ. As for the case where S1 is in the 'High' position, resistances approaching the maximum value cause the frequency of multivibrator operation to be markedly increased.

Other values of maximum resistance for the 'Low' setting of S1 can be provided by altering the value of R6. If, for instance, R6 is made 560Ω, the maximum value of resistance in the circuit being checked is approximately 500Ω, and so on. It would be inadvisable, however, to employ a lower value than 560Ω in the R6 position as the current which flows in the circuit being checked then becomes excessive.

COMPONENTS

Resistors
(All ¼ watt 10%)

R1	2kΩ
R2	68kΩ
R3	68kΩ
R4	2kΩ
R5	1kΩ
R6	1.2kΩ

Capacitors

C1	0.02μF paper or plastic foil
C2	0.02μF paper or plastic foil
C3	20μF electrolytic, 6V. wkg.

Transformer
T1 Output transformer type LT700 (Eagle)

Transistors

TR1	ACY18
TR2	ACY18
TR3	ACY18

Switches
S1 s.p.s.t. toggle
S2(a) (b) d.p.s.t. toggle

Batteries
B1 4.5 volt battery
B2 4.5 volt battery

Speaker
3Ω loudspeaker

Miscellaneous
2 test terminals or sockets
2 test leads with prods
Housing

With R6 at 560Ω this current is 16mA when the circuit being checked presents zero resistance to the test terminals.

The tester may also be employed for checking electrolytic capacitors having values of the order of 100μF or more. The capacitor to be checked should be connected, in an uncharged condition, to the test terminals with the polarity indicated in Fig. 2. Switch S1 should be in the 'High' position. If the capacitor is in good condition the multivibrator will oscillate for a short period as charging current flows through it to the capacitor, and it will cease to operate when the capacitor becomes fully charged. The audible effect is the appearance of a rapidly rising siren-like tone for a short period. If the capacitor is good, it will retain its charge and will not cause the multivibrator to oscillate again if it is reconnected to the test terminals a short time later. A capacitor with excessively low leakage resistance will cause the multivibrator to oscillate continuously, whilst an open-circuit capacitor will not allow the multivibrator to oscilate at all.

COMPONENTS AND CONSTRUCTION

As may be seen from the Components List, all of the components required are quite readily available.

If it is found that the multivibrator does not oscillate readily it is probable than one or other of the transistors employed is at the upper limit of its gain spread and is approaching the bottomed state. This condition may be alleviated by slightly increasing the value of the appropriate base resistor (R2 or R3) or slightly reducing the value of the appropriate collector resistor (R1 or R4). Difficulties of this nature are occasionally encountered in transistor a.f. multivibrators having relatively low values in the cross-coupling capacitors. In the author's model the multivibrator functions satisfactorily at supply potentials well below 1 volt.

With S1 in the 'High' position, the current drawn from battery B1 is approximately 5mA when the test terminals are short-circuited. When the test terminals are open-circuit the current taken from B1 consists of leakage current in TR3 only and, with the prototype, is about 0.2mA. When S1 is set to 'Low' additional current is drawn from both B1 and B2, this consisting of the current flowing through R6 and the circuit to which the test terminals are connected. B1 and B2 may be any convenient 4.5 volt battery, such as the Ever Ready flash lamp battery type 1289. If both batteries are of the same type, B1 will become exhausted before B2, since more current is drawn from it.

The test terminals may conveniently be two large insulated terminals, or two insulated sockets. Two flexible leads, terminated in test prods, are connected to them.

The loudspeaker can be any small 3Ω unit. The tone generated by the circuit should be loud enough to be readily audible under normal workshop conditions.

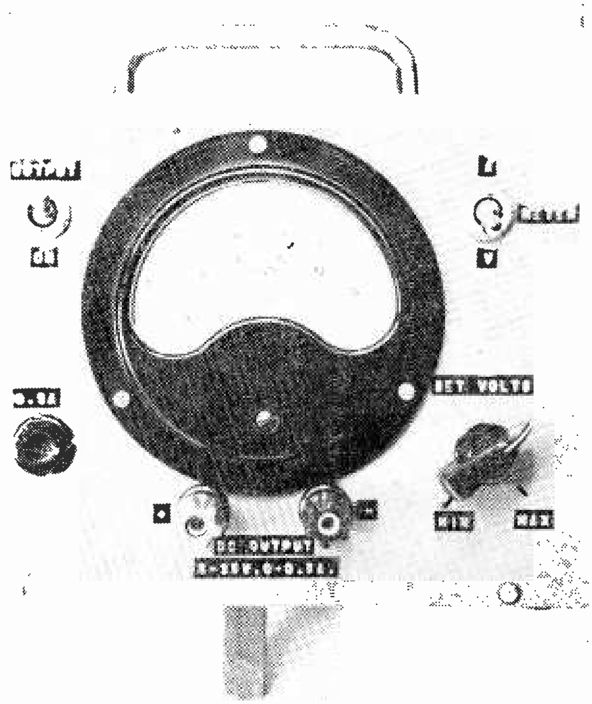
The whole circuit may be enclosed in a suitable housing having dimensions to suit the batteries and loudspeaker employed. As with most test gear of this nature, it is preferable for the housing to be made of an insulating material, such as wood, rather than of metal. ■

TRANSISTOR STABILIZED POWER UNIT

PART 1

by

P. CAIRNS, M.I.P.R.E., G3ISP



Offering an output that is continuously variable from 6 to 36 volts at output current up to 0.5 amp (greater at the higher output voltages), this compact power supply incorporates a simple and reliable circuit design. The circuit is described in this month's article, whilst constructional details will be given in the concluding article, to be published next month

THESE ARTICLES DESCRIBE A SIMPLE BUT VERY useful transistor stabilized power unit. The unit should meet the needs of most requirements met with in everyday experimental transistor work. A wide range of voltage output by means of a single control is offered, together with adequate load current facilities. Good regulation, low ripple, optional voltage/current metering and simplicity of construction are also provided. Other features are very compact construction and a modest outlay with regard to cost. The complete specification is given in Table 1, while a set of regulation characteristics is shown in Fig. 1.

DESIGN REQUIREMENTS

The need for a versatile but simple transistor power unit has often been felt by the writer. On looking through the many designs published from time to time in the technical press no suitably simple but effective design was readily found. Many of the circuits offered features and specifications far in excess of those required by the majority of amateur constructors. Extremely high levels of stabilization with very low ripple values, together with automatic overload and cut-out circuits, complex temperature compensated amplifiers, etc., were some of the features noted. Such specifications are seldom required outside the laboratory and for the average amateur constructor make such projects prohibitively expensive. It was therefore decided to design a circuit which provided an adequate specification to meet most everyday needs while at the same time using the minimum of components.

The final design evolved is shown in Fig. 2. In later paragraphs a number of possible modifications to the circuit will be discussed. As can be seen from Fig. 2, standard components are used while the circuit itself is extremely simple in operation. The minimum number of transistors which still allow good regulation to be achieved are employed. The wide range of voltage covered is obtained by a single potentiometer, this dispensing with the tapped transformer often used in circuits of this nature. This does, of course, have the disadvantage of limiting the available load current obtainable at the lower voltage output levels due to dissipation limits in TR1. Simple capacitor smoothing is used, the expense and

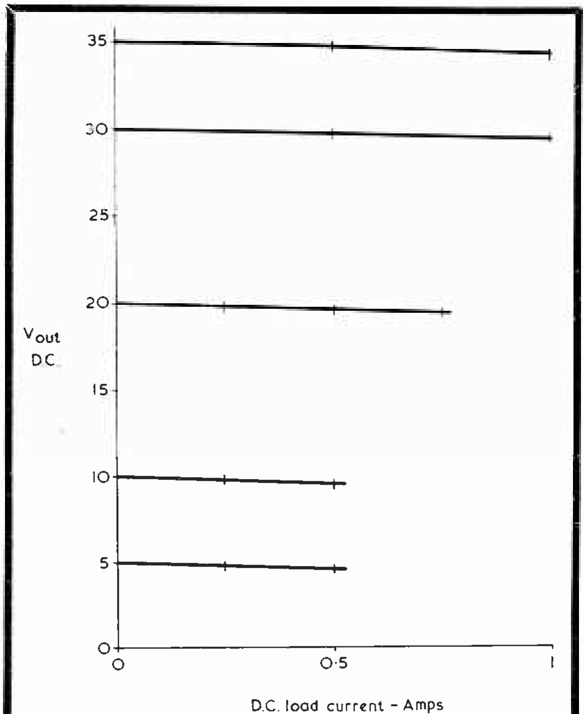


Fig. 1. Voltage regulation curves for the stabilized power supply

bulk of a choke not being warranted. It will be noted that the metering is indicated as optional. Thus, where cost is the deciding factor the complete metering circuit can be omitted without affecting the function of the circuit. Voltages and currents can be measured on an external multimeter, though this is not always as convenient as having self-contained metering. The amplifier uses the minimum number of components and only one reference diode. As TR2 and TR3 are both silicon types and D2 was chosen so as to have a zener voltage whose temperature coefficient was close to zero, no drift or dissipation problems with normal ambient temperature changes should be encountered with this part of the circuit.

No automatic current limiting and cut-out circuits are included in the design. An effective limiting circuit would greatly add to the cost and complexity of the unit. Also, in the writer's experience, which covers a wide range of commercial power units, most of which include some form of overload cut-out, the impression gained is that for the large part they are not always as effective as might at first be thought. Such circuits are most effective (and sometimes only effective) when a finite impedance is offered between the power unit output terminals and the actual short-circuit, this giving some small delay to the rate of rise of short-circuit current. The average couple of feet of twisted pair or flex used as supply leads is often sufficient for this purpose. If the short-circuit is applied directly to the terminals, however, the rate of change of current with respect to time is much greater and unless the overload circuit is particularly well designed, it can often be "beaten to the draw", with subsequent damage to the power unit. It was found that the fuse included in the present design was quite adequate for normal overloads and current surges.

CIRCUIT FUNCTIONING

The functioning of the circuit is quite straightforward. A transformer having only one secondary winding is used, this feeding a full-wave silicon bridge rectifier D1, the output of which is connected across the reservoir capacitor C1. This not only boosts the mean d.c. output level but provides a reasonable degree of smoothing. The d.c. output from this circuit is fed into the stabilizing circuit. TR1 is the series stabilizer and carries the full load current provided at the output terminals. Across the unstabilized voltage is connected the reference zener diode D2 with its bleed resistor R1 and decoupling capacitor C4. This provides the constant voltage reference against which all changes in output voltage are compared.

The p.n.p. transistor TR3 has its emitter coupled to this reference voltage, its base being connected to the slider of potentiometer VR1 which in turn is connected in the centre of the potential divider network R5, R6. The base of TR3 can therefore be altered so as to change the d.c. working point of that transistor. The collector output of TR3 is d.c. coupled to the base of the second amplifier stage TR2, this being an n.p.n. type. R4 provides limiting for TR3 collector current and prevents this transistor exceeding its maximum dissipation. TR2 emitter is clamped to the negative line while the collector output is d.c. coupled to the base of the series stabilizer TR1. R3 provides collector current limiting for TR2. Thus the circuit forms a complete closed feedback loop, from supply via TR3, TR2, TR1, and back again to supply. R2 takes care of TR1 leakage current.

Final smoothing is provided by C2 whilst C3 helps reduce the output impedance at high frequencies. The d.c. output is switched by S1 and it will be seen that both halves of a double-pole switch are connected in parallel. This helps to increase the maximum output current which may be switched. The d.c. output is completely floating, this being a very useful feature in any power unit as it allows either side of the supply to be earthed externally or, conversely, allows the supply to float at any level determined by external apparatus connected to the output terminals. R7 draws a constant bleed current which helps keep the circuit stable when supplying very small load currents.

The metering circuit comprises a basic 10mA movement, this being cheaper than a more sensitive movement and also more robust. A shunt, RM1, is connected in series with the output line, and a series resistor, RM2, is connected to the common side of the supply. The meter is switched by S2 to either the shunt position across RM1 for current measurement or the series position with RM2 for voltage measurements. The meter is connected on the live side of S1; this allows the necessary voltage to be set up before the supply is switched to the output terminals.

The action of the circuit is quite simple. With a particular voltage output level selected, a sudden increase in load current would tend to cause the output voltage to fall. The fall is registered by TR3 as

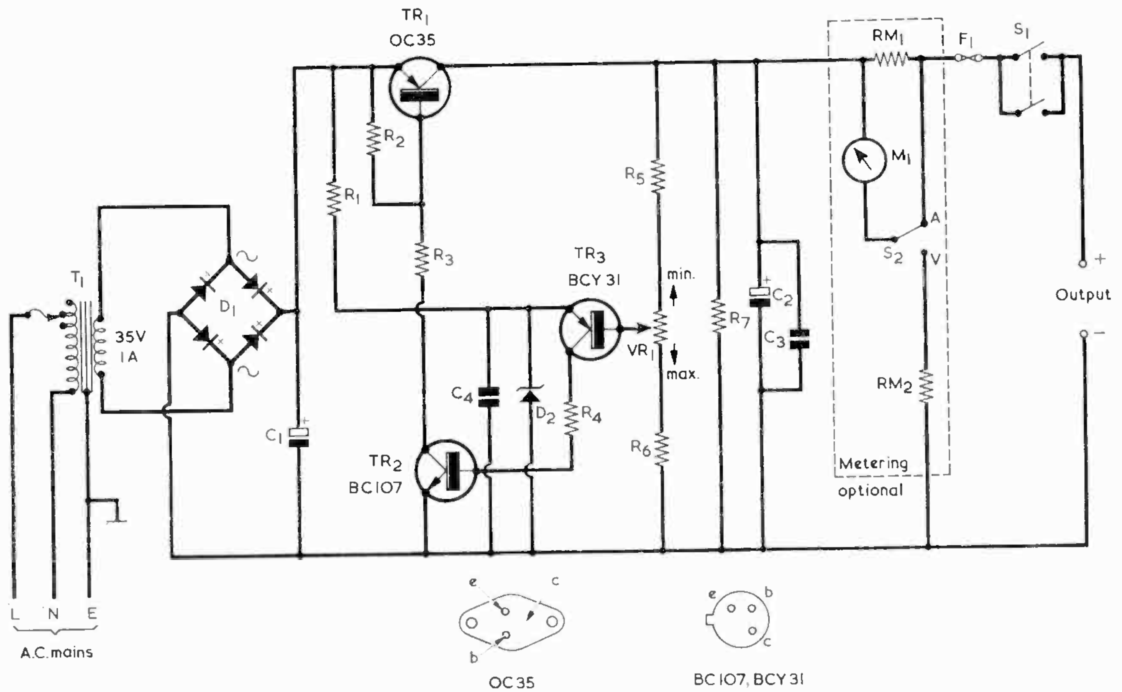


Fig. 2. Circuit diagram of the stabilized supply. S2 allows the meter to read output current or output voltage as desired

an increase in voltage with respect to the emitter, which is held at a constant potential by D2. TR3 is turned harder on, allowing more current drive into TR2 base which in turn drives more current into TR1 base; TR1 is therefore turned harder on and allows more current to flow from the source and so compensates for the intial increase in demand for load current. The output voltage therefore remains at an almost constant level which is selected by VR1. Thus, small changes in output voltage are detected and amplified, these being applied to TR1 which controls the flow of load current. An analogy can

COMPONENTS

Resistors
- R1 3.3kΩ, 1 watt, 10%
- R2 2.2kΩ, ½ watt, 10%
- R3 820Ω, ½ watt, 10%
- R4 8.2kΩ, ½ watt, 10%
- R5 1kΩ, ½ watt, 5%
- R6 1kΩ, ½ watt, 5%
- R7 1kΩ, 3 watts, wirewound
- RM1 Shunt meter resistor (see text)
- RM2 Series meter resistor (see text)
- VR1 5kΩ pot., linear, wirewound

Capacitors
- C1 1,000μF electrolytic, 50V wkg
- C2 2,500μF electrolytic, 40V wkg
- C3 0.022μF polyester
- C4 1μF polyester

Transformer
- T1 Mains transformer: primary 200–220–240V; secondary 35V at 1A (Osmabet Ltd., 46 Kenilworth Road, Edgware, Middlesex HA8 8YG).

Semiconductors
- TR1 OC35 (Mullard)*
- TR2 BC107 (Mullard)
- TR3 BCY31 (Mullard)
- D1 Encapsulated silicon diode bridge module, 70V r.m.s. 1A, type OSHO1A–100 (Mullard) or similar (see text)
- D2 5.6V 400mW zener diode, type BZY88–5V6 (Mullard) or similar

* Complete with mica washer and insulating bushes

Meter
- M1 Moving-coil meter, 10mA f.s.d.

Switches
- S1 d.p.s.t., toggle
- S2 s.p.d.t., toggle

Fuse
- F1 Cartridge fuse, 0.5A (or 1A if required) with panel-mounting fuseholder

Miscellaneous
- 1 red insulated terminal
- 1 black insulated terminal
- 1 pointer knob
- 12-way tagboard (see text)
- 3-way terminal block
- 2 spring clips, or clamps, for C1 and C2
- 3-core mains lead
- Mains lead clamp
- Material for chassis
- Cabinet type 'W', 8in. by 6in. by 6in. (H. L. Smith & Co. Ltd.).

