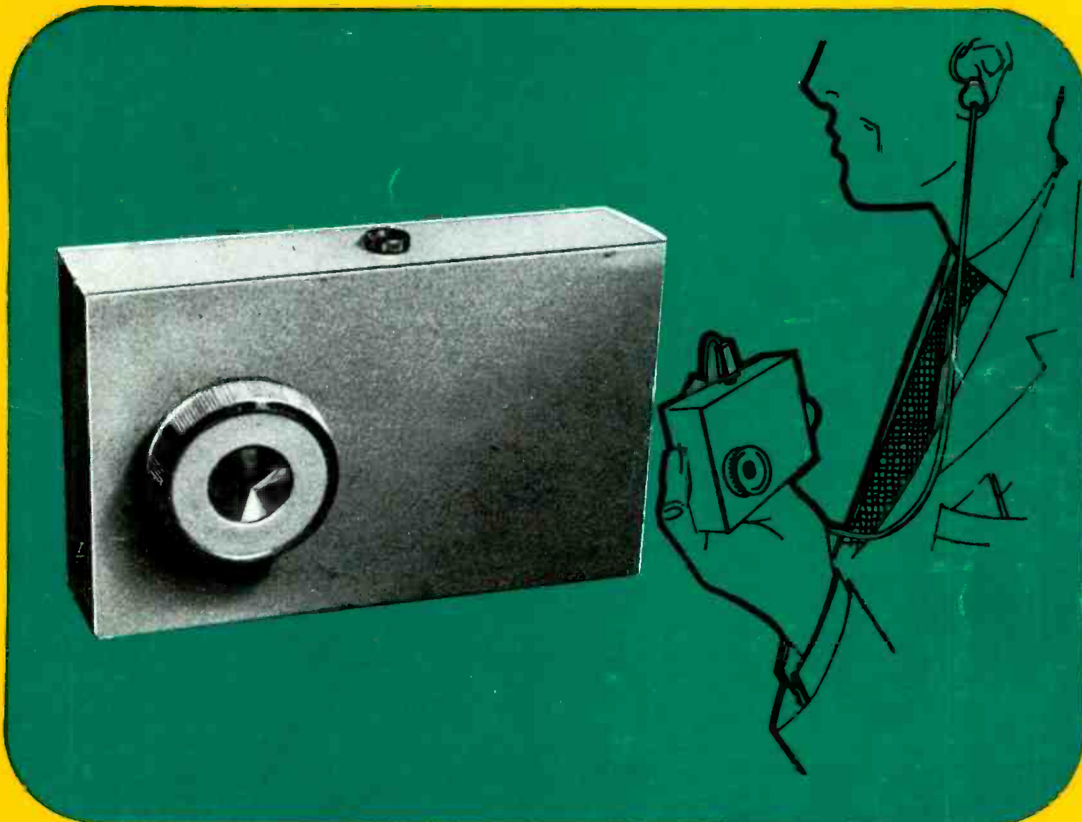
THE

RADIO CONSTRUCTOR

Vol. 25 No. 10 MAY 1972 20p



2 TRANSISTOR M.W. RECEIVER

A neat little medium wave portable receiver employing 2 transistors and feeding a crystal earphone.

FEATURED IN THIS ISSUE

The 'F.E.T. Twin' —A Medium Power Stereo Amplifier

Transmitter for Two Metres

The largest selection

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

PIV	1A TO-5	3A TO-66	7A TO-66	10A	16A TO-48	30A TO-48
	£p	£p	£p	£p	£p	£p
50	0·23	0·25	0·47	0·50	0·53	1·15
100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·80
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

SIL. RECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
	£p	£p	£p	£p	£p	£p	£p
50	0·40	0·05	0·05	0·07	0·14	0·21	0·47
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33		0·33	0·57	0·75	—

TRIACS

VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
100	30	50	76
200	50	60	90
400	70	75	1-10

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

DIACS

FOR USE WITH TRIACS
BR100 (D32) 37p each

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100 PIV. 90p each.

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TI843. BEN3000 27p each, 25-99 25p 100 UP 20p.

JUMBO COMPONENT PAKS

MIXED ELECTRONIC COMPONENTS

Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1.50 only

Plus our satisfaction or money back guarantee.

NPN SILICON PLANAR BC107/108 10p each; 50-99 9p; 100 up, 8p each; 1,000 off, 7p each. Fully-tested and coded TO-18 case.

FREE

One 50p Pak of your own choice free with orders valued £4 or over.

SPECIAL OFFER

2N2926 (Y) (O)
10 for 50p. 25 for £1
20,000 TO CLEAR

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT
T1	8	2G3713	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 pak

CADMIUM CELLS

ORP12 43p
ORP60, ORP61 40p each

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

	£p		
20 For	0.50	100 For	1.75
50 For	1.00	500 For	7.50
		1000 For	18.00

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 25p each.

120 VCB NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO-5 N.P.N. 25 up 15p each.

PHOTO TRANS.

OCP71 Type. 43p

SIL. G.P. DIODES £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.

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

D13D1 Silicon Unilateral switch 50p each.

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

NEW LINE

Plastic encapsulated 2 amp Bridge Rects.

50 v RMS 32p each
100 v RMS 37p each
400 v RMS 46p each

Size 15 mm x 6 mm

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS

NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No		£p
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 400 mW 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 · 2N2905	0.50
Q36	7 2N3646 TO-18 plastic 300MH2 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. 300MH2	0.50
Q52	8 BY100 type sil. rect.	1.00
Q53	25 Sil. & germ. trans. mixed all marked new	1.50

PRINTED CIRCUITS—EX-COMPUTER

Packed with semiconductors and components 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards, 50p. Plus 10p P. & P. 100 Boards £3. P. & P. 30p.

POWER TRANSISTOR BONANZA!

GENERAL PURPOSE GERM. PNP
Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. 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

AD161 *NPN*
AD162 *PNP*
M/P COMP GERM TRANS.
OUR LOWEST PRICE OF 55p *PER PAIR*.

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.
OUR PRICE EACH :

1–24	25–99	100 up
50p	45p	40p

2N3055
115 WATT SIL POWER NPN
50p EACH

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic.
BIP 20 PNP. Brand new.
VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR :

1–24 prs.	25–99 prs.	100 prs.
60p	55p	50p

EX-STOCK TYPE EACH AS PRICED

OC20	50p	OC28	40p	AD149	43p	BD131	70p	BD139	75p
OC22	30p	OC29	40p	AL102	85p	BD132	80p	BD140	85p
OC23	33p	OC35	33p	AL103	85p	BD135	70p	BD155	75p
OC24	45p	OC36	40p	BD121	60p	BD136	80p	BU105	£3
OC25	25p	AD140	40p	BD123	75p	BD137	70p	2N3054	45p
OC26	25p	AD142	40p	BD124	70p	BD138	80p		

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	45p	40p	35p

F.E.T.'S

2N3819	35p
2N3820	50p
2N3821	35p
2N3823	30p
2N5458	50p
2N5459	40p
BFW 10	40p
MPF105	40p

NEW EDITION 1971

TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each. Red cover edition.

A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST

RTL MICROLOGIC CIRCUITS

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

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

DUAL IN LINE SOCKETS

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

Prof. Type No.	1-24	25-99	100 up
TSO14 pin type	30p	27p	25p
TSO16 pin type	35p	32p	30p
Low Cost No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

OUR STOCKS of individual devices are now too numerous to mention in this Advertisement. Send S.A.E. for our listing of over 1,000 Semiconductors. All available Ex-Stock at very competitive prices.

-the lowest prices!

74 Series T.T.L. I.C'S DOWN AGAIN IN PRICE

Check our 74 Series List before you buy 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
BP141=SN74141	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.

LINEAR I.C's— FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	63p	53p	45p
BP 701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	53p	45p	40p
BP 709P—μA709C	53p	45p	40p
BP 710—72710	53p	45p	40p
BP 711—μA711	63p	50p	45p
BP 741—72741	75p	60p	50p
μA 703C—μA703C	43p	35p	27p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

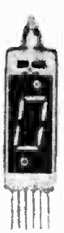
LOGIC DTL 930 SERIES I.C's

ROCK BOTTOM PRICES

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

NUMERICAL INDICATOR TUBES



MODEL	CD66	GR 116	3015F
Anode voltage (Vdc)	170 min	175 min	5
Cathode cur'nt (mA)	2.3	14	8
Numeral h'ght (mm)	16	13	9
Tube height (mm)	47	32	22
Tube diameter (mm)	19	13	12
I.C. driver rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1.70	£1.55	£1.90

All indicators 0.9 + Decimal point: All side viewing: Full data for all types available on request.

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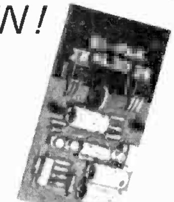
BI-PAKS NEW COMPONENT SHOP

A wide range of all types of electronic components and equipment available at competitive prices.

18, BALDOCK ST. (A10), WARE, HERTS. *Tel.: 61593*
OPEN 9.15—6 TUES. to SATS. FRIDAYS UNTIL 8 p.m.

BI-PAK DO IT AGAIN!

50W pk 25w (RMS)



0.1% DISTORTION
HI-FI AUDIO AMPLIFIER
THE AL50

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

ONLY **£3.25p** each

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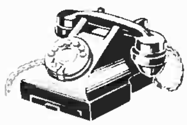

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BSY28	0·13	OC35	0·25
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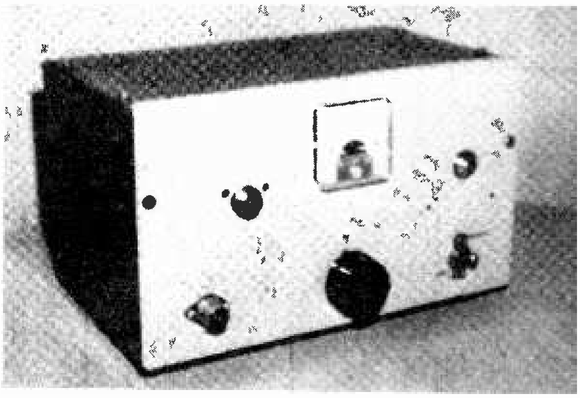
JUNE ISSUE WILL BE PUBLISHED ON JUNE 1st

Small Transmitter for Two Metres



The appearance of the completed transmitter

by

A. S. Carpenter, G3TYJ

A low-cost transmitter suitable for operation in a car having a 12-volt positive earth system

THE SIMPLE TRANSMITTER TO BE DESCRIBED WAS BUILT for use in a car with a positive earth system and, at the time of writing, cost approximately £10 to construct. The rig occupies little space and all power supplies are picked up via a 9-pin socket at the rear, these being 12 volts for heaters and 250 volts for h.t. The h.t. supply source is external to the transmitter.

Functionally the transmitter operates in mode A3 (a.m.) only and no provision is made for A1 (c.w.) emission. The transmitter p.a. stage is arranged as a push-push doubler, a system not often seen in v.h.f. rigs, the advantage being that odd-order harmonics are suppressed so that if 72MHz input is applied, output is at 144MHz or there is none at all. Additionally no two r.f. stages in the transmitter are tuned to the same frequency and this benefits stability. With a QQV02-6 valve in the p.a. position the transmitter runs at some 6 watts d.c. input; a QQV03-10 is also usable but is unlikely to be fully modulated.

Metering by r.f. sampling at the p.a. stage is utilised, the more usual current monitoring system being rejected on the grounds that p.a. anode current 'dip' in v.h.f. transmitters does not always coincide with maximum r.f. output. The method adopted is efficient in terms of signal transmission but does not allow the operator to keep a check on the p.a. current being drawn – except at the setting-up stage. At the cost of a few additional components, however, both forms of p.a. monitoring can be included if desired and to this end suggested circuitry will be discussed later.

TRANSMITTER CIRCUIT

The complete r.f. section of the transmitter can be seen in Fig. 1. Here V1, an ECC81 with both triodes strapped, functions as a conventional voltage-stabilized crystal-controlled oscillator, crystal X1 being fundamentally 6MHz or thereabouts depending on the local 2-metre zone requirements. When coil L1 is tuned to 18MHz and L2 to 36MHz, monitoring is possible by applying a meter set to read 0–1mA between test point TP1 and chassis, the meter positive lead being connected to chassis. Doubling to the 72MHz region is achieved by V2(b), the amplified r.f. subsequently being applied to the grids of V3 in push-pull. Interstage inductive coupling is accomplished via L3 and L4 plus a link winding. Adequate drive to the p.a. is achieved (low drive is a weak point in some v.h.f. designs) and when a 0–1mA meter is connected between TP2 and chassis with the correct polarity its needle is driven hard over to full-scale.

By strapping the anodes of V3 in parallel, output in the 144MHz region is obtained from the 72MHz input to the grids.

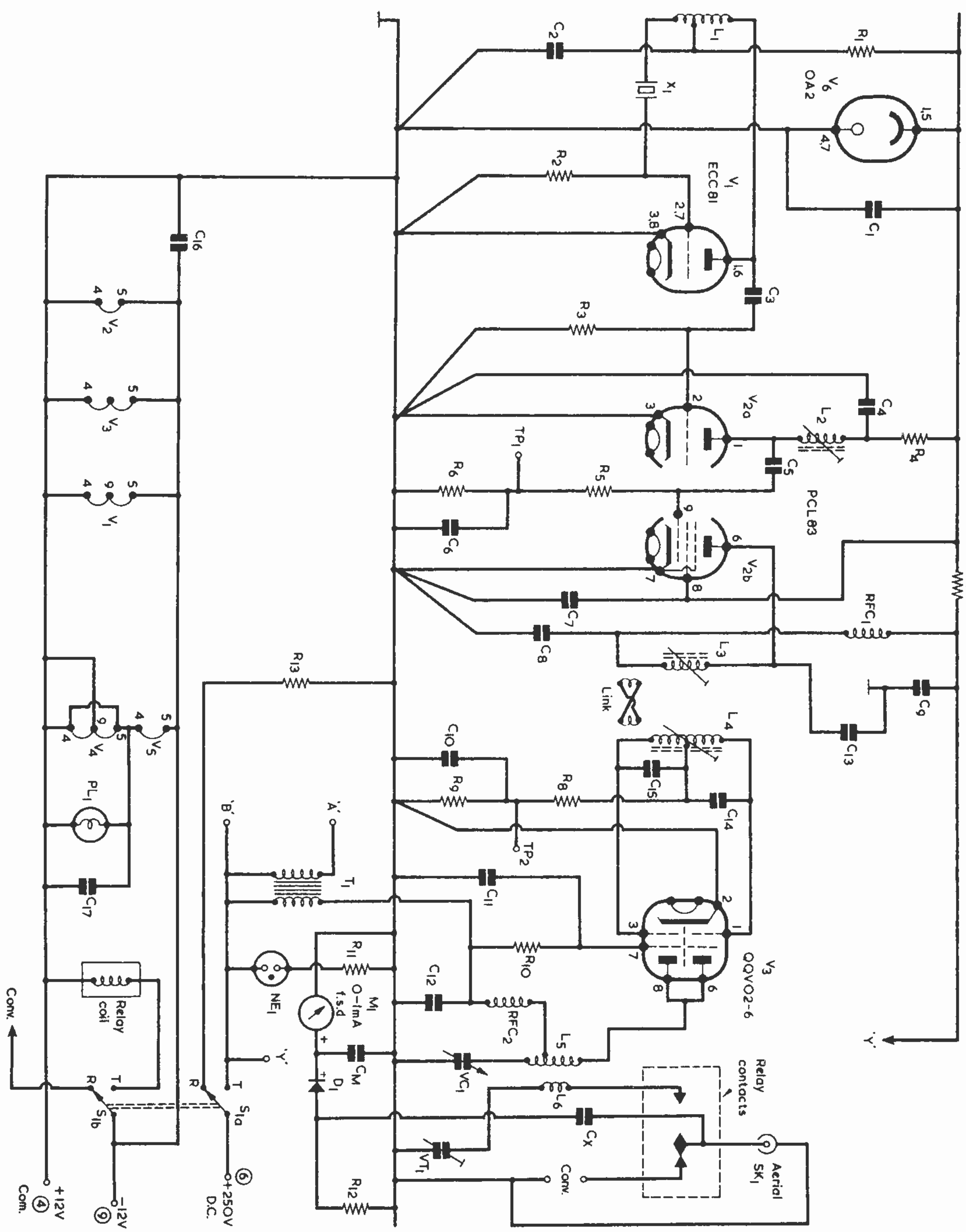


Fig. 1. The circuit of the r.f. section of the transmitter

COMPONENTS

Resistors
(All ½ watt 10% unless otherwise stated)

R1	15kΩ
R2	10kΩ
R3	47kΩ
R4	8.2kΩ
R5	56kΩ
R6	1kΩ
R7	6.8kΩ, 10 watts
R8	22kΩ
R9	1kΩ
R10	33kΩ
R11	Part of NE1 assembly
R12	4.7kΩ
R13	30kΩ, 10 watts
R14	3.3MΩ
R15	100kΩ
R16	10kΩ
R17	100kΩ
R18	470kΩ
R19	1kΩ
R20	470kΩ
R21	220Ω, 1 watt

Capacitors

C1	5,000pF ceramic
C2	2,000pF cermic
C3	15pF silvered mica
C4	1,000pF ceramic
C5	22pF silvered mica
C6	1,000pF feed-through ceramic
C7	1,000pF ceramic
C8	1,000pF ceramic
C9	1,000pF ceramic
C10	1,000pF feed-through ceramic
C11	470pF ceramic
C12	5,000pF ceramic
C13	8.2pF ceramic
C14	8.2pF ceramic
C15	8.2pF ceramic
C16	1,000pF ceramic
C17	1,000pF ceramic
C18	100pF ceramic
C19	0.01µF paper or plastic foil
C20	1,000pF paper or plastic foil
C21	25µF electrolytic, 6V wkg
C22	50µF electrolytic, 12V wkg
C23	1,000pF ceramic
C24	8µF electrolytic, 350V wkg
Cx	see text
CM	1,000pF ceramic
VC1*	25+25pF split stator variable, type C808 (Jackson Bros.)
VT1	50 Trimmer, type C801 (Jackson Bros.)

* Only rear section connected in circuit

Inductors

L1–L6	See Table
RFC1	See text
RFC2	See text
T1	Modulation transformer, single-EL84 to QQV03–10 Type, Garex Electronics, Chinnor, Oxon.

Valves

V1	ECC81
V2	PCL83
V3	QQVO2-6
V4	ECC83
V5	6BW6
V6	OA2

Crystal
X1 Crystal (see text)

Switch
S1(a)(b) d.p.d.t., toggle

Meter
M1 0–1mA, Eagle type MR2P or equivalent

Lamps

PL1	6.5V 0.15A, m.e.s., Cat. No. PL8 (Home Radio)
NE1	Neon bulb assembly with integral resistor (R11), Eagle BN113 (Henry's Radio)

Valveholders, Sockets
1 B7G valveholder
5 B9A valveholders
1 B9A valveholder, with skirt and screen
2 coaxial sockets
1 crystal socket
1 panel-mounting m.e.s. bulb holder, with lens

Coil Formers
1 – off ⅜in. dia. × 1⅛in. with iron-dust core and tag-ring, Cat. Nos. CR9, CR10 and CR11 (Home Radio)
3 – off ¼in. dia. Aladdin 356/8BA with 3-off iron-dust cores, Cat. Nos. CR1, CR5 (Home Radio)
1 – off tag-ring (for Aladdin former) Cat. No. CR6 (Home Radio)

Relay
12 volt relay, s.p.d.t. contacts, Garex Electronics

Metalwork
1 Lektrokit Chassis Rail (Short), Cat. No. LK211 (Home Radio)
2 Lektrokit Side Plates, Cat. No. LK301 (Home Radio)
2 Lektrokit Covers, Short, Perforated, Cat. No. LK521 (Home Radio)
1 Panel 18 s.w.g. aluminium, 8⅞ × 5⅜in.
1 Chassis 18 s.w.g. aluminium, 8¼ × 5½in

Miscellaneous
1 Knob
2 5-way tag-strips, centre tag earthed
1 insulated tag.

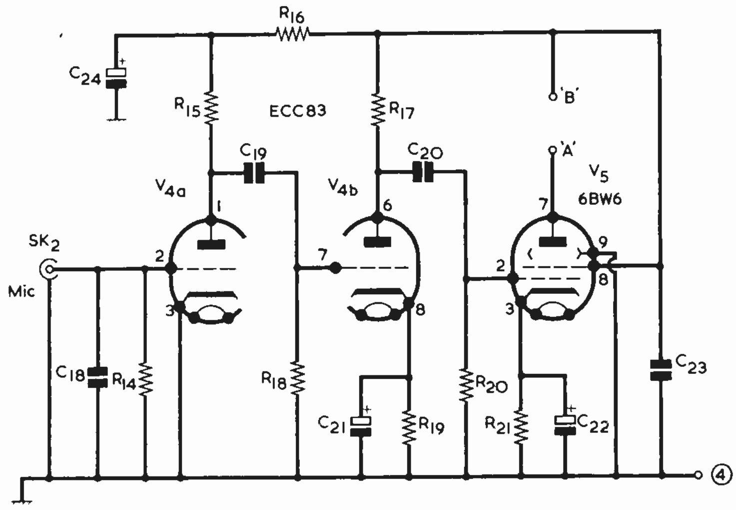


Fig. 2. The modulation amplifier

SWITCHING

The 'Function' switch, S1(a)(b), is a simple d.p.d.t. toggle type. When it is in the position shown, 12 volts are applied to all heaters plus the panel lamp and −12 volts d.c. is available for feeding a transistorised converter receiver. In order that the associated power supply unit is loaded when the 'Function' switch is at 'Receive', resistor R13 is connected into circuit to absorb power. When S1 is moved to the 'Transmit' position the converter supply potential disappears, the relay is energised and the aerial, previously in connection with the converter, is applied to the transmitter output at coil L6. The h.t. is applied also to the transmitter and modulator; whilst the panel warning neon, NE1, is also illuminated. The 'Function' switch could of course be alternatively integrated with that for the associated d.c./d.c. inverter – not shown – instead of being used additionally to the inverter switch as it is here.

When 2 metre signals are delivered to the aerial a sample is taken by diode D1 to the panel metre M1, this permitting control VC1 to be visually peaked for maximum output; the meter also shows if modulation is taking place when speech is fed to the associated microphone. The diode coupling capacitance, Cx, is obtained by twisting a p.v.c. covered wire – unconnected at one end – along the transmitter output lead to socket SK1. Capacitor CM is wired directly across the panel meter.

MODULATION

Due to the connections to transformer T1 both anode and screen-grid circuits of the p.a. are modulated, and the associated modulation amplifier shown in Fig. 2 is integral with the transmitter. The simple modulator circuit employed hardly requires detailed description although it may be noted that no audio gain control is fitted. Normally maximum audio gain is required but if a gain control is desired resistor R18 could be made a miniature 500kΩ log track potentiometer, the grid of V1(b) being fed from its slider. Components used in the modulator are selected to afford maximum output compatible with reasonable quality. The amplifier is intended for use with a high impedance microphone, which may be of either the crystal or dynamic types.

LAYOUT AND CONSTRUCTION

The mechanical assembly incorporates a Lektrokit Chassis Rail type LK211 at the rear, to which is secured a chassis made of 18 s.w.g. aluminium and having a flat section measuring 5 by 8¼in. (see Fig. 4) plus a ½in. section (see Fig. 5) which is bent over on the same side as the under-chassis components. With the chassis right way up, so that the ½in. section projects downwards, the lower edge of the ½in. section falls on the 'chassis mounting line' of the front panel (also 18 s.w.g. aluminium) as indicated in Fig. 3. Two Lektrokit Side Plates type LK301 are secured to the Chassis Rail at the rear by means of the holes already available, and to the rear of the front panel by means of holes which have to be drilled in that panel. Holes, not shown in the diagrams, will also be required for the securing bolts

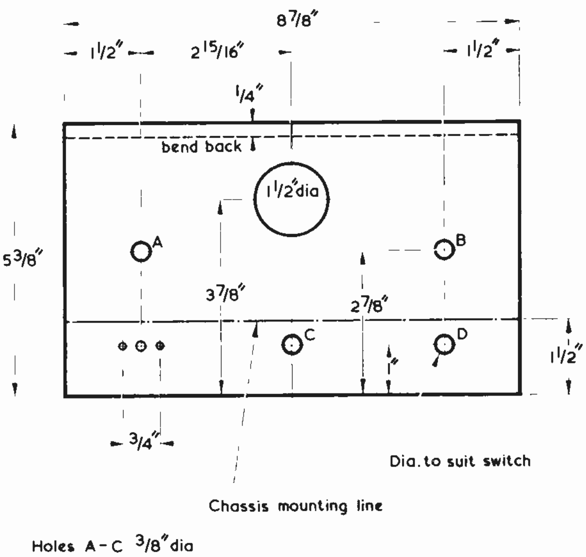


Fig. 3. Dimensions and holes required in the front panel

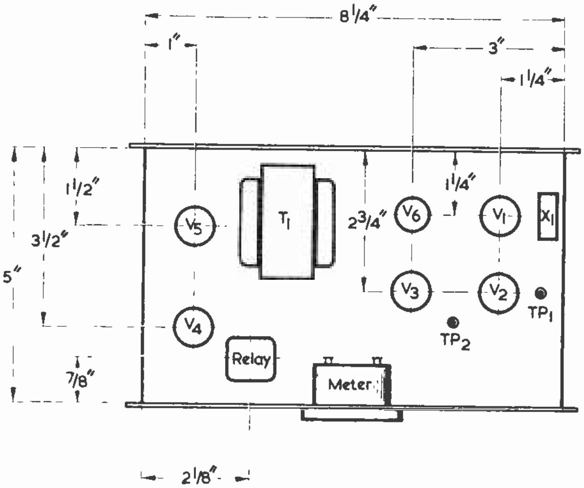


Fig. 4. The positions taken up by the components above the chassis

which hold together the front panel and the bent-over ½in. section of the chassis. It will probably be necessary to cut away a small section at the front edges of the chassis to take the flanges of the Side Plates. It is advisable to drill and assemble the chassis, front panel and side plates before commencing any further mechanical work, to ensure that these parts all fit together comfortably. The four mounting holes in the chassis which allow it to be secured to the Chassis Rail at the rear are best left to the last as their position is governed by the Side Plate dimensions. When the transmitter is completed two Lektrokit Covers type LK521 are added to the top and bottom, the rear of the case thus formed being left open. The Lektrokit parts, it may be added, are all available from Home Radio under the same Cat. Nos. as the Lektrokit type numbers. It should be noted that the complete assembly, as just described, affords a case that measures 9 by 5 by 5in. only.

Having achieved satisfactory assembly of the parts just dealt with, these may be disassembled and the holes for the various components cut out, working from Figs. 3 and 4. Consult also Fig. 5 for valveholder types and orientation. Capacitor VC1, it should be noted, is the rear section of a Jackson Bros. split-stator capacitor type C808, the front section of this capacitor not being used. The capacitor type C808 is chosen here because it fits into the layout well and has a rigid construction.

The output coaxial socket fits into one of the U-slots on the rear Chassis Rail. The 9-way power socket is a B9A valveholder which fits into another of the U-slots, the slot being enlarged to take it. The positions of these sockets may be seen in the photograph showing the rear of the transmitter.

The valveholder for V4 is a skirted B9A type, since this valve is fitted with a screen.

In Fig. 3, hole A is intended for neon NE1 and hole B for pilot lamp PL1. Hole C is for VC1 and hole D for S1(a)(b). The microphone input socket, SK2, is on the opposite side of hole C from hole D. In the photographs, the positions taken up by these components differ slightly from those shown in Fig. 3, the latter representing the neater arrangement.

The meter employed for M1 in the prototype was an Eagle MR2P. A suitable alternative is the Henelec 38 Series 0–1mA meter, which also requires a hole diameter of 1½in.

The below-chassis layout – and one that can hardly be bettered – is shown in Fig. 5, where most of the wiring is given. It is difficult to include all wiring in a single diagram, so heater leads and a few others have been omitted. Constructors are advised to work from the circuits of Figs. 1 and 2, using Fig. 5 as a guide. Note that the modulator components are well removed from the r.f. section and note too that, due to careful valveholder orientation, short leads are made possible where they matter most.

As just mentioned, power supplies are picked up by a B9A socket on the rear Chassis Rail – shown laid flat for clarity. The pin numerals associated with the power socket are shown ringed in Fig. 1.

