RADIO & ELECTRONICS CONSTRUCTOR

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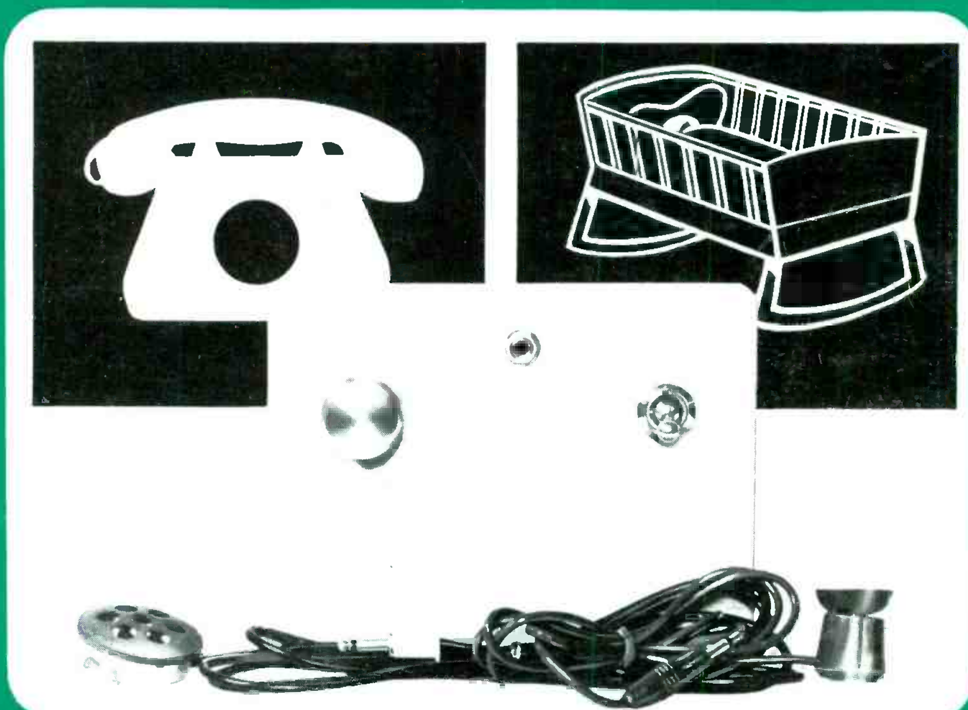

TELEPHONE AMPLIFIER & BABY ALARM

FEATURED IN THIS ISSUE

COMPREHENSIVE TRANSISTOR ANALYSER - Part 1 (2 part article)

Each £3 unit of Home Unit Insurance gives you protection up to the limit shown

This is the simplified insurance you have been waiting for. Not just cover on the contents of your home but a package of personal protection you and your family need. And it's how we save you so much money: just ONE policy to issue instead of nine!
You can build up to the cover you need by additional units (or ½ units after the first) up to a maximum of five. So simple. So easy. Apply to your Broker, Agent or local office of a General Accident company.
The Home Unit Policy can replace your existing insurances And remember – as you buy more possessions just add more Home Units at any time.

THE GENERAL ACCIDENT FIRE & LIFE ASSURANCE CORPORATION LTD

Metropolitan House, 35 Victoria Avenue,
Southend-on-Sea, Essex, SS2 6BT

It pays to be protected by a General Accident company

Please send me further particulars of the Home Unit Insurance.

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Address..

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20/9468

BI-PRE-PAK

COMPLETE TELEPHONES
Normal household type as supplied to the Post Office, ex. G.P.O. Only **95p** each. p. & p. 35p each.

TELEPHONE DIALS
Standard Post Office type. Guaranteed in working order.
ONLY 25p
p. & p. 15p.

OVER 1,000,000 TRANSISTORS IN STOCK

We hold a very large range of fully marked, tested and guaranteed Transistors, Power Transistors, Diodes and Rectifiers at very competitive prices. Please send for Free Catalogue.

600,000 Silicon Planar Plastic Transistors. Unmarked, untested - Factory clearance. A random sampling showed these to be of remarkably high quality.

Audio PNP, similar to ZTX500, 2N3702/3, BCY 70 etc.

Audio NPN, similar to ZTX300, 2N3708/9, BC168/9 etc.

R.F. NPN and Switching NPN

Please state type of Transistor required when ordering.

ALL AT 500 for £3.00 1,000 for £5.00
10,000 for £40.00

OUR VERY POPULAR 3p TRANSISTORS

TYPE "A" PNP Silicon alloy, TO-5 can.
TYPE "B" PNP Silicon, plastic encapsulation.
TYPE "E" PNP Germanium AF or RF.
TYPE "F" NPN Silicon plastic encapsulation.
TYPE "G" NPN Silicon, similar ZTX300 range.
TYPE "H" PNP Silicon, similar ZTX500 range.

FREE CATALOGUE

FOR TRANSISTORS, RECTIFIERS, DIODES, INTEGRATED CIRCUITS, FULL PRE-PAK LISTS.

TESTED AND GUARANTEED PAKS

B2	4	Photo Cells, Sun Batteries. 0·3 to 0·5V. 0·5 to 2mA.	50p
B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	50p
B81	10	Reed Switches, mixed types large and small	50p
B99	200	Mixed Capacitors. Approx. quantity, counted by weight	50p
H4	250	Mixed Resistors. Approx. quantity counted by weight	50p
H7	40	Wirewound Resistors. Mixed types and values.	50p
H9	2	OCP71 Light Sensitive Photo Transistor	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO-5 can	50p
H30	20	1 Watt Zener Diodes. Mixed Voltages 6.8 – 43V	50p
H35	100	Mixed Diodes. Germ Gold bonded, etc Marked and Unmarked	50p
H38	30	Short lead Transistors, NPN Silicon Planar types.	50p
H39	10	Integrated Circuits: 6 Gates, BMC 962,4 Flip Flops BMC 945.	50p
H40	20	BFY50/2, 2N696, 2N1613, NPN. Silicon uncoded T0-5	50p

UNMARKED UNTESTED PACKS

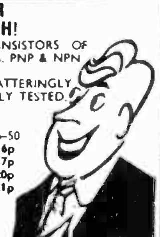
B66	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc	50p
B1	50	Germanium Transistors PNP. A.F. & R.F.	50p
H6	40	250mW. Zener Diodes DO-7 Min. Glass Type	50p
H34	15	Power Transistors, PNP, Germ NPN Silicon TO-3 Can	50p
H17	20	3 amp Silicon Stud rectifiers, mixed volts	50p
H15	30	Top Hat Silicon Rectifiers, 750mA. Mixed volts	50p
H16	15	Experimenters' Pak of Integrated Circuits. Data supplied	50p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp plastic. Mixed volts.	50p

POWER TRANSISTOR PRICE BREAKTHROUGH!

PLASTIC CASED SILICON POWER TRANSISTORS OF LATEST DESIGN. 40 WATTS and 90 WATTS. PNP & NPN TYPES.
ALL TYPES AVAILABLE AT THE MOST SHATTERINGLY LOW PRICES OF ALL TIME. ALL ARE FULLY TESTED, MARKED AND GUARANTEED!

		1–12	13–25	26–50
40W	NPN	20p	18p	16p
40W	PNP	21p	19p	17p
90W	NPN	24p	22p	20p
90W	PNP	25p	23p	21p

PAK	PAKS of complementary pairs				
MP 40	40W	40W	50p	48p	46p
MP 90	90W +	90W	60p	58p	56p



8 RELAYS FOR £1

VARIOUS TYPES
P. & P. 25p.

VARIOUS TYPES
POST & PACKING 25p

INTEGRATED CIRCUITS

THE LOWEST PRICES OF ALL FOR YOUR OTL

	LOGIC	1–12	13–25	26–50
Clocked Flip Flop	BMC931	20p	18p	16p
Ex. 2/4-Input Buffer	BMC932	12p	11p	10p
2/4-input Expander	BMC933	12p	11p	10p
Hex. Inverter	BMC934	12p	11p	10p
Hex. Inverter	BMC935	12p	11p	10p
Hex. Inverter	BMC936	12p	11p	10p
Hex. Inverter	BMC937	12p	11p	10p
Decade Counter	BMC938	25p	23p	21p
Div. by 16 Counter	BMC939	25p	23p	21p
Hex. Inverter	BMC940	12p	11p	10p
Hex. Inverter	BMC941	12p	11p	10p
Type D Flip Flop	BMC942	20p	18p	16p
Ex. 2/4-input Power	BMC944	12p	11p	10p
Clocked Flip Flop	BMC945	20p	18p	16p
4/2 Input Nand Gate	BMC946	11p	10p	9p
Clocked Flip Flop	BMC948	20p	18p	16p
4/2 Input Nand Gate	BMC949	12p	11p	10p
Pulsed Trig. Binary	BMC950	20p	18p	16p
Monostable Multivib.	BMC951	25p	23p	21p
Dual J/K Flip Flop	BMC953	20p	18p	16p
Dual J/K Flip Flop	BMC955	20p	18p	16p
Dual J/K Flip Flop	BMC956	20p	18p	16p
Quad. 2-Input Power	BMC958	12p	11p	10p
2/4-input Gate	BMC961	12p	11p	10p
3/3-input NAND Gate	BMC962	11p	10p	9p
3/3-input NAND Gate	BMC963	12p	11p	10p
Audio Amp. 3-watts	SL403D	£1.50	£1.40	£1.36
Linear Op. Amp	709C	25p	20p	15p
Decade Counter	SN7490	65p	60p	55p

LOW COST DUAL IN LINE I.C. SOCKETS
14 pin type at 15p each
16 pin type at 16p each
Now new low profile type.

BOOKS

We have a large selection of Reference and Technical Books in stock.
These are just two of our popular lines:
B.P.I Transistor Equivalents and Substitutes; 40p
This includes many thousands of British U.S.A., European and C.V. equivalents.
The Iliffe Radio Valve & Transistor Data Book 9th Edition P & P 21p 75p
Characteristics of 3,000 valves and tubes, 4,500 Transistors, Diodes, Rectifiers and Integrated Circuits.
Send for lists of these English publications.

MAKE A REV COUNTER FOR YOUR CAR

The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

£1 each

A CROSS HATCH GENERATOR FOR £3.50 !!!

YES, a complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. This is a project in the September edition of Practical Television.

This complete kit of parts costs £3.50, post paid.

A MUST for Colour T.V. Alignment.

Our famous P1 Pak is still leading in value for money.

Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

Please ask for Pak P1, only 50p
10p P & P on this Pak.

Please send me the FREE Bi-Pre-Pak Catalogue

NAME

ADDRESS

MINIMUM ORDER 50p. CASH WITH ORDER PLEASE. Add 10p post and packing per order. OVERSEAS ADD EXTRA FOR POSTAGE

BI-PRE-PAK LTD DEPT. C, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX, SS0 9DF
TELEPHONE: SOUTHEND (0702) 46344

COMPONENTS

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INDUSTRIAL - BULK OFFERS

JUST A FEW OF OUR BARGAINS ARE LISTED BELOW - PAY US A VISIT OR SEND STAMPED ADDRESSED ENVELOPE FOR A QUOTE ON YOUR REQUIREMENTS

VALVE BASES

Chassis or printed circuit B9A – B7G	3p
Chassis UX7 – B5 – UX5 – B9G	3p
Shrouded chassis B7G – B9A	4p
Octal chassis	4p
B8A chassis	5p
B12A tube base	3p

TAG STRIP

6 way 2p Single 1p

KITS

Plans separate	10p
Wide band signal injector	85p
Car 12V to 0–9V cassette or radio supply	£1.50

$1\frac{1}{4}$ glass fuses— 250 m/a or 3 amp (box of 12)	6p
3″ tape spools	4p
FX2236 Ferrox Cores	5p
PVC or metal clip on M.E.S. bulb holder	3p
All metal equipment Phono plug	2p
Bulgin, 5mm Jack plug and switched socket (pair)	20p
12 volt solenoid and plunger	25p
250 RPM 50 c/s locked frequency miniature mains motor	50p
200 OHM coil, $1\frac{1}{4}$″ long, hollow centre	10p
Relay, P.O. 3000 type, 1,000 OHM coil, 4 pole c/o	60p
R.S. 12 way standard plug and shell	50p

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	10p
6	4	Wafer Rotary	12p each
1	11	Wafer Rotary	12p each
4	3	Wafer Rotary	12p each
3	7	Wafer Rotary	12p each
2	5	Wafer Rotary	12p each
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p
2	1	Toggle	10p

VALVES – NEW AND BOXED

DY86	44p	EM87	90p	PL84	46p
EB91	26p	EL84	36p	PY81	40p
ECC82	36p	EY86	46p	PY82	42p
ECC83	36p	EZ80	30p	PY88	52p
ECH81	44p	PCC84	50p	UABC80	58p
EABC80	46p	PCC89	62p	UCL82	50p
EBF89	44p	PCF80	38p	UL84	50p
ECL82	44p	PCF82	50p	UY85	42p
ECL86	56p	PCL82	38p	UM84	32p
EF80	36p	PCL84	50p	UCH81	44p
EF85	44p	PCL85	64p	6BA6	26p
EF86	44p	PCL86	56p		
EF91	52p	PL36	78p	MANY	
EF183	40p	PL81	72p	OTHERS	
EF184	44p	PL83	56p		

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989

6–14 volt, 6 digit, illuminated, fully enclosed. £2.50

RESISTORS

$\frac{1}{8}$ $\frac{1}{4}$ $\frac{1}{2}$ watt	1p
1 watt	$1\frac{1}{2}$p
Up to 10 watt wire	8p
15 watt wire wound	10p

SKELETON PRESETS

5K or 500K 3p

SAFETY PINS

Standard size, 10 for 4p

THORN PTO2E 10-6s CHASSIS SOCKET 40p

5K switched volume control	15p
5K Log Pot	10p
1meg Tandem Pot	15p

THERMISTORS

VA1055
VA1066 10p each
VA1077

STEEL BOX WITH LID

10 x $5\frac{1}{2}$ x 3″ grey hammer finish £1

RELAY

6 volt, 2 pole c/o heavy duty contacts 50p

ELECTROLYTICS

Mullard C426, TCC, CRL, CCL, HUNTS, STC SUB MINIATURE, ETC.

MFD	Volt	
16	50	5p each
260	12	5p each
50	50	5p each
100	18	5p each
125	10	5p each
8	50	5p each
12	20	5p each
10	20	5p each
8.2	20	5p each
50	25	5p each
2.5	64	5p each
25	25	5p each

MFD	Volt	
20	12	4p each
500	6	4p each
100	25	4p each
100	6	2p each
6	3	2p each
8	6	2p each
25	6.4	3p
250	18	7p
400	16	6p
400	40	10p
8	500	9p
100	200	10p

CONDENSERS

MFD	Volt		
0.005	500		2p each
0.001	1,250		2p each
3.3PF	500		2p each
500 PF	500		2p each
2,200PF	500		2p each
3,300PF	500		2p each
0.1	350		3p each
0.1	500		3p each
0.25	150		3p each
0.056	350V	5%	3p each
0.061	350V	5%	3p each
0.066	350V	5%	3p each
0.069	350V	5%	3p each
0.075	350V	5%	3p each
0.08	350V	5%	3p each
0.1	1,500		4p each
0.25	350		4p each
0.5	350		5p
0.22	250		5p
0.25	500		5p

TUNING GANG

100PF, 50PF, 33PF
20p each

TRIMMERS

30PF Beehive
12PF P.T.F.E.
2,500PF 750V
33PF MIN.
AIR SPACE
10p each

1MFD 350 volt	10p
5MFD 150 volt	40p
10MFD 150 volt	50p
0.03 12 volt	2p
470PF 500 volt	2p
8MFD 800 volt electrolytic	75p

WIREWOUND POTS

250, 300 OHM, 1K, 4 watt, 10K, 20K, 50K, all at 10p each

RECORD PLAYER CARTRIDGE

ER.5XME Mono, with turn over stylii, single hole fixing 35p

GREEN INDICATOR

Takes M.E.S bulb 10p

CONNECTOR STRIP

Belling Lee L1469, 12 way polythene. 5p each

CAN CLIPS

1″ or $1\frac{3}{8}$″ or $\frac{3}{4}$″ 2p

T.O.5 HEATSINKS

Style 154 high conductivity 5p

PAXOLINE

$2\frac{3}{8}$ x $4\frac{3}{4}$ x $\frac{1}{16}$″ or 3 x $2\frac{1}{2}$ x $\frac{1}{16}$″	2p
$4\frac{5}{8}$ x $\frac{1}{2}$ x $\frac{1}{8}$″,	2 for 1p
220K 3 watt resistors	2p
VALVE RETAINER CLIP, adjustable	2p

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type 20p

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 8 p.m. Monday to Saturday Phone 01-223 5016

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE

LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE INSURANCE, ETC

THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

Cut these 3 pages out and keep for reference

BRAND NEW FULLY GUARANTEED DEVICES

AC 107	20p	AD 149	50p	BC 143	30p	BD 131	50p	BF 179	30p	C 444	35p	2G 301	19p
AC 113	20p	AD 161	33p	BC 145	45p	BD 132	60p	BF 180	30p	C 450	22p	2G 302	19p
AC 115	23p	AD 162	33p	BC 147	10p	BD 133	65p	BF 181	30p	MAT 100	19p	2G 303	19p
AC 117K	20p	AD 161 and		BC 148	10p	BD 135	40p	BF 182	40p	MAT 101	20p	2G 304	24p
AC 122	12p	AD 162(MP)	55p	BC 149	12p	BD 136	40p	BF 183	40p	MAT 120	19p	2G 306	40p
AC 125	17p	ADT 140	50p	BC 150	18p	BD 137	45p	BF 184	25p	MAT 121	20p	2G 308	35p
AC 126	17p	AF 114	24p	BC 151	20p	BD 138	50p	BF 185	30p	MPF 102	42p	2G 309	35p
AC 127	17p	AF 115	24p	BC 152	17p	BD 139	55p	BF 188	40p	MPF 104	37p	2G 339	20p
AC 128	17p	AF 116	24p	BC 153	28p	BD 140	60p	BF 194	12p	MPF 105	37p	2G 339A	16p
AC 132	14p	AF 117	24p	BC 154	30p	BD 155	80p	BF 195	12p	OC 19	35p	2G 344	18p
AC 134	14p	AF 118	35p	BC 157	18p	BD 175	60p	BF 196	14p	OC 20	63p	2G 345	16p
AC 137	14p	AF 124	30p	BC 158	12p	BD 176	60p	BF 197	14p	OC 22	38p	2G 371	16p
AC 141	14p	AF 125	25p	BC 159	12p	BD 177	65p	BF 200	45p	OC 23	42p	2G 371B	12p
AC 141K	17p	AF 126	28p	BC 160	45p	BD 178	65p	BF 222	95p	OC 24	56p	2G 373	17p
AC 142	14p	AF 127	28p	BC 161	50p	BD 179	70p	BF 257	45p	OC 25	38p	2G 374	17p
AC 142K	17p	AF 139	30p	BC 167	12p	BD 180	70p	BF 258	60p	OC 26	25p	2G 377	30p
AC 151	15p	AF 178	50p	BC 168	12p	BD 185	65p	BF 259	85p	OC 28	50p	2G 378	16p
AC 154	20p	AF 179	50p	BC 169	12p	BD 186	65p	BF 262	55p	OC 29	50p	2G 381	16p
AC 155	20p	AF 180	50p	BC 170	12p	BD 187	70p	BF 263	55p	OC 35	42p	2G 382	16p
AC 156	20p	AF 181	45p	BC 171	14p	BD 188	70p	BF 270	35p	OC 36	50p	2G 401	30p
AC 157	24p	AF 186	45p	BC 172	14p	BD 189	75p	BF 271	30p	OC 41	20p	2G 414	30p
AC 165	20p	AF 239	37p	BC 173	14p	BD 190	75p	BF 272	80p	OC 42	24p	2G 417	25p
AC 166	20p	AL 102	65p	BC 174	14p	BD 195	85p	BF 273	35p	OC 44	15p	2N 388	35p
AC 167	20p	AL 103	65p	BC 175	22p	BD 196	85p	BF 274	35p	OC 45	12p	2N 388A	55p
AC 168	24p	ASY 26	25p	BC 177	19p	BD 197	90p	BFW 10	60p	OC 70	10p	2N 404	20p
AC 169	14p	ASY 27	30p	BC 178	19p	BD 198	90p	BFX 29	27p	OC 71	10p	2N 404A	28p
AC 176	20p	ASY 28	25p	BC 179	19p	BD 199	95p	BFX 84	22p	OC 72	14p	2N 524	42p
AC 177	24p	ASY 29	25p	BC 180	24p	BD 200	95p	BFX 85	30p	OC 74	14p	2N 527	49p
AC 178	28p	ASY 50	25p	BC 181	24p	BD 205	80p	BFX 86	22p	OC 75	15p	2N 598	42p
AC 179	28p	ASY 51	25p	BC 182	10p	BD 206	80p	BFX 87	24p	OC 76	15p	2N 599	45p
AC 180	17p	ASY 52	25p	BC 182L	10p	BD 207	95p	BFX 88	22p	OC 77	25p	2N 696	12p
AC 180K	20p	ASY 54	25p	BC 183	10p	BD 208	95p	BFY 50	20p	OC 81	15p	2N 697	13p
AC 181	17p	ASY 55	25p	BC 183L	10p	BDY 20	£1.00	BFY 51	20p	OC 81D	15p	2N 698	24p
AC 181K	20p	ASY 56	25p	BC 184	12p	BF 115	24p	BFY 52	20p	OC 82	15p	2N 699	35p
AC 187	22p	ASY 57	25p	BC 184L	12p	BF 117	45p	BFY 53	17p	OC 82D	15p	2N 706	8p
AC 187K	20p	ASY 58	25p	BC 186	28p	BF 118	70p	BPX 25	85p	OC 83	20p	2N 706A	9p
AC 188	22p	ASZ 21	40p	BC 187	28p	BF 119	70p	BSX 19	15p	OC 84	20p	2N 708	12p
AC 188K	20p	BC 107	9p	BC 207	11p	BF 121	45p	BSX 20	15p	OC 139	20p	2N 711	30p
ACY 17	25p	BC 108	9p	BC 208	11p	BF 123	50p	BSY 25	15p	OC 140	20p	2N 717	35p
ACY 18	20p	BC 109	10p	BC 209	12p	BF 125	45p	BSY 26	15p	OC 169	25p	2N 718	24p
ACY 19	20p	BC 113	10p	BC 212L	11p	BF 127	50p	BSY 27	15p	OC 170	25p	2N 718A	50p
ACY 20	20p	BC 114	15p	BC 213L	11p	BF 152	55p	BSY 28	15p	OC 171	25p	2N 726	28p
ACY 21	20p	BC 115	15p	BC 214L	14p	BF 153	45p	BSY 29	15p	OC 200	25p	2N 727	28p
ACY 22	16p	BC 116	15p	BC 225	25p	BF 154	45p	BSY 38	18p	OC 201	28p	2N 743	20p
ACY 27	18p	BC 117	15p	BC 226	35p	BF 155	70p	BSY 39	18p	OC 202	28p	2N 744	20p
ACY 28	19p	BC 118	10p	BCY 30	24p	BF 156	48p	BSY 40	28p	OC 203	25p	2N 914	14p
ACY 29	35p	BC 119	30p	BCY 31	26p	BF 157	55p	BSY 41	28p	OC 204	25p	2N 918	30p
ACY 30	28p	BC 120	80p	BCY 32	30p	BF 158	55p	BSY 95	12p	OC 205	35p	2N 929	21p
ACY 31	28p	BC 125	12p	BCY 33	22p	BF 159	60p	BSY 95A	12p	OC 309	40p	2N 930	21p
ACY 34	21p	BC 126	18p	BCY 34	25p	BF 160	40p	Bu 105	£2.00	P 346A	20p	2N 1131	20p
ACY 35	21p	BC 132	12p	BCY 70	14p	BF 162	40p	C 111E	50p	P 397	42p	2N 1132	22p
ACY 36	28p	BC 134	18p	BCY 71	18p	BF 163	40p	C 400	30p	OCP 71	43p	2N 1302	14p
ACY 40	17p	BC 135	12p	BCY 72	14p	BF 164	40p	C 407	25p	ORP 12	43p	2N 1303	14p
ACY 41	18p	BC 136	15p	BCZ 10	20p	BF 165	40p	C 424	20p	ORP 60	40p	2N 1304	17p
ACY 44	35p	BC 137	15p	BCZ 11	25p	BF 167	22p	C 425	50p	ORP 61	40p	2N 1305	17p
AD 130	38p	BC 139	40p	BCZ 12	25p	BF 173	22p	C 426	35p	ST 140	12p	2N 1306	21p
AD 140	48p	BC 140	30p	BD 121	60p	BF 176	35p	C 428	20p	ST 141	17p	2N 1307	21p
AD 142	48p	BC 141	30p	BD 123	65p	BF 177	35p	C 441	30p	TIS 43	30p	2N 1308	23p
AD 143	38p	BC 142	30p	BD 124	60p	BF 178	30p	C 442	30p	UT 46	27p	2N 1309	23p

2N 1613	20p	2N 2926(R)	10p	2N 3906	27p
2N 1711	20p	2N 2926(B)	10p	2N 4058	12p
2N 1889	32p	2N 3010	70p	2N 4059	10p
2N 1890	45p	2N 3011	14p	2N 4060	12p
2N 1893	37p	2N 3053	17p	2N 4061	12p
2N 2147	72p	2N 3054	46p	2N 4062	12p
2N 2148	57p	2N 3055	50p	2N 4284	17p
2N 2160	60p	2N 3391	14p	2N 4285	17p
2N 2192	35p	2N 3391A	16p	2N 4286	17p
2N 2193	35p	2N 3392	14p	2N 4287	17p
2N 2194	35p	2N 3395	14p	2N 4288	17p
2N 2217	22p	2N 3394	14p	2N 4289	17p
2N 2218	20p	2N 3395	17p	2N 4290	17p
2N 2219	20p	2N 3402	21p	2N 4291	17p
2N 2220	22p	2N 3403	21p	2N 4292	17p
2N 2221	20p	2N 3404	28p	2N 4293	17p
2N 2222	20p	2N 3405	42p	2N 5172	12p
2N 2368	17p	2N 3414	15p	2N 5457	32p
2N 2369	14p	2N 3415	15p	2N 5458	32p
2N 2369A	14p	2N 3416	28p	2N 5459	40p
2N 2411	24p	2N 3417	28p	2S 301	50p
2N 2412	24p	2N 3525	75p	2S 302A	42p
2N 2646	47p	2N 3646	9p	2S 302	42p
2N 2711	21p	2N 3702	10p	2S 303	55p
2N 2712	21p	2N 3703	10p	2S 304	70p
2N 2714	21p	2N 3704	11p	2S 305	84p
2N 2904	17p	2N 3705	10p	2S 306	84p
2N 2904A	21p	2N 3706	9p	2S 307	84p
2N 2905	21p	2N 3707	11p	2S 321	56p
2N 2905A	21p	2N 3708	7p	2S 322	42p
2N 2906	15p	2N 3709	9p	2S 322A	42p
2N 2906A	18p	2N 3710	9p	2S 323	56p
2N 2907	20p	2N 3711	9p	2S 324	70p
2N 2907A	22p	2N 3819	28p	2S 325	70p
2N 2923	14p	2N 3820	50p	2S 326	70p
2N 2924	14p	2N 3821	35p	2S 327	70p
2N 2925	14p	2N 3823	28p	2S 701	42p
2N 2926(G)	12p	2N 3903	28p	40361	40p
2N 2926(Y)	11p	2N 3904	30p	40362	45p
2N 2926(O)	10p	2N 3905	28p		

DIODES & RECTIFIERS

AA 119	8p	BY 130	16p	OA 47	7p
AA 120	8p	BY 133	21p	OA 70	7p
AA 129	8p	BY 164	50p	OA 79	7p
AAY 30	9p	BYX 38.30	42p	OA 81	7p
AAZ 13	10p	BYZ 10	35p	OA 85	9p
BA 100	10p	BYZ 11	30p	OA 90	6p
BA 116	21p	BYZ 12	30p	OA 91	6p
BA 126	22p	BYZ 13	25p	OA 95	7p
BA 148	14p	BYZ 16	40p	OA 200	6p
BA 154	12p	BYZ 17	35p	OA 202	7p
BA 155	14p	BYZ 18	35p	SD 10	5p
BA 156	13p	BYZ 19	28p	SD 19	5p
BY 100	15p	CG 62		IN 34	7p
BY 101	12p	(Eq) OA 91	5p	IN 34A	7p
BY 105	17p	CG 651 (Eq)		IN 914	6p
BY 114	12p	OA 70–OA79	6p	IN 916	6p
BY 126	14p	OA 5	35p	IN 414B	6p
BY 127	15p	OA SSL	21p	IS 021	10p
BY 128	15p	OA 10	35p	IS 951	6p

NEW COMPONENT PAK BARGAINS

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C 2	200	Capacitors mixed values approx. count by weight	0.50
C 3	50	Precision Resistors .1%, .01% mixed values	0.50
C 4	75	⅛th W Resistors mixed preferred values	0.50
C 5	5	Pieces assorted Ferrite Rods	0.50
C 6	2	Tuning Gangs, MW/LW VHF	0.50
C 7	1	Pack Wire 50 meters assorted colours	0.50
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C 9	3	Micro Switches	0.50
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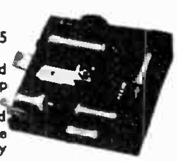

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Each kit contains two amplifier modules, 3 Watts RMS, two loudspeakers, 15 OHMS, The pre-amplifier, transformer, power supply module, front panel and other accessories as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

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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	1.86
800	0.10	0.17	0.11	0.25	0.37	0.55	2.00
1000	0.11	0.25	0.14	0.30	0.46	0.63	2.50
1200	—	0.33	—	0.38	0.57	0.75	—

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VBOM	2A TO-1 £p	6A TO-66 £p	10A TO-88 £p
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T6	8	2G344B	OC44
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All 50p each pak

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UIC05	12 × 7405	50p	UIC53	12 × 7453	50p	UIC94	5 × 7494	50p
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UIC07	8 × 7407	50p	UIC60	12 × 7460	50p	UIC96	5 × 7496	50p
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UIC30	12 × 7430	50p	UIC74	8 × 7474	50p	UIC151	5 × 74151	50p
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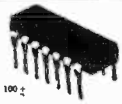

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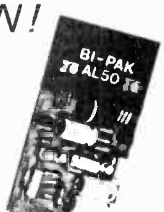

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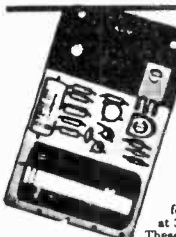

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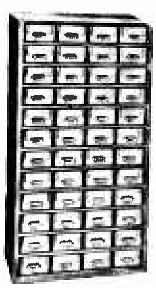

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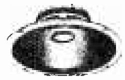

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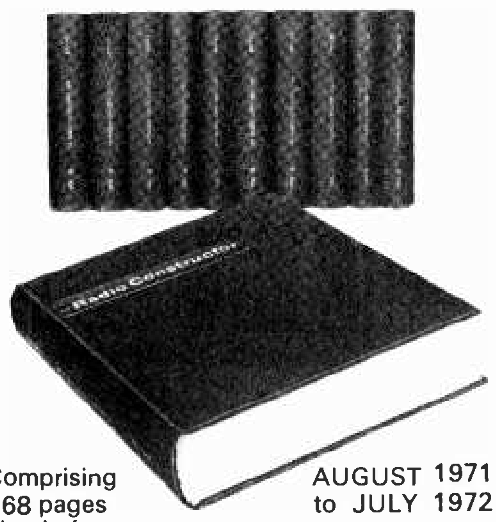

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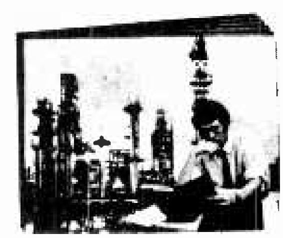

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FEBRUARY ISSUE WILL BE PUBLISHED ON FEBRUARY 1st.