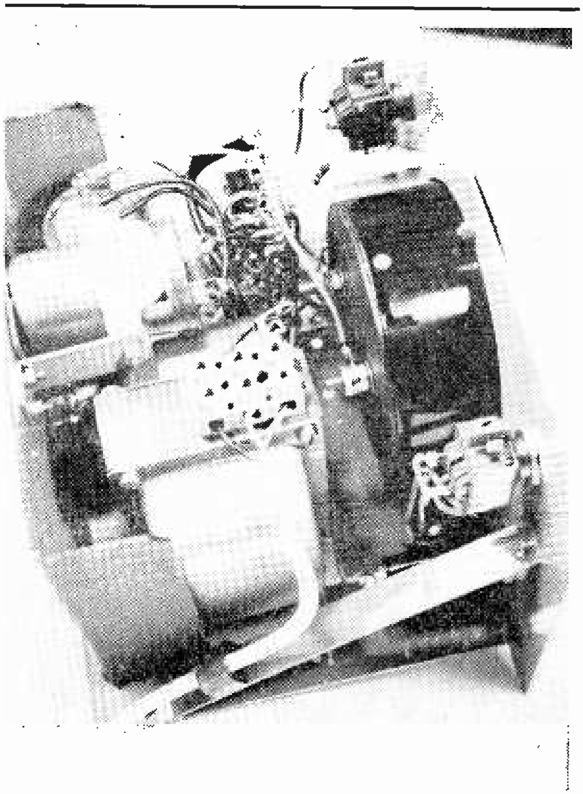
be given by a self-regulating pressure valve in a water system. The reverse action occurs for sudden decreases in load current. The circuit also compensates for a wide variation in source voltage, i.e. changes in mains voltage will not affect the d.c. output voltage.

OUTPUT CURRENT

While the output load current available is specified as 0.5 amp over the full voltage range, increased load current can be taken at the higher voltage outputs as indicated in Table I. Care should always be taken, however, not to exceed the power dissipation limits of TR1. With a low output voltage selected the source voltage is quite high by comparison, the difference in voltage being dropped across TR1. If an excessively high load current is drawn at the same time, TR1 case and junction temperature can rise very quickly and exceed the limits quoted by the manufacturer. TR1 will therefore be given more power to dissipate than it can cope with and will destroy itself, despite the large heat sink on which it is mounted. If it is intended to use the larger currents permissible at the higher voltages, it must be remembered to decrease the load current to under 0.5 amp if the output voltage is changed to a lower value. Adequate ventilation should be allowed for the heat sink if the power unit is to be operated at maximum current output at the low voltage levels, particularly if the ambient temperature is likely to be higher than average. The measured power dissipation of TR1 under various load/voltage conditions is shown in Fig. 3.

Table I
Specification

Output:	Continuously variable from 6 to 36 volts at 0 to 0.5 amp d.c. (load current may be increased to 0.75 amp over 15 to 25 volt range and to 1 amp over 25 to 36 volt range).
Regulation:	Less than 5% change from zero to full load.
Ripple:	At 6 volt output less than 20mV p–p (0.1%) at full load; at 36 volt output less than 70mV p–p (0.07%) at full load.
Dimensions:	8in. wide, 6in. deep, 6in. high; weight approx. 6lbs.



Side view, showing the meter, mains transformer, tagboard (at rear) and capacitor C1

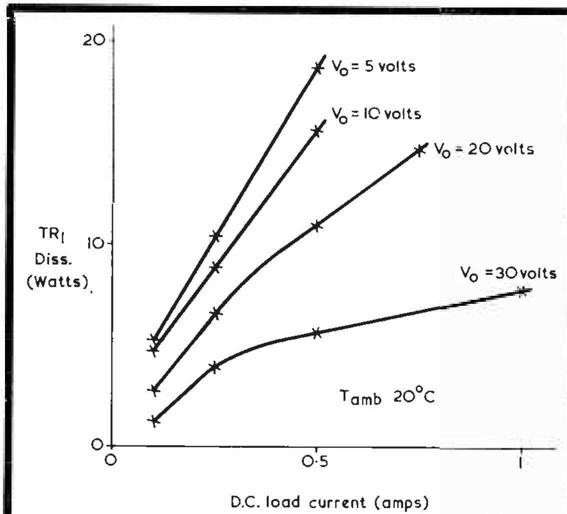
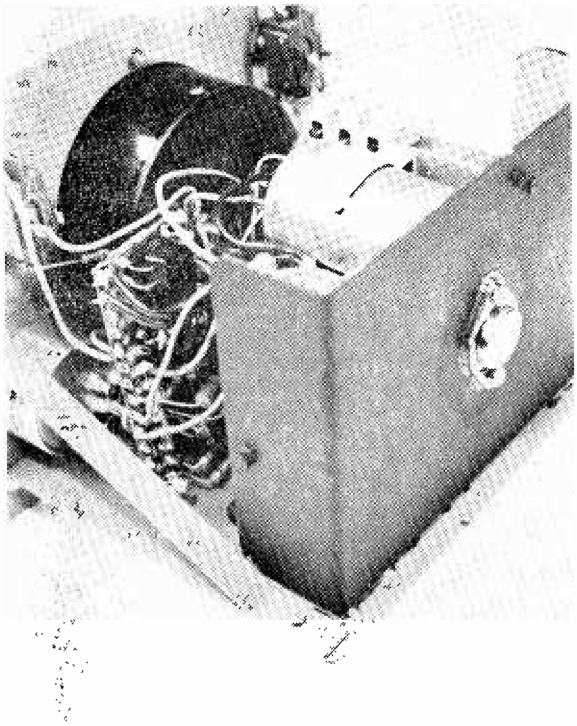


Fig. 3. Curves showing dissipation in TR1 at different output voltages

As mentioned previously, various modifications are possible so as to give increased load current say in the region of 1 amp, over the full voltage range. The simplest would be to double up on TR1, that is, connect another transistor of the same type in parallel with TR1. This would entail another heat sink and thus a larger case. A tapped mains transformer could also be used. Such transformers with secondary tappings every five or six volts are available commercially though they are more expensive than the type employed here. The use of such a transformer would also entail another front panel control switch capable of handling the full load current. Slight changes in R5 and R6 would also possibly be required. The tapped type of transformer is much used in commercial power units as it offers a simple method of keeping the source voltage at a reasonably low level with respect to the output voltage and so reducing the burden placed upon the series transistor.

The circuit can also be modified by using a different type of transistor. TR1 can be replaced with a silicon n.p.n. transistor type BDY20 (available from LST Electronic Components Ltd.). This is capable of much greater dissipation at a much



A rear view of the supply. TR1 is positioned centrally on the heat sink

higher temperature – 115 watts at an ambient temperature of 25°C – and it has a maximum junction temperature of 200°C. This would necessitate changing the bridge rectifier round so as to reverse the output polarities, TR3 being connected in the TR2 position and an ASY28 in the TR3 position so as to keep the configuration correct. The zener diode and electrolytic capacitors have also to be reversed. Small changes in R5 and R6 may also be necessary. This alternative circuit was tested by the writer and found to supply 1 amp continuously over the entire voltage range at much higher than average ambient temperatures. Regulation was slightly improved. As it requires no additional components, only a change of two transistor types and a reversal of circuit polarities, it is equally simple to build. The drawback is that the BDY20 transistor is a type generally used only in industrial applications, and it is more expensive than the OC35. It can be seen, however, that the basic circuit is extremely versatile and gives plenty of scope to those who like to experiment a little.

Constructional details, which will be given next month, apply to the OC35 version whose circuit is given in Fig. 2. The alternative versions are suggested for experienced constructors who understand the principles involved and are able to carry out the requisite circuit modifications.

In the Components List, RM1, RM2, D1 and the 12-way tagboard are referred to the text of the article for further details. These components will be dealt with in next month's issue.

(To be concluded)

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **NIGERIA**

The NBC regional station at Calabar on **6145** (48.82m) 10kW has been reported with news in English at 2100 followed by a programme of 'pops' at 2115.

● **CHINA**

The PLA (People's Liberation Army) transmitter at Fukien has been logged at 1822 with a typical programme of military music and harangues in a Chinese dialect on **3400** (88.24m). Also on **3200.**

● **HONDURAS REPUBLIC**

HRLC Radio Continental, San Pedro Sula, has been heard at 0030 on 4770 (62.89m) 1kW with Latin American music and many identifications.

● **TIBET**

Lhasa has been logged by BADX on **4035, 5935** and on **9490.** The **4035** transmission was heard from 1530 with talk in Chinese dialect and at 1700 with relay of Peking in Hindi. Definite "Hsi Tsiang" identification at 2345 then into exercises and music, time and identification again at 0000 with "East is Red" (Peking Style). Lhasa often radiates its own version of "East is Red" which is totally unlike that of Peking.

● **NEPAL**

Radio Nepal is reported by BADX on **4600** from various times around 1630 with chimes, 'pop' western music then sign-off with brief anthem after identification at 1650.

● **AFGHANISTAN**

Radio Afghanistan has been heard (BADX) on **4775** at 1607 with musical programme, three long 'pips' and identification at 1630 then into Pushtu/Dari talk.

● **BRAZIL**

ZYK33 Recife can be heard around 2100 on **15145** with identification "Radio Journal de Commercio" and Latin American music, etc.

ZYN30 Bahia on **15225** can often be logged around 2130 with typical LA music.

ZYX2 Goiania, Radio Brazil Central, is worth listening for on **4995** around 2130.

● **CEYLON**

Radio Ceylon may be heard on **4870** around 1650, where it has been reported by BADX with a talk in English, three chimes at 1700 and sign-off with a choral anthem.

● **INDONESIA**

RRI Djambi can be logged on **4927** with gamelan music and talk in Indonesian at 1530. BADX reports a clear identification at 1540 "Studio Djambi" (in Indonesian "Nusantara Djambi"), then Arabic-style chanting.

● **MALAYSIA**

Penang has been logged by BADX on **7295** at 1550 with native music till 1600 when six 'pips' were heard and identification "Inilah Radio Malaysia" followed by news in English.

● **CAMEROON REPUBLIC**

Radio Garoua can be heard on **5010** around 2130 with typical African music programme.

Acknowledgements:– BADX, Our Listening Post.

"VIBRATRON"

VIBRATO UNIT

by

R. J. CABORN

Constructional details of a self-conta guitars, portable organs and all othe low level signal. The requisite printed ready-

THE 'VIBRATRON' VIBRATO UNIT IS A RUGGED SELF-contained instrument employing silicon transistors which can be inserted between an electric guitar (or any other electronic instrument having a low level signal output) and the subsequent amplifier. It is not intended for operation with high level signals such as those offered by amplifier speaker outputs. It has continuously variable control over both vibrato speed and depth, and includes a foot switch which brings the vibrato in or out as desired. It is an ideal instrument for the musician who wishes to produce a really impressive performance.

THE CIRCUIT

The circuit of the vibrato unit appears in Fig. 1. In this diagram it will be seen that the 9 volt battery couples into the circuit by way of a contact on the input jack. In consequence, no on-off switch is required, the unit being turned on automatically when the input jack plug is inserted.

A second switch, S1, controls the supply to the multivibrator circuit incorporating transistors TR3 and TR4. S1 is a successional-action foot switch which alternately opens and closes each time it is pressed; it does not need to be held down continually to complete the circuit.

The multivibrator circuit is of conventional design, the frequency of oscillation being controlled by the vibrato speed control, RV2. The output of the multivibrator is fed first to R9, C7 and depth control RV1, and then to R8 and C6. C6 and C7, in combination with R8 and R9, round off the square wave provided by the multivibrator, causing the vibrato controlling waveform to have a smoothly changing character.

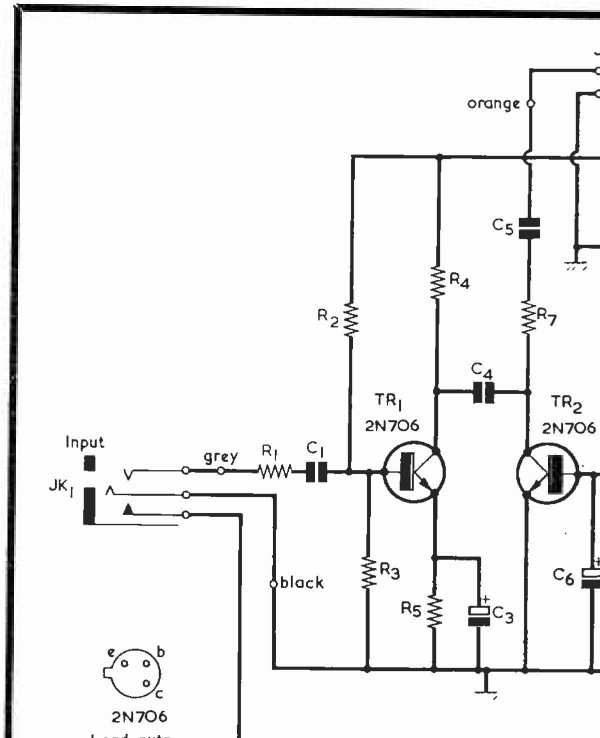
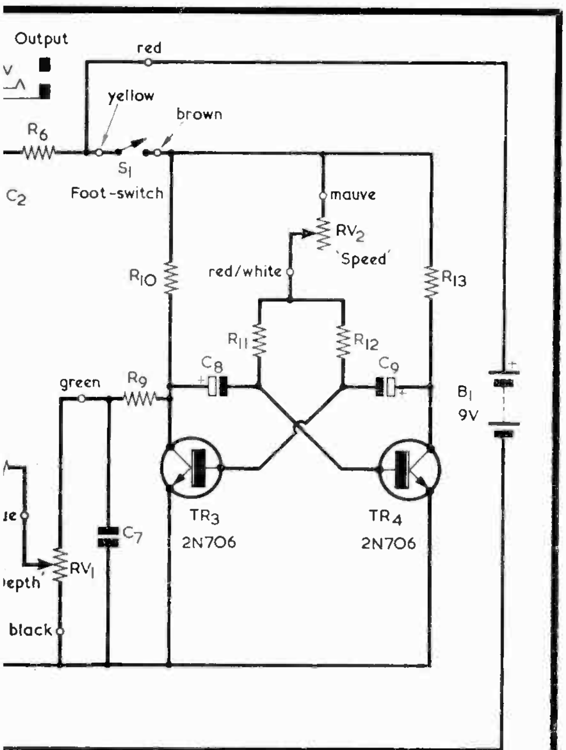


Fig. 1. The circuit of the vibrato unit. The colo printed circ

Cover Feature

ed vibrato unit suitable for electric electronic music sources offering a circuit board and case are available ade



's refer to the leads which connect to the board

COMPONENTS

Resistors

(All fixed values $\frac{1}{8}$ watt 5%)

R1	56kΩ
R2	62kΩ
R3	10kΩ
R4	3.9kΩ
R5	1kΩ
R6	4.7kΩ
R7	4.7kΩ
R8	22kΩ
R9	22kΩ
R10	10kΩ
R11	22kΩ
R12	22kΩ
R13	10kΩ
RV1	50kΩ potentiometer, linear
RV2	50kΩ potentiometer, linear

Capacitors

(All capacitors are miniature, all working voltages are in excess of 9 volts)

C1	0.1μF polyester
C2	80μF electrolytic
C3	80μF electrolytic
C4	0.1μF polyester
C5	0.1μF polyester
C6	10μF electrolytic
C7	0.1μF polyester
C8	2.5μF electrolytic
C9	2.5μF electrolytic

Transistors

TR1-TR4 2N706

Battery

B1 9-volt battery type PP3 (Ever Ready)

Switch

S1 Successional-action s.p.s.t. foot switch

Sockets

JK1 Phone jack with sleeve make contact (See Fig. 1)

JK2 Phone jack

Miscellaneous

Printed circuit board (Wilsic Electronics Ltd.)
Case, base plate and battery clip (Wilsic Electronics Ltd.)
Battery connectors
2 knobs
2 rubber feet
2 $\frac{1}{8}$in. insulated spacing pillars
Nuts, bolts, connecting wire, etc.

The input signal from the musical instrument is applied to input jack JK1. As already mentioned, the process of inserting the jack plug switches on the unit. The signal is then passed, via R1 and C1, to transistor TR1. This functions as a common emitter amplifier whose output couples via C4 to the collector of TR2. The emitter-collector impedance of TR2 varies at vibrato frequency due to the vibrato controlling waveform across C6 which is fed to its base. In consequence, the amplitude of the signal applied to its collector becomes modulated at vibrato frequency. The modulated signal is then passed to the output jack, JK2, via R7 and C5.

It will be seen that when the foot switch is open TR1 functions as a simple amplifier and causes the input signal to be applied to the output jack in unaltered form. Closing the foot switch turns on the multivibrator and thereby causes the input signal to be modulated.

All the components employed in the circuit are readily obtainable. Construction is eased by the availability of a printed circuit board that is already etched and pierced, together with a suitable metal case. The latter is finished in hammered grey and has control and jack functions printed on it. These parts are available from Wilsic Electronics, Ltd., 6 Copley Road, Doncaster. (Wilsic Electronics can also provide any of the other components required, or a complete kit, less battery, for the unit.)

The current consumption of the unit is small. When the multivibrator is switched in, the current drawn from the 9 volt battery varies between 1.5 and 2.2mA according to the setting of RV2. The current drops to less than 0.5mA with the multivibrator switched out.

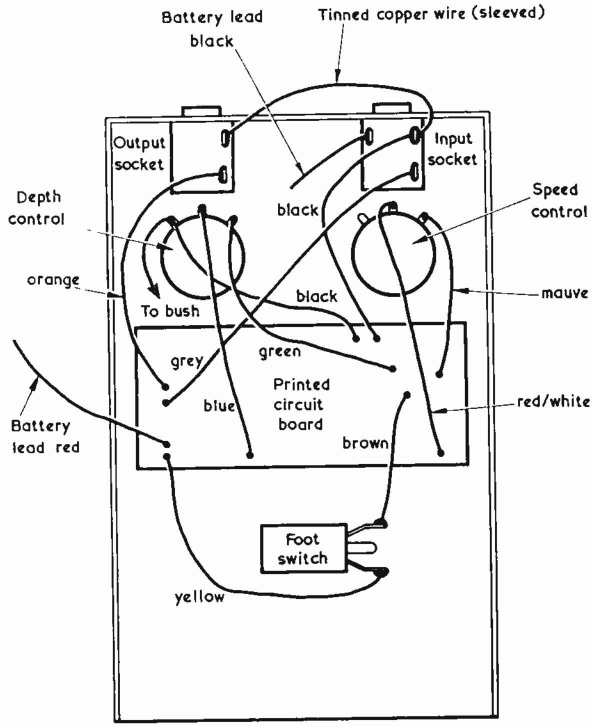


Fig. 3. Connecting the printed circuit board to the remainder of the components

CONSTRUCTION

In the constructional details which follow it is assumed that the reader is employing the Wilsic printed circuit board and metal case. The Wilsic kit includes short lengths of p.v.c. covered stranded wire in various colours and these will also be referred to in the instructions. Some of the circuit lines in Fig. 1 are identified by the corresponding wire colour.