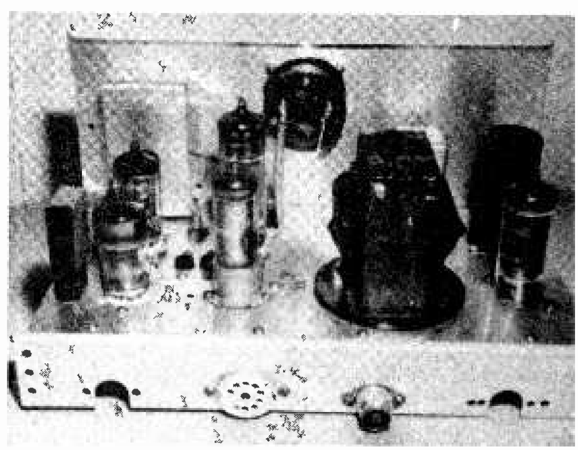
In the r.f. section the closeness of coils L3 and L4 should be observed; coil cores and test points can be reached from either side of the chassis. In the modulator section grid and anode leads of V4 are well separated to keep this high gain valve from going into instability. Decoupling components R16 and C24 must not be omitted.

Connections from S1(b) and the relay contacts to the converter are left to the individual constructor. If desired, the aerial connection to the converter may be taken to a further coaxial socket mounted at the rear of the chassis, and the 12-volt supply to a suitable socket, also mounted at the rear.

As a final point, it may be mentioned that, apart from the leads to the meter and to PL1 and NE1, there is no above-chassis wiring whatsoever.

COIL INFORMATION

All coils and r.f. chokes are home-wound and since L4 needs a centre tap this is initially made to the centre of a straight length of enamelled copper wire; later the tapped length is wound round a dummy former slightly smaller in diameter than the former proper and the correct number of turns allowed prior to cutting. The coil is then allowed to spring free whereupon it is possible to gently force-fit it to its proper former where it sits firm. Coil L3 is similarly made but no tapping is needed. Details of the coils, which are best pre-resonated



A view from the rear. Note the 9-way power socket on the rear flange and the fact that V4 is fitted with a screening can

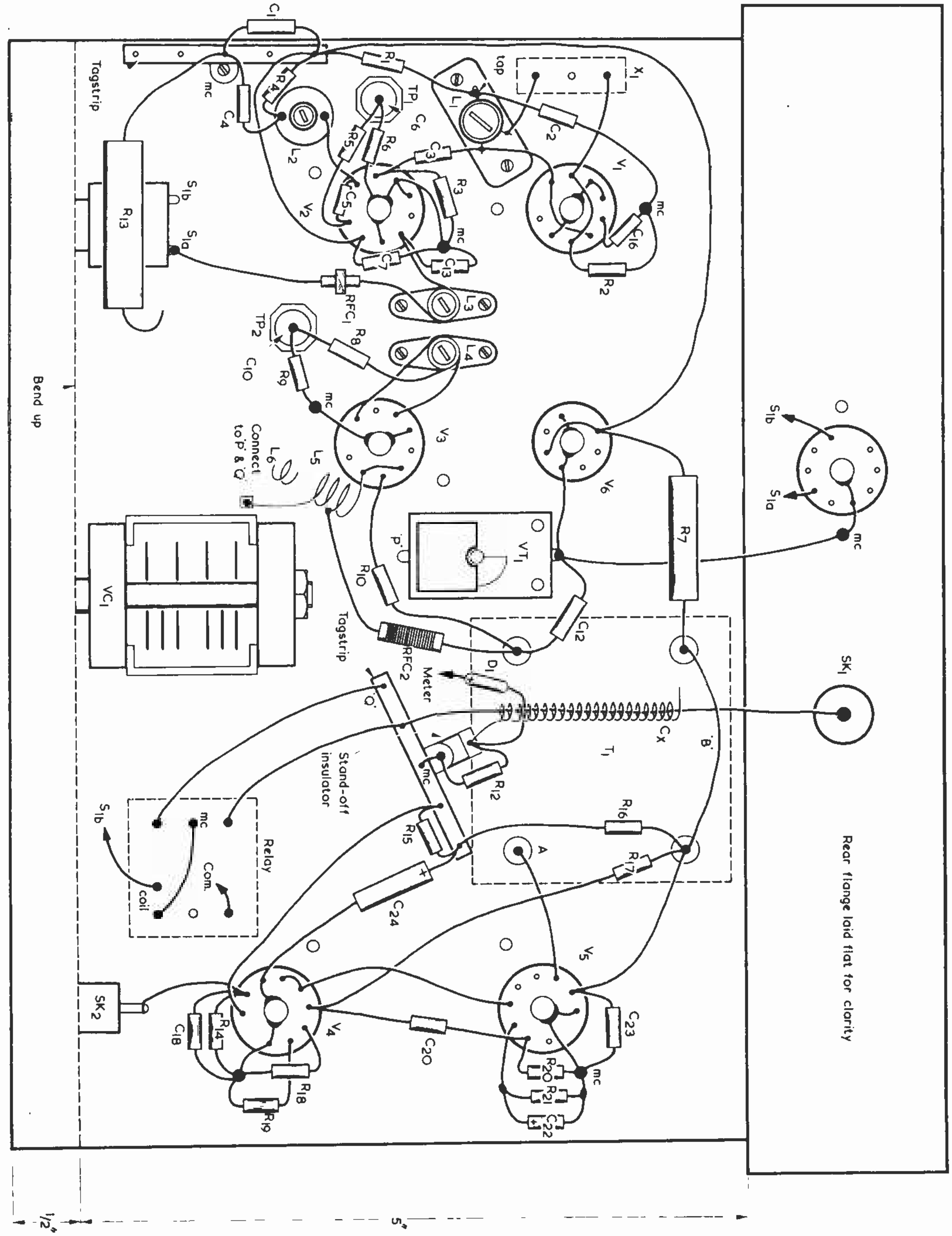


Fig. 5. Layout and wiring of the major components below the chassis. Check, against Fig. 1, that the relay tag positions correspond with those shown here before wiring up to this component

TABLE

Coil	*Turns*	*Spacing*	*Wire*	*Former and Core*	*Frequency (MHz)*	*Remarks*
L1	26	Close	28 s.w.g. enamelled	$\frac{3}{8}$in. dia. with tag-ring and iron-dust core	18	Tapped 5 turns from crystal end
L2	13	Close	28 s.w.g. enamelled	$\frac{1}{4}$in. dia. Aladdin type 356/8BA with tag-ring and iron-dust core	36	—
L3	7	Slight spacing	28 s.w.g. enamelled	$\frac{1}{4}$in. dia. Aladdin type 356/8BA with iron-dust core	72	—
L4	7	Slight spacing	28 s.w.g. enamelled	$\frac{1}{4}$in. dia. Aladdin type 356/8BA with iron-dust core	72	Centre-tapped
L5	$4\frac{1}{2}$	Wire diameter	18 s.w.g. bare tinned copper	Air-cored $\frac{1}{2}$in. dia.	144	Tapped 2 turns from VC1 end
L6	2	Wire diameter	20 s.w.g. tinned copper	Air-cored $\frac{1}{2}$in. dia.	—	P.V.C. covered and interwound with 'earthy' end of L5

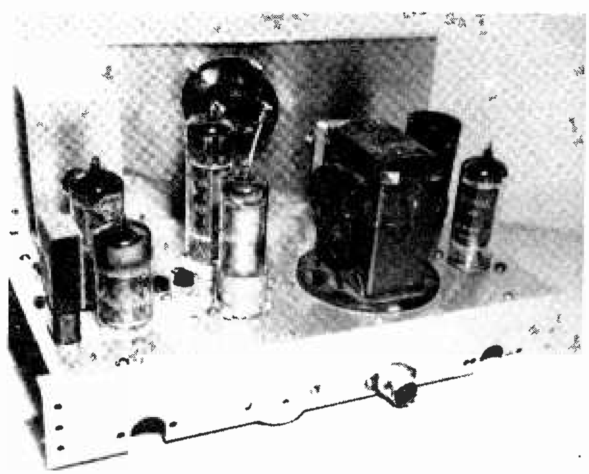
with a g.d.o., are given in the Table.

So far as the r.f. chokes are concerned, RFC1 consists of 40 turns of fine (around 36 s.w.g.) enamelled copper wire pile-wound on a 100kΩ $\frac{1}{2}$ watt 10% resistor of the type which has a ceramic tube over the resistance element. RFC2 consists of 50 turns of 26 s.w.g. enamelled copper wire close-wound on a $\frac{1}{4}$in. diameter piece of p.v.c. sleeving force-fitted over another 100kΩ resistor. In both cases the ends of the coils are soldered to the resistor lead-outs.

TESTS

When construction is complete and the usual wiring checks have been made, the valves may be inserted and the heater supply connected, whereupon panel lamp PL1 should light. A microphone should be connected, or pin 2 of V4(a) temporarily earthed to chassis. The d.c. supply feed to V3 is then broken by lifting both R10 and RFC2 clear of the modulation transformer connection. With h.t. applied, a meter set to read 0–1mA and clipped between chassis and TP1 (positive lead to chassis) should show an indication when S1 is moved to 'Transmit'. Also, V6 should exhibit a violet glow and the panel neon NE1 should light up. The cores of L1 and L2, in that order, are then peaked for maximum indication in the meter. The frequencies tuned by these coils can be rapidly checked by bringing a calibrated wavemeter close to each of them in turn, the resonance points being shown by a smart downward swing in the needle of the monitoring meter. Coil L1 should resonate at 18MHz and L2 at 36MHz. The core of L1 is then gently moved less than a half-turn to more fully engage the windings and to cause the drive, as monitored at TP1, to fall by a small amount. If this is not done, the oscillator may fail to start at the next switch-on.

The negative lead of the meter is next moved from TP1 to TP2 and the cores of L3 and L4 are peaked for maximum indication. After this, a 'figure-of-eight' is constructed from p.v.c. covered wire so that it fits snugly over the formers of L3 and L4 and is close to the windings; the ends of the 'figure-of-eight' linkage are, of course, soldered together. The cores of the two coils are then re-peaked, and the needle of the monitoring



Another view from the rear. The only wiring above the chassis is that which connects to the meter and to the two indicator lamps meter should now go well over to full-scale deflection. The cores are then sealed and the meter removed.

The h.t. supply is next switched off and a meter set to read 0–100mA is inserted between the junction of R10-RFC2 and the tag of T1, to which this junction would normally connect. C12 should still be connected to the tag of T1. A dummy load of 75Ω is next connected to SK1, and the h.t. re-applied, after which VC1 is tuned for a current dip in the meter. If no dip results, L5 is incorrectly constructed or requires slight adjustment, and the tuned circuit needs to be checked with a g.d.o. It is assumed that the earlier circuits are working at their correct frequencies. When a current dip is obtained, a 2.5 watt lamp load at SK1 should glow, and VT1 is then adjusted for maximum lamp brilliance. The meter on the transmitter panel should also give its highest reading at maximum lamp load brilliance but, if it is either over-driven or under-driven, R12 or Cx may require a slight adjustment.

ALTERNATIVE SWITCHING

By including a small d.p.d.t. slide switch below the panel meter it should be possible to monitor both the p.a. current and the maximum r.f. output. Suggested circuitry is given in Fig. 6. When S2(a) is at position '2' the meter operates as already described, but by moving the switch to position '1' the meter is inserted in series with V3 screen-grid and anode feed to read current flow. The basic panel meter is only 1mA f.s.d., but it can be made to monitor p.a. current satisfactorily by shunting it with resistor Rs which will be quite low in value – an ohm or so depending on the meter d.c. resistance. If a full scale reading of, say, 50mA is required, 49mA must be taken by the shunt resistor, and some 'cut and try' is usually required when making up this item. It can in practice be formed from resistance wire wound on a resistor as former. An external testmeter connected in the circuit can be used as a monitor and commencing

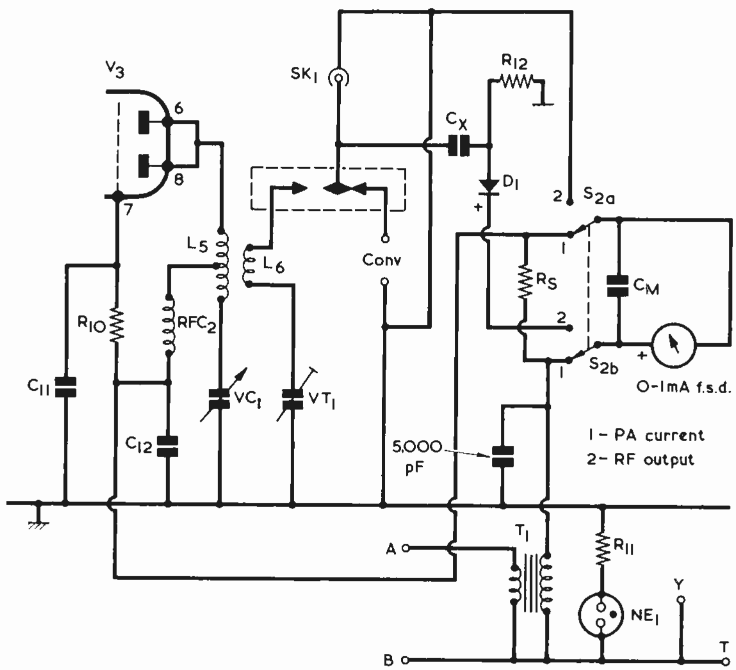


Fig. 6. A suggested method of enabling the panel meter to indicate p.a. anode and screen grid current as well as aerial r.f. output

Later, when RFC2 and R10 have been soldered back to the appropriate tag of T1, the test meter is needed to check that the current flowing in V6 is at a satisfactory level. This may be done by inserting the meter between the chassis connection and pins 4 and 7 of the tube.

For power economy reasons the current drain in V6 should be kept as low as is consistent with satisfactory striking in the tube, and R7 should be adjusted, if necessary, so that tube current is of the order of 10mA.

In subsequent practical tests, when a microphone is plugged in and VC1 set for maximum panel meter indication, slight kicks in the meter needle should be given when speech is applied.

The transmitter is then ready for 'air testing', whereupon a 2 metre aerial is connected, preferably via a reflected power meter. This permits VT1 to be properly set for minimum reflected signal when VC1 is adjusted for maximum forward signal in the usual way.

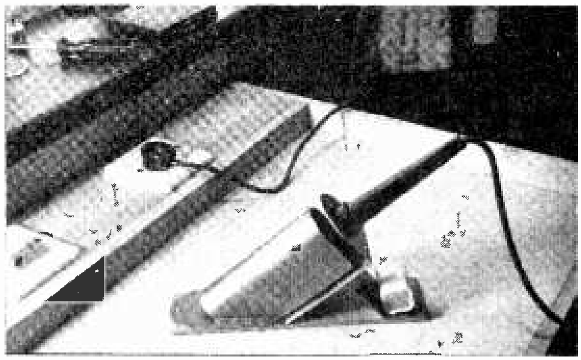
with a low value for Rs added wire on the resistor will permit the panel meter f.s.d. to approach a suitable level. Take care not to accidentally bring the meter into circuit on its own without the shunt resistor, as it may then be damaged by the high current it will pass. A high accuracy in panel meter indications will not normally be expected since it is only necessary to know that the current drain is within reasonably safe limits.

FINAL REQUIREMENTS

Except for the inevitable external modifications required to suit individual needs, the transmitter is complete. It remains only to colour the panel and to apply appropriate legends, after which the metal case sections can be bolted together to form the final attractive and sturdy construction. ■

NEWS . . . AND .

THE STANGARD



What to do with the soldering iron when it is hot and you want to put it down?

One answer is to use the "Stangard". As can be seen from our illustration, this most useful soldering accessory, is so designed that the iron can be easily withdrawn and replaced. The interior section of the "Stangard" is anodised black, thus acting as a "heat sink" to both element and bit, and it will accommodate irons up to a half-inch in diameter.

A bit cleaner is provided, as can be seen in the illustration, consisting of special material around a hard wood block, which is replaceable.

This most useful implement for the radio constructor can be obtained from Home Radio (Components) Ltd., of 234-240 London Road, Mitcham, Surrey. CR4 3HD.

NEW CLEANING IDEA

The enclosed photograph shows a canister of "Dust off" which is a unique new cleaning idea from Transcall Limited.

"Dust off" which has many applications, is ideal for the cleaning of electronic equipment, optical instrument and delicate machinery.

The canister contains liquified Fraon gas which is ejected from the nozzle as a powerful jet which will quickly remove all traces of lint, dust, carbon specks, tape powder, etc., without leaving behind any moisture, residue or oily fingerprints.

Each replaceable "Dust off" canister will give up to 300 powerful cleaning gusts.

For further information contact: Transcall Ltd., Cape Hill, Smethwick, Warley, Worcs.

WRITING TRANSMITTED BY TELEPHONE

Handwritten information can now be transmitted and received over the same telephone lines that carry conversations.

An experimental system, dubbed the "remote blackboard", has been devised by engineers at Bell Laboratories. It encodes handwriting motions on a writing surface into "bits" of information that are sent over ordinary telephone lines. At the receiving end the information is electronically translated and recorded on a self-developing photo sensitive film for simultaneous projection on to a large viewing screen. In this way the information is displayed at the receiving end in "real time" or nearly as fast as it is written at the transmitter. The recorded film may also be stored for future viewing.

The "remote blackboard" may one day be used along with a portable conference telephone, recently introduced by Bell, to transmit both audio and graphic information to distant classrooms, lecture halls, conference rooms and offices. It could also be used to bring classroom instruction to bedridden or invalid students. Conceivably, an entire lecture with handwriting, sketches and diagrams could be recorded on an ordinary stereo tape, recorded at one location, and transmitted over telephone lines to a number of classes meeting at various times and locations.

To transmit handwriting, a tiny location indicator is attached to any kind of writing instrument – chalk, pen, pencil or stylus. The location indicator is a commercial electronic device that provides a series of steady electronic pulses, and it determines all movements performed on a writing surface. The pulses indicate the exact location of the pen as it is moved over a surface bounded by two continuous strip microphones, sensitive enough to detect the position of the pen at any point. Lifting the location detector from the surface interrupts the "write signal". To complete the transmission the electrical pulses are fed to a data set that converts them to signals easily transmitted over telephone lines.

At the receiving terminal another data set translates incoming signals back to electrical impulses to drive two galvanometers (rotating mirrors). These deflect an ultra-violet light beam to follow all the motions performed on the writing surface at the other end. As the beam moves across the photosensitive film handwriting is produced, and simultaneously projected on to a wall or screen.

QUOTE

● There is now one radio set for every five people alive today – that is over 800 million radio sets.

—From the BBC Handbook, 1972.

. . . COMMENT

P.V.C. TUBING

Currently available to home-constructors is a new range of white hard p.v.c. tubing, which can be employed to form suitable housings or cases for various projects and experiments. The tubing can also be used for cable guides and coil formers. It is light, resilient and moisture repellent. Although it has a good finish in its own right it can readily be painted.

The tubing is supplied in round or oval (lozenge-shaped) forms in 1ft. lengths. Outside diameters of circular section tubes range from $\frac{5}{8}$ to 2in. Oval section tubes range from $\frac{1}{2}$ by $\frac{5}{16}$in. to $2\frac{1}{4}$ by $\frac{3}{4}$in. Push-on end caps are available for the three smallest sizes in round section.

A list of the various types of tubing, together with prices, is available from NCF Systems, 21A Bramble St., Coventry, CV1 2HU. It is necessary for an s.a.e. to accompany any request for the list.

IN BRIEF

● Electrovalue, of 28 St. Judes Road, Englefield Green, Egham, Surrey, are now stocking the Henry and Thomas Series 1300 "Minicon V" miniature connectors.

These multi-pin rectangular connectors with push button locking device have a contact resistance of 5MΩ maximum, a current rating of 5A, and an insulation resistance of 500V d.c. of 1000MΩ minimum.

These devices are available with 8, 16 and 24 contacts. Prices are competitive – 1 off price for 16 contact is £1.45, for example.

● Mr. Frank Stone, Export Director of A. F. Bulgin & Co. Ltd., recently retired after 47 years service with the company.

● A new soldering iron in an attractive bubble-pack, is being introduced by Remploy Ltd. It will soon be available in radio and electrical shops at a price around £1.35.

● Mr. Christopher Chataway, Minister of Posts and Telecommunications, has been appointed an Advisory Committee to advise on new regulations to protect radio and TV services from interference caused by the ignition systems of petrol engines. The present regulations have been in operation since 1953.

● The Churches' TV Centre at Bushey, Herts, is to have its studio re-equipped for colour by Marconi Communication Systems Ltd. The Centre, financed by the Lord Rank Foundation for Christian Communication, provides material for religious programmes and training for clergy and laity.

● Following the discontinuation of the Junior Engineer Kits previously distributed by Mettoy, Philips are to link with Radionic Products Ltd., in the marketing of a new range of electronic construction kits.

● The Electron Tube Division of EMI Electronics Ltd., has recently supplied photomultipliers to the cosmic ray and space group of the Physics Department of Imperial College, London, for use in its investigations of outer space.

DISPLAY FOR ELECTRONICS

Storviders units used by Cossor Electronics Limited at the Royal Festival Hall at a Symposium

Portable display equipment has become increasingly important in the Electronics Industry.

The normal display of photographs and equipment or merchandise can be enhanced by seating arrangements, screened cubicles, shelving ladders, enclosed cupboard units, strategically placed lighting and even a flower trough, all transportable in a lightweight carrying case.

With ever rising costs Storviders Ltd., provide a portable display system that is completely flexible, time saving, simple to use, light yet strong, easy to transport, eye-catching in design, flame-proof and economical in cost.

Whether a small isolated display is called for or a large exhibition stand, Storviders provides the answer.

Approved by the Design Centre, Storviders' eye-catching appearance in seven attractive colours is inevitably outstanding on all occasions where display for electronics is involved.

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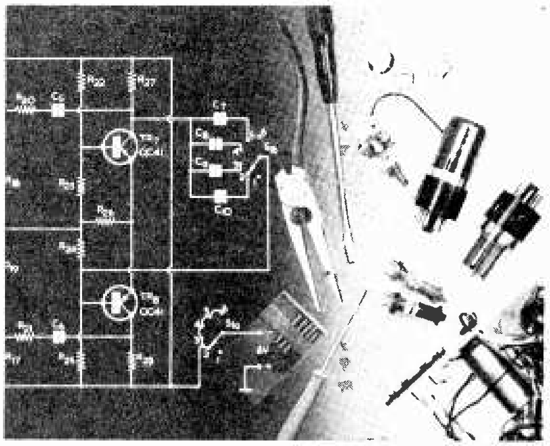
Multivibrator Capacitance Bridge

by G. A. FRENCH



CAPACITANCE MEASURING BRIDGES capable of reading values down to around 1pF are always useful in both the amateur and the professional workshop. It is possible to home-construct a bridge of this nature and, provided that reasonable care is exercised in design and assembly, to obtain thereby an instrument which is capable of measuring capacitance to an accuracy that is more than adequate for servicing and experimental work.

The instrument to be described in this month's article in the 'Suggested Circuit' series employs a bridge circuit which can be balanced to read capacitance values from less than 1pF to greater than 0.025μF. The bridge null is indicated by aural means, and the instrument is intended to be used in conjunction with any a.f. amplifier having an input impedance of 100kΩ or more and a sensitivity which enables it to give full rated output at about 1 volt peak-to-peak input. An amplifier suitable for use with a radio tuner or ceramic pick-up will be quite suitable. Many readers will already have an amplifier of this nature on hand as part of their bench equipment.

BRIDGE FUNDAMENTALS

Before proceeding to a description of the instrument it will be helpful next to initially examine some of the basic problems that are inherent in the design of capacitance bridges.

Bridges intended for the measurement of capacitance may have resistive or capacitive adjustment arms. For home-constructor applications it is, in the writer's opinion, preferable to employ adjustable capacitive arms, since the variable element may then be provided by a standard tuning capacitor instead of by a variable resistor. A tuning capacitor is capable of infinitely close resolution and is not subject to the mechanical wear or the risk of poor contact between the wiper and the track that occurs with variable resistors. Also, for long-term reliability a variable resistor has to be wire-wound, whereupon an inductive element is introduced into the bridge.

A simple capacitance bridge is shown in Fig. 1(a), in which an a.c. generator is coupled to the upper and lower ends of the bridge. At the same time, a null indicating device is coupled to the two central sections. The capacitance being measured is shown as Cx, and C2 is adjusted for a zero reading in the null indicator. Under these conditions,

$$\frac{C1}{C2} = \frac{C3}{Cx}$$

whereupon

$$Cx = C2 \times \frac{C3}{C1},$$

and the value of Cx can be read from a scale fitted to C2.

If C3 has a value that is one-twentieth of C1 then the bridge will be theoretically capable of measuring values in Cx which fall within the range of one-twentieth part of the minimum and maximum values offered by C2. If C2 has a minimum capacitance of 20pF and a maximum capacitance of 500pF the range of measurement in Cx extends from 1pF to 25pF. Similarly, if C3 has a value that is, say, 5 times that of C1, the range of measurement is from 100pF to 2,500pF.

In practice, it is not a simple matter to achieve results which closely approach the theoretical possibilities, and the problems which arise are mainly concerned with the means employed for coupling the a.c. generator to the bridge and of coupling the bridge to the null indicator. It is first of all necessary to examine the nature of the generator itself. Since the bridge is intended to measure values in Cx of the order of 1pF it is desirable that the frequency offered by the generator be well above audio frequency, since the reactance offered by a capacitance of 1pF will then be sufficiently low to enable such matters as insulation resistance to be ignored and the problem of low bridge output to be overcome. A frequency of the order of 1MHz, at which the reactance of 1pF is 159kΩ, would be suitable. The a.c. generator should, then, be a device feeding a radio frequency to the bridge. It will be helpful to have this radio frequency amplitude modulated by an audio frequency tone, since the null indicator can then consist of an a.m. detector followed by an a.f. amplifier and speaker or headphones. The bridge is adjusted for minimum audible tone.

The questions of coupling the input to the bridge and the bridge to the null indicating device may next be dealt with. For stable operation, it is desirable to have one terminal of the variable capacitor C2 earthed, i.e. connected to the chassis of the capacitance measuring instrument. As already mentioned, this capacitor can be a standard tuning capacitor, whereupon its metal frame can be at chassis potential and the problem of hand

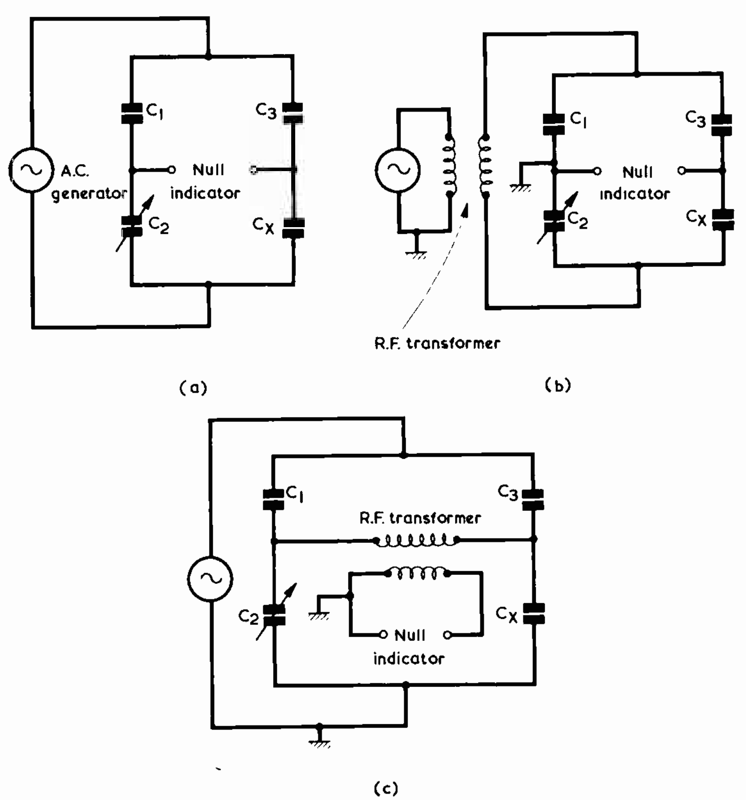


Fig. 1 (a). A simple bridge circuit capable of measuring capacitance. If low values of capacitance are to be measured it is preferable for the output of the a.c. generator to be at a radio frequency

(b). In practical circuits one side of the a.c. generator and null indicator are liable to be at chassis potential. Here, an r.f. transformer isolates the chassis connection from the input to the bridge

(c). An alternative approach, in which the r.f. transformer is in the output circuit

capacitance effects with simple construction methods is eliminated. It is also very desirable to have one side of the input to the bridge, or one side of the output from the bridge, connected to chassis. Obviously, it is impossible to have a chassis connection to both, and either the input or the output must be 'floating' with respect to chassis. There are two methods of achieving the 'floating' requirement and these are illustrated in Figs. 1(b) and (c). In Fig. 1(b) the input to the bridge is provided by means of a transformer, thereby allowing one side of the output to be earthed; whilst in Fig.1(c) the output from the bridge is taken by way of a transformer and one side of the input is earthed. Both methods of connection allow one side of the variable capacitor C2 to be at chassis potential. Further, one side of the a.c. generator and one side of the null indicator can also be at chassis potential.