COMPREHENSIVE TRANSISTOR ANALYSER

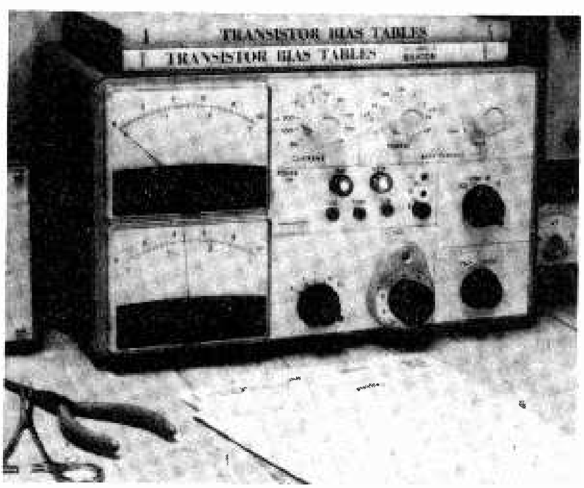
Part 1

by

H. T. Kitchen

This article, the first of a 2-part series, describes the circuit and functioning of an instrument which is capable of a very wide range of transistor tests. Constructional details will be given in the concluding article, to be published next month.

OF THE MANY PARAMETERS SURROUNDING A TRANSISTOR, the static parameters are possibly the most used ones from the amateur's point of view. They are certainly easier to measure to a high degree of accuracy than the dynamic parameters.



The completed transistor analyser, ready for use

The purpose of the instrument about to be described is to enable a wide variety of bipolar transistors to be analysed over a wide current and voltage range. The description which follows assumes that the reader has a working knowledge of transistor theory and techniques, and is familiar with current transistor parameter notation.

PARAMETERS

Of the static parameters, again possibly those most used are h_{FE}, I_B, I_C, I_{CBO}, and I_{CEO}.

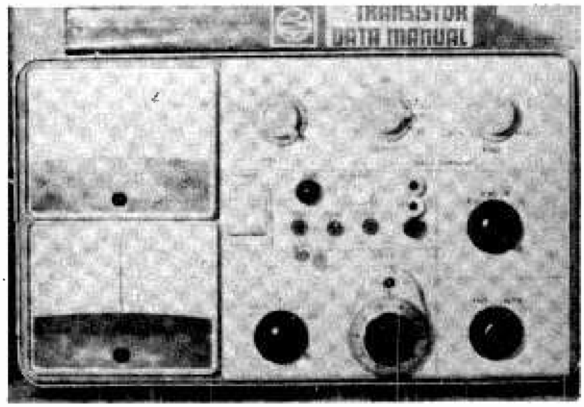
The first parameter, h_{FE} indicates the static value of the short-circuit forward current transfer ratio or, more simply, the d.c. current gain, and is derived from I_C divided by I_B. It is measured at known values of I_C and V_{CE}. Fig. 1(a) shows the basic circuit used for measuring h_{FE}.

The parameter I_{CBO} indicates the collector to base cut-off current with the emitter completely open-circuit. In good low power germanium devices I_{CBO} should not exceed some tens or a few hundreds of microamps. Fig. 1(b) shows the basic circuit used for its measurement. I_{CBO} can be measured at any magnitude of V_{CE} *within the ratings of the device under analysis*. It is customary, however, to measure I_{CBO} at a condition which approximates closely to actual working conditions.

The next parameter, I_{CEO} indicates the collector to emitter cut-off current with the base completely open-circuit. Fig. 1(c) shows the basic measuring circuit. As with I_{CBO} a good low power germanium device should show a leakage current in the tens or a few hundreds of microamps. Good low power silicon devices should, as with I_{CBO}, not exceed a few nanoamps (10^{-9}A). I_{CEO} can be measured at any magnitude of V_{CE} *within the ratings of the device under analysis*. However, as with I_{CBO}, V_{CE} should be selected to approximate closely to actual working conditions.

The collector current, I_C, required by different transistors can vary by a very wide ratio, approaching if not exceeding 10^4:1. If we consider the very low current silicon devices, collector currents of only a few microamps are not uncommon, particularly in the early stages of multi-stage high gain amplifiers. At the opposite extreme collector currents of several amps are often found.

Since h_{FE} is a function of I_C divided by basecurrent, I_B, it follows that I_B will also vary by a wide ratio, though this is somewhat less than the I_C ratio.



Checking small n.p.n. transistors. Collector voltage is 5 volts and collector current is 20mA

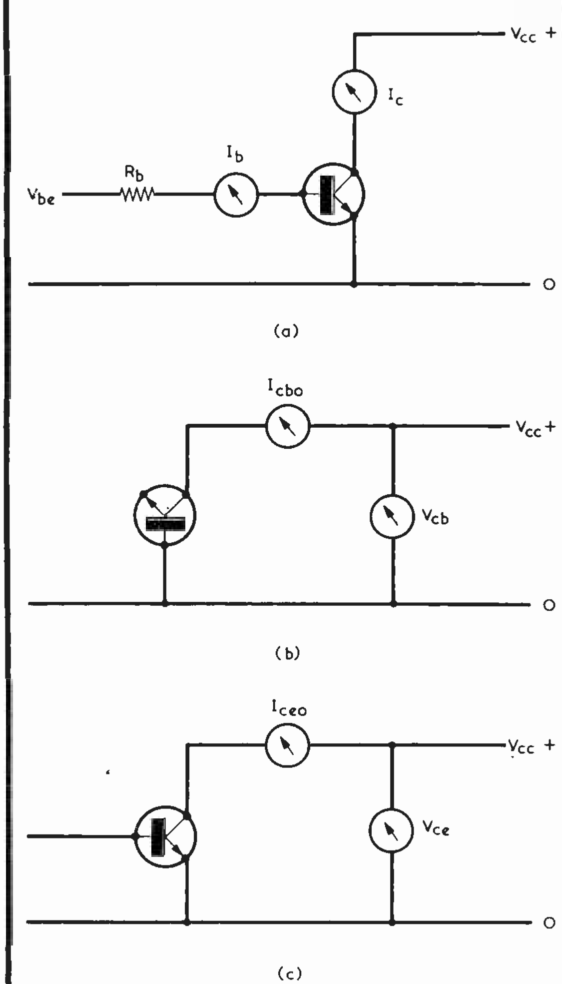


Fig. 1. Test connections for measuring (a) h_{FE}, (b) I_{CBO} and (c) I_{CEO}

Having discussed the most important static parameters individually, we can now discuss them generally a little further, and in doing so arrive at the specification of a wide range analyser. Of primary interest are V_{CE}, I_C and I_B. The function h_{FE} follows from I_C and I_B, and I_{CBO} and I_{CEO} are dependent upon V_{CE} primarily. The variations of I_{CBO} and I_{CEO} with temperature would not normally concern us here. Readers who have an interest in the variations of I_{CBO} and I_{CEO} with temperature can, nevertheless, use the 'outboard' sockets of the instrument to be described. The device being examined may then be placed in a suitably heated box or container and charts showing variation in performance against temperature can be drawn.

In order to analyse a device as fully as possible, the measuring instrument must be capable of reproducing working conditions as closely as possible and over as wide a range as possible. It is at this junction that simpler testers can prove an embarrassment, since their limited, usually fixed, facilities do not permit the requisite variations. Measurements made outside the desired parameters can therefore prove meaningless when viewed in the context of the desired parameters.

A very careful assessment of manufacturers' literature showed that nearly all requirements could be fully met by an instrument that provided the following ranges.

1. V_{CE}: continuously variable from 0 to 24V.
2. I_C: continuously variable from 0 to 1A max. at the above V_{CE}.
3. I_B: independent of 1 and 2, and variable from 0 to 30mA.
4. I_{CBO} measurable at 0 to 24V and 1A maximum.
5. I_{CEO}: measurable as for 4.

These parameters are applicable to bipolar transistors only, whether germanium or silicon. One must however doubt the usefulness of a transistor having an I_{CBO} or I_{CEO} of 1A!

The instrument that forms the basis of this article adequately meets all these requirements. Additionally, diodes can be checked for forward conduction and reverse leakage currents at varying reverse voltages up to the 24V maximum. Zener diodes can be checked for zener voltage and current up to the maximum limits of 24V and 1A. Capacitors can also be checked for leakage currents up to the maximum limits of 24V and 1A. Again, as with I_{CBO} and I_{CEO}, one must doubt the usefulness of a capacitor having a leakage current of 1A.

THE ANALYSER CIRCUIT

The circuit of the analyser is shown in Fig. 2. Though apparently complex, it is fairly simple when considered as a number of separate measuring circuits.

Meter M1 is the current meter, and is used for measuring I_C, I_B, I_{CBO} and I_{CEO}. It has a basic sensitivity of 50μA f.s.d. and is scaled to 0–3 and 0–10. Switch S1 switches in any one of a number of shunt resistors, R1–R9, thereby decreasing meter sensitivity in steps of 1–3–10, etc., up to a maximum rating of 1A f.s.d. Diode D1, in parallel with the meter, affords it a measure of protection in the event of an excessive overload.

Meter M2 is the voltmeter, and is used to measure V_{CE} only. It is identical to M1 in respect of specification. Multiplier resistors R10–R14, selected by S2, enable the meter to indicate voltages from 300mV to 30V, again in the 1–3–10 sequence. D2 is the overload protection diode for this meter.

COMPONENTS

Resistors

(All fixed values 5% ½ watt high-stability unless otherwise stated. See text for alternative values for R1 to R14.)

R1	2.4kΩ
R2	480Ω
R3	126Ω
R4	40Ω
R5	12.1Ω
R6	4Ω
R7	1.2Ω wire-wound
R8	0.4Ω wire-wound
R9	0.12Ω wire-wound
R10	3.6kΩ
R11	17.6kΩ
R12	57.6kΩ
R13	200kΩ
R14	600kΩ
R15	330Ω
R16	680Ω
R17	2.2kΩ
R18	6.8kΩ
R19	22kΩ
R20	68kΩ
R21	220kΩ
R22	680kΩ
R23	2.2MΩ
R24	56Ω
R25	390Ω 1 watt
R26	3.9kΩ
R27	330Ω
R28	270Ω
R29	1.5kΩ*
R30	3.3kΩ
VR1	2.5kΩ 10-turn 'Helipot' (see text)
VR2	10kΩ potentiometer, wire-wound
VR3	250Ω preset potentiometer, miniature skeleton

*R29 may require adjustment in setting-up.

Capacitors

C1	500μF electrolytic, 40 V.Wkg. (in can with mounting clamp)
C2	500μF electrolytic, 25 V.Wkg., wire-ended
C3	100μF electrolytic, 15 V.Wkg., wire-ended
C4	100μF electrolytic, 25 V.Wkg., wire-ended
C5	25μF electrolytic, 25 V.Wkg., wire-ended
C6	8μF electrolytic, 15 V.Wkg., wire-ended
C7	25μF electrolytic, 25 V.Wkg., wire-ended

Transformers

T1	Mains transformer, secondary 26V at 1.6A (see text)
T2	Mains transformer, secondary 9–0–9V at 80mA, Osmor type MT9
T3	Mains transformer, secondary 9–0–9V at 80mA, Osmor type MT9

Semiconductors

TR1	BC107
TR2	BC107
TR3	2N3053
TR4	2N3055†
TR5	2N3053
D1	1N4001
D2–D4	1N914
D5–D16	1N4002
D17	1N748A (or similar 3.9V 5% 400mW zener diode)

†With mica washer and insulating bushes.

Meters

M1, M2 0–50μA, scaled 0–3 and 0–10, British Physical Laboratories type S30V (see text)

Switches

(See text for details of S1 to S5)

S1	2-pole 10-way rotary
S2	1-pole 5-way, rotary
S3	7-pole 3-way, rotary
S4	5-pole 4-way, rotary
S5	1-pole 10-way, rotary
S6	2-pole on-off, rocker type (Arrow Switches) or toggle

Lamps

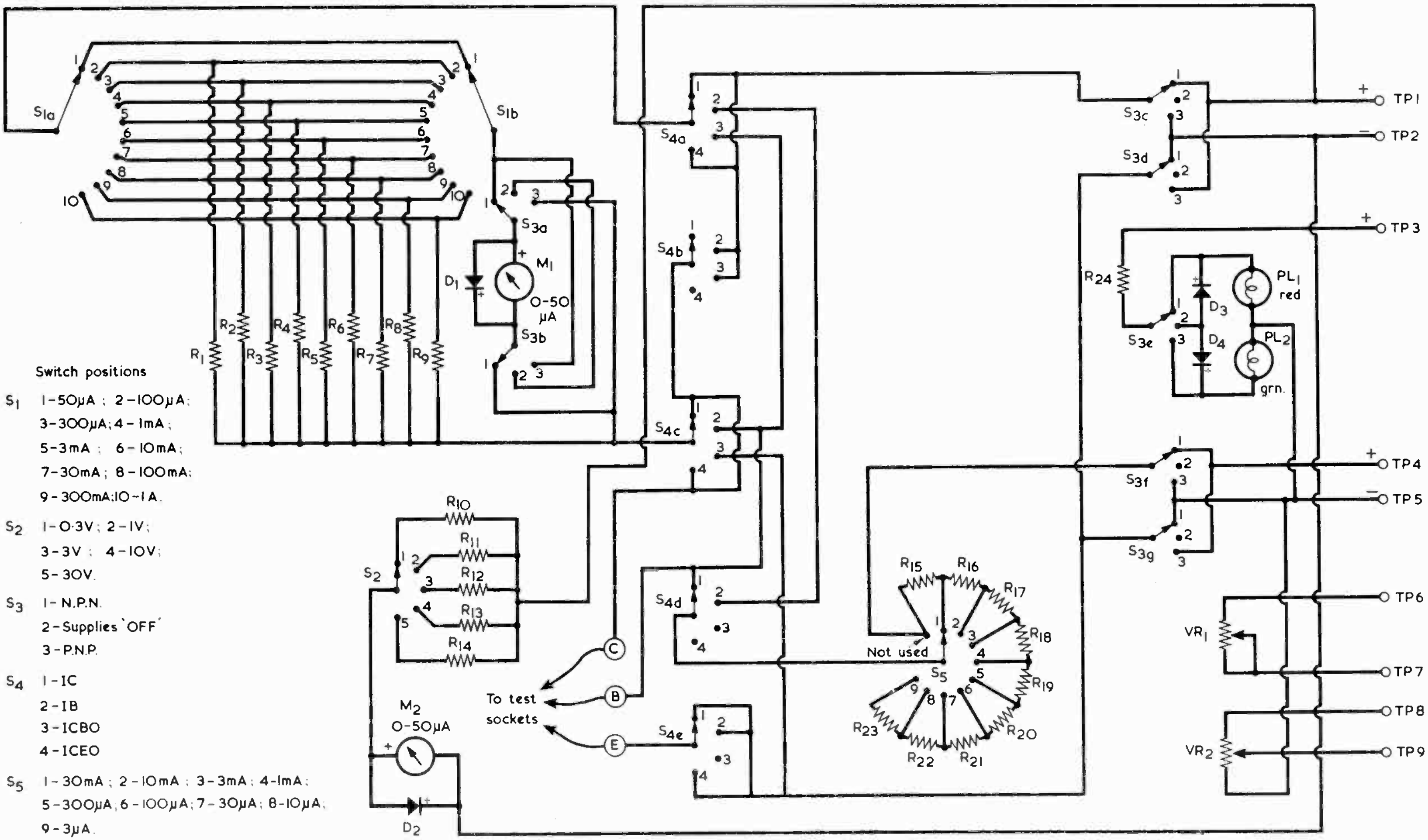
PL1, PL2 24V 1 watt l.e.s. bulbs (see text)

Sockets, etc.

3	Transistor sockets (see text)
1	Panel-mounting lampholder with red lens, for PL1
1	Panel-mounting lampholder with green lens, for PL2
3	3mm. test sockets, colours as required

Miscellaneous

2 heat sinks type H2 (Henry's Radio)
3 pieces plain Veroboard (without copper strips) 0.15in. matrix, 2¾ × 2½in. (see text)
Knobs, colour and style as required.
Veroboard pins, miniature turret tags (see text)
1 instrument case, Type Y, 12 × 7 × 7in. (H. L. Smith & Co. Ltd.)
12-way tagstrip
3 ferrite beads, Cat. No. FR4A (Home Radio)



Switch positions

S_1 1-50μA ; 2-100μA; 3-300μA; 4-1mA; 5-3mA ; 6-10mA; 7-30mA; 8-100mA; 9-300mA; 10-1A.

S_2 1-0·3V; 2-1V; 3-3V ; 4-10V; 5-30V.

S_3 1-N.P.N. 2-Supplies 'OFF' 3-P.N.P.

S_4 1-IC 2-IB 3-ICBO 4-ICEO

S_5 1-30mA ; 2-10mA ; 3-3mA ; 4-1mA ; 5-300μA; 6-100μA; 7-30μA; 8-10μA; 9-3μA.

Fig. 2. The circuit of the transistor analyser

S3 is the polarity switch, and its purpose is to provide the correct V_{CC} and V_{BE} for n.p.n. and p.n.p. devices. This it performs by means of switch sections S3(c) and S3(d) for V_{CC} and switch sections S3(f) and S3(g) for V_{BE}. At the same time, switch sections S3(a) and S3(b) reverse the polarity of meter M1 so that it always reads correctly irrespective of the polarity of V_{CC}.

During initial design work, much thought was given to indicating the polarity of V_{CC}, since damage can be caused to a device by supplying it with a reversed V_{CC}. This function is performed by S3(e), which selects one of a pair of red and green indicator lamps, red for a positive supply (collector to emitter) for n.p.n. devices, and green for a negative supply (collector to emitter) for p.n.p. devices. R24 limits the current flowing in the lamps to prevent the appropriate mains transformer being overloaded when the base bias drawn is at maximum.

The two diodes D3 and D4 are current steering diodes. In either the n.p.n. or the p.n.p. position, current can flow through PL1 or PL2. The two diodes, though linking the lamps together, are 'back to back' and therefore one of them will be reverse biased. Insufficient current to light the other lamp will therefore flow through the reverse biased diode. In the central position of S3(e), however, both diodes are forward biased, and therefore both lamps will be illuminated. The switching sequence is therefore: n.p.n. – red lamp illuminated only; OFF – green and red lamps illuminated together; p.n.p. – green lamp illuminated only. A very adequate warning is in consequence presented to the operator of the state of the supplies at all times.

The central position of S3, during which both lamps are illuminated, is the 'Off' position. In the 'Off' position, all supplies to the analyser circuit are disconnected, *even though the mains-derived power is still switched on*. This enables the device under test to be safely connected to and disconnected from the analyser circuit.

S4 is the function switch, enabling I_C, I_B, I_{CBO} and I_{CEO} to be selected as required. In order to illustrate the circuit operation of this switch more clearly, let us consider position 1, the 'I_C' position. Contact 1 of S4(a) is connected to the wiper of S3(c) and thereby to V_{CC}. The wiper of S4(a) is connected to the wiper of S1(a) and thence, by way of the shunt circuit, to the wiper of S1(b). The wiper of S1(b) passes to position 1 of S3(a) and to position 3 of S3(b) (thus forming the familiar 'crossover' switch) and from there connects to the wiper of S4(c). Position 1 of S4(c) connects to the collector test terminal. Continuity is therefore provided from V_{CC} via the shunt circuitry and meter M1 to the collector test terminal, and this will enable the collector current of the transistor being checked to be measured. Simultaneously, S4(d) connects the base test terminal to the wiper of S5. S5 is the coarse base current control, VR2 being the fine base current control. VR1 controls V_{CC} which is monitored by M2. We can now, by means of VR1, set V_{CC} to any desired magnitude. By means of S5 and VR2 we can control the base current and thereby the collector current which is, of course, monitored by M1. I_C is now known.

S4 is next switched to position 2, the 'I_B' position. Again, we can follow the circuit through. S5 wiper is now connected to position 2 of S4(d), and from there to position 2 of S4(a). The circuit continues from the wiper of S4(a), via S1(a) and (b), S3(a) and (b) and meter M1, to S4(c) wiper, and from there, via its position 2, to the base terminal. Continuity is therefore maintained for base current, but this time it is monitored by M1. Simultaneously, the collector is returned, via S4(b) to V_{CC}, so maintaining I_C. I_B is now known also, and so h_{FE} can be computed by dividing I_C by I_B.

S4(e) returns the emitter circuit to the supply in positions 1, 2 and 4, thus fulfilling the circuit requirements for I_C, I_B and I_{CEO}. In position 3, it open-circuits the emitter circuit in order to correspond to the I_{CBO} requirements. If, as with the prototype, an R.S. Components (formerly Radiospares) 'Makaswitch' is used, a 3-pole 4-way wafer should be used for S4(e), the separate sections being wired in parallel to reduce contact resistance.

The two switching sequences so far described can be seen to compare very closely with the basic circuit of Fig. 1(a), except that a single meter is switched for I_C and I_B, instead of the two separate meters shown.

Similarly, positions 3 and 4 of S4 can be followed through. On position 4 the circuit is the same as that of Fig. 1(c) with the base open-circuit. On position 3 the emitter is open-circuit, as in Fig. 1(b), but the current indicating meter, M1, is inserted between the base test terminal and the lower supply line, instead of between the collector test terminal and the upper supply line. With this configuration the meter still gives the same reading as it would if connected as in Fig. 1(b).

In all the explanatory circuits, n.p.n. transistors are shown. Clearly, p.n.p. devices can be substituted by merely reversing V_{CC}. This is mentioned merely to reassure readers who may be 100% p.n.p. orientated.

Ideally, separate meters should be used to monitor I_C and I_B simultaneously, since switching a meter into the I_B circuit could affect the I_C reading to a small degree. This is because the resistance of the meter alone, or shunted by a resistor, is a finite proportion of the series base resistance. However, the magnitude of error so caused is very small, and can safely be disregarded for all normal applications.

It will be noted the V_{CE} is measured by M2 directly across the supply input, so corresponding to V_{CC}, rather than across the collector and emitter test terminals. There are two reasons for this. Firstly, a separate polarity reversing switch is not required as in the case of M1. Secondly, at very low levels of I_C, the current required by M2 would be comparable to, or even greater than, the I_C actually drawn by the transistor. Considerable errors in the readings displayed by M1 and M2 would then result. With the present system of measurement, the difference in the prototype between V_{CC} and V_{CE} on the 50μA range is only 130mV (meter resistance of 2600Ω times meter current of 50μA), a fraction of the V_{CC} that can almost certainly be safely disregarded.

POWER SUPPLIES

The power supply section is shown in Fig. 3. The main, or V_{CC}, supply is a conventional stabilised power supply, and comprises transformers T1 and T2 and all the components in their secondary circuits. Such a supply, though somewhat complex, is necessary in order to meet all the requirements for V_{CC} and I_C outlined earlier. VR1, shown in Fig. 2 for completeness though it is really part of Fig. 3, comprises the output voltage control. VR3 is set, during the setting-up operations (to be described next month) for a zero volt output when VR1 is at minimum resistance.

The base bias supply, appearing at TP4 and TP5, was originally a simple potential divider. Although adequate at low current levels, the control afforded was coarse at moderate current levels and virtually unusable at high

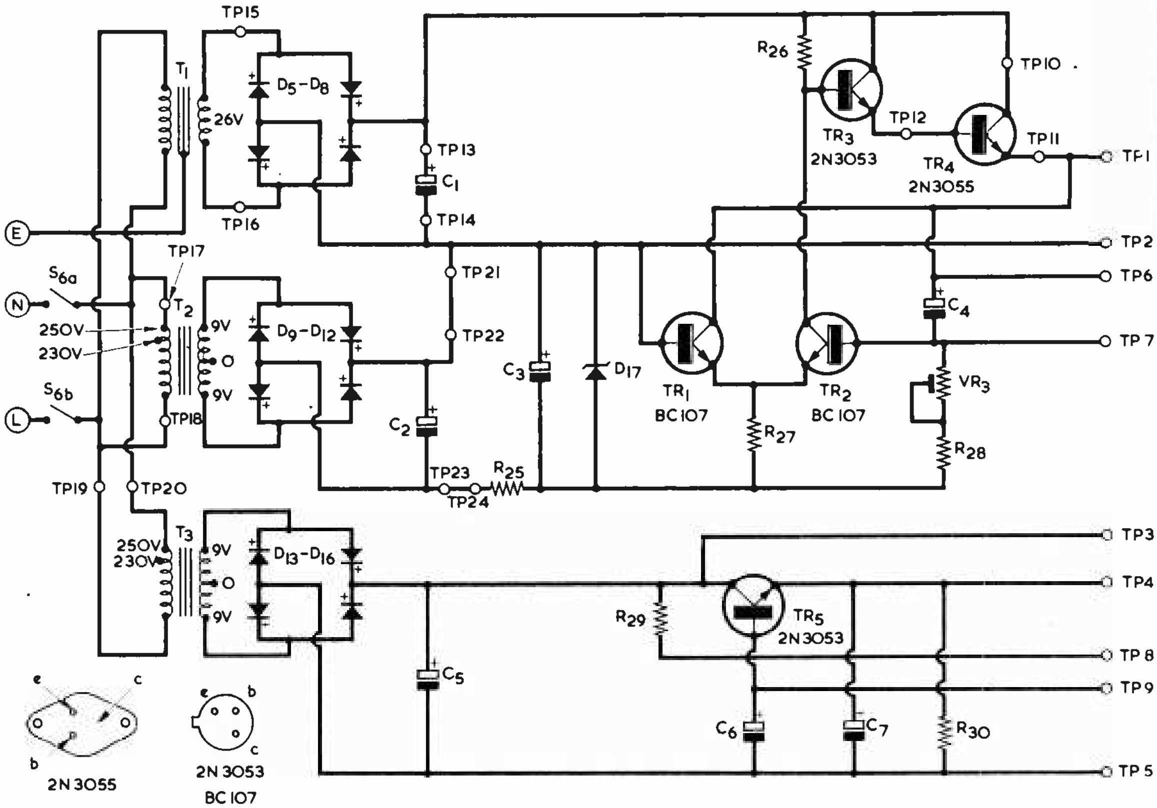


Fig. 3. Power supply section of the analyser

current levels. Experiments with an emitter follower showed the way, and the circuit now used has proved very acceptable. VR2, again shown in Fig. 2 for completeness, provides an output voltage at the emitter of TR5 that is infinitely variable between the limits of 0V and 10V, at a maximum current rating of 30mA. R29 is selected for the 10V limit, and will be dependent upon the hFE of TR5. VR2 therefore acts as a fine current control. In order to facilitate the setting of any current value required, a coarse current control is also incorporated. This is given by S5, which permits base currents between 3μA and 30mA to flow in an approximate 1–3–10 sequence, utilising the series connected resistors R15 to R23. The lowest resistance value of 330Ω, R15, allows a nominal 30mA to flow, assuming the emitter of TR5 is 10V above earth potential. By the end of the resistance chain, a total resistance of some 3.3MΩ permits a nominal 3μA to flow. With VR2 slider at the bottom end of its track, only a very small leakage current should flow through TR5, permitting base bias currents below 1μA to be easily set.

COMPONENTS

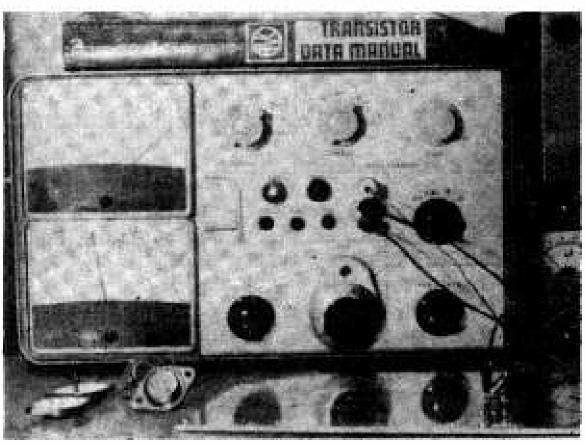
When it came to the components, there was only one maxim which the author bore in mind: This was to be a measuring instrument, and as such must incorporate the best components that could be afforded.

Some of the components require special mention, the most important of these being the two meters, M1 and M2. Those used in the prototype were made by British Physical Laboratories and are Type S30V. Unfortunately, readers may experience difficulty in obtaining these, as British Physical Laboratories do not supply to individuals. However, the R.S. Components panel meter type MR32S is an almost exact equivalent, with an f.s.d. of 50μA and an internal resistance of 2,400Ω, and can be used instead of the B.P.L. instrument. The R.S. Components meter may be obtained from Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN, or from Celectron-E, P.O. Box No. 1, Llantwit Major, Glamorgan, CF6 9YN.

Constructors may alternatively, of course, employ two of the lower-cost 0–50μA panel-mounting meters which are advertised by the large mail-order houses, since these will still perform the basic function of measurement. A further economy could be effected by using a less sensitive instrument in the M2 position, and this could have an f.s.d. as high as 1mA, if desired. An alternative meter for M1 will require different values in the shunt resistors R1 to R9, and a meter having a different f.s.d. in the M2 position will need different values in the multiplier resistors R10 to R14. It is assumed that the constructor will be capable of calculating the new values that are necessary. Different meters will, also, probably not have a 0–3 scale and the constructor may prefer, in consequence, to use a 1–2.5–10 sequence for voltage and current readings as this would enable the readings given to be more accurately evaluated.

The variable resistor employed for VR1 in the prototype instrument was a 10–turn 'Helipot' component, an added luxury being a turns counting dial. A unit of this nature can sometimes be picked up relatively cheaply by careful study of advertisements in the radio press. The 'Helipot' gives a really smooth control of voltage but it is not of course essential, and any standard 2.5kΩ wire-wound potentiometer may be used in its place.

Switches S1 to S5 may all be wafer types, and can conveniently consist of R.S. Components 'Maka-Switch' miniature switch kits made up as required. The parts for these kits can be obtained from a wide range of retailers including both Henry's Radio and Home Radio, and the wafers available are 1-pole 12-way (two required for S1 and one for S5) 2-pole 6-way (for S2), 4-pole 3-way (two required for S3) and 3-pole 4-way (three required for S4). All these wafers may be of the 'Break-Before-Make' type. It must be pointed out that these switches are rated at 300mA at 50 volts whereas, in the present design, some of the contacts are required to carry 1A. It has already been mentioned that S4(e) may consist of 3 poles wired in parallel in order to keep contact resistance low. Other switches through which currents up to 1A can flow are S3(c), S3(d), S4(a), S4(b), S4(c), and S1(a). In the latter case the current flows only when S1(a) is at position 10. No trouble was experienced with the prototype due to the fact that the switch contacts are overrun on occasion, and it has to be remembered that the voltages involved are considerably lower than the 50 volts of the contact rating and also that only a small proportion of work will normally be carried out at the higher currents. Readers who feel seriously that it would be preferable to run within, or close to, the contact specification could set a maximum collector test current in the instrument of 300mA or, say, 500mA. This restriction would cause only a very small loss in the overall usefulness of the instrument. Alternatively, if wafer switches specified for 1 amp at low voltages can be obtained these may be employed instead.



Testing a batch of OC35's. The collector voltage is 12 volts and collector current is 1 amp. Note the heat sink for the transistors being checked

Three mains transformers were used for the prototype because these were to hand. The MT9 transformers specified for TR2 and TR3 are available from many retailers, including Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE. The 26 V transformer employed for T1 in the prototype was a Belclere type X6705 but any other transformer offering about the same voltage and current may be employed instead. A suitable component would be Douglas type MT3 (Home Radio Cat. No. TMM1) which has a tapped secondary offering, amongst other voltages, 24 V at 2 amps. This would cause a slight reduction in the rectified voltage available.

The transistors used in the power supply section are freely available from many nationally advertised sources. Of these, only TR4 deserves special mention. The stabilizer is of the series variety and TR4 is the device across which the unwanted voltage is lost, and as such it can under some conditions dissipate appreciable power. The provision of an adequate heat sink is therefore essential. In the prototype this transistor is mounted on the rear wall of the cabinet, and as the latter is of 16 s.w.g. aluminium with a large surface area, its heat dissipating properties are quite adequate. Even though prolonged testing of power transistors may not be initially envisaged it is a very good plan to provide an adequate heat sink for, otherwise, after the instrument is complete (and memory gone dim) such testing may be undertaken to the detriment of TR4. TR4 is, incidentally, insulated from the cabinet surface by the usual mica washer and insulating bushes.