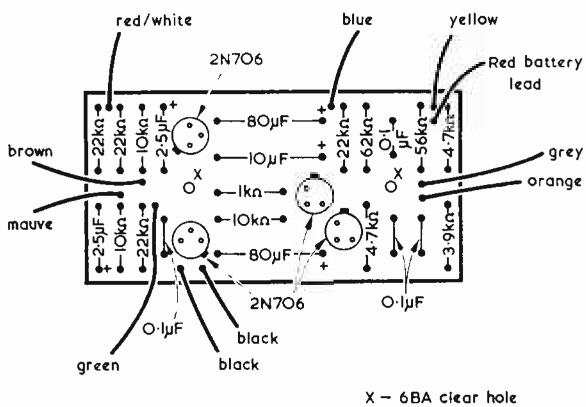


Fig. 2. Layout of components on the printed circuit board. This is available fully etched and pierced

Beginners are advised to take especial care over the soldering of components to the board. A small electric soldering iron should be employed together with a resin-cored solder intended specifically for radio work, a suitable type being Multicore 'Savbit'. On no account should a separate flux be used.

First, take up the printed circuit board and fit and solder the components to it in the manner shown in Fig. 2. For simplicity, this diagram gives component values, and there is no necessity to refer to the Components List to find the corresponding R and C suffix numbers. Ensure that the electrolytic capacitors are mounted with correct polarity; their positive lead-outs should pass through the holes marked with '+' signs. Each transistor is mounted so that the projection on its can takes up the position indicated. To make matters even simpler, the transistor outline is printed in white on the component side of the board. The transistor lead-outs pass through the corresponding holes in the board.

All connections should be soldered carefully. Take care not to overheat the transistors. Their leads should be soldered quickly, and they are the last components to be mounted on the board.

Next, solder to the board 5in. lengths of p.v.c. covered wire in the following colours: black, black, green, mauve, brown, red/white, blue, yellow, grey and orange. Their positions are illustrated in Fig. 2. Connect a 6in. length of red wire to the positive battery connector and solder its other end at the appropriate point in the board, as indicated in the diagram. (Alternatively, connect the red lead of the battery connector and flex assembly provided by Wilsic Electronics to this point in the board.)

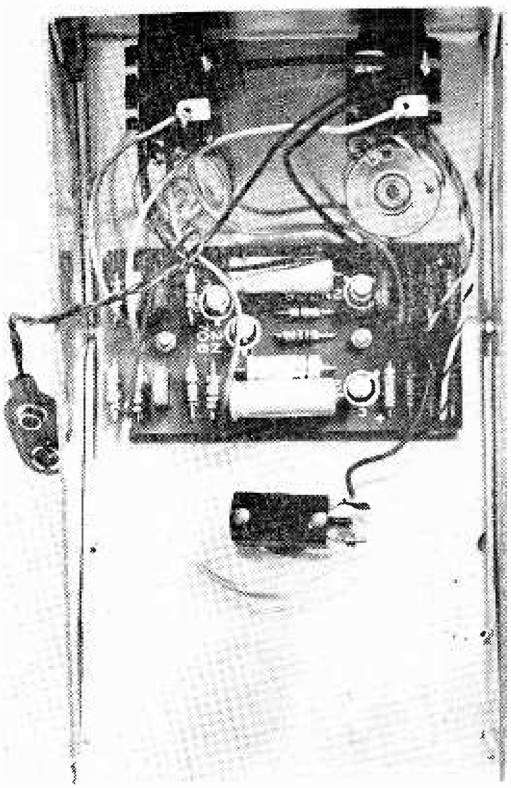
Take up the metal case for the unit and remove the base plate. Using self-tapping screws, fit a rubber foot at each of the two holes at the top corners (i.e. at the corners which, when the base plate is fitted, are away from the tapered end of the case). These rubber feet prevent the unit from moving about when in use. Using two short 6BA bolts and nuts, mount the battery clip on the inside surface of the base plate.

Fig. 3 shows the layout of components and printed circuit in the case. First, fit the input and output jack sockets so that their tags take up the positions shown in the diagram. The input jack has the extra tag which is associated with the on-off switching circuit. The bodies of the jacks are spaced off, inside the case, by spacing washers as required. The two potentiometers are next mounted, each with a shake-proof washer between its body and the inside surface of the case panel. Note that a piece of bare tinned copper wire should be looped, on the panel underside, around the bush of the potentiometer which functions as Depth control, its other end connecting to the earthy tag of the potentiometer, as shown in Fig. 3. This wire is soldered to the tag later when the leads from the printed circuit board are wired to the potentiometer, and it provides the chassis connection to the negative supply rail. Carefully cut the potentiometer spindles so that the knobs may be fitted correctly, and then fit these knobs.

Mount the foot switch in the position shown. The bush of this component has a knurled nut, which appears on the outside, and a hexagonal nut, which appears on the inside of the panel. Loosely adjust these nuts such that the switch body is spaced well back from the inside surface of the panel, but not so far back that it will foul the base plate when the latter is re-fitted. The switch is finally secured by tightening up the inside nut with suitable pliers.

The printed circuit board comes next. This is secured by two 6BA bolts, and is spaced away from the underside of the panel by two $\frac{3}{8}$in. plastic spacing pillars. Pass the two bolts with plain washers under their heads through the appropriate holes in the panel. Holding the bolts in place with one hand turn the case over so that the threaded sections of the bolts point upwards and pass a plastic spacing pillar over each. Next pass the printed circuit board, component side away from the panel underside, over the two bolts, fit nuts and finally tighten up. The printed circuit board has the orientation shown in Fig. 3, the two black leads being on the side nearer the potentiometers.

Next carry out the connections illustrated in Fig. 3.



A view inside the completed unit with its base plate removed

Some of the 5in. coloured leads can be shortened as necessary for neatness, but they should not be made excessively short. The photograph of the interior of the unit indicates the length of lead that is desirable. The right hand jack tags nearer the rear panel are joined together by a short length of tinned copper wire. This must be covered with sleeving as it may otherwise short-circuit to the switching contact tag of the input jack.

The black battery lead indicated in Fig. 3 can be a 6in. length of black p.v.c. covered wire which terminates in the negative battery connector. The two battery leads can then be twisted together over a short length for tidiness. (Alternatively, the black lead may be the black wire of the battery connector and flex assembly supplied by Wilsic Electronics.)

Wiring is now complete. Insert a battery in the clip on the base plate, fit the battery connectors to it and then replace the base plate.

The 'Vibratron' vibrato unit is now fully assembled and ready for use. ■

MEDIUM AND SHORT WAVE REFLEX RECEIVER

by

A. SAPCIYAN

This simple regenerative reflex receiver provides reception on the medium wave band and on short waves from 5.7MHz to 18MHz

SOONER OR LATER THE NEWCOMER TO RADIO construction becomes attracted by short waves and starts looking for a circuit capable of tuning the various bands satisfactorily.

A superhet is a must for a serious listener, but this type of receiver tends to be expensive and, in addition, its construction is rather complicated. In consequence, most home-constructors use simple regenerative receivers, which are nevertheless capable of giving good results. A reflex circuit with regeneration is quite satisfactory and offers a good performance without any difficulty. It may seem rather unlikely that short wave stations can be tuned in with a simple receiver of this nature, but such sets can perform better on the short wave bands than on medium waves.

SHORT WAVE RECEPTION

The receiver to be described in this article gives continuous coverage of the short wave bands from 5.7MHz to 18MHz in two ranges. A telescopic aerial is employed having a length of 3ft. No earth connection is necessary. In addition to this, medium wave reception is possible by means of a separate ferrite aerial. Range changing is carried out by a rotary switch and the use of plug-in coils is avoided.

The circuit, which is reproduced in Fig. 1, uses the reflex principle. Signals picked up by the telescopic or ferrite aerial are tuned by C1 and are amplified at r.f. by TR1. The diodes D1 and D2, which are in a 'voltage doubler' rectifier configuration, provide detection, and are coupled, for r.f. signals, to the collector of TR2 via C6. The detected signals then pass once more to TR2, this time for a.f. amplification. The collector current of the first stage should, for best results at r.f. and a.f., be around 1mA. VR1 enables this current to be provided and it controls the degree of regeneration and sensitivity. There is a certain level of automatic gain control since the diodes are d.c. coupled to TR1 base via the coupling coils of L1 or L2. Stronger signals cause the base of TR1 to go more positive.

The trimmer capacitors C3 and C4 are the feedback components. The former controls regeneration on the short wave bands and the latter controls regeneration on medium waves. It is necessary to use two different trimmers as the degree of feedback required will not be the same for short and medium waves. Both capacitors need only be adjusted once, after which they are left alone. Variable capacitor C2 is the bandspread component (i.e. it gives 'fine tuning') and is very useful while tuning short wave stations, particularly at the higher frequencies. For TR1 an AF125 is employed, this being the best amongst a wide range of types checked. It was preferred because of its better regeneration performance. The shield of TR1 is left open-circuit, this assisting regeneration. The value of R1 is very critical and that specified proved to be satisfactory with most diodes and transistors checked. It may possibly be necessary to adjust the value of R1 to obtain best results from VR1.

The signals, after being amplified at both r.f. and a.f. by TR1, pass to TR2 via a.f. coupling capacitor C8 and then to TR3 via C9. These two coupling capacitors should not be electrolytic types as these would affect the performance considerably. TR2 could be an OC44 instead of the OC75 quoted in the Components List, and it might be found that it gives better frequency response. TR3 is an OC75. The total consumption for all three stages is around 2.5mA.

The output is suitable for a low impedance magnetic earphone having a resistance around 150Ω; crystal earpieces are not recommended.

AERIAL COILS AND R.F.C.

The coil for the short wave band is wound on a normal Bakelite former of the 'Aladdin' type, with a diameter of approximately $\frac{1}{4}$in. and a length of 1in. The total number of turns for the tuned winding of L1 is 20 close-wound, being tapped at the 8th turn from the earthy end. The wire gauge is 32 s.w.g., silk covered. The coupling winding of L1 con-

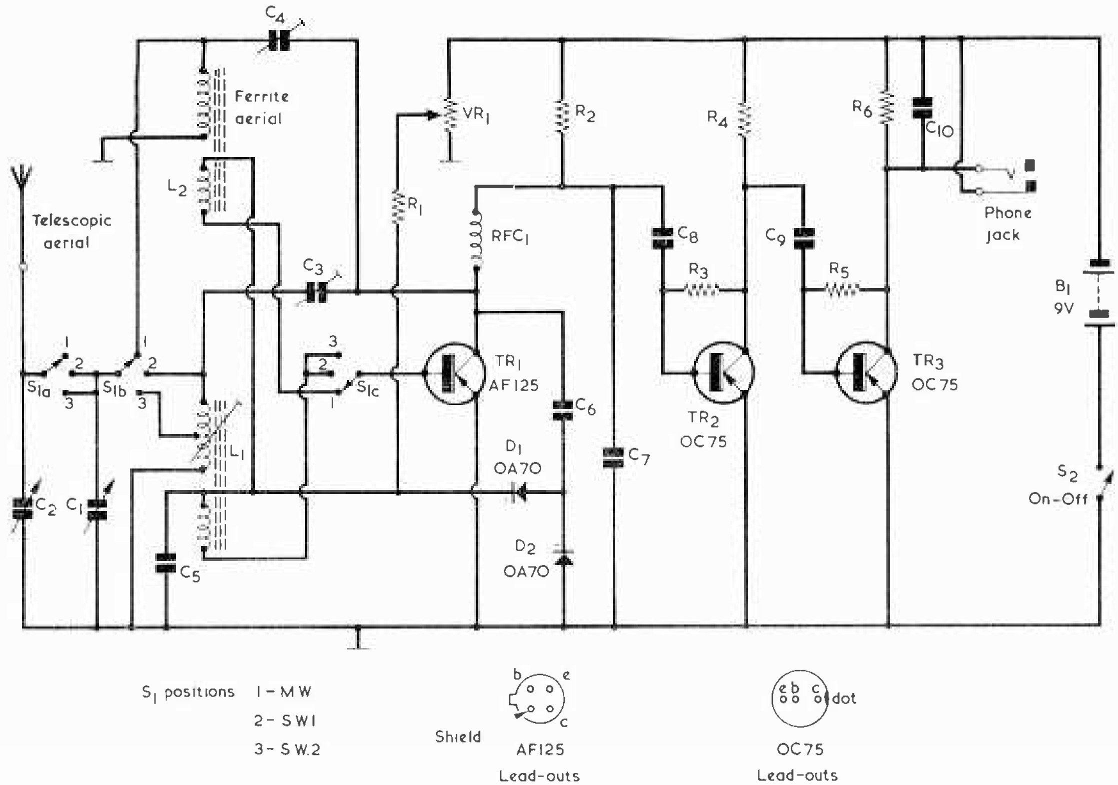


Fig. 1. The circuit of the reflex receiver. This provides coverage on medium waves and two short wave ranges

COMPONENTS

Resistors

(All fixed values ¼ watt 10%)

- R1 68kΩ (see text)
- R2 3.3kΩ
- R3 820kΩ
- R4 5.6kΩ
- R5 820kΩ
- R6 5.6kΩ
- VR1 100kΩ potentiometer, linear, with switch S2

Capacitors

- C1 150pF variable, air-spaced
- C2 25pF variable, air-spaced
- C3 60pF trimmer, Philips concentric
- C4 30pF trimmer, Philips concentric
- C5 0.01μF, paper or plastic foil
- C6 250pF, silvered mica
- C7 0.005μF, paper or plastic foil
- C8 0.25μF, paper or plastic foil
- C9 0.25μF, paper or plastic foil
- C10 0.01μF, paper or plastic foil

Inductors

- L1 Short wave coil (see text)
- L2 Medium wave coil (see text)
- RFC1 R.F. choke (see text)

Semiconductors

- TR1 AF125
- TR2 OC75 (see text)
- TR3 OC75
- D1 OA70
- D2 OA70

Switches

- S1(a)(b)(c) 4-pole 3-way rotary, miniature
- S2 s.p.s.t., part of VR1

Battery

- B1 9-volt battery

Miscellaneous

- Telescopic aerial, extended length 3ft. approx.
- Low impedance earphone, 150Ω, with jack plug
- Miniature jack
- 2 slow-motion drives type 4511/F (Jackson Bros.)
- 3 knobs
- Material for chassis and panel

sists of $1\frac{3}{4}$ turns of the same wire. The coupling winding is wound first and the tuned winding immediately after, the two windings being side by side without any spacing between them. For efficient dust core adjustment the winding should end close to the top of the former. The coil is not screened.

The writer used a ferrite slab with a length of 4in. and a width of $\frac{3}{4}$in. for the medium wave coil, L2. The tuned winding consisted of 73 turns of 30 s.w.g. enamelled wire and the coupling winding employed ten turns of the same wire. Both coils were close-wound and, as with the short wave coil, positioned side by side. The ferrite slab employed is not standard and constructors could alternatively use a $4\frac{5}{8}$ by $\frac{1}{2}$ by 5/32in. ferrite slab, as available from Henry's Radio, Ltd. Some slight adjustment of the number of turns in the tuned winding may be necessary to obtain precise coverage of the medium wave band. The coil is positioned approximately at the centre of the slab.

In both L1 and L2 the earthy end of the coupling winding should be adjacent to the earthy end of the tuned winding, as indicated in the circuit diagram.

A rear view of the wave-change switch and its wiring is given in Fig. 2.

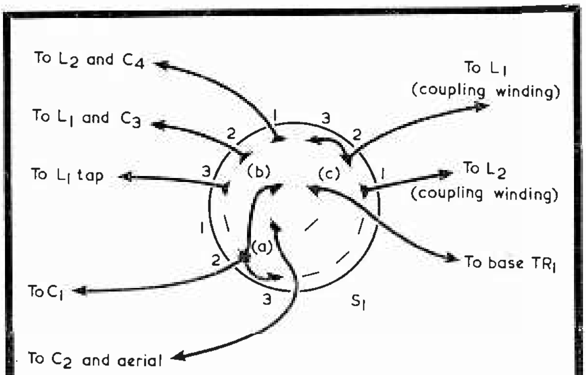


Fig. 2. Connections to S1, the wave-change switch. One of the switch poles is unused

The r.f. choke is a home-made component wound on a 1MΩ 2 watt resistor having a diameter of approximately $\frac{1}{4}$in. and a length of approximately $1\frac{1}{4}$in. The wire gauge is 36 s.w.g. silk covered. The total number of turns required is 900, this being given by random winding three pieces of 300 turns each. The number of turns need not be exact, and a few turns more or less will not make any difference. The coil ends are soldered to the lead-outs of the 2 watt resistor.

CONSTRUCTION

Construction is not critical, and the components can be laid out on a small chassis in much the same order as they appear in the circuit diagram. A metal front panel is required for C1, C2, VR1, S1 and the phone jack. C1 and C2 may each be fitted with a small epicyclic ball drive having a flange to take a piece of wire which functions as a tuning scale cursor. Suitable tuning scales are available in the Data Publications 'Panel Signs' series.