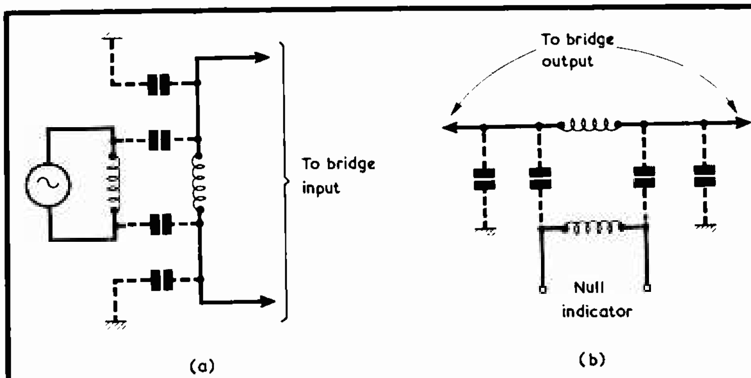


Fig. 2 (a). A complex network of stray capacitances appears in the isolating transformer of Fig. 1 (b). Some of the stray capacitances are shown here

(b). Some of the stray capacitances in the isolating transformer of Fig. 1 (c)

The two transformers of Figs. 1(b) and (c) have stray capacitances between primary and secondary and between the winding which connects to the bridge and chassis. The stray capacitances form a complex network but it will be adequate, for present purposes, to look upon them in the form shown in Figs. 2(a) and (b). These stray capacitances can be taken up in the calibration of the instrument but it is, nevertheless, desirable to keep them comparable with, or lower than, the lowest capacitance it is intended to measure.

In the instrument which forms the subject of this article, the arrangement of Fig. 1(b) is employed, the isolating transformer appearing in the input circuit to the bridge.

CIRCUIT DIAGRAM

The complete circuit of the measuring bridge is given in Fig. 3, and it will be noted that this has a number of unusual features. As stated earlier, the generator supplying the bridge should provide an amplitude modulated output at r.f., and it could in consequence consist of an r.f. oscillator which is modulated by an a.f. oscillator. However, the circuit can be simplified by having one oscillator perform both functions and this is achieved by the multivibrator consisting basically of TR1 and TR2. These two transistors form a standard 50:50 multivibrator running at around 1.5kHz, and they have relatively low values of collector and base resistance to ensure a rapid transition from one state to the other during the multivibrator cycle. The emitter of TR2 does not connect direct to chassis, as would occur with a conventional multivibrator, but couples to chassis instead via the base-emitter junction of TR3. TR3 is, in consequence, turned hard on during the periods when TR2 is conducting.

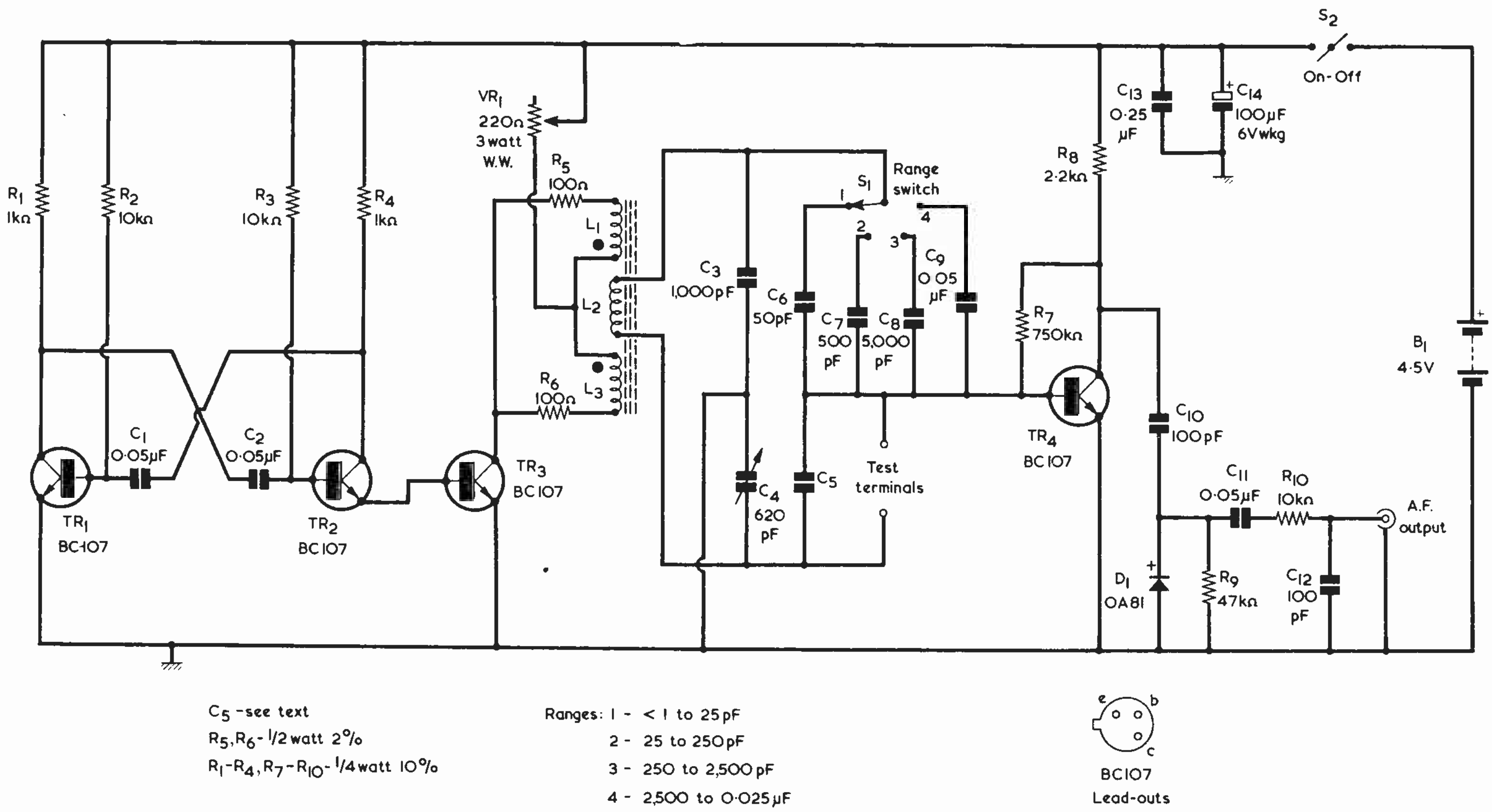


Fig. 3. The complete circuit diagram of the multivibrator capacitance bridge

The collector of TR3 couples, via the equal-value resistors R5 and R6, to windings L1 and L3 of the isolation transformer given by L1, L2 and L3. L1 and L3 are identical windings spaced symmetrically on either side of L2 on a ferrite rod, with the results that the stray capacitances between L2 and L1, L3 are small in value and a relatively tight coupling is provided from TR3 to L2. When VR1 is set to insert minimum resistance into circuit, current pulses of around 40mA are injected into L1 and L3 at the multivibrator frequency of about 1.5kHz. L1 and L3 are wound so that their fields are mutually assisting, whilst the presence of R5 and R6 ensures that the pulse currents which flow in them are equal.

Since the output from the multivibrator is a square wave it is rich in harmonics, all of these being modulated at the multivibrator frequency itself. These harmonics extend well above 1MHz and are used for energising the bridge. The fact that a band of frequencies instead of a single frequency is used has no effect on bridge operation, since the reactances offered by the capacitors in the bridge are all equally proportional to signal frequency.

A 'hidden' factor in the circuit is that coil L2 forms the inductive section of a parallel tuned circuit in which the capacitive part is given by the capacitance presented to it by the bridge components. This capacitance changes as the bridge is adjusted and the resonant frequency is not in consequence fixed but varies up to a maximum value in the region of 2MHz. The resonance is of considerable value in the present design because it provides a boost for multivibrator harmonics at and near the resonant frequency, and ensures an adequate drive voltage for the bridge when measuring low-value capacitors.

Before leaving the bridge drive circuit, mention should be made of the variable resistor VR1. This component provides an adjustment of drive level and is brought into use if it is found that excessive drive to the bridge prevents a clear null indication being provided. In most instances it will be found that perfectly clear nulls are given when VR1 is set to insert minimum resistance (and thereby provide maximum drive) and that VR1 only needs adjustment when measuring capacitors around 1,000 to 5,000pF. VR1 is specified as a wire-wound component because its track carries relatively large pulse currents, particularly when its wiper is close to the maximum drive setting.

BRIDGE CIRCUIT

The bridge circuit is given by the capacitors C3 to C9, together with the capacitor being measured, which is connected to the Test Terminals. Capacitor C3 corresponds with C1 of Fig. 1(b), C4 with C2 of Fig. 1(b), and whichever of C6 to C9 is selected by range switch S1 with C3 of Fig. 1(b). The capacitor connected to the Test Terminals is, of course, Cx. The values employed for C6 to C9 provide four ranges offering a reasonable amount of overlap from range to range.

C5 is a low value capacitor whose function is to balance out the minimum capacitance offered by C4 on Range 1. Working to the 50pF value for C6 shown in Fig. 3, the value of the capacitor under test is, at bridge balance on Range 1, always one-twentieth of the value of C4. Thus, if C4 offers a minimum capacitance of, say, 22pF, it becomes impossible to measure capacitors having values of 1pF and lower. The value of C5 is found experimentally and is that which causes the bridge to balance on Range 1 with no capacitor connected to the Test Terminals and with C4 very near its minimum capacitance setting. Capacitors connected to the test terminals then add to the capacitance given by C5. In the prototype C5 consisted of a 'twisted pair' of 26 s.w.g. p.v.c. insulated wires, these being twisted together over a length of about an inch. A 'preset' capacitor' of this nature is quite suitable for a measuring instrument provided that the insulated wires are relatively stout and are tightly twisted together. Any long-term changes in the capacitance offered by C5 will, in any case, be at once detectable because of the consequent changes in setting of C4 which corresponds to zero test capacitance on Range 1. There is no necessity to have similar balancing-out capacitors on the higher ranges because they are only required for the measurement of capacitance above the maximum value offered by the preceding range.

In Fig. 3 the values of C6 to C9 ascend as multiples by 10, and it should, at first sight, be possible to use a common scale for all the ranges if close tolerance capacitors are employed here. The figures on the common scale would then be multiplied by 10, 100, etc., according to the range selected. In practice, great care will be required with layout and the reduction of stray capacitances if a common scale is to be achieved, and it would be simpler to use normal low tolerance components for C6 to C9 and to provide individual scales for each range. A separate scale for Range 1 is necessary, in any event, because of the presence of C5. The components employed for C6 to C9 may be silvered mica, or paper or plastic foil. It is advisable to avoid the use of ceramic capacitors which, particularly at the larger capacitances, may have exceptionally wide tolerances and high temperature coefficients. C3 can also be a low tolerance component, and a silvered mica capacitor would be suitable here.

C4 is shown as having the rather unusual value of 620pF. In the prototype, this was given by a 2-gang 310+310pF tuning capacitor with both sections connected in parallel. The value of C4 is not very critical provided it lies between 600 and 700pF. A 2-gang 500+500pF could be employed instead of the 310+310pF component, it being wired up in the manner shown in Fig 4, where a 200pF silvered mica capacitor is inserted in series with one of its two sections. One important point is that C4 must be an air-spaced, and not a solid dielectric, component.

The null indicator of Fig. 1(b) appears tin Fig. 3 as the base and emitter of TR4. This transistor acts as an untuned r.f. amplifier and brings the low r.f. voltages which appear near the bridge balance point up to a sufficiently high amplitude for detection by D1. For nearly all test capacitances the amplification offered by TR4 is sufficient to allow the null to be clearly indicated and precisely resolved. At very low test capacitances, below around 15pF, the null is indicated by loss of tone of either side of the true balance position. The 'width' of this band is small, and at 1pF it extends only from about 0.8 to 1.2pF on the scale of C4.

After detection by D1 the consequent a.f. tone passes through the filter given by R10 and C12 for connection to the subsequent a.f. amplifier.

Two bypass capacitors, C13 and C14, are connected across the supply rails. C13 provides a low impedance r.f. path for the pulses fed to L1 and L3. C14 prevents the a.f. content of these pulses from being applied to the collector load of TR4.

COMPONENTS

Quite a few of the components have already been dealt with in the description of circuit operation. The transistors and diode are all standard readily-obtainable types. S1 is a 4-way rotary type. A miniature 3-pole 4-way rotary switch could be used here with no connections made to two of the poles. However, a rotary switch having

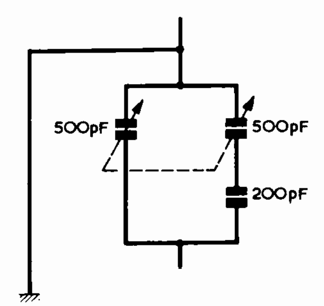


Fig. 4 If desired, C4 can consist of a 2-gang 500+500pF capacitor, with a 200pF silvered mica capacitor in series with one section

a 'flat' wafer construction would be rather better, since there would be lower stray capacitances between neighbouring tags and contacts.

In the prototype, VR1 was a Bulgin 3 watt wire-wound potentiometer (Home Radio Cat. No. VR22A). This component is not critical and any other 3 watt wire-wound component having a value between 200 and 250Ω could be employed in its place. The fixed resistors are as specified in Fig. 3. C1, C2, C11 and C13 may be paper or plastic foil, whilst C10 and C12 can be silvered mica.

Transformer L1, L2, L3 is home-wound on a 3/8 in. diameter ferrite rod, the length of which may be either 4in. or 6in. There are two methods of winding this coil, these being illustrated in Figs. 5(a) and (b). That shown in *opposite* direction to L1. Coil L2 can be wound on in any direction.

If any doubt exists as to the correct phasing of L1 and L3, the circuit should be assembled with no connection made between R5 and L1. The unit is then switched on and the bridge is adjusted to any setting which gives an audible output from the associated amplifier. If, when R5 and L1 are connected together the volume of the audible output increases, then the phasing of the two coils is correct. A similar check can be carried out by bringing a transistor portable radio switched to the long wave band close to the ferrite rod. The radio will pick up the field around the rod and reproduce a 1.5kHz tone which, with correct phasing, will increase in amplitude when R5 is connected to L1.

VR1, S1, S2 and an output jack for connection to the subsequent a.f. amplifier.

The components in the bridge circuit including the input leads from L2, should be kept reasonably well spaced out and away from any points that are at chassis potential. An important factor is that the transformer L1, L2, L3 offers a high level of radiation and the circuitry around TR4, including C5 to C9 and the connections to the Test Terminals, should be spaced away from it by some 4in. or more. An alternative approach is to house this transformer, together with TR1, TR2, TR3 and their associated components, in a screened box, from which two leads provide the drive from L2. This will necessitate the provision of rather a large screened box, however, since

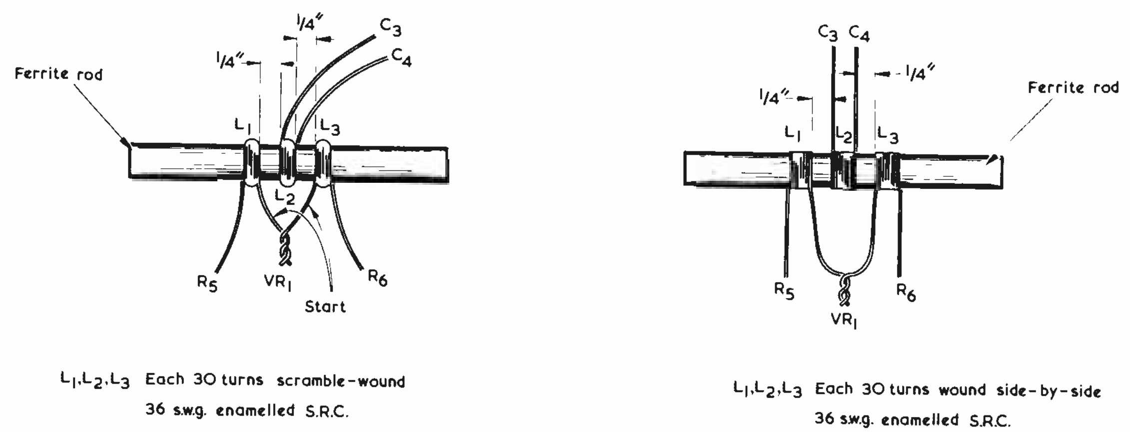


Fig. 5 (a). A simple method of winding the transformer L1, L2, L3
(b). A more difficult method, which offers slightly improved performance

Fig. 5(a) is the easier and gives quite satisfactory results if the coils are firmly secured in place after winding. Coil L2 is positioned at the centre of the rod whilst L1 and L3 are spaced away from it by ¼in. on either side. All coils are wound directly on the rod, and the wire is 36 s.w.g. enamelled, single rayon covered.

The method of winding shown in Fig. 5(b) is a little more difficult to carry out, but it offers slightly tighter coupling and lower stray capacitances between coils. Once more, L2 is at the centre of the rod, and L1 and L3 are spaced away from it by ¼in. Again, all coils are wound directly on the rod and the wire is 36 s.w.g. enamelled, single rayon covered. Note that, to obtain correct phasing, L3 is wound on in the

The battery for the instrument should offer a voltage of 4.5 and may consist of three 1.5 volt cells in series. The current drawn by the circuit is approximately 40mA when VR1 is set to give maximum drive and so it would be advisable to use cells having a reasonably high capacity. The instrument must not be powered by a supply offering more than 4.5 volts, as this could cause some of the transistor ratings to be exceeded.

CONSTRUCTION AND CALIBRATION

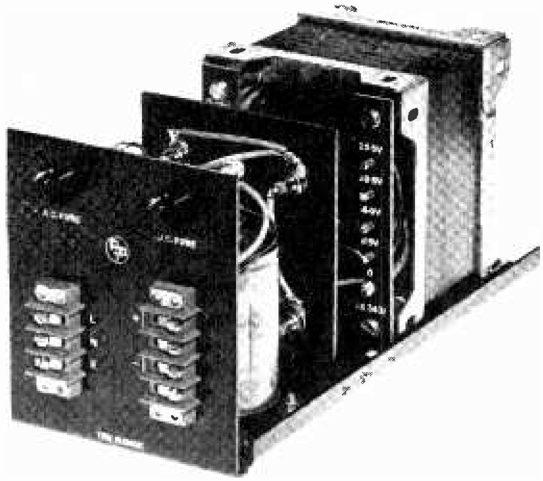
The components can be mounted in a metal or insulated case, with C4 mounted centrally on the front panel. The only other panel components are

the ferrite rod should not approach any metal surface closer than 2in. as there will otherwise be damping of the coils. The prototype circuit functioned satisfactorily without screening of the multivibrator circuit and transformer, although there was a slight, but otherwise unimportant, breakthrough of the a.f. tone at null settings when measuring the larger capacitors.

C4 is fitted with a large knob and a cursor, behind which a scale is fitted. Calibration is carried out by measuring a quantity of capacitors of known value and of making up, on a temporary scale, the corresponding positions of the C4 cursor. A final scale can then be prepared from the temporary scale by drawing graphs or by interpolation in the usual manner. ■

Trade News . . .

NEW GENERAL PURPOSE POWER UNIT



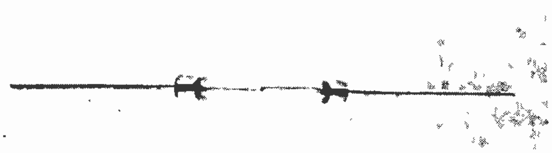
A new range of low cost, mains-powered transformer/rectifier subunits is available from A.P.T. Electronic Industries Ltd., Chertsey Road, Byfleet, Surrey.

Designated the TRU range, the units have been designed for general use in varied electrical and electronic applications including: motors, lamps, relays, solenoids; transistor and integrated circuitry etc., and to supply the dc power necessary to feed IC voltage regulators.

The smoothed, unstabilised dc output of the TRU range is fully floating and any number of units may be connected in series to provide higher voltages up to a maximum of 500v, with respect to earth, and in parallel for increased output currents. The units are simply, yet robustly constructed throughout using high quality components. The incorporation of long-life electrolytic capacitors ensures a unit of reliable performance and long service at an economic price.

According to model, the units within the range are available from £13.00 each.

MCA—200 LOW LEVEL REED SWITCH



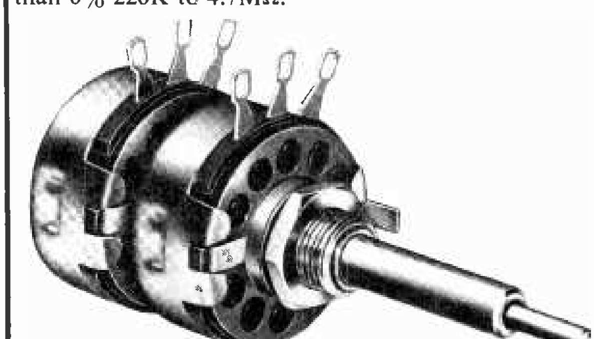
The MCA-200 is a miniature reed switch utilising a new contact material – Cobold – which makes it ideal for switching low to medium loads. A life of greater than 100 million operations is achievable on logic level loads. Typical applications are push button switches and data logging systems. The MCA-200 has a switching capability of 10 Watts and 200 volts and is available in the sensitivity range of 20-50 AT. Further details are available from: FR Electronics, Switching Components Group, Wimborne, Dorset.

EMI OFFERS EXTENSIVE ELECTRONIC MAINTENANCE AND CALIBRATION SERVICES UNDER NEW ORGANISATION – 'EMI SERVICE'

The photograph shows part of EMI Services' maintenance laboratories where general repair and calibration work on instrumentation is carried out

HOT MOULDED TRACK POTENTIOMETER

Ohmic S.A., a subsidiary of Bourns, have introduced the hot moulded track potentiometer Model MP 51 with long life and low noise. It is a double cup unit with independent concentric shafts thereby saving panel space. *General Features:* Resolution: Infinite. Resistance Range: 47Ω to 4.7MΩ. Resistance Tolerances: ±20% std. (±10% available). Power Ratings: 2 W at 70°C Linear, 1 W at 70°C Log. Operating Temperature Range: –55°C to +125°C. Contact Resistance: Less than 2% of TR. Resistance Variation with Vibration: Less than 2.5%. Load Life: 1,000 hrs. full load at 70°C Resistance Variation less than 3% 47Ω to 100K, less than 6% 220K to 4.7MΩ.



'THE F.E.T. TWIN'

A Medium Power Stereo Amplifier

by

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

A simple stereo amplifier which offers a high quality output and requires few components

NEARLY ALL THE STEREO AMPLIFIERS ON THE MARKET give a total output of not less than about 10 watts. This is admirable for some purposes, but is often more than is needed for ordinary domestic listening when one-tenth of this power will give an undistorted output which is still too loud for many tastes. The more powerful amplifier must be turned right down in these circumstances, and low settings of the volume control are not always conducive to the best quality. The present design gives a comfortable output level which will be found to be quite ample for domestic listening. Quality is of a very high order, as much negative feedback is used, and the cost of construction is low.

CIRCUIT OPERATION

The circuit is shown in Fig. 1, in which the two channels, A and B, are identical and have the same component numbering. Channel A is the left-hand channel, and Channel B is the right-hand channel. The description which follows can be considered to apply to either channel.

The input signal is fed through R1 to the volume control, VR2. VR1 and C1 form a variable treble-cut tone control. D1 and D2, two silicon diodes connected back-to-back, ensure that no voltage in excess of about 0.6, either d.c. or a.c., can reach the gate of the field effect transistor, TR1. This component has a very high input impedance, and is connected in the common source mode. It feeds directly to the base of a p.n.p. silicon transistor, TR2, which functions as a common emitter device giving high voltage amplification. The output of TR2 is directly coupled to the base of the power transistor, TR3, which is an emitter follower with a 15Ω speaker in its emitter circuit.

Source bias for TR1 is taken from the slider of a pre-set potentiometer, VR4, across the speaker, this being adjusted so that TR3 passes a little under 250mA. Full negative feedback at d.c. takes place and good thermal stability results. VR3, R3 and C2 prevent the full negative feedback being applied to the signal, the setting of VR3 determining the proportion of signal which is fed back. It will be seen that this potentiometer provides a differential action because, as negative feedback is reduced for the A section, it is increased for the B section, and vice versa. VR3 therefore forms an efficient balance control. The value of VR3, in conjunction with that of R3, is such as to provide full loading with an input of the order of 100mV, the exact sensitivity depending on the characteristics of the transistors used. The amplifier is therefore suitable for virtually all crystal cartridges and for some ceramic cartridges. The Acos GP94–1 gives splendid results with the prototype. If, however, 100mV input results in disappointing volume, sensitivity can be increased in exchange for a slight loss of quality by shunting each half of VR3 with a fixed resistor. A value of 47Ω is suggested, but various values between 22Ω and 100Ω may be tried. The smaller the value the greater the increase in sensitivity, and the greater the loss of quality.

The power supply is simple. A mains transformer feeds the rectifier D3, smoothing being carried out by C4, C3 and R4. About 9V will appear across C3 at a current flow of 500mA. If any difficulty is found in procuring a 5.6Ω 2 watt resistor for R4, a 10Ω resistor may be used in parallel with a 12Ω resistor, each with a minimum rating of 1 watt.

It will be seen that the power pack is designed to provide a live negative line even though this may appear to be the natural earth. The reason for this is to enable constructors who prefer working with metal to use an inverted chassis which is common to the positive supply line and to which the two output transistors may be bolted directly without the necessity for mica washers and insulating bushes. But if a metal chassis is used in this manner it must be remembered that it will be about 9 volts positive of the frame of the record deck or the chassis of any tuner with which the amplifier is used,

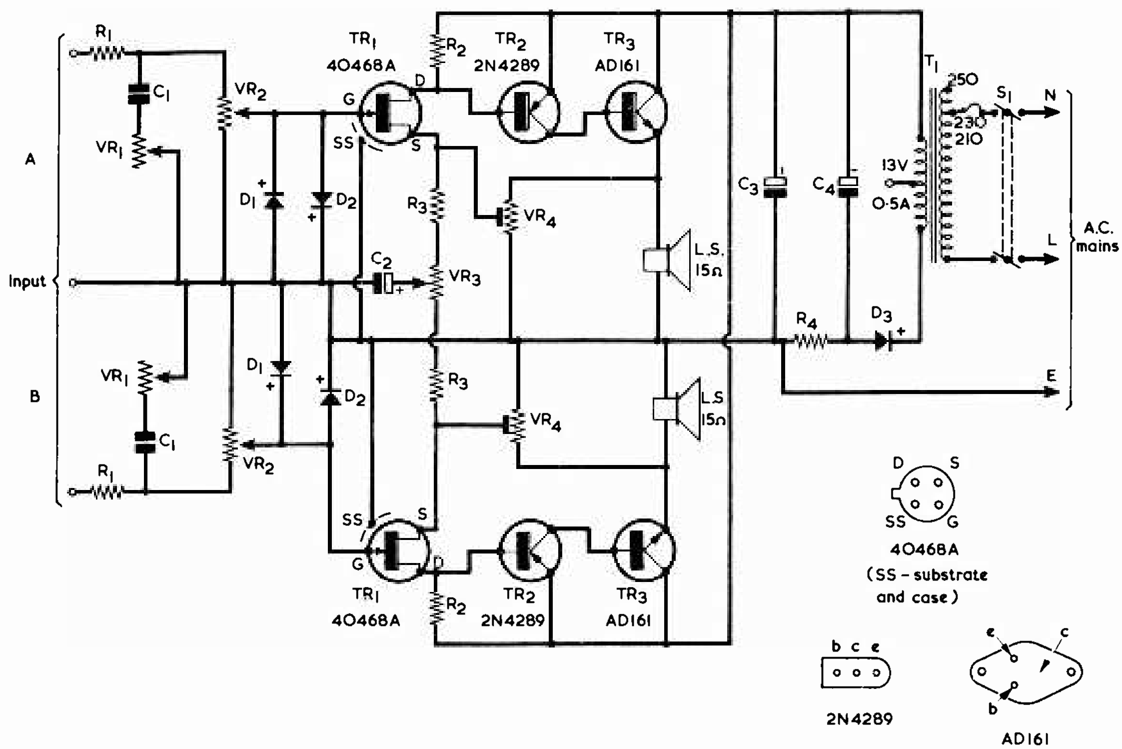


Fig. 1. The circuit diagram for the stereo amplifier. The two channels, A and B, are identical

COMPONENTS

Resistors

(All fixed resistors ½ watt 10% unless otherwise stated)

R1A, B	Each 220kΩ
R2A, B	Each 1kΩ
R3A, B	Each 18Ω
R4	5.6Ω 2 watt (see text)
VR1A, B	1MΩ dual potentiometer, log track
VR2A, B	1MΩdual potentiometer, log track
VR3	100Ω potentiometer, wire-wound
VR4A, B	Each 1kΩ potentiometer, preset, skeleton.