It will be noted that three transistor holders are included in the Components List. These are fitted to the front panel and are used as sockets for transistors under test. They should be capable of accepting TO5/TO18, TO1 and TO92 transistors respectively.

Further parts required are three plain Veroboard panels of 0.15in. matrix, each measuring 2$\frac{3}{4}$ by 2$\frac{1}{2}$in. These are pierced Veroboard panels without copper strips. Also listed are Veroboard pins and miniature turret tags. The reader should see the further details to be given in Part 2 before obtaining these parts.

Pilot lamps PL1 and PL2 were 24V 1 watt l.e.s. bulbs fitted in Bulgin lampholders type D675/1, one having a red lens and the other a green lens. L.E.S. bulbs rated at 24V 1 watt are obtainable from Home Radio under Cat. No. PL7B. If the Bulgin lampholder cannot be obtained an alternative is listed by Henry's Radio.

Both TR3 and TR5 are fitted with small clip-on heat sinks. These transistors are in a TO5 can, and a suitable heat sink is the type H2 obtainable from Henry's Radio.

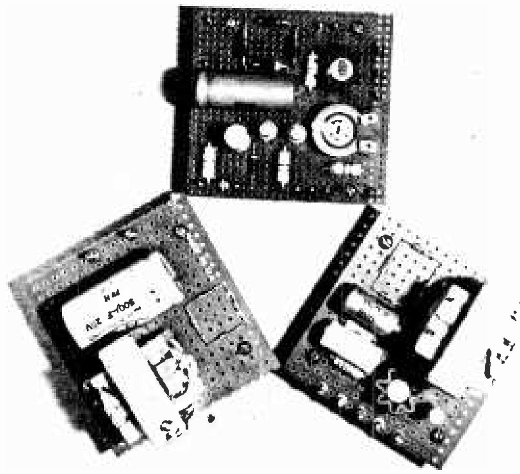
With the exception of R1 to R14 inclusive, all the fixed resistors are high-stability 5%, and the use of similar resistors is highly recommended.

The meter shunt resistors R1 to R9 are calculated from the time-honoured formula $Rs = \frac{Rm}{n-1}$ where Rs is the value of the shunt resistor, Rm is the meter resistance and n the current multiplication factor. The values shown in the Components List are applicable when the R.S. Components meter, with an internal resistance of 2,400Ω, is employed. The value of Rs for the 300μA range is therefore working from the formula, $\frac{2,400}{6-1}$ or 480Ω. If an alternative meter having a different internal resistance is used, the values of the shunt resistors will need to be calculated accordingly. Different shunt resistors will be required if, as has just been discussed, an alternative series of current ranges is to be incorporated.

The voltage multiplier resistors R10 to R14 are similarly based on the use of an R.S. Components 0–50μA meter with internal resistance of 2,400Ω. Here, the total resistance (multiplier plus meter resistance) is equal to $\frac{E}{f.s.d.}$ where E is the voltage to be measured and f.s.d. is the current sensitivity of the meter, (the reader will have recognised Ohm's Law!). For low voltages, where the resistance of the meter is a significant fraction of the total resistance, the meter resistance must be taken into account. Hence, for the 1V range (using the R.S. Components meter) the required value in the multiplier resistor switched in, R11, is $\frac{1V}{50\mu A}$ minus the resistance of the meter, which works out at 20,000 minus 2,400, or 17,600Ω. For optimum accuracy in practice the resistance of the meter must always be allowed for until it drops to some 1% to 2% of total resistance, after which it may be ignored. If an alternative meter is employed in the M2 position, the values required in R10 to R14 will need to be revised accordingly.

The practical process of obtaining the requisite shunt and multiplier resistors is dealt with in more detail in the second part of this article and the constructor is advised to consider the further comments given then before obtaining or making up the resistors concerned.

The prototype unit was housed in a cabinet type 'Y' measuring 12in. long by 7in. wide by 7in. deep, which is available from H. L. Smith and Co. Ltd., 287/289 Edgware Road, London, W.2. Here, length refers to the side to side dimension, width to the back to front dimension, and depth to the top to bottom dimension.



As will be described in Part 2, the majority of the Power supply components are fitted on three Veroboard panels. These are shown here before mounting

As will be seen from the accompanying photographs, the choice of suitable knob adds considerably to the appearance of the completed instrument. Here, the constructor is left to select suitable knobs from the wide range available from the component suppliers.

The Components List includes a 12-way tagstrip. None of the tags in this strip are earthed (i.e. none are used as mounting lugs) and it is positioned near the power supply section of the instrument where it assists in maintaining neat wiring. A suitable tagstrip, 3in, long, is available from Henry's Radio.

A final point is that 3 ferrite beads are also quoted in the Components List. As will be explained in Part 2, these are employed occasionally when checking v.h.f. transistors.

(*To be concluded*)

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Valve Stereo Decoder – H. Wilkinson, 116 Moorland Road, Scarborough, Yorks., YO12 7RD – Loan of circuit diagram with description of coils.

Radio Constructor, April 1965 issue – A. J. K. Barron, Hoppetts, Allens Green, Sawbridgeworth, Herts. – To purchase or borrow.

'Sonomag' Tape Recorder – H. L. Hammatt, 42 Park Avenue, Sittingbourne, Kent – circuitry required.

'Treco Scope', made by Range Electronics – S. M. Franklin, 200 City Road, London ECLV 2PH – Any data.

Philips Stereo Receiver 22GH924/15, also Amplifier 22GH923/15 – C. T. Hawker, 6 Brooklyn Gardens, Arle Road, Cheltenham, Glos. – Service sheets wanted.

Ex. Aircraft Receiver, Marconi AD108D – J. Yates, Junction Cottage, Gorsey Lane, Ashton-under-Lyne, Lancs. – Circuit and any conversion to 12V operation data, loan or purchase.

NEWS . . . AND .

EMI's MATT-BACK PROFESSIONAL RECORDING TAPE

Prominent amongst its series of professional audio tapes on show at the 1972 Audio Fair was EMI Tape's matt-back standard play magnetic tape, Emitape 816, which offers extremely low noise and low print-through characteristics. The tape's matt-coated backing gives it high-speed spooling and uniform wind capabilities. The backing also has a reinforcement effect, making the tape less susceptible to edge damage than conventional tapes. Emitape 816 is available in four standard widths – $\frac{1}{4}$", $\frac{1}{2}$", 1" and 2" – for all mono and stereo recording requirements.

The photograph shows Emitape 816 in use at EMI Records' Abbey Road recording studios in north-west London.

DAVIAN AT100B PERFORMS 100% TESTS ON TTL MODULES FOR DECCA NAVIGATOR RECEIVER

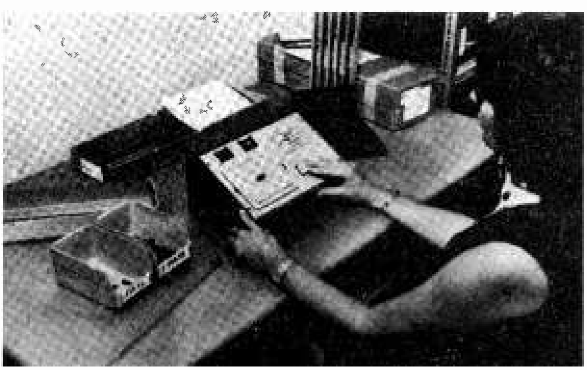
Davian's AT100B Automatic Integrated Circuit Tester plays an important part in maintaining the smooth production flow of solid-state Decca Navigator Mk. 21 Receiver.

These receivers, simple to use and automatic in operation, provide mariners with instant positional fixes at sea to a high degree of accuracy.

All t.t.l. devices used in the Receiver, for example, are thoroughly tested using the Davian AT100B Automatic Integrated Circuit Tester before assembly on to their respective printed circuit boards.

A suitable programme for each i.c. type to be tested is contained in hard-wired form in two small plug-in units. A Family Plug determines the V_{cc} levels, logic signal levels, and maximum clock-rate for the logic family of the device – i.e., TTL DTL etc.; and a Device Plug, tailored to suit the particular i.c. module to be tested, carries the 'ideal' logic equivalent, and determines the interface, loading parameters, and appropriate connections toe the Family Plug and mainframe logic circuits of the instrument. The Device Plug also carries the adaptor socket for the i.c. module under test. The AT100B can, therefore, be rapidly programmed to suit any selected i.c. module.

The Decca Navigator Company Limited carry a range of these programme plugs to suit the various i.c. devices used in the Navigator Receiver units. The Mk. 21 Receiver employs 35 t.t.l devices and is produced at the rate of approximately 180 per month, giving a consumption of 6,300 i.c's per month. Although only about 3% of the i.c. devices are "failed" by the Tester, this represents about 190 faulty devices per month. And it must be remembered that each faulty i.c. device assembled into a main circuit can be difficult to locate and may be responsible for the loss of several valuable man-hours of test and calibration time.



OSCAR IN ORBIT

The amateur radio satellite AMSAT-OSCAR-C which the Radio Amateur Satellite Corporation has been sponsoring, was successfully launched on Sunday, 15th October, last. On launch, it was designated OSCAR 6. It is the first of AMSAT's Communication Satellites to carry an amateur radio translator; signals in the two metre amateur band sent up to it, being translated into ten metre signals for the down-link. This enables a greater number of short-wave listeners and radio amateurs to listen for it, than has been possible with previous amateur radio satellites which had their down-link in the two metre or seventy centimetre bands, as far more listeners are equipped for ten metre reception than for the other two bands. Down-link signals can be heard around 29.5 MHz. OSCAR 6 became audible over Europe shortly after launching. Each orbit takes 1 hr. 55 min., and each orbit is 28.8 degrees west of the previous one. Predictions are available from various sources giving the times of crossings at the equator, and the degrees of longitude of these crossings. From these listeners can work out the most favourable orbits for their own reception facilities. Whilst a beam antenna is best, particularly if it can be elevated as well as turned in a horizontal direction, quite good reception can be had from much more modest aerial arrangements. The writer of this note, for instance, uses a 108 ft. long trapped dipole, running N–S and gets good reception of any orbit between 330 degrees west and 035 degrees west, approximately. One source of suitable predictions is the Radio Society of Great Britain's News Bulletin on 3600 KHz SSB at 0930 hrs. GMT on Sunday mornings. Those who are particularly interested in this project, will find 'Keeping Track of Oscar' by W. Browning, G2AOX, from the RSGB, price 10p in stamps, well worth sending for.

IN YOUR WORKSHOP

In the December issue parts (a) of figs. 8 and 10 were, unfortunately, transposed during printing. We regret the error which will have been apparent to most readers.

. . . COMMENT

IN BRIEF

● AMF Venner's wide-range Oscillator Model TSA 625/2, list price £38, is now in-stock due to the company's recent installation of an advanced electronics assembly and test plant.

● The American 'Foundation For Amateur Radio' organisation provides a central clearing house for information regarding amateur radio activities in the greater Washington, D.C. area.

Special consideration is given to visiting foreign amateurs, and a volunteer staff of linguists is available. Information/Hospitality Committee chairman is Bill Parrott, W4URL, 8548 Georgetown Pike, McLean, Virginia 22101, to whom enquiries should be addressed.

● Alexander Cole Ltd., have recently appointed Future Film Developments of 90 Wardour Street, London, as distributors for their 'Colclene' TF aerosols and lint free cloths to the professional audio market.

● The Institute of Electrical and Radio Engineers are to be associated with the Microwave 73 International Conference and Exhibition to be held in Brighton next June.

● Now available from Coutant Electronics of 3 Trafford Road, Reading ,Berks., is a 12 page technical booklet on their complete range of encapsulated regulators and overvoltage protection units.

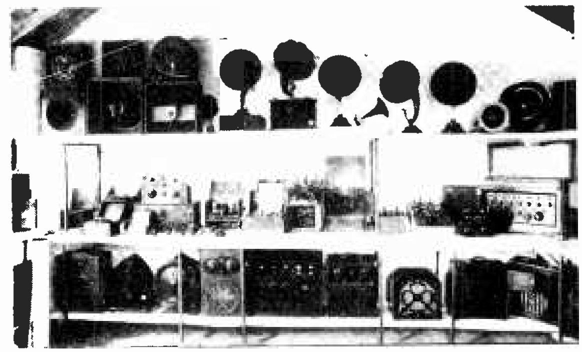
● Goulding Audio Ltd., of Marks Tey, Colchester, Essex, have recently announced the introduction of a new combined 8 Track Stereo Cartridge Player. LW-MW car radio. It measures $7'' \times 2'' \times 6\frac{1}{2}''$ and average installed cost, including speakers, is £67.

● The first independent local radio stations recently announced by the Independent Broadcasting Authority are all to go on the air with Marconi transmitters.

● The Midland National Amateur Radio and Electronics Exhibition, sponsored by the Amateur Radio Retailers Association, at the Granby Halls, Leicester was a successful first venture with an attendance well in excess of 4,000 during the 3 days.

● SDS Components Ltd., of Gunstore Road, Hilsea Trading Estate, Portsmouth, Hants want radio and electronics engineers to experiment with the diverse range of linear integrated circuits manufactured by Signetics. They are offering 5 linear i.c.s. which normally cost £9, for only £5, and are including a data library worth £2.60, free.

● Mr. John Bishop, C.Eng.MIERE, has recently joined GEC-Elliott Process Automation Ltd., as manager of its Telemetry and Supervisory Systems Division at Leicester.



VINTAGE RADIO MUSEUM

Further to the notes in our November issue, we show above a photograph of some of the equipment on display.

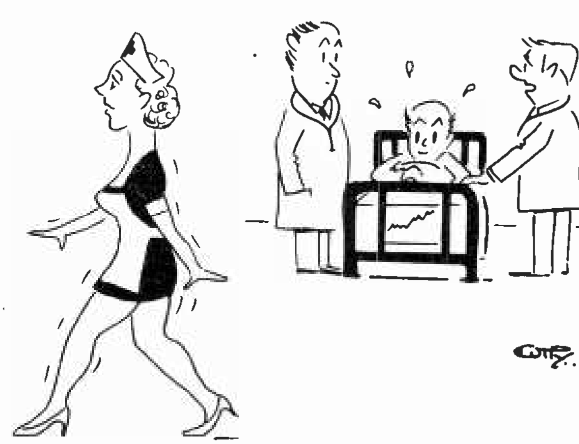
The Hon. Secretary and Curator is Mr. D. Byrne, G3KPO, of Homa House, Quadring Watergate, Spalding (telephone Gosberton 485 or STD 077-584 485), who would like to know of any additions for the museum. Especially wanted are old wireless books, magazines and catalogues, as these help in 'dating' various items of equipment.

AMATEUR RADIO SOCIETY OF IRELAND

The above society was recently incorporated under the provisions of the Companies Act 1963.

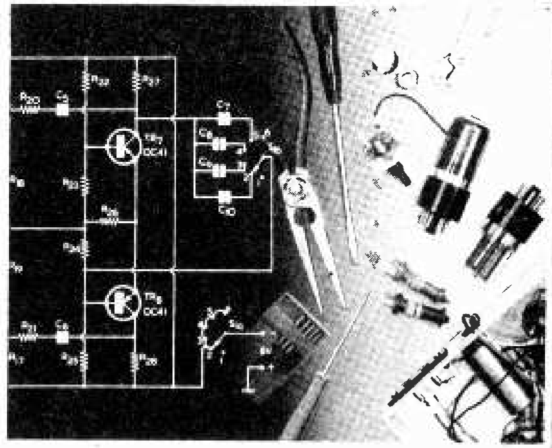
Formed by a number of enthusiasts who have been meeting for the past 2 years, they decided to put their activities on a more popular and business-like footing.

Membership enquiries should be addressed to The Hon. Secretary, c/o POB73, Athlone.



"That pulse generator will have to go!"

SENSITIVE MICROAMMETER



by G. A. FRENCH

IN THE SUGGESTED CIRCUIT WHICH was published last month (Suggested Circuit No. 265, 'Integrated Circuit Voltmeter') a voltmeter was described which had a sensitivity of 200kΩ per volt. This employed an integrated circuit operational amplifier type ML741C in conjunction with a 0–100μA moving-coil meter.

The instrument to be described this month also incorporates an integrated circuit type ML741C and a 0–100μA moving-coil meter, and it consists of a microammeter having three ranges, these being 0–5μA, 0–10μA and 0–20μA. The nominal input resistances on these ranges are 200Ω, 100Ω and 50Ω respectively.

BASIC PRINCIPLES

As with the voltmeter, the microammeter takes advantage of the functioning of an operational amplifier with feedback from the output to the inverting input. The basic feedback is shown in Fig. 1(a), and the overall gain is governed by the relative values of the two resistors RY and RX. Assuming that the source of input voltage has zero internal resistance, voltage gain is equal to RY divided by RX.

To produce a current indicating instrument, we need an output voltage from the op-amp which is proportional to input *current*, and one method of achieving this consists of causing the input current to flow through a resistor so that a corresponding voltage appears across the resistor. This we do in Fig. 1(b), in which the input current flows through the added resistor RZ. The input voltage to the circuit is now the voltage dropped across RZ. It will be seen that, since RZ is now the effective source of the input voltage, its resistance has to be taken into account. The amplification given to the voltage across this resistor is equal to RY divided by the sum of RX and RZ.

The arrangement of Fig. 1(b) is capable, therefore, of functioning as a current reading meter, with the current to be measured passing through RZ. A voltmeter connected across the output of the op-amp will then give readings which are proportional to the current in RZ.

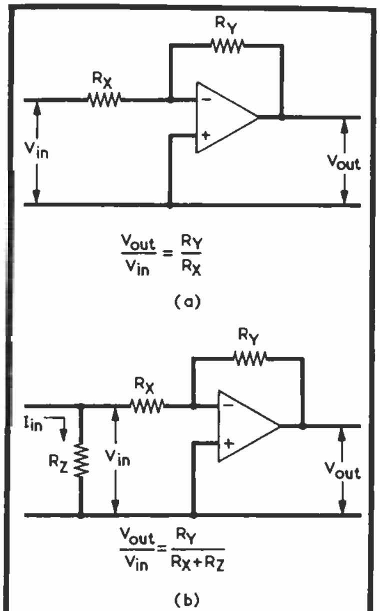


Fig. 1(a). An operational amplifier with voltage feedback
(b). A circuit in which output voltage is proportional to input current

FULL CIRCUIT

The full circuit of a microammeter employing the principle illustrated in Fig. 1(b) is given in Fig. 2. Here, the op-amp is the integrated circuit type ML741C. RY now appears as R5 whilst RX, when range switch S1 is in position 1, appears as R4 and RZ as R1, R2 and R3 in series. When S1 is set to position 2, RX appears as R4 and R1 in series, and RZ appears as R2 and R3 in series. Setting S1 to position 3 causes RX to be represented by R4, R1 and R2 in series, and RZ to be represented by R3 on its own. Since the overall gain offered by the op-amp is given (in Fig. 1(b)) by RY divided by the sum of RX and RZ, the different settings of S1 in Fig. 2 do not alter the voltage amplification ratio offered by the operational amplifier.

The output of the op-amp is passed to the voltmeter given by VR2 and the 0–100μA meter M.1 A measure of meter protection against overload is provided by the two silicon diodes D1 and D2. There is no need to protect the integrated circuit itself from output overloads because, amongst the many merits offered by the 741 i.c., is the fact that its output is short-circuit proof.

A number of complicating requirements have had to be met in the circuit. The value of R4 needs to be considerably higher than those of R1 to R3 or it will otherwise excessively upset the resistance ratio from range to range. A high value in R4 argues a correspondingly high value in R5, as also does a high overall voltage gain. On the other hand, circuit operation becomes impracticable if R5 has too great a value. The overall voltage gain can be kept to a low level by giving the voltmeter at the i.c. output a high sensitivity. Virtually all the commonly

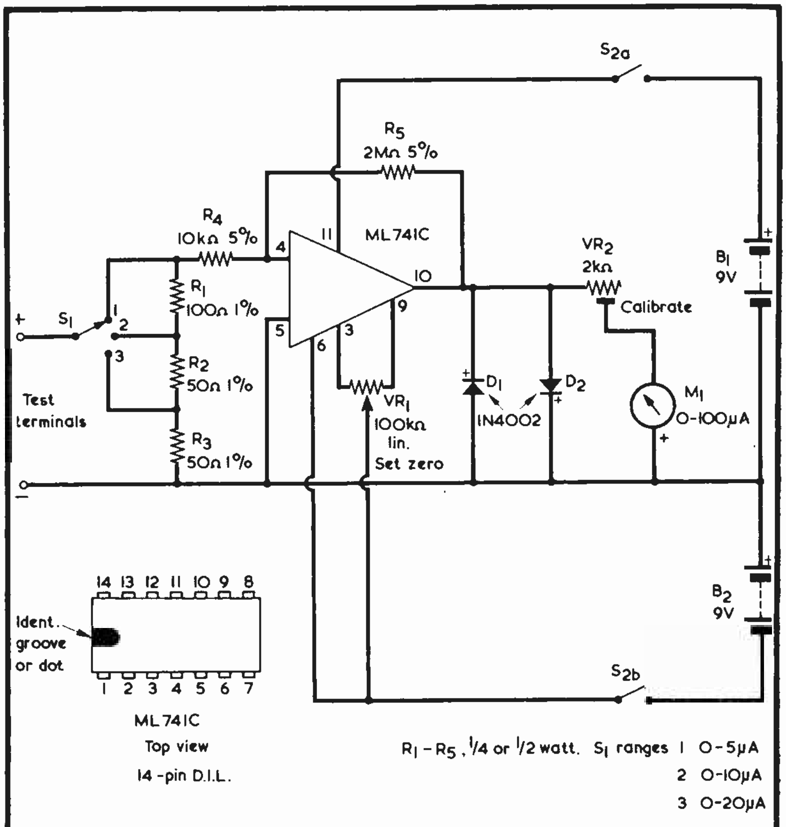


Fig. 2. The circuit of the microammeter which forms the subject of this article

available 0–100μA meters have internal resistances of the order of 1,000 to 1,250Ω, which correspond to voltages across the meter at f.s.d. of 0.1 to 0.125 volt. In the present design it was decided that the meter should give an f.s.d. reading when the output of the op-amp was at a nominal level of 0.2 volt, since this would enable all 0–100μA meters currently obtainable to be employed in the circuit. The highest sensitivity required of the instrument is 0–5μA and it was arbitarily decided to present this range of current with an input load of 200Ω, as occurs when S1 is in position 1. An input current of 5μA in a 200Ω resistor gives a voltage across the resistor of 1mV. So also does 10μA in 100Ω (given when S1 is in position 2) and 20μA in 50Ω (given when S1 is in position 3). Thus, the input voltage corresponding to full-scale input current on each range is 1mV, whereupon the op-amp has to provide a voltage gain of the order of 200 to give a full-scale output voltage of 0.2 volt. This voltage gain is given by making R5 approximately 200 times the value of the sum of R4, R1, R2 and R3. The design parameters are such as to enable R5 to be kept down to 2MΩ, a value which proves to be satisfactory in practice.

A zero set control is provided by VR1, which connects to pins 3 and 9 of the op-amp. These pins couple, inside the op-amp, to two transistor emitters in the input differential amplifier bias circuit, and are specifically intended for the cancelling out of input offset voltage where this is necessary.

A summary of circuit operation may now be given. Before use, the instrument is zeroed by means of VR1. S1 is then set to the range required, whereupon an input current of 5μA on Range 1, 10μA on Range 2 or 20μA on Range 3, causes the appearance of an input voltage of 1mV. The amplifier circuit offers a gain of (approximately) 200 times, resulting in an output of 0.2 volt and full-scale deflection in the 0–100μA meter. Lower values of input current on each range cause correspondingly lower readings in the meter, whereupon the instrument becomes capable of indicating any input current within the range selected by S1.

Whilst it is desirable for R1, R2 and R3 to be close-tolerance components, R4 and R5 may be 5% resistors. This is because the instrument is calibrated with the aid of a known test current, and any discrepancies from their nominal values in R4 and R5 (and hence the voltage amplification provided by the op-amp) are quite simply taken up in the adjustment of VR2.

A final point needs to be mentioned whilst dealing with the theoretical aspects of the circuit. As pin 4 of the op-amp is a virtual earth, R4 is effectively in parallel with R1, R2 and R3. Thus, when switch S1 is set to Range 1 the resistance across which the input voltage is actually built up consists of 200Ω with 10kΩ in parallel. This works out as 196Ω. On Range 2, the resistance is effectively 100Ω with 10,100Ω (R4 plus R1) in parallel, or 99Ω. When Range 3 is selected the resistance becomes 50Ω with 10,150Ω in parallel, or 49.75Ω. These discrepancies are taken up by calibrating on Range 2, whereupon Range 1 reads approximately 1% low, and Range 3 reads approximately 0.5% high. Such figures illustrate that R4 has about the lowest value that can be accommodated in the present design. The fact that the actual input resistances are a little lower than the values of R1, R2 and R3 is readily taken up in the calibration adjustment. If it is possible to select resistors, R1 can have a value which is a little higher, within tolerance, than 100Ω, and R3 can be a resistor which is a little lower, within tolerance, than 50Ω. Such resistors will shift the discrepancies between ranges in the desired directions. As, however, these discrepancies are very small it will be quite adequate, in a low cost instrument of this nature, to employ 1% resistors without selection for R1, R2 and R3, and to simply accept the slight errors inherent in the circuit.

COMPONENTS

The integrated circuit employed in the instrument is a 14-pin dual-in-line device type ML741C. The author obtained this from Henry's Radio, Ltd., who advertise it as a '741C(DIL)'. Other op-amps of the 741 type should function equally well, but the author has only checked the circuit with the particular component purchased from Henry's Radio. Fig. 2 shows the pin layout for the 14-pin version. The 741 i.c. may also be obtained in 8-pin d.i.l., and the pin connections here are shown in Fig. 3. In the 8-pin version, the outside ends of VR1 connect to pins 1 and 5, the positive supply connects to pin 7 and the negative supply connects to pin 4. It is advised that an i.c. holder be employed if the constructor has not previously handled devices of this nature. The i.c. is fitted to the holder after the latter has been wired into circuit.

Diodes D1 and D2 are silicon diodes which restrict the output voltage of the op-amp to about 0.6 volt in either direction. The writer used 1N4002's, but any other small silicon rectifiers would be equally suitable.

It is normally recommended that the offset null potentiometer (VR1) which

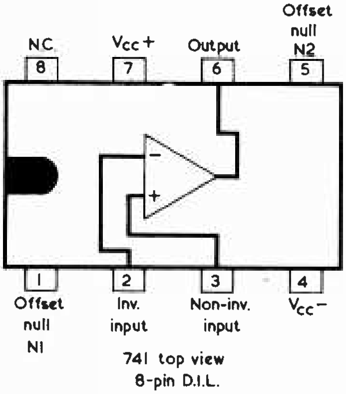


Fig. 3. Connections to the 8-pin d.i.l. version of the 741 op-amp

connects to pins 3 and 9 of a 741 i.c. be a 10kΩ component. The writer used a 100kΩ potentiometer here, however, because he had the subjective impression that this higher value resulted in a less 'fierce' control. Since 100kΩ is higher than the recommended value there is a slight risk that it may not be satisfactory for some 741 i.c's, whereupon a 10kΩ potentiometer will have to be employed instead. Whatever value is employed, the actual potentiometer fitted must be a good quality component, since the zero adjustment is fairly critical and the zero could be difficult to resolve with a potentiometer having poor contact between the slider and the track. A 'moulded-track' potentiometer would represent a good choice. As the zero adjustment is critical, some constructors may prefer to use the 100kΩ potentiometer on a temporary basis only whilst constructing the unit. When the instrument has been completed and the requisite zero position found, this potentiometer may then be replaced by a 20kΩ component and two fixed resistors in series on either side, as in Fig. 4. The values of the two fixed resistors are such that the zero position is approximately at the centre of the travel of the 20kΩ potentiometer. It should be mentioned that the needle of the meter swings hard against the end-stops in either direction when VR1 slider is some distance from the zero setting.

Potentiometer VR2 is a small pre-set variable resistor. A skeleton type would be quite adequate.

A further close tolerance resistor, not shown in Fig. 2, is required for setting-up purposes. This resistor is discussed later.

Switch S1 can be any 3-pole rotary type. S2(a)(b) is a d.p.s.t. toggle switch. Slide switches or rotary switches are *not* recommended for S2(a)(b), as it is desirable for both batteries to be switched on and off at precisely the same time.

The batteries, B1 and B2, may be any small 9-volt type. The current drawn from them is low, and they should have a long life. They should always be fitted when new, and discarded when exhausted, as a pair.

The instrument should not be used with one battery new and one battery partly exhausted.

The components may all be mounted in a small wooden or plastic case with the meter, S1, S2(a)(b), VR1 and the two test terminals on the front panel. Two flexible test leads terminated in prods or clips will also be required.

CALIBRATION AND USE

The instrument is calibrated with the aid of a close-tolerance resistor which passes a current of exactly 10μA when connected to a known voltage. A suitable resistor would be a 500kΩ 1% component, and this resistor will pass 10μA at a voltage of 5 volts.

The calibration set-up is shown in Fig. 5, which assumes that the calibrating resistor is 500kΩ, as just mentioned. Initially VR2 is set up to insert maximum resistance, after which the instrument is switched on, set to Range 2, and the 0–100μA meter zeroed by means of VR1. The potentiometer in Fig. 5 is adjusted to give a reading of 5 volts in the monitoring voltmeter and the instrument test terminals are next connected as shown. VR2 is then adjusted for a full-scale reading in meter M1 with the 5 volt reading in the voltmeter being maintained. The instrument test terminals are next disconnected, the zero setting offered by VR1 confirmed, after which the test terminals are reconnected, giving VR2 any final adjustment which may be needed. The instrument is then set up for use on all three ranges.

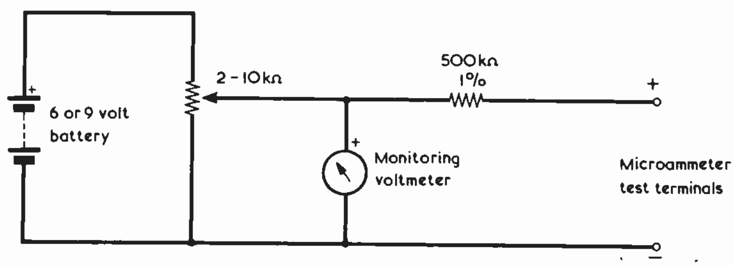


Fig. 5. Calibrating the microammeter

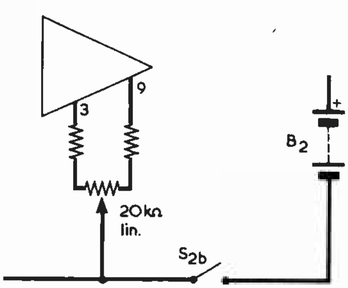


Fig. 4. If desired, VR1 may be replaced by a 20kΩ potentiometer with two fixed resistors in series. The values of the fixed resistors are found by experiment

The meter is easy to use and operates like any other current-reading instrument. It should be remembered that it is extremely sensitive, and that care must be taken not to accidentally apply excessive currents to its test terminals. As mentioned earlier, the zero adjust setting is rather critical. In the prototype there was a slight tendency towards drift of the zero adjustment, but this was not of a serious nature. The current consumption from each 9 volt battery is 1.5mA only. ■

QSX

By
FRANK A. BALDWIN

(All Times GMT)

In any one particular month it is generally the case that any active short wave listener, be he amateur or broadcast band enthusiast, can enter into the log book, or recall, a few items of choice Dx that stand out against the entries of 'usuals'. The writer, of course, is no exception to this asterisk-marked reception list. What can we produce this month? See below.

● HIGHLIGHTS

To commence with we have Godthaab, Greenland on **3999kHz** first heard at 0125 with a talk in Greenlandic (a form of Danish) interspersed with a few bars on a celeste at 0130 and at 0134. At 0136, a two-minute slow moving and mournful tune rendered on a celeste was heard, this being followed by a programme of TV theme music. Sign-off was at 0150, no National Anthem. The celeste tune was, presumably, the interval signal "Sunia Kaligpok" ("The Whaleboat 'Sonja' drags Whale").