ADJUSTMENT AND OPERATION

In order to facilitate adjustment, the bands should be set up separately. There are two switch positions for the short wave band and one for medium waves. After all connections have been made and battery polarity checked, the receiver is switched on and set to one of the short wave ranges. The sensitivity control VR1 should be turned until oscillation starts. The most sensitive point is just below oscillation level, and VR1 should be capable of adjusting the regeneration level comfortably as it is turned towards maximum, which is given when the slider is at the upper end of its track in Fig. 1. If no oscillation occurs with VR1 at its maximum setting increase the amount of feedback by adjusting C3. If this does not produce satisfactory oscillation, try reversing the connections to the coupling winding of L1. The final setting for C3 is that which gives the best range of control in VR1 for both short wave ranges.

It should then be possible to tune in stations very easily. The degree of regeneration should be readily controllable by VR1, but if control is 'fierce' R1 can be increased to 82kΩ or higher. However, such a change should rarely be necessary.

The process is then repeated on the medium wave band, but in this case it is C4 which is adjusted. If the value of R1 has to be altered it will be necessary to choose a final value for this resistor which suits both medium and short waves.

Frequency coverage can be checked very easily on the short wave ranges by a signal generator, the output of which is very loosely coupled to the receiver aerial. If no signal generator is available a short wave radio could be used for coverage checks. The reflex receiver is put near the short wave radio and sensitivity control VR1 is advanced until the set oscillates. The oscillation can then be picked up on the radio. If will be found that the setting of C3 has an effect on coverage at the high frequency end of the short wave band.

The medium wave band does not require any coverage checking as the number of turns is approximately correct for the band. As already mentioned, it may be necessary to add or take off a few turns depending upon the slab employed.

The telescopic aerial is not employed for medium wave reception and this, together with bandspread capacitor C2, is left open-circuit by the wave-change switch when the medium wave band is selected. It is possible to use an external aerial but, since this may affect the degree of feedback and cause damping, it should be coupled to the receiver via a 100pF variable capacitor, the latter being adjusted for best performance. ■

WHO WAS HE?

Answer to query on Page 275.

Gerald Marcuse. After his experiments were over, the BBC inaugurated the Empire Service in 1932. It has now grown into the External Services, broadcasting in English and 39 other languages for 700 hours a week.

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

★ AUSTRALIA

The Darwin transmitters have been reported operating on **21485** (13.96 metres) from 0400 to 0600 and from 1000 to 1130 on **11765** (25.50m). A recently added channel, to the Pacific area and Asia, is **15395** (19.49m) from 0830 to 0930 in English.

★ CENTRAL AFRICAN REPUBLIC

Radio Bangui has an extended schedule until 2300 on **5035** (59.58m) 100kW. An English newscast is radiated at 2100 and at 2215; the main programme language is French.

★ CUBA

Radio Havana can be heard with an English programme to Central and South America on the recently added channel of **15270** (19.65m) 50kW for this service. Previously on **15285** in parallel with **17717,** the programme can be heard from 2015 to 2140.

The English service to Europe is now on **15155** (19.85m) from 2005 to 2135, this channel replacing that of **17815** previously used.

★ SEYCHELLES

FEBA now has another transmitter in use from 0100 to 0315 on **11920** (25.17m) and on **15185** (19.76m). From 1230 to 1645 on **11930** (25.15m) and on **15370** (19.52m) both transmissions in the English and Hindi languages to India, Pakistan and Ceylon. Also to the Middle East from 1700 to 1900 on **11935** (16.73m) in both English and Farsi (Persian) languages.

★ INDONESIA

The Voice of Indonesia, Djakarta, has moved from **11720** to **11795** (25.43m) with programmes in English from 0900 to 0930.

★ SWEDEN

The programmes to Eastern and North America from 1400 to 1530, in English, Swedish and French, on **21625,** have now been changed to **21505** (13.94m). The late night transmission in English, Swedish and Spanish can now be heard on **6175** (48.58m) from 0000 to 0230.

★ CANADA

Radio Canada has an Afro-European service, in English, from 0710 to 0745 on **9625** (31.17m), **5990** (50.08m), **15325** (19.58m) and on **17820** (16.84m).

The European service, in English, can now be heard on **15325** from 1217 to 1313 and from 2115 to 2152 on **9605** (31.23m), **11720** (25.60m) and **15325.**

★ SOUTH AFRICA

Radio South Africa radiates a Sunday morning transmission to Ireland and the U.K. from 1000 to 1150 on **21535** (13.93m) 250kW. An evening transmission, in English, is radiated throughout the week from 1800 to 1850 on **15155** (19.80m) and on **21480** (13.97m) both 250kW.

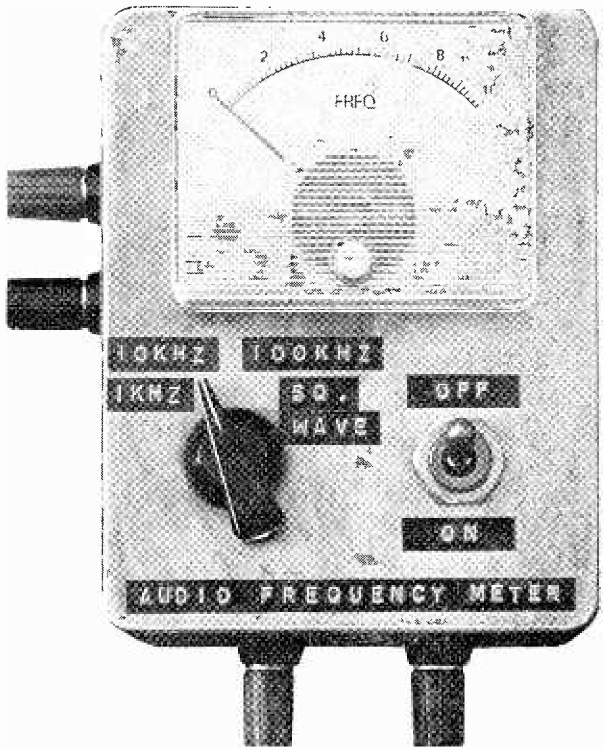
Acknowledgements:– Our Listening Post, SCDX.

AUDIO FREQUENCY METER

PART 2

by

J. T. NEILL



This concluding article describes the processes of construction and calibration. Also given are details of BBC audio frequency tone transmissions

CONSTRUCTION

SO FAR AS CONSTRUCTIONAL DETAILS ARE CONCERNED, there are few critical points, and the newcomer to integrated circuits can proceed with confidence. The size of the completed unit will depend largely on the size of the meter chosen and also on the source of power selected. It is recommended that a fairly large meter be employed for best reading accuracy.

Almost any method for housing the frequency meter that is thought suitable by the constructor can be used – in point of fact the first prototype was roughly wired up on Veroboard and the whole assembly carefully housed in a cardboard box, with the batteries, switches and meter connected up by trailing wires! However, the final version was put together in a robust diecast box, which is easily worked and provides good protection, both mechanical and electrical.

That part of the construction which does call for some careful attention is the detailed layout of the SN72709 and its associated components. It is strongly recommended that the layout follows closely that shown in Fig. 7 to ensure stability, bearing in mind the high gain and wide bandwidth of the op. amp.

The author's model, shown in the photographs published in Part 1, employs the 3.1 by 2.7 Veroboard illustrated in Fig. 7, and the components are mounted in an Eddystone diecast box measuring 4½ by 3½ by 2in. deep. Two PP3-type batteries are employed, these being held in position, when the lid is fitted, by two foam plastic pads secured to the lid alongside the Veroboard. In the photograph showing the front of the meter the input terminals are at the left and the square wave output terminals are at the bottom. A minor point is that, in the photograph of the interior, C1 is shown positioned between the input terminals rather than mounted on the board.

CALIBRATION

With wiring up completed and power applied, and with no input signal, check that the stabilised rail is at around 12 volts, the actual voltage depending on the zener diode used.

The output of the SN72709 should be close to half the supply rail voltage; when an input signal of, say, 500mV is applied with the range switch set to an appropriate range, the SN72709 output may change by a volt or so, depending on the characteristics of the particular op. amp. employed. When the input frequency varies, so then should the meter deflection.

If all is well at this stage, then calibration can proceed, and the means of carrying this out will depend very much on the other test equipment available to the constructor.

On Range 1 (up to 1kHz) an input signal of 50Hz, derived from the mains via a low voltage transformer and resistive divider at a level of, say, 0.5 volt r.m.s.,

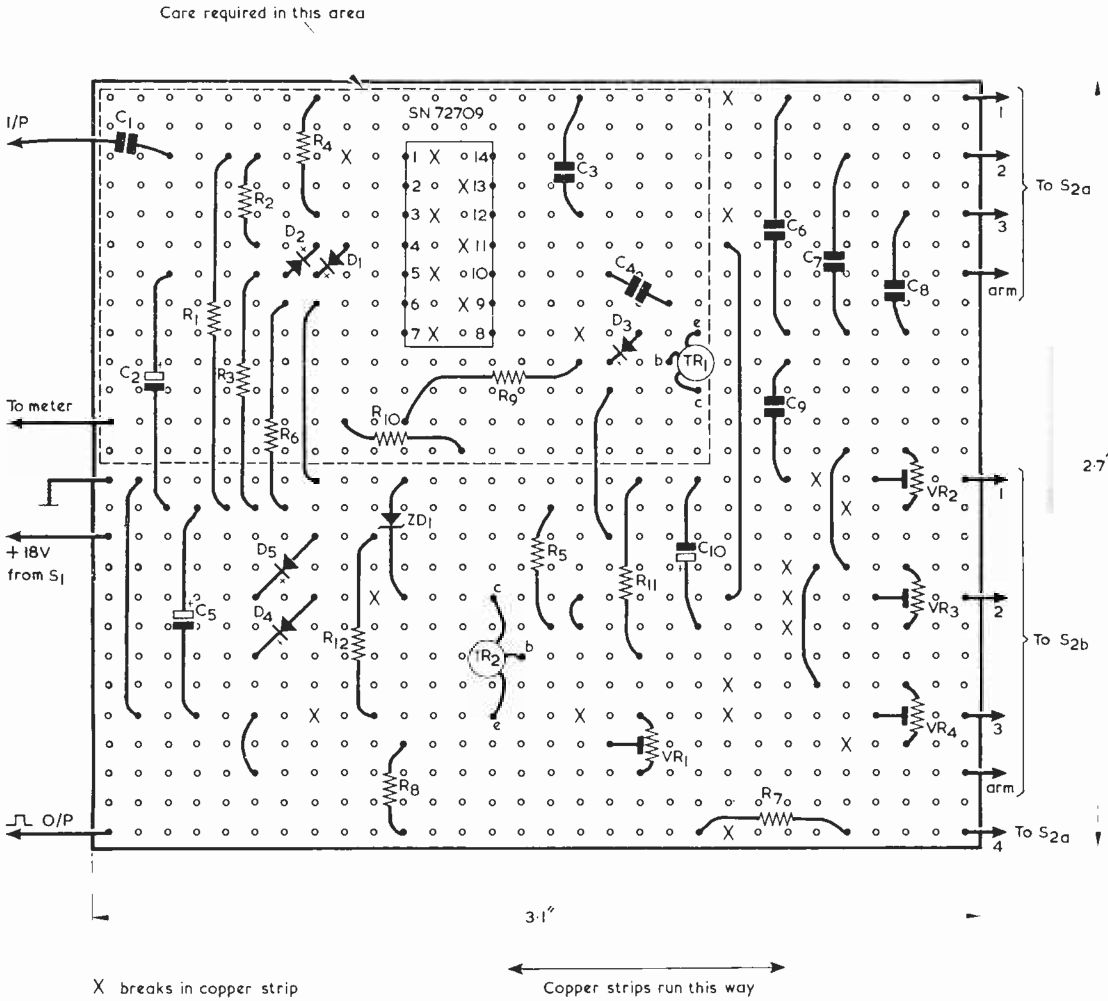


Fig. 7. Component layout on the Veroboard. This is viewed from the component side

will enable an adjustment to be made – although since it will be at 1/20 of full scale it will be only a rough one. The adjustment referred to is, of course, to VR2, which sets the value of meter shunt so that the correct meter deflection is arrived at.

A slightly better scheme is to use a bridge to rectify the transformer output before applying it to the resistive divider, as in Fig. 8. With the capacitive coupling its mean level adjusts itself so that effectively it appears to the frequency meter to be at 100Hz, which is a somewhat better frequency to use to adjust VR2.

With adjustment at only 100Hz on Range 1, and only one meter shunt for all ranges, as mentioned earlier, then only a low degree of accuracy will result. However, calibration on other ranges is possible if an accurate audio signal generator can be borrowed. Otherwise, use can be made of standard frequencies transmitted by the B.B.C. before and after programmes. A list of these is given in the Appendix.

It is often possible to connect from the receiver loudspeaker terminals to the input of the frequency meter for calibration purposes, but *great care* should be exercised in the case of mains-powered radios and television receivers. These almost always have their chassis connected to one side of the mains and connections to the frequency meter should be via a 500 working volt capacitor in each lead.

Should a good quality multi-speed tape recorder be available, a frequency can be multiplied by recording it at the lowest tape speed and replaying it at higher speeds. Thus, 1kHz replayed at four times the original tape speed gives an output from the recorder at 4kHz. This procedure can increase the number of test frequencies available.

Yet another scheme would make use of one of the test records marketed by some of the recording companies; these discs usually contain a large number of individually recorded frequencies and enable easy, accurate setting-up to be carried out.

In all these examples, where setting-up is done on

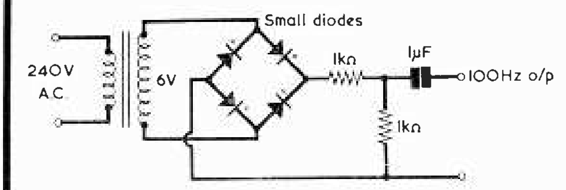


Fig. 8. Obtaining a 100Hz reference signal from the 50Hz mains supply

each range individually, then of course the appropriate meter shunt is adjusted, as brought into circuit by the second pole, S2(b), of the range switch.

As a final point in setting-up, the amplitude of the square wave output is adjusted by means of VR1. Besides the obvious uses of the frequency meter, it is possible to investigate the wow and flutter present in tape recorders.

For this purpose a stable tone of about 900Hz should be recorded on tape and then replayed into the frequency meter. Any frequency deviation present, due to wow and flutter, will be seen on the meter as jitter in the reading; the amount of this jitter is a measure of the amount of wow and flutter present in the tape recorder.

Another possibility is the modification of the unit to give a measure of the value of capacitors. For this, C6, C7 and C8 are replaced by an unknown capacitor and a fixed frequency input signal applied. Meter deflection is then proportional to the value of the unknown capacitor, whose value can thus be deduced. A suitable signal frequency must of course be employed.

Appendix

The following information, which was supplied by the B.B.C., will enable constructors to undertake calibration to a very high degree of accuracy.

250Hz. Radio 3, from five minutes to 35 minutes after closedown.

440Hz. Radio 2, from four minutes after closedown to two hours before the start of programmes. Radio 3, from six minutes to one minute before the start of programmes. Radio 4, from seven minutes to three minutes before the start of programmes.

1kHz. Radio 4, from four minutes to 34 minutes after closedown.

Additionally, when practicable, tones will be broadcast on TV sound during test transmissions; 440 Hz. on BBC 2 and 1kHz. on BBC 1.

It should be noted that no guarantee is given that any particular tone will be transmitted. Many of the transmitters are automatically operated and are switched on and off by time switches, set to operate at about 20 minutes before and after programmes. ■

INDEX

RADIO CONSTRUCTOR'S DATA SHEETS

NEW CATALOGUE

Now available is the latest 1971 edition of the Home Radio catalogue. This has 315 pages and lists over 8,000 components, more than 1,500 of which are illustrated. As with previous Home Radio catalogues, great attention has been paid to clarity and all items are fully cross-indexed as necessary. The components listed cover the full gamut of parts likely to be needed by the amateur constructor and experimenter.

Of added interest, particularly in view of the Post Office strike earlier this year, is the advice given concerning ordering and delivery. Components may be ordered by telephone (for which there is a night answering machine), by order form or by bank Giro. Similarly, deliveries may be made via post, British Rail Parcel Express Service or British Road Services. Another feature explained in the catalogue is the method of opening a credit account.

The catalogue is available from Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey, CR4 3HD, at 50p over the counter or 70p by post. It incorporates ten cut-out discount coupons for 5p each.

NEW PRODUCTS

ECONISTORS

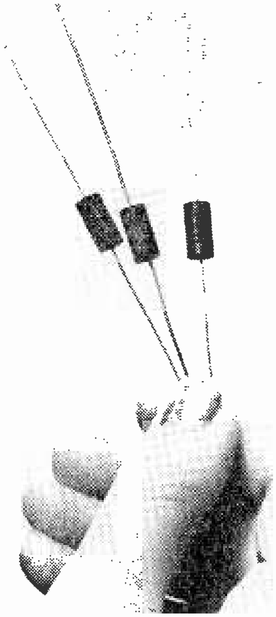
Precision wirewound resistors, Econistors, have now been added to the Guest International range of electronic components.

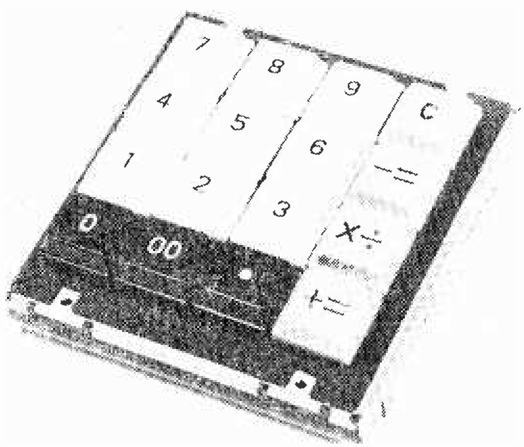
Econistors are supplied in 49 standard resistance values from 10 ohms to 1 megohm with resistance tolerances of 0.005%, 0.01%, 0.025% and 0.1%. The temperature coefficient is ± 3 ppm per degree C maximum from −55° to +125°C. Long-term stability is ± 25 ppm per year and still less than 50 ppm per year after three years operation under normal conditions.