Capacitors

C1A, B	Each 1,000pF, paper or plastic foil
C2	640μF electrolytic, 2.5 V.Wkg.
C3	3,200μF electrolytic, 10 V.Wkg.
C4	1,000μF electrolytic, 16 V.Wkg.

Semiconductors

TR1A, B	Each 40468A
TR2A, B	Each 2N4289
TR3A, B	Each AD161
D1A, B, D2A, B	Each silicon bias diode (see text)
D3	DD000 (Lucas)

Transformer

T1	R.S. Components filament transformer, secondary 13V 0.5A centre-tapped (Home Radio Cat. No. TH5D)

Speakers

Each 15Ω

Miscellaneous

18-way tagboard (Home Radio Cat. No. BTS10)
2 4-way transistor holders
2 phono sockets, with plugs
1 3-way DIN socket, with plug
3 knobs
1 clip for C3 (see text)
Screened cable
Plywood, Fablon, etc.

and it will be essential to insulate the speaker sockets, and input socket, from the chassis. If the method of construction employing plywood, next to be described, is used, only the small heat sink required will be at a different potential from other earthed items.

The components employed in the amplifier are generally available. The four diodes, D1A and B, and D2A and B, were 'silicon bias diodes' in the prototype. These were obtained from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE.

CONSTRUCTION

The first constructional step is to cut out a piece of ¼in. plywood to the shape and dimensions shown in Fig. 2. Cut out a second piece so that its dimensions are 7in. by 1⅞in. and drill out a ⅜in. diameter hole at its exact centre. Drill two further ⅜in. holes in this piece, these appearing on either side of the central hole and separated from it by 2in. in each case. These three holes will later take the controls VR2A and B, VR1A and B, and VR3. Finally cut out a third piece of ¼in. plywood so that its dimensions are 7in. by 6in.

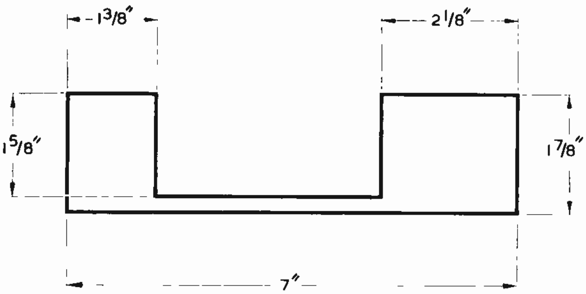


Fig. 2. Dimensions of the plywood piece on which are mounted the output transistor heat sink and the input and output sockets

Next, cut out a piece of aluminium sheet of around 18 or 16 s.w.g. to dimensions of 4in. by 1⅝in. and, following Fig. 3, drill holes for the two TR3 transistors and for S1. Also required are two small wood-screw holes at the end for securing the aluminium sheet in position. Mount S1 and the two transistors to the aluminium sheet so that the transistor lead-outs are on the same side of the sheet as are the switch tags, at the same time fitting a solder tag under one of the securing nuts for TR3B. No mica washers are used for the transistors, but make sure that the aluminium is flat so that they make good thermal contact to its surface. Mount the DIN input socket and the two phono output sockets to the plywood piece of Fig. 2, these taking up the positions shown in Fig. 3. Drill a hole in the plywood piece for the mains lead, and then screw on the aluminium plate so that it covers the inside of the plywood cut-out section.

Mount the three controls, VR2A and B, VR1A and B, and VR3 to the plywood piece having the three ⅜in. holes. Now screw the two smaller plywood pieces, complete with their components, to the two 7in. edges of the large piece. (If desired, small angle brackets, mounted in positions where they do not foul any components, may be used instead for securing together the three pieces of plywood.) It will be seen that in Fig. 3 the control panel is shown already screwed to the main panel, while the socket panel is shown lying separate and not yet screwed into position. This method of display is employed in the diagram for clarity in indicating components and wiring.

Take up an R.S. Components standard size 18-way tagboard (available from Home Radio under Cat. No. BTS10) and cut from this two smaller tagboards, one having 9 pairs of tags and the other having 3 pairs of tags. These two boards are mounted as shown in Fig. 3. If the metal chassis form of construction is employed fit insulating backing plates under the tag boards. (These may be cut from an 18-way size backing plate obtainable from Home Radio under Cat. No. BTS14.) With the plywood construction the tagboards may be spaced off slightly with spacing washers. T1 is screwed to the large plywood board as also is a clip for C3, the clip enabling the capacitor to be positioned horizontally.

Small components are next mounted on the tagboards as shown, and the wiring is carried out and completed. Note that holders are used for the two field effect transistors, TR1A and B. On no account should these two transistors be inserted in their holders until all wiring is complete. For clarity of presentation VR4B is shown as though it is above transformer T1. In practice this potentiometer appears alongside the transformer. When wiring to the primary of T1, connect to the tags which correspond to the local mains voltage.

SETTING-UP

Before setting-up make sure that two 15Ω speakers are plugged in. Do not switch on unless speakers are connected, or the voltage across C3 will rise to a value considerably higher than the 10V at which the component is rated, and it could be damaged.

Adjust VR4A and VR4B so that in each case the slider is in the half-way position. Clip a voltmeter across the outside tags of VR4A and adjust the slider of this component so that a reading of 3 volts is given. Repeat the process with VR4B. Return to VR4A, check the voltage across it, and readjust the slider if a reading other than 3 volts is given. Check back, in a similar way, at VR4B. The need for this double checking is that the adjustment of one component can affect the current passing through the other, owing to the variation of the load on the mains transformer and, hence, the voltage available across C3.

When a voltage of 3 is given across VR4A and VR4B, clip the voltmeter across R4 and note that the reading is not greater than 2.7 volts. If it is, return to VR4A and VR4B and readjust these for a similar voltage across their tracks which is now a little less than 3 volts, then re-check the voltage across R4. If this does not now exceed 2.7 volts, VR4A and VR4B may be left alone. Should the voltage across R4 still be in excess of 2.7 volts repeat the process at VR4A and VR4B until the voltage across R4 drops below 2.7. In most cases these re-adjustments of VR4A and VR4B will not prove necessary, and the need for them only arises because some 15Ω impedance speakers have a resistance rather lower than the usual value.

The amplifier is now ready for use, but a cover must be made for it, especially as the primary tags of T1 and the contacts of S1 are at mains potential and thereby

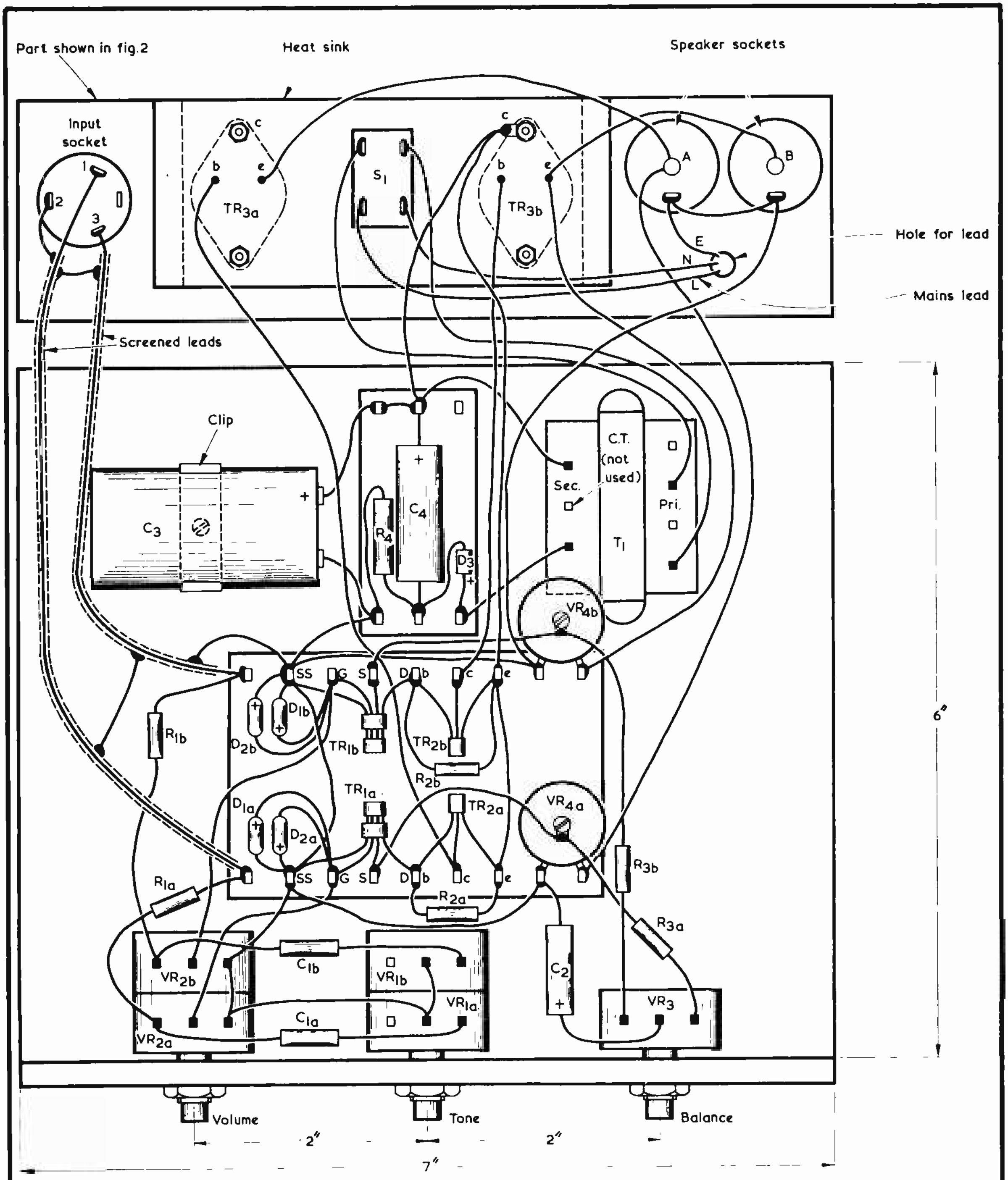


Fig. 3. Assembly and wiring of the components in the amplifier

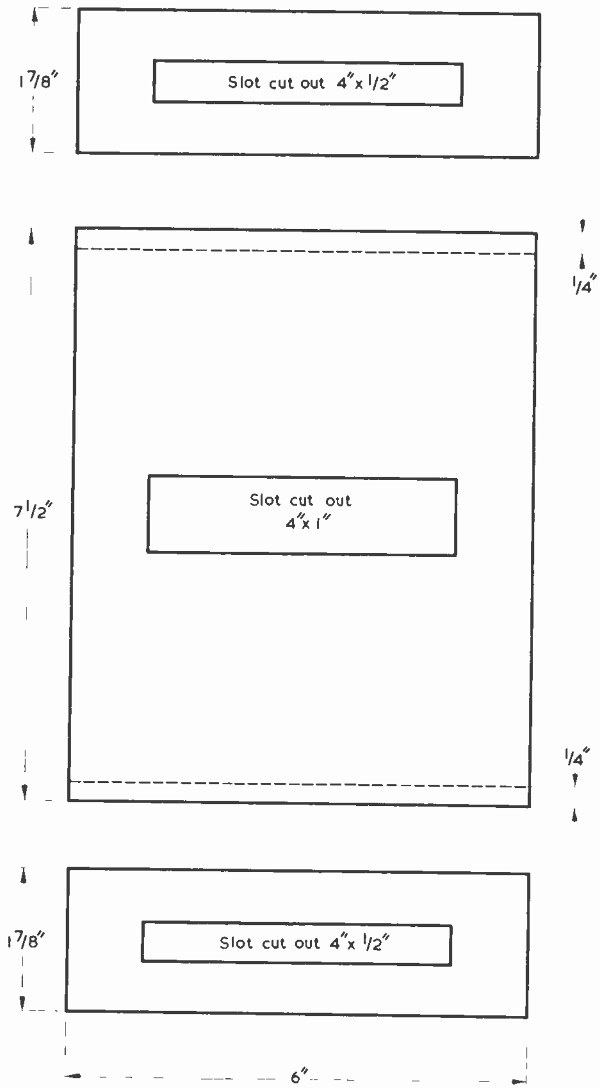
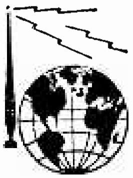


Fig. 4. A suitable cover can be made up with three pieces of plywood, as shown here

constitute a source of danger. All that are required are a top and two sides, which may be made up of ¼in. plywood as shown in Fig. 4, and screwed to the plywood base of the amplifier. Fablon or Contact will help to make a neat finish.

Note the slots cut in the three pieces of plywood which comprise the cover. These are essential for ventilation, and the insides should be covered with gauze having a wide mesh. If metal gauze is used, take great care to ensure that this does not approach any of the amplifier components or connections when the cover is fitted. ■



QSX

By FRANK A. BALDWIN

(All Times GMT)

The title of this feature – QSX – has undoubtedly caused some puzzlement amongst those new to Broadcast band listening. The explanation is simple – it is taken from the 'Q' code and conveys the meaning 'listen for'. The 'Q' code is used by both commercial and amateur radio operators and was originally brought into use as a means of contracting certain terms constantly used into three letters when using the c.w. (Morse) method of transmission. In modern usage however the 'Q' code is also used by amateurs when operating in the a.m. or s.s.b. modes. Broadcast band listeners have also, over the years, developed contractions which are used when conveying information to one another and in their various journals, but more of that on another occasion.

● LISTEN FOR

The above sub-head repeats the article title but the writer has, of late, tried to open the feature with news of importance to Broadcast bands operator readers of this journal. On this occasion it is news of a station operating on an 'out of band' channel – an event which never fails to excite the fraternity.

Radio Curom, Netherlands Antilles, has been logged on a measured frequency of **20778** from 1256 right through to fade-out at 2300. First heard on 19th February and secondly on 4th March, this feat was performed by Martin A. Hall, one of our foremost Dx'ers and a prominent member of the British Association of Dx'ers.

The programming was mainly of 'pops' with announcements and commercials in both Dutch and Papiamento (local dialect). We are indebted to 'Bandspread' for this information.

The address of Radio Curom is P.O. Box 31, Willemstad, Curacao, Netherlands Antilles. The identification in English is "This is Radio Curom in Willemstad, Curacao, Netherlands Antilles". In Dutch "Hier is de Curom te Willemstad op Curacao . . . ."

● AN UNUSUAL LOGGING

A recent unusual logging was that of Eskisehir Ataturk Lisesi on a measured frequency of **6252** at 1953 when radiating a talk in Turkish. The station was logged twice within a few days and is, in fact, a low-powered (450 watts) transmitter operated by a technical college in Ankara. As far as is known, no regular schedule is operated, this being one of a number of comparatively low-powered stations that operate on the short waves within the Turkish borders. The programmes are presumed to be entirely educational in content. The British Association of Dx'ers recently published a list of such transmitters, thought by the writer to be the first ever such list produced. It is available to Dx'ers for just two threepenny stamps from BADX at 16 Ena Avenue, Neath, Glam. Eskisehir Ataturk Lisesi also operates on **6726** but has not been heard on this channel by the writer.

● OTHER UNUSUAL LOGGINGS

Brian B. Walsh, of Romford in Essex, a long-time collaborator in QSX matters, heard FEBA (Far Eastern Broadcasting Association) Seychelles from 1730 until 1800 with a programme in English on **11950** which is an unlisted frequency at an unscheduled time. Acting upon this information, the writer logged them at 1733 with a religious programme in English.

Brian has also logged WNYW New York, with English to Europe, from 2215 on the unlisted frequency of **11805**.

Also noted have been the broadcasts from Radio Bangla Desh from 1130 to 1200 on **15520**, during which they announced a parallel channel of **11805**.

A further unusual logging made was that of the standard frequency station VNG at Lyndhurst, Australia on **12000**. Brian notes that reception of this station only seems possible around 2200 and when the signal path to Brazil is closed – no doubt due to long-skip conditions.

● MYSTERY SOLVED

B. Walsh has, like others, noted a transmission on **9020** in an Arabic-type language around 1900. You guessed right OM, it is Iran and is, in fact, Radio Teheran. The language is Farsi (Persian) and R. Teheran has used this channel in the past.

● CAPE VERDE ISLANDS

These islands can be logged in the form of CR4AC Radio Barlavento on **3930** (listed on **3910**). This station was heard here recently at 2300 with station identification in Portuguese after the sounding of one deep-toned chime. The late-night weekday schedule of this one is from 2200 to 0100.

● INTERESTING PROGRAMME

An unusual programme recently heard by the writer was that of part of the English and Eskimo transmission from Sackville, Canada, directed to the Canadian North on **15190**. Listening to the news of weather and road conditions in that area, and the temperatures, one could almost feel the icy blasts! This service is scheduled from 2200 to 2250 and is in parallel on **9625**.

● INTERESTING CHANNEL

There are a number of interesting channels on the LF bands which can provide some startling results at times. One such channel is that of **5010**. During the early evenings if one is lucky, the channel at such times is liable to be covered by commercial traffic, one may hear Radio Garoua in the Republic of Cameroon. The programme languages are in French and vernaculars, logged at 1830.

Much later, around 2300 or so, if conditions are right, one may hear HIMI Radio Cristal, Santa Domingo, Dominican Republic, who have a 1kW transmitter on a full 24 hour schedule. HIMI was recently logged here at 2300 with full identification followed by a programme of typical Latin American music.

● LESOTHO

This country, an enclave in the Republic of South Africa, has a transmitter operating on **4800** using both the Lesotho and English languages. A good chance of logging this station is presented on Sunday evenings – when some of the commercial traffic is absent – listen for the church service in English from 1830 onwards; logged here recently right through the hymns and sermon without any QRM!

● INDIA

Transmissions in English from the transmitter at Delhi abound on the short waves, **11960** at 2000 with identification and news in English being one of them. For a change, try **15080** at 1900, when Bombay takes a hand in the game. The programme consisted of a talk about the Pakistan Army, this following identification at 1910.

Cover Feature

2 - TRANSISTOR M.W.

R. A.

A neat little medium wave por transistors and fe

THIS RECEIVER USES ONLY TWO TRANSISTORS, AND covers the medium wave band. The output is for a crystal earpiece. Considering the small number of components employed the sensitivity of the receiver is quite good, and on the prototype several stations can be received, including foreign ones.

Although the receiver has not been miniaturised it is fairly compact, measuring $4\frac{1}{4} \times 2\frac{1}{2} \times \frac{3}{4}$in. Current consumption is a little over 1mA from a 9 volt battery, giving extremely long battery life.

THE CIRCUIT

A complete circuit diagram of the receiver is given in Fig. 1. L1 and VC1 form the tuned circuit and select the frequency to be received. L1 is wound on a ferrite rod, which makes it so efficient that no other aerial is required. Signals received by this coil are induced into the low impedance secondary coil, L2, which couples to the base of n.p.n. transistor TR1 via the d.c. blocking capacitor, C1. Transistor TR1 is used as a regenerative r.f. amplifier with R1 as the bias resistor and R2 forming part of the collector load. Regeneration is provided by way of the 'twisted pair' of insulated wires which couples the collector of TR1 back to the non-earthy end of L1. The 'twisted pair' forms a small pre-set capacitor, and the regeneration greatly increases sensitivity as well as helping to give better station separation.

The collector current of TR1 flows partly in R2 and partly through D1 and the base-emitter junction of p.n.p. transistor TR2. The diode provides rectification of the signal, thereby enabling TR2 to function as an a.f. amplifier. The output to the crystal earpiece is taken from across R3 via the jack socket SK1.

This jack socket is fitted with a single make contact which connects the negative side of the supply to the receiver when the earpiece is plugged in. This means that the set is automatically turned on when the earpiece is connected, and turned off when the earpiece is removed.

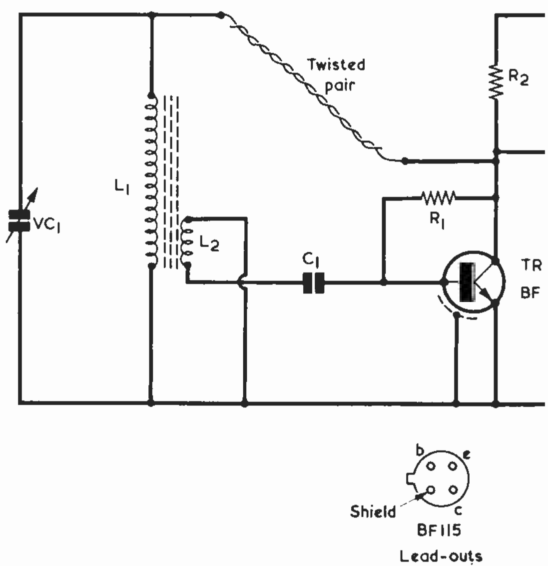
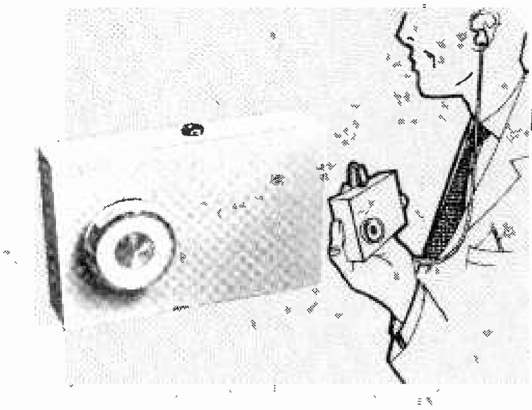


Fig. 1. The circuit of the simple regenerative receiv TR2 as a

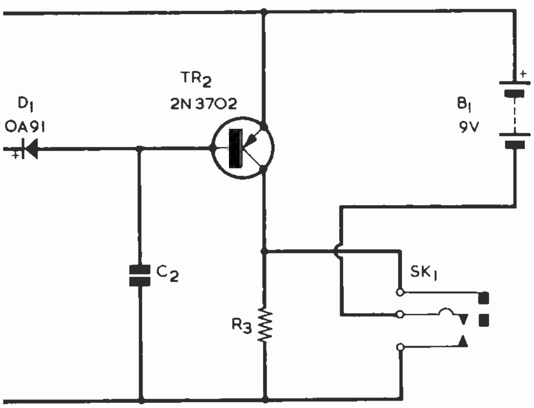
RECEIVER

ɜnfold



The appearance of the receiver after completion. It is automatically switched on when an earphone plug is inserted in the jack socket

ɔle receiver which employs two ; a crystal earphone



2N3702
Lead-outs

ʼR1 functions as r.f. amplifier, D1 as detector and ɪmplifier

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 1MΩ
R2 3.3kΩ
R3 3.9kΩ

Capacitors
C1 0.1μF polyester
C2 0.01μF disc ceramic
VC1 250pF or 300pF variable, solid dielectric miniature (see text)

Inductors
L1, L2 Medium wave ferrite aerial (see text)

Semiconductors
TR1 BF115
TR2 2N3702
D1 0A91

Battery
B1 9-volt battery type PP3 (Ever Ready)

Socket
SK1 3.5mm. jack socket with make contact (see text)

Earphone
Crystal earphone with 3.5mm. jack plug

Miscellaneous
Ferrite rod, 4in. by ⅜in. dia.
32 s.w.g. copper wire, enamelled or d.c.c.
Battery clips
Knob
Plain Veroboard, 0.15in. matrix
Formica, glue, etc.

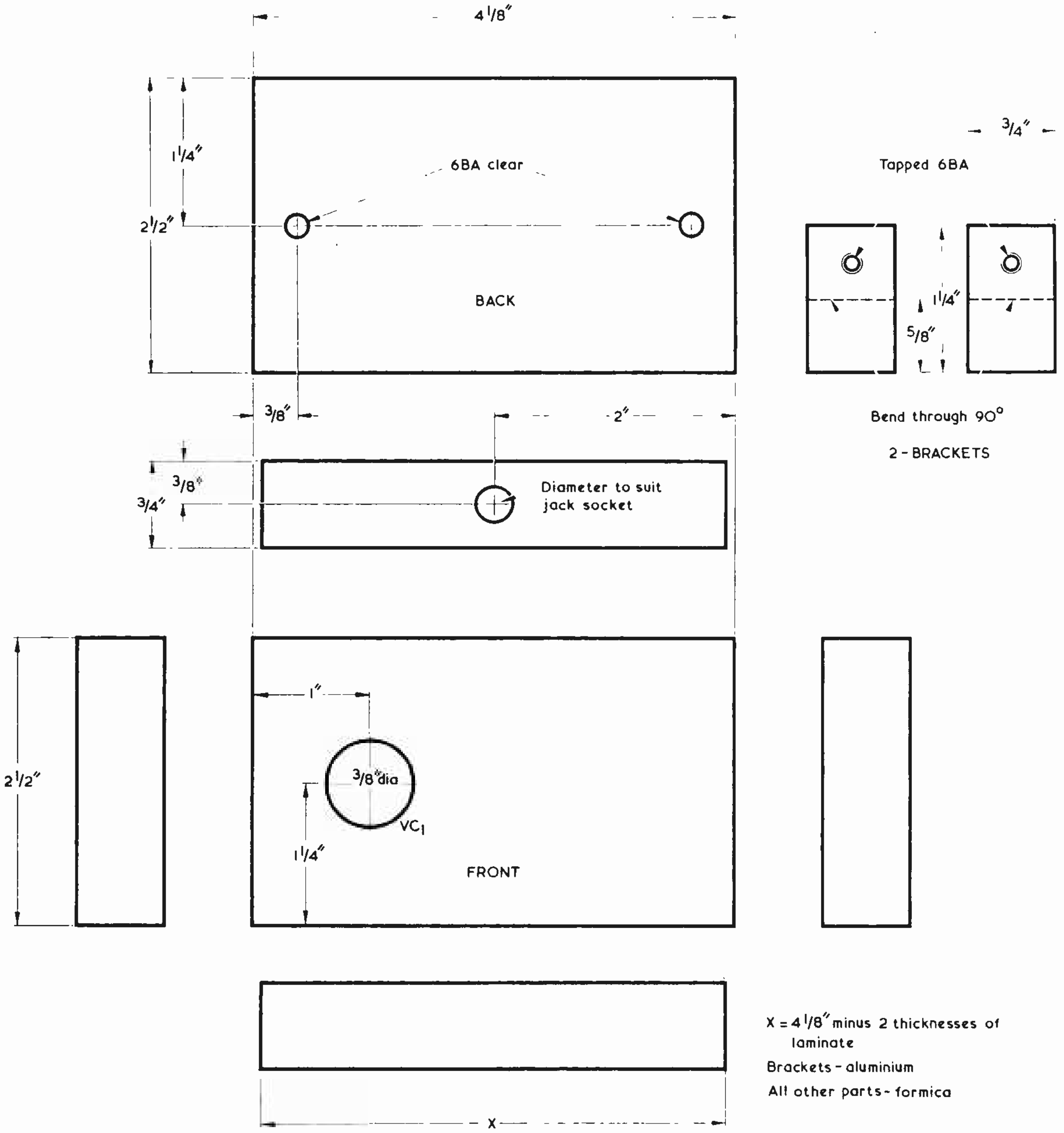
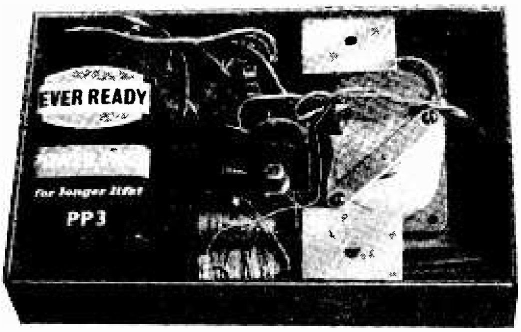


Fig. 2. Dimensions of the parts which form the case of the receiver

FORMICA CASE

The case is constructed from Formica, and full cutting details of the parts required are given in Fig. 2. As is mentioned later it may be necessary to modify the dimensions slightly to accommodate the ferrite rod and tuning capacitor, and the constructor should read the notes applicable to these components before commencing to make the case.