On **4744** we have been trying for some evenings past to positively identify a station mainly using the French language and having a decidedly African 'flavour'. This could be Lubumbashi, listed on **4750** but no longer heard on that channel. Reception on **4744** is very difficult to say the least, the channel being occupied most evenings by a teletype transmitter.

On **4763** at 2326, we logged RRI Medan, Indonesia with Arabic-type chants by OM and male chorus and clear station identification at 2330. If conditions are right for reception of this area in the U.K., it will be found that Medan puts in a very good signal around 2330 or so.

Tune to **4832.5** around 2230 and you may log Shenyang, Liaoning (China). We heard it from 2225 onwards, programme in Chinese dialect interspersed with military music. BADX (British Association of Dxers) report this one at 2200 with time pips and identification 'Liaoning jen min kwang po tien tai'.

Set the dial to **3871.5** from around 2000 onwards and you may hear Radio Pakistan. We logged it on this channel and heard a programme of Asian-type music and songs with a clear identification by YL in English at 2044. Sign-off is believed to be at 2130. A warning about this one however, you will require the receiver to be set at the most selective position to even locate the signal if conditions are normal for transmission from this area, a 1.2kHz bandwidth was that used by the writer.

Lastly under this paragraph heading we list another problem. If you can get into the shack slightly before 0400 (perish the thought?) and tune to **4871.5** you may hear a station signing-off with a National Anthem at 0403, we just caught the tail-end of the transmission. Would this be Colombo, Ceylon, listed on **4870**?

● LATIN AMERICA

One of the areas of the world that greatly interest most SWL's is Latin America. Reception of some of the low-powered transmitters has always held a fascination for the writer. The LA's of interest received lately have been –

4755 0331 ZYY3 R. Brasil, Campinas, with LA music and songs, 1 kW (63.09 metres).

4756 0250 ZYF23 R. Dif do Maranhao, Sao Luis, LA songs with identification plus echo-effect, 5kW (63.07m). This one is listed on **4755** but the actual measured frequency was **4756.5**kHz, a feature not uncommon with LA stations.

4765 0255 HJDY R. Catatumbo, Ocana, Colombia, with rousing political harangue in Spanish, complete with cheers from the crowd! 1kW (62.95m).

4770 0146 YVQE R. Bolivar, Cuidad Bolivar, identification and talk in Spanish, 1kW (62.89m).

4805 0223 ZYS8 R. Dif do Amazonas, Manaus, with LA songs and music in typical Brazilian style, 5kW (62.43m).

4825 0112 HIFA Voz de las Fuerzas Armadas, Santo Domingo, with identification followed by guitar solo, 3kW (62.18m).

4827 0325 HJHC R. Narino, Pasto, Colombia, LA music and songs with identification at 0332 as "Radio Narino, Bogata". 1kW (62.15m). This one is listed on **4825**.

4832 0103 TIHB R. Capital, San Jose, Costa Rica, with LA music and identification, 1kW (62.08m).

4865 0121 PRC5 R. Clube do Para, Belem, Brazil, with YL in LA songs, 2kW (61.66m).

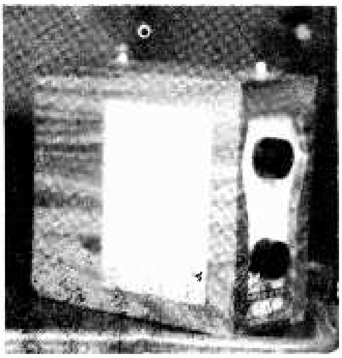
4865 0345 HJLZ La Voz del Cinaruco, Arauca, Colombia, with LA music and identification, 1kW (61.66m).

4875 0231 CP75 La Cruz del Sur, La Paz, Bolivia, with light classical music after identification, 10kW (61.53m).

4905 0314 HJAH Emisora Atlantico, Barranquila, Colombia, with light orchestral music and identification with echo-effect, 1kW (61.16m).

4975 2135 ZYV9 R. Timbira, Sao Luiz, Brazil, with 'futebol' commentary, 5kW (60.30m).

5010 0259 HIMI R. Cristal, Santo Domingo, Dominican Republic, LA music and identification, 1kW (59.88m). ■



REFLEX TRANSISTOR V.H.F. PORTABLE

by

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

Incorporating the author's 'Spontaflex' reflex circuit, this receiver provides both a.m. and f.m. reception from 40 to 110MHz. Battery consumption is low and the circuit employs commercially available plug-in coils.

THIS RECEIVER WILL GIVE GOOD loudspeaker results from signals in that part of the v.h.f. band which lies between 40 and 110MHz. It will receive f.m. signals from Radio 2, 3 and 4, and from local f.m. stations, and a.m. sound from BBC1 on television channels 1 to 5 inclusive. Other fixed and mobile signals can be picked up in addition, whether a.m. or f.m.

The circuit used is based on that employed in the 'Spontaflex' F.M. Portable, Mk. II, published in February 1972,* but the present set is much smaller than that receiver – it measures about 7¼ by 6¾ by 3¼in. – and covers a much wider frequency band.

CIRCUIT OPERATION

As the functioning of the various parts of the circuit has been described in detail previously, it will now suffice to refer briefly to Fig. 1. TR1 is a common base radio frequency amplifier. TR2 is the 'Spontaflex' amplifier offering current gain at signal frequency, detection, and then audio amplification in the common base mode. With f.m. signals the circuit is held in a gently oscillating condition whereupon sychronous detection takes place. For a.m. signals the circuit is held just short of the oscillating condition. Oscillation takes place in the Colpitts configuration, C5 providing the necessary capacitance tap. Control is obtained by varying the collector load of TR2 (and at the same time, the base bias of TR1). VR1, a log control connected so that resistance decreases and reaction increases as it is turned in an anti-clockwise direction, is employed in conjunction with VR2, and it provides a very smooth control. At the minimum volume end of the rotation of VR1 (in which condition the slider is at the upper end of its track as shown in Fig. 1) capacitor C2 presents virtually zero impedance to the collector of TR2. At the other end of the track, R5 prevents too low a value of resistance being in circuit.

TR1 functions again as an audio signal current amplifier, and there then follows common emitter amplification by TR3. TR4 and TR5 both have their bias set up by the amplitude of the incoming signal, as a result of which this Class A circuit gives the economy of its Class B cousin. About 300mW output power is available.

Some treble cut is needed. This is provided by C9. Constructors may vary the capacitance of this component to suit their taste.

Separate batteries are provided for the tuner section and the amplifier. Less than 1mA is taken from the 9 volt PP3 battery which will therefore maintain its voltage for a long time. It should be replaced as soon as the signal starts to wander a few minutes after switching on. The two large No. 800 batteries which feed TR4 and TR5 will also have a long life. These batteries are of the twin-cell cycle lamp type.

The coils are Denco Miniature Dual-Purpose, Blue, plug-in coils of the type intended for valve usage. In the present design they operate at frequencies higher than those quoted in the manufacturer's literature. Approximate coverage is as follows: Range 7, 110 to 79MHz; Range 6, 79 to 53MHz; Range 5, 55 to 40MHz. These coils may be obtained directly from Denco (Clacton) Ltd., 355-359 Old Road, Clacton-on-Sea, Essex, if difficulty is experienced in buying them locally.

Whilst dealing with the circuit, several further points need to be made. No connection is made to the shield lead-out of either TR1 or TR2. In the output stage, only half the output transformer primary is in circuit. The telescopic aerial employed by the author is an Eagle type TA632. This is a 10 section swivel-based aerial, having an extended length of 31½ins.

*Sir Douglas Hall, 'Mark II Modifications for the "Spontaflex" F.M. Receiver', *The Radio Constructor*, February 1972; also 'The "Spontaflex" F.M. Portable Receiver', *The Radio Constructor*, June 1969.

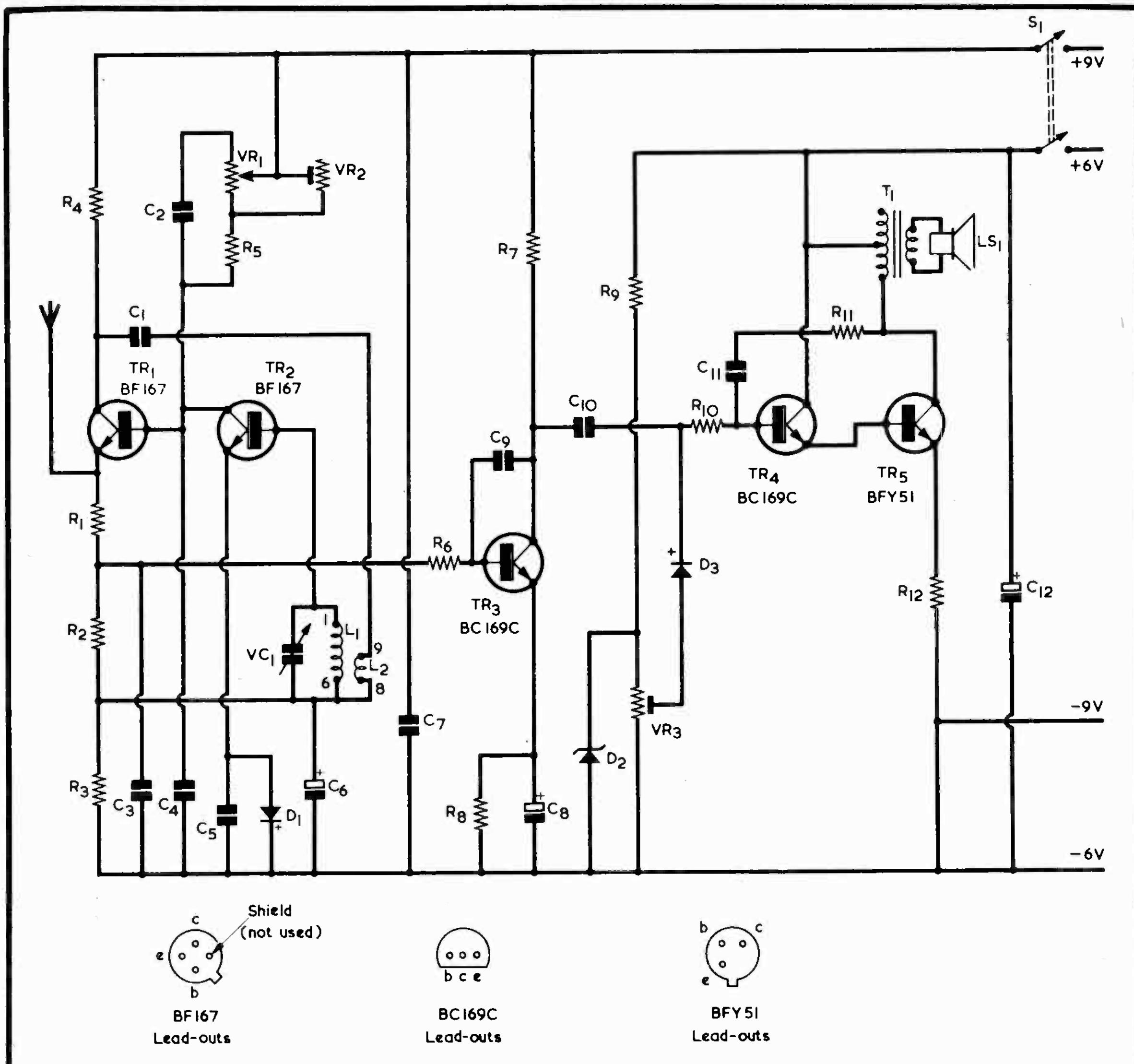


Fig. 1. The circuit of the v.h.f. portable

and a closed length of 6ins. It is obtainable from many retailers, including G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2. It is important that VR1 be a moulded track component and a suitable type is available from Home Radio under Cat. No. VR18B. VR2 is a miniature skeleton pre-set potentiometer, whilst VR3 is a standard skeleton pre-set potentiometer. This is not an important distinction, but it makes the mounting of these two components easier. Capacitor C2 is metallised foil, Mullard type C281, and is available from Home Radio under Cat. No. 2EJ23. C3 and C7 are Mullard Miniature Foil type C280 (Home Radio Cat. No. 2EH43). Capacitors C8 to C12 are not so critical with regard to type as are these in the v.h.f. section of the circuit.

D3 is a silicon bias diode, available under that description from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey.

When the receiver is completed, the controls appear at one end of the cabinet and a B9A valveholder and the on-off switch appears at the other end. Whichever coil is in use is plugged into this valveholder.

CONSTRUCTION

Before commencing construction, briefly examine Fig. 3(e) to obtain a general idea of assembly. The speaker body and magnet appear inside the rectangular framework offered by the four pieces of plywood shown here, being held in position by four angle brackets. The components, together with VC1 and VR1, are mounted on the vertical plywood piece to the right. An extension rod for VR1 passes across the speaker area and through a bush in the left hand vertical upright piece. At the same time, an extension rod for VC1 passes to an epicyclic ball drive on the left-hand upright piece. To be fitted later in the speaker area are the two No. 800 batteries and the PP3 battery. Finally, a small platform, on the right, is secured mechanically to VC1. This platform carries the B9A valveholder for the coils, and a slide on-off switch.

Dealing with the construction now in greater detail, turn to Fig. 2. Cut out the four pieces of ¼in. plywood shown in Figs. 2(a) to (d) inclusive. But first make sure that the plywood really is ¼in. thick and that the speaker really measures 6in. by 4in. It is unlikely that the speaker will be too

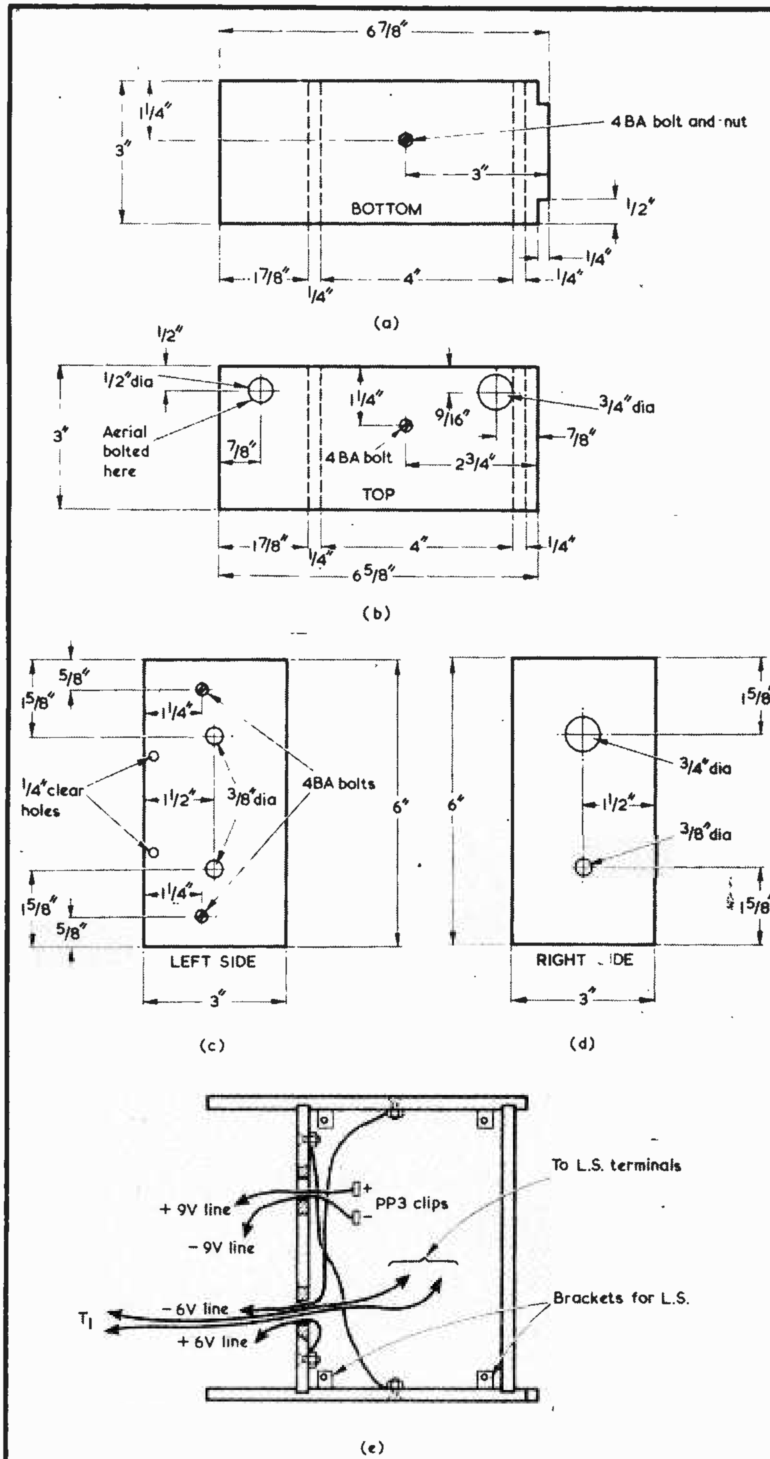


Fig. 2. (a). The bottom of the receiver frame. The material is $\frac{1}{4}$in. plywood
(b). The top of the frame
(c). Rear upright panel. VC1, VR1 and the other components are later fitted to this panel
(d). The forward upright panel
(e). The sections assembled together, showing also wiring to the battery contact screws

deep, or have too large a magnet, but if there is any doubt dimensions should be varied accordingly so that, when the four pieces are assembled as in (e), there will be room in the frame formed for the speaker. The four 4BA bolts in (a), (b) and (c) should be $\frac{3}{8}$in. long with countersunk heads. These are employed for making contact with the terminals of the two No. 800 batteries. The two holes in piece (b) are for the telescopic aerial and for the coil compartment respectively. (Coils are dropped through into an internal trough as will be described later.) The two large holes in Fig. 2(c) are for the bushes of VC1 and VR1, and the two small holes are for leads to the batteries and speaker. The two holes in (d) are for the epicyclic drive for VC1 and for the bush for the extension rod for VR1.

The four pieces are assembled as in Fig. 2(e). In Figs. 2 (a) and (b) the reader is looking at the top sides of both the top and the bottom. In Figs. 2(b) and (c) it is the heads of the 4BA bolts which are towards the reader, and in Fig. 2(a) it is the threaded section of the bolt which is towards the reader. The left hand side of Fig. 2(c) is screwed between the top and the bottom at the points indicated by the dashed lines so that the two $\frac{1}{2}$in. holes are away from the reader. The right hand side of Fig. 2(d) is fitted so that the large hole is uppermost. It may be positioned either way round, as it is symmetrical about its vertical centre line. The assembly of Fig. 2(e) corresponds to that of Fig. 3(e) viewed from the other side.

When the assembly of Fig. 2(e) has been completed the speaker should be mounted by means of small brackets. The front of the speaker should be set back a fraction to allow a piece of gauze to cover it without protruding beyond the frame. The cone of the speaker is towards the reader. Wiring to the battery contact bolts should be carried out as shown, and the leads taken through the appropriate holes to the speaker and to connector clips for the PP3 battery.

Next refer to Fig. 3. Cut a piece of Paxolin $2\frac{1}{2}$in. by $1\frac{5}{8}$in. and fit the B9A valveholder to it as shown in Figs. 3(a) and (c). The view in Fig. 3(c) is of the opposite side of the Paxolin. The valveholder is a low-loss ceramic or similar printed circuit type without a skirt, and it is fixed by adhesive in the hole cut out for it in the Paxolin.

Turn the assembly through 90° so that it may be viewed edge-on, as in Fig. 3(b). The switch should be nearer the reader (it is omitted in Fig. 3(b) for clarity). Fit two long brass 6BA bolts as shown. The longer bolt passes through the hole already existing in the ceramic base of VC1 and is tightened with two nuts on either side. The nuts should be positioned such that, when the Paxolin panel is parallel with the ceramic base of the capacitor, the tip of the shorter bolt rests on the moving

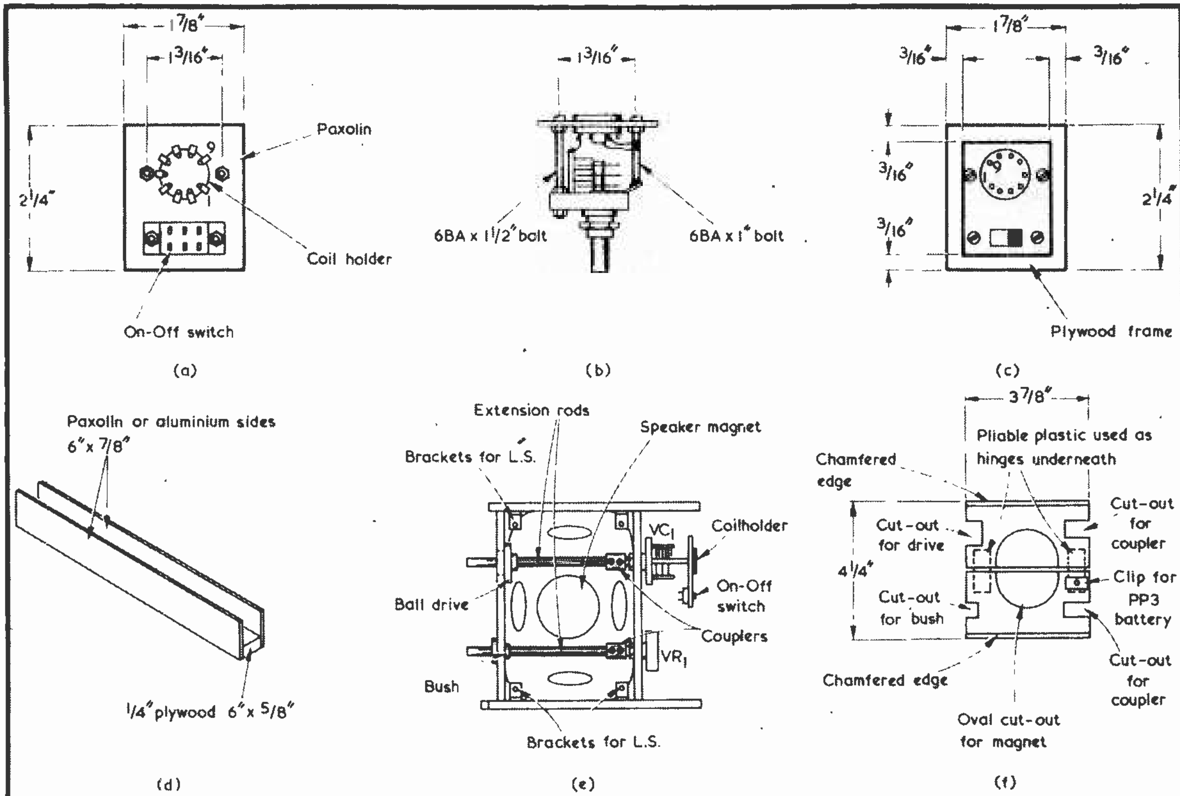


Fig. 3 (a). The platform on which the coil holder and on-off switch are mounted
(b). How the platform is secured to the tuning capacitor
(c). The plywood frame on the platform
(d). The coil trough. This houses coils that are not in use
(e). How VC1 and VR1 are fitted on the rear upright panel
(f). The hinged section which holds the two 3 volt batteries in position

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	390Ω
R2	3.9kΩ
R3	2.2kΩ
R4	2.2kΩ
R5	47kΩ
R6	1kΩ
R7	10kΩ
R8	3.9kΩ
R9	1.8kΩ
R10	100kΩ
R11	220kΩ
R12	4.7Ω
VR1	1MΩ potentiometer, log, moulded track
VR2	1MΩ pre-set potentiometer, miniature skeleton
VR3	5kΩ pre-set potentiometer, skeleton

Capacitors

C1	3pF tubular ceramic
C2	0.47µF metallised foil (Mullard C281)
C3	0.01µF miniature foil (Mullard C280)
C4	470pF tubular ceramic
C5	6pF tubular ceramic
C6	80µF electrolytic, 2.5 V.Wkg.
C7	0.01µF miniature foil (Mullard C280)
C8	80µF electrolytic, 2.5 V.Wkg.
C9	180pF silvered mica (see text)
C10	0.1µF plastic foil
C11	0.01µF plastic foil
C12	1,000µF electrolytic, 6.4 V.Wkg.
VC1	15pF variable, type C804 (Jackson Bros.)

Inductors

L1, L2	Denco Miniature Dual-Purpose coils, valve usage, Blue, Ranges 5, 6 and 7
T1	Output transformer type TT56 (Repanco)

Semiconductors

TR1	BF167
TR2	BF167
TR3	BC169C
TR4	BC169C
TR5	BFY51
D1	OA85
D2	Zener diode, 200mW, 2.7V, 3V or 3.3V
D3	Silicon bias diode

Switch

S1	Double pole slide switch

Speaker

LS1	3Ω speaker, 6 in by 4 in.

Aerial
Telescopic aerial type TA632 (Eagle)

Miscellaneous
B9A valveholder, printed circuit type
Epicyclic drive with flange, type 4511/F (Jackson Bros.)
2 knobs
18-way group board, standard size (R.S. Components)
2 spindle couplers
1 spindle bush
2 extension spindles
1½ in. 6BA brass bolt
1 in. 6BA brass bolt
¼ in. plywood
Paxolin
Fablon or Contact, Perspex, etc., as required

vanes tag of the capacitor. Solder the tip of the shorter bolt to that tag. Finally, make a plywood frame to fit on to the Paxolin panel, as shown in Fig. 3(c), and glue this to the panel.

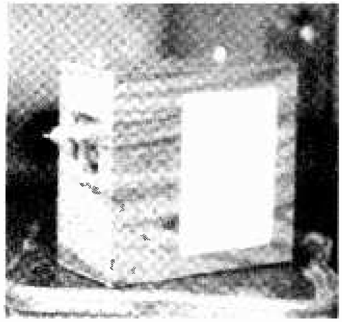
Next, make the trough to hold the coils, this being illustrated in Fig. 3(d).

Turn the main frame of Fig. 2(c) through 180° so that it appears as in Fig. 3(e), with the magnet of the speaker towards the reader. Fit the VC1 assembly in its appropriate hole in the frame as in Fig. 3(e) and fit VR1 in its hole. On the other upright of the frame fit the epicyclic drive (inside, not outside the frame) and the bush, and couple up extension rods as shown. The fixing nut on VC1 should be very tight.

Now cut a piece of ¼in. plywood as in Fig. 3(f). This is really in two pieces, but it is better cut out as one, and then cut across the line where the plastic hinges are fitted. Its function is to hold the two No. 800 batteries in position and it does this in the manner shown in Figs. 4(a) and (b). The plastic hinges are fitted underneath, as shown in Fig. 3(f). The oval cut-out for the speaker magnet may be made immediately, but the four cut-out areas which leave space for the spindle couplers, ball drive and bush for VR1 are best marked out directly from these. In consequence, it is suggested that the piece of Fig. 3(f) be placed over the speaker magnet and the four cut-out areas marked accordingly. Cut out these areas and chamfer the outside edges of the plywood as shown. Place the two No. 800 batteries in position with the top (positive) terminal strips up against the bolts which appear in the panel holding VC1 and VR1, and the two other terminal strips, in the middles of the batteries up against the two bolts in the top and bottom sections of the frame. Now partially close the two parts of Fig. 3(f) by pressing the chamfered edges towards each other, and slip the assembly over the magnet so that the chamfered edges press into the 'waists' between the two cells making up each battery. Now press on the junction of the two parts of Fig. 3(f) so that it flattens out again, this action forcing the chamfered edges into the waists and holding the batteries firmly up against the top and bottom of the frame. If necessary, further chamfering of the edges is carried out until the batteries are correctly held in position. The coil trough is now placed in position, plywood base downwards, on top of the piece of Fig. 3(f) and to the left of the two batteries, and it will hold the batteries firmly up against the right hand section of the frame. It will be found that an appropriate hole is in the top of the frame above the trough, and this will allow the coils to be dropped in it for storage.

Because the hinged section of Fig. 3(f) is a little under 4in. wide there will be room for leads to pass between it and the right hand side of the frame.

A small clip for the PP3 battery is made and screwed to Fig. 3(f) as shown.



The required coil is inserted into a socket at the rear

WIRING

Turn next to Fig. 5, which shows the wiring. The valveholder for the coil, VC1, S1 and VR1 are already mounted. The valveholder and S1 are both shown as though they were transparent; this results in the valveholder tags, from 1 to 9, proceeding in an anti-clockwise direction. The leads from tags 6 and 8 of the valveholder are soldered to the 1in. 6BA screw, as illustrated in Fig. 3(b). This allows a low inductance connection to the moving vanes of VC1. Tag 1 connects to the fixed vanes, as shown in Fig. 3(b) and Fig. 5. Use a reasonably stout wire for these connections. All other connections to VC1 are made at its tags, as shown in Fig. 5.

The two tagstrips, one with 6 tags and one with 13 tags, are cut from an R.S. Components standard size 18 way group board (Home Radio Cat. No. BTS10). Two nuts are used as spacing washers to lift the 6 way tagstrip clear of the wood, and the fixing screws should pass through the tag holes indicated, the remaining tags being isolated from the wood. The 13-way tagstrip is secured by three screws, these passing through the end tag holes and the hole at the tag to which the positive end of D3 connects. The 13-way tagstrip may be spaced off

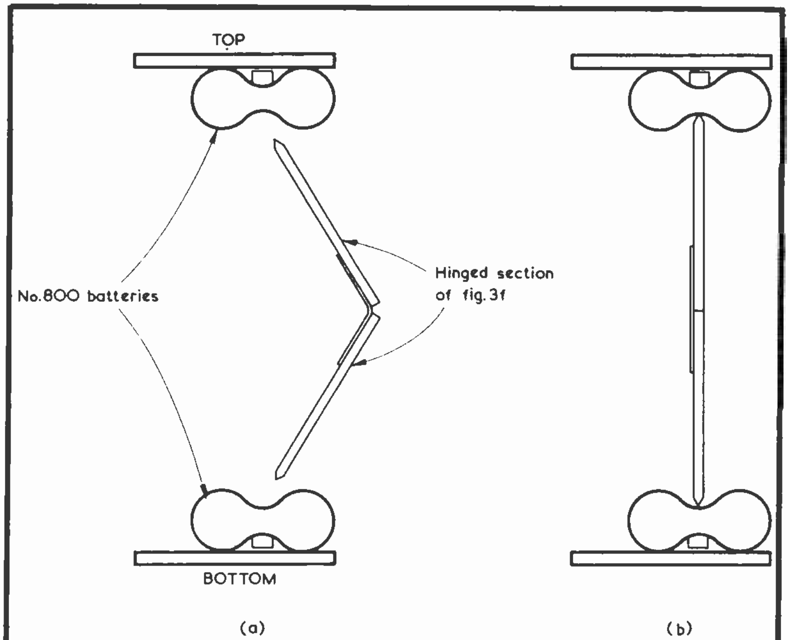
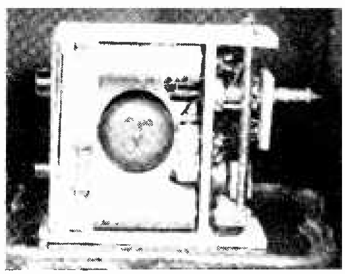


Fig. 4 (a) The hinged section of Fig. 3 (f) is initially applied to the 3 volt batteries in the manner shown here
(b) When the hinged section is pressed down flat the batteries are held securely in position



Side view of the receiver framework. The No. 800 batteries may be seen at top and bottom, and there are two coils in the coil trough from the wood, but this is not essential as none of the tags are in a v.h.f. circuit. Components should be wired up with leads as short as possible and not as in Fig. 5 where, for clarity, components are shown spaced out. In practice no components should lie outside the edge of the panel. The leads to VC1 and the B9A valveholder must, in particular, be as short as possible, or the desired ranges may not be covered.

The aerial is bolted into its hole at the top of the frame. Make sure that it can be parked inside without fouling transformer T1.

All the wiring should now be completed with the exception of the 6 volt positive battery lead to switch S1.

SETTING UP

Setting up involves the adjustment of VR2 and VR3. Set the slider of VR3 to the track end which connects to the negative supply line, and the slider of VR2 to the track end which has no connection. Insert a meter switched to read current between the 6 volt positive battery lead and S1 and adjust VR3 until a current of 7mA is indicated. No signal should be tuned in whilst this is being done. For maximum useful life from the 6 volt battery the procedure may be repeated after 20 hours use when the voltage has settled down. If it proves impossible to obtain as low a reading as 7mA, suspect C11, which must have first class insulation. After VR3 has been adjusted, remove the meter and connect the positive battery lead to S1.