All windings are multiple Pi and balanced to minimise the effect of capacitive reactance. The winding is encapsulated in low leakage Epoxy to ensure reliability and long-term stability.

The body size is 13mm long with 7mm diameter. The axial leads are tinned copper.

Econistors are also available in non-standard values but to maximum of 1.1 megohms.





KEYBOARD SWITCHES

FR Electronics announce the addition of the Alps Gold M16 Keyboard to their growing range of Keyboard Switches.

The Gold M16 is a low profile 4 x 4 matrix keyboard utilising sealed reed switch contacts as the switching medium. The contacts are rated at 12v 0.1A and offer an initial contact resistance of less than 500MΩ including printed circuit. The units have an overall size of 72mm x 74mm x 24mm and are ideally suited to applications such as desk top or pocket calculators.

SOLID STATE RELAYS

FR Electronics have also introduced a compact unit into their range of Control-Pak Solid State Relays.

It is a standard switching unit for A.C. Loads of 4 amps continuous rating at either 120V or 240V supply.

Input is electrically isolated from the load and is triggered by either non-isolated contact closure or D.C. inputs of 5, 12 or 24 Volts.

Inductive and capacitive loads can be handled with inrush up to 60 Amps.

Control-Pak units are completely encapsulated for use in corrosive and other hazardous environments, long life where shock and vibration resistance is required or where rapid switching is required.

The style C unit measures 54mm x 32mm x 25mm and has an expected switching life in excess of 100 million operations.

THE 'EUROPAVERTER' 49-METRE BAND CONVERTER

by

DESMOND WALSH

This small and inexpensive 2-transistor unit opens up one of the main short wave entertainment bands by converting its transmissions to medium wave frequencies

THE CONVERTER WHOSE CONSTRUCTION is described in this article is called the 'Europaverter' because it enables the Europa or 49 metre broadcast band to be received on any radio covering the medium wave band. This Europa band (as it is called by many Continental manufacturers) is very popular in Western Europe for broadcasting, especially during daytime. Quite a number of stations operating in the band offer good signals in the British Isles and the 'Europaverter' provides a cheap and simple means of listening, whether in the home, in the car, or out of doors.

CRYSTAL CONTROL

The 'Europaverter' is a 2-transistor crystal controlled converter, and changes signals in the 49 metre band to the medium wave range. TR2 is in the oscillator stage, and is a germanium p.n.p. transistor type OC170. See Fig. 1. A quartz crystal, X1, is connected between collector and base. A tuned circuit, given by L3 and C2, and which is tuned approximately to the crystal frequency, is connected in the collector circuit of TR2. TR1 is the r.f. amplifier-mixer, and is also an OC170 transistor. The base of TR1 is tapped into the input coil, L2, to provide matching, and a coupling winding enables external aerials to be connected. Oscillator signals coupled by L4 into the emitter circuit of TR1 mix with 49 metre signals, and a tuned circuit connected to the collector, L5, C4, selects resultant signals in the medium wave range. The bandwidth of the medium wave tuned circuit is not really wide enough to cover the 300kHz or so of the 49 metre band so the peaking capacitor, C4, is provided. Since the unit operates with a fixed oscillator frequency,

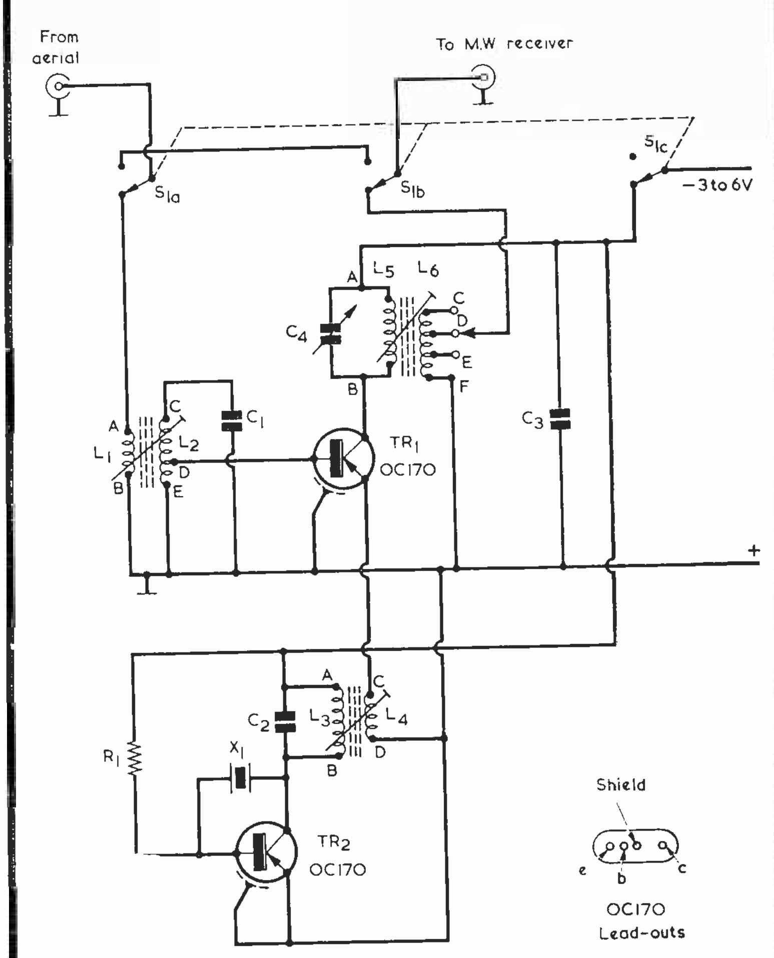


Fig. 1. The circuit of the 'Europaverter'. This causes transmissions on the 49 metre band to be converted to medium wave frequencies

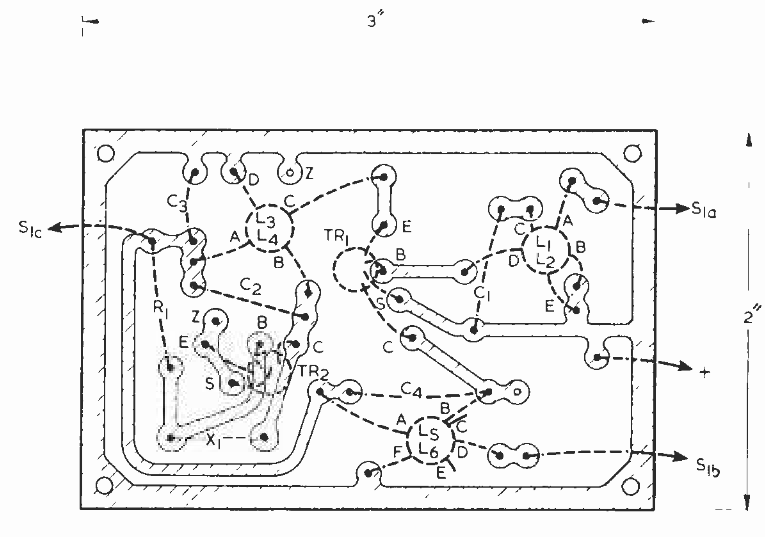
tuning along the 49 metre band is achieved by adjusting the tuning of the medium wave receiver.

The unit functions with supplies in the 3 to 6 volt range. At 4.5 volts current consumption is about 5mA. Section S1(c) of S1(a)(b)(c) switches the unit on and off. When switched off, sections S1(a) and (b) bypass the converter circuitry and transfer the aerial direct to the medium wave receiver.

Printed circuit construction enables a neat and mechanically stable unit to be constructed. The layout of the copper laminate board is given so that constructors can obtain similar results to the author.

CRYSTAL FREQUENCY

Any physically small crystal in the computed range can be utilised, common types being FT243 and HC6U. The author used a surplus type FT243 of frequency 7,100kHz. (A wide range of crystals is available from Henry's Radio Ltd., including a type FT243 at 7,100kHz.) The author's crystal frequency mixes with 6.1MHz to give 1MHz (300 metres) and with 5.9MHz to give 1.2MHz (250 metres). The tuning sense is thus reverse, i.e. tuning upwards in frequency on the medium wave band results in tuning towards the low frequency end of the 49 metre band. If the opposite sense of tuning is required the crystal must be on the low frequency side of the band. Crystals in the 5.2 to 4.6MHz range enable the 49 metre band upper limit of 6.2MHz to be reached within 1.0 to 1.6MHz on the medium wave band. Crystals in the 6.9 to 7.5MHz range will enable all the 49 metre band to be received with tuning in the reverse sense. The low limit of 5.9MHz will then be in the range 1.0 to 1.6MHz. Dust cored coils, of which details are given later, enable resonance in the crystal frequency ranges to be reached.



Not shown: jumper wire between points Z

Fig. 2. Copper side of the printed circuit board. The components are on the reverse side. The board is reproduced full size and this diagram may be traced

COMPONENTS

Resistor
R1 See text

Capacitors
C1 20pF silvered mica
C2 20pF silvered mica
C3 0.005µF ceramic
C4 250pF to 350pF variable, solid dielectric

Inductors
L1 to L6 See text

Transistors
TR1 OC170
TR2 OC170

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

Crystal
X1 quartz crystal (see text)

Battery
3V, 4.5V or 6V battery

Miscellaneous
2 control knobs
2 coaxial sockets
Crystal holder (optional – see text)
Copper-clad board, 3 x 2in.
Material for chassis.

PRINTED CIRCUIT

A piece of copper laminated board 3in. by 2in. is used, and is prepared in the following manner. The layout is copied from Fig. 2 (which is reproduced full size) to the circuit board by means of a pencil or felt-tipped pen. The shaded areas representing the copper to remain are shielded from the etching solution with gloss or cellulose paint applied with a very small and fine paint brush. Neatness, though not really contributing to the working of the unit, nevertheless enhances its appearance, an important point when showing the completed converter to friends. The etching solution is ferric chloride solution. Addition of a small amount of dilute sulphuric acid will shorten the time taken to etch the copper. Heating the solution will do likewise. When all the unprotected copper has gone from the board, this is flushed clean and the paint is scraped from the board. The copper is then cleaned with an abrasive metal polish, all traces of which must be removed before components are connected to the board. The holes for the component leads are drilled with a very small bit, this being $\frac{1}{16}$in. or smaller. Care must be taken here as excessive straining on the bit will snap it.

COILS

The author's coils were wound on surplus dust cores $\frac{3}{16}$in. in diameter and $\frac{1}{2}$in. long, with brass threaded stems. These dimensions are just a little smaller than those of standard 6mm. threaded dust cores. A piece of gummed paper tape with sticky side outward was wound round each core to form a sleeve, with the core a nice sliding fit inside. See Fig. 3. The sleeve then acts as a former. The smaller winding of each coil, i.e. L1, L4 and L6, is wound on first in all cases. The larger winding is then wound over on top. The windings are not very critical and can be random wound over $\frac{1}{4}$in. of the paper sleeve. It will be noted that L6 has three taps. These offer outputs at high, medium and low impedance to suit the particular receiver with which the converter is used.

Readers employing different cores (or different crystal frequencies) may find it necessary to experiment a little with the turns on the tuned windings, i.e. L2, L3 and L5. If it is found that maximum strength of a received 49 metre signal is obtained with the dust core too far out of the coil, turns need to be

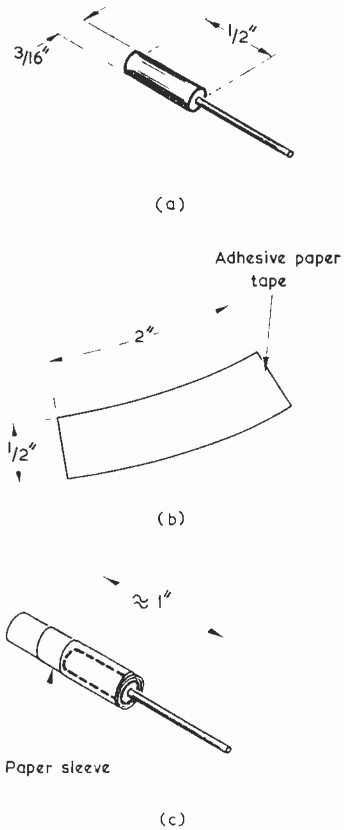


Fig. 3(a) Dimensions of the dust core employed in the prototype. (b). The adhesive paper tape. This is applied spirally, sticky side out, around the core. (c). After trimming at the ends, the paper tape functions as a coil 'former'

TABLE

Winding Details of Coils in Prototype

(All coils are wound with 28 s.w.g. enamelled s.c.c. wire)

Coil	*No. of turns*
L1	10
L2	75. tapped at 10 turns from chassis end
L3	75
L4	10
L5	150
L6	50. tapped at 10 and 20 turns from chassis end

taken off accordingly. Should maximum signal strength be given with the core fully in the centre of the coil, a few turns need to be added. Winding direction is not important. The winding turns employed in the author's unit are listed in the accompanying Table.

For final alignment, the aerial coil, L2, is adjusted for maximum signal strength at about 6.05MHz and is then left, after which the oscillator coil, L3, is similarly set up for maximum signal strength. C4 should be capable of peaking the medium wave signals which result from all signals in the 49 metre band.

The coils can be connected directly to the board by means of their leads. Only one of the taps in L6, that which is found best for the particular medium wave receiver being used, is connected to the board.

The printed circuit board is mounted on the base of a small L-shaped aluminium chassis which also provides the front panel, on which are mounted C4 and S1(a)(b)(c). The size of the components used here determines the dimensions of the panel. Note that neither side of C4 is at chassis potential, whereupon its mounting bush must be insulated from the panel. Its moving vanes should connect to the negative supply rail.

Coaxial sockets for the input and output may also be fitted on the panel. The lead to the receiver should be kept reasonably short, and it consists of coaxial cable. The outer conductor of this cable connects together the chassis of the converter and the chassis of the receiver.

The two circuit points on the printed circuit board for X1 have ½in. spacing to suit the crystal used. Some simple means of making contact to the crystal pins, by way of small pieces of thin springy metal, may be devised. Alternatively, a crystal holder can be affixed to the board.

The battery for the unit may be any 3 volt, 4.5 volt or 6 volt type. For a 3 volt supply, R1 should be 470kΩ, for a 4.5 volt supply it should be 680kΩ; and for a 6 volt supply it should be 820kΩ. Whatever value is employed, the resistor is a ¼ watt 10% component.

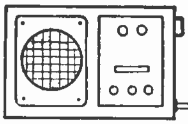
OPERATION

Results with this simple unit have been very pleasing. About ten stations at good strength have been received during the daytime with a 20ft aerial and, naturally, very many more at night.

The author has used the unit mainly with a car radio, which has good screening and therefore does not pick up medium wave signals which could beat with the converted 49 metre signals. If the unit is employed with a transistor portable radio, strong medium wave signals will of course produce beats with converted 49 metre transmissions. During daytime it may be possible to rotate the set for minimum medium wave signal, but for reception at night it will be necessary to screen the receiver. This is not a particularly drastic operation, especially with a small radio, as it can be carried out by covering the receiver with metal foil or by putting it in a large open biscuit tin.

As a final point, the current consumption of the protoype was 3mA from a 4.5 volt battery before the crystal was fitted. It rose to the 5mA level mentioned earlier when oscillating. ■

In your work-shop



As usual, Christmas Eve finds Smithy the Serviceman, aided by his able assistant, Dick, working hard on the inevitable rush of receivers which have to be made ready by Christmas Day. Nevertheless, the pair still manage to finish early enough to enable Smithy to conclude the discussion on microphones which he commenced last month

IT WAS THE DAY BEFORE Christmas. It was the time of Christmas cards, of Christmas decorations, of Christmas presents and of Goodwill to All Men. It was the time of office parties, unaccustomed cigars, snow, public house extensions and the entertainment of mothers-in-law. It was the time of preparation of vast quantities of turkey and of duff; whose consumption would be accompanied by unwonted draughts of sherry, gin or vodka; and it therefore heralded the period of testy lassitude, dyspepsia, throbbing heads and fizzing Alka-Seltzers which would inevitably follow.

Christmas: season of *schmaltz* and sallow slothfulness.

On this Christmas Eve both Smithy the Serviceman and his assistant Dick had decided to give the festivities a miss. On the previous year Dick had laboured extensively in providing and putting up decorations for the Workshop, and had then flatly refused to take them down again afterwards. Those decorations had been the cause of harsh words between the two, and they both looked back upon the incident with suppressed bitterness. By tacit consent Workshop business was, this year, carried on as usual: the benches were unsullied by Christmas cards or by any other concessions to the Yuletide spirit, and the whole place had the brisk and bustling atmosphere of an efficient servicing establishment, with no nonsense about it.

CARBON MICROPHONE

And the work *was* brisk, too. As happened every year at this time the pair were inundated with faulty TV sets, record-players and radios which had, for some strange unaccountable reason, all decided to cease operation in the few days preceding Christmas. It was not until the afternoon was half-way through that they were able to clear up the last set and to carry it proudly over to the heavily laden 'Repaired' racks.

"Phew," said Smithy, mopping his brow as he collapsed upon his stool. "These Christmas Eves get worse as the years go by."

"It was certainly a stinker today," agreed Dick. "Thank goodness there are no more sets to do until after Christmas."

"Thank goodness, indeed," echoed Smithy. "And thank goodness also that we haven't bothered to go all Christmassy this year. I'm certain that we'd never have been able to finish as early as we have done if we hadn't treated today just like any other working day."

"There's little doubt about *that*," confirmed Dick. "In any case, what's so special about today? It merely happens to be the 24th of December, that's all."

"True," agreed Smithy. "What's more, since we're treating today just the same as any other day, I'm going to finish it off by having a little gen-session with you."

Dick's jaw dropped open.

"You're *offering*?"

"I am," confirmed Smithy gravely. "You may recall that during our last little natter together we discussed microphones, and I said that I'd continue with that subject at a future date. This was because I wasn't able at that time, to cover all the microphone types that are available."