As will be gathered from Fig. 2 the front panel covers the edges of the two end pieces and the two side pieces. The side pieces are shorter than the width of the front panel by two thicknesses of the laminate to allow for the two end pieces. The back panel has the same dimensions as the front panel and also has two 6BA clearance holes for mounting bolts. These pass into two tapped holes in



A view inside the rear of the receiver

small brackets fitted to the cabinet sides. (The Formica employed should not be the heat-resistant type, as this sometimes has a metal shim laminated in the material.)

Formica is not always easy to cut. If care is taken it can be sawn using a hacksaw, or alternatively it can be cut by scoring both sides of the material along the line on which it is to be severed, the scoring being made as deep as possible with a knife or razor blade. If the material is then bent with a jerk along this line it will break with a good clean straight edge.

Any modern general purpose adhesive such as Bostik or Evo-Stik can be used to glue the pieces of the case together. The two metal brackets, to which the back is secured on completion of the receiver, are glued to the two sides of the case, as indicated in Fig. 5 and the accompanying photograph. It will be helpful to mark out the holes in the brackets after they have been secured to the case by using the back, with the 6BA clearance holes drilled in it, as a template. The bracket holes may then be drilled out and tapped. If desired, self-tapping screws can be employed to hold on the back instead of 6BA screws.

FERRITE AERIAL

The ferrite rod aerial is a home-made unit, although the circuit should work with any commercially produced medium wave ferrite aerial intended for transistor usage. However, these are more expensive than the home-made version.

A coil former is made by winding two or three layers of thin card or fairly thick paper around the rod to form a fairly rigid tube. The coils are then wound on in the manner shown in Fig. 3 with the turns, ideally, side by side. The coils may be given a coating of polystyrene dope, when completed, to hold them in position. The coils are positioned centrally on the rod.

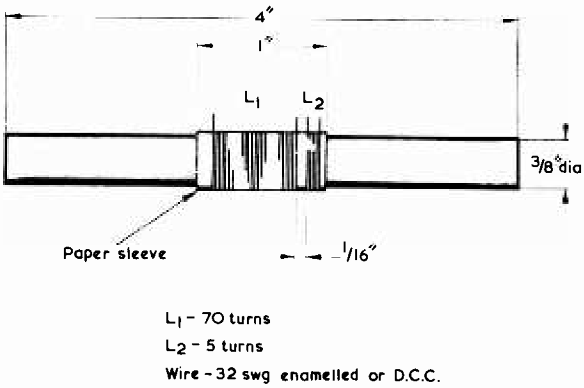


Fig. 3. How the ferrite aerial is wound

ELECTRICAL CONSTRUCTION

Most of the components are mounted on a piece of plain 0.15in. matrix Veroboard (i.e. without copper strips) using the layout shown in Figs. 4 and 5. If a piece of board larger than that shown in Fig. 4 is used, it may be secured in position by trapping the part without components between VC1 and the front of the case. The outline of the section so trapped is indicated by the dashed lines in Fig. 5. This scheme was not possible with the prototype because the particular tuning capacitor employed had too short a mounting bush, and the board was kept in place by wiring it to the jack socket with stout single-strand wire. The stiffness of the wire was sufficient to keep the board in place.

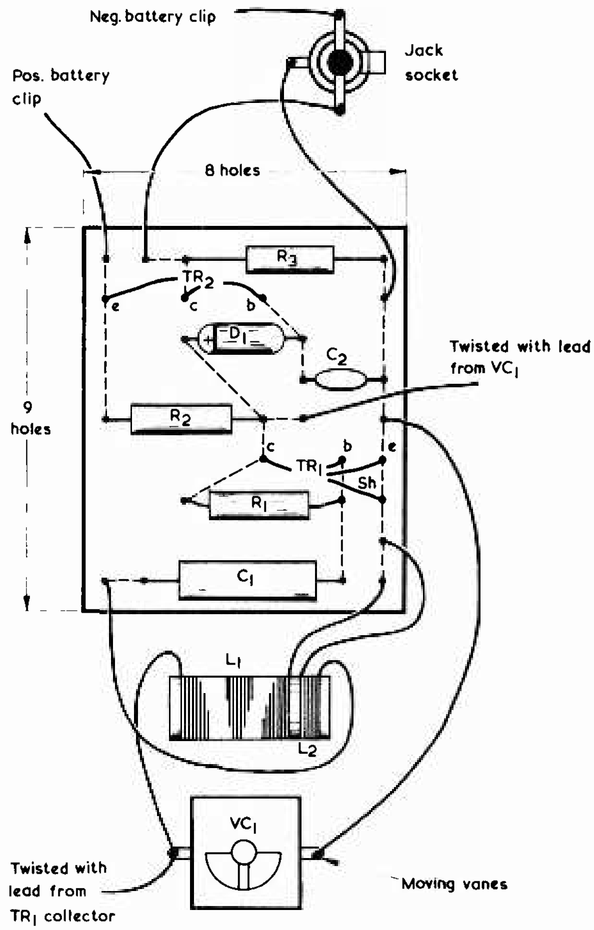


Fig. 4. Connections on and around the Veroboard. The board will extend to the right if it is secured under VC1, as is described in the text

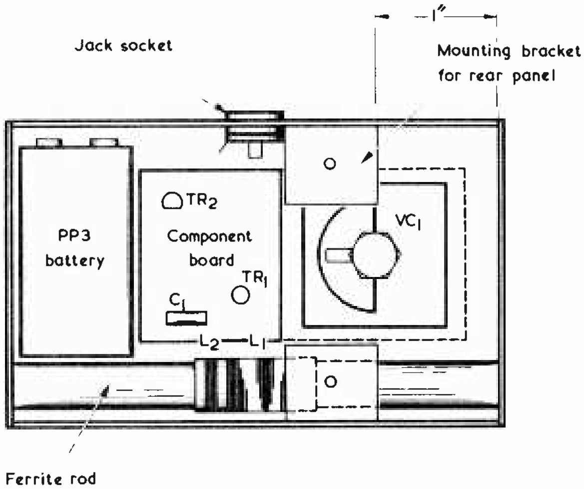


Fig. 5. Layout of components inside the case. The dashed line around VC1 indicates the extension of the Veroboard of Fig. 4 when this is secured under the tuning capacitor. Also shown are the positions of the two brackets to which the back is bolted

Fig. 4 gives a complete wiring diagram, whilst Fig. 5 shows the positioning of the components within the case. Note that the jack socket is mounted in a hole in one of the side pieces. Most jack sockets are fitted with a break contact which is intended to cut the speaker of the associated receiver out of circuit when a plug is inserted. If a socket of this type is to be used, it will be necessary to modify the break contact so that it acts, instead, as a make contact. Details of this modification are given in Fig. 6.

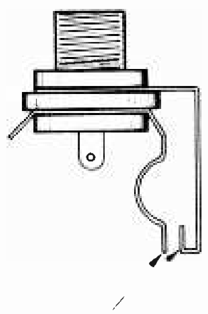


Fig. 6. The jack socket after modification

If the battery fits too loosely into the case, a pad of foam rubber, or similar, can be glued to the inside where the battery rests. The ferrite aerial is held in place by gluing the rod ends to the end pieces of the case.

Due to dimensional tolerances, there is a possibility that the ferrite rod may be a little longer or a little shorter than its nominal 4in. If it is excessively long the 4⅛in. case dimension shown in Fig. 2 may need to be increased slightly in order that the rod may be accommodated. If, on the other hand, the rod is shorter than 4in. the 4⅛in. case dimension may need to be reduced slightly or the rod will fit too loosely into the case.

Another component which may affect case dimensions is variable capacitor VC1. The author employed a miniature 250pF solid dielectric capacitor taken from and old kit radio in the prototype but this type is not generally available. A miniature 300pF solid dielectric capacitor (such as the Home Radio Cat. No.VC79C) may be used in its place but the constructor should confirm that whatever capacitor is employed can be accommodated in the case dimensions of Fig. 2 before commencing to make the case. If necessary, the case dimensions may be increased to suit. This, and the ferrite rod, are the two components mentioned earlier which may effect the dimensions of the case.

SETTING UP

Once the set is completed the two twisted wires forming the feedback capacitor must be adjusted. Initially, only short lengths of the wires should be twisted together. The receiver should be tuned to the high frequency end of the band by turning VC1 fully anti-clockwise. If the set is functioning properly it should now be possible to tune several stations at this end of the band.

If the two wires are twisted together a little more, both sensitivity and selectivity will be increased, but eventually a point will be reached where the receiver will begin to oscillate. It will be obvious when this happens as there will be a very marked decrease in background noise. Oscillation will occur first at the high frequency end of the band.

If oscillation cannot be obtained and the set appears insensitive, the connections to L2 should be reversed.

The twisted pair should be set so that the greatest possible sensitivity is obtained, without the set oscillating at any setting of VC1. The receiver is then ready for use.

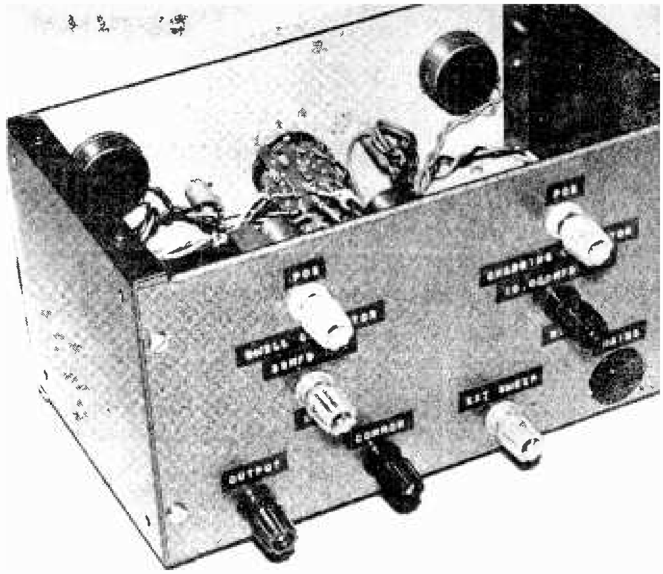
Although no trouble was experienced with the prototype, there is a slight possibility that the value of R1 may require adjustment with some transistors. This point may be checked, if it is felt necessary, by measuring the current drawn from the 9 volt battery by the receiver in the non-oscillating condition. This current should be slightly in excess of 1mA. If it is considerably greater than this figure, the value of R1 should be increased accordingly. There is no need to carry out the test or adjust the value of R1 if the receiver functions correctly after it has been completed. ■

Wide Range Linear Sawtooth Generator

Part 2

by

David Aldous, M.S.E.R.T.



A view from the rear with the top cover removed

This concluding article describes the construction of the linear sawtooth generator.

MAIN CIRCUIT BOARD

Most of the components are mounted on the main circuit board, which is a Lektrokit Chassis Plate No. 6. This has a row of copper strips and holes on a 0.1in. matrix, similar to Veroboard.

Fig. 8 shows the copper side of the board and indicates the points where the copper strips should be cut. Also shown are the holes which should be drilled out 6BA clear to take the preset potentiometers P1 to P4 and the heat sink for TR1. Before mounting any components all holes should be drilled and all strips cut, as illustrated. The next job is to form the 'edge pins'. These consist of projecting pieces of wire mounted at the edges of the strips at the points indicated in Fig. 8, and allow the later connection of wires to components external to the board. They are made up as illustrated in Fig. 10(a). A short length of 22 s.w.g. tinned copper wire is passed through the two adjacent holes at the strip edge, being looped on to itself as shown. The loop is then soldered, as also is the wire to the copper strip, leaving a short piece of the wire projecting upwards and thereby providing a 'pin' for later connections.

When all the 'edge pins' have been mounted, potentiometers P1 to P4 are fitted by means of the 6BA mounting stud on each body. Wire links should be soldered to the appropriate tags and also to the board as shown in Fig. 8 and in the detail in Fig. 10(b).

After this the wire links above the board, and the resistors and capacitors

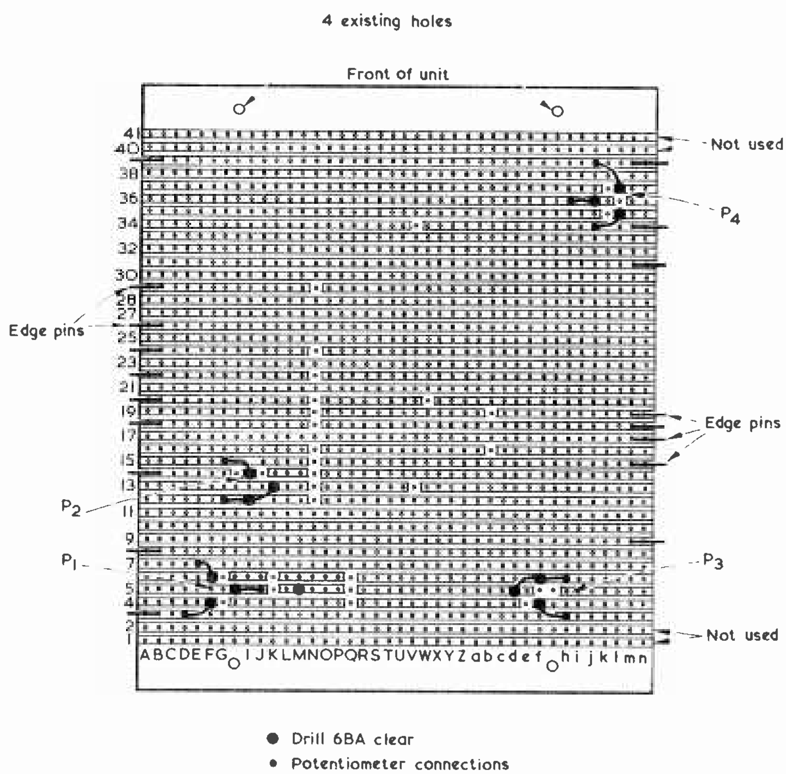


Fig. 8. The copper side of the main circuit board

are next fitted, these taking up the positions shown in Fig. 9. The holes in each pair of holes for R2, R10 and R13 are rather close together, and care should be taken not to bend the leads of these resistors closer than $\frac{1}{16}$in. away from the body. If necessary, loop the wire back on itself before passing it through the hole. Next mount all the semiconductors, paying particular attention to the mounting method shown for the transistors (apart from TR1) in Fig. 10(c). Do not bend any transistor or diode lead closer than $\frac{1}{16}$in. from the body. A fine-nosed pair of pliers should be used when bending all component leads. Transistor TR1 is held under its heat sink, which is secured with a 6BA bolt and nut.

Note that the jumper lead from hole F16 to hole K5 does not connect to the copper at hole K5. Instead, it passes through this hole and connects to the copper at hole J5.

The zener diodes are shown with a line across the body near the cathode end. This is the end which connects to positive when the device is employed as a zener diode.

When wiring is complete the board should be put on one side. No connections for external circuits are made to the 'edge pins' at this stage.

POWER SUPPLY BOARD

The power supply board is assembled on a Lektrokit Chassis Plate No. 1, using the layout shown in Fig. 11. Lead-through insulators (Lektrokit Part No. LK2021) are pushed through the panel at the points shown. These are best inserted with some means of support under the panel, such as a pair of closed pliers with the lead-through passing into the gap between the jaws, pushing the insulators through from the top with the jaws of a second pair of pliers.

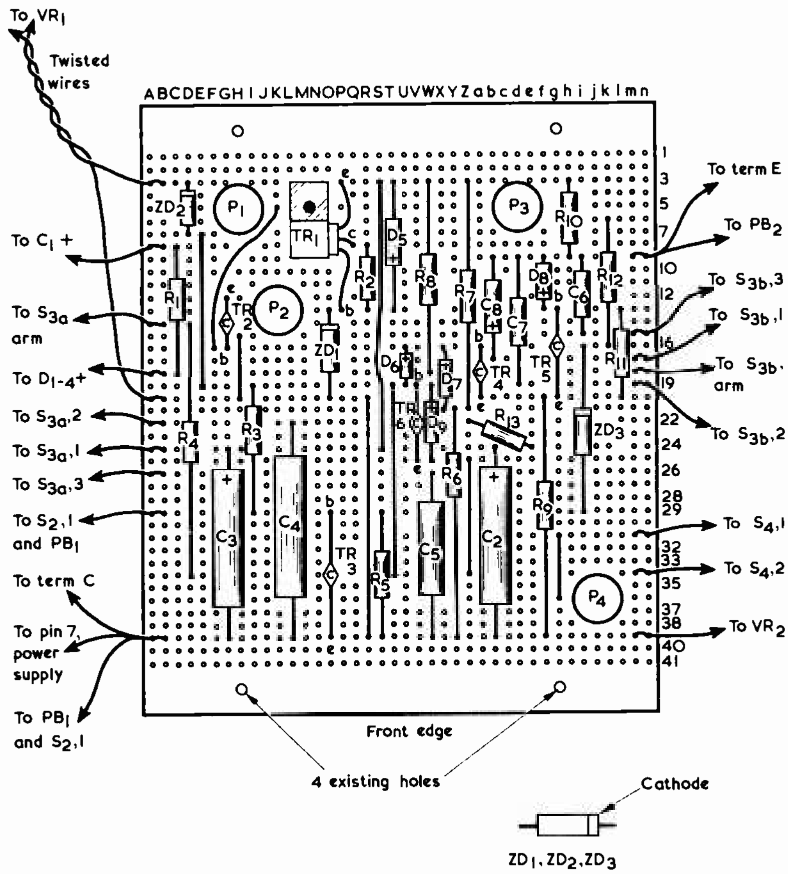
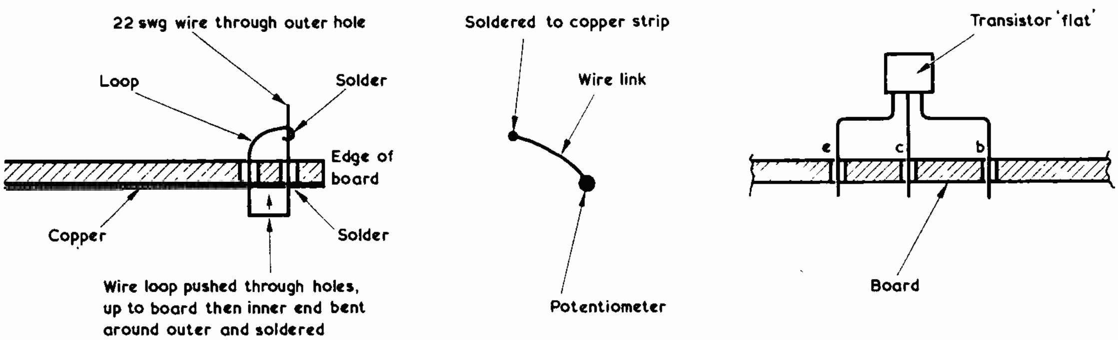


Fig. 9. Layout and wiring on the component side of the board



(a) (b) (c)

Fig. 10 (a). Illustrating how the 'edge pins' are formed

(b). Detail illustrating the connections to the potentiometers on the copper side of the board

(c). The leads of transistors TR2 to TR6 are formed in the manner shown here. The body of the transistor is centralised over the hole in the board to which the collector connection is made

When this has been done, the holes for the mains transformer should be opened out to 4BA as also should the hole for the solder tag. The lugs on the transformer may not be flush with the bottom of the laminations; in this case pack up from the plate with one or two washers under each lug, as required. Place the solder tag over the plate where shown and bolt this and the transformer down firmly with ¼in. bolts, using a shake-proof washer under each nut.

Complete all the wiring shown in Fig. 11 with the exception of leads connecting to external circuits, then put the plate on one side.

MECHANICAL ASSEMBLY

The front and rear panels are next marked out as shown in Figs. 12 and 13 respectively. Marking should be done on the *reverse* side of each panel, with the panel laid down on a sheet of paper to protect the enamel finish. Marking is best carried out by a soft lead pencil initially, this being followed by a sharp pointed scriber when all drilling points have been located. All holes should be counter-punched before drilling. It is important to note that the hole diameters for S1, S2, S4, PB1 and PB2 in Fig. 12, and for the terminals in Fig. 13, all apply to the R.S. Components parts employed in the prototype. Components from other sources may require different hole diameters, and this point must be checked before drilling commences. The 1in. hole for the mains socket is made with a Q-max chassis-cutter (Home Radio Cat. No. TL13, with Allen key Cat. No. TL15C) after removing the portion of the flange shown in Fig. 13. This is best removed by making two cuts with a hacksaw on either side of the section to be taken out, and then bending this section back and forth until it breaks off. Any rough edges can then be removed with a fine-cut file.

REAR CHASSIS RAIL

The rear chassis rail is a Lektrokit Chassis Rail, Short, Part No. LK211, and it is modified as shown in Fig. 14, in which the flange is towards the reader. The holes are made with a ⅜in. Q-Max chassis cutter (Home Radio Cat. No. TL10, with Allen key TL12) in the following manner. The cutter is first slackened off so that it can be slipped over the chassis rail, and the points of the cutting head are then located in the holes either side of the slot in the rail. At this stage, the flats on the cutter head should be held in a vice or with a spanner. The cutter bolt is then tightened up with the fingers until the cutter binds firmly onto the rail, when this has been done the Allen key should be used to tighten the cutter until it pulls through the rail. When all slots have been treated in this way, the holes should be cleaned up,

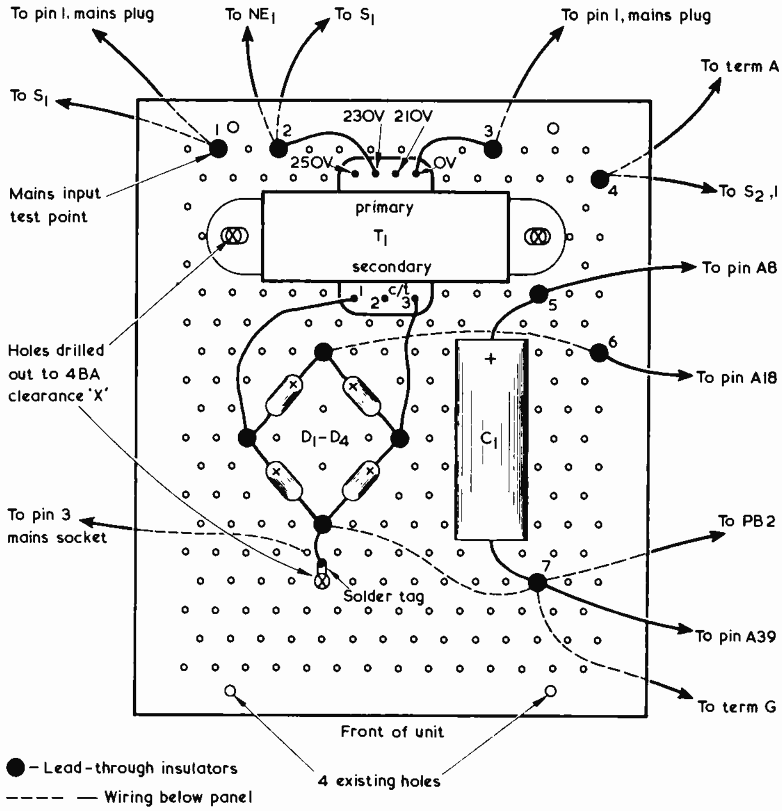


Fig. 11. Layout and wiring of the power supply section

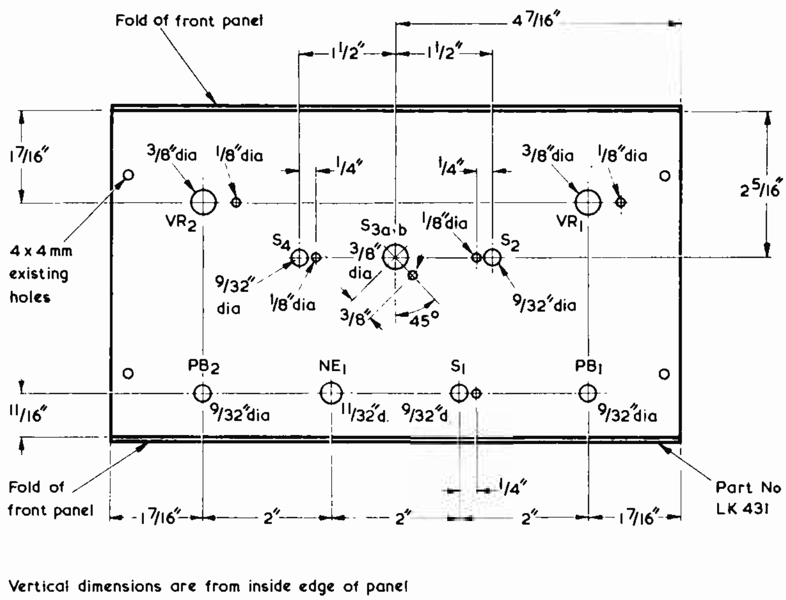
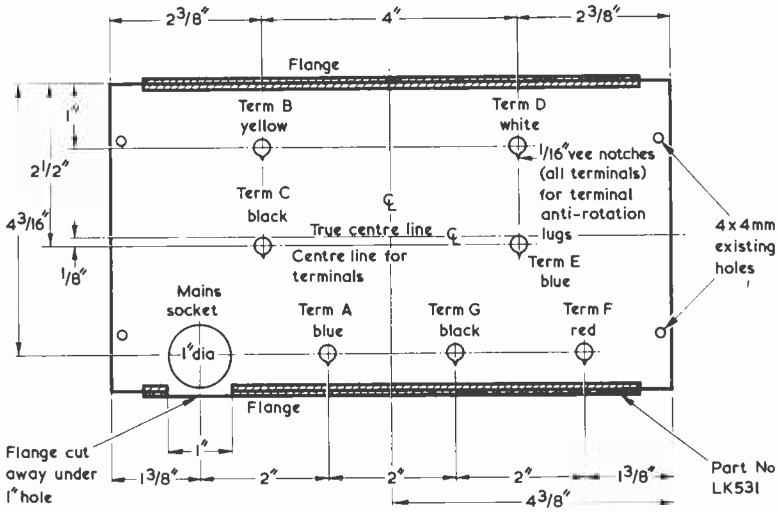
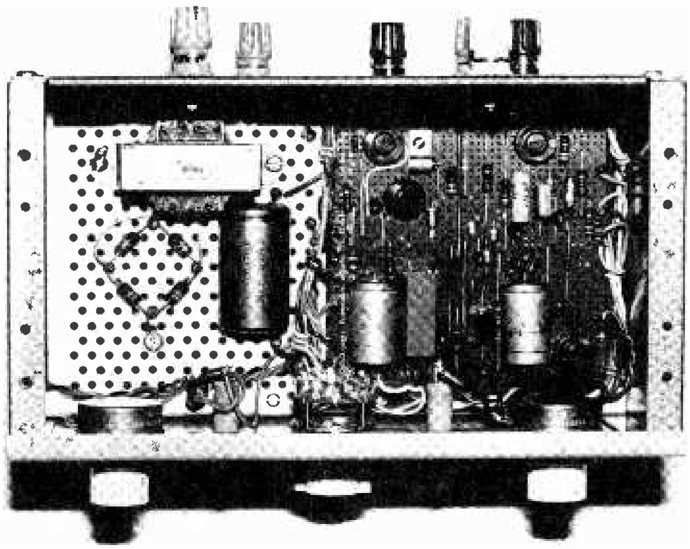


Fig. 12. Drilling details for the front panel. In this view the rear of the panel is towards the reader. Note that, as is discussed in the text, hole diameters are for R.S. Components parts



Vertical dimensions from inside curve of upper flange — All terminal holes 1/4"dia

Fig. 13. The holes required in the back panel. Again, the rear of the panel is towards the reader, and hole diameters correspond to R.S. Components parts



This top view, looking straight down into the unit, clearly shows the positions of the main components

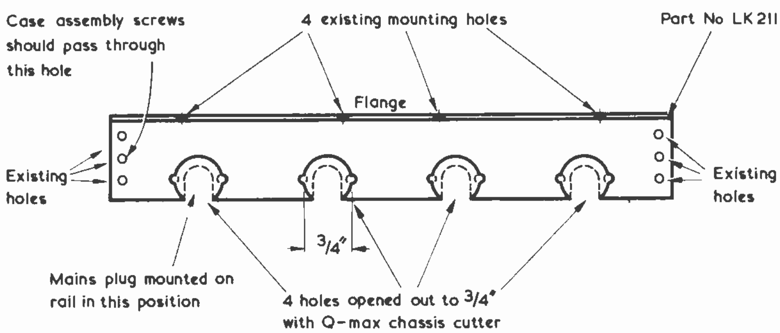


Fig. 14. Modifying the rear chassis rail. The flange is towards the reader

using a fine, half-round file. At this stage, mount the mains plug, using a large spanner to tighten the nut provided. The anti-rotation stud on this part should be located in one of the notches left by the chassis cutter. The front chassis rail is not treated and is used unmodified.