Now insert the Range 6 coil and set VC1 to full capacitance and VR1 to about one-fifth of the way from fully clockwise. Adjust VR2 so that oscillation just starts as denoted by a hiss. This setting will allow optimum ease of adjustment in VR1 throughout the tuning range of the receiver.

Set the core of Range 5 coil so that it is fully inserted within the coil. This will mean that about ¼in. of threaded rod protrudes through the top. The other two coils are without cores.

Insert the Range 7 coil and turn VR1 until a hiss denotes oscillation. Adjust VC1 and tune in Radio 2, Radio 3 and Radio 4. It will be found that these are received with VC1 roughly at mid-travel. VR1 should be adjusted for suitable volume. If it is set too far anti-clockwise, there will be distortion and violent oscillation. If, on the other hand, it is set too far clockwise there will be lack of volume or complete silence.

BBC1 television sound will require either the Range 6 or the Range 5 coil according to the channel being listened to.

Try varying lengths of aerial by adjusting the number of sections drawn out. Also, try different direction and angles for the aerial. In many cases, the maximum length will give best results.

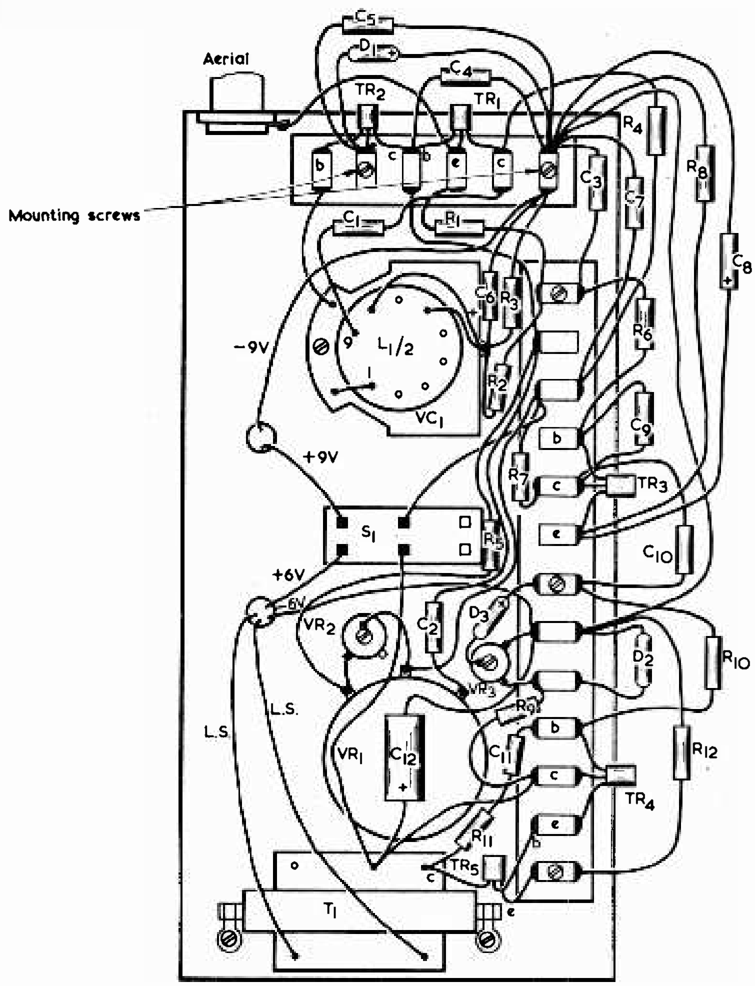
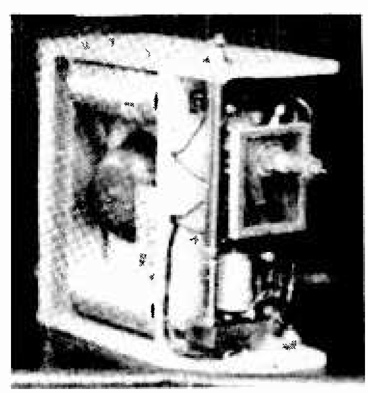


Fig. 5 Wiring up the components on the rear upright panel

Another view of the inside framework of the receiver



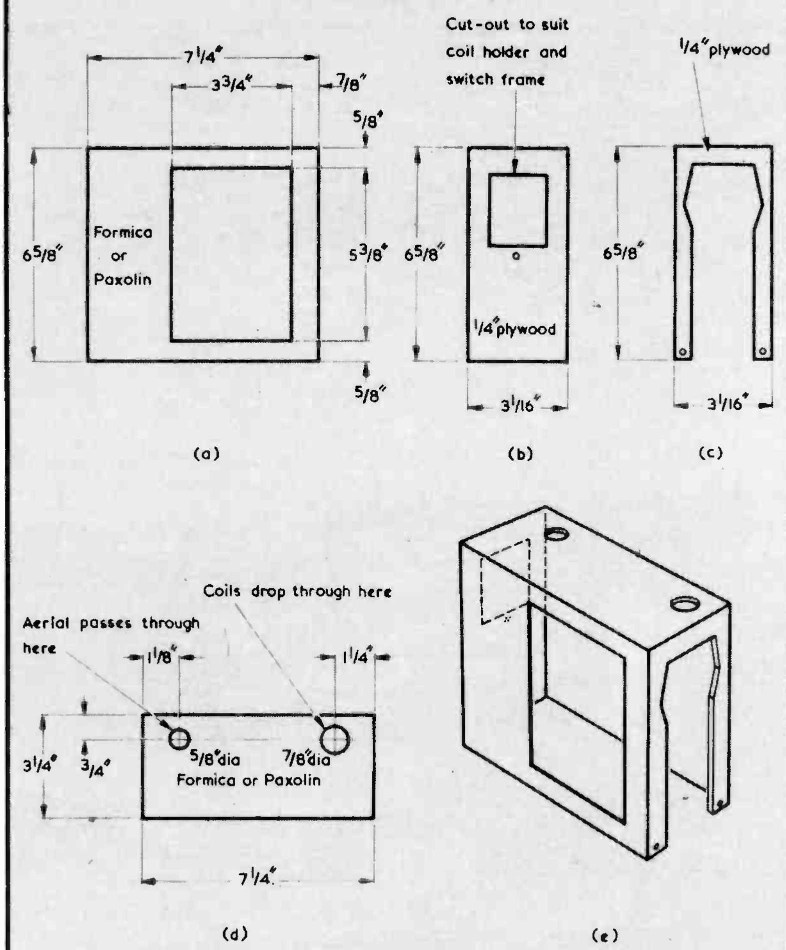


Fig. 6 (a) One of the sides of the case for the receiver. The other side does not have the speaker aperture
(b) The rear panel of the case
(c) The front panel. Its shape enables a tuning scale to be provided
(d) The top panel
(e) How the case is assembled

CABINET

There remains only a cabinet. This is illustrated in Fig. 6, which is largely self-explanatory. There are two sides, each 6⅝in. by 7¼in., one of these having an aperture for the speaker, as in Fig. 6(a). The back, shown in Fig. 6(b), has a cut-out for the coil valveholder panel, and it should be marked out from that panel to correspond with the exact position the latter has taken up. The front section, illustrated in Fig. 6(c), may be cut to suit the constructor provided the lower end is open and there is plenty of room for three tuning scales. The case is slipped over the receiver framework and may be held in place by two small screws passed through the feet of Fig. 6(c) into the cut-out sections (see Fig. 2(a)) of the base of the frame. A third screw, passed through a hole just below the cut-out in the rear panel of Fig. 6(b) and into the small frame round the coil valveholder will help to hold this panel steady when the switch is being operated, and thus relieve strain on the fixing nut of VC1.

Before making the case, the dimensions shown in Fig. 6 should be checked against the actual measurements of the receiver frame. If, due to small variations in cutting out and assembly, these measurements vary from the exact values shown in the diagrams, the case dimensions should be adjusted as necessary.

The flange of the tuning drive may next be fitted with two wire pointers and a tuning scale made out. Perspex may be used to cover the scale, and a stopper made from the top of the coil trough. Finally the case is covered with Fablon or Contact.

Although this receiver has been designed to tune from 110 to 40MHz using standard, unmodified commercially made plug-in coils, its frequency range can be extended if the experimentally minded reader so wishes. Provided wiring has been carefully carried out and all components are in first-class condition, a Range 7 coil with two turns removed from the end of the larger winding near to the pins, should provide coverage from about 160 to 120MHz. This, of course, includes the 144 to 146MHz amateur band. ■

BACK NUMBERS

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We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 6p postage.

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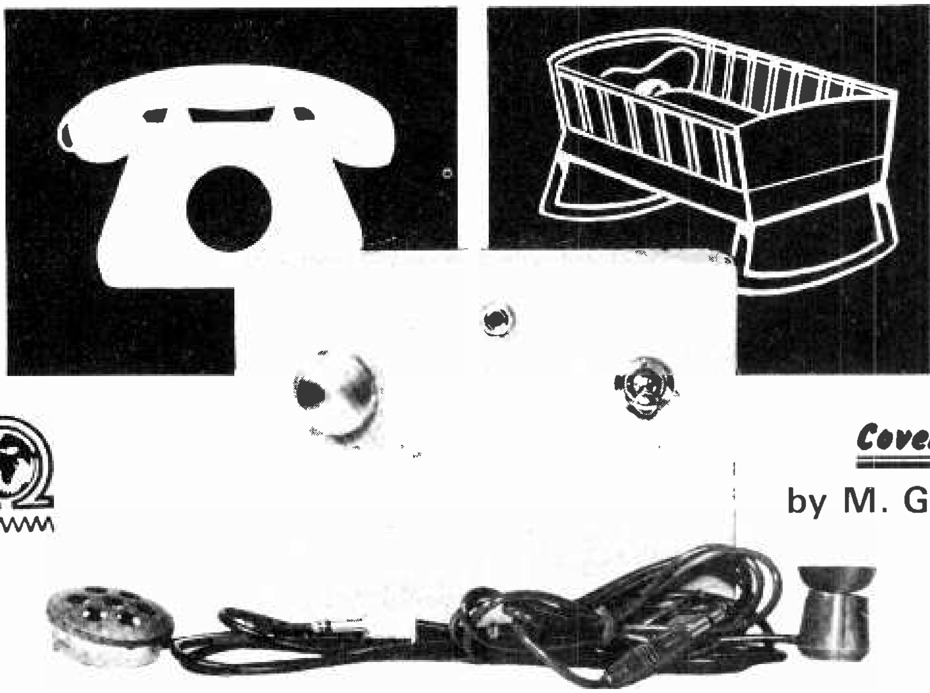
TELEPHONE AMPLIFIER and BABY ALARM



Cover Feature

by M. G. Argent

A general purpose unit which may be employed as a telephone amplifier or as a baby alarm.

An auxiliary amplifier for the telephone can have many advantages. Firstly, there is the extra volume obtained, which is most useful where there are noises near the telephone, as occur in factories and similar locations. Secondly, an amplifier of this nature enables more than one person to hear the conversation. It represents an ideal addition in business offices.

The unit to be described is very sensitive, which makes it a good choice for a telephone amplifier. It may also be employed as a baby alarm.

THE CIRCUIT

The circuit diagram is shown in Fig. 1. The output stage of the amplifier is a Class AB push-pull type. This is very economical so far as power supplies are concerned. The unit draws a quiescent current of about 7mA only.

The output pair of transistors, TR4 and TR5, are driven by TR3, a common emitter stage. The purpose of TR2, apart from amplification, is to keep the junction of TR4 and TR5 emitters at approximately half the supply potential.

The input to TR2 is taken from volume control RV1, the latter being fed from TR1, the input stage. The d.c. supply to TR1 is decoupled by R3 and C2 to avoid low frequency instability. High frequency oscillation is suppressed by C6.

When used as a telephone amplifier, a telephone pick-up coil is plugged into the input socket. A suitable pick-up coil complete with rubber sucker and screened lead is available from Henry's Radio under the description 'Telephone Recording Adaptor'. (It appears in the Henry's Radio catalogue in the microphone section.) For the baby alarm function a magnetic microphone insert may be employed. A suitable component is also available from Henry's Radio, the type employed by the author being a 'Magnetic Insert (RT)', which has 600Ω resistance and 2,000Ω impedance at 1kHz. This functions as a microphone as it stands. The microphone must be connected to the amplifier by screened cable.

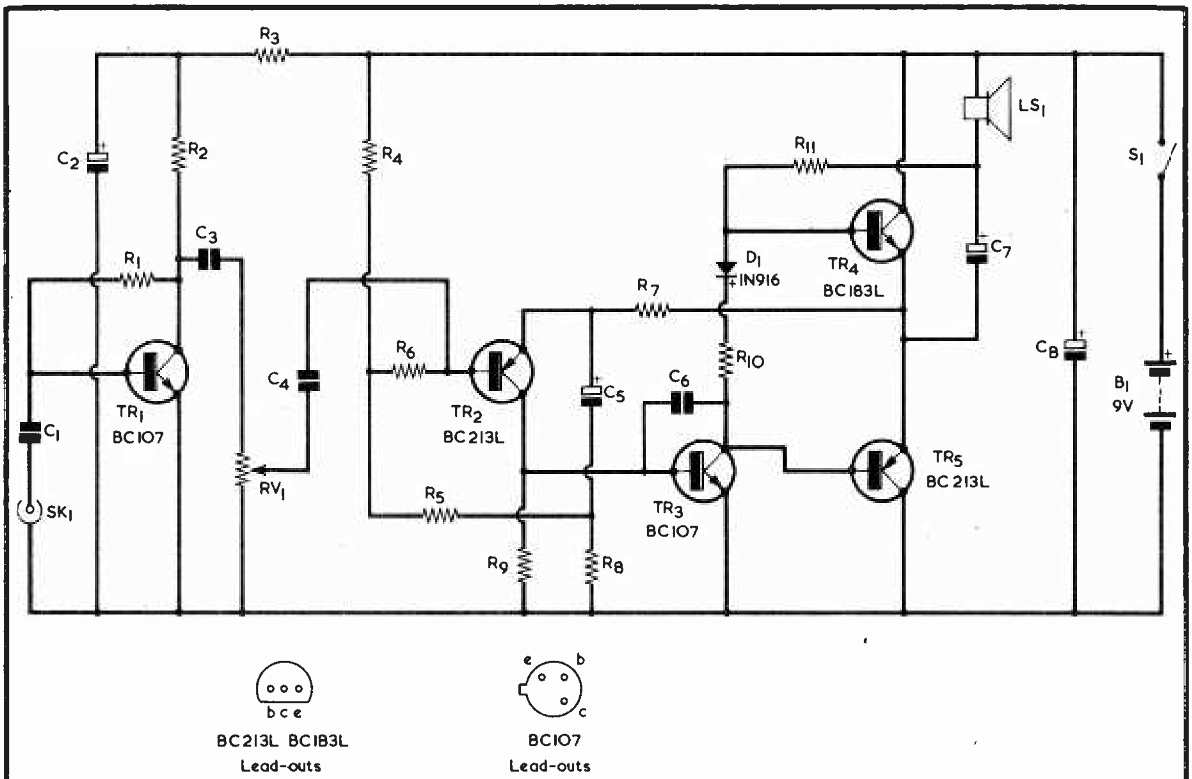


Fig. 1. The circuit of the amplifier unit

COMPONENTS

Resistors
(All fixed values ¼ watt miniature 10%)

R1	470kΩ
R2	12kΩ
R3	1.8kΩ
R4	100kΩ
R5	68kΩ
R6	470kΩ
R7	10kΩ
R8	10Ω
R9	27kΩ
R10	82Ω (see text)
R11	560Ω
RV1	5kΩ potentiometer, log track

Capacitors

C1	0.1μF
C2	40μF electrolytic, 10 V.Wkg.
3C	0.1μF
C4	0.1μF
C5	10μF electrolytic, 10 V.Wkg.
C6	100pF ceramic
C7	200μF electrolytic, 10 V.Wkg.
C8	40μF electrolytic, 10 V.Wkg.

Semiconductors

TR1	BC107
TR2	BC213L
TR3	BC107
TR4	BC183L
TR5	BC213L
D1	1N916

Switch
S1 s.p.s.t. toggle

Speaker
LS1 Loudspeaker, 2 to 3 in., 15Ω

Battery
B1 9-volt battery

Socket
SK1 Input jack or phono socket

Accessories (as required)
1 Telephone pick-up coil (see text)
1 Microphone insert (see text)

Miscellaneous
1knob
Battery connectors
Veroboard, 0.1 in. matrix, 12 strips by 36 holes
Screen lead
Materials for case, etc.

CONSTRUCTION

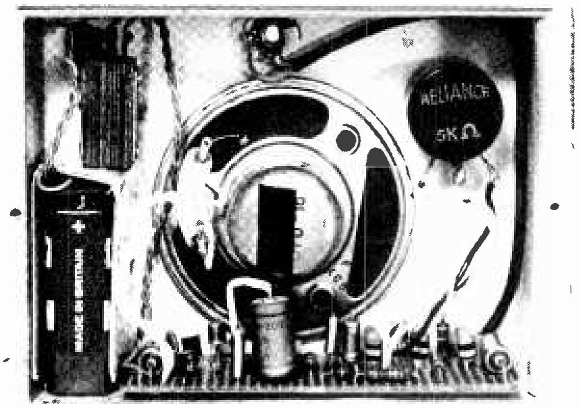
All the components except RV1, LS1, SK1 and S1 are assembled on a piece of 0.1in. matrix Veroboard having 36 holes by 12 strips. The component and copper sides of the board are shown in Fig. 2. On the copper side, the strips are cut at holes A12, F18, G18, J12, J25, K12 and K20.

The 0.1μF capacitors C1, C3 and C4 should be miniature types. Mullard Miniature Foil Capacitors are particularly suitable, and were employed in the prototype. The electrolytic capacitors can be Mullard miniature, and it is in order to employ 16 V.Wkg. types if 10 V.Wkg. components cannot be obtained.

R10 should not be fitted at this stage as its value has to be checked experimentally.

RV1 is connected to the board at holes E12, F12 and L12. The slider connects to hole F12, and the maximum volume end of the track (spindle fully clockwise) connects to hole E12. The leads to the volume control need not be screened.

The board can be fitted in any housing favoured by the constructor. The author's unit was housed in a wooden box measuring $5\frac{1}{4}$ by 4 by $1\frac{3}{4}$ ins., as shown in the accompanying photographs. A $2\frac{1}{2}$ in. round speaker was employed, and the battery was a PP3. The box was covered in wood finished vinyl wallpaper, which gave a pleasing appearance. No speaker aperture is visible in the front view of the box as the wallpaper simply covered the cut-out for the speaker. The wallpaper is thin enough to allow the passage of sound from the speaker.



The inside of the prototype amplifier

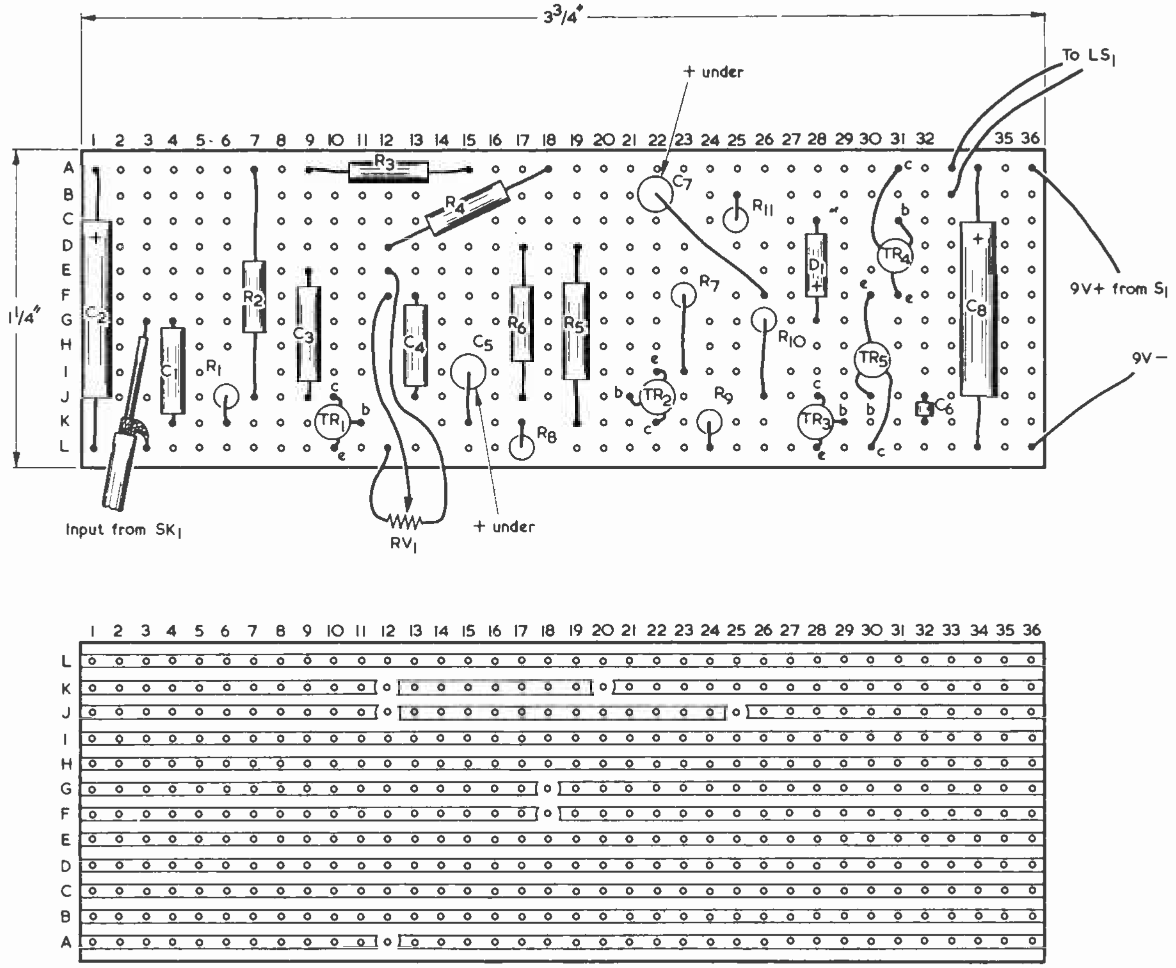


Fig. 2. Component and copper sides of the Veroboard on which the amplifier is assembled

TESTING AND USING

Before switching on, a careful check for wiring errors and short-circuits between copper strips should be carried out. The value of R10 will depend on the particular transistors employed in the output stage. Temporarily connect a 250Ω or 270Ω potentiometer to the R10 circuit points and adjust this to insert minimum resistance. Connect the battery to the unit via a current reading meter, switch on and carefully increase the resistance inserted by the potentiometer until a no-signal current for the unit of 7 to 7.2mA is indicated by the meter. Switch off, remove the potentiometer and measure the resistance it has inserted. Then, fit a fixed resistor of the nearest preferred value in the R10 position. If a resistor of too low a value is employed for R10, excessive crossover distortion will result. On the other hand, too high a value can result in thermal runaway and the output transistors will be permanently damaged. If in doubt, choose the lower value resistor. The resistor employed in the prototype had a value of 82Ω.

When the unit is used as a telephone amplifier, the telephone pick-up coil is plugged into the input socket SK1. The coil is stuck on to the telephone base by means of its rubber sucker; and its purpose is to pick up the magnetic field around any inductive component in the telephone. The precise position has to be found experimentally and will depend upon the type of telephone used. In the author's case, the best position was on the left hand side near the top. The easiest way to find the best position is to dial the time signal. This gives a signal of long enough duration to move the coil around to find the optimum position.

As a baby alarm the unit is ideal. It is necessary for the microphone and loudspeaker to be in different rooms as there will otherwise be acoustic feedback from the loudspeaker to the microphone, resulting in a howl. This means that either the microphone or the loudspeaker has to be on the end of a long lead. Since the loudspeaker wire does not need to be screened it will, normally, be preferable to have a long loudspeaker lead rather than a long microphone lead.

An additional use for the unit is the tracing of mains cables buried in the walls. Using the telephone pick-up coil and placing it against the wall, a buzzing sound will be heard in the vicinity of unscreened mains cables. The sound will increase in intensity as the coil approaches the cable. The sound will only be heard if there is current flowing through the cable. Thus, if the cable is in a lighting circuit the lights have to be switched on. ■

RECENT PUBLICATIONS

THE RADIO AMATEUR'S HANDBOOK, 1972 Edition.
700 pages 6½ x 9½ ins. Published by the American Radio Relay League. Price, hard cover £3.10, soft cover £2.30.

This edition is the forty-ninth, and it exhibits extensive revision from previous editions. "The Radio Amateur's Handbook" is described on the cover as being "The Standard Manual of Amateur Radio Communication", which it can justly claim to be. It is interesting to note that since the first edition appeared in 1926, 4,000,000 copies have been sold.

The Handbook presents a complete treatment of every aspect of modern amateur radio, from elementary theory to advanced practical instruction.

Much new material has been added, and your reviewer noticed with interest that facsimile is covered for the first time, as also is space communications. There is very thorough coverage of frequency modulation and repeaters, an aspect of amateur radio which is likely to play an ever increasing part in the amateur radio scene in this country in the future, as it has done recently in Europe.

The twenty-five chapters cover every aspect of amateur radio, including electrical laws and circuits, valve and semiconductor principles, power supply theory and practice, hf, vhf and uhf transmitting and receiving systems, mobile, portable and emergency equipment, am, ssb, fm and such specialised communication systems as rtty. Also dealt with are interference, test equipment and measurements, constructional practices, aerials and the assembly and operation of an amateur radio station.

In the Foreword, contributed by John Huntoon, W1RW, General manager of ARRL, mention is made of a list of "all time best sellers", recently published by the magazine *Time*. The list was in two parts – fiction and non-fiction. Heading the non-fiction list was "The Bible", followed by Dr. Spock's "Baby and Child Care". The only technical publication on the list was "The Radio Amateur's Handbook". Interesting – but perhaps not at all surprising since this Handbook is really such an excellent publication.

AMATEUR RADIO TECHNIQUES, 4th Edition. By Pat Hawker, G3VA.
256 pages, 7 x 9½ in. Published by the Radio Society of Great Britain. Price £1.60.

A new edition – the fourth – of this popular handbook has now been published. Like the previous editions, it aims at extending the radio amateur's awareness of new techniques and ideas in the current field of amateur radio practice. As its author says in the Foreword to this edition, it is not a book which displaces the standard handbooks of amateur radio, but one which is an "ideas book" rather than a constructional manual.

In the old *RSGB Bulletin*, now called *Radio Communications*, a regular series of articles called "Technical Topics" was started in April 1958. These endeavoured to keep the radio amateur up to date with new ideas and technical practice. This book is a selection from fourteen years of these articles, and includes the ideas which have proved their practical value in the amateur world.

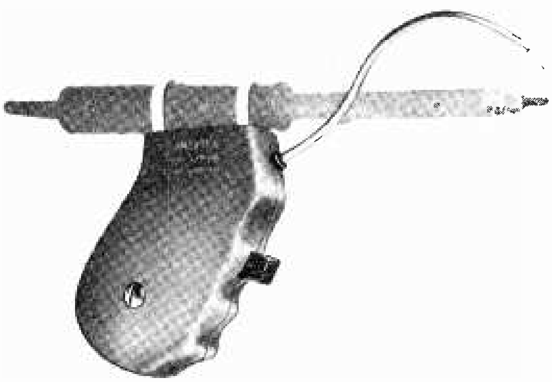
The contents include semiconductors, components and construction, receiver topics, oscillator topics, transmitter topics, audio and modulation, power supplies, aerial topics, fault-finding and test units, and an appendix giving the i.f's of just about every receiver likely to be met in Amateur radio practice, both surplus and current. Each section contains new and additional material making this volume substantially larger than previous ones.

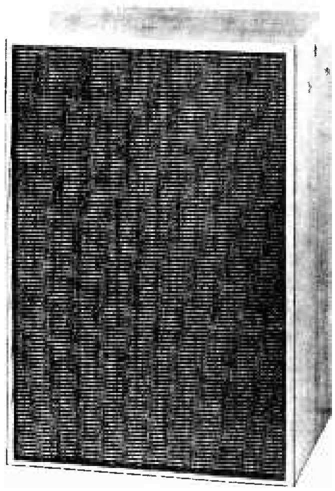
New Products

IMPROVED SOLDER FEED

In current production, the Mark 3 Anextra includes several improvements to simplify its main function of eliminating the need for three hands when soldering. The reel of solder, 18 to 22 gauge is contained in the pistol grip which is easily attached to most types of soldering irons. The maximum 4 oz. reel of solder is easily changed. The amount of solder fed by each pressing of the trigger is quickly adjusted to suit the joints being made. The operator thus holds both the iron and solder in one hand, being free to hold the work with the other hand.

Supplied with a 1 oz. reel of 60/40 22 s.w.g. solder, with simple instructions, the ANEXTRA is £3.75 post free U.K., direct from the makers, or send S.A.E. for leaflet from: ANEXTRA LTD., Chiltern Works, Rear of 77/78 Chiltern View Road, Uxbridge, Middx.





MATCHED SPEAKERS

An inexpensive domestic hi-fi loudspeaker system, the 'Linear 138/10', is now being introduced through wholesale and retail outlets by Linear Products Ltd., a member of the Audio Fidelity Group.

The 15 watts (RMS) system employs a 13 in × 8 in (33 cm × 20 cm) high quality deep cone elliptical unit with a parasytic tweeter to give a frequency range of 50Hz – 15KHz. Voice coil impedance is 15 ohms.

The teak finish cabinet has a front covering of grey/blue 'Vynair' and measures 16 in high × 11 in wide × 9 in deep.

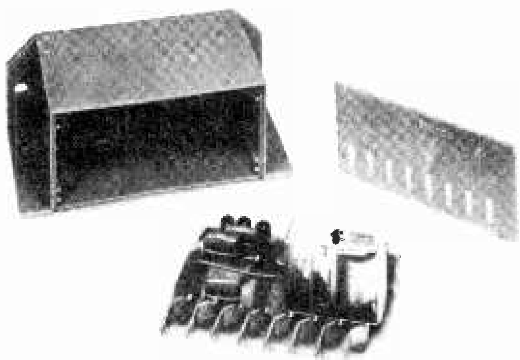
Available only in matched pairs, the 'Linear 138/10' price is £19.95 per pair.

Further information from: Linear Products Ltd., Electron Works, Armley, Leeds.

COMPONENT HOUSING

A small, compact and inexpensive electronic component housing is announced by LOGIKONTROL Ltd.

Made of High Impact Polystyrene, it measures 90 × 50 × 37 mm. including mounting flanges and has an internal volume of 10 cc. Among various unique features, it has facility for 2 printed circuit boards on which miniature mains transformers and relays may be mounted. Printed circuit fast-on connectors and snap-fit lid eliminate the need for a special plug and socket. Available in 5 different colours from: LOGIKONTROL Ltd., 17 Little Edward Street, London, NW1 4AT.



Transistorised Oscilloscope

Part 2

by R. A. Penfold

This concluding article deals with the design and construction of the timebase, the Y amplifier, the Y attenuator, the sync. amplifier, and the calibration unit.