"Blimey, Smithy," said Dick appreciatively, "this really *is* unexpected. Well, the last time we talked about microphones you told me about the moving-coil, crystal and ribbon types. What other sorts of microphone are there?"

"Quite a few," replied Smithy. "To start off with, I'll deal with one of the commonest microphones that's going. This is the carbon microphone which is, of course, employed in telephone handsets. We don't use carbon microphones very often in normal electronic work but it's nice to know something about them nevertheless. You can sometimes obtain G.P.O. type carbon microphones in handsets sold by surplus stores and you can get quite a bit of fun playing around with these. I want to sketch out a few of the things I'm going to talk about, so would you please come over to my bench?"

Obediently, Dick picked up his stool, carried it over to Smithy's side and perched himself on it. Smithy had already pulled his note-pad towards him and was scribbling on the top sheet. (Fig. 1)

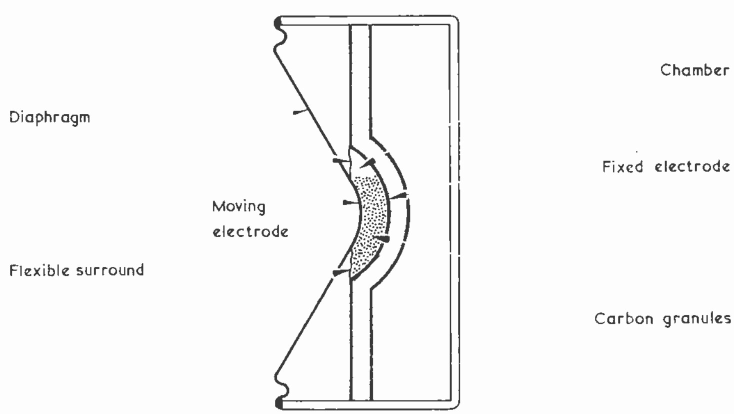


Fig. 1. The basic construction of the carbon microphone

"Here's the basic set-up for a carbon microphone," he announced. "There's a fixed electrode and a moving electrode, the latter being atttached to the diaphragm. Between the two electrodes is a space or 'chamber', this being nearly filled with fine particles of carbon, which are called 'granules'."

Smithy stopped for a moment and drew a further sketch. (Fig. 2)

"When you speak into the micro-

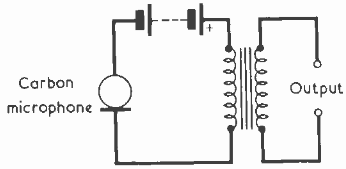


Fig. 2. Connecting the carbon microphone into a working circuit

phone," he continued, "the diaphragm moves in and out in sympathy with the sound waves, as also does the moving electrode. The resistance between the two electrodes, which is given by the contact resistance between the carbon granules, then varies. It goes down when the moving electrode moves inwards and causes the granules to be more tightly compressed, and it goes up when the moving electrode moves outwards and reduces the pressure on the granules. If the electrodes are connected in series with a battery and the primary of a transformer, the varying resistance causes the current in the primary to change at the audio frequency impressed upon the diaphragm. That audio frequency then becomes available, as an alternating voltage, from the secondary of the transformer."

"Yes, I see," said Dick. "There are one or two things that I'm not too sure about here, though. For instance, does the microphone always exhibit the same average resistance?"

"Oh no," replied Smithy. "Every time the microphone is moved in any way the granules flow into new positions and so the average resistance offered by the microphone can vary quite considerably whilst it is being used. Because of this random movement of granules a carbon microphone introduces a lot of background noise. Incidentally, modern telephone carbon microphones are designed to ensure that there is always a mass of granules between the two electrodes for all reasonable positions of the microphone. This is achieved by careful design of the shape of the chamber which holds them. Funnily enough, it is a good thing to move a telephone carbon microphone around a bit every now and again, as is given by lifting and replacing the handset when making a telephone call, because this keeps the granules mobile and prevents them packing."

"Packing?"

"Packing," confirmed Smithy. "If they aren't moved around occasionally they tend to pack, or settle down into a semi-solid mass, and the microphone then becomes very inefficient."

"How do they make the granules? Do they chop up bits of carbon?"

"Oh no," replied Smithy. "Ordinary carbon isn't hard enough to be used for microphone granules; it's much too crumbly and it tends to break up into dust. What they use nowadays, believe it or not, is powdered anthracite coal. This is crushed and ground and the subsequent granules are sorted out for size and given a special heat treatment. A typical granule, by the way, is of the order of seven or eight thousandths of an inch in diameter. And that's pretty well enough about carbon microphones. They have the disadvantage of introducing distortion and they offer a noisy background, and it is for these reasons that we don't normally employ them in electronic work."

"Why do the Post Office use them so much, then?"

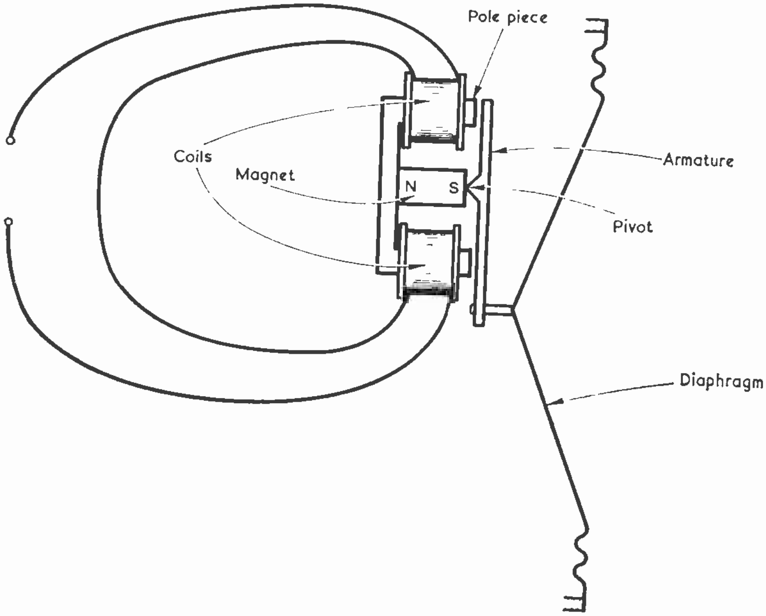
"Because they're inherently self-amplifying. The sound waves do not have to generate the corresponding electrical signal directly, as occurs with other microphones; they merely have to modulate a standing electric current. As a result, carbon microphones offer very much higher electrical outputs than other types of microphone, and it is this factor which makes them so useful for telephone applications."

ROCKING-ARMATURE MICROPHONE

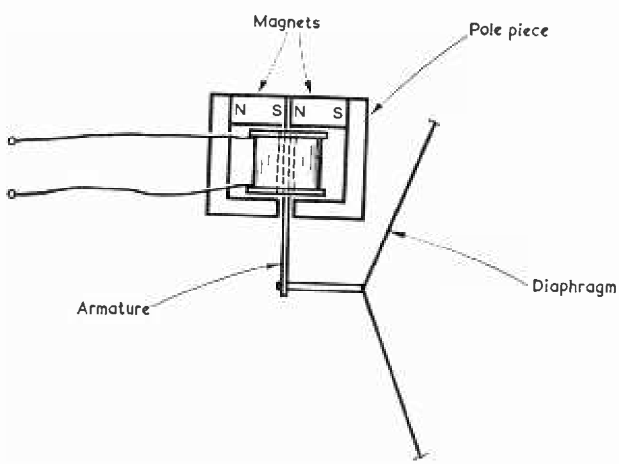
Dick looked momentarily out of the window. It was already beginning to get dark and a few snowflakes were falling, forming an irregular outline at the lower part of the window-frame.

"Think of all those twits outside," he remarked scornfully. "All of them charging around getting last things in for Christmas. They should be like us and just ignore it."

"True, true," said Smithy, preoccupied. "But let's keep on with this microphone business. Now, I want to clear up a few other sorts of microphone next. These fall into the category of moving-iron microphone. Many of them are virtually the same in basic design as an ordinary magnetic headphone. Indeed, a headphone, particularly one of the large 2,000Ω types, makes quite a useful microphone if you're prepared to accept the low quality it offers. It can offer a surprisingly



(a)



(b)

Fig. 3(a). The method of operation of the rocking-armature microphone. (b). In balanced-armature microphones the armature is positioned centrally between opposite magnetic polarities, as in the typical example shown here. The coil is fitted around the armature but need not be mechanically secured to it

high a.f. output."

"I seem to have heard a lot recently," remarked Dick, "about rocking-armature headphones and microphones. Are these moving-iron types?"

"Oh, definitely," said Smithy. "Both the headphone and the microphone have the same basic construction, which consists of an armature which is free to rock between a central magnet and two pole pieces. Here's the general idea."

Smithy scribbled out a sketch illustrating the rocking-armature construction. (Fig. 3(a).)

"As you can see," he went on, "when the armature rocks in one direction it increases the flux density in one pole piece and decreases it in the other. The alterations in flux density then induce currents in the coils wound on the pole pieces. These coils are connected in series and the electrical a.f. signal corresponding to the sound which actuates the armature then appears at the two outside terminals. As with the other moving-iron microphones, the rocking-armature type does not feature very often in present-day electronic work. There are other types of moving-iron microphone, too, of which the balanced-armature type represents an example. A typical balanced-armature construction is like this."

Smithy scribbled another diagram. (Fig. 3(b).)

"And that's all the attention we need give to moving-iron microphones," he resumed. "So let's get on to the next type."

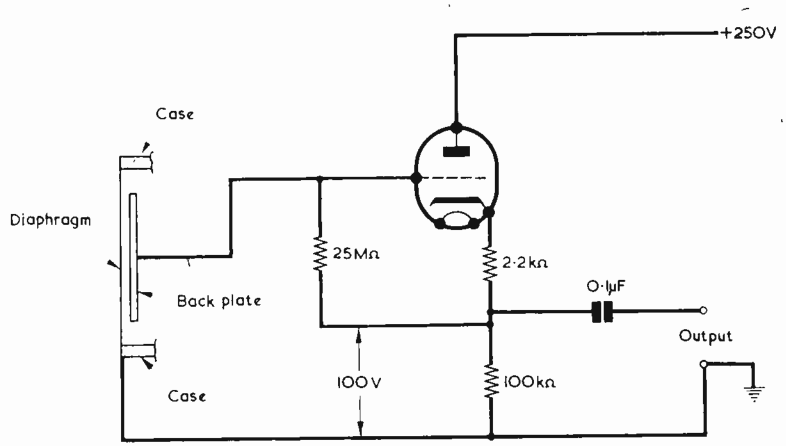


Fig. 4. The capacitor microphone consists essentially of a metal or metallised diaphragm positioned very close to a fixed back plate. This rather early valve head amplifier circuit serves to demonstrate the resistances and voltages required for successful operation

CAPACITOR MICROPHONE

"What type is that?"

"The capacitor microphone," replied Smithy, "or, as it is still quite frequently referred to, the condenser microphone. This consists fundamentally of a flat diaphragm made of a conducting material which is positioned very close to a flat metal back plate. The diaphragm and back plate are insulated from each other, and they constitute a capacitor."

"Oh, I see," interposed Dick. "I suppose that the diaphragm moves under the influence of sound, with the result that the capacitance changes in sympathy with that sound."

"That's the idea," confirmed Smithy. "Now, the average capacitance between the diaphragm and the back plate is small and the deviations in capacitance are even smaller, and so the leads connecting the diaphragm and the back plate to the subsequent amplifier need to be kept very short. In consequence, what is described as a head amplifier is built into the case of the microphone itself. In most instances, nowadays, the head amplifier incorporates a field-effect transistor, but let's start off by taking an example of the older type of microphone in which the head amplifier employed a valve. This is because the valve circuitry makes a good introduction to the basic principles involved."

Smithy pulled his pad towards him once more, and proceeded to sketch out a circuit diagram. (Fig. 4).

"As you so rightly said just now," he went on, "the capacitance in the capacitor microphone varies with the movement of the diaphragm. We want to convert these capacitance changes to voltage changes and the only way we can do that is to charge up the capacitor and do our best to see that it cannot discharge quickly. We have to ensure that it cannot discharge at a rate which is comparable with the time taken up by half a cycle at the lowest audio frequency we want the microphone to handle. If the capacitance is able to discharge too quickly, reproduction of the lower frequencies will be reduced."

"It would seem," said Dick "that whatever discharge takes place occurs by way of some sort of resistance. Would it be safe to say that it would be in order to reduce the value of this resistance if the value of the capacitance between the diaphragm and the back plate could be increased?"

"It would," agreed Smithy. "In fact that's quite a shrewd remark on your part."

"And," continued Dick, encouraged, "do we get a voltage change when the capacitance changes because of this business of a capacitive charge being equal to voltage multiplied by capacitance?"

"Blimey," said Smithy, impressed, "you *are* with it today. You're quite right, too; the situation is governed by the equation $Q = CV$, where Q is the charge in a capacitor in coulombs, C is the capacitance in farads and V is the voltage which caused the charge to be taken up. If the charge doesn't leak away, changing the capacitance *must* vary the voltage across the capacitor. Now let's get back to that circuit I drew out a few moments ago. If you look at this, you'll see that the capacitor microphone diaphragm and back plate connect between earth and the grid of a triode valve. The voltage which causes the diaphragm and back plate to acquire the charge is the 100 volts which appears across the resistor in the cathode circuit of the valve. This is known as the polarising voltage and it is applied to the diaphragm and back plate via a 25MΩ grid resistor. Thus, the capacitor microphone has a voltage of 100 volts across it. The capacitance between the diaphragm and back plate of a capacitor microphone is of the order of 50pF only, which corresponds to a reactance of about 30MΩ at 100Hz, and we might at first sight expect that the response at this frequency would be seriously down when the discharge resistor is only 25MΩ, as it is in my diagram. However, there is a form of boot-strapping at the cathode of the triode, and the lower end of the 25MΩ resistor follows the voltage changes across the diaphragm and back plate when the diaphragm moves. So, when the voltage across the diaphragm and back plate capacitor increases so also, by nearly the same amount, does the lower end of the 25MΩ resistor, and the discharge current due to the increased voltage becomes much lower than it would have been if the lower end of the resistor had stayed at a fixed potential. In other words, the discharge circuit presented to the capacitor is, effectively, considerably higher than the physical value of the grid resistor."

"That seems fair enough," said Dick brightly. "The only snag so far as I can see is that even if you do get the grid resistor value down to 25MΩ there are still liable to be troubles due to leakage resistance between valveholder tags, and so on."

"That's very true," confirmed

Smithy. "One of the difficulties with capacitor microphones employing valve head amplifiers has been the necessity of keeping valve and valveholder leakage resistances to as high a level as possible. Apart from attenuating the bass response, such leakage resistances are liable to introduce noise. At least one design overcame this problem by completely encapsulating the head amplifier, including the valve, in a block of resin. Another trouble resulting from the use of a valve as head amplifier is microphony in the valve. Yet a further snag is the necessity of supplying the valve with heater and anode currents."

"I suppose," remarked Dick, "that all these difficulties are removed if the valve is replaced by a field-effect transistor."

"They're certainly considerably eased," said Smithy. "But, before getting on to the f.e.t. head amplifier let me quickly show you a cunning circuit that was occasionally employed with valve head amplifiers when it was necessary to couple the microphone to the head amplifier by a short length of screened cable. The circuit isn't applicable to present-day capacitor microphone techniques but its basic method of operation lends itself to lots of other applications where it's necessary to screen a high impedance a.f. signal coupling lead, and where you don't want a high cable self-capacitance to be connected across the source of the signal."

Smithy tore the top sheet from his note-pad and drew out the circuit. (Fig. 5).

"Here you are," he announced. "This circuit is the same as the last one I sketched out, with the exception that the microphone is now coupled to the head amplifier via screened cable. Note that the cable isn't of the ordinary type. Instead, it's of the double-screened variety and consists of a central conductor and two concentric screens. The outside screen connects to earth, whilst the inside screen couples to the cathode of the head amplifier. We now have the same sort of effect as we had with the grid resistor. When the voltage from the capacitor microphone increases so, by very nearly the same amount, does the voltage on the inside screen. Because of this, charge and discharge currents into the self-capacitance between the centre conductor and the inside screen are very much smaller than would be given if the inside screen were at fixed potential, and the effective capacitance between the centre conductor and the inside screen is considerably reduced. There will, of course, still be a relatively high self-capacitance between the inside and outside screens, but this couples across the low output impedance of the cathode follower and, assuming reasonable component values, has little effect on the overall response."

F.E.T. HEAD AMPLIFIER

"Gosh, that's neat," said Dick enthusiastically. "You could use that approach in all sorts of circuits where you want to take a low-capacitance a.f. screened coupling from one point to another."

"You could, indeed," agreed Smithy. "And, of course, the valve cathode follower could be replaced by a transistor emitter follower or by an f.e.t. source follower."

He looked at the Workshop clock and gave a sigh a satisfaction.

"Only an hour to go before official packing-up time," he remarked

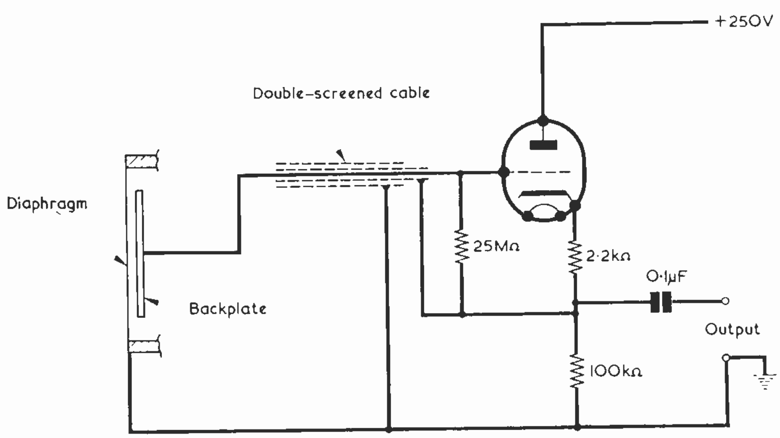


Fig. 5. A screened coupling to the microphone is permissable if double-screened cable is employed in the circuit shown here

contentedly. "After that we close down for the holiday."