CHASSIS ASSEMBLY

Chassis assembly is a straightforward 'nuts and bolts' procedure and should present no difficulty to the constructor. A good idea of the assembly can be obtained from the photographs. In the author's prototype, the assembly was held together with the self-tapping screws provided with the front panel and covers of the Lektrokit chassis, although there is no reason why 6BA nuts and bolts should not be used if preferred. In the event of self-tapping screws being used, it is essential, when fitting the rear chassis rail, that the case assembly screws pull the chassis rail tightly up to the holes in the side plates through which the screws pass. Before mounting the front chassis rail, fit the mains neon indicator, NE1, using the Spire clip provided. Make sure that the clip is pressed *tightly* up to the panel and as close as possible to it, otherwise the rail will bow inwards when the front panel is fitted, making mounting of the circuit boards rather difficult.

When the case has been assembled, the other components on the front and rear panels can be mounted, and when this has been carried out the power supply panel should be fitted using four 6BA bolts and nuts. For this and the succeeding steps, reference should be made to the photograph of the inside of the unit and to Figs. 9, 11 and 14. Before mounting the main circuit board, solder short lengths of insulated solid core wire to the appropriate 'edge pins'. The lengths should be as follows: pin A3, 8in.; pin A8, 2in.; pin A14, 5in.; pin A18, 1in.; pin A20, 8in.; pin A22, 4in.; pin A24, 5in.; pin A26, 4in.; pin A29, 3in.; pin A39, two lengths 8in. and one length 2in.; pin n9, one length 6in. and one length 4in.; pin n15, 8in.; pin n17, 8in.; pin n18, 8in.; pin n19, 8in.; pin n31, 5in.; pin n34, 5in.; and pin n39, 4in.

The main circuit is mounted in the same way as the power supply panel, after which the wires from the 'edge pins' should be taken to the points indicated in Fig. 9, referring also to the details given in Figs. 11 and 15. Outstanding wiring to the power supply panel and to the components on the front and rear is then carried out, following Figs. 11 and 15.

Care should be taken to dress the wires neatly, as in the photograph, in order to avoid burning them when soldering to their destinations. The wires may be twisted as shown in the photograph or held in bunches by short lengths of wire bound round the bundles to hold them in place. The

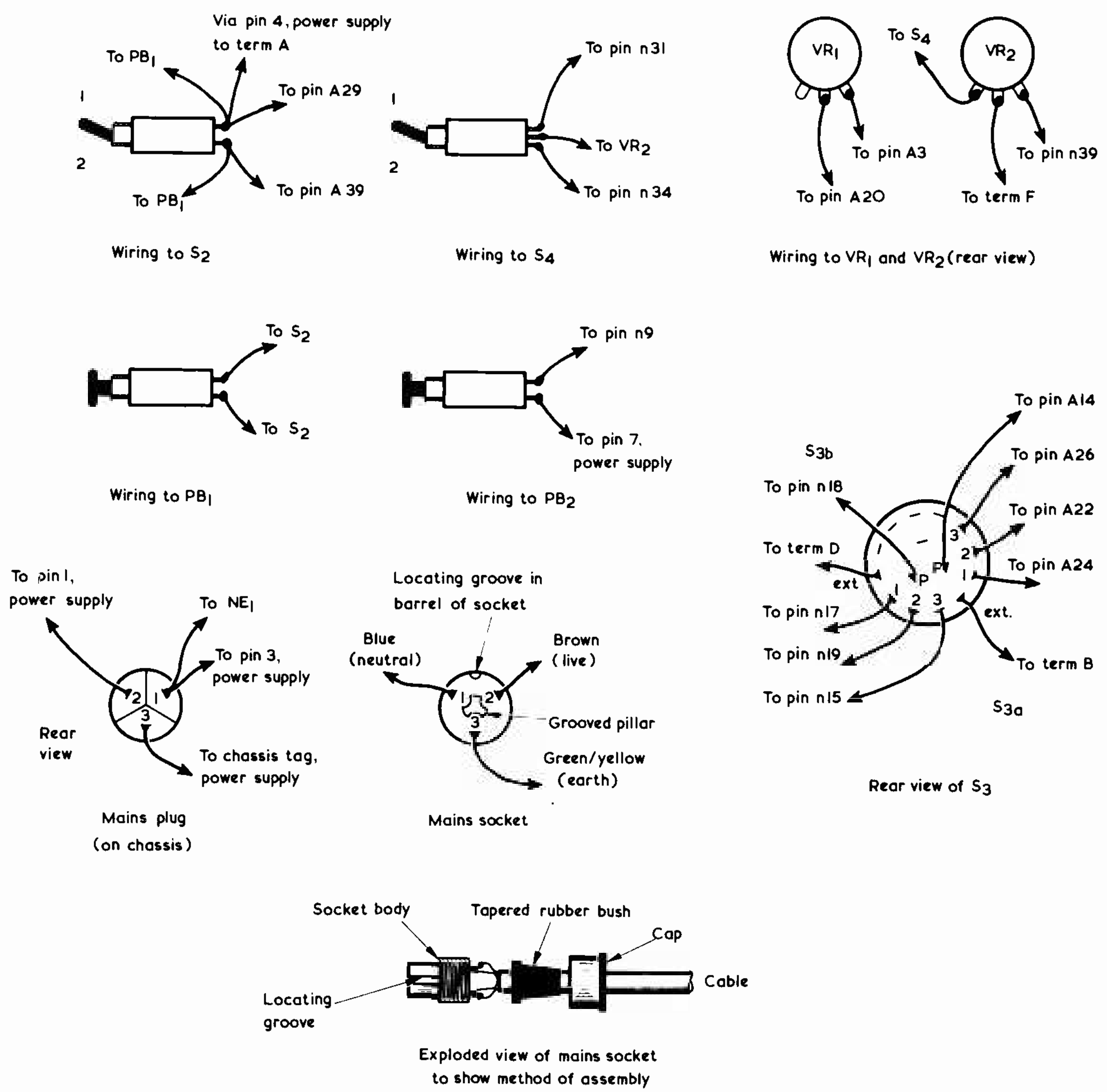


Fig. 15. Details of wiring to the front panel components. Switch S1 and neon bulb assembly NE1 are not included here, as the wiring to these components can be followed from the details given here and in Fig. 11. The tags on S2 may differ in position from those illustrated – in position 1 S2 closes the circuit connected to its two tags. Note that only two poles of switch S3 are employed

wires to the push-button PB1 and PB2, are taken down the side of the circuit board. Check that all leads have been fitted correctly. If everything is in order, the mains lead should be made up in accordance with Fig. 15. After assembly, a suitable mains plug should be fitted. The unit is plugged in and switched on, after which make sure that nothing unusual occurs. If all is in order, the setting-up procedure can be commenced.

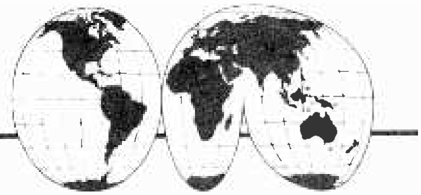
(to be concluded)

In Part 1 of this series it was stated, under 'Refinements', that the circuit could be caused to revert to the 'dwell' state by feeding a positive-going voltage to Terminal E. This should have read 'negative-going'.

The zener diodes suggested at the end of Part 1 for ZD2 and ZD3 should be BZY88C5V1 and BZY88C10 respectively.

Owing to pressure on space, the Setting-Up Procedure will appear next month.

SHORT WAVE NEWS



FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

In the South Atlantic, the Falkland Islands have a broadcasting service based in the capital Stanley. The transmitter is listed as having a power of 0.5kW on **3958** but, according to a S. African Dx'er the station has been heard on five occasions using frequencies which vary slightly around **3930** (76.34 metres). Although reception of this station is unlikely, at least by the majority of listeners in the U.K., the April to September schedule is listed for those who care to 'have a go'. Weekdays from 1400 to 1600, from 2230 to 0200. Saturdays from 1400 to 1600 and from 2030 to 0200, Sundays from 1400 to 1600 and from 2200 to 0100.

● NORTH VIETNAM

The latest schedule from Radio Hanoi of the programmes in English, according to BADX, are as follows: 0030 to 0100 on **7038** (42.62m) and on **10040** (29.88m). Half-hour periods from 0500, 0830, 1000 and 1200 on **10040** and on **12025** (24.95m). From 1300 to 1330 on **12025** and on **15012** (19.97m), from 1530 to 1600 on **10040** and on **12025**, from 2000 to 2030 on **12025** and on **15012** and from 2300 to 2330 on **7038** and on **10040**.

● NETHERLANDS

The English transmissions for Europe on weekdays from Lopik (Hilversum) are as follows (May to August): from 0930 to 1050 on **6020** (49.83m) 10/100kW; from 1400 to 1520 on **6020**; from 1830 to 1950 on **6020** and on **6085** (49.30m) 100kW.

On Sundays the well-known 'Happy Station' programmes are radiated in English as follows: from 0930 to 1050 on **6020, 6410** (46.80m) and on **7275** (41.24m). From 1400 to 1520 on **6020** and from 1830 to 1950 on **6020, 6085** (**15310** from Bonaire).

To Eastern North America, weekdays, from 2130 to 2250 on **9715** (30.88m) and on **11730** (25.58m) both 100kW from Lopik. From 0200 to 0320 on **11730** from Bonaire and to Western North America from 0500 to 0620 on **9715** and on **11730** from Bonaire.

● SOUTH AFRICA

Radio South Africa (RSA) radiates programmes in English to Europe from 1800 to 1850 on **15155** (19.80m) 100/250kW and on **21480** (13.97m) 250kW and from 2215 to 2315 on **9525** (31.50m) 250kW and on **11900** (25.21m) 250kW. On Sundays an additional programme is radiated from 1000 to 1150 on **21535** (13.93m) 250kW.

● YEMEN

It is reported that Radio Sana vacates the **4938** (60.75m) 25kW channel after 1600 and is then only heard on Medium waves. BADX Bandspread.

● U.S.S.R.

Radio Tashkent, Uzbek S.S.R., according to reports, has added another frequency in its External Service, **7145** (41.99m) from 1600 to 1800 when in Persian, Uzbek and Arabic, according to BADX.

Also reported on **6040** (49.67m) in English from 1400 to 1430.

● PAKISTAN

The External Service of Radio Pakistan radiates a programme to the U.K. from 2000 to 2100 on **3870** (77.50m), **4975** (60.30m), **7095** (42.28m), 7290 (41.15m) and on **9460** (31.72m), all 10/50kW.

The Western Europe programme is from 1815 to 1830 on **7095** and **9710** (30.90m) and the Turkish Service from 1900 to 1945 on **7095** and **9710**.

Karachi radiates a local programme from 0130 to 0330 on **3935** (76.24m) and **4875** (61.54m); from 1400 to 1615 on **5975** (50.21m) and **7095**; from 1630 to 1810 on **4975** and **5975** and from 2000 to 2130 on **3935** and **4875**, 10/50kW.

Peshewar for local consumption from 0130 to 0330 and from 1300 to 1800 on **3330** (90.09m) 10kW.

Islamabad from 0130 to 0410 on **7240** (41.41m) and **9850** (30.46m); from 0600 to 1340 on **15130** (19.83m) and on **17865** (16.80m) the **15130** channel not on the air from 1000 to 1115, 10kW.

Quetta from 0130 to 0400 (Sundays 0345) on **3915** (76.64m) and from 1300 to 1730 on **4815** (62.31m) both 10kW.

Islamabad with W. Pakistan Service from 0830 to 1100 on **6170** (48.62m); from 1230 to 1300 on **3940** (76.15m) and from 1400 to 1730 on **7240** (41.44m) and on **9750** (30.77m), all according to BADX 'Bandspread'.

● KENYA

The Voice of Kenya (all English) is on the air from 0255 (0325 on Sundays and holidays) to 0620 sign-off (0630 on Saturdays, Sundays and holidays) on 4800 (62.50m); from 0630 (Saturdays and Sundays) and from 0900 (other days) to 1100 (to 1255 Saturdays and Sundays) on **7120** (42.13m) and from 1255 to 2010 (2110 Saturdays only) on **4800**.

National Service (all Swahili) from 0255 (0325 on Sundays and holidays) to 0645 on **4915** (61.03m); from 0645 to 1245 on **7140** (42.02m); from 1245 to 2005 (Saturdays 2105) on **4915**.

Vernacular Services to N.E. and Coastal Areas from 0330 to 0500 on **4880** (61.48m), from 0800 to 1100 on **7240** (41.44m) and from 1400 to 1930 on **4880**. This Service not broadcast on Sundays or holidays.

For Nairobi and Central Areas from 0900 to 1030 on **7150** (41.96m) and from 1400 to 1830 on **4950** (60.60m).

For Western Area from 1300 to 1745 on **4850** (61.86m). All according to BADX 'Bandspread'.

According to a QSL card just received from Kenya by B. Walsh of Romford additional frequencies, which are unlisted, are given as **4934** (60.80m), 7295 (41.12m) and **11765** (25.50m), no indication of powers or services being mentioned.

● MALI

Radio Mali, Bomako, may be heard from 1500 to 1600 radiating a programme in English to the U.S.A. and Canada on **17725** (16.93m) 100kW, according to reports.

● ETHIOPIA

Radio Ethiopia has been reported using **9610**

(31.22m) when it was logged with an English programme until 1700, when a broadcast in Amharic commenced.

● **PAPUA**

VL8BM Port Moresby has moved from **11880** (25.25m) to **9575** (31.33m) 10kW. According to the schedule, VL8BM is on the air Monday to Friday inclusive from 0100 to 0200 and from 0430 to 0530 in English and Pidgin.

● **QATAR**

The Qatar Broadcasting Service radiates a programme in English from 1200 to 1300 on **9570** (31.35m) 100kW, newscast at 1230.

● **SWAZILAND**

Swazi Commercial Radio, a recently launched venture, is reported using **3223** (93.09m) and **6155** (48.74m), asking for reports to Swazi Commercial Radio, P.O. Box 941, Mbabane, Swaziland. Additional channels which may be added are **4890** (61.35m) and **7100** (42.25m).

● **ROUMANIA**

The English schedule of Radio Bucharest to Europe is from 1300 to 1330 on **11940** (25.13m), **15250** (19.67m) and on **17710** (16.94m). From 1930 to 2030 on **9570** (31.35m) and **11775** (25.48m). From 2100 to 2130 on **7195** (41.70m) and on **9690** (30.96m).

● **AFRICA**

In the March issue, I listed some stations on the L.F. bands that could be heard operating from the 'Dark Continent' but many of our readers, equipped with domestic-type sets, cannot cover those frequencies. In this issue, such readers may be interested in the following loggings made on the higher frequency bands.

11850 2030 (25.32m) 250kW Ejura, Ghana, with a programme in English. Sign-off is at 2100. This programme was part of the North American Service which commences at 2000 and ends at the sign-off time shown. Identification is "This is the External Service of Radio Ghana". The address is: Ghana Broadcasting Corporation, P.O. Box 1633, Accra.

11895 2200 (25.22m) 100kW Dakar, Senegal, with native music and announcements in French with station identification. This is the Network 1 programme which is scheduled from 1000 to 2400. The address is: Radiodiffusion du Senegal, B.P. 1765, Dakar.

11900 2215 (25.21m) 250kW RSA Johannesburg, South Africa, with the news in English. This is part of the service in English to Europe and the U.K. which commences at 2215 and ends at 2315. Address: South African Broadcasting Corporation, P.O. Box 8606, Johannesburg.

11920 1940 (25.17m) 100kW Abidjan, Ivory Coast, heard when radiating a programme of African music and songs. Identification in French at 1950. This frequency is part of the International Network, the schedule (weekdays) being from 0600 to 0800, from 1800 to 2400 and on Saturdays from 0600 to 2400. The English programme is scheduled on weekdays from 1830 to 1845 with the news at 1830. Address: Radiodiffusion Television Ivoirienne, B.P. 2261, Abidjan.

15170 2133 (19.78m) 50kW Monrovia, Liberia, logged when announcing the station identification in English. This transmission is part of the scheduled Arabic Service to North Africa, from 2100 to 2300. Radio Station ELWA can be heard in English from 0930 to 1100 on Sundays on **11975** (25.05m) 50kW, although this is only one part of the English schedule (mostly early mornings). The station is operated by the Cultural Missionary Broadcasting Service of the Sudan Interior Mission, the address being: Box 192, Monrovia.

15175 1945 (19.77m) 250kW RSA Johannesburg, South Africa, with station identification and the news in English. This is part of the English Service to Ghana/Nigeria from 1856 to 1950 on this channel and in parallel on 9695 (30.94m) 250kW.

● **A READER'S LOG**

Julian Moss of Rayleigh in Essex, has once again sent along the results of his sterling work on the short waves.

Here is a selection—

7010 2130 R. Peking, identification in U.S.S.R. dialect.
9460 2120 R. Pakistan, with identification in English.
9525 2200 AIR Delhi, newscast in English.
9525 2207 RSA Johannesburg, interval signal on guitar.
9605 2115 Sackville, Canada, news about Canada.
9615 2235 Vatican with programme in English to the Philippines.
9670 2030 Damascus, Syria, with the news in English.
9690 2000 AIR Delhi, with the English programme.
9695 2215 RSA Johannesburg, sign-on in English.
9745 2000 Baghdad, Iraq, newscast in English.
9805 2215 Cairo, U.A.R., a programme on life in Egypt.

We should be pleased to include logs from readers of this feature but we cannot undertake to publish them in their entirety.

REPORTING S.W. BROADCAST RECEPTION

Various codes have been favoured in the past for reporting reception to shortwave broadcasting stations. For instance, the QSA/R code as used in amateur radio has been extended to S.W. broadcast reporting.

A reception reporting code which is currently becoming much favoured by S.W. Broadcast engineers interested in correlating propagation reports from their listeners is that known as the International SINPO Code and it is as follows:

	S. Carrier strength	*I.* Interference	*N.* Noise	*P.* Propagation disturbance	*O.* Overall merit
5.	Excellent	Nil	Nil	Nil	Excellent
4.	Good	Slight	Slight	Slight	Good
3.	Fair	Moderate	Moderate	Moderate	Fair
2.	Poor	Severe	Severe	Severe	Poor
1.	Just audible	Very severe	Very severe	Very severe	Unusable

Thus a very good signal, of full programme value, ie., "just like the local Broadcast station" would be rated 55555 and so on.

NOTES ON SEMICONDUCTORS

Further Notes—6
PLOT

by

Peter Williams

The basic circuit for a simple transistor current gain measuring instrument

WE CAN NOW ASSEMBLE SOME OF THE ELEMENTS described in earlier notes into simple but useful pieces of test and measuring equipment. As a starter let us look at some of the properties of transistors that we might need to know in various applications.

CURRENT GAIN

The most obvious property is the transistor current gain. In some cases it is enough to know the d.c. current gain under one set of defined operating conditions. For this purpose a particularly simple circuit will be described later. A second requirement is to know the way in which current gain changes with supply voltage. A related circuit is one which allows measurement of collector saturation characteristics – important when a transistor is used to switch on a load and the p.d. between collector and emitter is to be minimized. These last two are considered together since they have identical base drive circuits.

The basic test circuit is illustrated in Fig. 1. The zener diode provides a fixed p.d. across R2, which is selected to supply the required base current to TRt, the transistor under test. It is important that TR1 should be a low-current type with high gain at the lowest base current required. Typical component values might be Vs = +15V, Z1 = 5.2V zener, R1 = 4.7kΩ, R2 = 4.7MΩ for Ib = 1μA in test transistor.

Resistor R2 can be reduced to 4.7kΩ for base currents in TRt of up to 1mA. One method would be to switch preferred value resistors for R2 or alternatively to replace it by a logarithmic potentiometer with hand-calibrated scale.

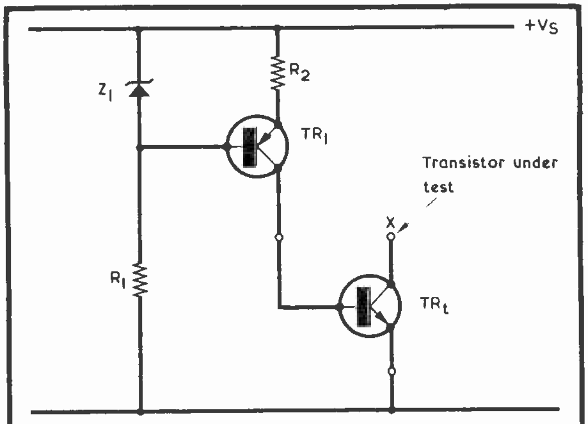


Fig. 1. Basic circuit for testing transistor current gain. Base current in TRt may be varied by adjusting the value of R2

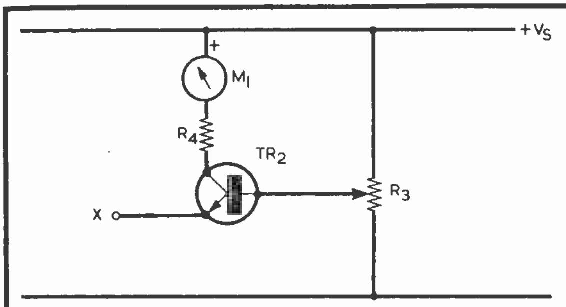


Fig. 2. The collector voltage of the transistor under test may be varied by coupling it to the emitter of the transistor shown here. Voltage is varied by adjusting R3. Meter M1 indicates the collector current of the transistor under test

If the current gain at Vce = 15V gives sufficient information, then a milliammeter between the collector of the transistor under test and Vs is sufficient. It does however carry the risk of damage to the meter with a transistor having a short-circuit between collector and emitter; it also allows the possibility of damage to the transistor if the base current is set too high since this would lead to excessive collector current. Any limiting resistor would cause a fall in the effective collector supply voltage.

The solution is shown in Fig. 2. The collector of the transistor under test is fed from the emitter of a transistor whose base potential can be adjusted by the potential divider R3. Several points need watching. The value of R3 should be low enough that the maximum base current of TR2 causes no significant fall in potential. As a rough guide the standing current in R3 should equal the maximum expected value of collector test current (since the base current of TR2 will then represent at most 1% of the potential divider current if TR2 has a current gain of 100). R3 would be calibrated in terms of the voltage on TR2 emitter.

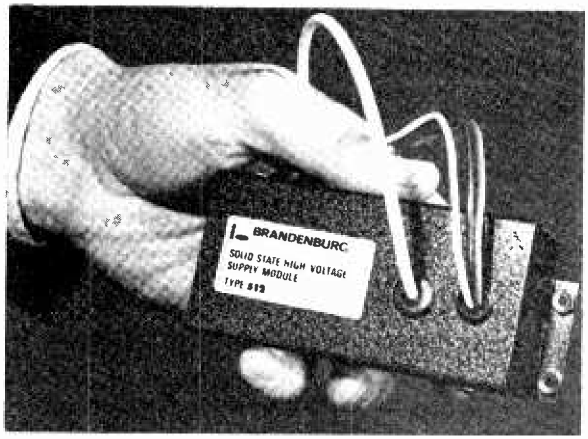
The limiting resistance R4 can be chosen to drop 2 to 3V at the expected current, allowing the emitter of TR2 to rise to greater than 10V when required. As a final point, the Vce of the test transistor can be more accurately set at low levels if a forward biased diode (or diode-connected transistor) is inserted in series with the bottom end of the potential divider to balance out the Vbe of TR2. In the next note we will see how this circuit can be modified to measure the collector saturation characteristics. ■

New Products

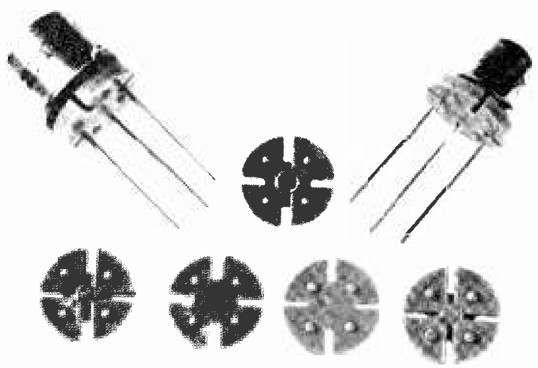
MODULAR POWER SUPPLY

A low cost, high performance modular high voltage supply for oscilloscope tubes has been announced by Brandenburg Ltd. It is also suitable for applications where a compact, lightweight EHT supply is required.

Designated the model 512, this addition to the recently announced range of HV modules provides between 4kV and 7kV at a maximum of 120μA. It is capable of withstanding an output short-circuit for up to 10 seconds without damage. The impregnated EHT components are fully screened in a metal can with overall dimensions of only 2in. × 1½in. × 4½in. (50mm × 38mm × 150mm). The price of the model 512 is £15. Further information can be obtained from Brandenburg Ltd., 939 London Road, Thornton Heath, Surrey, CR4 6JE.



TRANSISTOR MOUNTING PADS



Girdlestone Electronics Limited announce a new range of Transistor Mounting Pads – type MC 1087/3. Injection moulded in Polyethylene, the pads provide excellent isolation between the transistor leads and the chassis or panel of the unit incorporating the transistor. The four lead channels are angled at 45° from the vertical, making the pads suitable for either TO5 or TO18 configurations. This design allows the user to standardise on a single design of pad, and since both TO5 and TO18 leads are led out at the same points, also allows standardisation of hole pitch on P.C. Boards. In the standard material, the pads are suitable for a temperature range of –40°C to +75°C.

Users will be particularly interested to note the price – believed to be one of the lowest in the U.K., at £2.00 per 1,000 for small quantities. Further details may be obtained from Girdlestone Electronics Limited, Melton Hill, Woodbridge, Suffolk, IP12 1AX.

SKIL POWER TOOL

The new SKIL model 1431H ratcheting drill features two speeds by gear reduction. This means triple power at low speed. The combined ratcheting-drilling action is selected for drilling holes in concrete and masonry. The tool can also be set for drilling only, and is therefore suitable for metal, wood, plastic and composition materials.

Technical Data

Double insulated, radio/tv-suppressed, safety stop carbon brushes, super burnout protected motor, dependable ball bearing construction.

Capacity in steel ⅜in. (10mm), in masonry ½in. (12 mm), in wood 1$\frac{3}{16}$in. (30 mm).

No-load speed: 900 and 2,600 r.p.m. Number of blows 11,000 and 32,000 per minute. Input 400 Watts, cord length 10ft. (3m). Chuck capacity $\frac{1}{16}$–$\frac{25}{64}$in. (1.5–10 mm), net weight 5½lbs. (2.4kg). Sales and service in the U.K.: SKIL (Great Britain) Ltd., 1B Thames Avenue, Windsor, Berkshire, SL4 1QJ.

AUTOMATIC SIGNAL GENERATOR

By

R. A. Butterworth, G8BI

The approach described in this article is intended to be experimental only, as the author has been prevented by illness from pursuing it through to a final form. Nevertheless, the basic idea is so original and thought-provoking that we feel it should be presented to readers in its existing form, whereupon the more experienced constructor should be able to make up an automatic signal generator along the lines described.

FROM TIME TO TIME WE ALL GET DOUBTS ABOUT THE performance of the receiver we are using, whether it be home constructed or commercially manufactured. One section of the receiver which may give rise to shortcomings in performance is the r.f. stage, and we may suspect the alignment of the r.f. tuned circuits. Ideally, we require a signal generator to line up the r.f. circuits accurately, but not all of us possess such an instrument or are able to borrow one.

The approach to be described in this article enables the r.f. stages of an a.m. superhet receiver to be aligned without the aid of a signal generator, all that is required being a simple unit which can be made up from a few transistors and other components.

PRINCIPLE OF OPERATION

Briefly stated, the heart of the idea is an 'inversion of the superheterodyne principle'. The latter, as readers will know, involves mixing two frequencies together in order to obtain a beat frequency which is equal to the difference between the two. In a superhet the difference frequency is the intermediate frequency. The mixer also produces a frequency equal to the sum of the two frequencies, but this is not taken advantage of in the superhet.

Now suppose, as is illustrated in the block diagram of Fig. 1, we make up a mixer stage and apply to this a signal taken from the oscillator of the receiver to be aligned, together with a second signal which is equal to the intermediate frequency of the receiver. The mixer will then produce both the sum and difference frequencies, and *the difference frequency will be equal to the aerial signal frequency of the receiver*. This difference frequency may be passed through an emitter follower buffer amplifier and fed to the receiver aerial terminal via a variable attenuator, whereupon an input signal which is always at correct frequency is available for r.f. alignment.