TIMEBASE CIRCUIT

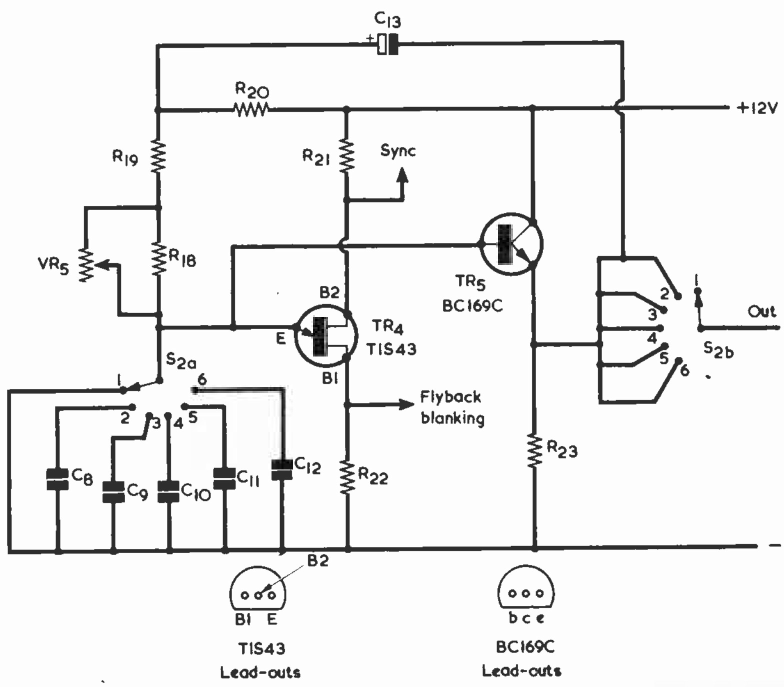
The circuit of the timebase generator is shown in Fig.11. This covers 5Hz to 500kHz in five ranges. Several circuits were tried, and the one shown is that which gave the best results, despite being the simplest. It does, however, require a unijunction transistor. The TIS43 specified is about the cheapest unijunction available. Similar transistors, such as the 2N2646, should work equally well in the circuit.

The circuit is based on a relaxation oscillator. This is a circuit where a capacitor is charged through a resistor until a triggering point is reached which causes the capacitor to be rapidly discharged. The process then starts again from the beginning, giving continuous oscillation.

In the circuit of Fig.11 whichever capacitor is selected by S2(a) will begin the charge through R18, R19, R20 and VR5. To obtain the required linear sawtooth waveform, the current through the resistors should remain constant, but the current flowing through the resistors will of course depend upon the voltage present across them. When the timebase capacitor has just begun to charge there will be almost the full supply potential across the resistors, but as the capacitor charges the voltage across it will increase. This will cause the voltage across the resistors to drop, as will the current through them also.

To counteract this the bootstrapping technique has been employed. TR5 is connected as an emitter follower and any voltage rise at its base will cause a similar voltage rise at its emitter, but at a lower impedance.

Fig. 11. The circuit of the timebase unit



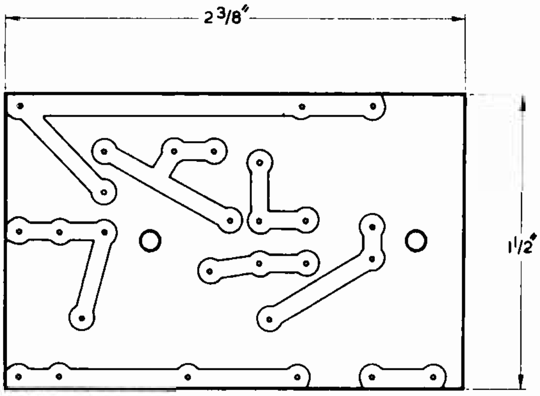


Fig. 12. The copper side of the timebase printed circuit board. This is reproduced full size and may be traced

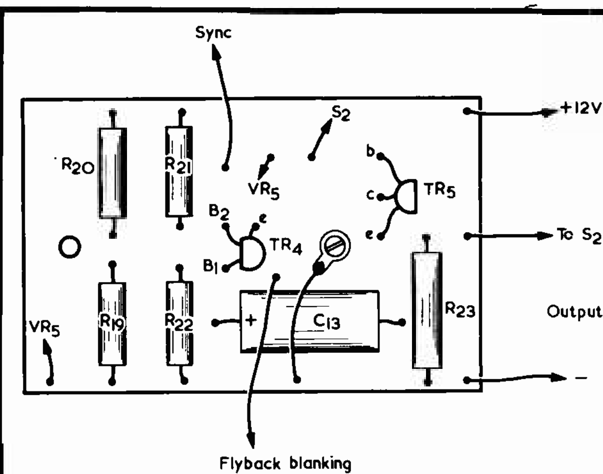


Fig. 13. The component side of the timebase board

Thus it will be seen that if the voltage rises at TR4 emitter it will rise by a similar amount at TR5 emitter, this rise in turn being coupled via C13 to the junction of R19 and R20. The voltage across VR5, R18 and R19 will therefore remain almost constant, and so will the current flowing through them. A near linear sawtooth waveform is thus obtained.

VR5 adjusts the resistance through which the capacitor has to charge, and thus operates as a fine frequency control. S2(a) alters the value of the timebase capacitor, giving five ranges. In position 1 the emitter of TR4 is short-circuited to chassis and the timebase output is removed from the X amplifier input, so as to enable the X amplifier to be used for Lissajous figure work.

The timebase generator is assembled on a printed circuit board measuring $2\frac{3}{8}$in. by $1\frac{1}{2}$in. Etching details of the board are shown in Fig.12, which is reproduced full-size and may be traced. The component layout on the other side of the board is given in Fig.13.

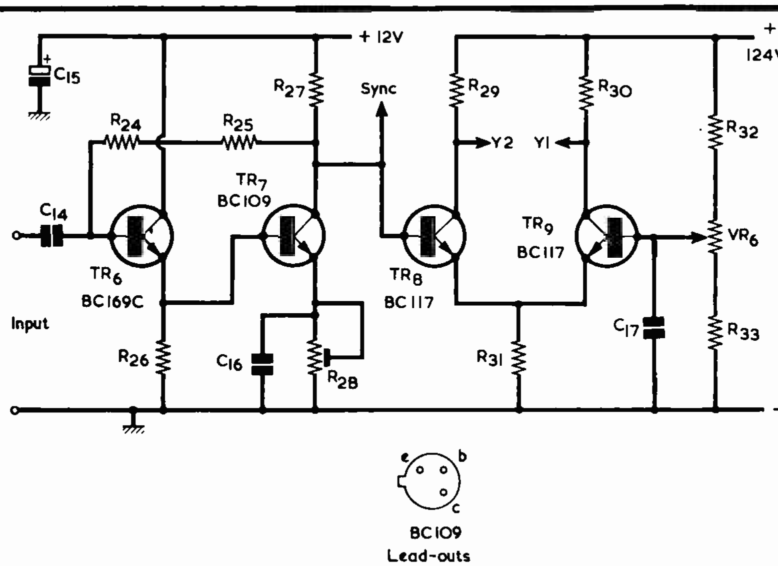
R18 is not fitted to the board but is mounted directly on VR5. Capacitors C8 to C12 are wired to the tags of S2. The board is mounted on the chassis in the position shown in Fig.2 (published last month), being insulated from the metal in the same manner as the two boards which have already been fitted. The output of the timebase, from S2(b) slider, is coupled to the input of the X amplifier via a short screened lead.

To test that the timebase is functioning correctly, the X gain should be nearly fully backed off, and the timebase range switch set to position 1. With the power turned on the unit should operate as before, since the timebase circuit is turned off. S2 should next be set to position 2, and this should produce a line across the screen. The line can be adjusted to the required length by manipulation of the X gain control. It should be ensured that a line can be obtained on the remaining four switch positions. The line should be at an even intensity over its entire length.

Y AMPLIFIER

The circuit diagram of the Y amplifier is shown in Fig.14. This uses four silicon n.p.n. transistors. To ensure little loading effect on the attenuator (to be described later) the circuit must have as high an input impedance as is reasonably possible. An emitter follower is therefore used at the input. This is directly coupled to the next stage, which is a common emitter

Fig. 14. The circuit of the Y deflection amplifier



amplifier.

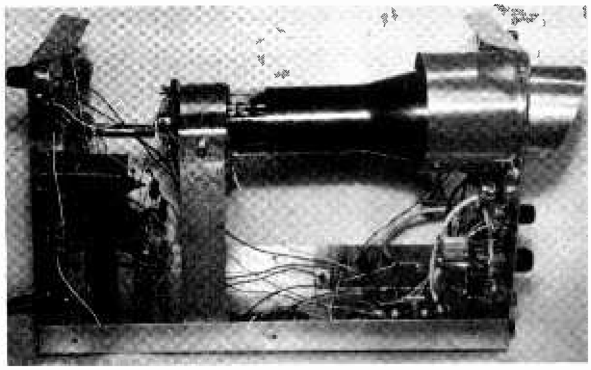
Biasing for the circuit is obtained from the collector of TR7, via the two 10MΩ resistors, R24 and R25. R26 is the emitter load for TR6, and R27 is the collector load for TR7. The preset resistor, R28, adjusts the amplifier gain, and is set to give a basic sensitivity of 10 mV/cm. R28 is bypassed at high frequencies by C16, and this gives high frequency boost to the circuit.

The Y output stage is basically similar to that used in the X amplifier, except that the biasing current is obtained from the previous stage instead of from a potential divider, and the shift control has been moved to the base circuit of the second transistor. C17 is used to give high frequency boost to the output stage. Like the X amplifier, the output is direct coupled to the c.r.t. deflection plates.

Signals for the sync. amplifier are taken from the collector circuit of TR7. The supply bypass capacitor, C15, is required to remove stray pick-up from the timebase generator through the 12 volt supply lines.

The values in C16 and C17 which give the flattest frequency response may vary slightly from one amplifier to another, and the best value for C16 will depend upon the exact setting of R28. If a suitable signal generator is available, it is advisable to select the best values for these components by trial and error, the values specified being a good starting point. This procedure is, however, by no means essential, and good results should be obtained with the values shown in the Components List.

The Y amplifier is assembled on a printed circuit board measuring 4ins. by 1½in. Diagrams illustrating the etching and component layout of the board are



A side view. Note the timebase capacitors wired to switch S2

given in Figs.15 and 16 respectively. The board is fitted to the chassis in the position indicated in Fig.2.

When the amplifier has been completed and all wiring checked, initial testing may be carried out. For the time being, R28 should be set to insert about one quarter maximum resistance.

The timebase switch should be set to position 2 (bringing the 1μF capacitor in circuit) and the unit turned on. Touching the Y input lead should produce one or more cycles on the screen, the exact number being dependent upon the setting of the fine frequency control. This control will require careful adjustment to obtain a stable trace.

The Y shift control should allow the trace to be moved off the screen in either direction.

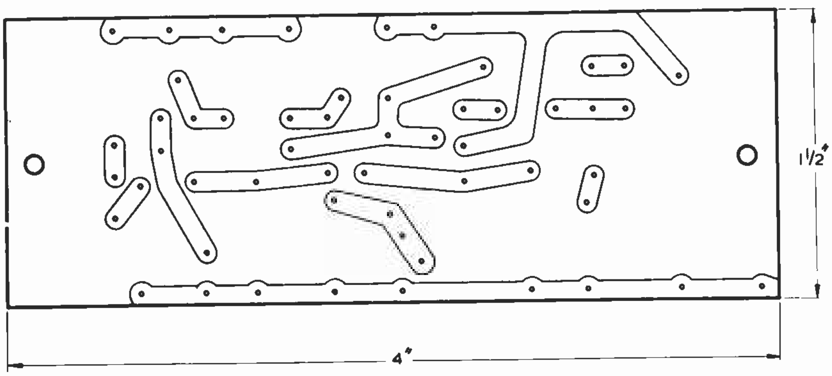


Fig. 15. How the Y deflection amplifier board is etched

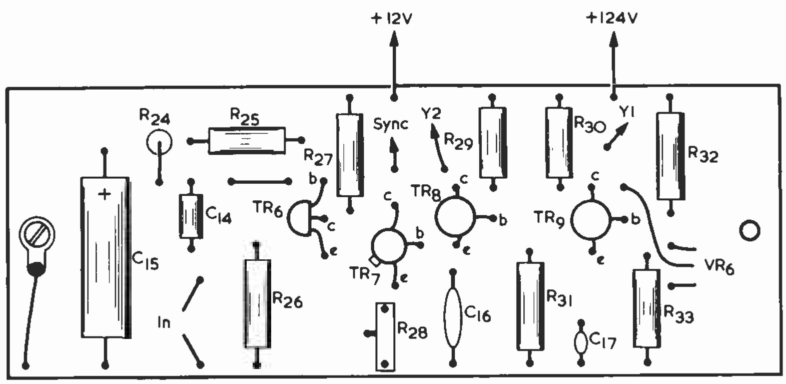


Fig. 16. Component layout on the Y deflection amplifier board

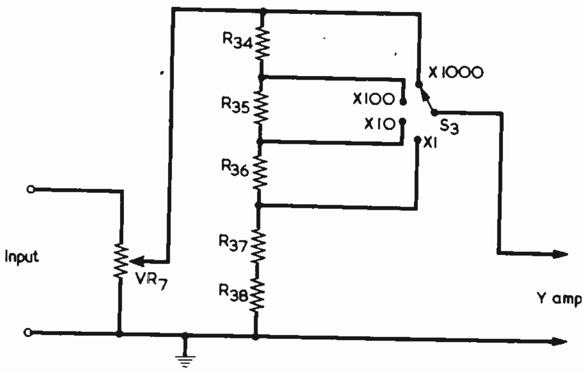


Fig. 17. The Y attenuator section

ATTENUATOR

The circuit of the attenuator section is given in Fig.17. VR7 is the fine gain control, and R34 to R38 form a simple step type attenuator. The resistors used here should be high stability low noise types. They should also be close tolerance, although the closest tolerance generally available for R34, at 10MΩ, will normally be 5%. VR7 connects to the Y input sockets on the front panel.

In the Components List, S3 is specified as 3 pole 4 way rotary. This is a standard miniature rotary switch and two of the poles are not used.

Resistors R37 and R38 are available in the E24 series of values, or they can be made from a 10kΩ and a 1kΩ resistor connected in series to make 11kΩ, and a 100Ω or a 120Ω will suffice for R38.

The attentuaor resistors are mounted on S3. All connecting leads should be screened to prevent unwanted pick-up. Neither the gain control nor the attenuator are frequency compensated, but are accurate enough at audio frequencies.

Once the unit has been calibrated, the attenuator gives the following basic sensitivities: X1, 10V/cm; X10, 1V/cm; X100, 100mV/cm; X1000, 10mV/cm.

SYNC. AMPLIFIER

The function of the synchronisation amplifier is to synchronise the timebase frequency to a factor of the frequency of the input signal, so as to give a stable trace on the screen. It is possible to obtain a stable trace by careful adjustment of the timebase fine frequency control but, without some form of synchronisation, constant readjustment would be required, especially at high frequencies.

The circuit of the sync. amplifier is shown in Fig.18. A more complicated circuit was originally envisaged, but a simple amplifier between the Y amplifier and the timebase generator was found to be all that was required in practice for satisfactory operation.

S4 is the sync. on-off switch. R21 in the timebase circuit forms the collector load for the sync. amplifier, and R40 biases the stage. R39 controls the degree of synchronisation.

The unit operates by amplifying signals from the Y amplifier, these being then used to control the potential at TR4 base 2, and thus the triggering point of the circuit and its frequency of operation. In this way the timebase frequency is synchronised with the input signal.

The sync. amplifier is assembled on a printed circuit board measuring 2½ by 1in. Etching details of the board are given in Fig.19 and the component layout in Fig.20. Once again, the etching diagram is reproduced full-size and may be traced.

R39 should be set to give the sync. a fairly wide pull-in range. It should not, however, insert too little resistance, or the basic timebase frequency will be raised too highly.

The sync. amplifier board is mounted on the bottom of the chassis in the position shown in Fig.2.

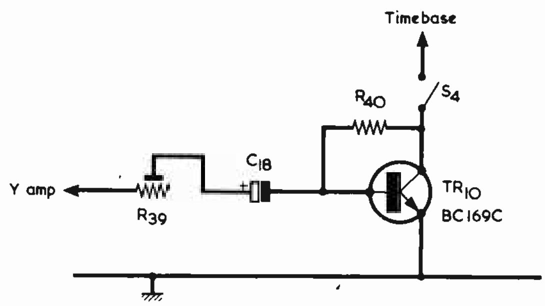


Fig. 18. The circuit of the sync. amplifier

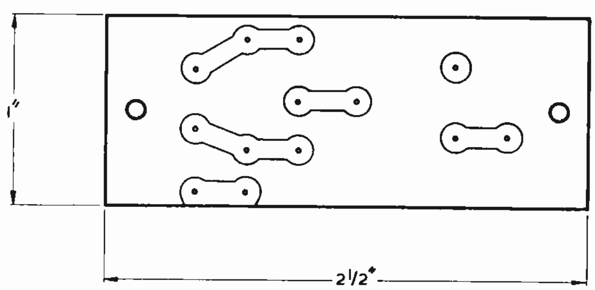


Fig. 19. The copper side of the printed circuit board for the sync. amplifier

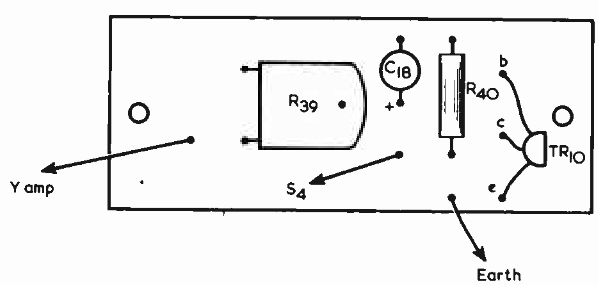
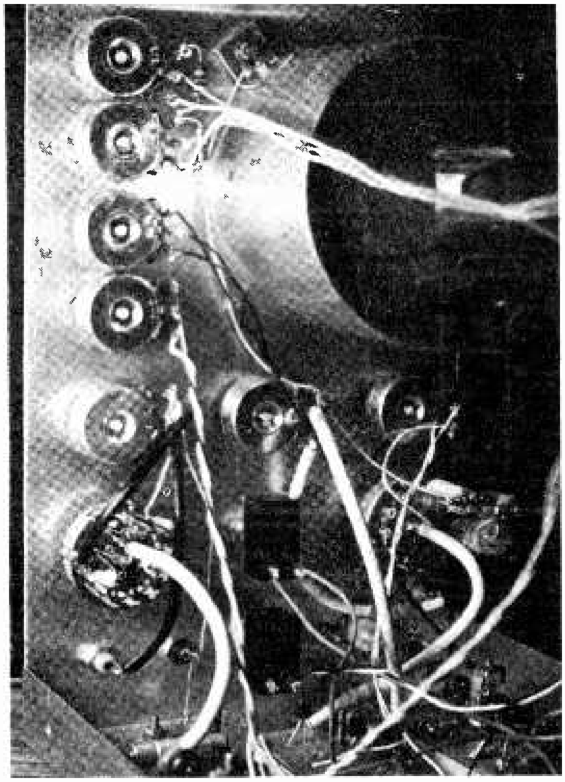


Fig. 20. The components in the sync. amplifier



Some of the wiring behind the front panel

FLYBACK BLANKING

At low frequencies flyback blanking is not required, as the flyback period is so short that it leaves no visible trace on the screen. At higher frequencies, however, deficiencies in the X amplifier's upper frequency response prevent the flyback period from being short enough to leave no noticeable trace, and flyback blanking is needed.

A circuit diagram of the flyback suppression circuit is shown in Fig.21. During the flyback period positive

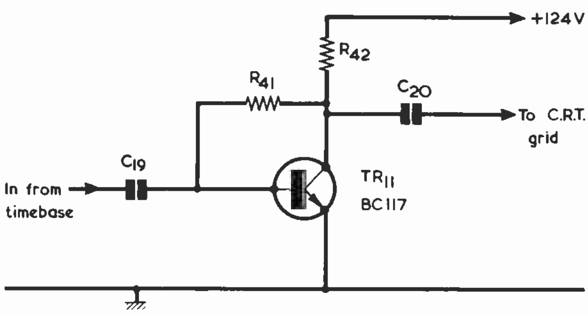


Fig. 21. The flyback suppression circuit

pulses are generated at TR4 base 1, and these are coupled to TR11 base. R42 is the collector load resistor, and R41 is the base biasing resistor. The amplified pulses at TR11 collector are coupled via C20 to the c.r.t. grid, where the pulses cut off the trace during the flyback period.

The circuit is constructed on a 5-way tagstrip. A wiring diagram showing this is given in Fig.22.

The tagstrip is mounted on the rear panel of the

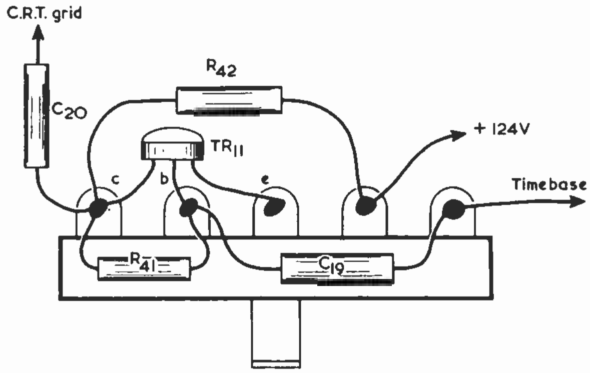


Fig. 22. The flyback suppression components are wired on a 5-way tagstrip

chassis in the position indicated in Fig.1 (published last month).

CALIBRATION

A signal of a known amplitude is required for calibration of the Y amplifier. Some signal generators are suitable for this. Alternatively, the circuit of Fig.23 can be constructed. This provides signals of 1V, and 500 mV peak-to-peak.

It is merely a multivibrator, the output from which is taken to two silicon diodes which clip the signal at about plus and minus 500mV, giving 1V peak-to-peak. R47 and R48 from a simple attenuator which halves this to 500mV.

Any small silicon diodes are suitable for D11 and D12, and almost any p.n.p. transistors will work in the circuit.

A suitable layout for the unit on a piece of 0.15in. matrix Veroboard is shown in Fig.24. Calibration units are sometimes made integral parts of oscilloscopes, but this has not been done here, and the assembly was left as an external unit. Power is obtained from a small 9V battery such as a PP3.

For a calibrated sensitivity of 10 mV/cm. the attenuator should be switched to the X100 position (100mV/cm.) With a 500mV peak-to-peak signal connected to the Y input terminals, R28 (Fig.14) is adjusted until the top and bottom edges of the trace are 5 cm. apart. The gain control must, of course, be at maximum while the unit is being calibrated.

The calibration of the timebase requires that a scale be fitted behind the knob of VR5. In the author's unit the scale was provided by Panel-Sign transfer numbers (available from Data Publications, Ltd.) applied directly to the metal of the front panel.

A signal of a known frequency is required for the calibration procedure. If a calibrated signal generator with suitable ranges is available, the task is very much easier. The signal generator is connected to the Y input, and set to a frequency of 50Hz. The timebase range switch is set to position 3 (with the 0.1μF capacitor in circuit) and VR5 is set to the low frequency end of the range. With the sync. unit turned off, VR5 is then adjusted to give one complete cycle on the screen. When one cycle is displayed on the screen the signal generator and the timebase are operating on the same frequency. The scale of VR5 can be marked '5' at this point.

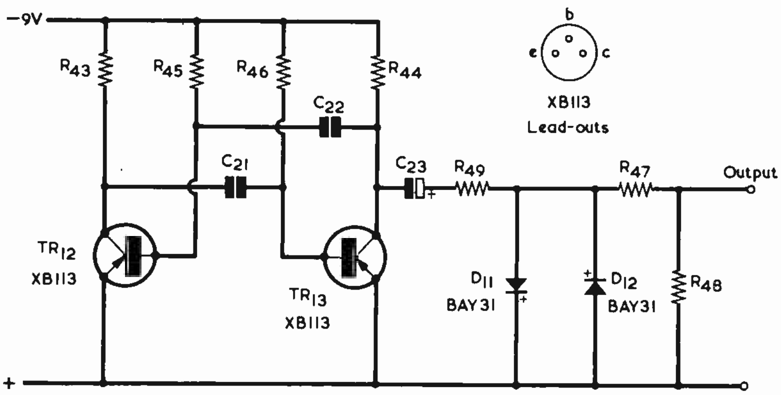


Fig. 23. The calibration unit. This is external to the oscilloscope and is powered by its own 9 volt battery

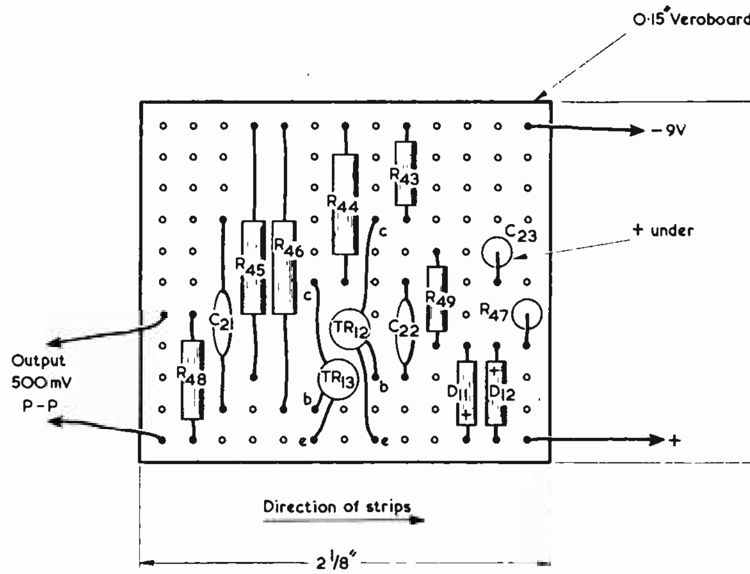


Fig. 24. The calibration unit may be assembled on a piece of Veroboard, as shown here. There are no breaks in the copper strips of the board

The same process can now be used at other frequencies (75Hz, 100Hz, etc.) up to 500Hz, at which point the scale is marked '50'.

If no suitable signal generator is available, the mains frequency can be used. A length of lead should be connected to the Y amplifier positive input terminal and, with the attenuator and fine gain controls set for maximum sensitivity, mains hum picked up in the lead should be displayed on the screen. The timebase range switch should be set to position 2 (with the 1μF capacitor in circuit), and VR5 should be adjusted towards the high frequency end of the range, where it should be possible to obtain a display of one cycle. The timebase frequency is 50Hz at this point.

VR5 is next adjusted to give a display of two cycles, and the timebase frequency is then 50/2, or 25Hz. With four complete cycles the timebase frequency is 12.5Hz, 10Hz with five cycles, 5Hz with ten cycles, and so on. With these points known it is possible to estimate the positions of the remaining points on the scale.

The oscilloscope can be used for approximate frequency measurement using the same process as that just described, except that it is now the timebase frequency which is known and it is the frequency of the incoming signal which is being determined.

OVERLOAD PROTECTION

As this is a transistor design, there is a somewhat greater risk of damage due to overload than occurs with a circuit using valves. In consequence, great care must be taken not to seriously overload either of the deflection amplifiers. If a signal of more than a few volts peak-to-peak is applied to the input gate or base, damage to the input or succeeding transistors could well result.

A certain amount of overload protection could be given by connecting a couple of low voltage zener diodes (series connected with opposite polarities) across each amplifier input (from the slider of VR3 to chassis in Fig.8 and across the output of the attenuator in Fig.17), and constructors who prefer to have overload protection may incorporate such diodes if they wish. The diodes will, however, increase the input capacitance and may still not give sufficient protection against a serious overload.

It is therefore essential to exercise the utmost care when a signal of high amplitude is applied to the oscilloscope and to always check that the attenuator is on the correct range. When in doubt, always set the attenuator to give highest attenuation and then reduce as necessary after the signal has been applied. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

The International Service from Brazil, radiated from 2000 to 2400 on **11720** (25.60 metres) and in parallel on **15447** (19.42m) has now been heard on an added third channel, that of 9655 (31.07m) according to a report.

AROUND THE DIAL

●CONGO

Broadcasts from Brazzaville may be heard during the evenings on **9715** (30.88m). We logged them at 2110 when a programme of African songs rendered by a chorus of young ladies was being radiated. The channel was clear until 2127 when a nearby transmission in Arabic opened and heterodyned the signals from Brazzaville. The address for reports is – Radiodiffusion Television Congolaise, B.P. 2241, Brazzaville, Republic of Congo.

●SAUDI ARABIA

Slightly above Brazzaville, signals from the Kingdom of Suadi Arabia can be heard on **9720** (30.86m). We observed Riyadh at 2130 when the station identification was given by a female announcer, this being followed by a programme of Arabic music and songs.

●GHANA

Tema can be heard most evenings on **9545** (31.43m) around 2130 or so. We heard a talk in English about Zambia from 2150 until 2200, at which time the station identification was made. The programme is beamed to Europe and is well worth tuning in.

●DOMINICAN REPUBLIC

HISD Radio Television Dominicana, Santa Domingo, radiates from 1100 to 0500 on **9505** (31.56m) and signals from this transmitter can sometimes be heard here in the U.K. HISD was recently observed by us at 2220 when a programme of guitar music, announcements and 'jingles' in Spanish, with a clear station identification at 2230 were heard.

●VENEZUELA

YVOS Radio Occidente, Tovar, has a 10kW transmitter radiating from 1000 to 0400 on **9750** (30.76m). Signals from this station can, at times, be heard in the U.K. We logged them at 2230 with station identification in Spanish after a series of drum beats and a trumpet fanfare.

●ARGENTINA

Another 10kW transmitter that can sometimes be heard in the U.K. is that of LRS1 Radio Splendid, Tucuman, on **9740** (30.80m). Observed by us recently at 2225 when radiating a sports commentary in Spanish.

●BRAZIL

ZYW23 Radio Brasil Central, Goiania, has a 7.5kW transmitter with a schedule from 0800 to 0400. This one was logged by us recently at 2255 on **9755** (30.75m) when a talk in Spanish followed by station identification at 2301 and Latin American music was heard.

●CANADA

Sackville can be heard on **9625** (31.16m) with a programme about Canadian affairs in English, we logged them at 2302.

TIME-CHECK

The 31 metre-band transmissions listed above are set out here on a time basis for the convenience of readers.

GMT	*Freq.*	*Stn.*	*Rcvd.*
2110	9715	Brazzaville	
2130	9720	Riyadh	
2150	9545	Tema	
2220	9505	HISD S. Domingo	
2225	9740	LRS1 Tucuman	
2230	9750	YVOS Tovar	
2255	9755	ZYW23 Goiania	
2302	9625	Sackville	

●LIBERIA

ELWA Monrovia may be logged on **15170** (19.77m) being recently logged at 2000 with the interval signal, station identification in French and followed by a music programme.

●NIGERIA

Lagos uses the **15185** (19.75m) channel and transmissions from this station can often be heard here in the U.K. during the early mornings, recently being observed by us at 0720 with a newscast in English.

●INDIA

All India Radio, Delhi, may be heard with station identification and the news in English at 2000 on **7215** (41.58m). This is usually followed by a programme of Indian music.

●SOUTH AFRICA

RSA (Radio South Africa) Johannesburg may be heard with the news in English and station identification at 2215 on **11970** (25.06m) the transmission being directed to Europe and the U.S.A. Also in parallel on **9525** (31.49m), **9695** (30.94m) and on **11900** (25.21m).

●RUMANIA

Bucharest operates an early morning schedule in English and this was observed by us on **11940** (25.12m) at 0700, when station identification was made, followed by a programme about Rumanian provinces.

●IVORY COAST

Abidjan may be heard on **11920** (25.16m) with mainly French programming. We logged it at 2240 when a programme of local pop music and songs, with announcements in French, were being radiated.

●GABON

Libreville can be heard on **9700** (30.92m) from 2050 onward when it was logged through to 2240. A newscast in French is radiated at 2103, all according to BADX (British Association of Dxers).

●POLAND

Warsaw may be heard by early risers on **9675** (31.00m) where we listened to a programme in English about conditions in Poland and the answering of listeners letters, all at 0625 onwards. Also in parallel on **7285** (41.18m).

●AUSTRALIA

Radio Australia can be heard in the mornings here in the U.K. They have been logged by us on **9570** (31.34m) at 0815 with stock market report, station identification and the news in English; on **11765** (25.49m) with "Waltzing Matilda", identification and newscast in English from 0759 to 0825 and on **15320** (19.58m) at 0757 with identification in English, chimes and 6 'pips' at 0800.

●KUWAIT

Radio Kuwait is another station that can easily be logged in the mornings, try **21605** (13.88m) or **21685** (13.83m) at 0815, at which time we heard a programme of Arabic music and songs.

●SYRIA

Radio Damascus may be heard at 2030 on **9655** (31.07m) with the news in English and a local weather forecast. Station identification was made at both 2030 and 2044.