"Good show," responded Dick. "I suppose we'll then have to fall in with everybody else and put up with all this Christmas business."

"I suppose so," said Smithy resignedly. "Still, it will soon be over, and everything will be back to normal again afterwards."

"I can hardly wait," commented Dick. "I've got really disenchanted over Christmas these days. It's just a period of commercial exploitation."

"Exactly," agreed Smithy. "For instance, just look at the price of Christmas cards. I bet somebody's making a bomb there."

"It's the same," grumbled Dick, "with all the other things people get at Christmas time. All those nuts and dates and figs and things."

"They only give you indigestion."

"Of course they do."

The pair fell silent for a moment as they pondered on the excesses of the Festive Season.

"Oh well," said Smithy eventually. "Let's get back to these capacitor microphones."

"Right-ho," replied Dick wearily. "Well, we've cleared up the capacitor microphones which use valve-head amplifiers. What about those with f.e.t. head amplifiers?"

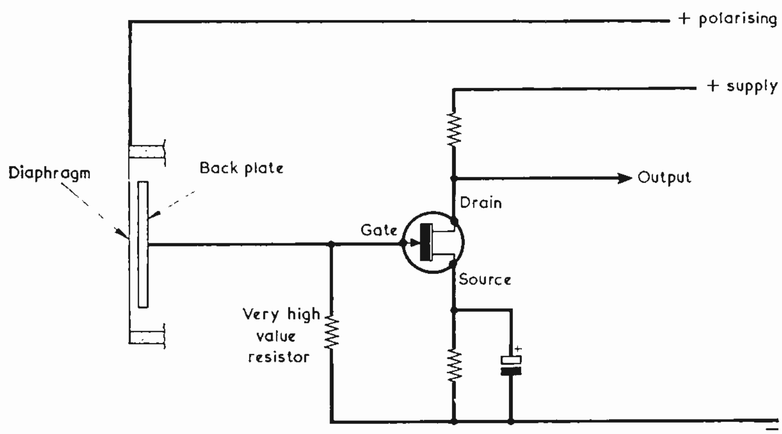
"Capacitor microphones with f.e.t. head amplifiers," stated Smithy, "represent a considerable improvement on those with valve head amplifiers. Indeed, one could hardly conceive of a device more suited for use with a capacitor microphone than the f.e.t. It has exceptionally high input impedance, it works at relatively low supply voltages and currents, it does not require a heater supply, it's small, and it is non-microphonic. With all these advantages, the f.e.t. is virtually custom-built for the job."

Smithy leaned over and scribbled out yet a further circuit. (Fig. 6(a).)

"Here's one method of coupling the diaphragm and back plate of the capacitor microphone to an f.e.t.," he resumed. "The polarising supply, which needn't now be much more than 50 volts or so, is simply applied via the microphone to the gate of the f.e.t., this being taken to the negative supply rail by way of a very high value of resistor. The f.e.t. has source bias, which is provided by a resistor and capacitor in the same way that cathode bias is applied to a valve. The signal can then be taken off from the drain."

"How about supplying the polarising voltage?"

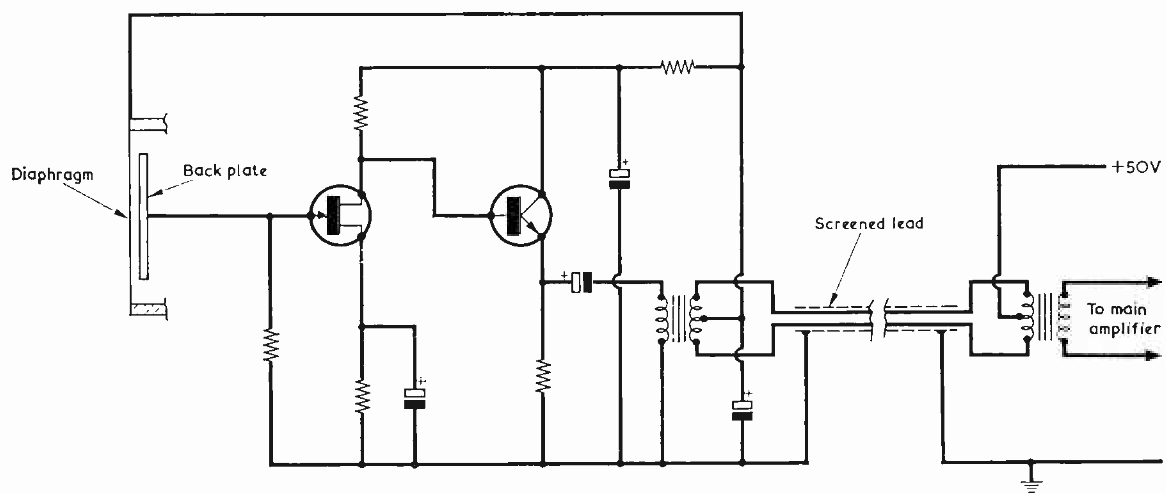
"That can be done by way of the output cable," said Smithy, sketching out another circuit. (Fig. 6(b).) "What I'm drawing now shows a typical f.e.t. head amplifier in its



(a)

Fig. 6(a). Coupling the capacitor microphone to a field-effect transistor. An n-channel f.e.t. is assumed

(b). A typical f.e.t. head amplifier with emitter follower transistor. Both the polarising voltage and the transistor supply current are applied via the screened lead coupling the microphone to the main amplifier



(b)

complete form. In this version I've included a transmitter emitter follower after the f.e.t. to provide a really low output impedance. The emitter follower is coupled to an output transformer which then feeds into a screened cable having two cores. The polarising voltage is fed by way of centre-taps in the secondary of the output transformer and the primary of an input transformer at the main amplifier end of the cable. This polarising voltage is also the supply for the two transistors, being dropped to a suitable value by a resistor in the head amplifier. The supply current flows in opposite directions in the two halves of the centre-tapped transformer windings so that the two fields cancel out in the transformer cores. The transformers can, therefore, be quite small components since their cores only have to handle the alternating a.f. currents."

"I see," said Dick thoughtfully. "Incidentally, there's something that's just occurred to me."

"What's that?"

"Well," continued Dick, "If the microphone works by changing sound waves to a varying capacitance, couldn't that varying capacitance be used to frequency modulate an oscillator by having it in the oscillator tuned circuit?"

"Certainly it could," confirmed Smithy. "Indeed, several designs of head amplifier, both for valves and transistors, have employed the frequency modulation idea, the f.m. signal frequently being demodulated in the head amplifier unit itself. This approach has the advantage that no polarising voltage is required. However, it is probable that, with the advent of the f.e.t. and the very simple a.f. circuitry with which it can be used, f.m. head amplifiers will be ousted by f.e.t. amplifiers of the type we've just discussed."

ELECTRET MICROPHONE

"The idea certainly seems to be simple enough," agreed Dick. "Let's get back to the diaphragm and back plate. What material is used for the diaphragm?"

"In the earlier days," said Smithy, "it used, in most cases, to be a thin sheet of aluminium alloy. At present, though, it is more common to use a thin sheet of plastic which has had a layer of gold or aluminium sputtered on to one of its surfaces. The plastic sheet is fitted to the microphone with the conducting surface away from the back plate, so that there is no risk of the two short-circuiting together. Since a volume of air is trapped between the diaphragm and the back plate, the latter may have slits or holes cut into its surface to reduce the damping effect on diaphragm movement which would otherwise be given. A more modern approach consists of employing a back plate made of a porous material."

"I should imagine," remarked Dick, "that the plastic used for the diaphragm has to be pretty tough."

"It has to be extremely tough," replied Smithy. "It is stretched very tightly when the microphone is assembled, and it must not lose its tension afterwards despite widely varying changes in the temperaure around it. Also, great care has to be taken to ensure that it doesn't pick up electrostatic charges. If it picked up an electrostatic charge which, at the inside surface of the plastic, was of opposite polarity to the polarising voltage, the microphone wouldn't work properly. Electrostatic charges of this nature are known as 'electret' effects, which brings me to yet another type of microphone."

"Which one's that?"

"It's a relatively new type which purposely employs electrostatic charge principles," explained Smithy, "and it is in fact *called* the electret microphone. To be precise, I should tell you that an electret is the electrical version of a magnet, and that it consists of a material holding a continual charge and exhibiting opposite poles of electricity on two opposite ends or surfaces. It is possible to get certain plastics to act as electrets, and they hold their charge in just the same way as a magnet holds its magnetism. An electret microphone is built in the same way as a capacitor microphone, but it requires no polarising voltage since the diaphragm is an electret consisting of a sheet of plastic material exhibiting opposite polarities on its two surfaces. The outside surface of the plastic diaphragm is metallised, as with the capacitor microphone, and this metallising forms one of the microphone terminals. The other terminal is the back plate. In other words, the electret microphone is basically the same as a capacitor microphone with the exception that it has its polarising voltage built in, as it were."

"How do they get the plastic polarised?"

"The material is heated whilst being kept in a strong electrostatic field," replied Smithy. "For the thin films required for electret microphones, the plastic can be placed between two metal sheets, a high voltage then being connected across them."

CHANGE OF HEART

With a gesture of finality, Smithy pushed his note-pad away from him.

"And that," he announced, giving a sigh of relief, "is that. No more electronics till after Christmas!"

"Fair enough, "said Dick equably. "In any case I think I've picked up enough gen on microphones for the time being."

He sat quietly for several moments then, on a sudden impulse, walked over to the 'Repaired' rack, where he picked up a little transistor radio and switched it on. Inevitably, it reproduced Bing Crosby's rendering of 'I'm Dreaming of a White Christmas'. Dick irritably switched the radio off again and replaced it on the rack.

Silently, he walked back towards Smithy and sat down once more. The pair looked around the Workshop, which had suddenly acquired a bleak and desolate aspect.

"I'm beginning to wonder," said Dick morosely, "if we haven't been overdoing this anti-Christmas attitude a bit. It might be all right trying to ignore the Christmas spirit, but it doesn't half leave you feeling cheesed-off!"

"It does rather, doesn't it?" agreed Smithy. "I'm thinking that a change of heart wouldn't be a bad idea, too. So, let's start getting Christmassy now, even if it *is* a bit late in the day."

He got down from his stool and began to rummage mysteriously in the cupboard below his bench. There was the cheerful tinkle of glass and bottle.

"Why, Smithy, you old devil," exclaimed Dick. "You had the stuff hidden away there all the time!"

"I always believe in being prepared," chuckled Smithy, as he carefully filled the two glasses he had produced. "I had an idea that we wouldn't be able to keep up our stand against Christmas for too long. So here you are, Dick, and a very Merry Christmas to you as well."

"Thank you, Smithy, "responded Dick warmly, as he took the glass from Smithy, "and the same to you, too."

"Thanks, my boy," replied Smithy, "and, now, let us be upstanding for our annual toast."

They stood and raised their glasses.

"Let us wish the Compliments of the Season," pronounced Smithy, "to the readers who've put up with us through all of 1971. A truly Happy and Merry Christmas to you all."

They both drank deeply.

"And," said Dick, "it wouldn't be a proper Christmas if I didn't end, as I have done on so many previous years, by adding 'God Bless Us, Every One!'" ■

The cartoons appearing in this issue were based on ideas submitted by B. H. Baily.

Radio Topics

By Recorder

JUDGING FROM SEVERAL ITEMS of correspondence we have received recently, some of our newer readers aren't too confident about what is involved in the lining up of a newly constructed a.m. superhet receiver, particularly if, as is frequently the case, a signal generator is not available.

This is a perennial problem but, fortunately, it is one that is fairly easy of solution. Everything fits neatly into place if you start off by considering the r.f. and i.f. sections of the receiver as a whole and then examine their individual circuit functions. In the details which will now be given, it is assumed that the receiver is one employing standard superhet components and circuitry.

SUPERHET ALIGNMENT

We all know that in a standard a.m. superhet the signal is picked up by the aerial and is then passed (via an r.f. amplifier in the more sophisticated type of receiver) to the mixer, or frequency-changer, stage. This stage incorporates an oscillator which runs at a frequency that is *higher* than the signal frequency by an amount that is equal to the intermediate frequency, or i.f. The oscillator and signal frequencies beat together in the mixer and produce (amongst other frequencies which need not concern us here) an output frequency which is equal to the difference between them. This frequency is then accepted by the intermediate frequency stages, amplified and passed on to the detector diode. After detection, the resultant a.f. signal is fed to the a.f. amplifier and is subsequently applied to the loudspeaker or headphones.

So far so good. What we must next take into account is that, since the tuned circuits in the i.f. amplifier are all designed to operate over a small band of frequencies centred on the fixed intermediate frequency, the i.f. amplifier can be made extremely efficient in terms of selectivity. Indeed, very nearly all the adjacent channel selectivity in a standard a.m. receiver is provided by its i.f. amplifier, and it is this amplifier which dictates what particular small band of frequencies is passed to the detector. The r.f. tuned circuit resonant at signal frequency which appears before the mixer does not normally provide a very great deal of additional adjacent channel selectivity; its main purposes are to bring the required signal up to a high level so that it can best overcome self-generated noise in the mixer and to prevent the entry of second channel signals into the mixer circuit, where they would cause the appearance of whistles. (A second channel signal is one whose frequency is *above* the oscillator frequency by an amount equal to the intermediate frequency. If it finds its way into the mixer stage it will also produce an output at intermediate frequency.)

Since the i.f. amplifier provides virtually all the adjacent channel selectivity in the receiver, the oscillator tuned circuit becomes the 'gate-keeper', as it were, which *admits*, or *selects*, the signal which can be passed through the i.f. amplifier. When you adjust the oscillator trimmer or oscillator dust core of an a.m. superhet receiver the effect is as if you were tuning the whole receiver. You will find it possible to tune through one or more stations just as though you were actually turning the tuning dial of the receiver.

So, the oscillator tuned circuit *selects* the frequency which the set will receive. The next requirement of the receiver is that, as the receiver ganged tuning capacitor is rotated, its signal frequency section should keep the aerial tuned circuit resonant at the desired frequency. This means that the ganged tuning capacitor has to keep the two tuned circuits resonant at separate frequencies that are spaced from each other by the intermediate frequency. Such a requirement is, theoretically, a little difficult to satisfy if perfect results are required but, in practice, it can be met more than adequately by a little juggling with component values in the two tuned circuits. Since the oscillator frequency is higher than the signal frequency, the oscillator tuned coil has a lower inductance than the signal frequency tuned coil. Also, it is tuned by a lower value of tuning capacitance, as occurs in, for instance, the 165 + 70pF 2-gang tuning capacitor which is commonly encountered in miniature medium, or medium and long wave, transistor sets. The lower capacitance may be provided by having fewer and/or smaller vanes in the oscillator section of the tuning capacitor. Alternatively, the two sections of the tuning capacitor may have the same value, a series capacitor being inserted between the oscillator section and the oscillator tuned coil. Such a component is described as a 'padding' capacitor. Whilst on the subject of terms, the process of keeping the oscillator and aerial tuned circuit frequencies separated from each other by the intermediate frequency over the tuning range of the receiver is referred to as 'tracking'.

TUNED CIRCUIT ADJUSTMENTS

Now, precisely what means of adjustment are available to us in the alignment of a superhet? Referring first to the oscillator circuit, this, in modern receivers, has two means of adjustment: first, a parallel capacitive trimmer across the tuned circuit and, second, an adjustable iron-dust core inside the oscillator coil. The aerial tuned circuit will also have a parallel trimmer and, if it has an aerial coil, an adjustable iron dust core inside the latter as well. But the set will more probably have a ferrite rod aerial, whereupon an adjustment of inductance is available by sliding the coil along the ferrite rod. Its inductance goes up as the coil approaches the centre of the rod.

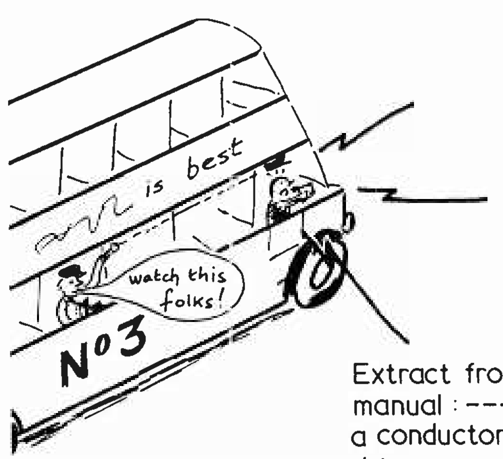
The capacitive trimmer in both the oscillator and the aerial circuit has greatest effect on resonant frequency at the high frequency (low wavelength) end of the tuning range. This is to be expected, of course, since the capacitance offered by the tuning capacitor itself is then at its lowest. The variable inductance (offered by the iron dust core or by sliding the aerial coil along its ferrite rod) has an effect at all settings of the tuning capacitor. However, since we already have a trimmer to look after the high frequency end of the range there is no point in introducing complications by adjusting the inductance at the high frequency end as well, and it is adjusted at the low frequency (high wavelength) end only. Thus, we can now introduce the Golden Rule for alignment of both signal frequency and oscillator tuned circuits in a standard a.m. superhet: adjust trimmers only at the high frequency end of the range, and adjust inductance only at the low frequency end of the range. If tracking is good (as it will be when the proper coils and tuning capacitor values are employed) the range between the high and low frequency ends will then look after itself.

The other adjustments in the superhet are the cores of the i.f. transformers. These are adjusted for optimum response at the intermediate frequency.