The author has tried an experimental circuit to provide the facility shown in Fig. 1 and the result was, at first, uncanny. The impression was given that a strong i.f. signal was breaking through because wherever the receiver was tuned on all its bands the signal was there.

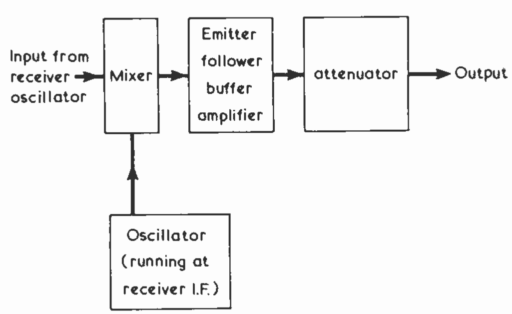


Fig. 1. Block diagram illustrating the line-up of the automatic signal generator. Output is always at receiver aerial frequency

The fact that the signal was indeed at aerial frequency was proved by adjusting an r.f. trimmer and noting the result on the receiver S-meter.

Two effects have to be guarded against. First, the coupling to the receiver oscillator must not cause it to be detuned. A very loose coupling given by a wire held close to the oscillator components should suffice. Second, the automatic signal generator offers the sum frequency as well as the difference frequency, and the sum frequency will be the image frequency of the receiver. Care must be taken on the higher short wave frequencies to avoid trimming to this image frequency. The correct frequency will be that corresponding to greater capacitance in the signal frequency trimmer or trimmers.

The tuned circuit for the oscillator in the signal generator will, for most receivers, be required to cover the range 450 to 475kHz, and could be provided by an i.f. transformer of the type having a single tuned winding. The internal fixed tuning capacitor of the transformer may be removed and an external variable capacitor connected in its place to enable the frequency of oscillation to be varied. Some receivers have an i.f. of 1.6MHz and the signal generator oscillator will be required to run at this frequency. A medium wave oscillator coil could cope here.

A suitable line-up for the signal generator unit consists of OC170 mixer, OC45 oscillator and OC170 emitter follower. The output attenuator may be a 1kΩ potentiometer in the emitter circuit of the emitter follower, the output signal being taken from its slider. A suitable arrangement for the mixer transistor would consist of applying the signal from the receiver oscillator to its base and the signal from the signal generator oscillator to its emitter. The difference frequency could then be taken from its collector.

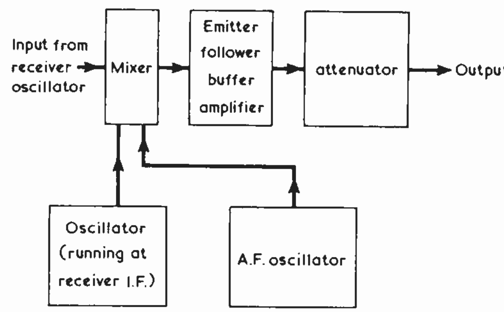


Fig. 2. A modulated output would be given by adding an a.f. oscillator, as shown here

As a further idea, it would be possible to have the output of the signal generator amplitude modulated by using the approach shown in Fig. 2. Here, the output of an audio oscillator is also applied to the base of the mixer in the signal generator. A further suggestion consists of having the oscillator in the signal generator frequency modulated by a sawtooth oscillator; the unit could then be used, in conjunction with an oscilloscope, as a wobbulator. ■

GaAs TRANSISTORS IN GHz AMPLIFIERS

by

J. B. Dance, M.Sc.

Transistors capable of amplification at centimetre wavelengths have now been developed

EXPERIMENTAL TRANSISTOR AMPLIFIERS AND OSCILLATORS operating in the range 14 to 18GHz (14,000 to 18,000MHz) have been made at the I.B.M. Research Laboratories in Zurich. It is understood that they are the highest frequency transistor amplifiers and oscillators which have yet been produced.

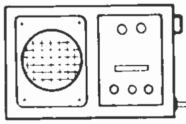
GALLIUM ARSENIDE TRANSISTORS

The main feature of the circuits is the use of gallium arsenide transistors, which enable the very high frequency response to be obtained. This semiconductor material is often associated with infra-red emitting diodes, but at very high frequencies it has the advantage that the saturation electron drift velocity in the material is about twice as great as in silicon.

The maximum gain yet obtained from a single device of this type is about 8dB at 15GHz. A 4-stage narrow band amplifier can provide a power gain of up to 16dB at 14.9GHz with a bandwidth of 150MHz at 3dB down. Another design employs a 3-stage amplifier to provide a gain of up to 6dB at 18GHz with a bandwidth of 380 MHz. A 17GHz oscillator has provided a power output of 4mW.

Tests already performed show that the maximum frequency of oscillation of the present transistors is probably above 30GHz. However, theoretical calculations seem to indicate that GaAs transistors may be produced which can be used at frequencies up to 60GHz, where the wavelength is half a centimetre. ■

In your workshop



This month Smithy the Serviceman, aided as always by his able assistant Dick, takes a rest from servicing and concentrates on a simple constructional project. The result is a 2-transistor tuner unit which is pre-tuned to the Radio 2 programme on 1,500 metres

"Do you know," asked Dick, "what would be a really *useful* gadget in this Workshop?"

Smithy drained the contents of his tin mug and gazed at his assistant speculatively.

"I'll buy it," he commented at length. "What *would* be a useful gadget in this Workshop?"

"A Radio 2 tuner unit," replied Dick promptly. "A simple portable unit which is pre-tuned to Radio 2 on 1,500 metres. It would be just the job for testing a.f. amplifiers, and we could easily knock it up ourselves."

RADIO 2 TUNER

"We already have two audio signal generators for testing amplifiers," Smithy reminded him. "There's one on your bench and one on mine."

"I know that," said Dick impatiently, "but they only generate a.f. *tones*. A Radio 2 tuner would, on the other hand, offer music most of the time. What's more, we could hitch it up to the Workshop amplifier whenever we wanted to for news bulletins and things like that."

Dick indicated a battered valve a.f. amplifier, sporting a voltage amplifier triode and output pentode, which stood at the back of Smithy's bench and which the pair used occasionally for such functions as signal tracing and the testing of pick-ups. For these processes it was provided with a flexible screened input cable terminated in two crocodile clips.

"I hope," said Smithy with sudden suspicion, "that you aren't thinking of using this tuner unit to give us non-stop pop music in the Workshop all day long."

"Of course I'm not," protested Dick. "As I see it, the tuner will be used mainly as a servicing aid."

Smithy directed a stern gaze at Dick, who returned it with an expression of utter guilelessness.

"Humph," grunted Smithy, partly satisfied with the *bona fides* of his assistant's suggestion. "Well, I must confess that the idea of a Radio 2 tuner does appeal to me rather. This is not only because of its usefulness after it's been built but also because the relatively low frequency of the 1,500 metre transmission makes it possible to use rather novel circuitry. The frequency of this signal is only 200kHz, and you can think of handling it almost in the same way as you would an audio frequency. There's a good half-hour of our lunch-break left, and I could use that time profitably in working out a circuit for this tuner. So, fill up my mug, Dick, and I'll get started."

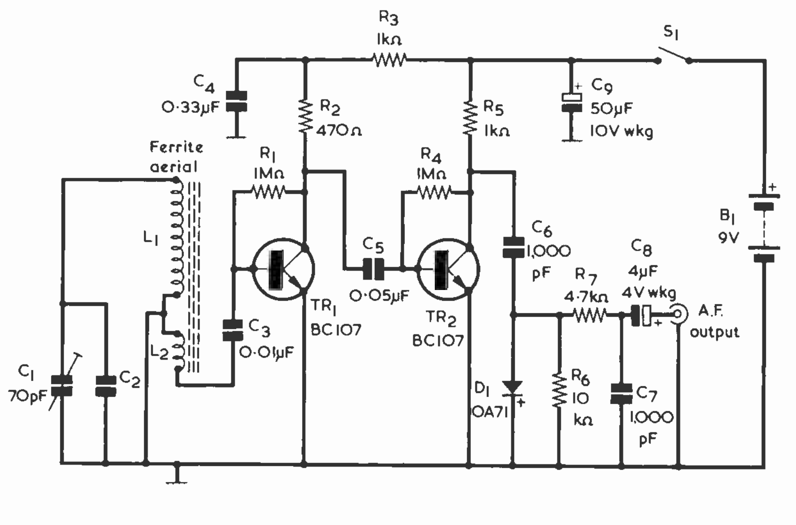
Eagerly, Dick snatched up Smithy's mug and carried it over to the Workshop sink, alongside which stood the motley array of utensils which provided the tea that was so essential for Smithy's well-being. At the same time, the Serviceman pulled his note-pad towards him and thoughtfully commenced to sketch out a circuit.

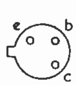
Dick returned with the fully charged mug and waited patiently whilst Smithy proceeded with his design. After some minutes, Smithy laid his pen on the bench with a grunt of satisfaction.

"Here we are," he proclaimed proudly. "This is the circuit for our projected Radio 2 Tuner."

Dick gazed at Smithy's drawing. (Fig. 1).

"It looks simple enough," he commented. "I'm a bit puzzled, though, at the fact that you've got two transistors between the tuned circuit and the diode detector. Shouldn't the





BC 107
Lead-outs

All resistors 1/8 watt 10%
C_1 mica trimmer
C_3, C_4, C_5 polyester
C_6, C_7 ceramic

Fig. 1. The circuit of Smith's Radio 2 tuner. The value of C2 is found experimentally and is of the order of 220pF

diode follow the first transistor?"

"Not in this design," replied Smithy confidently. "As I said just now, the relatively low frequency of the long wave Radio 2 transmission makes it possible to use some rather unusual design techniques."

Dick looked more closely at Smithy's circuit.

"So far as I can see," he remarked doubtfully, "that second transistor is just working as an r.f. amplifier without any tuned circuit at all."

"It is," confirmed Smithy. "In fact, both transistors function at r.f. and they form a very wide band amplifier. I'll give you a description of the circuit now, starting at the left-hand end. At this end we have L1 and L2, which are both wound on a ferrite rod to provide a ferrite aerial. L2 is the coupling coil, and it connects to the base of TR1 via the 0.01μF capacitor C3. At the same time, L1 is the tuned winding and it's tuned by trimmer C1 with C2 in parallel."

"You haven't," broke in Dick, "given a value for C2."

"That," replied Smithy, "is because I don't know what the value will be at the moment. The function of C2 is to provide a fixed capacitance which enables Radio 2 to be tuned in within the range of C1. The value of C2 depends on the ferrite aerial coil, and it will have to be found by experiment."

"Fair enough," said Dick equably. "So we now have the Radio 2 signal picked up by the ferrite aerial and passed on to the base of TR1."

"That's right," agreed Smithy. "Now, TR1 functions as an r.f. amplifier whose collector load resistor, R2, is decoupled from the positive supply line by R3 and C4. The collector of TR1 couples to the base of TR2 via C5, and TR2 acts as a second r.f. amplifier. As you've already stated, there are no tuned circuits around TR2, and it handles the 200kHz signal in much the same way as it would an a.f. signal. Both TR1 and TR2 are BC107's this being a transistor type which can cope very adequately with a signal at 200kHz."

"The detector circuit following TR2," remarked Dick, as he looked closely at Smithy's circuit, "seems to be standard enough, at any rate."

"That's true," agreed Smithy. "There's just a straightforward shunt detector given by D1, with R7 and C7 acting as a low-pass r.f. filter to prevent r.f. getting into the output. Also, C8 stops the d.c. component of the detected signal being passed to the subsequent a.f. amplifier."

"Hang on a minute," said Dick "There's something else I've spotted. This is supposed to be an r.f. amplifier, and yet you've put a dirty great 50μF electrolytic across the supply rails! Surely, something like 0.25μF would have been adequate here. Besides, won't an electrolytic capacitor have a higher impedance at 200kHz than, say, a 0.25μF paper or polyester capacitor?"

"I've put in the 50μF capacitor," explained Smithy, "because the two transistors are capable of offering amplification at a.f. as well as at radio frequencies. The capacitor guards against the slight risk of non-linearity in TR2 at high signal levels from providing partial detection and thereby feeding a.f. back to TR1. The risk is pretty low, I'll admit, but I think it justifies the use of an electrolytic bypass capacitor across the supply lines. In any case, an 0.25μF capacitor wouldn't be quite as good an r.f. bypass component as you imagine, since it offers a reactance of around 3Ω at 200kHz, which could be significant in a low impedance amplifier circuit such as we have here. The impedance offered by a good quality 50μF electrolytic should be lower than 3Ω at 200kHz."

"There's another thing," said Dick, as a further idea occurred to him. "There doesn't seem to be any regeneration."

"I'm leaving the question of regeneration until we've constructed the tuner," replied Smithy. "I've got an idea here which would have to be tried out in practice."

TUNER CONSTRUCTION

Dick's eyes lit up.

"Don't tell me," he remarked keenly, "that we're actually going to build this tuner."

"That's exactly what we're going to do," confirmed Smithy. "And, what's more, we're going to do it right now. It shouldn't take us long to get it working, and I'm very eager to see how this theoretical circuit of mine performs in practice."

"Blimey," said Dick enthusiastically. "This looks like being a *really* interesting session. It's ages since we last tackled a constructional job."

"Then it will do us both good," replied Smithy. "We're liable to get stale if we spend all our time servicing other people's designs without occasionally dreaming up one or two of our own from time to time. Anyway, you pop over to the spares cupboard and get all the components except for C2, whose value we don't know yet, and the materials for the ferrite aerial, which we'll tackle later. Whilst you're doing that, I'll work out a suitable layout."

As Dick sorted through the shelves of the spares cupboard, Smithy opened a drawer in his bench and extracted some tagstrips which he regarded thoughtfully. After a minute or so he put three of these on one side, returned the remainder to the drawer, then took out his pen to make a further sketch on his note-pad. He had just completed this when Dick returned from the spares cupboard with a small cardboard box full of components.

"Here we are, Smithy," he called out cheerfully, as he put the box on Smithy's bench. "All parts present and correct!"

"Fine," said Smithy, tearing from his note-pad the sheet bearing his latest sketch. "And here's a little metal chassis you can next make for the tuner."

Dick looked at Smithy's diagram. (Fig. 2).

"That shouldn't take too long to make up," he remarked. "What's the material?"

"Any metal sheet which is sufficiently strong not to bend unduly in a 6 inch length," replied Smithy. "We've got some scraps of 16 s.w.g. aluminium knocking around somewhere, and one of those should do admirably."

"What are the holes for?"

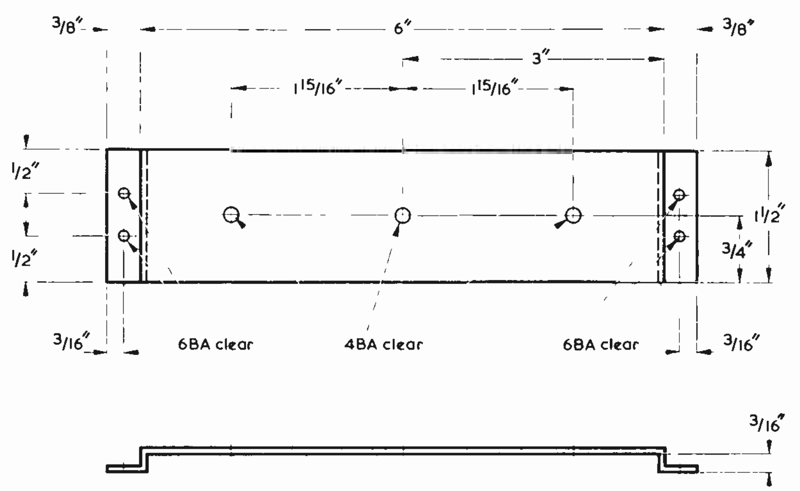


Fig. 2. Details of the chassis employed for the tuner. The material may be any suitable metal

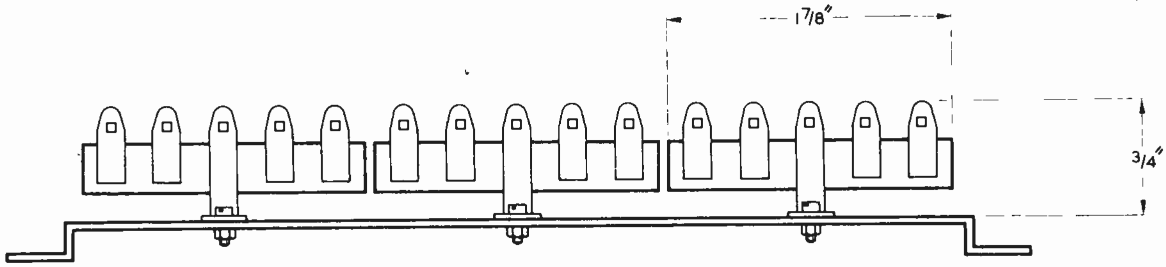


Fig. 3. The three 5-way tagstrips mounted on the chassis. Those shown here are Home Radio Cat. No. BTS34H. Alternatives are the Lektrokit 5-way tagstrips type LK2231, which should be mounted on the same centres. Their Home Radio Cat. No. is LK2231 also

"I'll tell you later," said Smithy. "For the time being just get on with making it up."

After some delving in a remote corner of the Workshop (accompanied by the dislodgement of much dust and the outraged evacuation of a spider who, until then, had enjoyed one of the most undisturbed and prosperous locations in the U.K.) Dick succeeded in finding the scrap oddments of aluminium sheet referred to by Smithy. Selecting a suitable piece, Dick next proceeded to cut and bend it to the shape and dimensions ordained by the Serviceman.

From that moment the peaceful silence of the Workshop was shattered as, first, there was the shrill rasp of Dick's file upon the edge of the metal sheet, this being followed by the heavy thump of his mallet whilst the metal was being bent. Afterwards, the piercing shriek of the Workshop electric drill pervaded the air as Dick proceeded to cut out the seven holes required in the chassis; whilst the last movement was a reprise of the file rasp as he carried out final touching-up operations. Dick accompanied his performance by emitting a curious low-pitched tuneless whistle, indicative of great concentration and apparently having a function similar to that of the drones in the bagpipe. Dick could always be relied upon to extract the last decibel of sound from any metal-working job.

Smithy, however, was impervious to the clatter around him as, completely absorbed, he produced yet a further diagram.

Both craftsmen finished their respective tasks at the same moment. As, with a flamboyant movement, Dick placed the completed chassis on Smithy's bench, that worthy, with an equally ostentatious gesture, returned his pen to his breast pocket. Each surveyed the other's handiwork with interest.

"Very good," commended Smithy, as he examined the little chassis Dick had just completed. "This will do very well, indeed."

"You haven't done so badly, either," remarked Dick, pointing at Smithy's latest diagram. "Blimey, it looks as though you've worked out a complete wiring layout."

"I have, pretty well," concurred Smithy. "But let me first show you how that chassis of yours is to be used. I propose to mount on it three 5-way tagstrips, each having the centre tag earthed, like this."

Smithy picked up a screwdriver, rummaged in his box of bolts and nuts then proceeded to mount the tagstrips to the chassis so that the tags ran in a straight line along its length. (Fig. 3).

"In our Radio 2 tuner," he went on, "we are producing quite a high degree of r.f. amplification, and a sensible approach towards layout consists of mounting the components in a row, with the input circuitry at one end and the output circuitry at the other end. This ensures good physical separation between input and output and reduces the risk of unwanted feedback."

"Are these tagstrips standard types?" asked Dick.

"Oh yes," replied Smithy. "They're a common size used both by professional engineers and by amateur home-constructors and they are each $1\frac{7}{8}$ inches long and $\frac{3}{4}$ inch high. An alternative would be Lektrokit 5-way tagstrips, which are a little smaller in size. If Lektrokit tagstrips were used, they would still need to be mounted on the same centres, and with the tags all in line."

Smithy put down the chassis and indicated the drawing he had just completed. (Fig. 4).

"And here," he remarked, "is a wiring diagram for the unit, with the exception of C1, C2 and the ferrite rod aerial connections. So that I could show the wiring more clearly I've had to spread the components out a bit but, in practice, they should all be wired in with leads that are as short as is reasonably possible. This applies in particular to C3 and R1 in the base circuit of TR1. As we've already noted, the two transistors form a wide band amplifier, and the base of TR1 is particularly susceptible to direct pick-up of unwanted signals by way of long leads. I'll leave it to you now to get these components wired up."

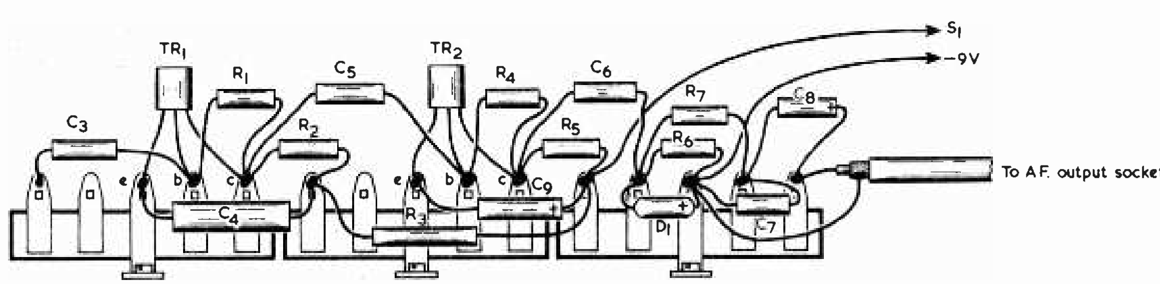


Fig. 4. Wiring of all components apart from C1, C2 and the ferrite rod aerial. The parts are shown spaced out for clarity, but wiring should in practice be kept reasonably short

WIRING UP

Zealously, Dick sat down at Smithy's bench and at once commenced to sort out the components. Very soon, Smithy's soldering iron was actively in use as, following the Serviceman's wiring diagram, Dick set about the process of connecting up the parts. Smithy watched him for some minutes, thoughtfully sipping from his mug. As Dick approached completion of his task Smithy put down the mug and picked up the flexible screened cable connected to the valve a.f. amplifier on his bench. He switched this on and turned its volume to full level. After some moments the amplifier loudspeaker produced a loud hum as Smithy applied his finger to the crocodile clip which connected to the input screened cable centre conductor. Satisfied that the amplifier was functioning correctly, Smithy reached over to the back of his bench and took up a PP9 9-volt battery and two battery connector clips.

"I've just about finished now," called out Dick. "What about the on-off switch, S1? Shall I wire that into the circuit, too?"

"Not for the time being," said Smithy. "If you've completed all the wiring, you should now have two flexible leads running from the right-hand tagstrip for connection to the negative side of the battery and to S1. Terminate the negative lead with a negative battery clip and the lead to S1 with a positive battery clip. We won't need the switch while we're checking out the tuner."

"Righty-ho," said Dick cheerfully. "I'll get that done right now."

Dick quickly carried out Smithy's bidding, then finally checked his handiwork.

"It's all okay," he announced, after a few moments. "No incorrect connections or even the suspicion of a dry joint!"

"I'll take your word for it," grinned Smithy. "Well, you've now assembled the tuner all the way from the output back to C3 at the input, so we shall next see what happens when we connect it up to the amplifier."

Smithy applied the earthy crocodile clip from the amplifier to the chassis of the nearly completed tuner and, to the accompaniment of a loud hum from the amplifier, its live clip to the negative terminal of C8. The hum stopped as Smithy took his hand from the amplifier crocodile clip. Next, Smithy connected the PP9 battery to the leads from the tuner, and the pair listened attentively. Apart from a slight hiss, there was no sound from the speaker.

"Touch the left-hand end tag of the tagstrips," said Smithy, "the tag to which C3 connects."

Obediently, Dick put his finger on the tag. Immediately, a loud burst of music together with speech was reproduced by the speaker, both being accompanied by a gurgle similar to modulation hum.

"Hell's teeth," snorted Dick, as he hurriedly took his finger away, "What on earth was that?"

"Evidence," chuckled Smithy, "of a highly satisfactory wide band amplifier and detector! The sound from that speaker was a mixture of our local a.m. radio signals, including the Radio 2 signal that we require, with yourself acting as an aerial."

"Oh, I see," said Dick brightly. "In other words we've got an r.f. amplifier and detector, and all we've now got to do is to put a tuned circuit in front of it to select the particular signal we want."

"That's the situation precisely," said Smithy. "So our next job is to get the ferrite aerial set up."

A thought presented itself to Dick.

"Those signals we picked up didn't seem to be of very high quality," he commented, frowning. "There was a funny gurgle behind them all the time."

"That was due to the 50Hz hum you also injected into the tuner," remarked Smithy, "which must have been high enough in amplitude to cross-modulate the r.f. signals. Don't forget that the two transistors in the tuner are capable of amplifying a.f. as well as r.f."

"Won't that hum," asked Dick, "cause trouble when we *do* connect the ferrite aerial?"

"Oh no," said Smithy. "With the ferrite aerial connected, the base of TR1 will connect to chassis via C3 and coupling coil L2. These will effectively bypass any hum voltages."

FERRITE AERIAL

"Good enough," replied Dick. "So the next thing to do is to get on with the ferrite aerial. I assume that it will be home-wound."

"It will," confirmed Smithy, as he reached over and disconnected the positive clip from the PP9 battery. "I'll go and get you the bits now."

Smithy rose and walked towards the spares cupboard. After some searching, he returned carrying a ferrite rod, a reel of wire and a single-gang 500pF variable capacitor.

"Hallo," said Dick, "what's the variable capacitor for?"

"You'll see in a minute," replied Smithy. "But let me first give you the gen on the ferrite aerial windings. The wire I've got here is 36 s.w.g. enamelled and single rayon covered copper, and I'd suggest you commence by winding L1. This should start 2½ inches from one end of the rod and it consists of 175 turns which you can scramble-wind up to a length of about 1½ inches. L2 is 30 turns of the same wire, scramble-wound to a length of about ¼ inch, and spaced away from L1 by ⅛ inch. The rod, by the way, is 6 inches long by ⅜ inch in diameter." (Fig. 5).

Dick absorbed this information.

"Isn't 175 turns," he asked after a moment, "rather low for a long-wave

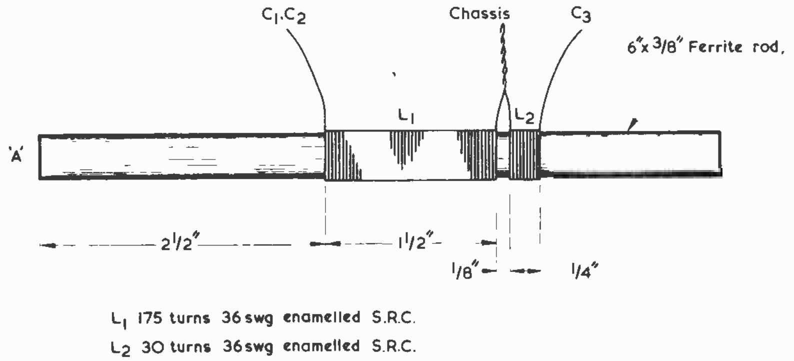


Fig. 5. Details of the ferrite rod aerial

winding?"

"It would be," said Smithy, "if we were making a conventional long-wave winding for a transistor circuit. But I don't want a conventional winding here. What I want is a winding which will resonate at 200kHz with a fairly high capacitance, say about 150 to 300pF, connected across it. With a tuning capacitance of this order any regeneration we may add should be pretty smooth and easy to control."

"Are the coils wound direct on the ferrite rod?"

"They are," confirmed Smithy. "And I think it mightn't be a bad idea to specify the direction in which the wire is wound. Let's start off by referring to the L1 end of the rod as end 'A'. We can then say that, with end 'A' towards you, the wire of L1 goes on in an anti-clockwise direction as it proceeds round and down the rod." (Fig. 6).

"That should be easy enough to do," commented Dick. "Right, I'll start off now with L1."

It was not long before Dick had completed winding the aerial coils. He secured the coil ends with thin strips of adhesive tape, then cut each winding lead-out to around 6 inches. He next cleaned and tinned the ends, then looked expectantly up at Smithy.

"Right," said that worthy, "now, it's my turn to do a little bit of wiring. I dug out that 500pF variable capacitor so that I could get a rough idea of the capacitance required to tune the 175 turn coil to 200kHz. I'll now make a few temporary connections."