●SOUTH AFRICA – 2

In addition to the previous information, South Africa can also be heard at 1930 on **7270** (41.26m), **11970** (25.06m) and on **15175** (19.76m). Station identification and news of African events is radiated at 1945, sign-off (on **15175** where we heard them) at 1950.

●CHINA

A morning newscast in English can also be heard from Radio Peking at 0830 on **15060** (19.92m). We have also recently logged Radio Peking on **6270** (47.84m) at 2346, on **9500** (31.57m) at 0200 with announcement "Aqui Peking" and the "East is Red" tune, and on **17605** (17.04m) at 0731 when a programme in a Chinese dialect was heard.

●FINLAND

Radio Finland from Pori can be heard with an English programme at 1400 onwards on **15185** (19.75m). At 1415 we listened to a programme about Finnish composers.

●NIGERIA

In addition to a statutory authority, Nigeria has two commercial organisations operating on the short waves. One of these, Radio Television Kaduna, can be heard on a nominal frequency of **9570** although in fact both ourselves and BADX have measured the channel as **9569** (31.35m). Reception was confirmed with the station identification in English and talking drum interval signal at 2015. The address for reports on this one is – P.O. Box 250, Kaduna. N. Nigeria.

●CANADA

Radio Canada can be heard, in English to Africa, on **17820** (16.83m) from 0700. At 0730, after station identification, a programme in French to Africa is radiated.

●LIBERIA

The Voice of America transmitter in Monrovia can be heard at 0800 on **15130** (19.82m) when radiating the news in English directed to the Middle East and Africa.

●SOUTH AFRICA – 3

Or you could try **21545** (13.92m) at 0830 to hear a programme in English if you prefer the higher frequencies.

●PAKISTAN

Radio Pakistan can be heard in English at 1415 (when we logged them) on **21730** (13.80m) with a programme of European dance music and announcements. Sign-off channel is at 1430 with the National Anthem.

●LATIN AMERICA

Reception of Latin American stations is often possible on the International Broadcast Bands and some of those we have heard recently are –

●BRAZIL

ZYZ36 Radio Globo, Rio de Janeiro, on **11805** (25.41m) at 2135 with an excited commentary in Portuguese.

ZYR56 Radio Excelsior, Sao Paulo, on **9585** (31.29m) at 0001 with a sports commentary – futebol as usual!

ZYB22 Radio Rio Mar, Manaus, on **9695** (30.94m) at 2315 with station identification and an apparently endless talk!

●URUGUAY

CXA6 Montevideo on **9620** (31.18m) at 2300 with station identification in Spanish.

●BANGLADESH

Radio Bangladesh may be heard on **17936** (16.72m) at 1230, at which time we heard them with the news in English followed by station identification at 1240.

AROUND THE DIAL

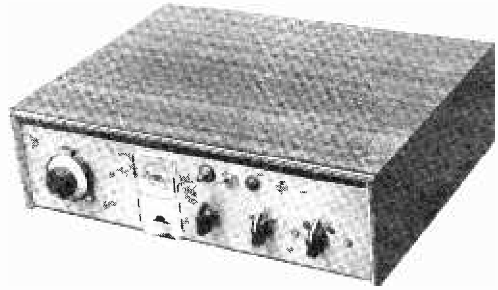
●AFARS & ISSAS

Radio Djibouti on **4780** (62.76m) has been heard by BADX (British Association of Dxers) operators from about 2200 to 2301 sign-off when the fascimile station on **4782** is silent.

●AZORES

Ponta Delgarda can be logged on **4865** (61.66m) at 1900, at which time we heard a trumpet fanfare and station identification in Portuguese. ■

The 'WYVERN'



160 Metre Solid State Transmitter

Part 3

by
John R. Green, B.Sc., G3WVR

In this concluding article we deal with the construction of the modulator section and the VU meter driver, after which we carry on to general assembly and testing.

THE TWO PRECEDING ARTICLES HAVE DEALT WITH THE construction of the v.f.o. section, the wideband driver, the frequency doubler and driver section, the p.a. stage and the power supply. The final two sections to describe are the modulator and the VU meter driver. The modulator is covered next.

MODULATOR

The modulator circuit, shown in Fig. 17, is a slightly modified version of the author's tried and tested, and many times proven, hi-fi amplifier design. Like most audio designs, no great originality can be claimed for it.

Before the purists are shocked into speech paralysis at the use of an n.p.n. silicon transistor (2N3055) working in complement with a p.n.p. germanium transistor (0C36), the author would like to point out that the amount of feedback used in the amplifier is more than adequate to compensate for this misdemeanour, and the performance of the amplifier is indistinguishable by ear from expensive designs claiming very low distortion figures. The only real advantage of using complementary pairs such as the MJ481 and MJ491 is that they easily provide a flat power response up to 20kHz; but such a response is quite unnecessary for speech or music where the power requirements lie in the 20Hz to 3kHz frequency band.

Returning to the circuit in question, one version of this has been built with uprated capacitor working voltages and run from a 45 volt supply, whereupon it delivered 30 watts r.m.s. at 1kHz into a 3Ω load. The use of the circuit on the 22 volt supply available in the transmitter will provide more than adequate power to fully modulate the 10 watt input, with extremely good quality and symmetry of sidebands.

It was found necessary in early development to modulate both the driver and the p.a. stages to achieve good results. The p.a., operating at high level, required both its collector supply *and* the drive to be modulated, whereas the driver, operating at lower level, would modulate well simply using collector modulation. The combination of both of these gave the best results.

The input sensitivity of the modulator is in the 100mV region and, although the author's transmitter incorporates an internal microphone pre-amplifier, he advocates the use of an external pre-amplifier. This should be battery powered and housed in a die-cast box as this technique is more reliable for avoiding r.f. feedback.

COMPONENTS

Resistors
(All fixed values ½ watt 10% unless otherwise stated)

R34	22kΩ
R35	10kΩ
R36	22kΩ
R37	10kΩ
R38	47Ω
R39	4.7kΩ
R40	100Ω
R41	330Ω
R42	1kΩ
R43	1kΩ
R44	0.5Ω 1 watt
R45	0.5Ω 1 watt
R46	47Ω
R47	10kΩ
R48	4.7kΩ
R49	See text
RV2	10kΩ potentiometer, log
RV3	5kΩ potentiometer, linear, pre-set
RV4	5kΩ potentiometer, linear, pre-set

Capacitors

C30	25μF electrolytic, 25 V.Wakg.
C31	100μF electrolytic, 25 V.Wkg.
C32	1,000μF electrolytic, 12 V.Wkg.
C33	50μF electrolytic, 25 V.Wkg.
C34	25μF electrolytic, 25 V.Wkg.
C35	25μF electrolytic, 25 V.Wkg.
C36	1,000μF electrolytic, 25 V.Wkg.
C37	1,000μF electrolytic, 25 V.Wkg.
C38	8μF electrolytic, 25 V.Wkg.

Semiconductors

TR12	2N3250/2N3905/2N3702
TR13	BFY50/2M3053
TR14	BFY50/2N3053
TR15	BFY50/2N3053
TR16	OC81/BFX88
TR17	2N3055
TR18	OC36/OC35
D5	1N916

Miscellaneous
Coaxial socket (for mod. input)
VU meter
4BA studding
Printed circuit board
16 s.w.g. aluminium
Screened cable
Material for case

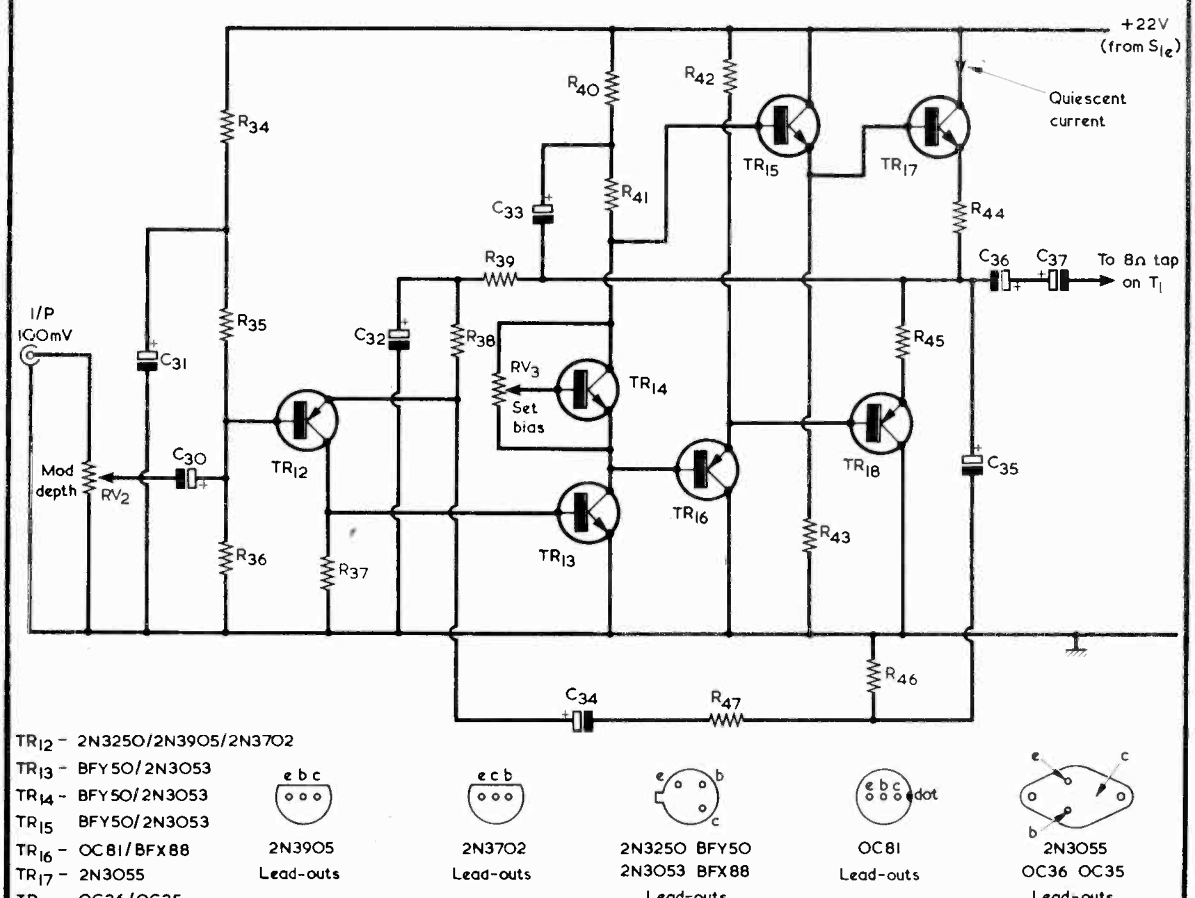


Fig. 17. Circuit diagram for the modulator amplifier

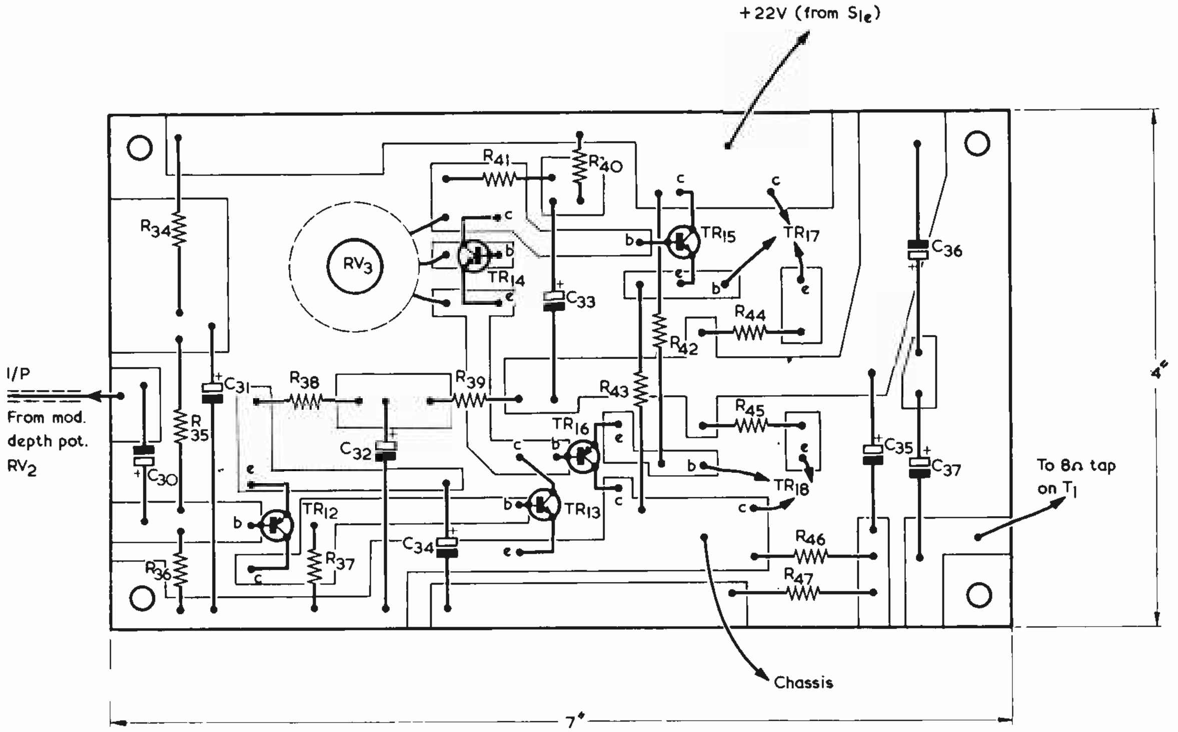


Fig. 18. The modulator printed circuit, as seen from the component side

The printed circuit board, seen from the component side, is shown in Fig. 18. This is too large to reproduce full size, as were the previous boards, but constructors should not have difficulty in copying out and scaling up the pattern as there are no small or cramped copper areas. The body of potentiometer RV3 is on the same side of the board as the components and its spindle projects through on the copper side.

The two output transistors are mounted on the aluminium cover plate shown in Fig. 19. The board is mounted between the cover plate and the main transmitter chassis with the aid of four 2½in. lengths of 4BA studding, with nuts on either side of the board and the plate. The photograph of the modulator section clearly shows the method of assembly. This also shows the microphone pre-amplifier, just referred to, which was incorporated by the author. TR17 is insulated from the cover plate, whilst TR 18 is bolted directly to it, since its collector is at chassis potential.

It is necessary to drill a hole in the main chassis of the transmitter to provide access to the spindle of RV3. Alternatively, this component may be set up before the amplifier module is installed.

When setting up the quiescent current, start with the wiper of RV3 at the TR14 collector end of its track, then turn it towards the emitter end until current registers in a meter inserted in the collector lead of TR17. Adjust RV3 to give some small current reading in TR17 collector circuit. About 20mA will suffice to prevent crossover distortion but some constructors may wish to run in Class AB at, say, 100mA quiescent current. Do not, however, draw excessive quiescent current or additional smoothing in the 22 volt line will be required.

The modulation depth potentiometer, RV2, is mounted on the rear of the main chassis, and it should be coupled to the input socket and to the modulator via screened wire.

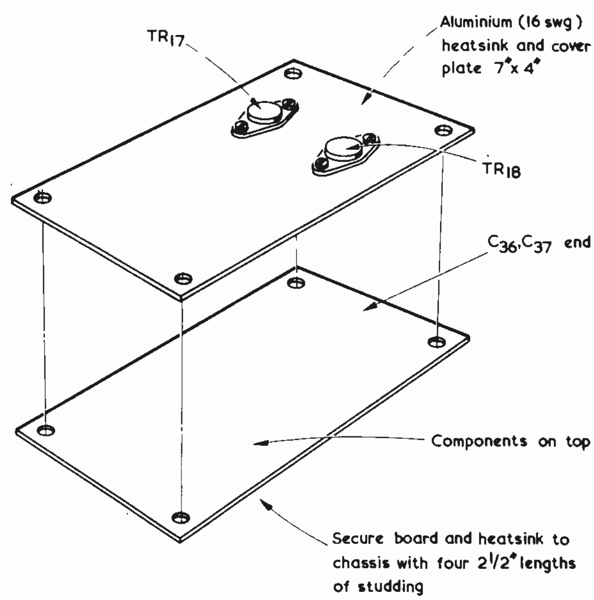


Fig. 19. Details of the modulator board and the heat sink

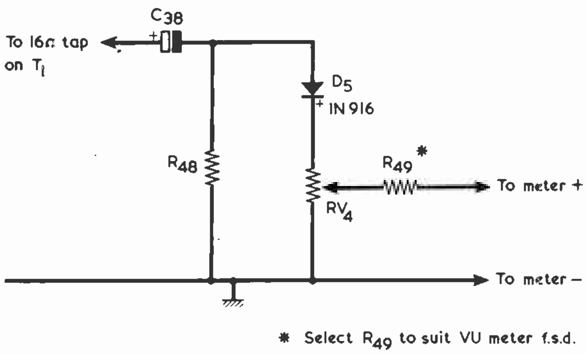
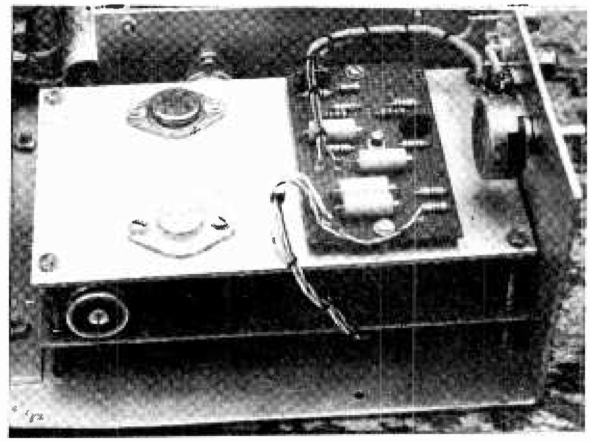


Fig. 20. The circuit of the VU meter driver



This photograph illustrates the manner in which the modulator board and its heat sink are mounted on the chassis. The Veroboard assembly on top of the heat sink is an optional pre-amplifier

VU METER DRIVER

The circuit for the VU meter driver is shown in Fig. 20. This is simply a rectifier system and the printed circuit for it is shown in Fig. 21. This is seen from the component side and is reproduced full size. The body of the potentiometer, RV4, is on the copper side of the board and its spindle projects through on the component side. It is mounted on the main chassis with the component side uppermost between the mains transformer and the modulation transformer, being secured by four short lengths of 4BA studding, with nuts which space its underside away from the chassis. (In the photographs an extra 0.1μF capacitor is visible on the meter driver board. This was connected across R48 at the time when the photographs were taken but has since been removed.)

The use of a VU meter enables overmodulation to be avoided and gives the transmitter that professional look. It may be set up very simply by adjusting RV4 and selecting a value for R49 which suits the meter employed.

The procedure for setting up, in the absence of an oscilloscope, is to just overmodulate (on dummy load if you wish to remain popular!) and listen for splatter on an adjacent receiver. Turn the modulation level down until the splatter just disappears and then, using RV4, set the VU meter to read 'OdB' on peaks.

Note that the circuit will suit any type of VU meter, whether it incorporates its own rectifier or not.

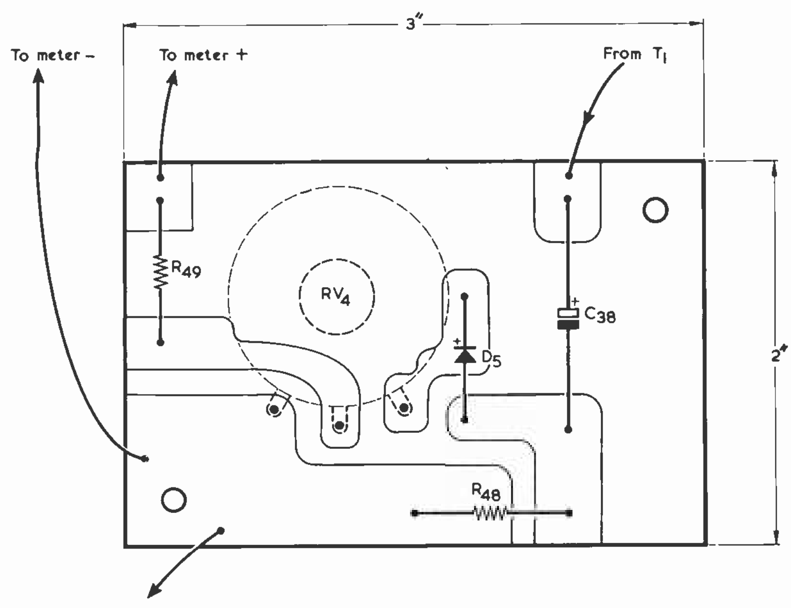


Fig. 21. The component side of the meter driver board. This is reproduced full size and may be traced

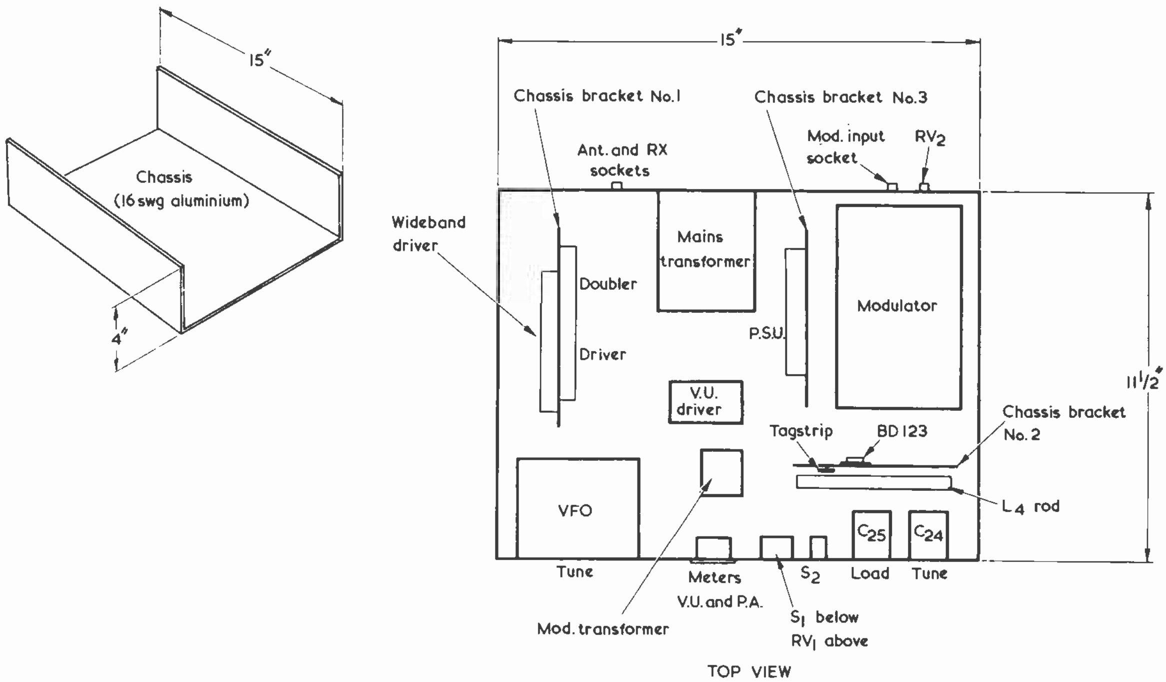


Fig. 22. Detail of the main chassis and the manner in which the circuit modules and controls are positioned

COMPLETE ASSEMBLY

The layout of the modules in the final assembly is shown in Fig. 22. Detailed dimensions on positioning have not been given since (thinking particularly of front panel controls) component sizes may vary, and the final positions are left to the constructor to decide.

All chassis members should be made from 16 s.w.g. aluminium. Do not use a thinner gauge or the resulting construction will not be rigid enough.

Chassis work has been simplified as much as possible and only two bends are required on the main chassis to give a base measuring 15 by $11\frac{1}{2}$ins. and a front and rear measuring 15 by 4ins.

A brushed aluminium finish may be achieved by thoroughly glasspapering the chassis (use a fine grade paper and keep strokes along one direction) and then washing and scrubbing with scouring powder.

The three Chassis Brackets, Nos. 1, 2 and 3 have already been mentioned. Each of these measures 6 by 3ins. with a $\frac{1}{2}$in. mounting flange. Also previously mentioned is the 7 by 4in. flat heat sink plate for the modulator.

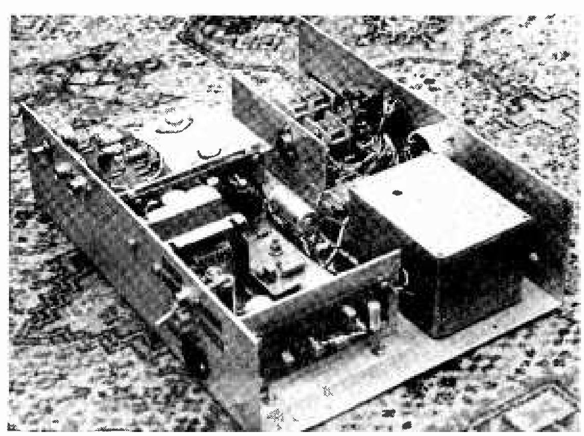
The top cover for the chassis is constructed from $\frac{1}{4}$in. plywood with two $\frac{1}{2}$ by $\frac{1}{2}$in. hardwood battens to reinforce the corner joints. Two further battens of the same size accept wood screws passing through holes in the transmitter base and allow the chassis and cover to be secured together.

The completed cover may be sapele or teak veneered, then varnished to give a very handsome appearance indeed. Details of the cabinet cover are given in Fig.23.

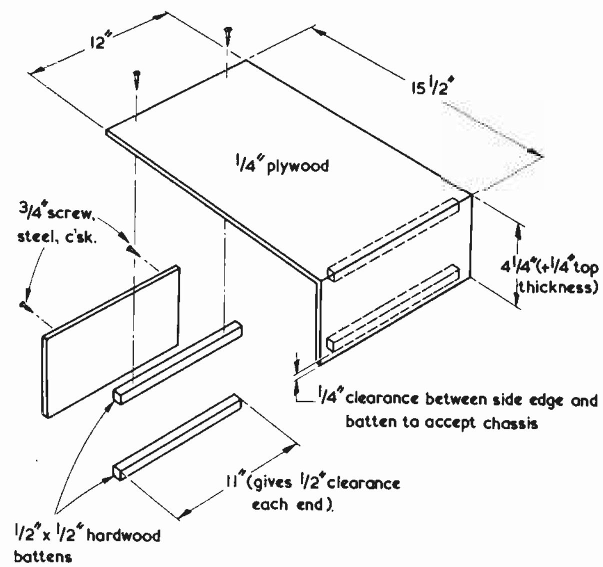
BUILDING AND TESTING

Constructional details and information on circuit operation have already been given. It is worth stating at this stage that it is a good procedure to build and then test each module as it is completed, otherwise you may find yourself with a complete, but defunct, transmitter, and are then faced with a lot of time-consuming fault-finding work.

Build the power supply first, since it is one of the simplest sections and is, in any case, needed to run the other stages.



The clean and uncluttered layout of the transmitter is readily demonstrated by this photograph



Sides (2) - 12" x 4 1/4"
Top (1) - 15 1/2" x 12" (overlaps sides)
Battens (4) - 11" x 1/2" x 1/2"
Construction: Glueing and screwing

Veneering
Sapele or teak veneer glued to top and sides using Evo-stick or Bostik contact adhesive, sanded and varnished

Fig. 23. The cabinet for the transmitter is made up in the manner illustrated here

From then on, build and test the v.f.o., the wideband driver, the doubler and driver, the p.a. stage, the modulator (which could first be tested with a 3 to 8Ω speaker) and finally the VU meter driver. Mount each section on the main chassis only after it has been checked (with the possible exception of the p.a. stage) and the tedious process of continually dismantling and re-assembling will then be avoided.

Finally, it is possible to make this design work with a minimum of fuss, and most constructors who understand the basic principles of transistor operation and have had a little experience should succeed.

It is also, of course, a great advantage if a prospective constructor has already successfully built a valve transmitter, since this will have given invaluable experience of lining up and adjusting r.f. stages, possibly with only a receiver, a testmeter and a grid-dip oscillator as test equipment. On that note, it is relevant to point out that the author's transmitter was developed, built and tested without the use of an oscilloscope. ■

THE 'WYVERN' TRANSMITTER

In the Components List for the 'Wyvern' Transmitter, Part 1, published in the last November issue, C2 was quoted as 390pF and C3 as 200pF. These values can take the v.f.o. tuned circuit out of the specified range and constructors are advised to use, instead, 200pF for C2 and 150pF for C3.

Party Line for Computers

THE BRITISH POST OFFICE IS TO CARRY OUT AN important experiment which could be the first step in setting up a public network linking the country's computers, so that they can communicate with one another as easily as *people* do through the telephone system. A BBC Science and Industry programme reported on the experiment.

Already, streams of words and figures – translated into a peculiar warbling sound – flow between machines over the public telephone network. Some computer users go one step further and lease private cables from the Post Office, which they can use at any time. This is how the banks, for example, handle their endless streams of figures.

But, the Post Office regards both of these as temporary solutions. Public telephone lines are not really suitable for carrying computer data, and special private lines can link each point only to a few others.

As banks, airlines, government agencies, local authorities and others acquire computers, the Post Office expects a demand to develop for a public computer network which can link any point in the network with any other.

The first experimental network will have three exchanges, probably in London, Manchester and Glasgow.

It will not be like the telephone network, where once you have dialled the appropriate code and been connected you can say what you like for as long as you like. Instead, messages will be sent in short 'packets', rather like telegrams, each headed with the address of its destination.

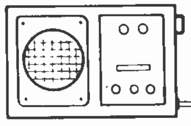
Packets travelling between say, London and Glasgow will be a mixture of scraps of many different messages, all to be sorted out and sent to their correct destinations by the equipment at the other end.

This system means that long-distance lines can be used at near their maximum capacity. Money will be saved since fewer lines will be needed to carry the same amount of traffic. But the electronic equipment for sorting the packets will be expensive.

So the main purpose of the experiment will be to find out whether the system brings tangible benefits in cost. If it does not, the Post Office will probably go ahead and build a simpler system, more like the existing phone system.

But, either way, the machines which were once completely isolated, and at present can talk to each other with difficulty, will within five or ten years be able to ring each other up – provided their human operators tell them to – and exchange data at rates to match their phenomenal speed of calculation. ■

In your work-shop



This month we encounter Smithy the Serviceman, together with a somewhat dejected Dick, embarking on the New Year with a few simple transistor radio faults. Smithy demonstrates routine servicing approaches whilst Dick carries out a repair which does not give quite the predicted results.

"HAPPY NEW YEAR, SMITHY!"

A somewhat bleary-eyed Smithy turned to face his assistant as the latter proceeded to hang up his mackintosh on the hook behind the door.

"And a Happy New Year to you too, Dick," he replied. "Blimey, you're early this morning aren't you? On most New Year's Days you don't totter in until it's nearly lunch-break."

Smithy examined his assistant more closely.

"What's more," he went, on "you look as fresh as though you'd never celebrated New Year's Eve at all."

"I didn't," stated Dick morosely. "Or at least I only managed to start celebrating it from about quarter to twelve onwards."

"What happened?"

"I don't really wish," said Dick unhappily, "to be reminded about last night for the moment. One result of the evening is that I've brought in a radio set for repair."

Dick reached inside a brown paper bag he had brought into the Workshop, and produced a small medium and long wave transistor set.

FAULTY RADIO

"What's wrong with it?" asked Smithy.

"It doesn't give any output at all," replied Dick. "In fact, it's as dead as a door-nail."

"Humph," grunted Smithy. "Well, things are pretty quiet for the time being now that Christmas is over, so it would do no harm if we had a look at that set right now. Have you done any work on it yourself?"

"I haven't even opened the back," confessed Dick. "So far as I know it might not even have a battery in it."

Smithy walked over to the set, picked it up and returned with it to his bench. He turned the volume control experimentally, and a mechanical click indicated that the set was now switched on. Smithy turned the control fully clockwise, but there was no sound from the loudspeaker. He changed over the wavechange switch, but the loudspeaker did not reproduce the crackles which would normally have resulted from this operation. Adjustment of the tuning control similarly produced no signals.

"It certainly seems to be dead," pronounced Smithy. "Let's open up the back."