Let us now take an example. Assume that you have just completed the construction of a superhet and are all ready to align it. The section which must be tackled first is the i.f. amplifier It is necessary to align the i.f. transformers first, not only to ensure that you are working at the correct frequency when subsequently aligning the oscillator and aerial circuits, but also to ensure that the set is brought up to its most sensitive state in the stages following the mixer. If you have a modulated signal generator, set it to the required intermediate frequency and inject its output via a 0.01μF capacitor into the base of the mixer transistor or, with a valve set, into the signal grid of the frequency changer. The signal generator modulation should then be audible from the speaker or phones, whereupon you adjust the i.f. transformer cores in turn for optimum response, reducing the output from the signal generator as required. It is as well to run through the cores at least two times to ensure final accurate alignment. Always work with the receiver volume control at full and with enough output from the signal generator to be just comfortably audible. The i.f. peaks will be 'swamped' if the signal generator output is too high.

If you haven't got a signal generator it is necessary to work with received signals. All home-constructor i.f. transformers of reputable make are sold pre-aligned, for the simple reason that the factory test for each transformer consists of aligning it to its correct frequency and checking its response. So, provided none of the i.f. transformer cores have been fiddled with, your home-constructed i.f. amplifier will already be close to the correct frequency before you even start, any slight discrepancies being due to different stray capacitances in the receiver as compared with those in the factory test gear. Set the receiver to medium waves and search for your local station. Even if it is only very weak, this is good enough to start with. Tune it in for maximum signal strength then peak up the i.f. transformers. Don't alter the receiver tuning whilst this procedure is in progress or you will alter the frequency fed to the i.f. amplifier. Reduce signal strength as sensitivity increases, either by shortening the aerial or rotating the ferrite rod.

With the i.f. amplifier set up, the aerial and oscillator circuits come next. Here, the oscillator trimmer and dust core are set up for *correct frequency of reception*, whilst the aerial trimmer and inductance adjustment are set up for *optimum signal strength* at the frequency selected by the oscillator. In the absence of explicit instructions, inductance adjustments of both oscillator and aerial tuned circuits on medium and short waves may be carried out at the low frequency end of the range with the tuning capacitor vanes very nearly fully enmeshed except for about 10°, whilst trimming of both oscillator and aerial tuned circuits on the medium and short wave bands may be carried out at the high frequency end with the tuning capacitor vanes enmeshed by about 5°. (This usually gives slightly better tracking than occurs if the adjustments are made with the capacitor vanes fully enmeshed and fully open.) If the receiver has a tuning scale, and a signal generator is available, first set up the oscillator tuned circuit so



Extract from a technical manual :--- "No 3 bus provides a conductor to energise the driver ...."

that the correct frequencies are received as indicated by the dial. This involves an initial inductance adjustment at the low frequency end of the range, a trimming adjustment at the high frequency end of the range, a further inductance adjustment at the low frequency end, a further trimming adjustment at the high frequency end, and so on until the correct frequencies are given at both ends. It should not be necessary to repeat the process more than three times, if that.

Then adjust the aerial tuned circuit for maximum signal strength at the low and high frequency ends in the same way: first, inductance adjustment at the low frequency end; second, trimmer adjustment at the high frequency end; and keep repeating until no further adjustment is required. If you're using a signal generator it is in most cases best to couple this very loosely to the receiver. Clip its earthy output lead to the receiver chassis and let its 'hot' output lead rest on or near the aerial circuit wiring.

If you haven't got a signal generator you will have to initially set up the circuit with received signals. On medium waves this isn't too difficult at the high frequency end because the Radio 1 signal on 247 metres (1214kHz) offers an easily identifiable 'marker' to start off with, this corresponding in most receivers to about 15° of tuning capacitor enmeshment. The oscillator and aerial tuned circuits can be roughly trimmed up at this frequency, whereupon the set should be sensitive enough to pick up weaker signals nearer the high frequency end of the range. These are Radio 4 (the old West 'Home') on 206 metres (1457kHz) and Radio Luxembourg on 208 metres (1,442kHz). A useful 'end-marker' is Radio 3 on 194 metres (1546kHz). The situation is not quite so easy at the low frequency end of the medium wave band unless you are lucky enough to be able to pick up the low frequency Radio 3 signal on 464 metres (647kHz). Other signals which can help you line up the tuning correctly on the scale are, in reducing order of usefulness, Radio 4 on 434 metres (692kHz), 371 metres (809kHz) and 341 metres (881kHz). These are the old North, Scotland and Wales 'Home' signals respectively. It will be seen that, when you are initially trying to work on medium waves with received signals, you establish rough trimming settings at the high frequency end then start working at the low frequency end. Once you have got identified low and high frequency stations to work with, the process consists of inductance adjustment at the low frequency end, trimming adjustment at the high frequency end, and so on, as with the signal generator.

If the receiver you have constructed does not have a tuning scale and you are uncertain of its actual medium wave range, set up the high frequency end with the trimmers as just described, then set up the low frequency end to what appear to be reasonable settings of the oscillator dust core and the aerial coil dust core or the position of the ferrite aerial coil on the ferrite rod.

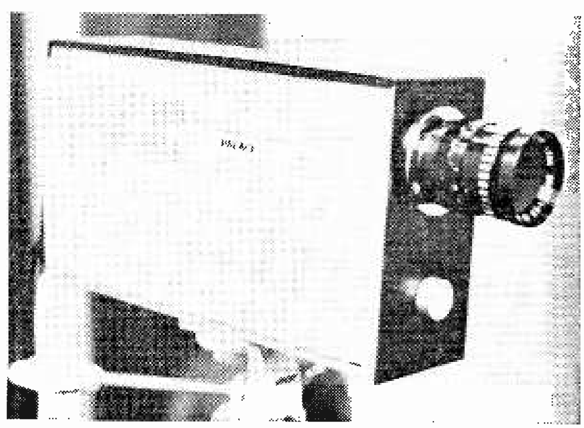
MORE TO COME

It looks as though I have come to the end of my allotted space for this issue and so I shall return to the subject of superhet alignment next month, when I shall deal with the adjustment of short and long wave ranges.

I see also that we have arrived at yet another December issue. This last twelve months have certainly presented us at *The Radio Constructor* with many pleasures and – perhaps – accomplishments, and we hope that they have been appreciated by you, our readers. So now let me offer you all best wishes for a truly Merry Christmas with plenty of turkey and the trimmings, and stacks of plum duff in the oven for afters.

See you next year! ■

INEXPENSIVE CLOSED CIRCUIT TV



A solid state television camera for closed circuit operation is now available from the Industrial Imports Division of Dodwell & Co. Ltd. Priced at just over £100, it is designed for applications where ease of operation, high sensitivity and high resolution capability are primary requirements. Typical applications include security surveillance, hospital patient monitoring, visual control of dynamic situations such as process control of industrial plant or traffic monitoring. The range of applications is extended beyond that normally associated with CCTV systems as the camera can be connected directly to a domestic television set which is then used as a monitor.

Automatic light compensation for varying light levels between 50 to 8,000 lux provides stable operation from a standard of 500 to 50 lux minimum. The type 7735A vidicon used in the camera has a resolution of 500 lines, and random interlace scanning is provided. The output signal is composite video/RF modulated at 1.5V peak-to-peak into 75 ohms. Horizontal frequency is 15.75Hz and with power locking, the vertical frequency is 50/60Hz.

Ambient operating range is 32°F to 104°F. A 220V 50/60Hz operating voltage is required with a power consumption of 12.5VA. Weight is 6.8 lb. and the dimensions are $3\frac{1}{8}$ x $9\frac{1}{2}$ x $5\frac{1}{8}$in. The price of £101.90 means that this camera brings CCTV well within the budgets of visual aids for education authorities and municipal authorities for hospitals, road safety, and security operations.

A range of lenses is available, all having a standard 'C' type mount. Remote control pan, tilt and zoom facilities can be provided. Viewing monitors are available in this range of equipment, with the the alternative of 5 or 9 inch screen sizes.

LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● TURKS & CAICOS Is.
VP5NV was heard recently using the CW mode at 2000 on **14008**, putting a very strong signal into the U.K.

● ARGENTINA
One of the strongest and consistent CW signals on the 14MHz band from this country is that of LU9EGB, often to be heard around 2030 on, or near, **14050.**

● SURINAM
An active SSB signal is that of PZ9AC, heard working into the U.K. on **14280** at 2000 recently.

● COLOMBIA
Another active SSB mode station is that of HK3CFN, often to be heard around 2130 or so on, or near, **14130.**

● ZAMBIA
Zone 36 can be logged by listening for the SSB signals of 9J2GJ, 1920 on **14150.**

● MALDIVE Is.
VS9MT has been heard using SSB on **14190** at 1650. Also reported using **21345** at 1453.

● GABON REPUBLIC
TR8AG has been heard, using CW, on **14074** at 0050.

● SPANISH SAHARA
EA9EJ has been heard using SSB on **14215** at 0707 and on **21310** at 1730.

★ BROADCAST BANDS

● SWITZERLAND
Programmes in English from SBC Berne may be heard at 0700, 1100, 1315, 1515 and at 2100 daily on **3985** (75.28M), **6165** (48.66m) and on **9535** (31.46m), all channels 250kW. Also at 0845 on the same frequencies from Mondays to Saturdays inclusive. Swiss folk music can be heard on these omnidirectional channels daily at 0645, 1300, 1500 and at 1730. Other channels used are **6120, 9590, 9750, 11715, 11720, 11765, 11775, 11865, 15305, 15430, 17795, 17830, 17845, 21520, 21585** and **21605.**

● RADIO NEDERLAND
The Malagasy relay of Radio Nederland will commence experimental transmissions this month to the following schedule – 1230 to 1350 daily in Indonesian to S.E. Asia on **15330** with parallel transmissions from Lopik (Holland) on **17810** and **21480.** From 1400 to 1520 daily in English to South and South East Asia and Europe on **15330** with Lopik in parallel on **6020, 17810** and **21480.** From 1700 to 1820 daily in Dutch to S. Africa on **6020** only, from 1830 to 1950 daily in English on **6020** only. In January, it is hoped to add 1530 to 1650 in Dutch to the Middle East, South and West Asia and Europe on **11895,** Lopik in parallel on **6020** and **17810.**

● TURKEY
Ankara Radio may be heard on **9515,** in parallel with **11880** with announcements in Turkish and Arabic-type music (Home service) from 0355 to 0600 (to 1100 Sundays, 1130 Saturdays) and from 1500 to 2055 (from 1000 Saturdays and Sundays).

Acknowledgements: Our Listening Post and BADX.

MORE NEWS

NEPAL
Radio Nepal is reported by the British Association of Dx'ers (at the time of writing) on **9590** in the clear at 1602. To hear Nepal the hard way, why not try the parallel channel of **4600**? It has been done by Alan B. Thompson of Neath from 1620 through to 1650 sign-off. Considering the power of Katmandu is only 5kW, and the frequency involved, this represents a Dx feat of no mean order!

CAPE VERDE
If you think your receiver is super-selective, try **3886** around 2230 for Radio Clube do Cabo Verde. The language used is Portuguese and sign-off is at 2300. The channel suffers heavy QRM from utility stations.

INDONESIA
RRI Medan can sometimes be logged on **5084** around 1630 when conditions are good for reception of this area. Sign-off is at 1700 with the Indonesian melody 'Love Ambon'.

CEYLON
Radio Ceylon may be logged on **5076** around 1650 until sign-off at 1707, the latter fact being the 'give-away' for identification purposes according to BADX.

LAST LOOK ROUND

7MHz BAND AND THE FAR EAST

For those readers who would like to try and hear Far Eastern broadcast stations on the 7MHz band, we list the following – all capable of being logged at this time of the year in the U.K.

7245 Saigon, South Vietnam, (20kW). This one is best heard between 1530 and 1600 and often features typical Asian-style music interspersed with announcements in Vietnamese. Sign-off is at 1600 following the National Anthem.

7251 Singapore (7.5kW). Radio Singapore can be heard on this channel if conditions are right. Listen around 1515 for the time signal followed by news in Malay.

7295 Penang, Malaysia (10kW). Radio Malaysia can sometimes be heard around 1550 with Malay music, six 'pips' at 1600, "Inilah Radio Malaysia", then news in English.

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NEW CATALOGUE NO. 18, containing credit vouchers value 50p, now available. Manufacturers new and surplus electronic and mechanical components, price 23p post free. Arthur Sallis Radio Control Ltd., 28 Gardner Street, Brighton, Sussex.

CONSTRUCTORS USED COMPONENTS. Parcels at 50p each, including postage, 50 assorted resistors, 50 assorted capacitors. 10 electrolytic capacitors. 10 assorted knobs. 5 assorted potentiometers. 20 assorted valve bases. Please state which parcel required. Broadcast type twin gang variable capacitors at 18p each. Speakers at 50p each. 7 inch, 5 inch 5½ x 3½ inch elliptical. P. & P. 18p. Box No. G142.

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(Continued on page 317)

SMALL ADVERTISEMENTS

(Continued from page 315)

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FOR SALE: Electronic Devices (Cheltenham) Ltd. electric "bug" morse key. £10. Box No. G170.

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FOR SALE: Raven radio control Tx & Rx. Multichannel reed. £25. S.A.E. for details. Box No. G172.

(Continued on page 319)

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(Continued from page 317)

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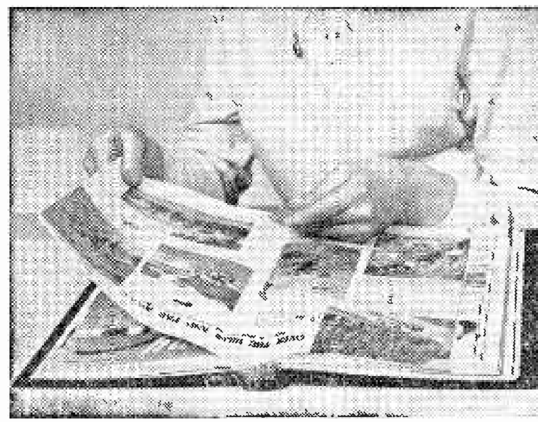

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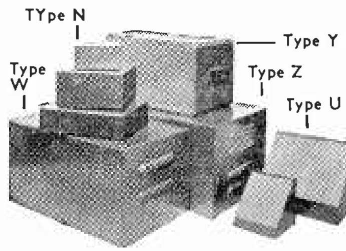

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The Table lists B.B.C. transmissions in the languages shown. Two-figure numbers indicate Metre Bands and three-figure numbers indicate Metres. Times are in G.M.T. and, where applicable, days are quoted in brackets. This Table completes the list started in Data Sheet 55

ROMANIAN

0400–0415 25, 31, 41, 49
1115–1130 13, 16, 19, 25
1600–1645 16, 19, 25
1915–1930 41, 49 (M, W, F)
1930–2000 19, 25, 31, 41, 49
2100–2130 19, 25, 31, 41, 49

RUSSIAN

0300–0330 19, 31, 41, 49 (Su)
0345–0400 19, 25, 31, 41, 49 and 464m.
0500–0515 16, 19, 25, 31, 41
1000–1030 13, 16, 19, 25 (Su)
1045–1100 13, 16, 19, 25
1330–1345 13, 16, 19, 25
1445–1530 13, 16, 19, 25, 31
1530–1545 13, 16, 19, 25, 31 (M to S)
1545–1600 13, 16, 19, 25, 31 (Tu, F)
1645–1700 13, 16, 19, 25, 31, 41
1700–1800 13, 16, 19, 25, 31, 41
2000–2100 16, 19, 25, 31, 41, 49

SERBO-CROAT/SLOVENE

1045-1100 13, 16, 19 (Tu, Th, Sa)
1100–1115 13, 16, 19, 25 (Slovene)
1415–1430 13, 16, 19
1530–1600 19, 25, 31 (Slovene) (Su)
1730–1815 19, 25, 31
1800–1830 31, 49 (Slovene)
2145–2215 31, 41, 49, 75 and 232m.

SINHALA

0930–1000 13, 16 (Tu, F)
1615–1645 25 (Tu, F)

SOMALI

1430–1500 13, 16, 19
1800–1815 13, 16, 19
1815–1830 19

SPANISH

Europe
0730–0745 31, 41 (M, W, Th, F)
1315–1330 19, 25
2115–2200 41, 49
Latin America
0015–0415 16, 19, 25, 31 or 49

SWAHILI

0330–0345 16, 19, 25, 31
1545–1630 13, 16, 19, 25

TAMIL

0930–1000 13, 16 (Su, M, Th)
1615–1645 25 (Su, M, Th)

THAI

1315–1345 13, 16, 25, 31
2345–0000 19, 25, 31, 49

TURKISH

0515–0530 16, 19, 25, 31, 41
1545–1600 13, 16, 19 (Tu, Th, Sa)
1815–1900 19, 25, 31, 41, 49

URDU

0110–0140 31, 41, 49 and 213, 428m.
1515–1600 13, 16, 19, 25 and 213m.

VIETNAMESE

1130–1200 13, 16, 19, 25, 31, 41
2245–2300 19, 25, 31, 41, 49, 75

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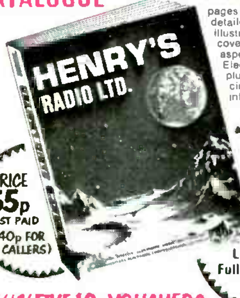

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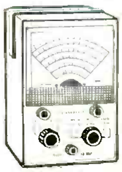

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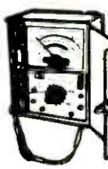

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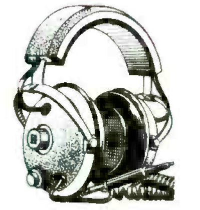

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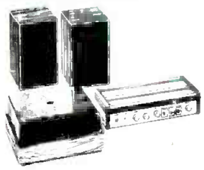

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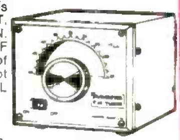

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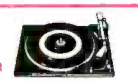

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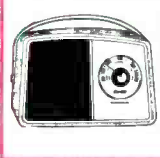

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