Picking up his soldering iron and a short length of wire, Smithy connected the frame of the variable capacitor, together with the two common lead-outs from L1 and L2 to the chassis tag to which the emitter of TR1 was already connected. He next connected the free end of L1 to the fixed vanes of the 500pF variable capacitor, and the free end of L2 to C3. (Fig. 7). He positioned the ferrite rod well away from the tuner chassis, and reconnected the positive battery clip to the PP9 battery. The sound of faint music became audible from the speaker of the a.f. amplifier. Smithy adjusted the variable capacitor carefully and was rewarded, when it was near mid-travel, by very loud reception of the Radio 2 programme with excellent quality.

"Gosh," said Dick, impressed. "that sounds smashing, that does."

Smithy disconnected the PP9 battery.

"It's not bad, is it?" he replied, obviously pleased with the performance of the unit. "Well now, let's have a look at that variable capacitor setting. Rough check, I'd say it was giving a capacitance of around 240pF. It's served its purpose now, and we don't need it any more and it can be disconnected. You can finish this job off yourself now, Dick. Get a 200pF silvered mica capacitor, which will now

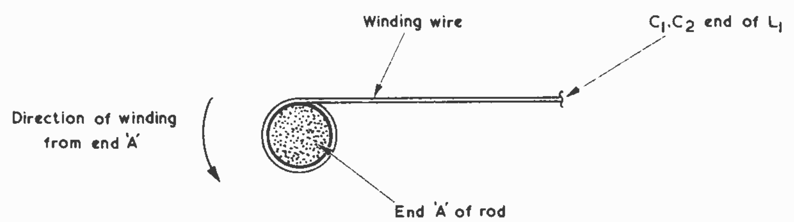


Fig. 6. Direction of winding, as viewed from end 'A' of the ferrite rod

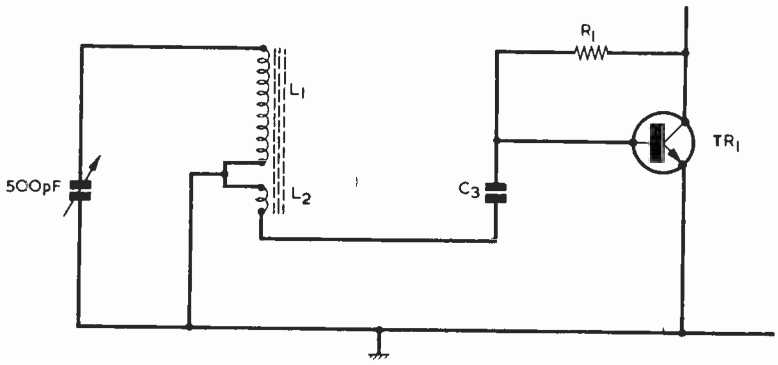


Fig. 7. Smithy found the tuning capacitance required by the ferrite rod aerial for reception at 200kHz by temporarily connecting a 500pF variable capacitor across L1

become C2, and connect this, with trimmer C1 in parallel, between the earth tag to which the emitter of TR1 connects and the empty one next door. Also, connect the non-earthy end of L1 to this same tag." (Fig. 8).

Dick rushed to the spares cupboard and returned with the 200pF capacitor.

"The trimmer," continued Smithy, "can be perched on fairly stout wires. If its adjusting screw is common to one of the plates, make that plate the one which connects to chassis. And keep the leads to C1 and C2 as short as is reasonably possible."

"These connections won't take long, Smithy," said Dick, busy with the soldering iron. "Ah, that's it. All ready to try out now!"

Smithy reconnected the PP9 battery, whereupon the Radio 2 signal appeared once more, albeit at reduced volume. He adjusted the trimmer.

"Darn it," he grumbled. "My guess at the value for C2 wasn't quite right. I can tune in the Radio 2 signal all right, but only with the trimmer screwed up tight. Could you remove the 200pF capacitor, Dick, and put in a 220pF one instead, please?"

"Surely," replied Dick obligingly. "I'll make the change in a couple of shakes."

Several minutes later, Smithy was trying out the tuner with a 220pF capacitor in the C2 position.

"That's fine," he announced. "I can now tune in Radio 2 with a useful amount of trimmer adjustment either side. All that's left now is the regeneration bit."

"How do you plan to get regeneration?"

"I'm hoping," said Smithy, "to be able to rely on induced currents between the wiring on the tagstrips and the ferrite aerial rod. Let's play around a bit!"

Dick watched as Smithy tried various positions of the rod relative to the tagstrips. Finally, Smithy set up the rod parallel to the strips with end 'A' at the same end as C3 on the strips. (Fig. 9). Smithy positioned the rod on a match-box so that he could move it to and from the tagstrips without actually touching it with his fingers, the rod being parallel to the strips all the time. As he moved the rod towards the strips, the tuner went gently into oscillation and Smithy was able to zero-beat the Radio 2 transmission on trimmer C1. He then moved the rod away until a position was reached, with the rod about 1¾ inches away from the strips, where the tuner was just below the oscillation point.

"That's it, then," said Smithy with extreme satisfaction. "The increased sensitivity resulting from the regeneration is not great but it's still sufficiently large to be more than worth-while. I think I'd better let you in on a few of the things I've just discovered. I've found that, with end 'A' of the rod at the C3 end of the tagstrips, I get easily controllable regeneration if I keep the rod parallel to the tagstrips and just move it to and fro. If, on the other hand, I have end 'A' at the C8 end of the strips I get the reverse effect and signal strength actually *decreases* as the rod approaches the strips. It's necessary to avoid holding the rod

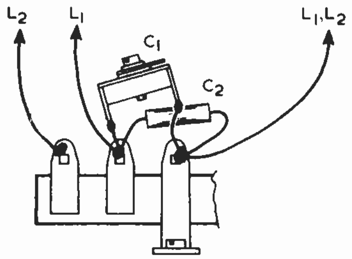


Fig. 8. Final wiring steps. This diagram shows the connections to C1, C2 and the ferrite rod

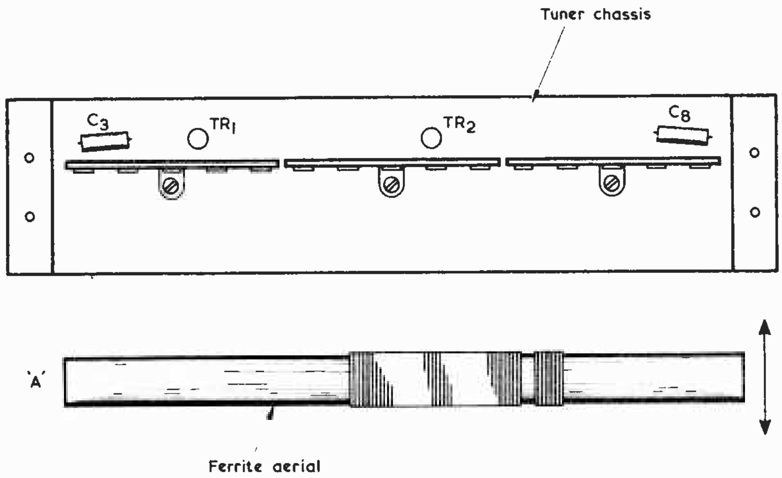


Fig. 9. The ferrite rod is maintained parallel with the tagstrips. Regeneration is controlled by varying the distance between the rod and the tagstrips

directly with the fingers as you move it around, since this causes the tuner to pick up signals other than Radio 2 and gives confusing results. Also, the tuner can break into oscillation when the rod is held in one or two positions close to the C3 end of the strips. However, this effect is absent when it is parallel to them."

"What," asked Dick, "do we do next?"

"Just tidy things up a bit and put the tuner into an insulated case. Before starting to talk about that, though, let's first check the current the tuner draws from the 9-volt battery."

Smithy pulled his testmeter towards him, switched it to a current range and inserted it in series with the positive battery lead.

"The current drawn by the tuner," he remarked, removing the testmeter clips, "is only a little over 2.5mA, so you could get a long battery life if you powered it with a small 9 volt battery such as the PP3. This battery could be fitted inside the case, somewhere near the C8 end of the tagstrips, and S1 could be mounted on the top of the box. The metal chassis can be secured to the bottom of the box by screws passing through the four 6BA clear holes at the ends, and the ferrite rod can be positioned at just the right distance from it for correct regeneration."

FINAL POINTS

"Well," remarked Dick, "that certainly constitutes quite a neat little tuner unit. I assume that this circuit could be built up by anyone else if they wanted to."

"I see no reason why not," replied Smithy. "Although there are one or two points which need to be mentioned. Since there is only one tuned circuit, and since the tuner incorporates a wide band amplifier, it might not be successful in areas where a local medium wave signal is very much stronger than the Radio 2 Signal. There is a risk, there, of the strong medium wave signal breaking through. Again, the a.f. output of the tuner depends on the level of the Radio 2 signal in the locality in which it is used, but it should in general be of the same order as that given by a ceramic pick-up cartridge. The tuner can, incidentally, feed into any amplifier having an input impedance of 20kΩ or more."

"Would any of the tuner components need adjustment in value?"

"Well," replied Smithy thoughtfully, "the obvious one in this respect is, of course, C2. In our case we found that C2 needed to be 220pF, but it is quite possible that it may need to have an alternative value lying between some 170pF and 270pF in other tuners built up to the circuit. The best thing to do is to start off with 200pF and work from there. If the Radio 2 signal increases in strength with the trimmer nearly unscrewed, then C2 should be reduced in value to suit, and so on. Another component which may need adjustment is R7. There is a high r.f. level at the detector diode, and some of this r.f. could get past the filter given by R7 and C7. With some amplifiers, it is feasible that instability could occur when the volume control of the amplifier was set to full. If this occurs, the value of R7 should be increased."

"Any other points?"

"The only other one is the question of the regeneration," replied Smithy. "As the feedback coupling is of a random nature, it's liable to vary between different units, although it should be pretty consistent if all the r.f.-carrying wiring on the tagstrips is kept short. If the aerial is wound in the same direction as was ours, then the regeneration effect should be given with end 'A' of the rod at the same end as C3. However, should regeneration not be given, there's no harm in trying the effect with end 'A' of the rod at the C8 end. Finally, if one, or both, of the transistors happens to have very high gain it might be difficult to prevent oscillation with the rod quite some distance away from the tagstrips. In this event, gain can be lowered by reducing the value of R2. And that, I think, pretty well covers everything."

Dick looked at the tuner unit with an expression akin to affection. He reconnected the positive battery lead, whereupon the Irish tones of Terry Wogan, pressing on with his indefatigable and highly commendable Fight on Flab, filled the Workshop. Startled, both Dick and Smithy looked at the clock, to find that the construction of the tuner had taken up at least two hours of the time that should properly have been apportioned to the repair of ailing radios and television sets. But even Smithy, on this occasion, was content to ignore such a monumental lapse, and to remark that the time and effort spent in making up the Radio 2 tuner had, in all senses of the word, been truly constructive. ■

"I don't seem to be able to communicate with my parents anymore!"

HOME-SOLDERING HINT

by
R. L. GRAPER

How to deal with a soldering task which occasionally confronts the constructor.

IT IS OFTEN NECESSARY FOR THE HOME-CONSTRUCTOR TO fabricate a mechanical part which is not readily available from the local shop or through the mail-order stores. A typical example occurred recently with the writer, and the solution he employed may be of interest and assistance to other constructors encountering a similar problem.

SOLDERING JOB

The job consisted of soldering a small brass hexagon nut to a thin brass strip intended for the mechanism of an unusual switching device. The strip had to be flexible, whereupon it was too thin to be tapped in the normal way, and the only solution consisted of soldering a nut to it.

After several failures, due to solder running into the threads of the nut and the difficulty of gripping the nut centrally over the hole in the strip, the procedure now to be described was adopted with complete success.

Some steel studding, or threaded rod, of the same B.A. size as the nut was found, together with two steel nuts, also of the same B.A. size. A clearance hole for this studding was drilled through the thin brass strip at the predetermined position and the studding passed through. The brass nut was then threaded on, and the steel nuts fitted, one at the top and one at the bottom, to provide the necessary clamping. When all the nuts were tightened up, the brass nut was firmly secured to the brass strip.

Using an electric soldering iron having a medium sized bit and resin-cored solder, the solder was run

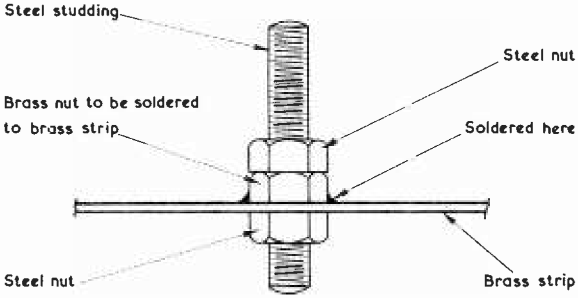


Fig. 1. Side view of the clamping assembly after soldering

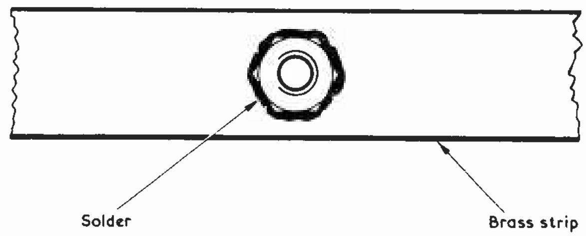


Fig. 2. The clamping assembly as seen from above

around the six faces of the brass nut, allowing it to flow onto the faces and onto the strip with a satisfactory joint to both surfaces. When quite cold, the temporary steel studding and its associated steel clamping nuts were removed, being replaced by brass studding as was required by the design of the switch.

The clamping assembly, after soldering and before the removal of the steel parts, had the appearance illustrated in Figs. 1 and 2.

A few words of explanation may be needed here. The solder 'took' to the brass surfaces only, since steel is very difficult to solder without the use of a special flux. The results was that the solder only ran onto the outside surface of the nut and the upper surface of the brass strip. It could not run into the threads of the nut because of the presence of the studding and the upper clamping nut.

This job should only be attempted with the aid of resin-cored solder, as intended for radio work, and most certainly not with a separate flux of the killed spirits type. Also, the soldering iron used requires an adequately sized bit to allow for the heat dissipation that will occur. The very small types of soldering iron that are used for delicate wiring work could not quite cope for the heavier demands of heat required. With such irons the heat would dissipate into the steel studding, the associated nuts and the strip, and it would be necessary to hold the iron on the work for too long a period.

A final point is that it is not essential to use steel studding for the temporary clamping of the brass nut. A steel bolt of the same B.A. size could be employed, if of adequate length. The bolt-head can be on the upper side of the clamping assembly, the upper steel nut being run onto it before it passes through the brass nut.

Radio Topics

By Recorder

I SHOULD IMAGINE THAT ONE OF THE things which make manufacturers of mechanical and electrical equipment gnash their teeth down to the gums is the failure of those purchasing their products to read the instructions which accompany them. I would hate to hazard a guess as to how much research and development time has been lost in laboratories because people employing unfamiliar measuring equipment have not bothered to look up the correct manner in which such equipment should be used. I have, for instance, seen people fiddling around for ages with a fairly complicated oscilloscope, when ten minutes spent with the operating manual would have answered all their questions on how to set up the 'scope for a particular trace.

UNGOVERNED MOTOR

Sometimes, the lack of attention to the obvious verges on the fantastic. I remember encountering, during my Service days in the past, a receiving station which was powered by a small diesel generating set capable of being regulated for loads, if my memory serves me correctly, of the order of 1 to 10kW. Indeed, the range of regulation was shown on a whacking great plate on the front of the set. And yet the characters at that station used to load that set with a few receivers during the day (total power consumption about 100W) and with the receivers plus lights and a small electric fire at night time (giving a total load of around 1.5kW). And they wondered why that sadly abused generator set used to 'take off' every now and again and feed so much voltage to the receivers that it blew all the fuses! If they had put a permanent 1kW load on that generator, say by means of an electric fire element, the generator would have been brought into the range at which it was designed to be self-regulating, and it would then have quite happily accepted extra loads from a few watts up to 9kW without giving any trouble at all.

I always make a practice of checking all the manufacturer's instructions whenever I obtain a new item of equipment. Indeed, it would be silly not to do so. In buying the equipment I have paid for those instructions as well and so, apart from saving myself possible trouble in the future, by reading them I am also making absolutely certain that I get my full money's worth!

POLY-PLANAR SPEAKERS

The accompanying photographs show two examples of 'Poly-Planar' speakers, as manufactured by The Magitran Company, New Jersey, U.S.A. These are imported and distributed in the U.K. by Highgate Acoustics, 184-188 Great Portland Street, London, W1N 5TB.

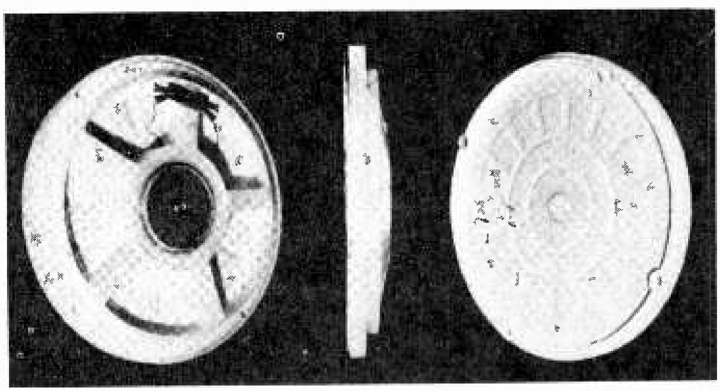
Poly-Planar speakers represent a considerable breakaway from conventional moving-coil cone speaker design. The latter reproduce sound by mechanical motion of the relatively loosely suspended cone system. The cone is generally made of paper or prepared cellulose, folded or formed to cone shape, so that an adequate degree of rigidity may be obtained without a significant increase in mass. The degree to which a rigid piston of this type produces sound is determined by its size, how it is baffled and the magnitude of the electromotive driving force. Baffling in general is, of course, a means of preventing the rear wave of sound from interfering with or cancelling the front wave, and it may take the form of absorbing the rear wave, shielding the rear wave from the front, or processing this wave in such a manner that it becomes in phase with the front wave. Baffling may be equally applied to Poly-Planar speakers, but it is stated that these new designs also have the facility of being operated unbaffled to provide a bi-directional radiating characteristic.

The Poly-Planar speaker functions basically in a manner similar to that of the cone speaker. There is a magnetic structure which produces a radial field within a closely spaced gap. A voice coil is immersed in the gap and electrical signals applied to the coil produce motor action with resulting acoustic output. In place of the conventional paper or cellulose cone, however, there is a flat plastic panel which is only a fraction of the depth of the equivalent cone structure. This panel is made rigid by the choice of plastic materials in conjunction with a special surface skin treatment. The material employed is expanded polystyrene in a compacted bead structure, and since the beads are largely air the mass is extremely low. As an example, the weight of a typical ⅛in. acoustic panel is less than 0.2 grams per cubic inch.

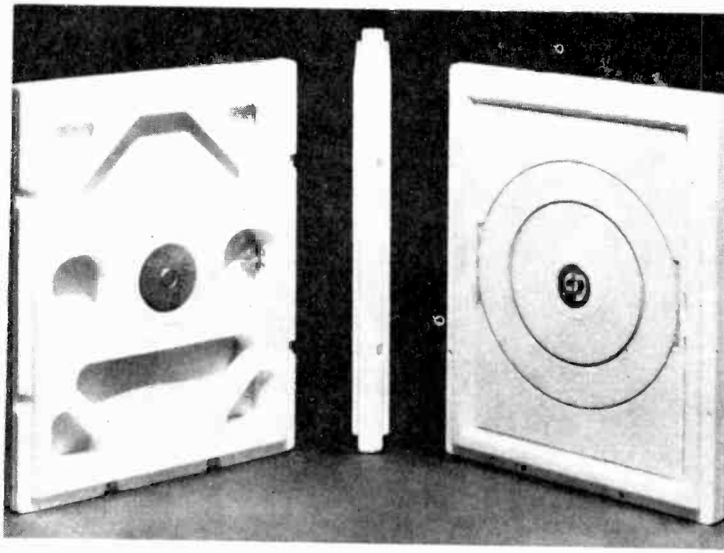
To obtain the desired acoustic properties the panel incorporates a combination of circular grooves in conjunction with special acoustic filler materials. This combination provides a balance of compliances and damping for wide response characteristics. With a flat rectangular panel a larger piston area is also available, and hence the length and width dimensions can be made smaller than the cone speaker, or superior low frequencies can be reproduced for the same equivalent area.

In view of the rigidity of the acoustic panel, conventional 'spiders' or supporting structures are not required to maintain or centre the voice coil in the magnetic gap. The acoustic radiating panel is supported directly by a frame made of similar polystyrene plastic which provides an identical coefficient of expansion. This results in a physical structure substantially independent of wide changes in temperature or ambient conditions. Due to the physical characteristics of the acoustic panel, the supporting frame may be made shallow without detracting from the required rigidity necessary to prevent flexing at low frequencies.

Poly-Planar speakers are available in a wide range of designs, and their



The flat, virtually all-plastic, construction of Poly-Planar speakers is strikingly evident in these three views of the type RP-8. This speaker is approximately 1in. in thickness



Another Poly-Planar speaker. This construction is available in two versions, the P-40 and P-20, which are rated at 25 watts r.m.s. and 15 watts r.m.s. respectively. Impedance, as with the other speaker illustrated, is 8Ω

flat nature enables them to be hung up on a wall in the same manner as a picture. Indeed, the speakers can be obtained in the form of art prints, or even mirrors, from which the sound emanates. Another design is an all-weather version which can be used indoors or outdoors as required.

Further details are available from Highgate Acoustics at the address given earlier.

POLLUTION

The pollution problem becomes worse as Mankind continues to change the substances bestowed on him by a benevolent Mother Nature into new and virtually indestructible forms. Apart from the obviously toxic materials which are dumped here and there by the criminally irresponsible members of our society, there are also items which, whilst reasonably harmless in themselves, simply clutter up the surroundings after they have served their limited spell of usefulness. Typical of the latter are the non-returnable bottles in which one can nowadays obtain beer and soft drinks. A full soft drink bottle is an eminently satisfactory proposition: it occupies a merited volume of space and it carries out its function of containing the drink with consummate efficiency. Empty, and with no financial encouragement to return it to its manufacturer, that bottle becomes a nuisance. It forms an eyesore if it is discarded in what is left of our dwindling countryside. Worse, it can be broken by the thoughtless, with results such as cuts on the feet and legs of seaside holiday-makers.

Fortunately, some aspects of the pollution problem can raise a chuckle, as I discovered recently in the case of a family which is suffering from Coat Hanger Pollution. It seems that their local dry cleaners not only present them with the cleaned garment but also with a wire coat hanger on which to support it. They now find that they have a wardrobe which is filled with unused coat hangers.

One obvious solution to this predicament is to smuggle the excess coat hangers into a hotel and thereby make good the normal loss of coat hangers to which such establishments are notoriously prone. The pollution problem then dramatically changes to a flow system which satisfies everyone. The dry cleaner customer can periodically dispose of his stock of unwanted coat hangers, the hotel manager can maintain a static inventory, and those hotel guests who have such an avid appetite for coat hangers can depart with their suit-cases bulging with the things. In fact, it is not beyond the bounds of possibility for a complete loop to be set up, the final link being formed if the hotel guests flog the coat hangers back to the dry cleaners again.

It occurs to me, also, that there are other uses to which these surplus coat hangers can be put. They employ a fairly rigid and heavy gauge wire which is nevertheless readily capable of being cut and bent to any desired shape, whereupon they can easily be made into brackets for securing small batteries in position, soldering iron stands, handles for home-made radios, and small whip aerials. Sufficient action along these lines could, indeed, result in an actual shortage of wire coat hangers; which means that I'll get an even higher dividend from my shares in Acme Coat Hangers (Wigan) Ltd.

Turning to another aspect of pollution, research into electrically driven cars which may eventually oust the petrol-consuming version continues apace. It is untrue, however, that these are to be marketed as Voltswagens.

NEW NAVIGATION TRAINER

I note that an entirely new navigation procedures trainer which is the most advanced of its type available, and which will help pilots to qualify as navigators in less time, has been delivered and put to work in B.O.A.C.'s London Airport Training Centre by Marconi Space and Defence Systems Limited, a G.E.C.-Marconi Electronics company. Costing £130,000, the digital trainer, which is the result of two years of research by B.O.A.C.'s technical training experts and Marconi's Trainer and Simulator Division at Hillend in Fife, has revolutionised the whole of the navigation training procedures for pilots at the Centre.

The simulator enables up to fifteen students to fly the same exercise routes simultaneously through the same weather conditions and yet navigate independently. Previously, one student would have navigated from a facsimile navigator's position with the other students following his actions on slave systems. Obviously this resulted in a long and repetitive process before all students were sufficiently well trained to navigate the actual routes.

Each student training with the new simulator sits at a cubicle with only his charts, a simple typewriter keyboard and a data display similar to a television screen. This replaces the mass of instruments and controls normally associated with the navigator's position, but does not, after a short period of familiarisation, detract from the realistic effect of the training exercise. During the exercise the students call up navigational aids and information or feed their instructions via the keyboards to a digital computer at the heart of the system. This produces a display of all the instrument readings and any other navigational information which would normally be available to them in flight, from which they can then calculate their position and change course accordingly. The instructor can monitor any student's performance from his own cubicle and, at the end of the exercise, the computer prints out individual records for subsequent analysis and discussion.

One of the contract requirements for the new simulator called for a very strict equipment availability test. This required that the simulator operate at 98% availability for twelve hours per day, six days per week, for ten consecutive weeks. Although a total time of twelve months was agreed for this phase, the system improved on the requirements in the first ten week period. ■

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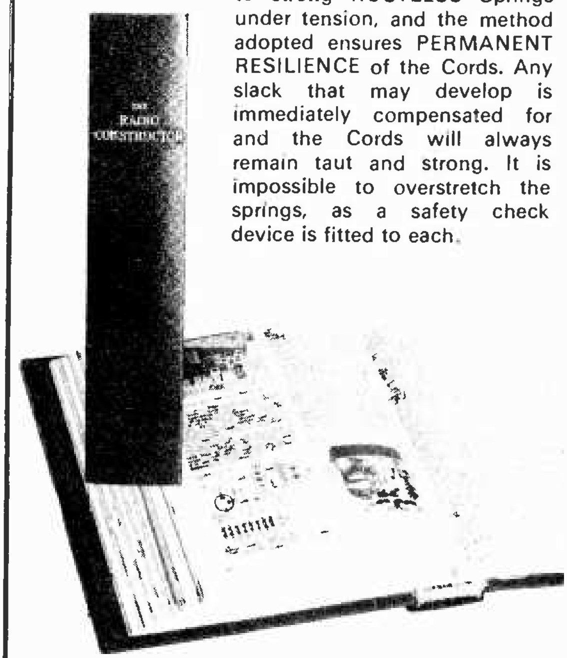

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The Table lists preferred resistance values (originally introduced for for carbon composition resistors) over two decades from 100 to 10,000Ω in ±20%, 10% and 5%. The series extends both above and below the figures given. Modern resistors are most frequently in ±10% and 5%. Following B.S. 2488, the ±10% series may be referred to as 'E12' and the ±5% series as 'E24'.

±20%	±10%	±5%	±20%	±10%	±5%	±20%	±10%	±5%
100	100	100			510		2,700	2,700
		110		560	560			3,000
	120	120			620	3,300	3,300	3,300
		130	680	680	680			3,600
150	150	150			750		3,900	3,900
		160		820	820			4,300
	180	180			910	4,700	4,700	4,700
		200	1,000	1,000	1,000			5,100
220	220	220			1,100		5,600	5,600
		240		1,200	1,200			6,200
	270	270			1,300	6.800	6,800	6,800
		300	1,500	1,500	1,500			7,500
330	330	330			1,600		8,200	8,200
		360		1,800	1,800			9,100
	390	390			2,000	10,000	10,000	10,000
		430	2,200	2,200	2,200			
470	470	470			2,400			

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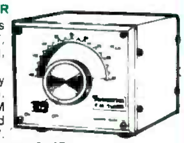

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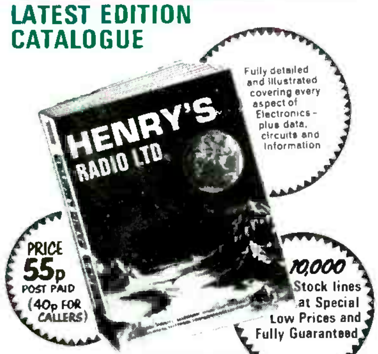

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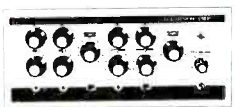

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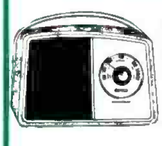

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