He removed the back to reveal a PP9 battery and the printed circuit board of the receiver, together with the volume control, the tuning capacitor and the ferrite aerial. He switched the set on again and, taking up his testmeter prods, checked the battery voltage. The meter indicated 7.5 volts.

"The battery voltage is a bit down," he announced to Dick, who was now standing beside him. "7.5 volts isn't so low that it should result in complete silence but there's no point in pressing on without a proper 9 volts on this set. Get me a new battery, will you, Dick?"

"Okeydoke," replied Dick obligingly, as he walked over to the spares cupboard. His disgruntled expression was slowly clearing now that he and Smithy were engaged in an actual servicing job.

Whilst Dick was at the spares cupboard Smithy carried out a quick routine test for obvious visible faults. This included checking all leads between the printed circuit board and external components, including in particular the leads to the ferrite rod aerial. Everything, however, appeared to be in order. Smithy next glanced at the transistor type numbers. The transistors were all p.n.p. types.

Dick returned, pulling the seal off a new PP9 battery which he then handed to Smithy. The Serviceman connected it to the receiver, switched the latter on again and checked the voltage given by the battery. It was 9.3 volts.

"Good," grunted Smithy. "Well we can start getting technical now!"

"What are you going to do next?"

"I'm going to make a simple isolation test," stated Smithy, "to see whether the snag is in the r.f. and i.f. stages of this receiver, or in the a.f. stages. The absence of background hiss makes it pretty certain that the snag is in the a.f. stages but I'll carry out a check of the r.f. and i.f. stages first just to confirm that they're working."

"The fault," Dick pointed out, "could simply be a lack of power to the set. Perhaps the on-off switch isn't closing properly."

"True," agreed Smithy, "and my check for r.f. and i.f. operation will also confirm whether the switch has closed correctly as well."

"How are you going to test the r.f. and i.f. stages?"

"By simply connecting my testmeter across the outer volume control tags," said Smithy. "This is a set using p.n.p. transistors and nearly all medium and long wave transistor radios of this type have the volume control acting as the diode detector load. Since it's usually very easy to get to the volume control tags, the check I'm going to do now is often worth carrying out as a matter of routine."

Smithy switched his testmeter to a low voltage range and applied the test prods to the volume control. The meter gave a small forward reading.

"The set's got power all right," said Smithy cheerfully. "That reading is the voltage that's dropped across the volume control due to the a.g.c. circuit in which the control appears. The top end of the volume control couples to the negative supply rail via the a.g.c. network which feeds the a.g.c. controlled transistor or transistors." (Fig. 1.)

Smithy carefully turned the tuning control of the receiver. The meter needle suddenly moved towards zero and continued backwards until it pressed against the left-hand end-stop.

"What caused that?" asked Dick, puzzled.

"I've tuned in a station," explained Smithy. "The diode detected the signal and passed a positive voltage to the top end of the volume control. This means that the r.f. and i.f. stages must be working, and that it's the a.f. stages that are at fault."

"Can you carry out that check with the more modern sets which use n.p.n. transistors?"

"Not so readily," replied Smithy. "You'll find that in those sets the diode load is more likely to be a fixed resistor with the volume control coupled to it by a capacitor."

"Then," said Dick, "there isn't

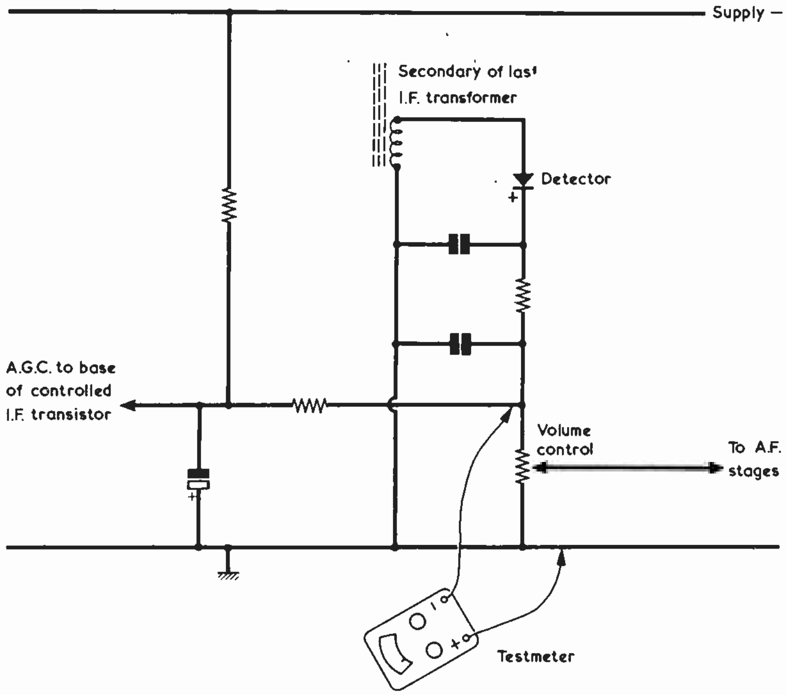


Fig. 1. Coupling a testmeter, switched to a low voltage range, to the volume control tags of an a.m. receiver employing p.n.p. transistors. The meter gives a forward reading which changes to a backward reading when a signal is tuned in. This detector and a.g.c. circuit, with representative component values, appears again in Fig. 3.

much you can do so far as carrying out checks at the volume control is concerned."

"Oh yes there is," replied Smithy. "Another useful test which you can carry out on all sets consists of setting the volume control just a little way from the zero volume position, switching your testmeter to a resistance range and touching its prods to the outside tags of the control. If the a.f. stages are all right, you should get a good loud crackle from the speaker as you apply the prods. The testmeter should be set to a fairly high resistance range for this check." (Fig.2.)

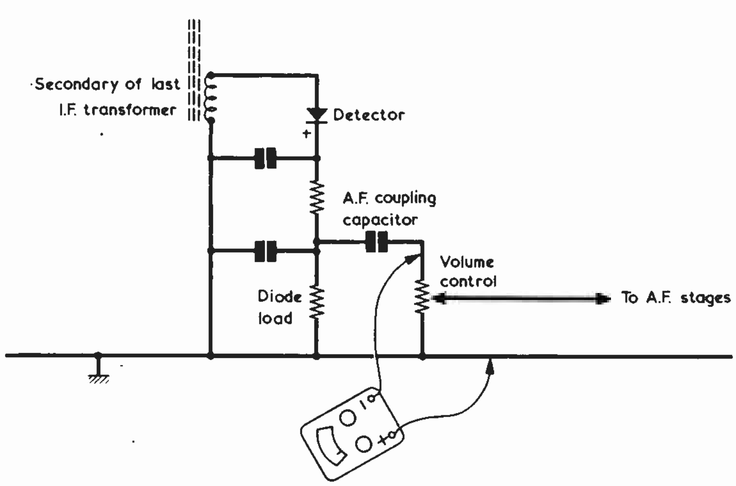


Fig. 2. The a.f. stages may be checked by coupling the testmeter, switched to a fairly high ohms range, across the volume control. A crackle should be heard from the speaker when the testmeter prods are applied. This test can be used when the volume control is the diode load, or when it is coupled to the load by a capacitor, as here

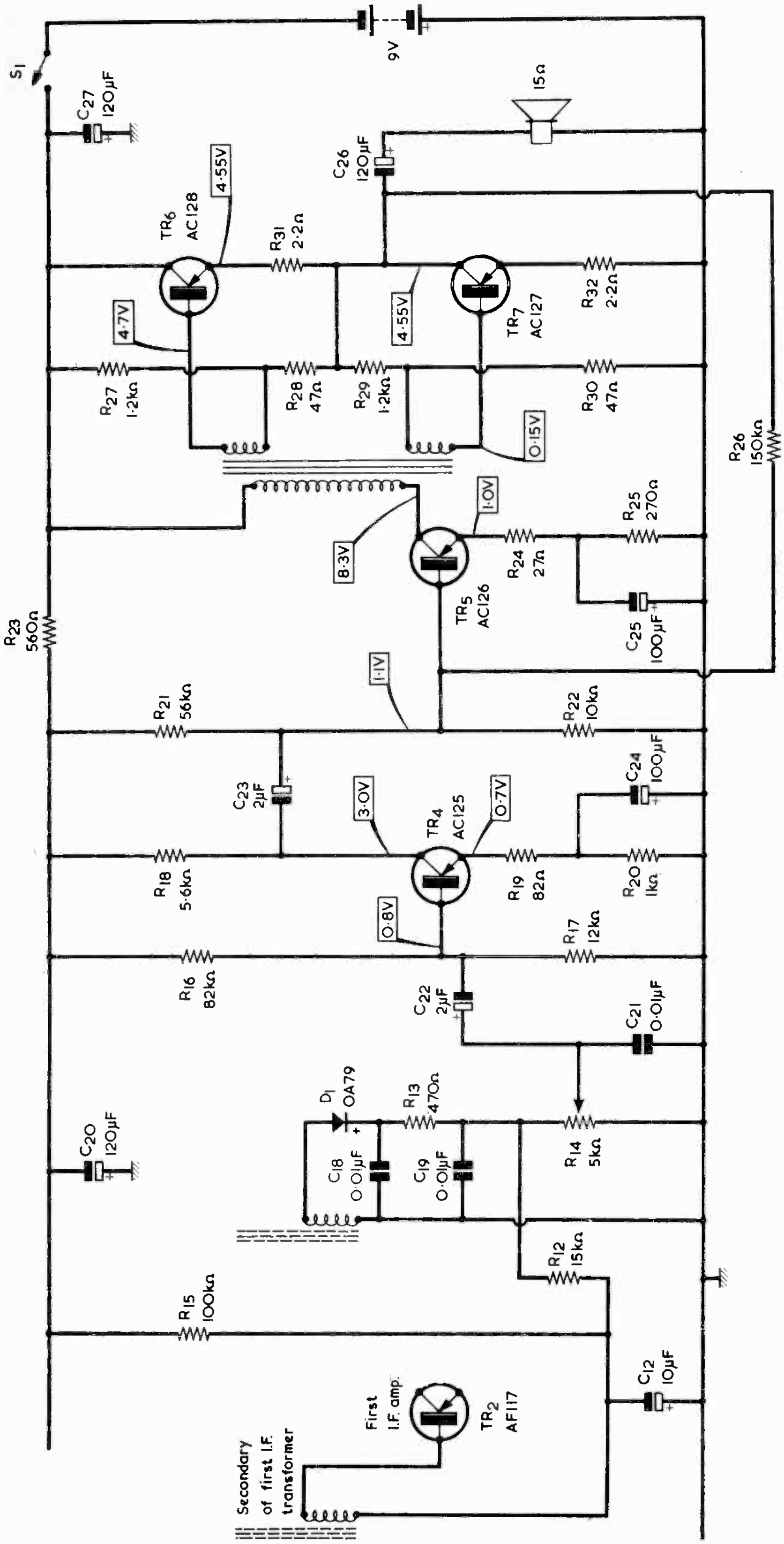


Fig. 3. The a.f. stages and a.g.c. circuit of the receiver serviced by Dick and Smithy

MOVING PROBLEMS

Dick grinned.

"Well, that's a good idea," he chuckled. "It looks as though I've already learned my first new hint for the New Year!"

"Blimey," said Smithy. "I'd forgotten already that this was New Year's Day. Tell me, Dick, what *did* happen to you last night?"

Dick's face fell as his memories of the night before once more rose up in his mind.

"It was my Aunt Effie," he stated disconsolately. "She pretty well nearly wrecked the whole night for me."

Smithy clicked his tongue in sympathy. Dick had more than his fair share of aunts.

"Aunt Effie, eh?" he repeated. "Is she the one who's eccentric?"

"All my aunts are eccentric," replied Dick bitterly, "but Aunt Effie's the kinkiest of the lot. Do you know, Smithy, she reckons that England is set for fire and damnation ever since girls started wearing mini-skirts."

"Why, that's preposterous," expostulated Smithy. "Mini-skirts are the best thing that ever happened in this country."

"Of course they are," agreed Dick. "But she's chock-full of nutty ideas like that. The snag is that all my family flannel up to her. I just can't think why."

"There may," remarked Smithy mysteriously, "be reasons."

"Anyway," said Dick, resolved now to expunge from his mind the miseries of the previous night, "what happened yesterday was that she asked me to help her move some things around in her house. For some weird reason, she wanted to swap over her bedroom and her sitting room. I'd already got the evening lined up and I was going to meet the crowd at Joe's Caff round about 9 o'clock, so I told her I'd call in at 7.30."

"That seems very reasonable."

"That's what I thought, too. But, flaming heck, I couldn't get away until half past eleven. When I did eventually join the gang the festivities were nearly over. What a New Year's Eve!"

Dick sank into an unhappy contemplation of his misfortunes.

"Never mind," said Smithy comfortingly. "We'll do a bit more work on this receiver, and you can forget about last night for the time being. Seeing that we've got to dig into the a.f. stages of this set we might as well get its service manual out next."

"All right then," said Dick listlessly. "I'll pop over and get it now."

He checked on the model number of the receiver, then wandered over to the service manual files. He soon returned with the service sheet required and he placed it on the bench. Smithy leaned over and examined the a.f. and a.g.c. section of the receiver circuit. (Fig.3.)

"You couldn't have anything much simpler than this," he remarked. "The

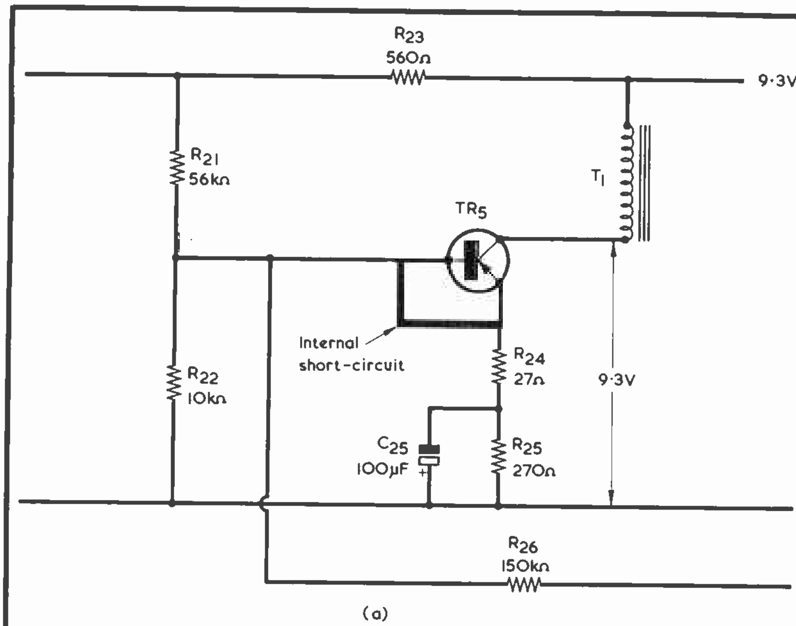
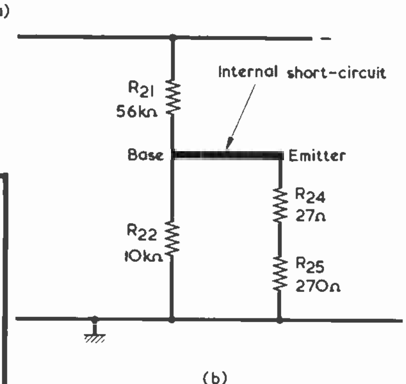


Fig. 4(a). One of the transistors in the receiver had an internal short-circuit (b). The effective resistive circuit resulting from the short-circuit



slider of the volume control couples to transistor TR4 which, in turn, couples to TR5. TR5 is the driver transistor and it drives the output pair, TR6 and TR7, by way of the transformer T1. Finally, there's negative feedback from the output back to the base of TR5 by way of R26."

"The circuit," commented Dick, "has got voltages marked on it as well."

"Yes," said Smithy, " and that's a very commendable practice, too. I'll start off by checking the emitter voltages of TR4 and TR5. If these voltages are about the same as those shown in the service manual they'll indicate that the transistors are passing just about the correct current."

Smithy clipped the positive test lead of his meter to chassis. He examined the printed circuit board for a few moments then applied his negative test prod to one of the transistor lead-outs.

"I've got my prod on the emitter of TR4," he called out. "What does the meter say?"

Dick peered at the testmeter.

"About 0.8 volts."

"That's near enough," said Smithy. "I'm trying the emitter of TR5 now. What's the voltage?"

"There isn't any," stated Dick. "Are you sure you've got the prod on?"

"Definite."

Dick looked more closely at the meter scale.

"Well," he said, "there's either no voltage or there's just the faintest suspicion of a voltage."

"Looks like we've located the stage with the snag in already," said Smithy. "I'm trying the base of the transistor now."

"You're getting the same again," said Dick. "There's just a tiny forward movement in the meter needle."

"Good show," said Smithy. "I'll check the collector next."

He moved his prod to the transistor collector lead-out.

"The needle's gone right over now," announced Dick. "It's giving a reading of 9.3 volts." (Fig.4(a).)

"Then we've found the fault," remarked Smithy. "A duffy transistor. Assuming no external short-circuit, the base and emitter of TR5 must have shorted out, with the result that R24 and R25 are effectively in parallel with R22. This means that both the base and emitter connect to the 9 volt rail via a 56kΩ resistor and to the positive rail via a resistance which is just a little less than 300Ω." (Fig.4(b).)

"Why was the collector voltage so high?"

"Because," replied Smithy, "there can't be any collector current. If the base and emitter are shorted together the transistor will be effectively cut off. That means it won't pass any collector current worth talking about, and there'll be no voltage dropped in the primary of the transformer the collector connects to. Transistors don't go wrong all that often but, when they do, they can produce some peculiar results. Right then, we now require a new driver transistor in this receiver, so perhaps you could oblige."

NEW TRANSISTOR

"All right," said Dick, as he took Smithy's place in front of the receiver. "I'll have to get the printed circuit out of the receiver cabinet if I'm going to fit that new transistor."

He examined the receiver then proceeded to unfasten the screws which held the printed circuit board in position. At the same time, Smithy went to the spares cupboard for a new transistor. As he came back, his thoughts returned to their previous conversation.

"Tell me," he asked chattily, "what exactly was involved in changing over those two rooms at your Aunt Effie's place?"

"First of all," said Dick, "there were the preliminaries to get over. These consisted of going through two albums full of photographs of herself as a young girl. Then she kept nattering on about how the wireless has never been the same since those nasty Goons took over from Flotsam and Jetsam and Christopher Stone. Who are they, Smithy?"

"Flotsam and Jetsam," replied Smithy, "were a pair of singers and Christopher Stone was a disc jockey."

"I mean the Goons."

Smithy shot a glance at his youthful assistant.

"I must be getting older than I thought," he sighed. "Anyway, what happened next?"

"She conned me into doing a whole lot of electrical repairs round the house. And, of course, she had no tools there at all. Have you ever, Smithy, experienced the sense of utter frustration which arises when you're trying to fit a new cord to an electric iron with nothing other than a pair of blunt scissors and a nail file?"

Dick must have intended his question to be of a rhetoric nature because, before the Serviceman had time to reply, he next laid down Smithy's soldering iron and announced that he had soldered in the new transistor.

"Right," said Smithy. "We'll try this set out then."

Dick fitted the printed circuit board temporarily in the receiver case and snapped its knobs back on the control spindles. He switched the receiver on, turned the volume to full and swung the tuning knob expectantly.

The receiver was silent.

Irritably, Dick switched to the other waveband, but there was not even a crackle as he operated the switch. Similarly, no station became audible at any point on the second waveband.

"Darn it," snorted Dick. "I fit a new transistor and the set still doesn't work."

"Now, don't get all aeriated about it," reproved Smithy. "Just check the voltages on that replacement transistor."

Dick took up Smithy's test prods and applied them to the lead-outs of the new transistor. This time the voltages were approximately equal to those indicated in the service manual.

"Fair enough," said Smithy. "Well, this isn't the first time we've encountered a set with more than one fault in it. See if the output transistors have the correct voltages on them, too."

Dick measured the voltages at the output transistors. Again all was apparently as it should be.

"Well now," said Smithy, stroking his chin reflectively, "if all the voltages in the a.f. stages are correct then we can be pretty certain that the resistive parts of the circuit are all right. That means the snag most probably lurks in a capacitive part of the circuit. Hang on a minute, I've just had an inspiration."

Smithy extended a finger and poked tentatively at the 2µF electrolytic capacitor which coupled the collector of TR4 to the base of TR5. There was a sudden crackle from the speaker. Smithy grinned and, retaining his pressure on the body of the capacitor, proceeded to turn the tuning control of the receiver. After some moments very loud and distorted music became audible from the speaker.

"This is much more like it," he announced, obviously pleased. "The positive side of that electrolytic connects to the copper of the printed circuit board quite close to the base lead-out of TR5. You must have disturbed the solder joint for the capacitor when you wired in the new transistor."

But Dick had already removed the knobs and was re-examining the rear of the circuit board.

"I'm afraid you're right, Smithy," he confessed ruefully. "When I soldered in the base lead for the new transistor I drained nearly all the solder away from the point where the electrolytic wire connects to the foil. There must have been a pretty poor joint there when the set was originally assembled at the factory, because the capacitor wire's just poking loosely through the hole now."

Dick carefully applied the iron to the offending joint and, after close examination, finally pronounced it to be satisfactory. Once again the printed board was repositioned in the cabinet. This time, when the receiver was switched on it was very much alive. Some stations were reproduced at comfortable volume but others produced an exceptionally high output and could only be reduced to an acceptable and distortion-free level by rotating the receiver for low signal pick-up on the ferrite rod aerial.

A.G.C. FAULT

"This set is still not right," grumbled Dick, as he switched off the receiver.

"True," said Smithy equably, "very true."

"It's too loud now," continued Dick irritably. "It's quite definitely overloading on the more powerful stations."

"I couldn't agree more," confirmed Smithy.

"Well, stap me," said Dick indignantly, "you don't seem to be very worried about it."

"I'm not."

"We've already," complained Dick, "found two faults on this set. Now we've got a third."

"Take it easy," admonished Smithy. "Just look at things from a logical viewpoint. We started off by finding a faulty transistor, which we replaced. In the process of replacing that transistor we accidentally created another fault, which we have successfully cleared. The receiver is now working, but in a manner which technical geysers like you and I know to be wrong. But a non-technical person who's not all that much with it might well consider that the present performance of the set is quite natural and would simply put up with it, merely rotating the set on very strong signals until they sounded right."

"Gosh, Smithy," exclaimed Dick. "Why, you're a genius, mate!"

"Am I?" queried Smithy, surprised. "I thought I was good, but I didn't know I was all that good."

"It's your diagnosis about the non-technical person who's not all that much with it," explained Dick. "That non-technical person is my Aunt Effie and you couldn't possibly find anyone who's more non-technical and less with it than she is. It's her set and she foisted it off onto me for repair just before I managed to escape from her house last night."

A spark of chivalry touched Smithy's heart.

"I do think," he remonstrated, "that you're being a bit ungallant towards your Aunt Effie. Surely she can't be as bad as you make out."

"Can't she just? Why, she puts ruffles on her piano legs."

"Dear me," remarked Smithy. "Is she a widow?"

"Not Aunt Effie. She's a strict spinster and has been all her life. 'Effie the Ineffable' our family call her."

"Well, she certainly does seem to be rather a peculiar person," conceded Smithy, baffled. "I think we'd better get back to that radio and get it finally fixed. Now, for goodness' sake think for a moment and then tell me what's the most probable cause of the present fault."

"Let me see now," said Dick ruminatively. "The set reproduces some stations much louder than others and it also overloads on them."

"Well?"

Dick's brow suddenly cleared.

"Why, of course," he exclaimed, "It's obvious! The a.g.c. isn't working."

"Hooray," commented Smithy drily. "And what's the component which will almost certainly cause the a.g.c. to fail to operate?"

Dick looked at the circuit diagram of the receiver a.f. and a.g.c. stages.

"We know," he remarked pensively, "that there *is* an a.g.c. voltage developed across the volume control, because one of the first things we did was to measure it. Also, emitter bias *must* be getting to the base of the controlled i.f. transistor because the set's reproducing signals. That means that R15 must be passing a reasonable current. Ah, I know!"

Feverishly, Dick set Smithy's testmeter to a resistance range, snatched up the test prods and applied them across R12. The testmeter needle hovered just above 100kΩ.

"This is it," he called out exultantly. "R12 has either gone high or it's gone completely open-circuit."

"An outstanding piece of circuit diagnosis," commented Smithy.

"Do you really think so?"

"Masterly."

"What was happening," explained Dick excitedly, "was that, with R12 being high value or open-circuit, only a very low proportion or none at all of the a.g.c. voltage was getting to the base of the controlled transistor."

"I would," remarked Smithy gravely, "never have believed it."

"I'll now," stated Dick, patently in charge of the situation, "wire in a new resistor."

PLUGS AND SOCKETS

And this the jubilant Dick proceeded to do, after which the receiver behaved with proper decorum, reproducing signals which were not too loud, not too soft, but just right.

"What I don't quite understand," remarked Smithy, as Dick triumphantly fitted the screws which secured the printed circuit board in position, "was how long you took, last night, in moving the actual *furniture* from your aunt's bedroom to her sitting room and from her sitting room to her bedroom."

"Oh," said Dick carelessly, "the furniture was no problem. Just a bed, a wardrobe, a writing desk, a couple of tables and things like that. I did the furniture bit in no time at all. The problem was that she has a whole forest of electric lamp standards, together with a TV, two electric fires, a bed-head lamp, two electric clocks, one of them with an alarm for the bedroom, and an electric blanket. All of these had to be changed over."

"Surely," protested Smithy, "there were no difficulties there?"

"In a place like my Aunt Effie's," replied Dick carefully, "things aren't quite what you encounter in a normal house. To start off with, there are plenty of sockets in both the rooms."

Dick drew a deep breath.

"However," he resumed, "all the sockets in what is now the sitting room are 10-amp round, whereas all the sockets in what is now her bedroom are 13-amp flat . . ." ■

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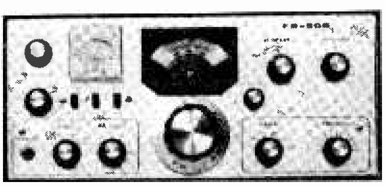

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COMPONENTS TO CLEAR: Woden Mic. transformer, M.T.101, £1.50. E.C.C. Miniature relay type 2,5A, £1.00. 8 in. speaker, 30p. Eddystone 5 pin coil formers, 10p. Metal rectifiers, type SETT 2 W.B., 30p. Capacitors: 5mfd 3000V d.c., 30p. 2mfd 1000V d.c., 20. 1mfd 1000V d.c., 15p. 4mfd 500V d.c., 10p. Box No. G196.

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SMALL ADVERTISEMENTS

(Continued from page 403)

FOR SALE: R1155B receiver with psu. Working order. £20, carriage extra. Miles, 17 Queen's Road, Blandford Forum, Dorset.

VALVES TO CLEAR: VR91, 171DDP, 801, U14, HP4106, 6B4–G, 6AG5. All at 20p each. Box No. G197.

WANTED: Early books on wireless, pre-1925. Details to Box No. G198.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept. – both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazines, etc., £2.00 per annum. (U.K. and British Commonwealth), overseas 6 Dollars or £2.50. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

FOR SALE: E.H.T. voltmeter £2. Electronic Ignition £6. Camera, new, £5. Copying machine £9. Chapman Radio Hi-Fi speaker, cost £50, offers? 4 Riversley Road, Gloucester, GL2 0QT.

AMATEUR RADIO. How to become an amateur. Full information available free from The Irish Amateur Radio Society, P.O.B. 73, Athlone, Ireland.

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

VISCONOL CATHODRAY CONDENSERS 0.0025 mfd. 2.5kV 30p each, 0.002 mfd 15kV 60p, 0.02 mfd 12.5kV 65p, 0.025 mfd 5kV 40p, 0.1 mfd 6kV, 0.5 mfd 2.5 kV, 1 mfd 2kV, £1 each. CAPACITORS 0.1 mfd 150 volt £1 per 100, 44,000 available. MORSE KEYS precision type 50p each. STROBOSCOPE FORKS 124 cycles 80p each. JACK PLUGS 2 point screw on cover 15p each. Send for Lists. L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, Croydon, Surrey.

TRANSISTORS TESTED. All transistors no matter what type tested to full SPEC. Any type. Specification given in full, shown on typewritten sheet. Sent by express post for same day service if required. I.C.'s rudimentarily tested. Cost to you: 3 for 2p. Singles 1½p each. 5 for 4p. Quantities at 25 for 22p. 30 for 24p. Harrington, 25 Poynter Road, Enfield, Middlesex.

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

FOR SALE: Back numbers of *The Radio Constructor*, Volumes one to twenty-four, also *Popular Electronics* from October 1969 to December 1971. Offers please. Box No. G205.

Q MULTIPLIER COILS. High efficiency pot core assemblies for use in the range 50kHz – 2MHz. Other frequencies to order. 50p. each plus 5p. p. & p. State frequency required and whether p.c. or single hole mounting. Overseas enquiries invited. Storey, 145 The Knares, Basildon, Essex.

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SMALL ADVERTISEMENTS

(Continued from page 405)

THE BRITISH AMATEUR ELECTRONICS CLUB. A club for all who are interested in electronics as a hobby. Quarterly Newsletter sent free to members. Subscription 50p per year. Details from Hon. Secretary, J. G. Margetts, 17 St. Francis Close, Abergavenny, Mon.

MECCANO FOR "CYCLOPS" – Special Pack of all Meccano parts required – £3.39 including postage. Send off today to *The* Meccano Spare Parts Specialists and start building! "Everything Meccano" at M. W. MODELS, 165 Reading Road, Henley-on-Thames, Oxon. Telephone 3342.

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

FOR SALE: Cossor 1035 double beam oscilloscope ext. & int. trigger or synch. £21. Telephone: 01-444 8216 evenings.

POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrapping, facsimile letters, automatic typing, copy service, campaign planning, design and artwork, printing and stationery. Please ask for price list. – The Holborn Direct Mail Company, Capacity House, 2–6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407 1495.

FOR SALE: Cossor sine/square wave generator. Offers? Gallop, 58 Burleigh Road, Hertford, Herts. Telephone: 7093.

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WANTED: *Wireless World* issues wanted July 1971 to April 1972 inclusive, together with June 1972. Also *Radio Constructor* Volume 16. J. R. Ault, 23 Newton Street, West Bromwich, Staffs.

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COIL DATA III

The Table gives calculated inductance values, in microhenrys, of single-layer air-cored coils having diameters of $\frac{3}{4}$ and $\frac{7}{8}$ in. and lengths (l) as shown. Thus, a 25-turn coil of diameter $\frac{3}{4}$ in. and length $1\frac{1}{4}$ in. has a calculated inductance of 5.4μH.

	Dia. $\frac{3}{4}$ in.				Dia. $\frac{7}{8}$ in.			
Turns	l = $\frac{1}{2}$ in.	l = $\frac{3}{4}$ in.	l = 1 in.	l = $1\frac{1}{4}$ in.	l = $\frac{1}{2}$ in.	l = $\frac{3}{4}$ in.	l = 1 in.	l = $1\frac{1}{4}$ in.
4	0.27	0.21	0.17	0.14	0.34	0.31	0.22	0.19
6	0.61	0.47	0.38	0.32	0.77	0.69	0.49	0.42
8	1.1	0.83	0.67	0.57	1.4	1.2	0.86	0.75
10	1.7	1.3	1.1	0.88	2.1	1.9	1.4	1.2
12	2.4	1.9	1.5	1.3	3.1	2.8	1.9	1.7
14	3.3	2.5	2.1	1.7	4.2	3.8	2.7	2.3
16	4.3	3.3	2.7	2.3	5.5	4.9	3.5	3.0
18	5.4	4.2	3.4	2.9	6.9	6.2	4.4	3.8
20	6.7	5.2	4.2	3.5	8.5	7.7	5.5	4.7
25	10.0	8.1	6.6	5.4	13.0	12.0	8.5	7.3
30	15.0	11.0	9.5	8.0	19.0	17.0	12.0	11.0
35	21.0	16.0	13.0	11.0	26.0	24.0	17.0	14.0
40	27.0	21.0	17.0	14.0	34.0	31.0	22.0	19.0
50	42.0	32.0	26.0	22.0	54.0	48.0	34.0	29.0